Appendix E:
Tailings Properties

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E1. Introduction

The tailings retained within the NTSF are predominantly silt-sized soils which were discharged as a slurry that subsequently consolidated. These tailings have accumulated with flat beach slopes such that the tailings are near horizontally bedded.

The CPTu investigations of the tailings undertaken in 2017 remain relevant and have not been duplicated by the ITRB; rather, the original data has been retrieved, and then evaluated. The earlier 2013 CPTu data has been assessed at a high level as it reflects conditions five or more years ago.

Appendix C documents the insitu testing and sampling of tailings, undertaken on behalf of the ITRB in 2018, together with previous investigations completed in 2013 and 2017.

In terms of property measurement, the ITRB has undertaken substantial laboratory testing as, comparatively, the earlier campaigns carried out little work on this aspect.

This appendix presents the following work:

- Documentation of the laboratory testing, followed by detailed analysis of that data to determine the tailings properties. These properties have been used to simulate the laboratory tests (using the same NorSand model as the deformation analysis) to confirm that the derived properties are consistent with the tailings stress-strain behaviour.
- A detailed evaluation ("interpretation") of the CPTu data using the measured properties of the NTSF tailings. This work leads to the insitu state parameter that controls soil behaviour (and liquefaction in particular).

Both the calibrated parameters and the insitu state parameter have been carried forward into the numerical analyses documented in Appendix H.

E2. ITRB Laboratory Testing

E2.1 Overview

The ITRB's investigations and subsequent testing focused on determining the properties and other aspects of;

- the insitu tailings that remained within the impoundment near the slump, and
- the tailings from the slump run-out where the properties may have changed during the slump due to considerable dynamic mixing, as apparent on the video records.

In order to fast track critical state testing of the tailings, two bulk samples were collected from the tailings runout on the slump. Sample HA401; a low plasticity, clayey silt, was considered to represent the bulk of the tailings that had liquefied, while sample, HA402, possibly representing the coarsest phase of the tailings, was taken by carefully scraping the surface of a number of randomly selected sand boils.

The insitu tailings in the vicinity of the slump provide an insight on the condition of the tailings relevant to how the slump initiated.

Within the constraints of the post-failure exclusion zone, bulk samples of insitu tailings and nominally undisturbed piston samples were taken from drillholes located as close as practicable to the slump. Table E2-1 provides details of the materials comprising the bulk samples collected from Lexan tubes. Three samples were collected in June 2018, while a further two were collected from stored Lexans in December 2018.

Table E2-1: Bulk sample details of insitu tailings

Sample	Sample Date	Visual Description	Investigation ID	Depth (m)
TC1	June 19-23, 2018	Clayey SILT	CE407	21.0 – 22.5 30.0 – 31.5
TC2	December 17, 2018	Clayey SILT	CE413	15.0 – 16.5
TC3	December 17, 2018	Clayey SILT	CE413	27.0 -28.5
TS1	June 19-26, 2018	Sandy SILT, trace clay	CE407	27.9 – 28.3
			CE408	14.6 – 15.0 15.6 – 15.8 17.7 – 18.0 22.1 – 22.5 29.7 – 30.0
TS2	June 24-26, 2018	Sandy SILT trace clay	CE408	21.0 – 22.5

Initial testing was focused on determining the critical state locus with further testing to evaluate resistance to cyclic loading (earthquake or similar) and evaluation of the stress path indicated by numerical analyses.

Initial testing was carried out on bulk samples, with four samples being tested at Golder Associates (Golder) Perth laboratory. The focus of the critical state and associated advanced laboratory testing has been on the following samples:

- HA401 Slumped Clayey SILT (predominant run-out tailings)
- HA402 Slumped Sandy SILT (sandier run-out tailings)
- TC1 'Insitu' Clayey SILT (predominant insitu tailings)
- TS2 'Insitu' Sandy Clayey SILT (sandier insitu tailings)

Four bulk samples (HA401, HA402, TC1 and TS2) were shipped to Golder's Perth laboratory by air freight, while the remaining bulk sample (TS1), piston samples and disturbed samples were shipped to Trilab's Brisbane laboratory.

Subsequently, sample HA401 was split and sent to Trilab, sample TS1 was sent to Golder's Perth laboratory and sample TC2 was shipped to KCB's Vancouver laboratory.

The following tests were undertaken to characterise the tailings:

- Atterberg Limits
- Particle size distribution by hydrometer
- Particle size distribution by X-Ray sedimentation
- Specific gravity
- X-Ray Diffraction (XRD) – semi quantitative
- Scanning Electron Microscopy (SEM)

The following 'advanced' laboratory tests were undertaken on the tailings:

- Isotropically consolidated undrained (CIU) triaxial;
- Isotropically consolidated drained (CID) triaxial;
- Anisotropically consolidated constant shear drained (CSD) triaxial;
- Cyclic direct simple shear test (CDSS);
- Bender element test;
- Oedometer consolidation; and
- Stress path triaxial testing.

E2.2 Advanced Laboratory Test Methods

E2.2.1 Critical State Testing

The Critical State Locus (CSL) was determined by undertaking a number of CID and CIU tests on samples that had been reconstituted to a range of densities. This testing provides a reference data set and is generally not at, nor intended to be at, the insitu density of the tailings. The testing was generally undertaken in accordance with the procedures detailed in Appendix B of the *Soil Liquefaction, 2nd edition* (Jefferies & Been, 2016).

Key aspects of the testing are:

- Sample preparation involving the following steps 1) Drying in low temperature oven (50°C), 2) breaking down of aggregations, 3) thoroughly mixing, 4) sub-sampling, 5) reconstituting to a moisture content of ~10% using TSF decant water supplied by CVO and 6) curing.

- Compaction of sample into a split mould (mounted on the triaxial pedestal) to a specified density by moist tamping in eight layers, using vibration where high densities are required. Golder used 63 mm diameter specimens while TriLabs testing was undertaken on 75 mm diameter specimens.
- Accurate measurement of changes in cell volume and pore fluid.
- Computer controlled loading and data acquisition to achieve approximately 4000 readings by 20 % strain. A much higher rate of sampling was used by Golders, with the data subsequently filtered to reduce file size.
- Void ratio and moisture content determined by lightly freezing the assembled sample (including pedestal) before dis-assembly.

Constant shear drained (CSD) triaxial tests were also undertaken to support the CSL testing and assess the strength of the tailings under conditions of reducing lateral confinement, a condition that potentially existed when the tailings embankment began to move.

CSD triaxial tests were prepared in a similar manner to the CIU and CID samples for CSL testing. CSD tests were anisotropically consolidated to a specified value of K_0, followed by a reduction in the mean effective stress. Servo controlled loading was used during the CSD testing.

Table E2-2 summarises the type, density and consolidation pressure of the principal CSL tests.

Table E2-2: CSL tests completed showing consolidation stress

Test	Density (1)	Test Type	Consolidation Stress					
			HA401		HA402 18004	TC1 18018	TS1 18028	TS2 18017
			Golder 18003	TriLab				
1	VL	CIU	50	50	50	100		100
2	L	CIU	100	100/250	100	200	100	200
3	L	CIU	500	500	500	800	500	800
4	L	CID	300	300	100 (D)	400	300	400
5	L	CID	800		300 (D)	1200		1200
6	D	CID	50		800	100		100
7	D	CID	100			200		200
8	D	CID	800		500 (L)	1000		1000
9	D	CID	1300					
10	L	CSD (3)	200 (2)					200 (2)

Notes:

(1) Except where noted on individual samples; VL= very loose, L = loose, D=dense.

(2) Mean effective stress.

E2.2.2 Cyclic Direct Simple Shear (CDSS)

The ability of the tailings to withstand earthquake induced ground motions was tested using cyclic direct simple shear (CDSS) tests. The CDSS is a plain strain test that is analogous to the vertical propagation of earthquake motion through the tailings. This type of testing is the *de facto* current standard, at least for silts.

The tests were all carried out on reconstituted samples, using modern GDS equipment, and a 'large' sample size of 100 mm diameter. Tests were mostly carried out on TC1 material; with one test completed on TS1.

The upper, loose tailings will be the most vulnerable to earthquake ground motion because of the amplification of that motion as it propagates upwards from the underlying bedrock. Consequently, sample preparation was as loose as possible within the constraint of DSS preparation. After consolidation to the test stress level these samples were found to be loose to somewhat looser than the insitu tailings.

Tailings close to the upstream construction may behave differently (and likely, stronger) than the tailings further away from the point of tailings discharge. A static bias (the ratio of horizontal shear stress to initial vertical effective stress) is applied to the specimen to replicate these conditions while an absence of static bias replicates conditions away from the upstream raise.

Cyclic loading is specified as the cyclic stress ratio (CSR) which is the ratio of cyclic shear stress to the initial vertical effective stress. Relatively low values of CSR, between 0.05 and 0.10, were adopted to replicate the expected low magnitude of ground motion (even with amplification).

The majority of tests were completed using a sinusoidal cyclic loading, however two tests were undertaken that closely replicated the two seismic events recorded on March 8, 2018, albeit with a much reduced separation between the two events.

E2.2.3 Bender Element Tests (BE)

The small strain shear modulus was investigated in the laboratory via the measurement of shear wave velocity. With this test miniature transducers ("bender elements") embedded in the platens at either end of a triaxial test specimen were used to measure the shear wave travel time, with shear waves being identified by polarity reversal. A single sample, TC1, was consolidated anisotropically (K_0 = 0.6) in steps, with shear wave velocity being measure at each step.

E2.2.4 Oedometer Consolidation Tests (OED)

Four oedometer consolidation tests were completed on 75 mm diameter piston samples in accordance with AS1289.6.6.1. Specimens were loaded in increments to 3200 kPa, with one unloading / reloading cycle between 400 kPa and 100 kPa.

E2.2.5 Stress Path Triaxial Testing

The stresses developed in the tailings during the construction of the various embankment stages and Stage 1 Buttress was extracted from the FLAC 2D analyses at various critical points.

Stress path triaxial tests were completed by preparing the samples in a loose state followed by anisotropic consolidation. The samples were then loaded to replicate the loading path at a particular point within the tailings. As the loading path can influence how the soil responds once the stress state exceeds the soil's instability locus, a number of tests were undertaken to test various loading scenarios.

Six stress path tests were completed in Golder's Perth laboratory and three in KCB's Vancouver laboratory.

E2.3 Test Results

The results of laboratory test undertaken as part of the 2018 ITRB investigations are provided in the annexures to this Appendix, whilst summaries of the test results are provided in the following sections.

E3. Tailings Characteristics

E3.1 Overview

Tailings stratigraphy and condition can be initially assessed (at a “screening” level) by processing CPTu data using standard methods. This section describes that work, giving a context for the detailed testing that then follows.

E3.2 Stratigraphy

The CPTu measurements at CPT–N04 (2017-010) are shown on Figure E3-1, together with the standard normalised responses of friction ratio (F) and excess pore pressure (B_q). The left-hand plot on this figure shows the tip resistance, with the ‘spikes’ on the plot being caused by sand layers within the overall tailings; the induced excess pore pressure drops at the same time because sand is ‘free draining’. The friction ratio is less in sand than in silts, but this is a less sensitive indicator.

The CPTu measurements can be combined to derive a ‘normalised soil behaviour type’ or SBTn (Roberston, 1990). In the case of 2017-N04, the SBTn indicates a profile that is predominantly clays above RL 727, clays with intermittent 0.1 to 0.2 m thick sandy lenses between RL727 and RL697 with the lower 14 m of the profile reverting to silty clay. A thicker layer of interbedded sandy mixtures and clays is present from RL 723 to 727 m.

The investigations carried out for the ITRB indicate that the tailings are predominantly silt, not clay; an effect that arises with loose silts which show large excess pore pressure when sheared (eg Bq~0.5-0.6) and which the standard CPTu evaluation methods then indicate as ‘soft clay’.

Laboratory index tests in conjunction with the CPTu data, suggests an appropriate stratigraphic characterisation of the tailings should be based on the relative proportions of sand layers within the overall silt-dominated profile. Figure E3-1, shows the three strata, A, B, and C, adopted using this characterisation.

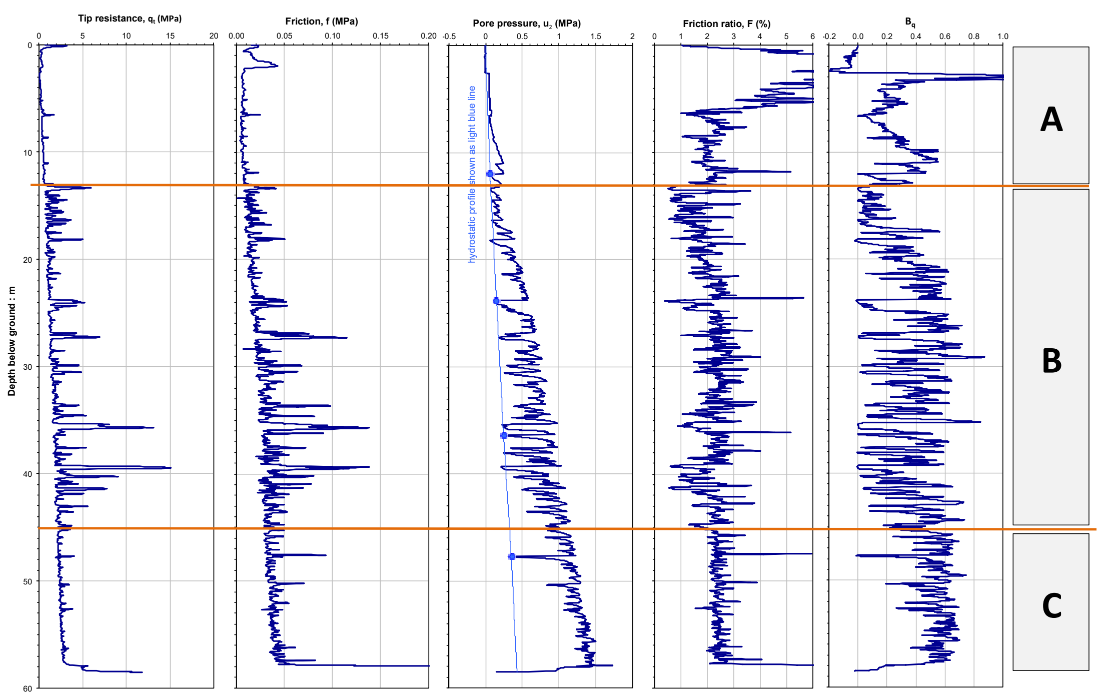


Figure E3-1: CPT N04 showing measured and derived parameters

E3.3 Soil Condition

The CPTu data is readily processed one step further to indicate how dense or loose the tailings are. There are two standard charts for this, which are presented for CPTu 2017-N04 on Figure E3-2 and Figure E3-3. In each case, the CPT data has been averaged into representative depth increments and annotated as to the A, B and C strata just discussed.

The plot on Figure E3-2 is based on Shuttle & Cunning (2008) and uses the state parameter (Ψ) approach. The plot uses dimensionless penetration resistance (relying on Bq) versus Friction Ratio. The green line indicates the boundary between contractive (potential for flow slide) and dilatant (limited deformation) soil behaviour. As can be seen, all of the 2017–N04 profiles classifies as potentially contractive material with the C stratum being a little weaker than the overlying tailings.

The plot on Figure E3-3 is based on Robertson (2016) and is a plot of normalized tip resistance versus friction ratio. The 'S' shaped line on this graph similarly denotes the boundary between contractive and dilatant behaviour. The inference from this figure remains the same, with all of the 2017–N04 profile classifying as contractive.

Plots showing the tailings conditions at all CPTu locations is provided as Annexure EJ.

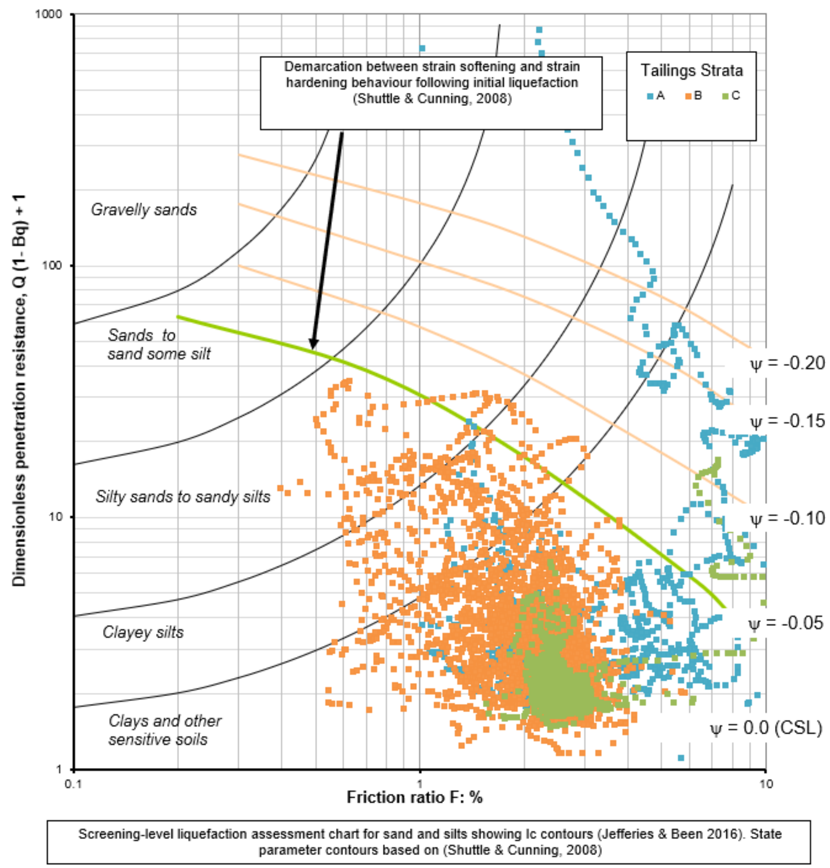


Figure E3-2: CPT-N04 – Shuttle and Cunning (2008) tailings state plot

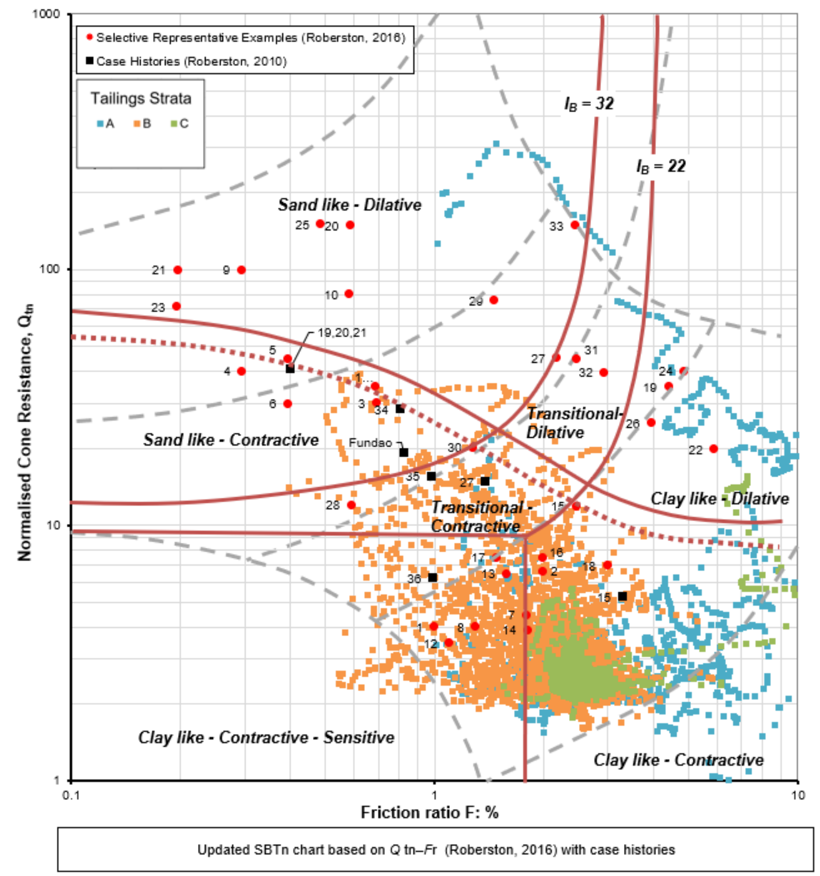


Figure E3-3: CPTu-N04 – Robertson (2016) tailings state plot

E3.4 Tailings Properties

E3.4.1 Atterberg Limits

Atterberg Limits were obtained for various insitu samples collected from drill holes CE407, CE408 and CE413 as well as for the bulk samples subjected to CSL triaxial testing. The plastic limit for HA402 could not be determined as this material is predominantly clean sand from a sand boil and is inherently non-plastic. Test certificates are provided in Annexure EB, while results are summarised in Figure E3-4.

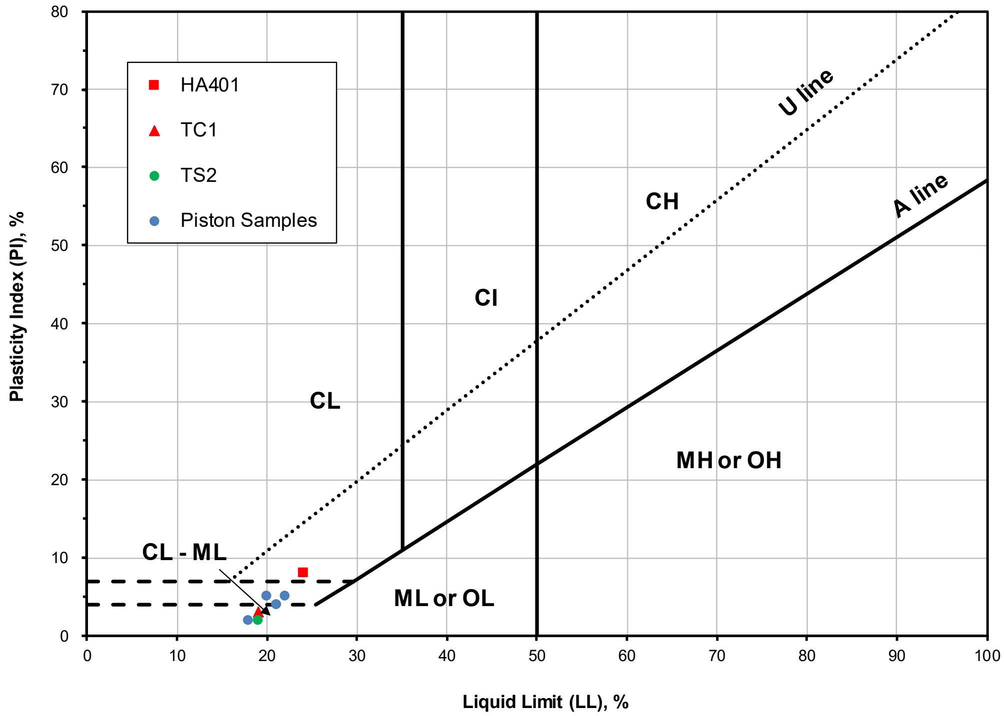


Figure E3-4: Plasticity chart for NTSF tailings samples

E3.4.2 Specific Gravity

The specific gravity determined on fifteen samples (using AS 1289.3.5.1) ranged between 2.55 and 2.77 with a mean value of 2.69. The specific gravity of triaxial test samples for critical state locus determination was completed in accordance with ASTM D5550 using helium pycnometry and AS 1289.3.5.1. These tests are compared in Table E3-1.

Table E3-1: Specific Gravity of tailings samples

Bulk Sample	Specific Gravity	
	AS 1289.3.5.1	ASTM D5550
HA 401	2.73	2.70
HA 402	2.63	2.66
TC1	2.74	2.71
TS2	2.69	2.70

E3.4.3 Particle Size Distribution

Particle Size Distributions (PSD) test certificates are provided in Annexure EB while the results for bulk samples are presented graphically in Figure E3-5, with HA401 and HA402 determined by X-Ray Sedimentation (shown as dashed lines) and a composite Concentrator 1 sample (Golders, 2016). PSD for all remaining tailings samples (excluding bulk samples) are presented graphically in Figure E3-6.

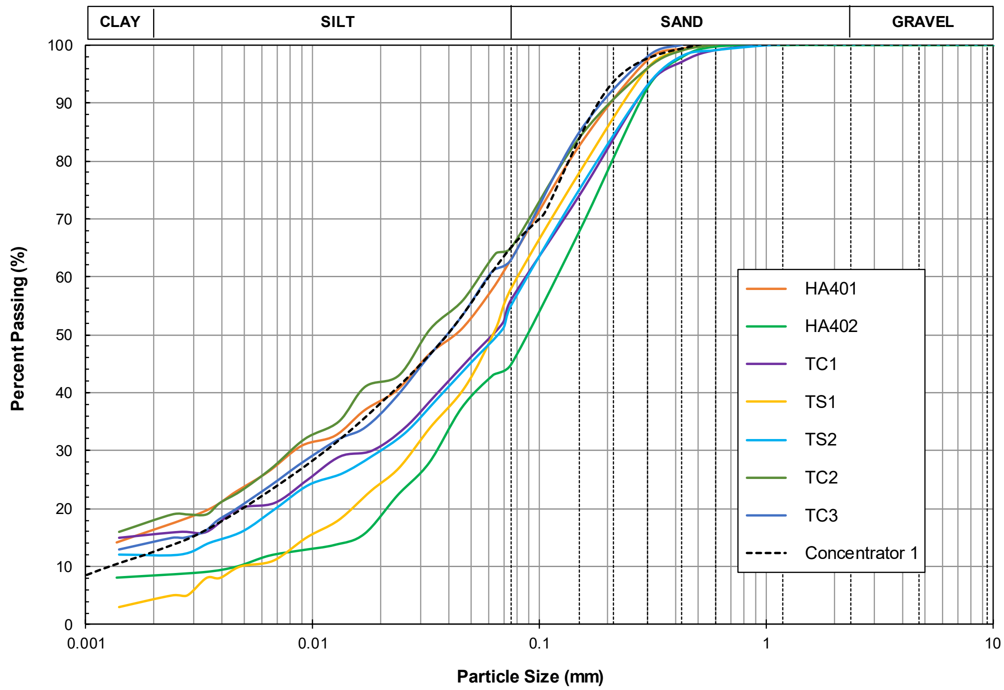


Figure E3-5: Particle size distributions for tailings triaxial samples

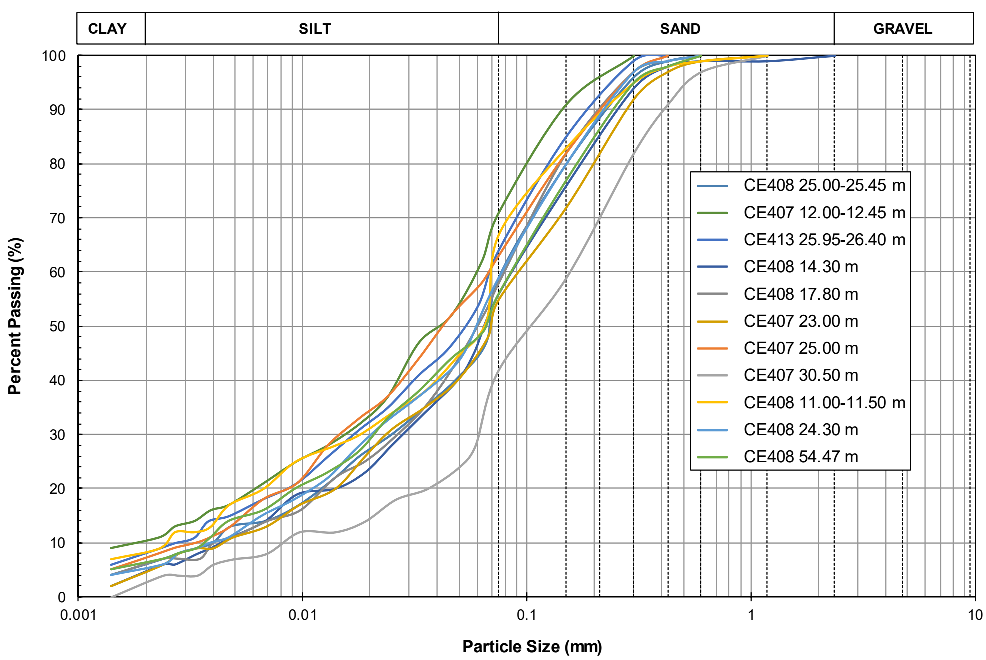


Figure E3-6: Particle size distributions for tailings samples

Key observations regarding Figure E3-5 and Figure E3-6 are:

- The dominant NTSF tailings classify as a low plasticity Sandy SILT according to AS1726-2017.
- X-Ray Sedimentation yield similar result to hydrometer analysis, with slightly lower clay content recorded using X-Ray Sedimentation.
- HA401 PSD is very similar to the Concentrator 1 (C1) sample tested by Golder's in 2016.
- TC1 and TS2 are very similar in grading, with TS2 containing slightly less clay than TC1.
- Although taken from a sand boil, HA402 is representative of some portions of the tailings profile; eg. CE407 30.5 m

E3.4.4 Mineralogy

Semi-quantitative X-Ray Diffraction (XRD) analysis was completed on samples HA401 and TC1 to determine the main mineral constituents of the NTSF tailings. XRD reports are included in Annexure EC. Representative sub-samples were removed and lightly ground such that 20% was passing 20 microns to eliminate preferred orientation. Analyses were completed by Microanalysis Australia by using cobalt radiation for the x-ray source, search match software Eva 4.3 and an up-to-date ICDD card set.

Mineral phases and concentrations for HA401 and TC1 are listed in Table E3-2. The NTSF tailings generally consists of four dominant mineral phases, i.e. Albite, Quartz, Clinochlore and Microcline. These results are consistent with an earlier mineralogical investigation of the Cadia Hill extended tailings samples (JKTech Job No. 3233,11/2003).

Table E3-2: NTSF Tailings XRD mineral phase concentrations

Mineral Phase	Concentration (%)	
	TC1	HA401
Albite	46	34
Quartz	19	21
Clinochlore	9	18
Microcline	14	15
Illite	2	4
Calcite	3	3
Amhipbole Group	4	2
Magnetite	3	1
Gypsum	1	Trace
Pyrite	Trace	Trace
Bohemite	-	Trace

E3.4.5 *Particle Shape*

Run out and insitu tailings were subject to scanning electron microscopy (SEM) tests undertaken by *Microanalysis Australia* using a Carl Zeiss EVO50 scanning electron microscope fitted with an Oxford INCA X-Max energy dispersive spectrometer (EDS).

Tests were undertaken on bulk samples HA401 and TC1 to qualitatively investigate particle characteristics on a microscopic level such as describing particle angularity.

Particles are angular to sub-angular, with some showing a characteristic rhomboid shape, as shown in the SEM images presented in Figure E3-7 and Figure E3-8. SEM reports are included in Annexure ED.

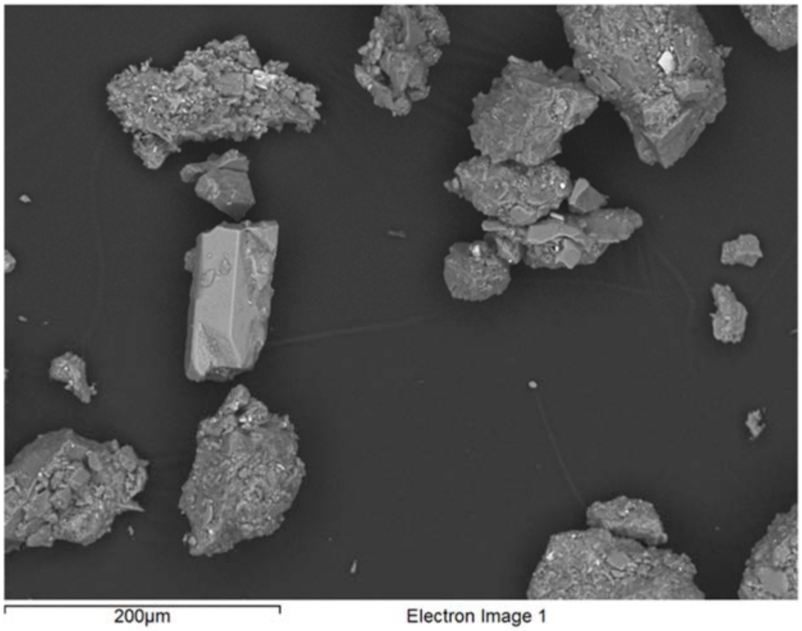


Figure E3-7: SEM image of NTSF insitu tailings from TC1

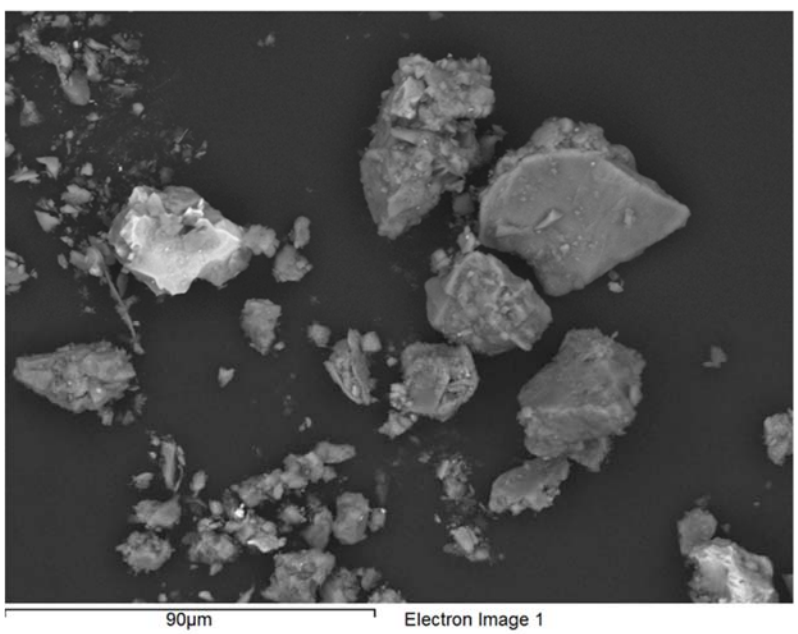


Figure E3-8: SEM image of NTSF run out tailing from HA401

E3.5 Tailings Properties for Monotonic Loading

E3.5.1 Small Strain Modulus

The shear wave velocity of the insitu tailings adjacent to CPT-N04 was measured, as part of the 2017 field campaign, using a seismic dilatometer (SDMT) and the "elasticity" or small strain shear modulus, G_{max}, was estimated using the following relationship:

$$G_{\max} = v_s{}^2(m/s) \times \rho_{bulk}(kg/m^3)$$

This insitu data for the small shear strain modulus is plotted against the mean effective stress at the test depth in Figure E3-9 as the blue points.

The small strain shear modulus was measured in the laboratory bender elements and this is also shown on Figure E3-9 as brown squares. Detailed results for the bender element tests are included in Annexure EL.

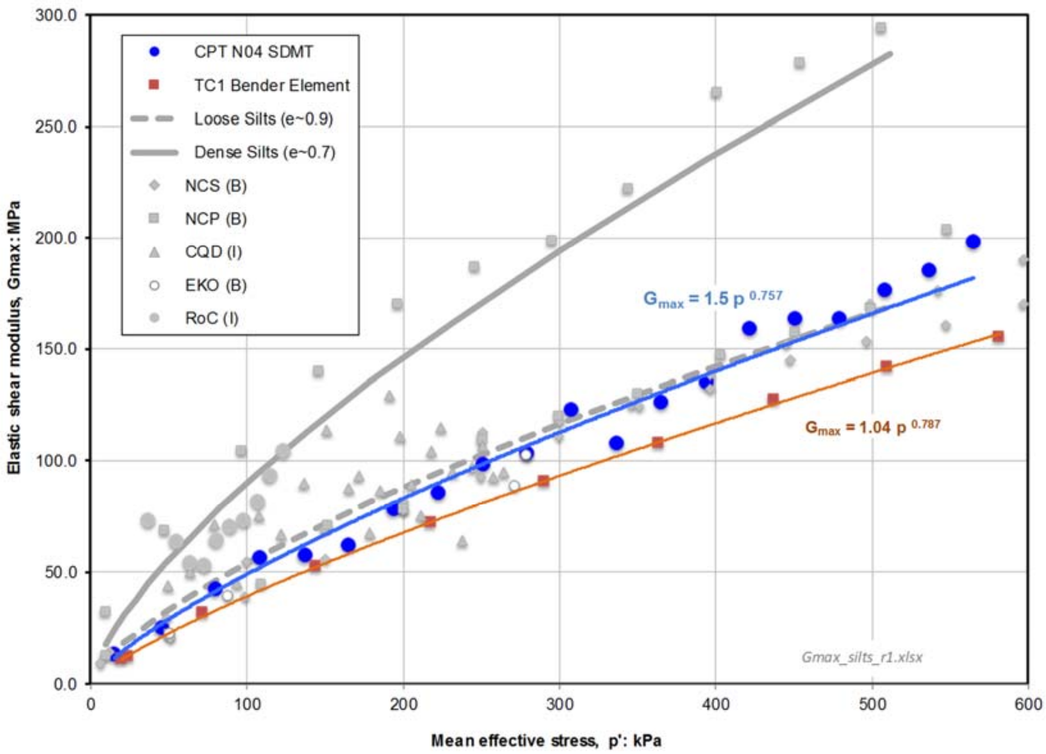


Figure E3-9: Elastic shear modulus (G_{max}) for NTSF tailings

The elasticity of the NTSF tailings determined by these two test methods is comparable, with the insitu data being slightly stiffer. The difference in behaviour may be a result of aging or alternatively, a difference in particle arrangement or fabric; ie. the insitu tailings were deposited hydraulically while the laboratory sample was loosely tamped.

The elastic stiffness of the NTSF tailings appears normal for loose silt, when compared with data from other sites ((Shuttle & Jefferies, 2016)) and shown in grey on Figure E3-9.

The relationship between G_{max} and p' for NTSF silt can be expressed by a power law:

$G_{max} = 1.5 \times p'^{0.757}$ (MPa) Equation 3-1

E3.5.2 Confined compressibility

Four oedometer tests were undertaken on undisturbed samples of insitu tailings from CE407, CE408 and CE413. Samples were loaded to between 3 and 3200 kPa. The results of these tests are presented in Figure E3-10 on a plot of void ratio versus log applied pressure while key parameters for each test are summarised in Table E3-3.

The low-stress part of the curve corresponds to the re-consolidation of the sample to both its original insitu stress state as well as some densification due to disturbance during sample extrusion. Over the stress range of 100 kPa to 2000 kPa these samples exhibited a compression index of 0.05 $<C_c<$0.09. The compressibility increases at stress levels greater than 2000 kPa, possibly caused by grain crushing (a behaviour seen in other soils).

Oedometer test certificates are included in Annexure EK.

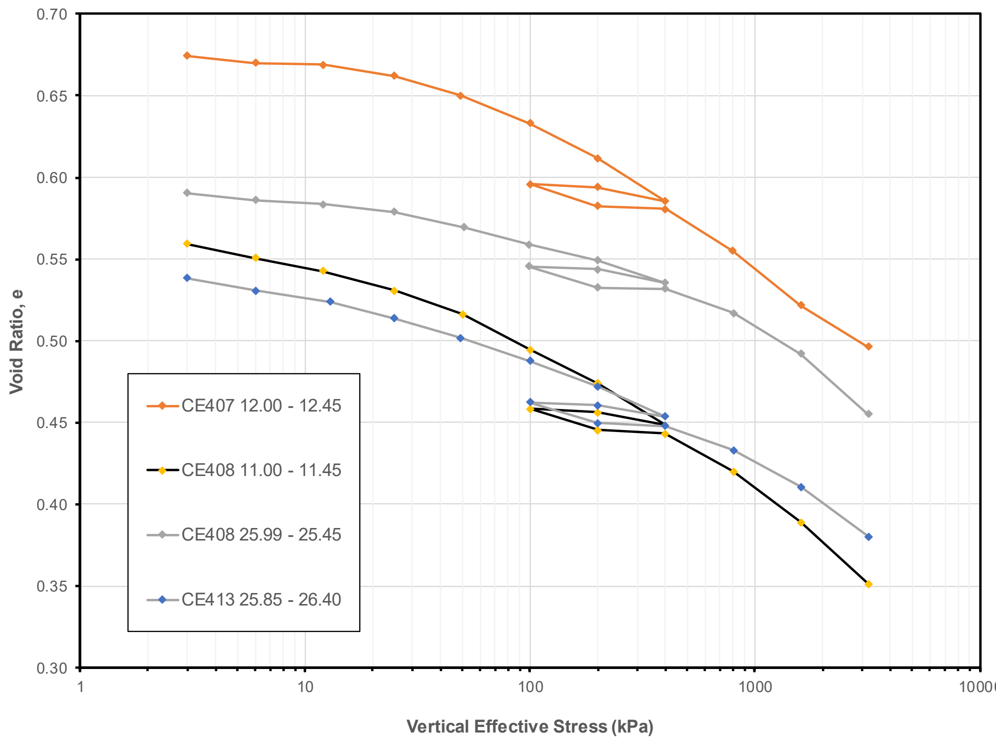


Figure E3-10: Oedometer Test Results

Table E3-3: Summary of consolidation test data

ID	Depth	RL	γb (t/m3)	>75µm (%)	w (%)	eo	Cr	Cc	p'c
CE407	12.00-12.45	719.8	2.02	29	25.0	0.674	0.025	0.112	110
CE408	11.00-11.50	732.8	2.13	33	22.2	0.561	0.025	0.113	130
CE413	25.95-26.40	717.9	2.20	36	23.5	0.538	0.024	0.100	155
CE408	25.00-25.45	718.8	1.99	41	19.2	0.591	0.023	0.112	300

E3.5.3 Critical State Locus

The CSL for each tailings sample was determined using the standard method, with triaxial tests on predominantly loose samples, tested both drained and undrained. The critical state is the end point of those tests that reach the condition of continuing deformation at constant deviator stress and constant void ratio. Dense tests generally cannot reach this condition within the deformation limits of the triaxial test equipment.

The result of triaxial tests on the TC1 tailings are presented in Figure E3-11 as a void ratio versus mean effective stress plot (e versus log p'). The inferred CSL is the green line on this figure. The three undrained tests all reached their critical state, which is shown as a blue dot. The loose drained tests were close to their critical state at the limits of the test equipment. The dense tests did not reach the CSL, as is usual, and were carried out to measure stress-dilatancy of the tailings.

Although a linear semi-log distribution is a reasonable representation of the CSL, close inspection of the test results suggests the now-common "curved" equation is a better fit:

$$e_c = a - b * \left({p'}/{100}\right)^c \qquad \text{Equation 3-2}$$

where: e_c critical state void ratio

p' mean effective stress measured in kPa, and

a, b, c soil properties defining the CSL.

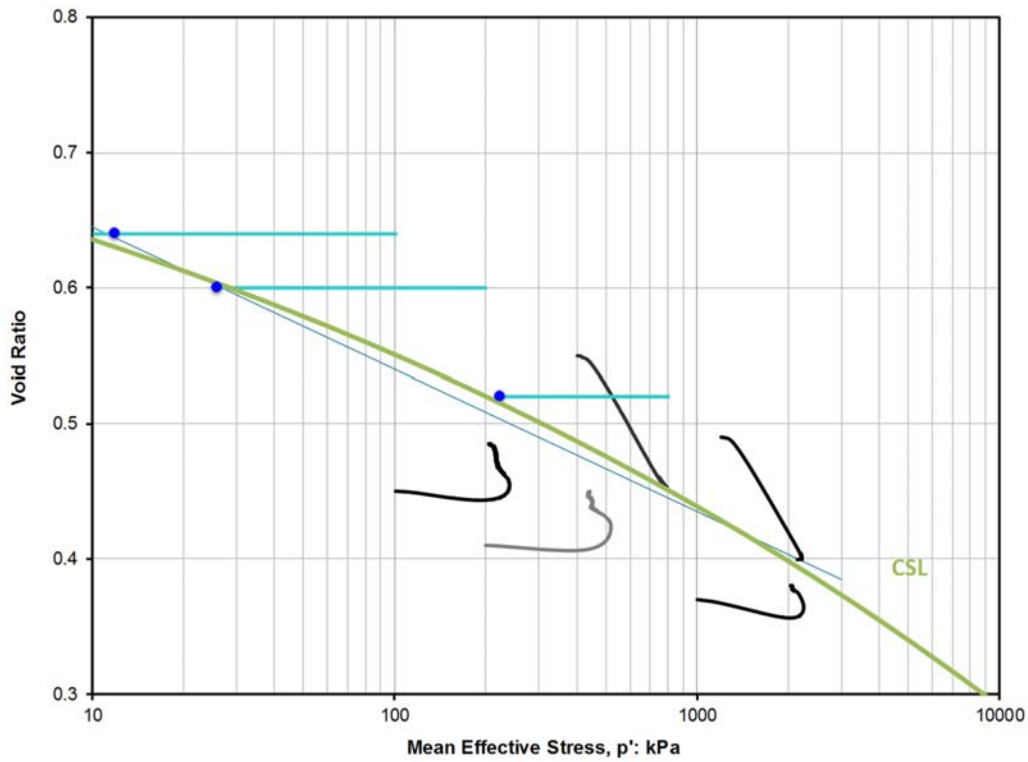


Figure E3-11: Triaxial test paths showing critical state locus for TC1

Similar results were obtained for the sandier insitu tailings as well as the mixed tailings found in the run-out soils. In all cases a slightly 'curved' CSL was the best fit to the tests, with the properties given in Table E3-4. The CSL's of these soils are compared on Figure E3-12.

The effect of mixing during the slump is to give the mixture a more contractive state. That is, for any given void ratio the mixed CSL (red line) lies at a lower void ratio than that for either of the 'parent' tailings. The implication of this is that the tailings will accelerate as they slump because of further loss of undrained strength.

Plots showing the results from triaxial tests on the bulk samples are presented in Figure E3-12, while test certificates are provided for individual samples in Annexure EE to Annexure EI.

Key points to note with respect to the CSL testing are:

- A CSL has not been reported for the sand boil material from the slump (HA402) as this material was not considered representative of the insitu materials encountered
- The CSL for sample TS1 is based on limited testing (2 x CIU and 1 x CID) and was undertaken to confirm the similarity of samples TS1 and TS2.
- CSL testing of sample HA401 was undertaken by both Golders and Trilabs. The results presented in Annexure EE are considered to be within the accuracy of measurements.

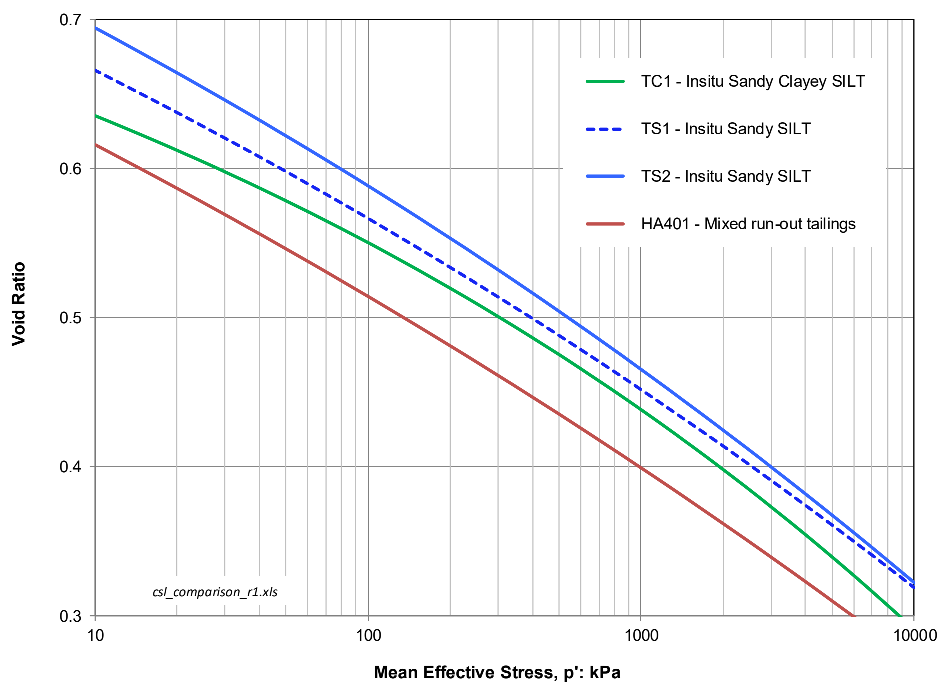


Figure E3-12: Comparison of CSL for NTSF tailings

Table E3-4: NTSF Tailings CSL Properties

Bulk Sample	CSL Parameters		
	a	b	c
TC1 – Insitu Sandy Clayey Silt	0.906	0.355	0.119
TS1 – Insitu Sandy SILT	1.302	0.735	0.063
TS2 – Insitu Sandy SILT	1.350	0.762	0.065
HA401 – Mixed run-out tailings	1.400	0.885	0.053

E3.5.4 Drained Strength

The drained strength of soils is controlled by their critical friction ratio (the property M or, equivalently, ϕ_c) and their dilatancy (controlled by the property χ and their current state parameter). Although these properties are most easily determined using drained triaxial tests on dense samples, as part of the CSL testing programme, the properties carry over into the full spectrum of soil stress-strain behaviour – drained or undrained, loose or dense.

The data from the various tests is summarised on the upper graph of Figure E3-12 which plots the stress ratio at peak strength (η_{max}) versus the dilation rate at that strength (D_{min}). As there is considerable similarity between the three tailings tested, a single line (shown in green) has been adopted to represent the tailings strength behaviour. This line is defined by the slope (1-*N*) where N is the volumetric coupling parameter, and the critical state friction ratio, the intercept M_{tc}, where $\phi_{CS} = tan^{-1}(1/_M)$.

The dilation that develops as soil deforms (shears) is a consequence of the available space for particles to move into – and thus controlled by the state parameter, ψ. The state dilatancy parameter, χ_{tc}, is the slope of the trend line for minimum dilatancy (equal to dilatancy at peak stress ratio) versus the state parameter at peak stress ratio (D_{min} vs ψ at D_{min}) as shown on the lower plot of Figure E3-13. As is the usual case with silts, there is a small range of state over which to infer this property and with consequent loss of precision. As a consequence, an average representative value χ_{tc} = 8.0 was adopted for the deformation modelling. The calculated values for these deformation parameters are listed in Table E3-5.

Table E3-5: Adopted deformation parameters

M_{tc}	N	χ	ϕ'_{cs}	H	ν
1.5	0.3	8.0	34°	50 -450ψ	0.2

The strength property determination discussed above illustrates how those properties are determined. However, these properties are used in the opposite way in subsequent analysis (as illustrated by the 'blue arrows' on Figure E3-13. The input is the state parameter (ψ), which establishes the limiting dilation, D_{min}. This limiting dilation in turn both controls the relative strains (for example, vertical versus horizontal) as well as the strength of the soil. Hence, the insitu state parameter must be determined to use these properties.

E3.5.5 Stress-Strain Behaviour

The properties determined above were used in the NorSand model to compute the stress-strain behaviour of the tailings, which was then compared to the measured stress-strain behaviour. This is slightly less than full validation because NorSand, as do other comparable models, requires a plastic hardening modulus in addition to the properties listed in Table E3-5. The approach adopted was to estimate this plastic hardening modulus and then to adjust ("iterate") that modulus to provide a best -fit of the theory to the data.

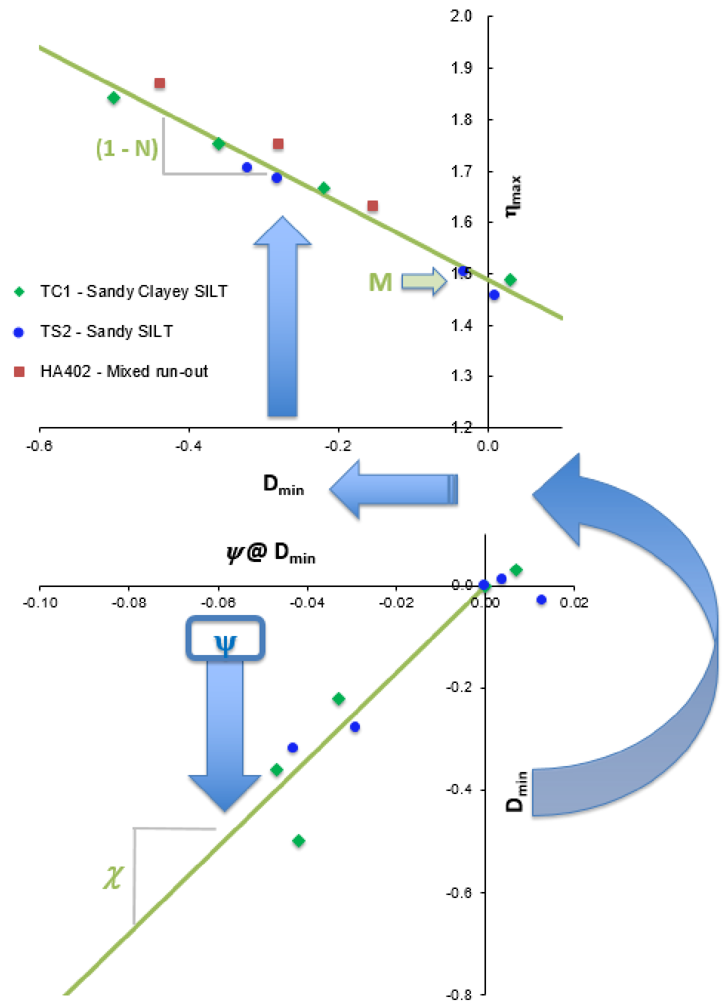


Figure E3-13: Strength and dilatancy of NTSF tailings

Examples of the fits obtained are shown on Figure E3-14 and Figure E3-15. The first figure shows a moderately dense test on the predominant insitu silt (TC1), which checks that the dilatancy has been properly captured by the determined soil properties and establishes the plastic hardening modulus. The second figure shows that the same properties carry across to undrained behaviour, although as usual a reduced elastic shear modulus is needed from that determined shear wave velocity measurements in the field. In both cases the reported void ratio of the test is honoured. The plastic hardening modulus determined by this iterative fitting is linearly dependent on the state parameter, illustrated on Figure E3-16.

The iterative fitting was done for the predominant silt (TC1) and the 'sandier interlayers' (TS2), as the derived plastic modulus was needed for calibrating the CPT insitu. In fitting the test, the plastic hardening modulus was varied to best-fit each test. This produces some scatter around the trend, generally attributed to the effect of the detailed particle arrangement "fabric" that is not captured by void ratio. A linear trend line was fitted through the modelling results: $H = H_0 - H_\psi$. Values for these modulus parameters are given on Table E3-5.

Displacement modelling used the average trend for H as a uniform soil type.

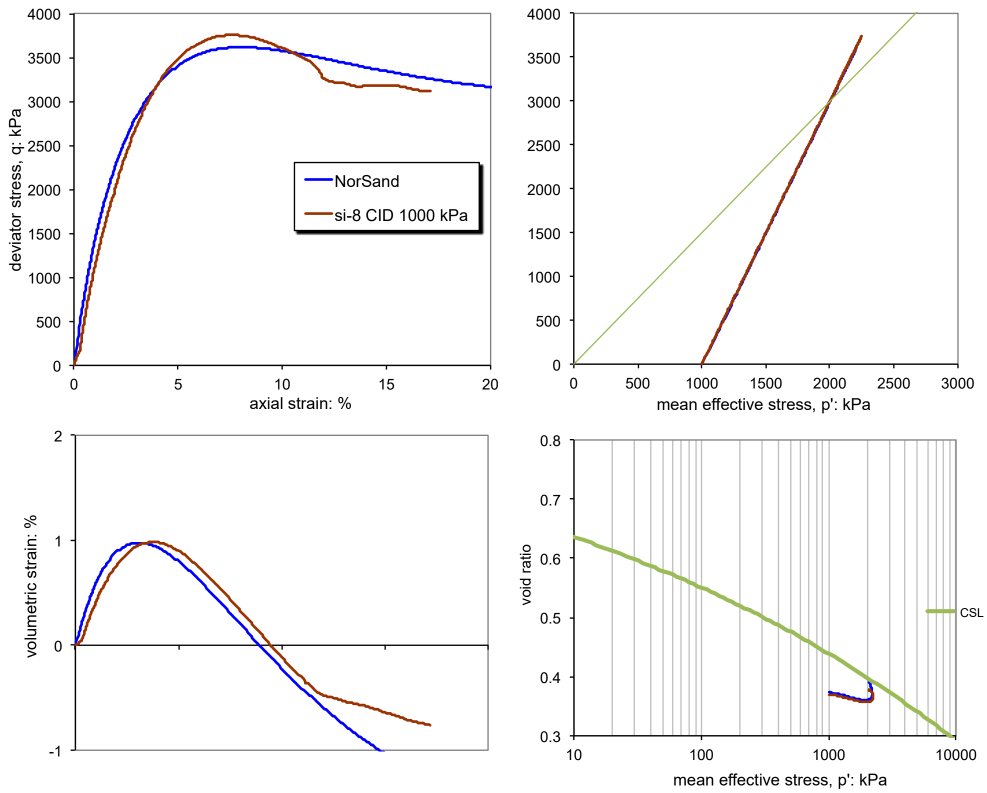


Figure E3-14: Calibration to a dilatant drained triaxial test on the predominant silt

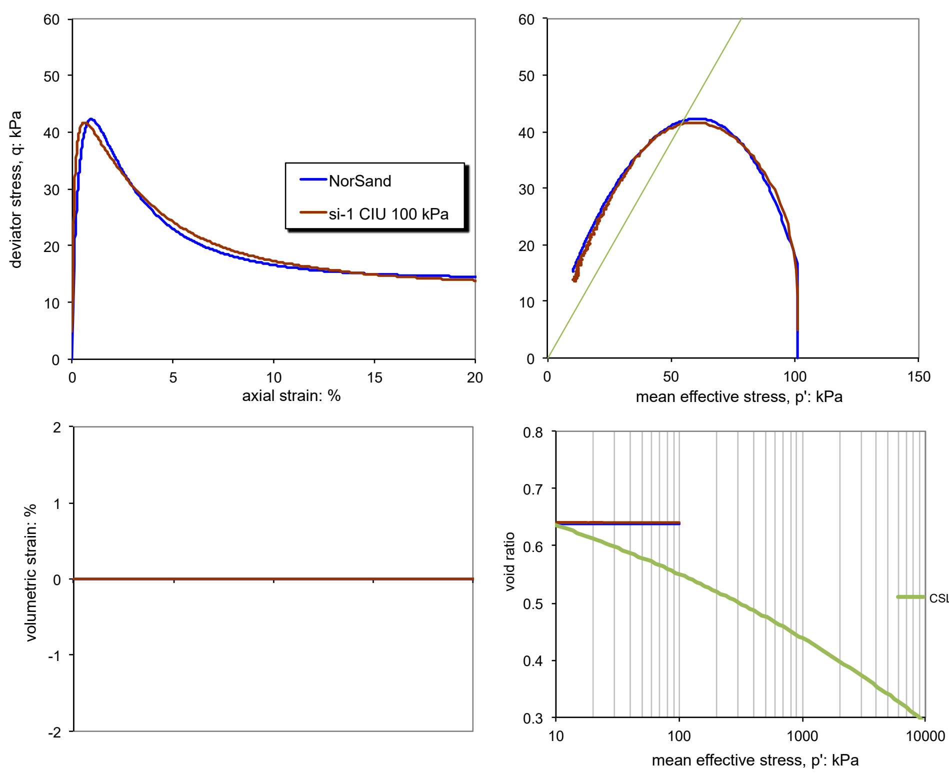


Figure E3-15: Calibration to a contractive undrained triaxial test on the predominant silt

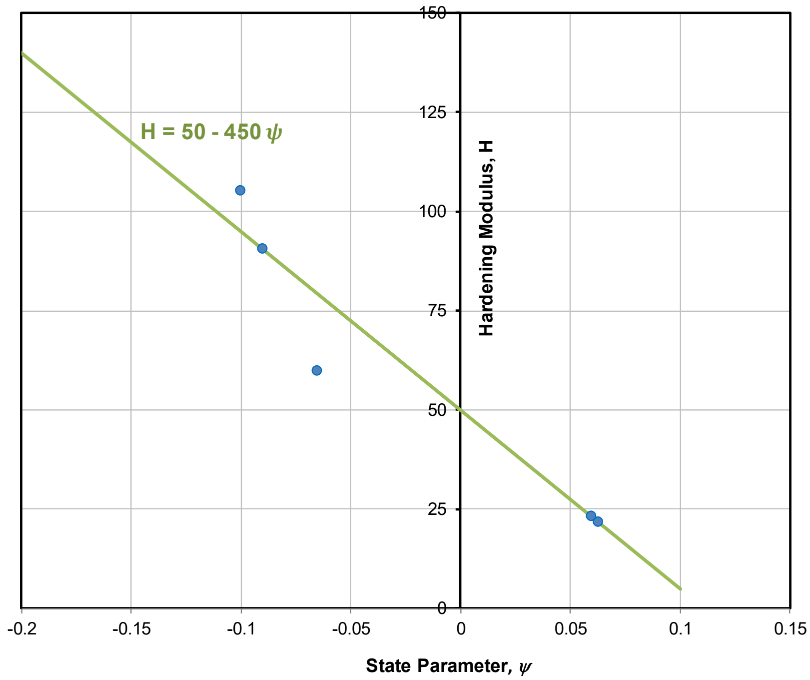


Figure E3-16: Plastic hardening modulus used in fitting tests on TC1 silt

E3.6 Cyclic Strength

E3.6.1 Test Program

All cyclic direct simple shear tests (CDSS) were carried out on the predominant insitu silt (TC1) sample because the wavelength of earthquake motion is such that the thinner sand lenses will not be "seen" by the ground motion.

Seven tests were carried out for the 'far-field' condition upstream of the dam crest where the tailings were most likely in a geostatic stress state; i.e. minimal to no 'static bias'. Three of these tests were at a vertical effective stress of 50 kPa and three at 300kPa. The 50kPa stress was selected to correspond to the lowest stress level of the saturated tailings, as the upper 3 -5 m of tailings appears unsaturated and would not be subject to liquefaction. The 300 kPa stress level was selected to define trends with stress, noting that strong ground motions are normally amplified during propagation from the underlying bedrock and thus it is the near surface stress levels that are of greatest initial interest.

All tests were on samples that were slightly looser than the best-estimate of the insitu ψ of the tailings, with some tests being markedly looser. The cyclic stress level was chosen to simulate low-level earthquake motions (or comparable) with two tests at a markedly greater cyclic stress to ensure that the effect of loading was observed. Thus, this part of the test program provides a slightly conservative view of how the tailings might responded just upstream of the dam.

A further two tests were then added to the program to measure the response of tailings beneath the upstream raise fills where deformation modelling revealed the most highly loaded soils; i.e. with a high 'static bias'. The test conditions were abstracted from the deformation modelling ('Point 1', Appendix H). The test samples were prepared loose, but densified substantially as the static shear stress was applied; a behaviour also seen in the deformation modelling. The cyclic stress level was set based on the March 8, 2018 earthquakes. In one test, a uniform cyclic stress was applied, while the computed stress-time history was applied in the other test.

The cyclic testing was then supplemented by two monotonic direct simple shear tests, carried out to illustrate the tailings response in the absence of earthquake loading from the computed stress state representing the most highly loaded tailings. One of these tests was undrained from the outset; the second was loaded drained to the stress state from the displacement modelling before being loaded undrained.

E3.6.2 Sample Preparation

Samples were reconstituted ‘very loose’ and then consolidated to the test pressure of 50 or 300 kPa (Figure E3-17). As usual, there was marked void ratio reduction when load was first applied before a proper consolidation trend was established.

The CSL shown on Figure E3-17 is from triaxial testing of TC1 tailings converted from mean effective stress to vertical stress using an assumed K_0=0.7. As can be seen, the as-tested state parameters were markedly loose of the critical state, lying in the range +0.10 < ψ < +0.16 while the characteristic insitu state is approximately ψ~ +0.09.

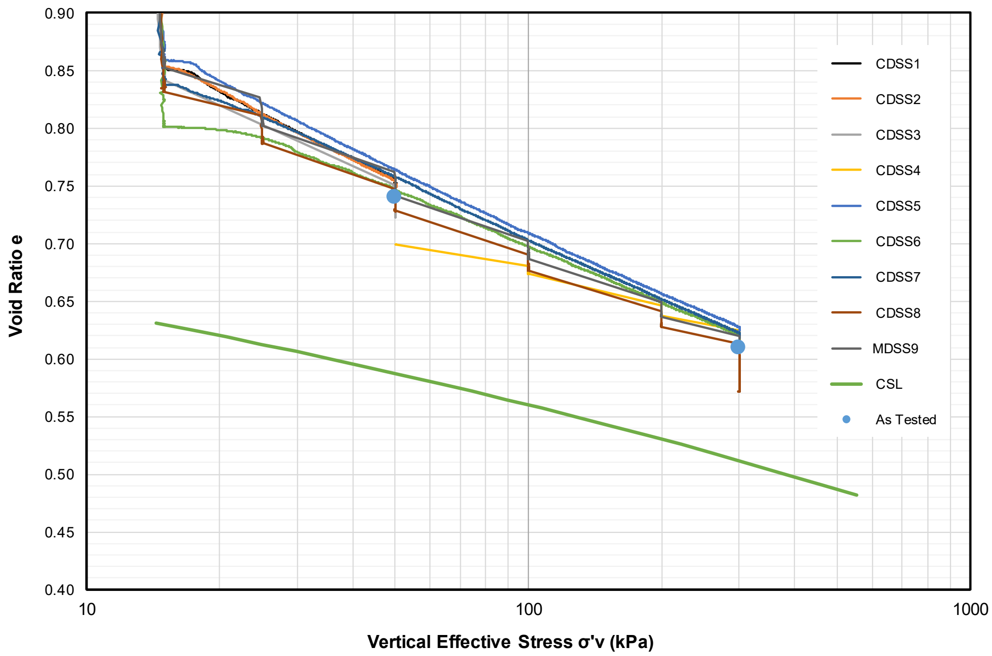


Figure E3-17: Evolution of sample void ratios to tested conditions

E3.6.3 Test Conditions

The test conditions are summarised in Table E3-6 and Table E3-6 using the standard loading metrics of imposed cyclic stress ratio and static bias. One test had a ‘custom’ cyclic loading that replicated the two small earthquakes on March 8, 2018.

Certificates for the cyclic simple shear testing are included in Annexure EN.

Table E3-6: CDSS test conditions and applied loading for 'far field' tests

Sample ID	State	Test No.	Consol.	Bias	Void Ratio	Ψo	CSR Applied	Number of Cycles to:	
			kPa	α	e			γ > 2.5%	ru > 0.9
TC1	Very Loose	CSS1	50	0.05	0.75	0.16	0.096	20.3	23
		CSS2	50	0.05	0.75	0.16	0.054	495	495
		CSS3	50	0.00	0.72	0.14	0.054	500	500
		CSS4	300	0.00	0.61	0.10	0.059	505	505
		CSS5	300	0.05	0.62	0.11	0.094	18.3	20
		CSS6	300	0.05	0.62	0.11	0.056	510	510
		CSS7	300	0.05	0.62	0.11	0.127	3.5	5

Table E3-7: CDSS and MDSS test conditions and applied loading for 'in dam' tests

Sample ID	State	Test No.	Consol.	Bias	Void Ratio	Ψo	CSR Applie d	Number of Cycles to:	
			kPa	α	e			γ > 2.5%	ru > 0.9
TC1	Very Loose	CSS8	300	0.30	0.57	0.060	0.057	~12	See text
		MSS9	300	0.00	0.61	0.096	monotonic		
		MSS10	300	0.30	0.59	0.082	monotonic		
		CSS11	300	0.30	0.56	0.046	custom		
TS1		CSS11	300	0.30	0.60	0.080	custom		

E3.6.4 Far Field Tests Results

The measured behaviour in one of the high-load samples (test CSS-5) is shown on Figure E3-18. The shear strain induced by cyclic loading remains small until the excess pore pressure increase to about r_u ~0.8, which also corresponds to the sample beginning to show a "butterfly" stress-path as loading continues. This is normal behaviour, in both sands and silts, with the soil accommodating substantial excess pore pressures before cyclic softening becomes established.

Typically, the number of cycles to 'liquefaction' is reported in cyclic shear tests. However, for these tests two criteria have been used to define liquefaction, namely

- a shear strain of >2.5% regardless of whether static bias was used; and,
- an excess pore pressure ratio, r_u >0.9.

The results of applying these criteria to the test results are tabulated in Table E3-6.

It should be noted that values quoted at ~500 cycles are an underestimate, as testing was terminated at this point and none had met the liquefaction criteria at the test limit.

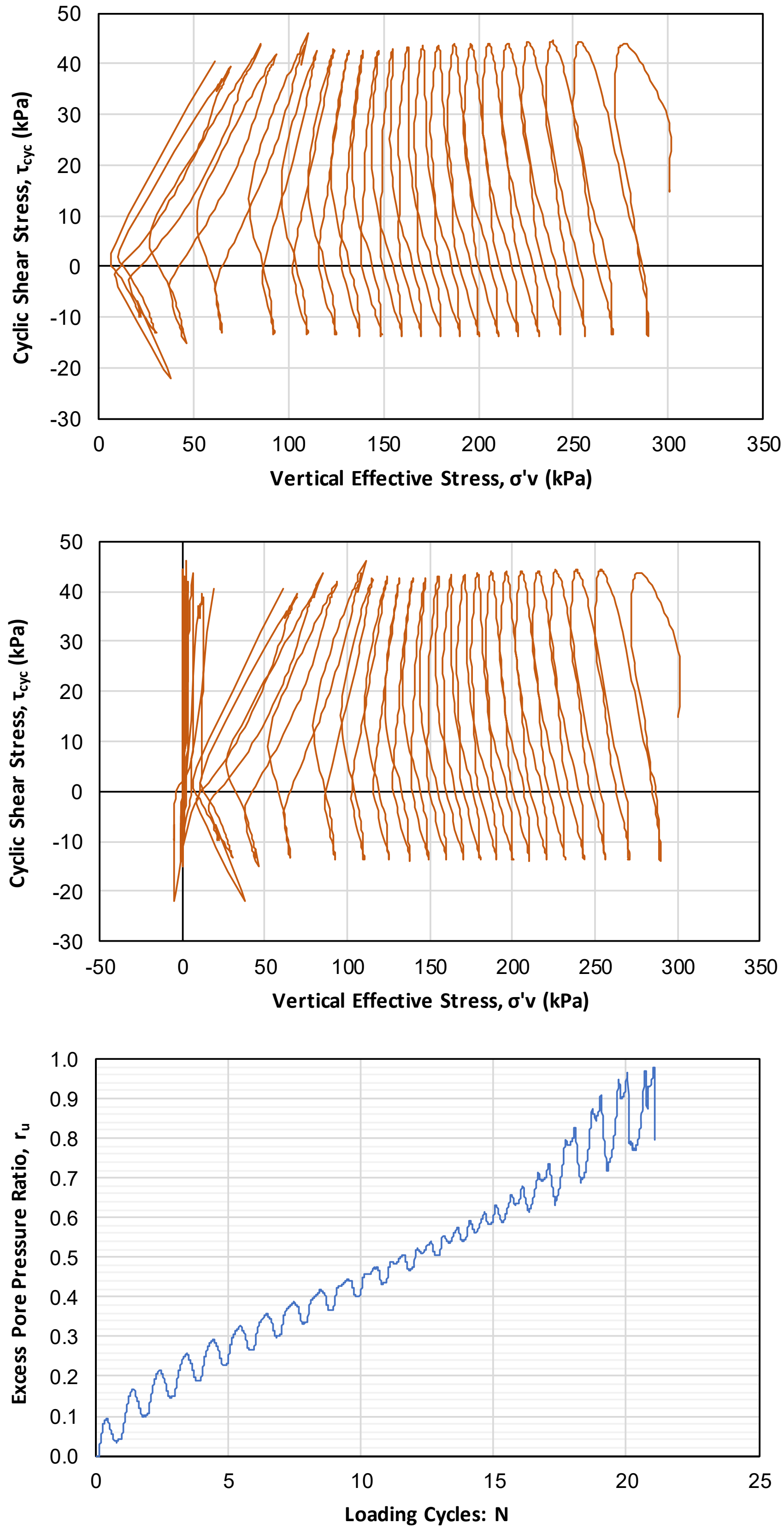


Figure E3-18: CDSS5 test result on TC1

It does not matter whether the strain or excess pore pressure criterion of liquefaction is preferred as the results are similar. The trend for the number of cycles to the strain criterion versus cyclic stress ratio is presented on Figure E3-19; a logarithmic x-axis is used as cyclic loading is a fatigue-like process. There is no obvious effect of soil state nor any obvious effect of static bias; the results are also notably strong for such loose soil.

Further insight can be gained if the excess pore pressure ratio r_u is considered at 5 and at 15 load cycles. This is shown on Figure E3-20. There is again little obvious effect of static bias or soil state, but what is very clear is a 'yield' stress ratio (or, equivalently, a strain threshold) below which there is no generation of excess pore pressure. This limit is approximately at a cyclic stress ratio of ~0.045. As threshold strains have been observed in other soils, the measured appears reasonable.

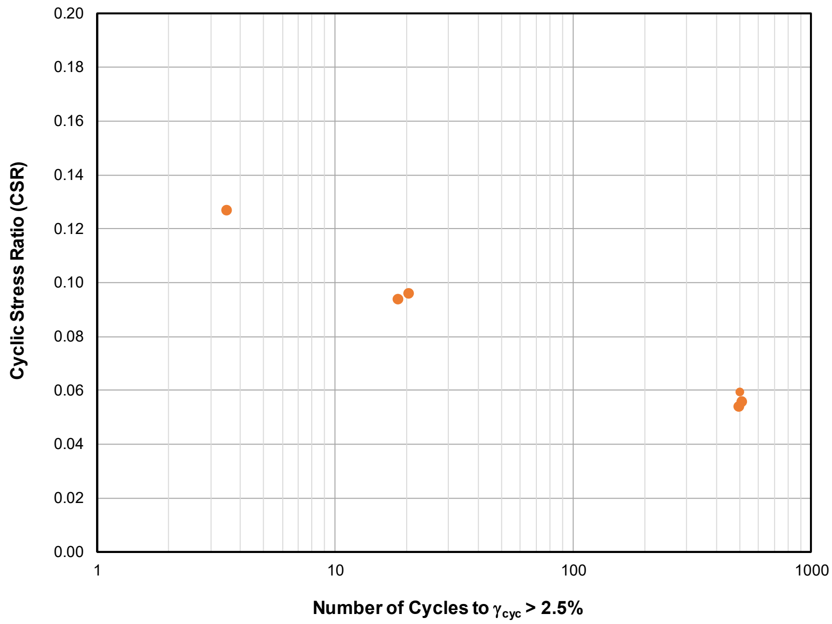


Figure E3-19: Strain based onset of liquefaction vs severity of loading

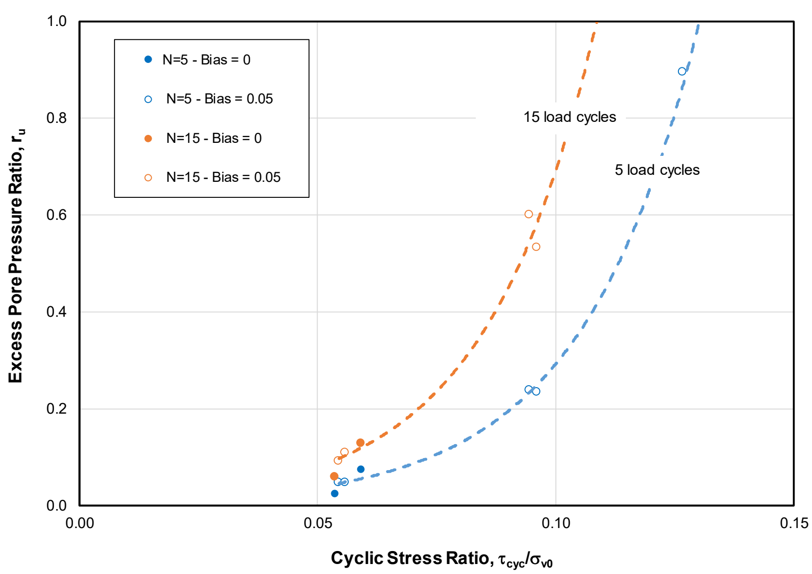


Figure E3-20: Excess pore pressure ratio at N = 5 & 15 vs severity of loading

E3.6.5 Near Field Tests Results

The FLAC 2D deformation analysis (Appendix H), established the stress state within the tailings after completion of the Stage 1 Buttress. A zone of particularly high mobilised stress ratio (Point 1) was chosen and the stress history was output. A static bias of 0.3 was adopted and this was then used to define the start of a second set of tests to evaluate the tailings response during the March 8, 2018 seismic events.

The first cyclic test used a uniform sinusoidal cyclic loading as is standard. The results are shown on Figure E3-21 as the blue lines. Also shown on this figure is the result of a duplicate sample tested monotonically from the same initial conditions, shown as the red lines. The cyclic test actually shows greater strength than the monotonically loaded sample, which is most likely a reflection of slightly different sample preparation. The measured cyclic behaviour amounts to about 12-15 cycles of almost 'load-unload' behaviour during which the pore pressure increased slowly; at that point the stress path intersected the samples monotonic undrained strength and this largely controlled the response. Essentially, this test had so much 'static bias' that its strength was controlled by the maximum shear stress rather than the cyclic aspect.

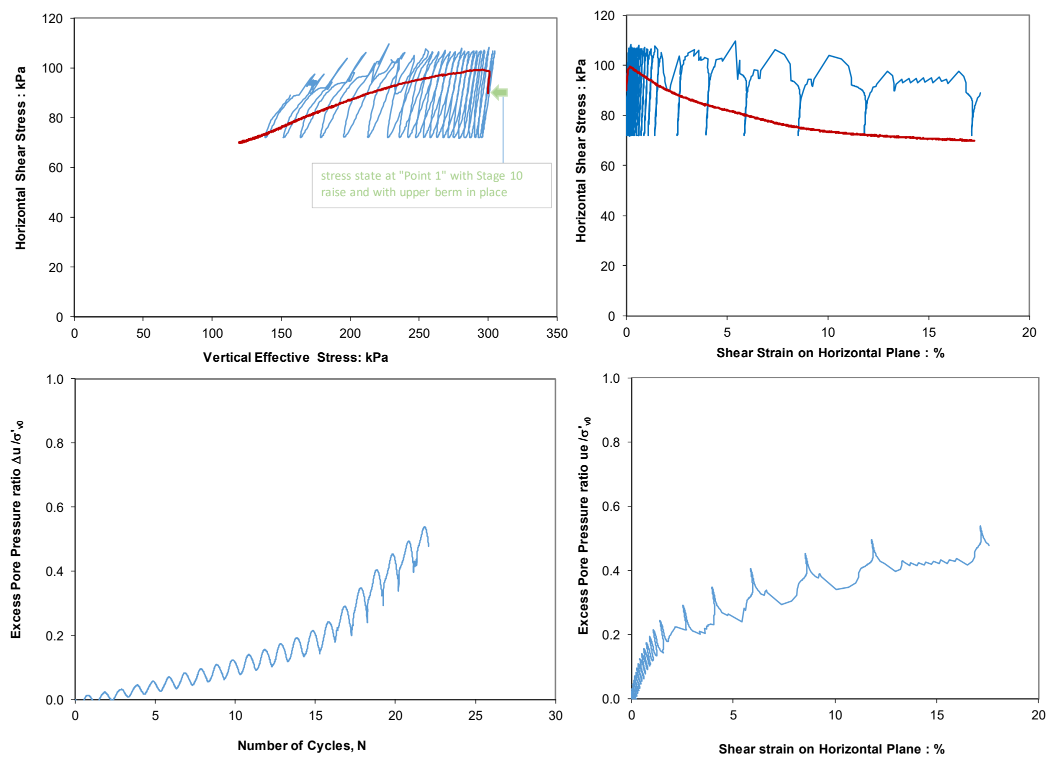


Figure E3-21: Measured response of 'highly stressed' zone in cyclic loading

A further test was then carried out which exploited the ability of the GDS equipment to simulate a custom waveform. The computed earthquake response of the tailings at the 'Point 1' location was recovered from the analysis as a time history of variation in the horizontal shear stress. After discussion with the equipment manufacturers, the variation in shear stress with time computed by FLAC 2D at Point 1 was filtered into a cyclic loading record for the simple shear equipment. Both pulses of the March 8, 2018 seismic events were included, with the time between them reduced for testing convenience whilst test conditions were maintained undrained. The test equipment was able to reasonably match the desired shear stress variation computed by FLAC 2D, illustrated on Figure E3-23.

Two of these custom cyclic tests were carried out; one on the predominant silt tailings (TC1) and one on the slightly sandier sample (TS1) representing the ‘interbedded layers’ apparent on the CPT records. Both samples were prepared loose, and both were loaded drained to the ‘static bias’ computed by FLAC 2D for Point 1 and with the consequent shear-induced densification. The results of these two tests are shown on Figure E3-23. Very little excess pore pressure was generated in either case (the vertical effective stress changes minimally) with the response being quasi-elastic unload-reload from a dominant pre-cyclic stress state established by the drained loading.

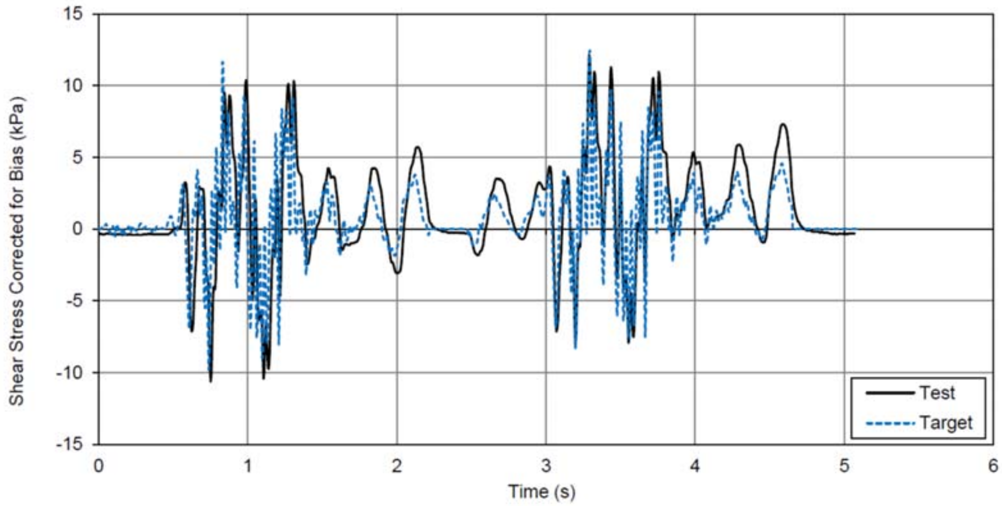


Figure E3-22: Ground motion input to CDSS test simulating earthquake motion at Point 1

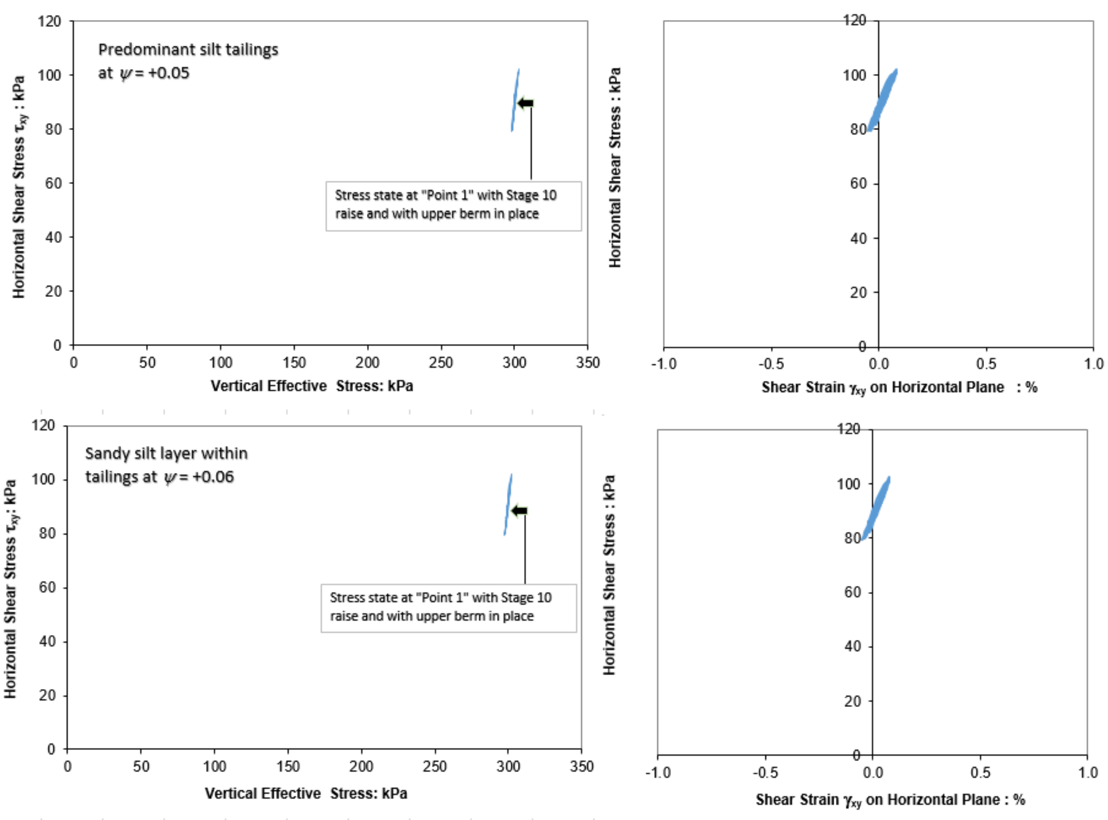


Figure E3-23: Response of Point 1 tailings to 8 Mar 2018 earthquake in cyclic simple shear

E3.7 Stress-Path Testing

E3.7.1 Stress-Path

The trajectory over which the mean effective stress (σ_m) and the distortional stress (the 3D stress invariant σ_q) changes is known as the 'stress path' and this can influence how soil responds.

FLAC 2D deformation modelling was used to assess how stresses developed at five points within the tailings as shown on Figure E3-24. Of these five locations, 'Point 1' corresponds to the most plastically loaded tailings with the greatest ratio of the parameter η (=σ_q / σ_m). The stress-paths at Point 1 and Point 5 are shown on Figure E3-24.

Soil can fail by transitioning from a drained loading path to an undrained one if the stress state exceeds the soil's instability locus. Although the instability locus can be computed, the ITRB wished to confirm this by a physical testing and commissioned a number of stress path triaxial tests.

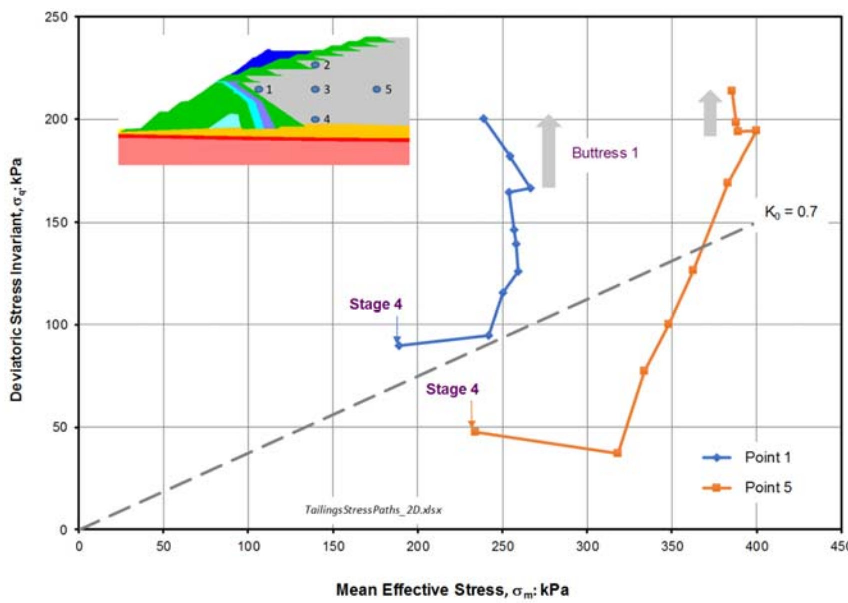


Figure E3-24: Computed stress-path tested used in triaxial shear

E3.7.2 Test Method and Program

Six stress path tests were completed by Golder's Perth laboratory and two by KCB's Vancouver laboratory.

At Golder's Perth laboratory, two stress path triaxial tests were completed on Sandy Clayey SILT tailings represented by sample TC1, while four tests were completed on Sandy SILT represented by sample TS1. In all cases the samples were prepared by moist tamping the tailings in a manner used for the CSL testing. Following assembly and saturation, the triaxial specimens were anisotropically consolidated at a mean effective stress of (p') of 188kPa and K_0 ~ 0.64, corresponding to the stress at 'Point 1' at the end of Stage 4.

On completion of anisotropic consolidation, the samples were loaded in such a manner to replicate the construction of the embankment Stages 5 to 10 and the Stage 1 Buttress. Two loading paths were followed, a fully drained path with consolidation being permitted during each loading stage, and a partially undrained path where the load was applied in 5kPa increments under undrained conditions, followed by drainage.

Following loading up to conditions replicating those on completion of the Stage 1 Buttress, the loading path followed two trajectories as shown on Figure E3-26. In the case of Path A and B, the load applied resulted in a constant deviator stress, while in the case of Path C the deviator stress increased following the same trajectory as that during the Buttress 1 construction.

During the stress path tests the principal stress was applied by either 'dead weights' or by servo controlled loading. A brief description of each test and loading conditions is provided in Table E3-8.

In the case of KCB test TX05, the specimen was cyclically loaded after following the Point 1 stress path that replicated construction from Stage 4 to the end of Buttress 1. The custom double pulse wave form which used the March 8, 2018 seismic event (Figure E3-22) was used for the cyclic loading.

The various loading paths adopted for the stress path testing are shown on Figure E3-25.

Table E3-8: Stress path triaxial test details

Sample	Test	Test Type	Description	K0	Stress
TS1 18028	Sa-1	Test A	Fully drained construction loading path. Constant deviator stress loading.	0.64	Servo (DigiRFM)
	Sa-2	Test B	Anisotropic consolidation from p'=20kPa Partially undrained construction loading path. Constant deviator stress loading.	0.65	Servo (DigiRFM)
	Sa-3	Test C1	Fully drained construction loading path. Increasing deviator stress.	0.62	Dead Weights
	Sa-7	Test C2	Anisotropic consolidation from p'=20kPa Fully drained construction loading path. Increasing deviator stress.	0.62	Dead Weights
TC1 18018	Sa-10	Test C3	Partially undrained construction loading path. Increasing deviator stress.	0.62	Dead Weights
	Sa-11	Test C4	Partially undrained construction loading path. Increasing deviator stress. Last stage fully undrained with valves closed.	0.61	Dead Weights
TC2 A03353	TX03	Test C5	Isotropically consolidated - 3 Stages. Fully drained construction loading path. Increasing deviator stress.	-	Dead Weights
	TX04	Test C6	Isotropically consolidated – 4 Stages. Fully drained construction loading path. Increasing deviator stress	-	Dead Weight
	TX05	Cyclic	Isotropically consolidated – 4 Stages. Fully drained construction loading path. Double pulse cyclic loading	-	Servo

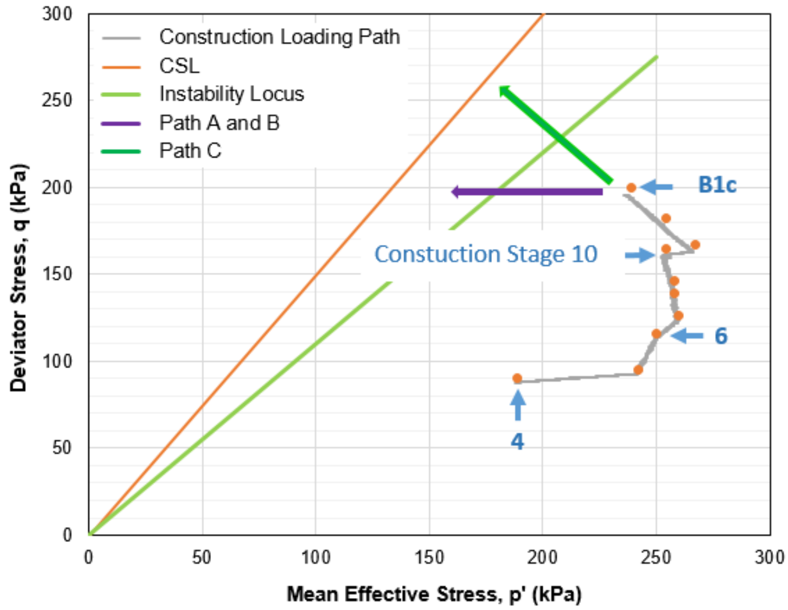


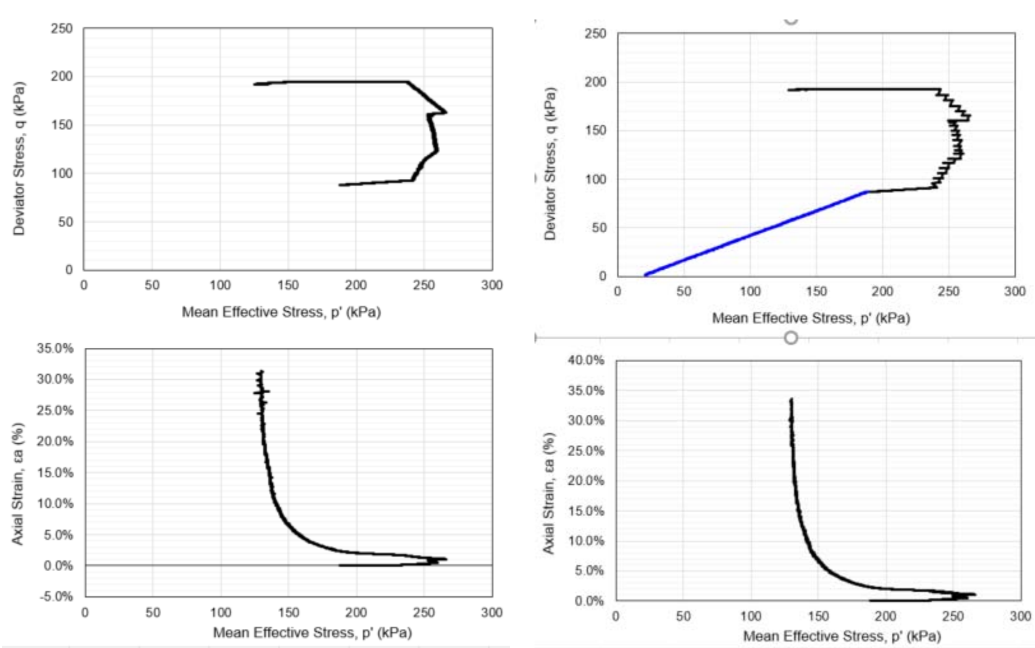
Figure E3-25: Loading paths adopted for stress path tests

E3.7.3 Test Results

Stress path plots, together with plots of axial strain versus mean effective stress are provided for samples TS1 and TC1 on Figure E3-26, while full details are provided in Annexure EO. Results for sample TC2 are included in Annexure EP.

In the case of test Sa-11, essentially instantaneous collapse of the sample (liquefaction) resulted when it was subject to a small increment of shear stress under undrained conditions. As it is difficult to appreciate the speed at which liquefaction can develop past the instability locus, a video has been prepared of this test illustrating this very rapid change and which is included in the report as Annexure ER.

Test A: Sa-1 Test B: Sa-2



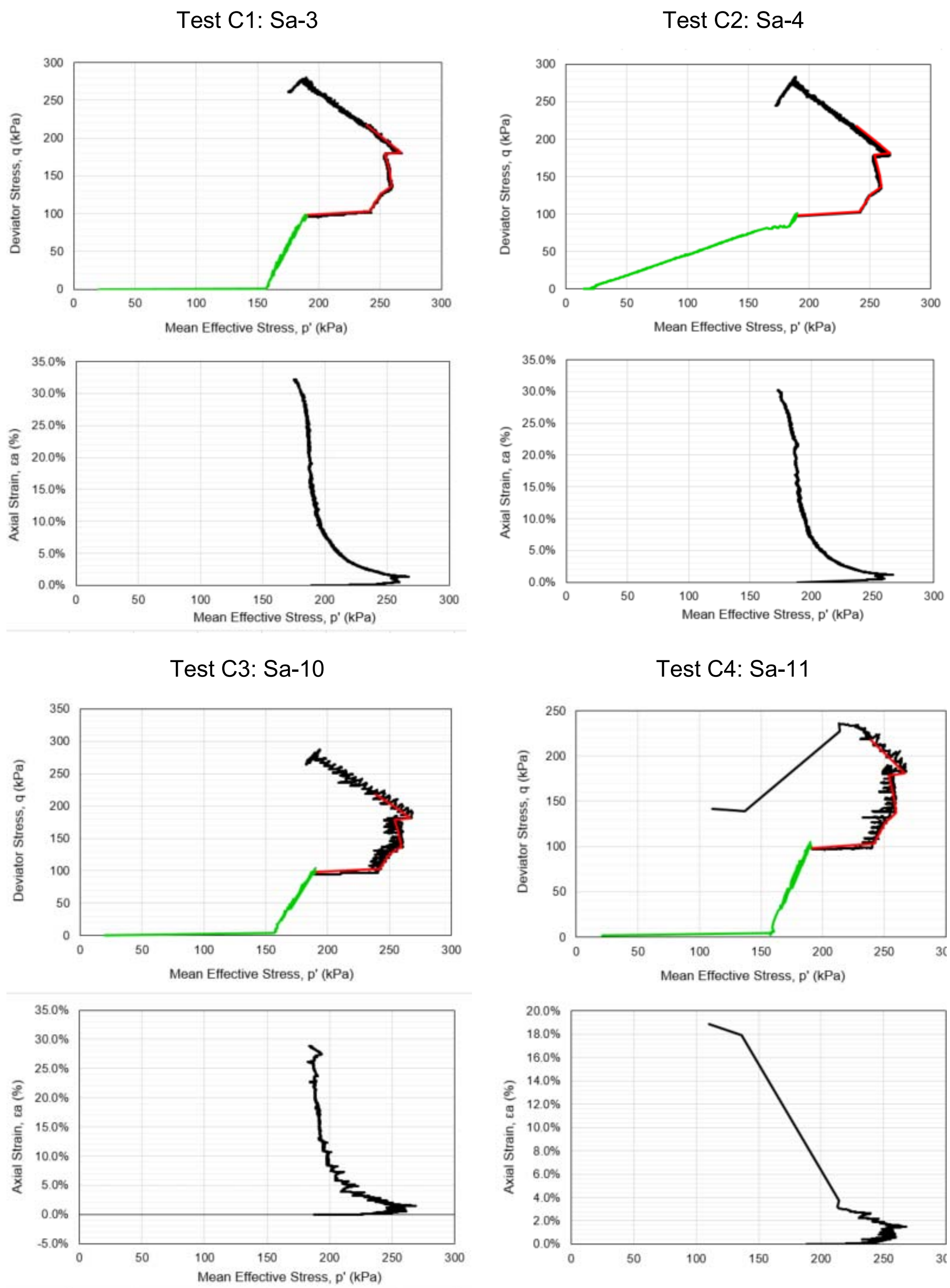


Figure E3-26: Stress path and axial strain plots for Tests A, B and C

Although the double pulse waveform used for the cyclic loading of sample TX05, replicated in full the two seismic evens of March 8, 2018 (albeit with the time between them reduced to 2 sec), approximately 700 cycles of this double pulse waveform were applied to the sample. The results indicate an initial transient pore pressure response that was minimal and most likely a system compliance issue leading to phase-lag between mean stress increase/decrease and measured pore pressure. Only after approximately 70 cycles of this double pulse waveform was there an increase in the axial strain.

The first cyclic loading pulse and pore pressure response are shown on Figure E3-27 and Figure E3-28 respectively. As can be seen, there is no increase in residual excess pore pressure at the end of the loading cycle.

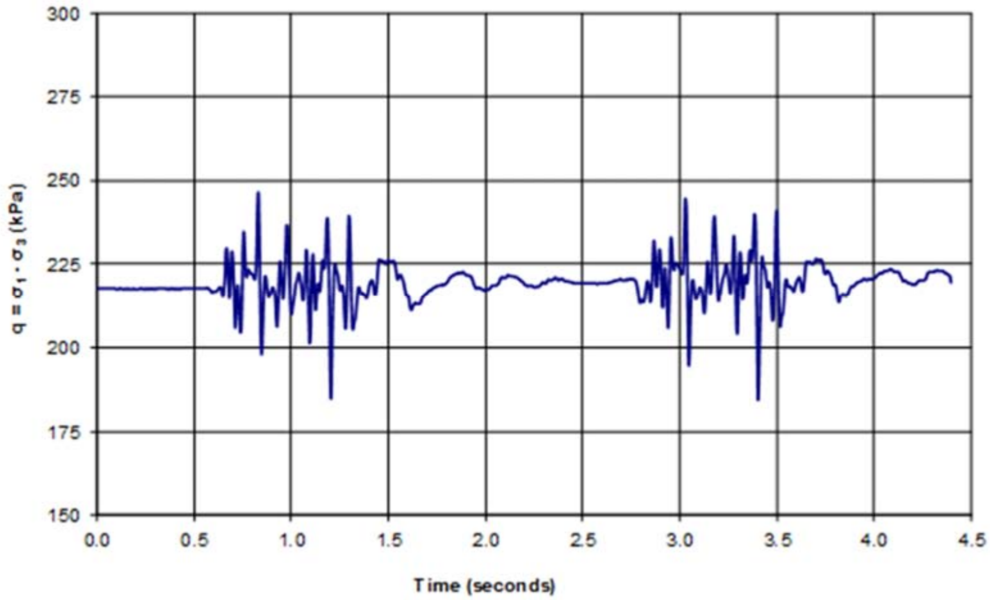


Figure E3-27: First cyclic loading pulse

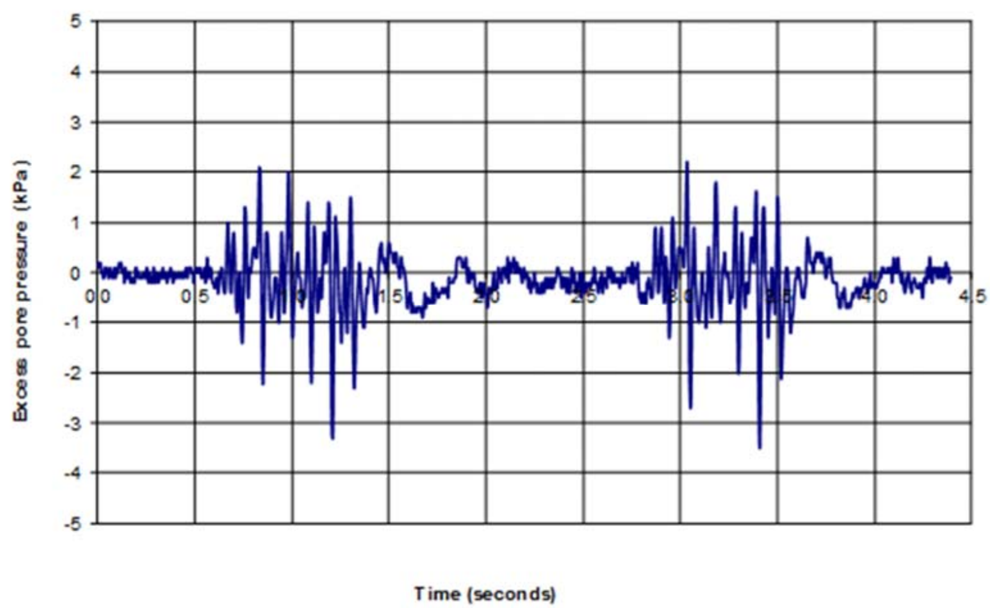


Figure E3-28: Pore pressure response to first cyclic loading pulse

E4. Insitu State Parameter

E4.1 Overview

The CPTu does not measure soil state, relative density or void ratio. These parameters have to be recovered from the CPTu data by processing the measured mechanical responses as the CPTu probe is pushed into the ground. This processing is theoretically difficult with no complete universal method; thus, the industry has always looked to calibration studies. In the case of sands, calibration studies involved controlled chamber testing. In the case of clays, calibration studies reference another test method (commonly triaxial testing of undisturbed samples or insitu vane shear).

Silts have, to date, no controlled chamber test studies nor can undisturbed samples be tested as there is always gross disturbance during extrusion and sample handling. Further, silts have largely been avoided in the literature with few cited papers. There are also few case-histories of failure in silt and those that have been published are missing basic information on soil properties.

The approach followed here has been developed over the past decade and is based on the mechanics of soil behaviour being the same in silt as in sand. Thus, the numerical methods developed and calibrated for sand can be extend to silt by allowing for the lower hydraulic conductivity of silt, which switches the penetration from drained to undrained. There is a very small window of partially drained penetration, which can be ignored for practical purposes.

The current state of the art for CPTu behaviour in silt lie in work at Somincor (Shuttle & Jefferies, 2016) and that work has been further extended for the NTSF.

The CPTu has only been calibrated for the predominant Sandy clayey SILT (TC1). Theoretically the tailings would require a ‘thin layer correction’, to accommodate for thin sandy layers, however this is beyond the current assessment. At other sites it has been found that soils within a tailings impoundment display very similar state parameters even as their gradation changes with distance from the discharge point. Thus, a reasonable assessment of the insitu state of the NTSF tailings is to focus on the predominant silt alone.

E4.2 Methodology

E4.2.1 Cavity Expansion Analogue

Although a few attempts have been made to capture the true CPTu geometry in finite element analysis, nearly all understanding is based on ‘cavity expansion’ analysis. The attraction of cavity expansion analysis is that a true 3D situation can be approximated by 1D (with soil particles just moving radially away from the CPT). Such an approximation allows relatively straightforward simulation of CPTu penetration using ‘large strain’ finite element methods. One of the programs that does this is known as the ‘CPTwidget’. It has been extensively calibrated in sands, while the initial extension to silts was undertaken by Shuttle & Cunning (2007) with further development and calibration at Somincor (Shuttle & Jefferies, 2016).

The cavity expansion methods work as an analogue to the load on the conical tip of the CPT. In the case of piezocone testing, this analogue is for the ‘u1’ location of the pore pressure sensor. However, most of the CPT industry (and as was the case at the NTSF) deploys the pore pressure sensor at the ‘u2’ location just behind the shoulder of the CPT tip, as experience is that the u2 location gives with most sensitive indication of changing soil type and properties.

The ‘CPT Widget’ has been enhanced (Release 2.5) to output an analogue of induced pore pressure at the u2 location. This enhancement was based on the common assumption that the u2 location reflects only pure shear of the soil.

E4.2.2 CPT Calibration at NTSF

The ‘widget’ uses NorSand and thus the soil properties determined during the laboratory testing are used directly as inputs. The widget outputs the soil-specific coefficients for evaluating CPTu data based on these properties and which are used in the equation:

$$\boldsymbol{\psi} = \left(\ln\left(\boldsymbol{Q}^{*}/\boldsymbol{k}\right)\right)/\boldsymbol{m}$$ **Equation 4-1**

where $Q^{*} = Q\,.\left(1 - B_q\right) + 1$

The computed relation for the normalised tip resistance is shown on Figure E4-1. As has been found in all other silts, there is no effect of elasticity in the computed trends; nor is there any bias with stress level. The fitted trend line through the results corresponds to the usual semi-log fit and is given by the coefficients; k’ = 11.5 and m’ =19.0

The matching computed excess pore pressure trends are shown on Figure E4-2. The computed trend has been fitted with a quadratic equation for ease of using the calibration in CPT processing; the parameters have been weighted for best-fit of the equation in the zone of interest +0.05 < ψ < +0.13. The fitted trend is given by:

$$\boldsymbol{B_q} = \mathbf{2.1} * \boldsymbol{\psi} + \mathbf{35} * \boldsymbol{\psi}^{\mathbf{2}}$$ **Equation 4-2**

Where, Bq is that at the u2 location as used at Cadia.

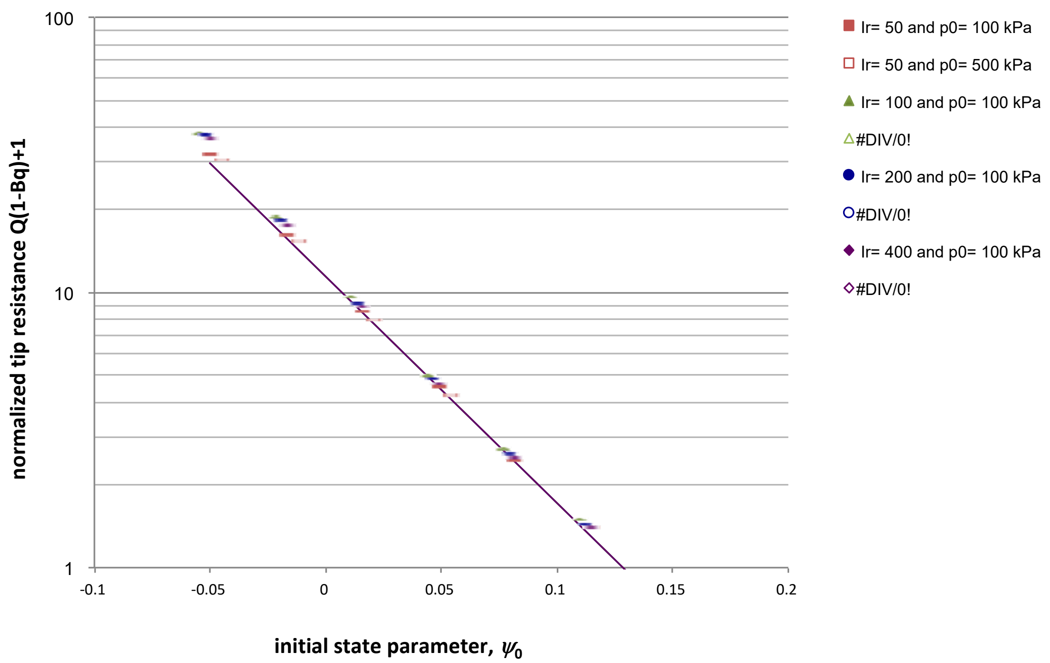


Figure E4-1: Computed CPTu resistance and fitted trend for CPTu in NTSF TC1 silt.

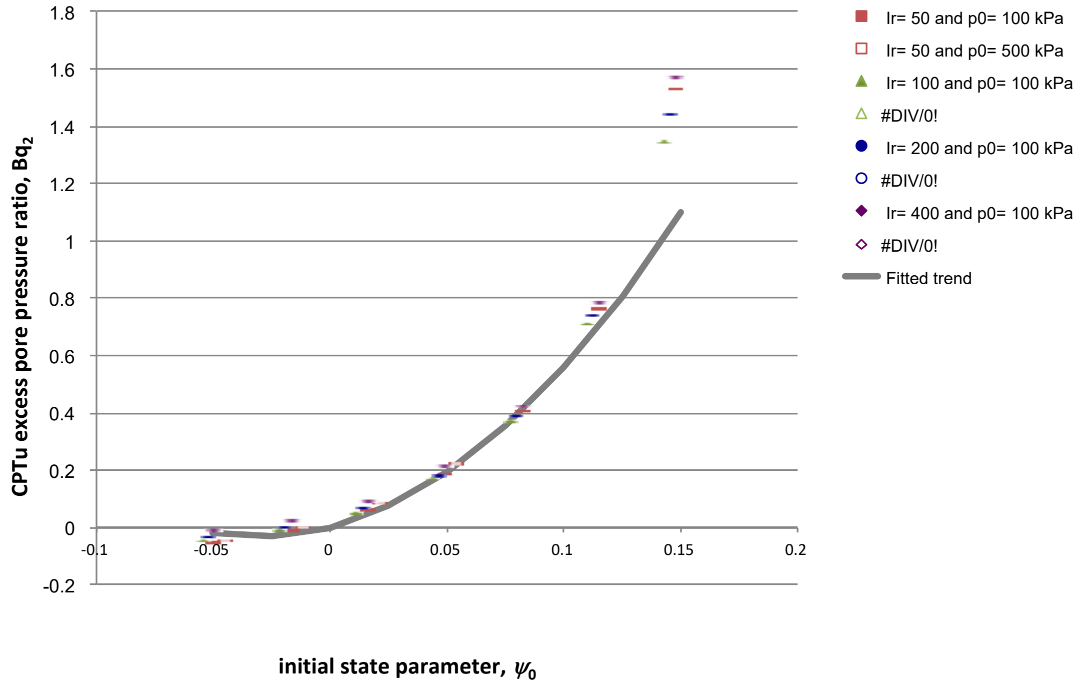


Figure E4-2: Computed excess pore pressure and fitted trend for CPTu in NTSF silt TC1.

E4.3 CPTu Processing

E4.3.1 Insitu state parameter profile

The derived calibrations have been used in processing the data from CPT-N04 located near the edge of the slump and these are shown on Figure E4-3. The state parameter ψ computed using both Figure E4-1 and Figure E4-2 show very good correspondence.

Processed results for all CPTu completed during the 2013 and 2017 campaigns are included in Annexure EJ.

The characteristic state parameter ψ_k is that for which about 90% of the stratum is denser (more dilatant), as both stochastic simulations and physical tests have shown that the looser zones control the stability of the overall soil mass. This characteristic state has been assessed by eye (as opposed to formal statistical processing), with the estimate that this characteristic state is about ψ_k = +0.09, possibly a little looser at depth.

E4.3.2 Undrained strengths: Peak and post-liquefaction

The peak undrained strength has been computed using the conventional 'total stress' method. Although vane shear test undertaken in conjunction with the 2017 CPTu campaign indicate a lower value, the coefficient adopted for the current analysis is N_{KT}=16; a value established at , Somincor after the extensive work on silts (Shuttle & Jefferies, 2016).

The strength computed on this basis is the results shown in grey in the middle plot of Figure E4-3 and corresponds to a peak undrained strength ratio s_u/σ_v' = 0.18.

As the current laboratory calibrations are generally considered to over-estimate actual strengths developed during liquefaction failures, the post-liquefaction strength is based on the computed state parameter as well as case-history experience. The strength computed on this basis is the results shown in green in the middle plot of Figure E4-3. This corresponds to a characteristic post-liquefaction undrained strength ratio $s_r/\sigma_v' = 0.09$, perhaps reducing to $s_r/\sigma_v' = 0.08$ at depth.

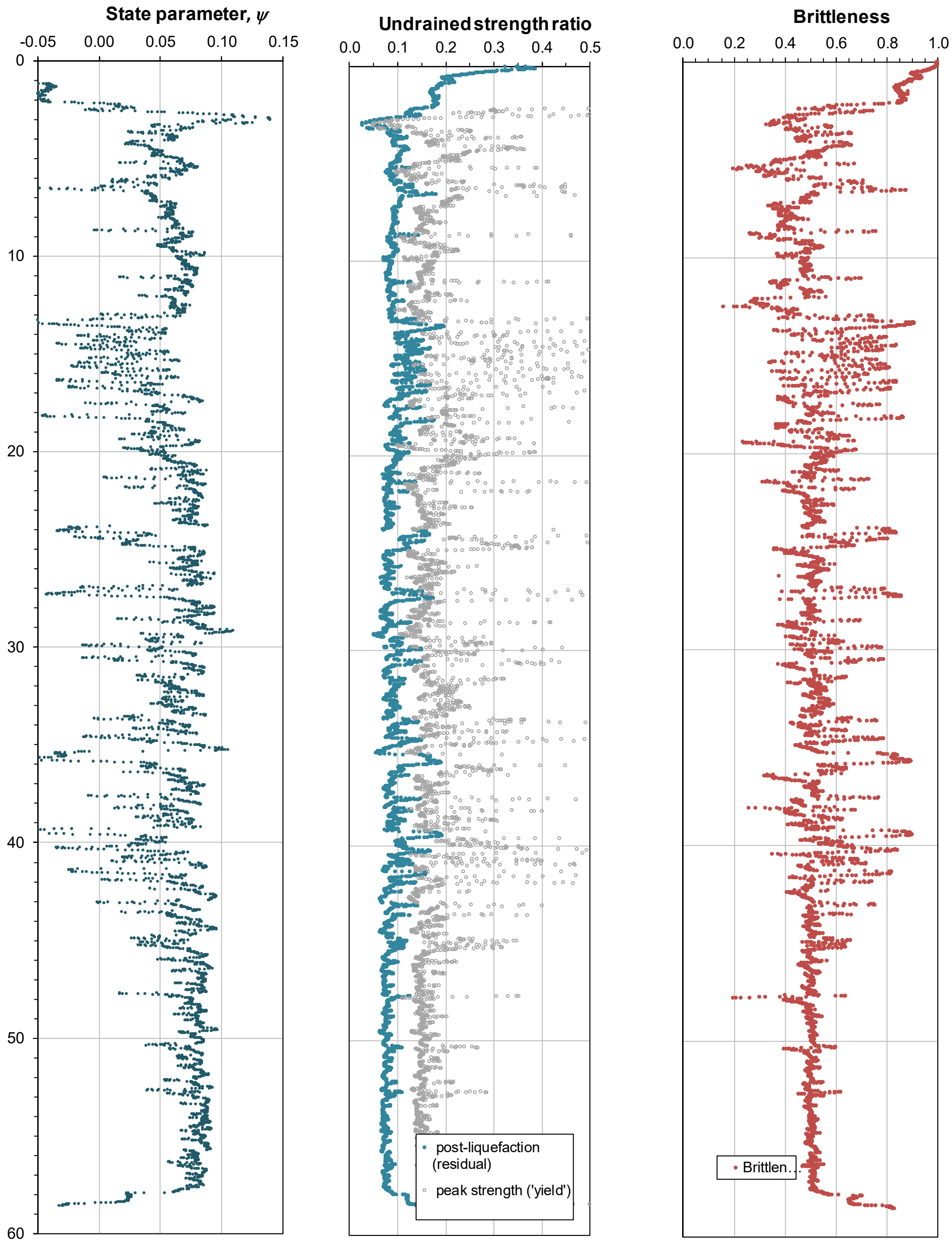


Figure E4-3: CPTu 2017 N04 state parameter, undrained strength ratios and brittleness

E4.3.3 Brittleness

Brittleness is the proportion of undrained strength lost on liquefaction. This has been computed from the strength profiles derived from the inferred state parameter (tip resistance method) and is shown on the right hand plot of Figure E4-3. Although this indicates ~60% loss of tailings strength on liquefaction, this may be an over-estimate as the observed post-liquefaction slopes at the NTSF slump are reasonably steep and would indicated a higher post -liquefaction strength.

The average brittleness (with standard deviation) and average critical state undrained shear strength ratio (Sadrekarimi, 2013) have been calculated for CPT N03 and N04 and are plotted on Figure E4-4. Figure E4-4 supports the view that the NTSF tailings are susceptible to liquefaction as the NTSF data lies within the zone where case histories of flow liquefaction have been reported (Robertson, 2010b).

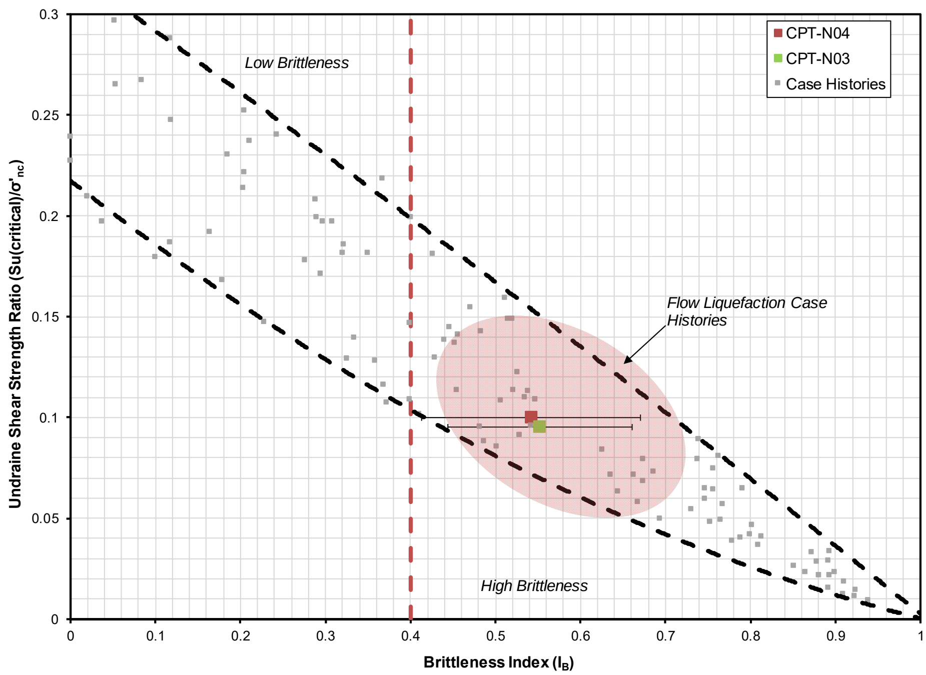


Figure E4-4: CPTu 2017- N04 - Robertson brittleness plot

E4.3.4 Validation Check

As part of the 2017 CPTu campaign, ATC Williams recovered high quality undisturbed samples using specialised sampling equipment. Further, they recognised the potential for sample disturbance, and sample handling procedures were established to minimise this. These samples were used to validate the state parameter determined from CPTu testing. This validation was undertaken in the following manner:

- This sample depth for each undisturbed sample was converted to an insitu mean effective stress using: the estimated saturated unit weight of the tailings; the measured pore water pressure from CPT dissipation tests; and, a geostatic stress ratio coefficient K_0=0.7.
- The critical void ratio was computed for the insitu mean effective stress using the critical state parameters for both the TC1 and TS1. Both CSL were used because the CPT show that layering of sandier and predominant-silt is pervasive in the depth range of these samples and the proportion of each layer in the tube is not known.
- The state parameter was calculated based on the initial void ratio reported for each undisturbed sample and the critical void ratios calculated for each CSL.

For each undisturbed sample, the range in computed state parameters are shown on Figure E4-5 together with the state parameter derived from the CPT, screened to remove sandy layers.

The range of insitu ψ estimated from the tube samples generally straddles the profile of ψ computed from the CPT and provides a first-order validation of the insitu state parameter. However, as there are uncertainties in each method of estimating ψ, the analysis presented here is in the nature of an 'engineering check' rather than a formal validation.

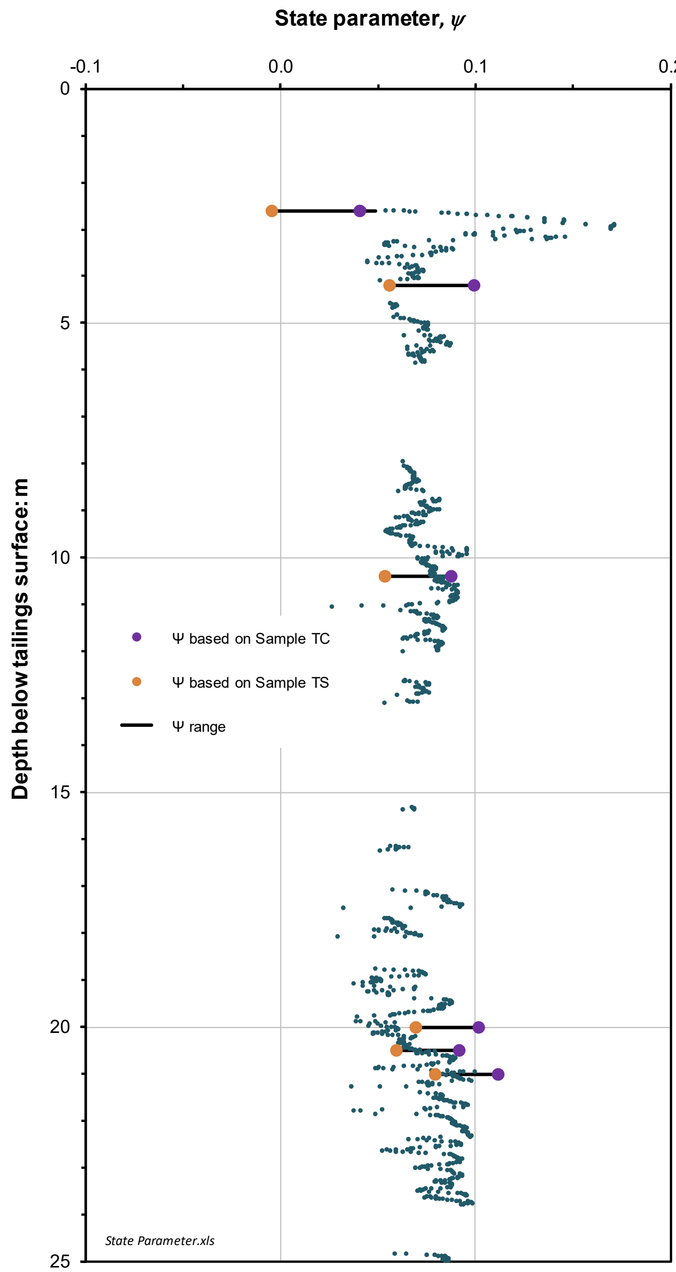


Figure E4-5: Comparison of ψ determined from CPT N04 and undisturbed samples

E5. References

Ghatfhazi, M., & Shuttle, D. (2008). Interpretation of sand state from cone penetration resistance. *Geotechnique, Vol. 58, Issue 8*.

Jefferies, M., & Been, K. (2016). *Soil Liquefaction.* CRC Press.

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Robertson, P. (2010b). Evaluation of Flow Liquefaction: influence of high stresses. *Performance Based Design in Earthquake Geotechnical Engineering.* Vancouver.

Sadrekarimi, A. (2013). Influence of state and compressibility on liquefied strength of sands. *Canadian Geotechnical Journal, Vol. 50*, 1067-1076.

Shuttle, D., & Cunning, J. (2007). Liquefaction potential of silts from CPTu. *Canadian Geotechnical Journal, Vol. 44*.

Shuttle, D., & Cunning, J. (2008). Reply to the discussion by Roberston on "Liquefaction potential of silts from CPTu". *Canadian Geotechnical Journal Vol. 45*.

Shuttle, D., & Jefferies, M. (2016). Determining silt state from CPTu. *Geotechnical Research Vol. 3 Issue 3*.

Annexure EA
Figures

Figure E1 Location of CPTu

NOTES.

1. ALL DIMENSIONS, ELEVATIONS AND COORDINATES ARE IN METERS, EXCEPT WHERE INDICATED OTHERWISE.
2. HORIZONTAL DATUM CORRESPONDS TO GDA 94 MGA ZONE 55.
3. VERTICAL DATUM CORRESPONDS TO AHD.
4. LiDAR SURVEY COMPLETED BY AAM ON THE 19TH OF MARCH 2018.
5. GEOLOGY BASED ON NEWCREST GEOLOGICAL MAP DATED 24/05/2000.

LEGEND

- "2013 URS INVESTIGATION" CPT
- "2017 ATCW TAILINGS INVESTIGATION" CPT AND VWP

NTSF PLAN WITH CPTs

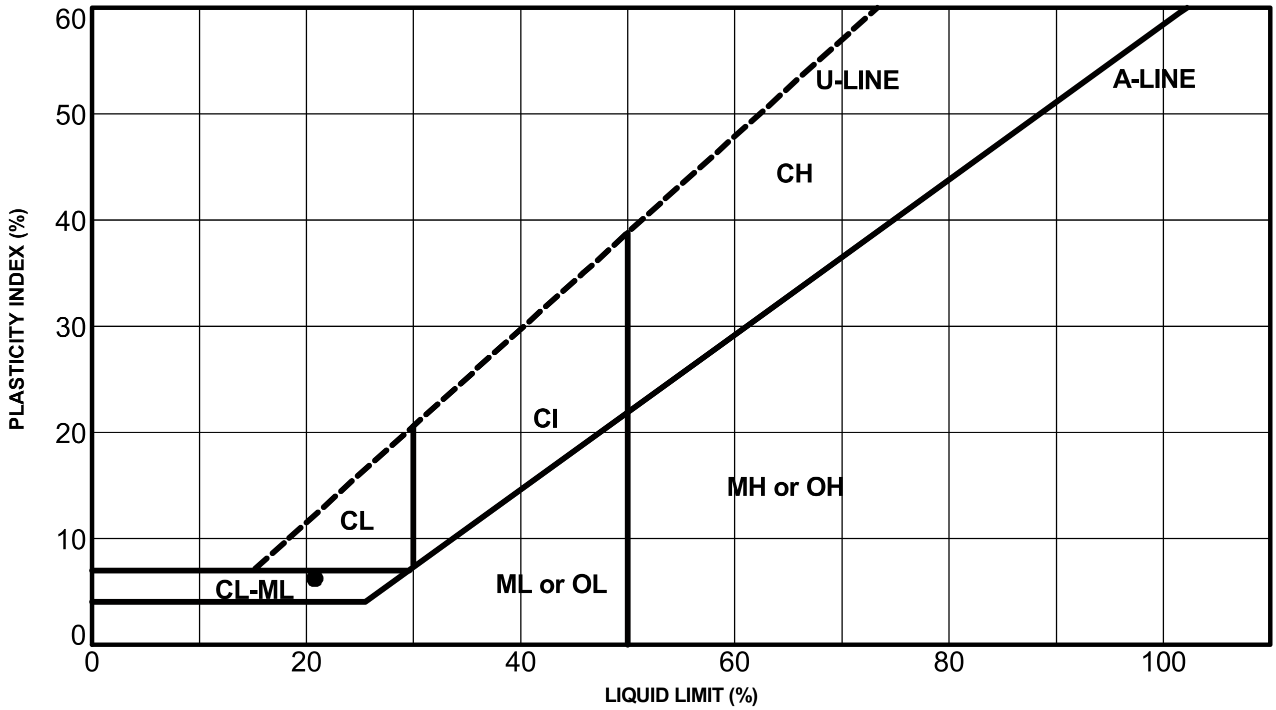
CADIA NTSF FAILURE INDEPENDENT TECHNICAL REVIEW BOARD

FIGURE E1

DESIGNED	DRAWN	APPROVED
IG	PK	
DATE	DWG. No.	
13-12-2018	H356804-00000-22A-272-0005	

Annexure EB
Index Tests

PLASTICITY CHART

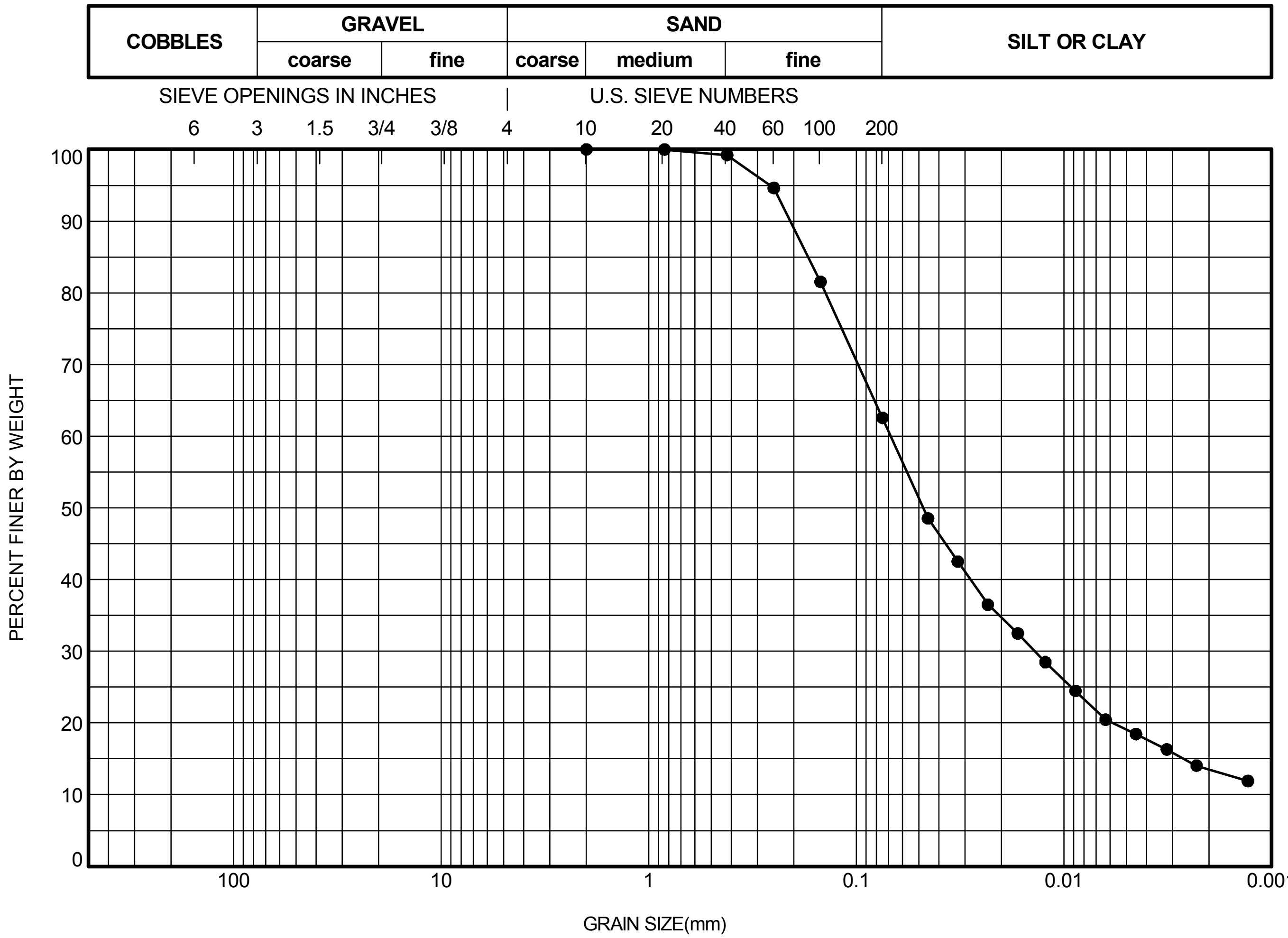


	HOLE	SAMPLE	DEPTH (m)	W_L	W_P	PI	% FINES	REMARKS/SAMPLE DESCRIPTION
●	Tailing		0.0	21	15	6	62.6	

Klohn Crippen Berger

PROJECT NO.: A03353A01	
PROJECT: NWM CVO NTSF	
LOCATION: Australia	
FIGURE:	
DRAWN BY: CM	**CHECKED BY:** JG

GRAIN SIZE DISTRIBUTION



	HOLE	DEPTH (m)	D85	D60	D30	D10	CC	CU	%GRAVEL	%SAND	%FINES
●	Tailing	0.0	0.171	0.068	0.014				0.0	37.4	62.6

	HOLE	SAMPLE	DEPTH (m)	W%	W_L	W_P	PI	REMARKS / SAMPLE DESCRIPTION
●	Tailing		0.0		21	15	6	

CU = COEFFICIENT OF UNIFORMITY = D60/D10 PARTICLE SIZES, e.g. D85, in mm Tested by Wet Sieving Method (ASTM D6913 & ISO/TS 17892-4)

Klohn Crippen Berger

PROJECT NO.: A03353A01	
PROJECT: NWM CVO NTSF	
LOCATION: Australia	
FIGURE:	
DRAWN BY: CM	**CHECKED BY:** JG

KCB_GRAIN_SIZE-SI GINT TEMPLATE.GPJ SIEVE.GDT 18-1-19

SPECIFIC GRAVITY OF SOIL SOLIDS (ASTM-D854)

Hole Number	Tailing					
Sample Number						
Depth (m)						
Sample Description						
Flask No.	SG9					
Volume of Flask @ 20^o C ml	500					
Method of Air removal	Boil					
De-airing Period hr	2					
Test temperature ^{o} C	26.4					
Mass of Flask+Water (M_a) g	667.42					
Mass of Flask+Water+Soil (M_b) g	729.64					
Mass of Dish/Flask+Soil	267.84					
Mass of Dish/Flask	169.68					
Mass of Dry Soil (M_o) g	98.16					
Correction factor (K) @ Test Temperature	0.99847					
Specific Gravity of Solids @ 20^o C	**2.727**					
Average Specific Gravity of Solids @ 20^o C	**2.73**					

Hole Number						
Sample Number						
Depth (m)						
Sample Description						
Flask No.						
Volume of Flask @ 20^o C ml						
Method of Air removal						
De-airing Period hr						
Test temperature ^{o} C						
Mass of Flask+Water (M_a) g						
Mass of Flask+Water+Soil (M_b) g						
Mass of Dish/Flask+Soil						
Mass of Dish/Flask						
Mass of Dry Soil (M_o) g						
Correction factor (K) @ Test Temperature						
Specific Gravity of Solids @ 20^o C						
Average Specific Gravity of Solids @ 20^o C						

Specific Gravity of Solids @ 20^o C = $(K \times M_o)/(M_o + M_a - M_b)$

Klohn Crippen Berger

PROJECT#:	A03353A01		
PROJECT:	NWM CVO NTSF		
LOCATION:	Australia		
DATE:	2019-01-04		
TESTED BY:	CM	CHECKED BY:	JG

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ATTERBERG LIMITS TEST REPORT

Test Method: AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client	Hatch Pty Ltd	**Report No.**	18080165-AL
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	28/08/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080165	18080172	18080180	18080182	18080183	
Test Date	20/08/2018	20/08/2018	20/08/2018	23/08/2018	23/08/2018	
Client ID	CE408 - DH401	CE407 - DH402	CE407 - DH402	CE413 - DH404	CE406 - DH410	
Depth (m)	16.00	23.00	30.50	53.50-53.80	18.40-18.50	
Liquid Limit (%)	22	20	Not Obtainable	39	71	
Plastic Limit (%)	17	15	Not Obtainable	15	24	
Plasticity Index (%)	5	5	Non Plastic	24	47	
Linear Shrinkage (%)	2.0 *	2.0	Not Obtainable	12.5 +	19.0 +	
Moisture Content (%)	21.5	18.6	15.6	20.1	27.5	

Sample No.						
Test Date						
Client ID						
Depth (m)						
Liquid Limit (%)						
Plastic Limit (%)						
Plasticity Index (%)						
Linear Shrinkage (%)						
Moisture Content (%)						

<u>NOTES/REMARKS:</u> The samples were tested air dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

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ATTERBERG LIMITS TEST REPORT

Test Method: AS 1289 2.1.1, 3.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1

Client	Hatch Pty Ltd	**Report No.**	18080185-AL
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	28/08/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080185	18080187	18080189	18080192	18080196	18080197
Test Date	20/08/2018	20/08/2018	21/08/2018	21/08/2018	23/08/2018	20/08/2018
Client ID	CE408 - DH401 - PS1	CE408 - DH401 - PS3	CE407 - DH402 - PS1	CE413 - DH404 - PS2	CE407 - DH402 - PT3	CE412 - DH405 - PT2
Depth (m)	11.00-11.50	25.00-25.45	12.00-12.45	25.95-26.40	51.00-51.50	39.50-39.72
Liquid Limit (%)	21	Not Obtainable	21	18	51	81
Plastic Limit (%)	17	Not Obtainable	17	16	19	37
Plasticity Index (%)	4	Non Plastic	4	2	32	44
Linear Shrinkage (%)	1.0 *	Not Obtainable	1.0 *	0.5 *	15.0 +	17.5 +
Moisture Content (%)	20.2	17.8	23.1	21.6	23.2	48.5

Sample No.						
Test Date						
Client ID						
Depth (m)						
Liquid Limit (%)						
Plastic Limit (%)						
Plasticity Index (%)						
Linear Shrinkage (%)						
Moisture Content (%)						

NOTES/REMARKS: The samples were tested air dried, dry sieved and in a 125-250mm mould.

Sample/s supplied by the client * Cracking occurred + Curling occurred

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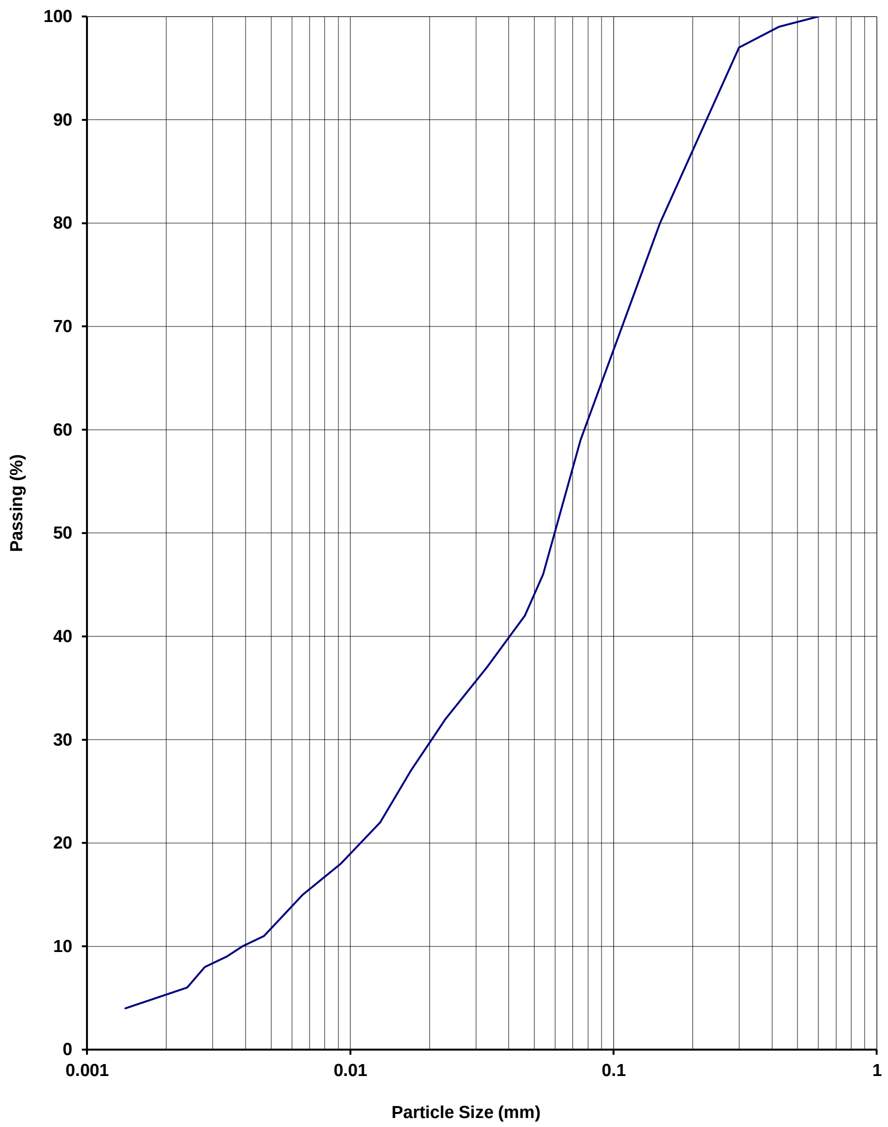
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18110735-G
		Workorder No.	0005180
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	25/11/18-29/11/18
		Report Date	29/11/2018
Project	Cadia NTSF Failure		
Client ID	CE408/DH401	**Depth (m)**	24.30

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	100
0.425	99
0.300	97
0.150	80
0.075	59
0.054	46
0.046	42
0.033	37
0.023	32
0.017	27
0.013	22
0.0092	18
0.0066	15
0.0047	11
0.0039	10
0.0034	9
0.0028	8
0.0024	6
0.0014	4



NOTES/REMARKS: -

Moisture Content 19.9% -2.36mm Soil Particle Density(t/m^3) 2.70

Sample/s supplied by the client

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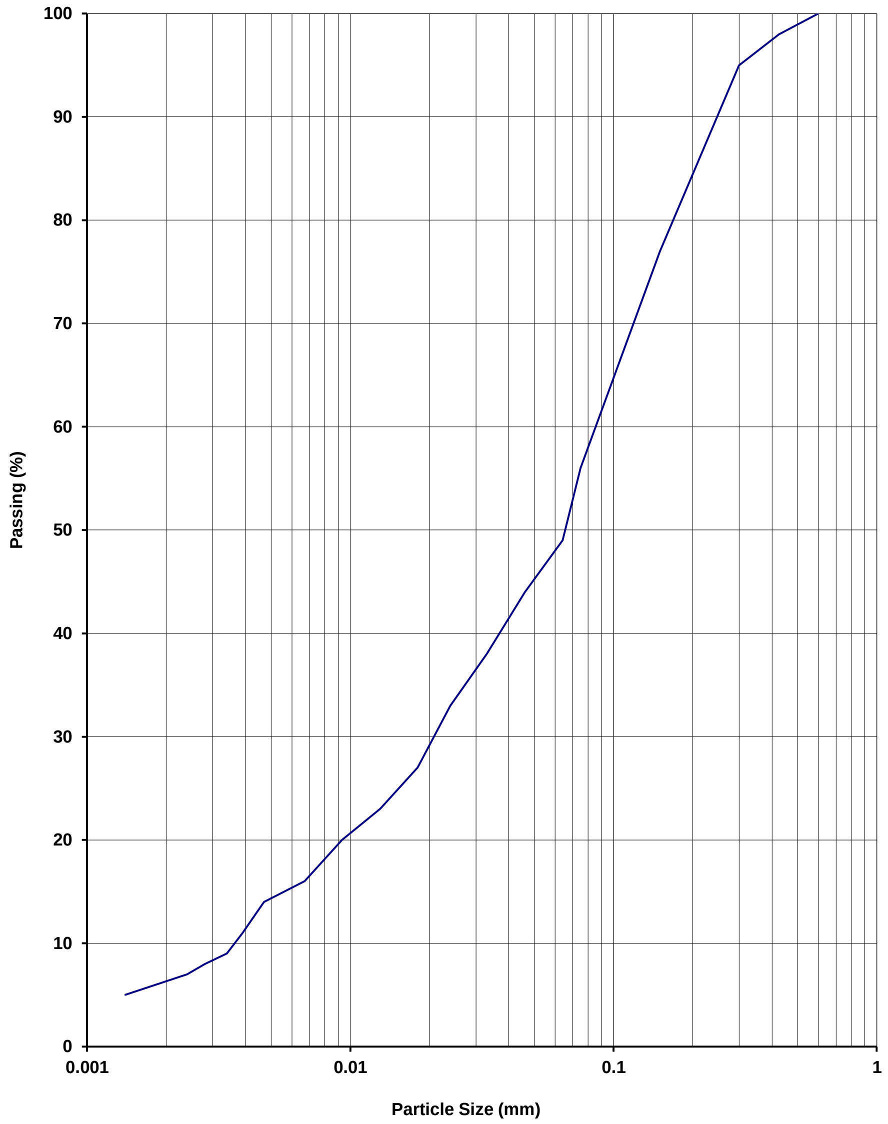
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18110738-G
		Workorder No.	0005180
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	21/11/18-29/11/18
		Report Date	29/11/2018
Project	Cadia NTSF Failure		
Client ID	CE408/DH401	**Depth (m)**	54.47

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	100
0.425	98
0.300	95
0.150	77
0.075	56
0.064	49
0.046	44
0.033	38
0.024	33
0.018	27
0.013	23
0.0093	20
0.0067	16
0.0047	14
0.0039	11
0.0034	9
0.0028	8
0.0024	7
0.0014	5



NOTES/REMARKS: -

Moisture Content 21.1% -2.36mm Soil Particle Density(t/m^3) 2.67

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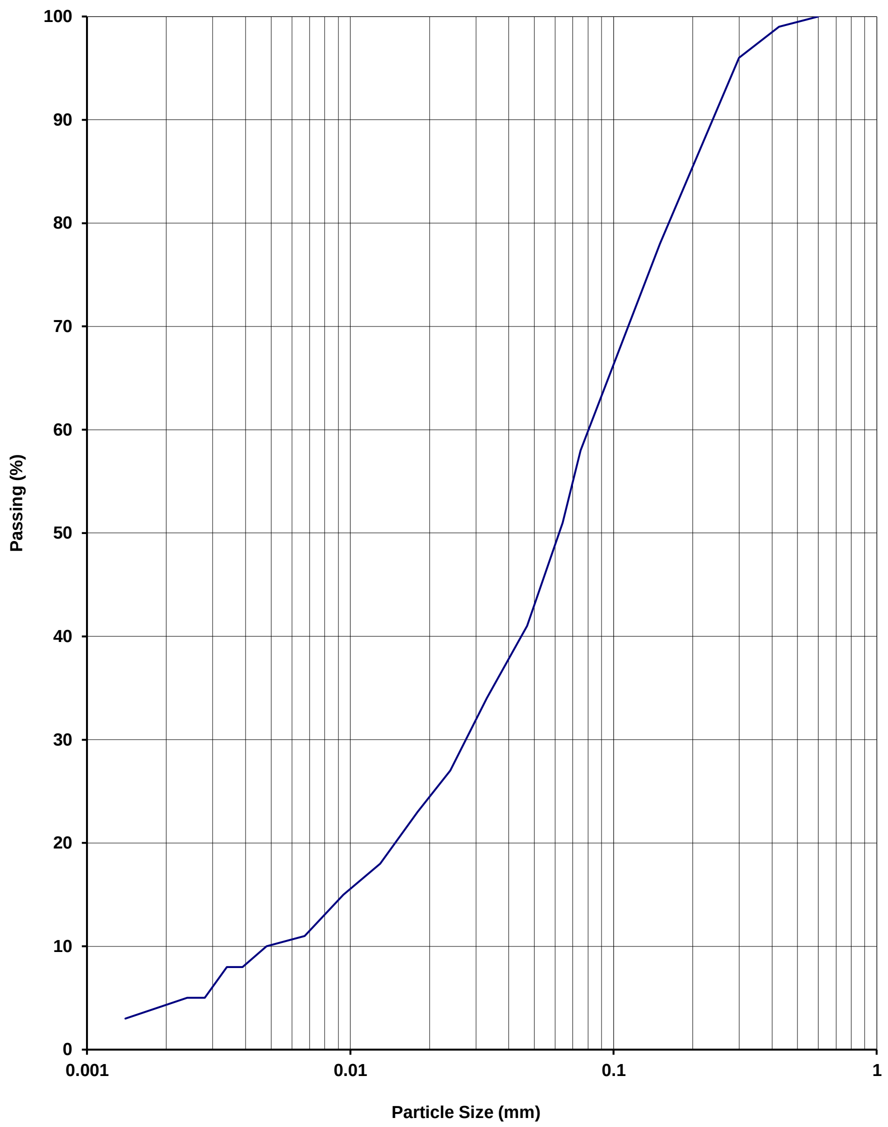
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18120386-G
		Workorder No.	0005297
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	12/12/18-18/12/18
		Report Date	18/12/2018
Project	H356804 Cadia NTSF Failure		
Client ID	Tailings TS1	**Depth (m)**	Not Supplied

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	100
0.425	99
0.300	96
0.150	78
0.075	58
0.064	51
0.047	41
0.033	34
0.024	27
0.018	23
0.013	18
0.0094	15
0.0067	11
0.0048	10
0.0039	8
0.0034	8
0.0028	5
0.0024	5
0.0014	3



NOTES/REMARKS: -

Moisture Content 17.5% -2.36mm Soil Particle Density(t/m^3) 2.67

Sample/s supplied by the client

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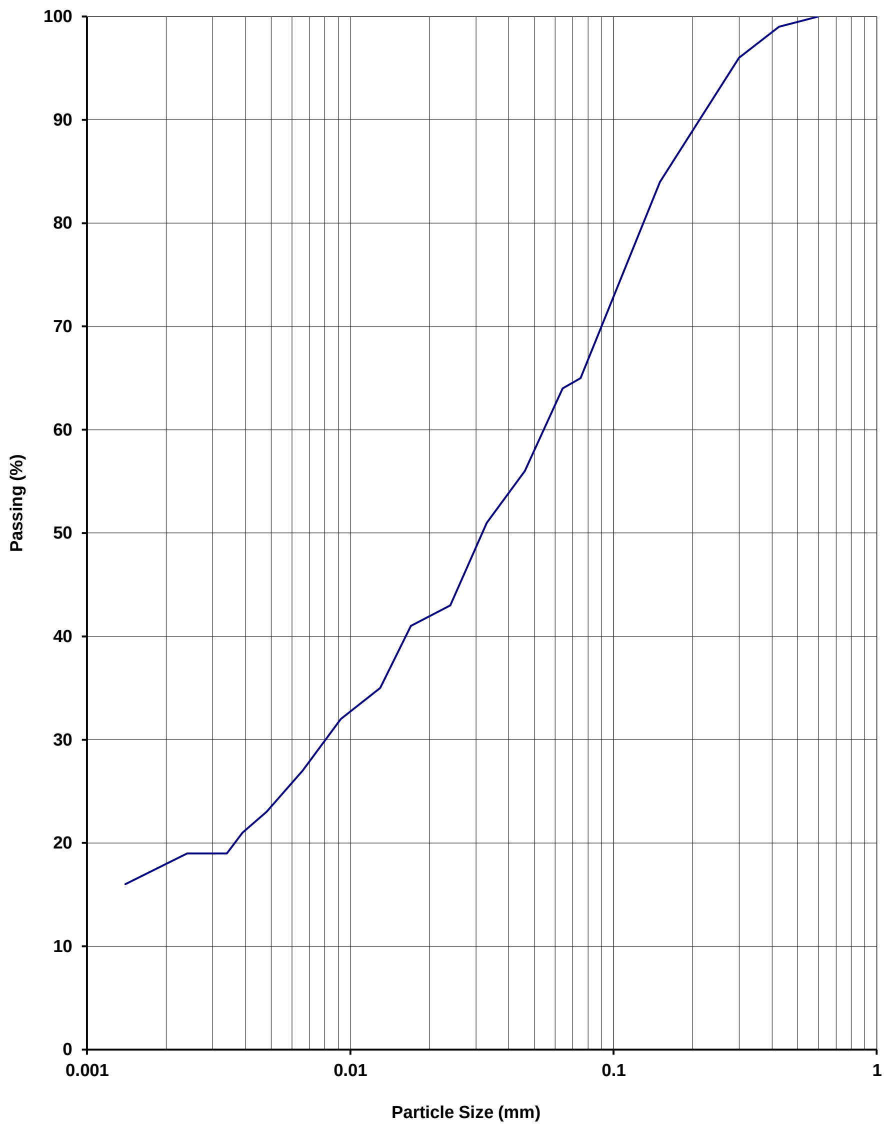
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18120520-G
		Workorder No.	0005334
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	18/12/18-4/1/19
		Report Date	4/1/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE413 - TC2	**Depth (m)**	15.00-16.50

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	100
0.425	99
0.300	96
0.150	84
0.075	65
0.064	64
0.046	56
0.033	51
0.024	43
0.017	41
0.013	35
0.0092	32
0.0066	27
0.0048	23
0.0039	21
0.0034	19
0.0028	19
0.0024	19
0.0014	16



NOTES/REMARKS: -

Moisture Content 20%   -2.36mm Soil Particle Density(t/m^3) 2.65

Sample/s supplied by the client

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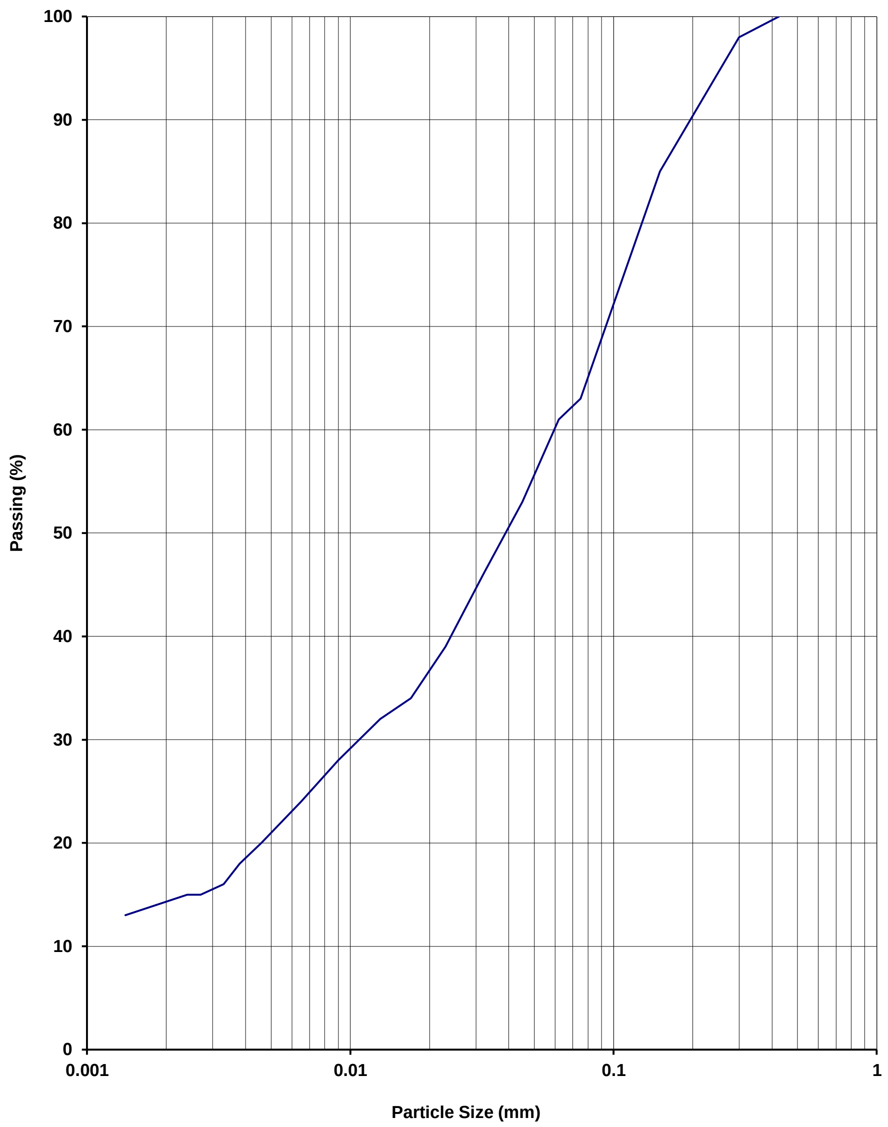
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18120521-G
		Workorder No.	0005334
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	158/12/18-4/1/19
		Report Date	4/1/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE413 - TC3	**Depth (m)**	27.00-28.50

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	
6.7	
4.75	
2.36	
1.18	
0.600	
0.425	100
0.300	98
0.150	85
0.075	63
0.062	61
0.045	53
0.032	46
0.023	39
0.017	34
0.013	32
0.009	28
0.0065	24
0.0046	20
0.0038	18
0.0033	16
0.0027	15
0.0024	15
0.0014	13



NOTES/REMARKS: -

Moisture Content 19.2% -2.36mm Soil Particle Density(t/m^3) 2.73

Sample/s supplied by the client

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Perth
2 Kimmer Place,
Queens Park
WA 6107
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MOISTURE CONTENT TEST REPORT

Test Method: AS 1289 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080164-MC
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	22/08/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080164	18080166	18080168	18080169	18080170	18080171	18080173
Test Date	13/08/2018	13/08/2018	13/08/2018	13/08/2018	13/08/2018	13/08/2018	13/08/2018
Client ID	CE408 - DH401	CE408 - DH401	CE407 - DH402	CE407 - DH402	CE407 - DH402	CE407 - DH402	CE407 - DH402
Depth (m)	15.50	17.20	21.50	21.70	22.00	22.20	23.50
Moisture Content (%)	19.5	20.5	16.7	25.7	17.9	22.0	18.6

Sample No.	18080174	18080176	18080177	18080178	18080179	18080181	
Test Date	13/08/2018	13/08/2018	13/08/2018	13/08/2018	13/08/2018	13/08/2018	
Client ID	CE407 - DH402	CE407 - DH402	CE407 - DH402	CE407 - DH402	CE407 - DH402	CE407 - DH402	
Depth (m)	24.50	26.00	26.50	29.30	29.80	31.10	
Moisture Content (%)	21.1	17.6	21.0	21.7	18.6	17.2	

Sample No.							
Test Date							
Client ID							
Depth (m)							
Moisture Content (%)							

NOTES/REMARKS:

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

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346A Bilsen Road,
Geebung
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Ph: +61 8 9258 8323

MOISTURE CONTENT TEST REPORT

Test Method: AS 1289 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18110734-MC
		Workorder No.	0005180
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	03/12/2018
Project	Cadia NTSF Failure		

Sample No.	18110734	18110735	18110736	18110737	18110738	18110739	18110740
Test Date							
Client ID	CE408/DH40 1	CE408/DH40 1	CE408/DH40 1	CE408/DH40 1	CE408/DH40 1	CE408/DH40 1	CE408/DH40 1
Depth (m)	24.40	24.30	24.20	54.54	54.47	54.39	54.30
Moisture Content (%)	22.0	19.9	19.8	20.8	21.1	20.9	18.4

Sample No.							
Test Date							
Client ID							
Depth (m)							
Moisture Content (%)							

Sample No.							
Test Date							
Client ID							
Depth (m)							
Moisture Content (%)							

NOTES/REMARKS:

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

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SOIL PARTICLE DENSITY TEST REPORT

Test Method: AS 1289 3.5.1

Client	Hatch Pty Ltd	**Report No.**	18080190-SG
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	22/08/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080190	18080191	18080193				
Test Date	16/08/2018	16/08/2018	20/08/2018				
Client ID	CE407 - DH402 - PS2	CE413 - DH404 - PS1	CE413 - DH404 - PS3	-	-	-	-
Depth (m)	21.00-21.50	13.80-14.25	34.00-34.45	-	-	-	-
Soil Particle Density (t/m³) (-2.36mm)	2.77	2.70	2.65				
Soil Particle Density (t/m³) (+2.36mm)	-	-	-				
Total Soil Particle Density (t/m³)	2.77	2.7	2.65				

Sample No.							
Test Date							
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Soil Particle Density (t/m³) (-2.36mm)							
Soil Particle Density (t/m³) (+2.36mm)							
Total Soil Particle Density (t/m³)							

NOTES/REMARKS:

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Trilab
Soil Rock Calibration

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UNIT WEIGHT TEST REPORT

Test Method: AS 1289 6.4.1

Client	Hatch Pty Ltd	**Report No.**	18080190-UW
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	14/08/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080190	18080191	18080193	18080197	-	-	-
Test Date	10/08/2018	10/08/2018	10/08/2018	10/08/2018	-	-	-
Client ID	CE407 - DH402 - PS2	CE413 - DH404 - PS1	CE413 - DH404 - PS3	CE412 - DH405 - PT2	-	-	-
Depth (m)	21.00-21.50	13.80-14.25	34.00-34.45	39.50-39.72	-	-	-
Moisture (%)	17.8	21.3	23.2	48.5	-	-	-
Wet Density (t/m³)	2.11	1.95	1.95	1.70	-	-	-
Dry Density (t/m³)	1.79	1.61	1.59	1.14	-	-	-

Sample No.	-	-	-	-	-	-	-
Test Date	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Moisture (%)	-	-	-	-	-	-	-
Wet Density (t/m³)	-	-	-	-	-	-	-
Dry Density (t/m³)	-	-	-	-	-	-	-

NOTES/REMARKS:

Sample/s supplied by the client

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Park

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory No. 9926

Annexure EC
X Ray Diffraction (XRD) Analysis

microanalysis australia

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1340
Sample: 18_1340_03
Client ID: HA401 0-2m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th August 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

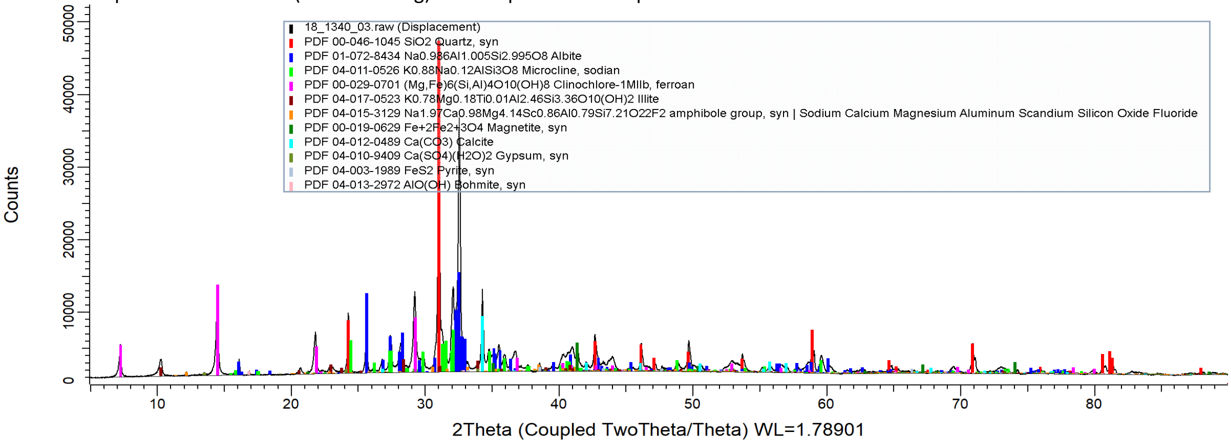
Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.3. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary
The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Albite (Na0.986Al1.005Si2.995O8)	34	medium
Quartz, syn (SiO2)	21	good
Clinochlore-1MIIb, ferroan ((Mg,Fe)6(Si,Al)4O10(OH)8)	18	good
Microcline, sodian (K0.88Na0.12AlSi3O8)	15	medium
Illite (K0.78Mg0.18Ti0.01Al2.46Si3.36O10(OH)2)	4	medium
Calcite (Ca(CO3))	3	good
amphibole group, syn | Sodium Calcium Magnesium Aluminum Scandium Silicon Oxide Fluoride (Na1.97Ca0.98Mg4.14Sc0.86Al0.79Si7.21O22F2)	2	medium
Magnetite, syn (Fe+2Fe2+3O4)	1	medium
Gypsum, syn (Ca(SO4)(H2O)2)	trace	low
Pyrite, syn (FeS2)	trace	low
Bohmite, syn (AlO(OH))	trace	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Owen Carpenter, B.Sc.(Physics)
Reported: Owen Carpenter, B.Sc.(Physics)
Approved: Ian Davies, B.Sc.(Chemistry)

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1340
Sample: 18_1340_02
Client ID: TC1
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th August 2018 for the above mentioned analyses. A representative sub –sample was removed and lightly ground such that 90% was passing 20 µm. Grinding to this size helps eliminate preferred orientation.

Analysis

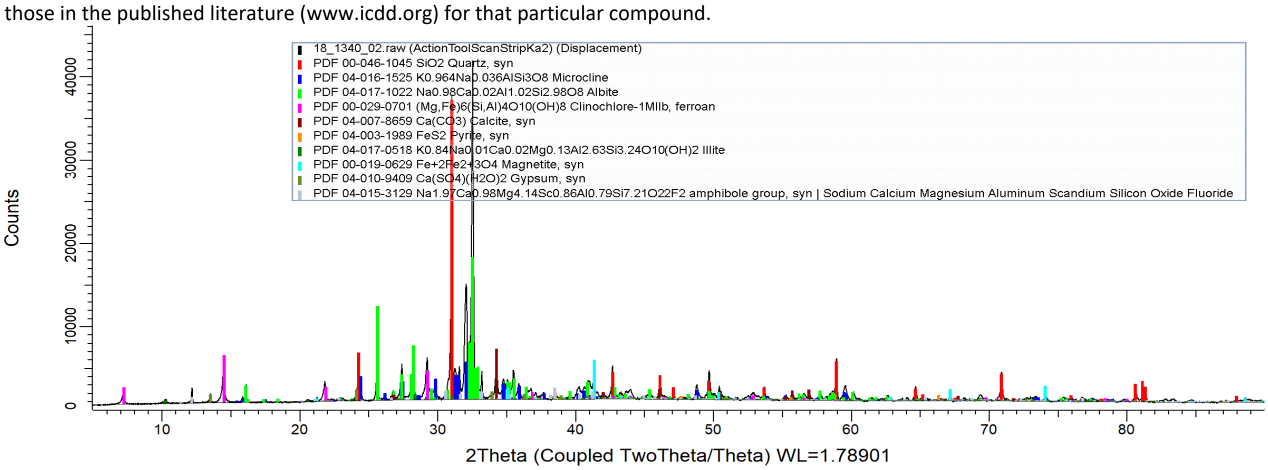
Only crystalline material present in the sample will give peaks in the XRD scan. Amorphous (non crystalline) material will add to the background. The search match software used was Eva 4.3. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for some attention to be paid to preferred orientation but is limited in considering substitution and lattice strain.

Summary
The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Albite (Na0.98Ca0.02Al1.02Si2.98O8)	46	medium
Quartz, syn (SiO2)	19	good
Microcline (K0.964Na0.036AlSi3O8)	14	medium
Clinochlore-1MIIb, ferroan ((Mg,Fe)6(Si,Al)4O10(OH)8)	9	good
amphibole group, syn | Sodium Calcium Magnesium Aluminum Scandium Silicon Oxide Fluoride (Na1.97Ca0.98Mg4.14Sc0.86Al0.79Si7.21O22F2)	4	medium
Calcite, syn (Ca(CO3))	3	good
Magnetite, syn (Fe+2Fe2+3O4)	2	good
Illite (K0.84Na0.01Ca0.02Mg0.13Al2.63Si3.24O10(OH)2)	2	medium
Gypsum, syn (Ca(SO4)(H2O)2)	1	low
Pyrite, syn (FeS2)	trace	low

The ICDD match probability is reported as an indication as to how well the peak positions and relative intensities for the sample matched those in the published literature (www.icdd.org) for that particular compound.



Analyst: Owen Carpenter, B.Sc.(Physics)
Reported: Owen Carpenter, B.Sc.(Physics)
Approved: Ian Davies, B.Sc.(Chemistry)

Annexure ED
Scanning Electron Microscopy (SEM)

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1340
Sample: 18_1340_03
Client ID: HA401 0-2m
Date: 20/08/2018
Analysis: Scanning electron microscopy (SEM) with elemental analysis by energy dispersive spectroscopy (EDS)

Sample preparation

The sample was supplied to Microanalysis Australia as solid particulate matter.

A sub-sample was removed and placed on top of a double sided carbon tab before being carbon coated. Non-conducting samples require coating prior to SEM analysis to prevent charging whilst being analysed by the electron beam.

Analysis

The sample was analysed using a Carl Zeiss EVO50 scanning electron microscope (SEM) fitted with an Oxford INCA X-Max energy dispersive spectrometer (EDS).

EDS is a semi-quantitative technique (at best) on well prepared, optically flat samples. Factors such as sample unevenness may adversely bias elemental concentration interpretation. EDS has a spatial resolution of ~5 µm meaning spectra from particles less than this size may contain elemental concentrations biased by their surroundings.

No calibration standards (standardless quant) were used in the EDS detector standardization prior to analysis.

Summary

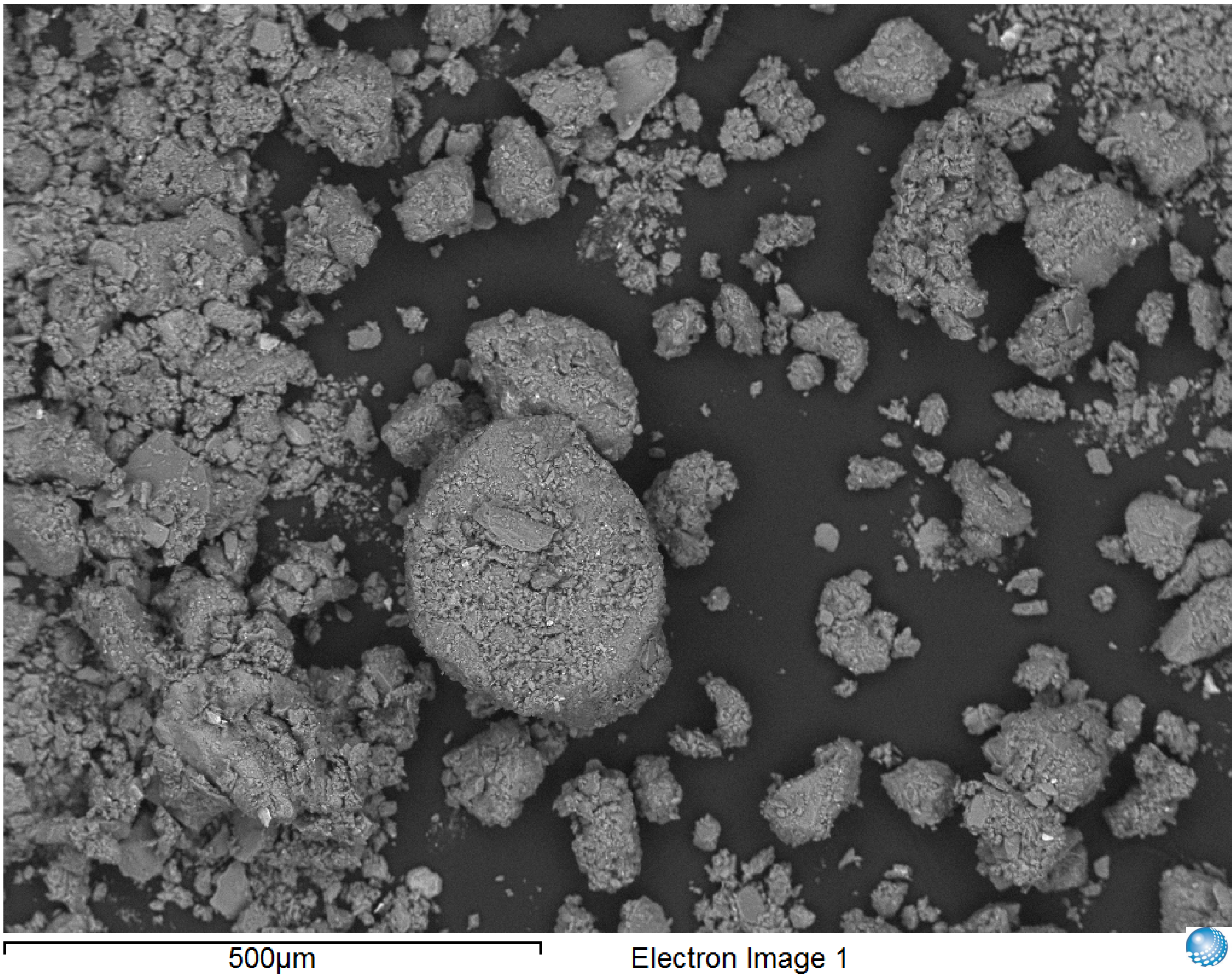
All images were acquired using backscatter electrons. Image contrast is directly proportional to average atomic number i.e. the brighter the area, the higher the atomic number.

Analyst: Greta Brodie, B.Sc. (Applied Chemistry)

Reported: Greta Brodie, B.Sc. (Applied Chemistry)

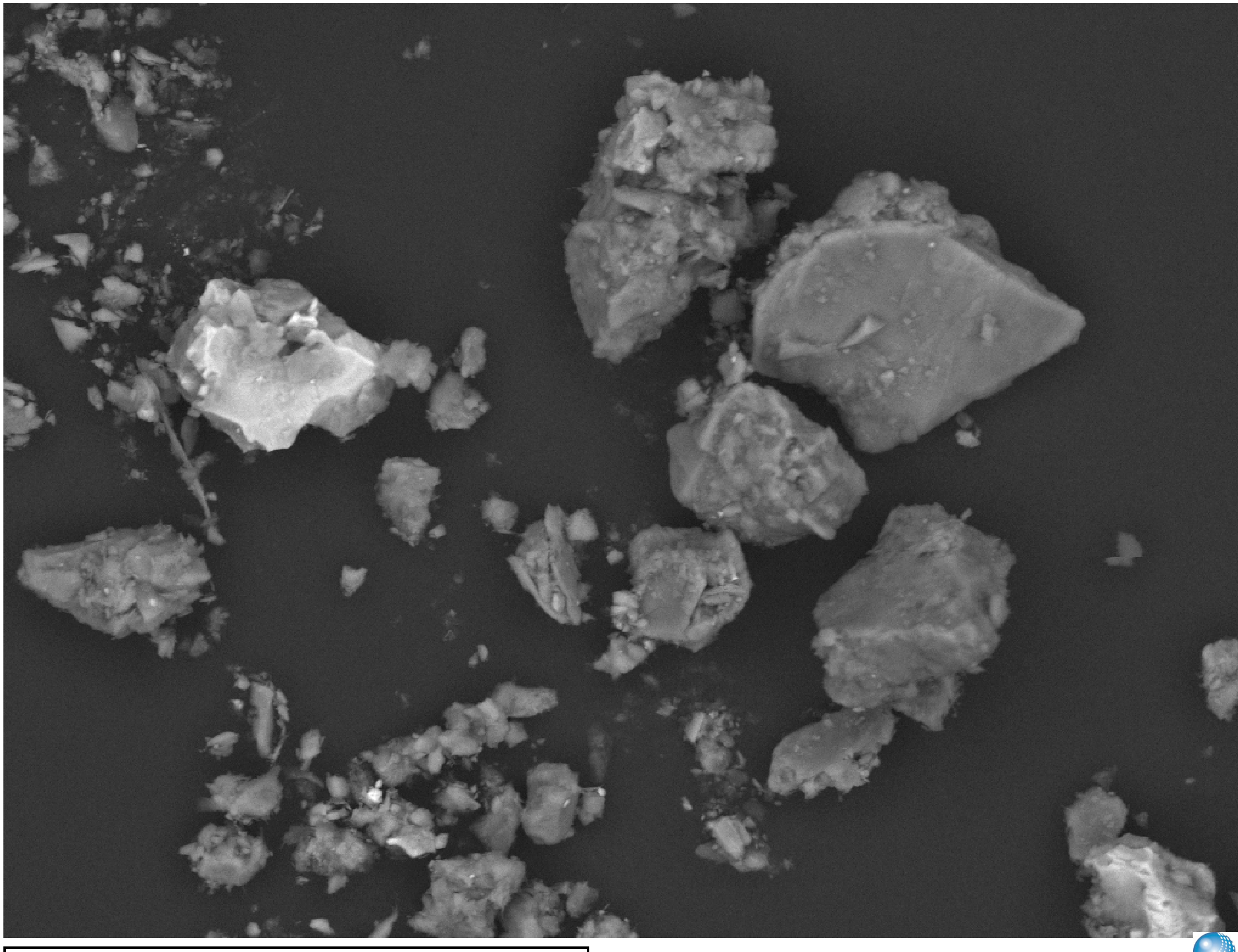
Approved: Nimue Pendragon, B.Sc.(Nanotechnology)

Sample: 18_1340_03 Type: Default ID: HA401 0-2m	Project: 18_1340 Owner: lab Site: Site of Interest 1



microanalysis australia

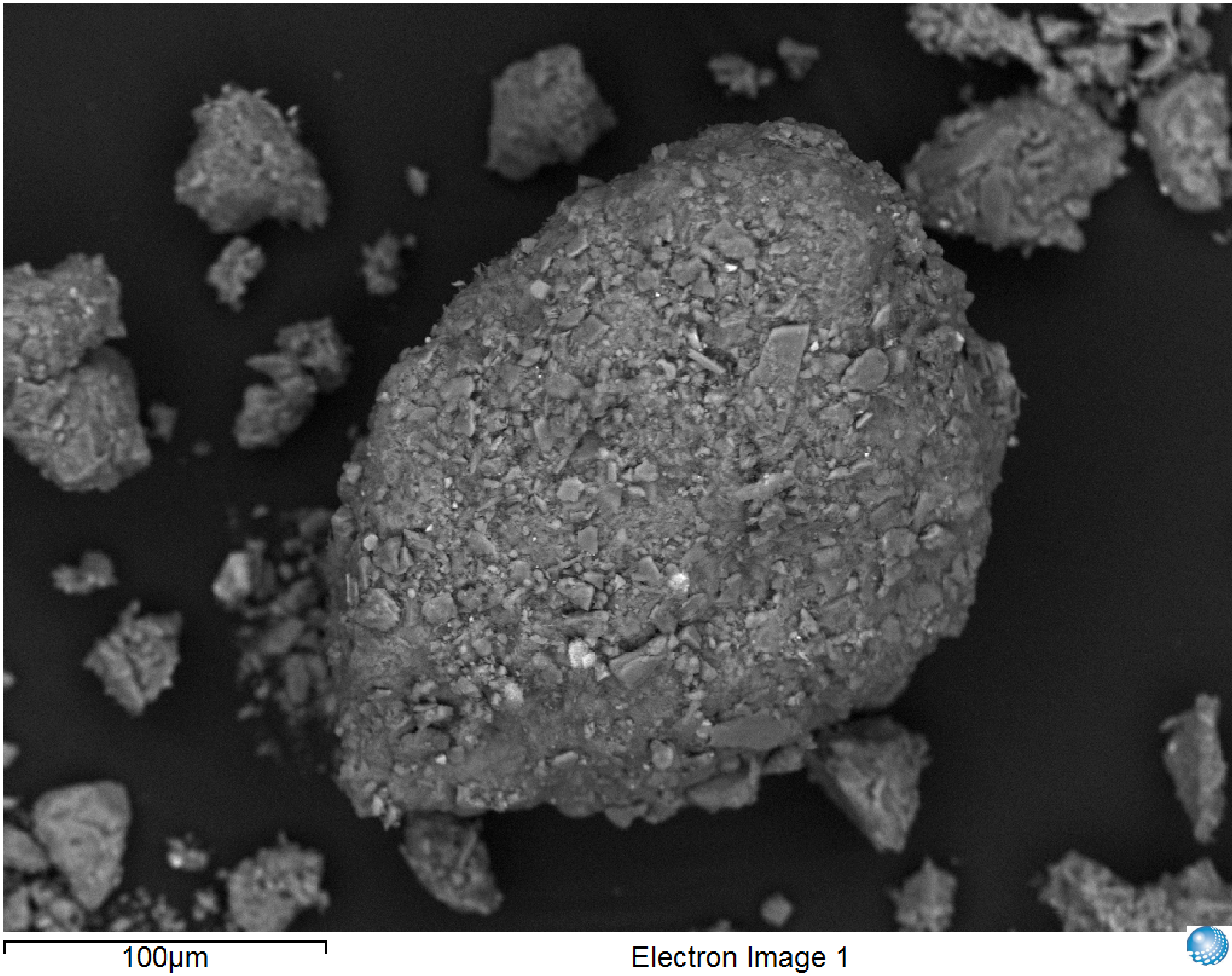
Sample: 18_1340_03 Type: Default ID: HA401 0-2m	Project: 18_1340 Owner: lab Site: Site of Interest 2



Electron Image 1

microanalysis australia

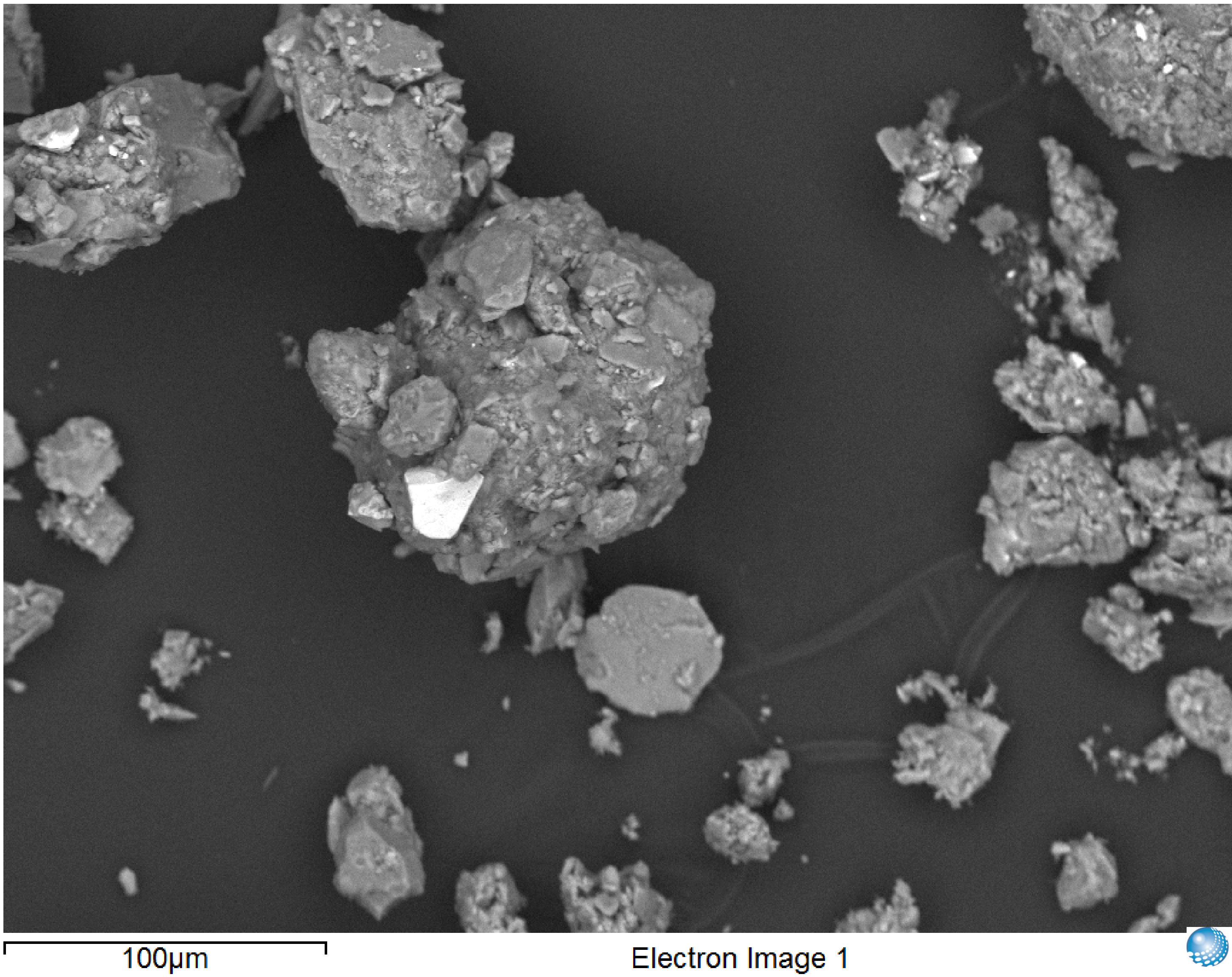
Sample: 18_1340_03 Type: Default ID: HA401 0-2m	Project: 18_1340 Owner: lab Site: Site of Interest 3



Electron Image 1

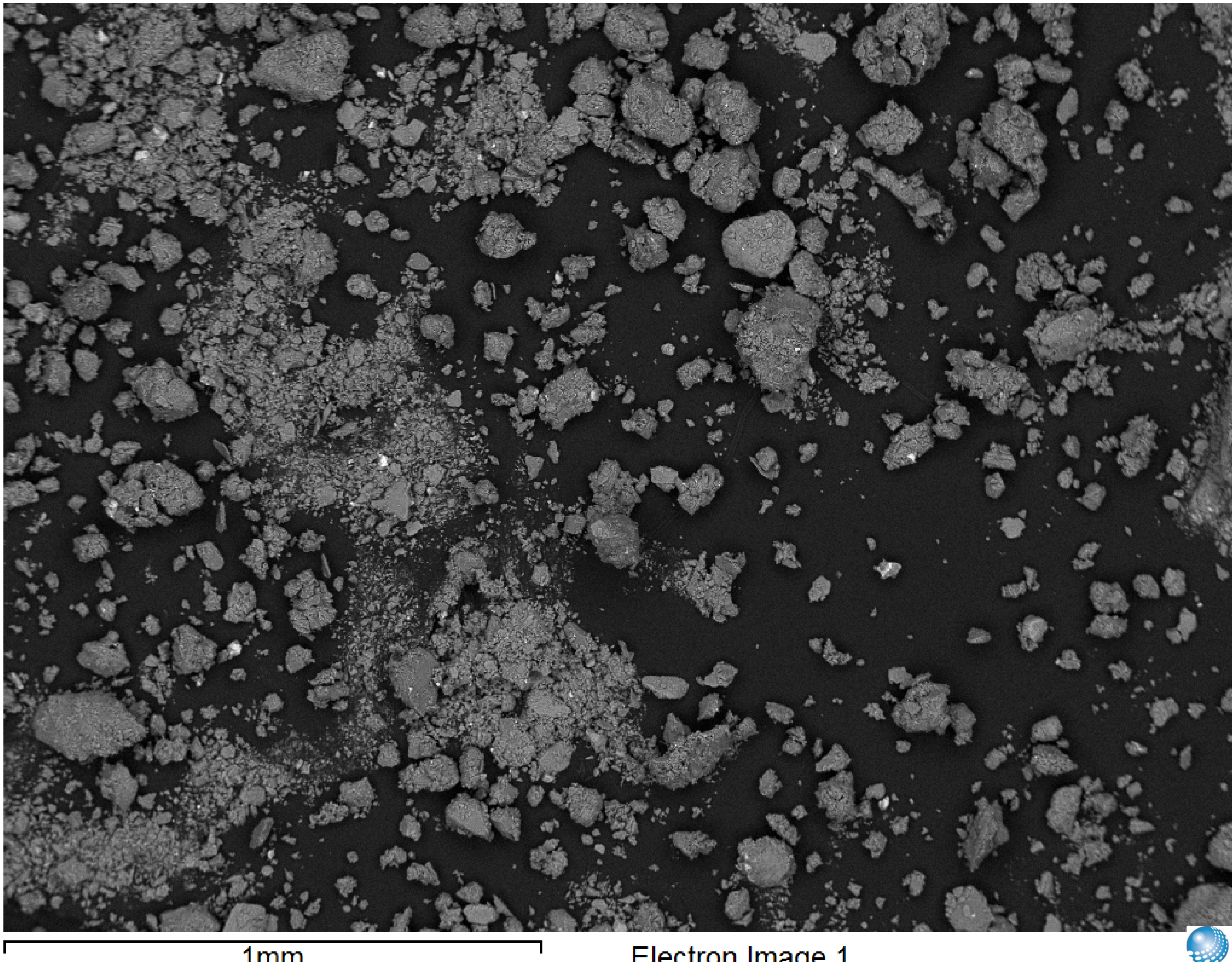
microanalysis australia

Sample: 18_1340_03 Type: Default ID: HA401 0-2m	Project: 18_1340 Owner: lab Site: Site of Interest 4



Electron Image 1

Sample: 18_1340_03 Type: Default ID: HA401 0-2m	Project: 18_1340 Owner: lab Site: Site of Interest 5



Electron Image 1

microanalysis australia

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1340
Sample: 18_1340_02
Client ID: TC1
Date: 20/08/2018
Analysis: Scanning electron microscopy (SEM) with elemental analysis by energy dispersive spectroscopy (EDS)

Sample preparation

The sample was supplied to Microanalysis Australia as solid particulate matter.

A sub-sample was removed and placed on top of a double sided carbon tab before being carbon coated. Non-conducting samples require coating prior to SEM analysis to prevent charging whilst being analysed by the electron beam.

Analysis

The sample was analysed using a Carl Zeiss EVO50 scanning electron microscope (SEM) fitted with an Oxford INCA X-Max energy dispersive spectrometer (EDS).

EDS is a semi-quantitative technique (at best) on well prepared, optically flat samples. Factors such as sample unevenness may adversely bias elemental concentration interpretation. EDS has a spatial resolution of ~5 µm meaning spectra from particles less than this size may contain elemental concentrations biased by their surroundings.

No calibration standards (standardless quant) were used in the EDS detector standardization prior to analysis.

Summary

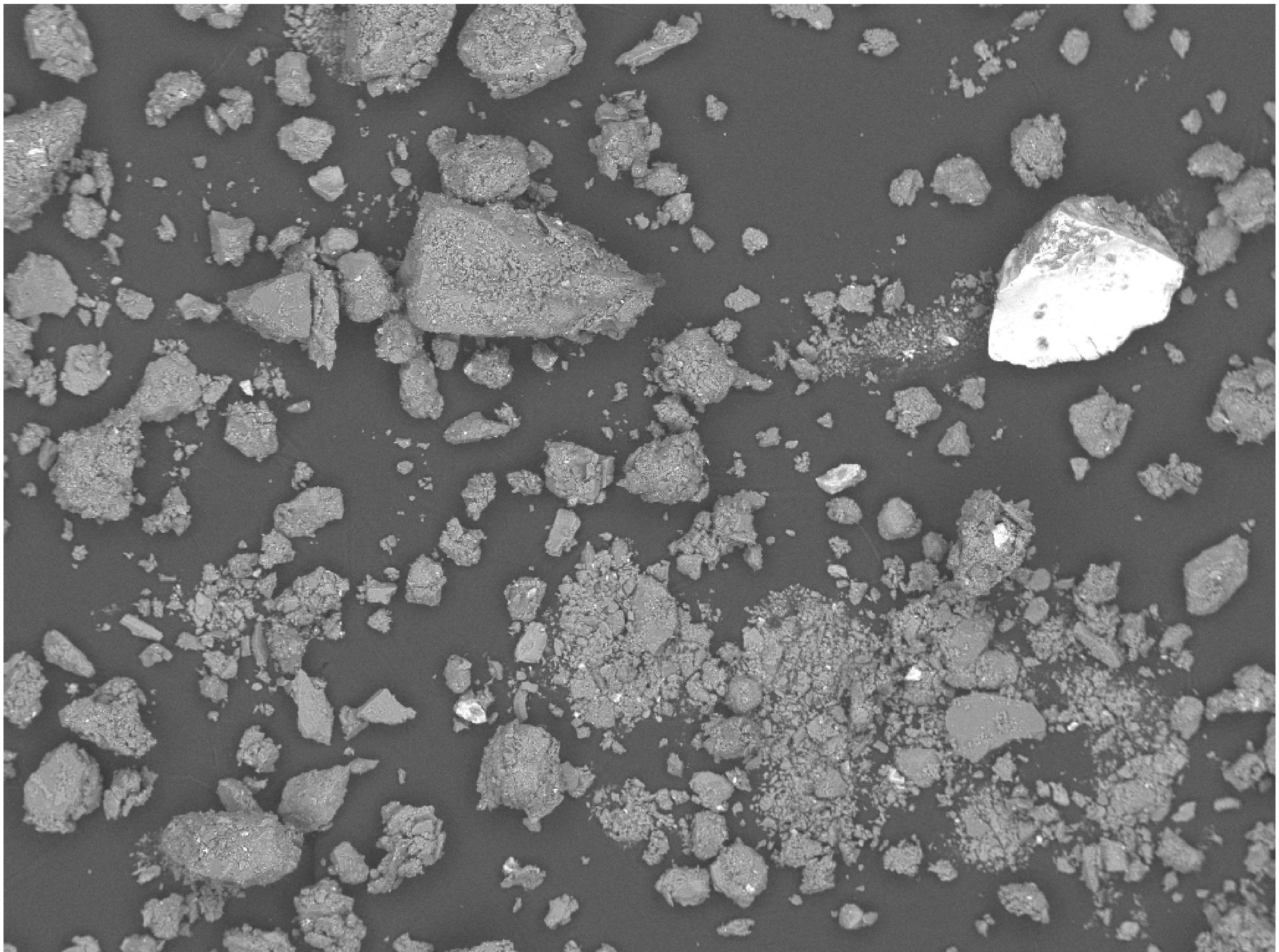
All images were acquired using backscatter electrons. Image contrast is directly proportional to average atomic number i.e. the brighter the area, the higher the atomic number.

Analyst: Greta Brodie, B.Sc. (Applied Chemistry)

Reported: Greta Brodie, B.Sc. (Applied Chemistry)

Approved: Nimue Pendragon, B.Sc.(Nanotechnology)

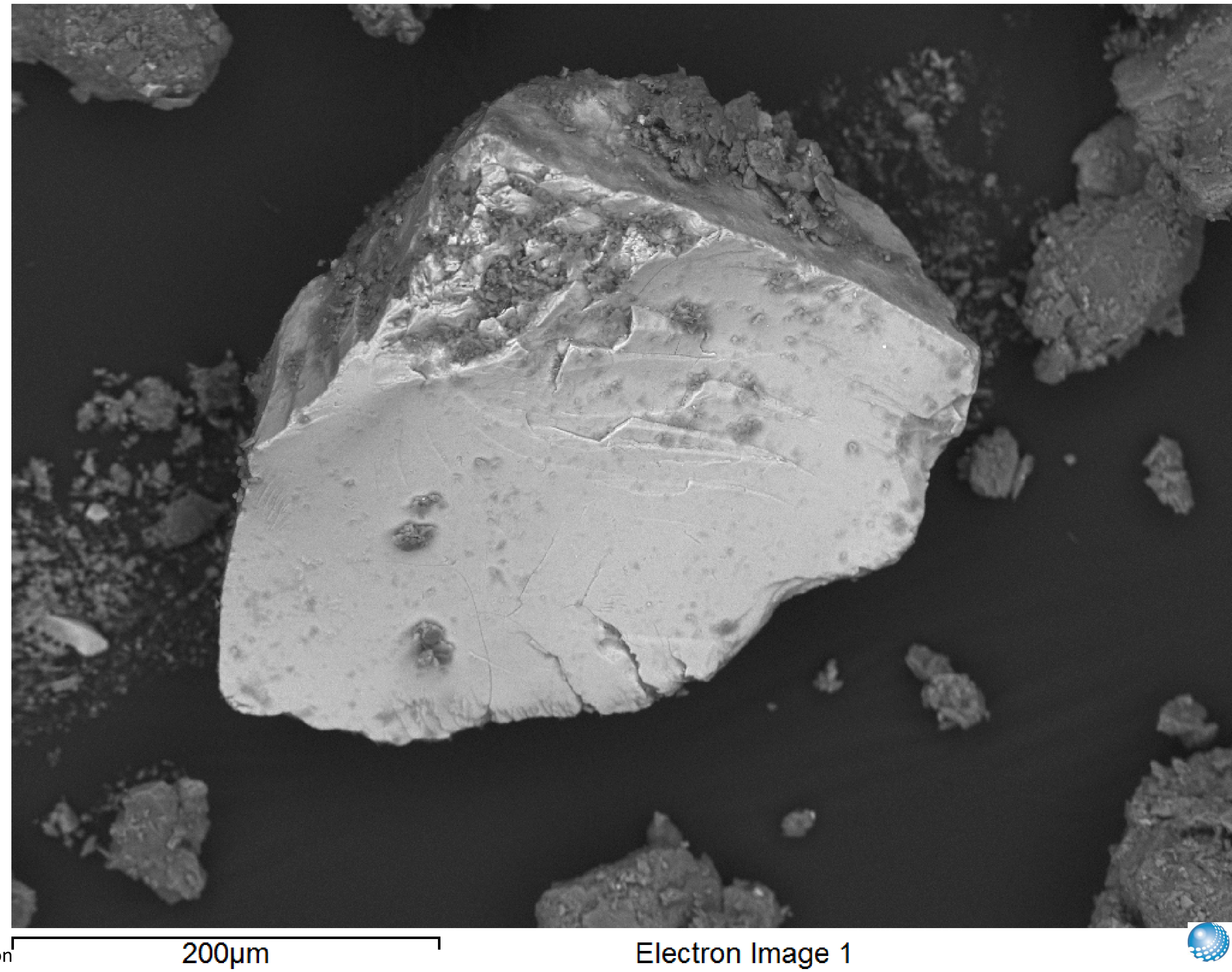
Sample: 18_1340_02 Type: Default ID: TC1	Project: 18_1340 Owner: lab Site: Site of Interest 1



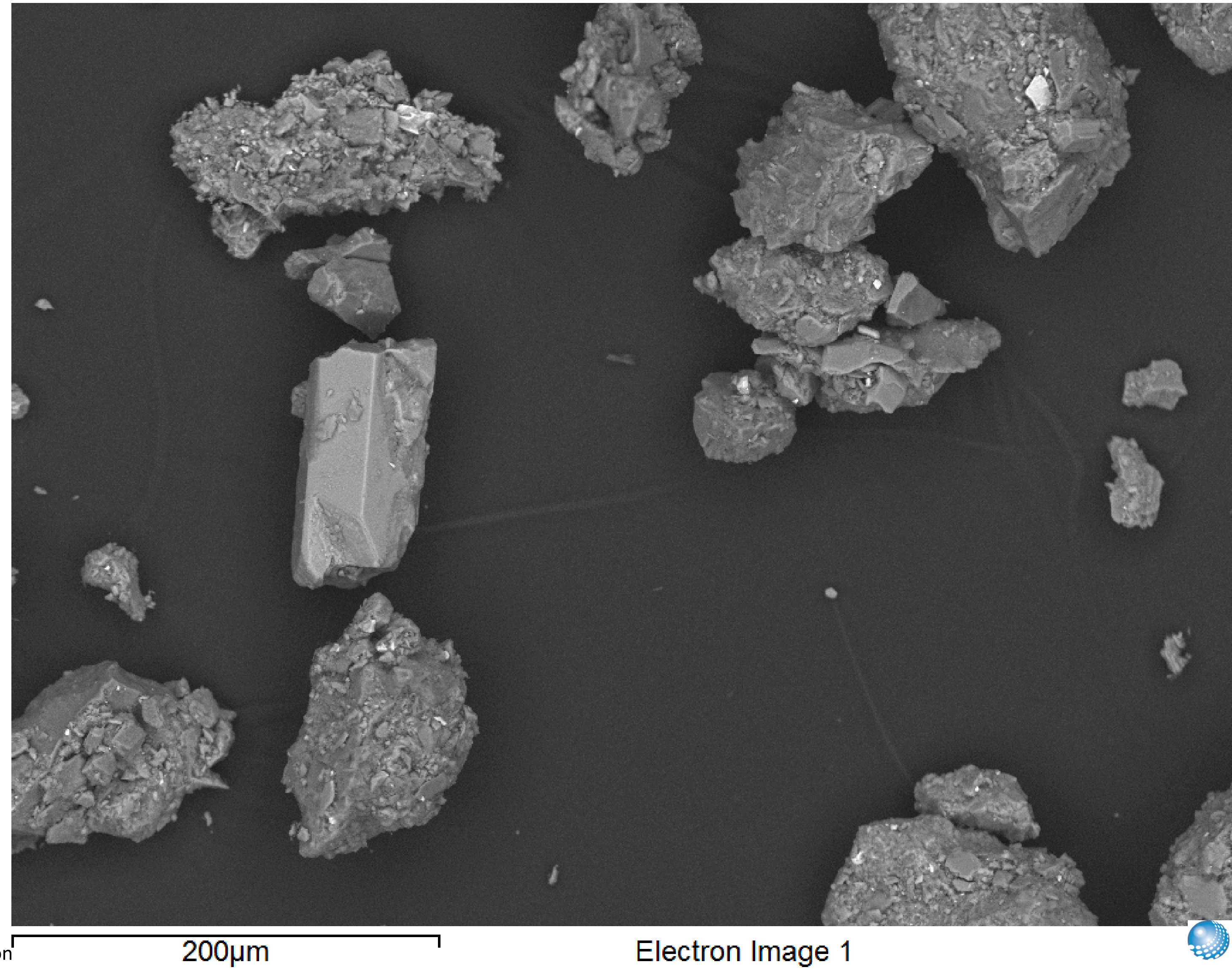
1mm

Electron Image 1

Sample: 18_1340_02 Type: Default ID: TC1	Project: 18_1340 Owner: lab Site: Site of Interest 2

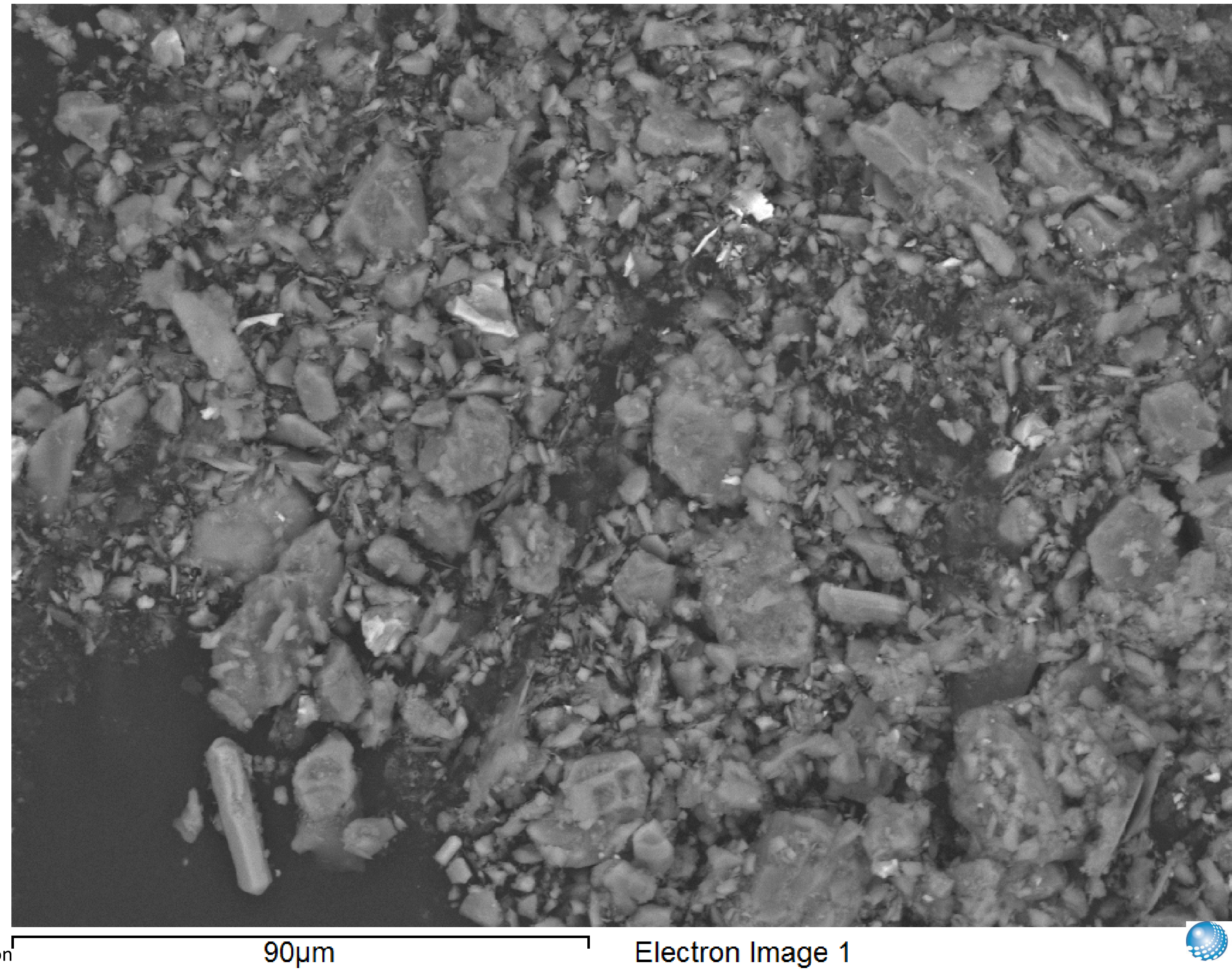


Sample: 18_1340_02 Type: Default ID: TC1	Project: 18_1340 Owner: lab Site: Site of Interest 3

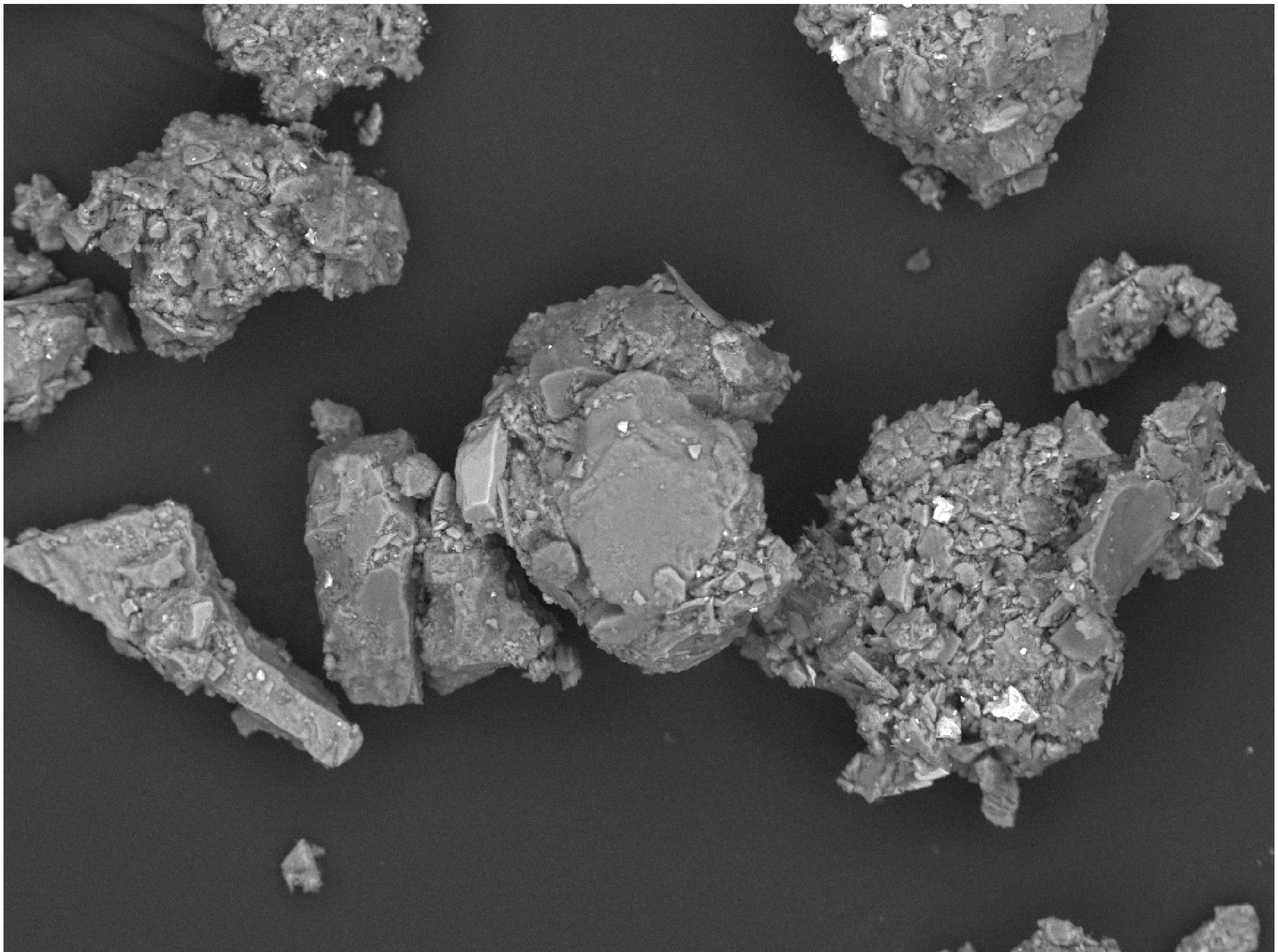


Be Con

Sample: 18_1340_02 Type: Default ID: TC1	Project: 18_1340 Owner: lab Site: Site of Interest 4



Sample: 18_1340_02 Type: Default ID: TC1	Project: 18_1340 Owner: lab Site: Site of Interest 5



200µm

Electron Image 1

microanalysis australia

Annexure EE
HA 401 - CSL Test Certificates

HA401

Golder (Perth) Testing

	As tested initial			At max dilation (=Dmin)		
Test ID	p0	e0	psi0	Dmin	eta_max	psi
RunOut_sa4-CID	300.9	0.510	0.055	0.000	0.545	0.045
RunOut_sa5-CID	801.7	0.460	0.054	0.000	0.517	0.048
RunOut_sa6-CID	50.7	0.400	-0.144	-0.440	1.870	-0.100
RunOut_sa7-CID	101.2	0.390	-0.119	-0.280	1.754	-0.094
RunOut_sa8-CID	800.9	0.330	-0.076	-0.153	1.631	-0.048

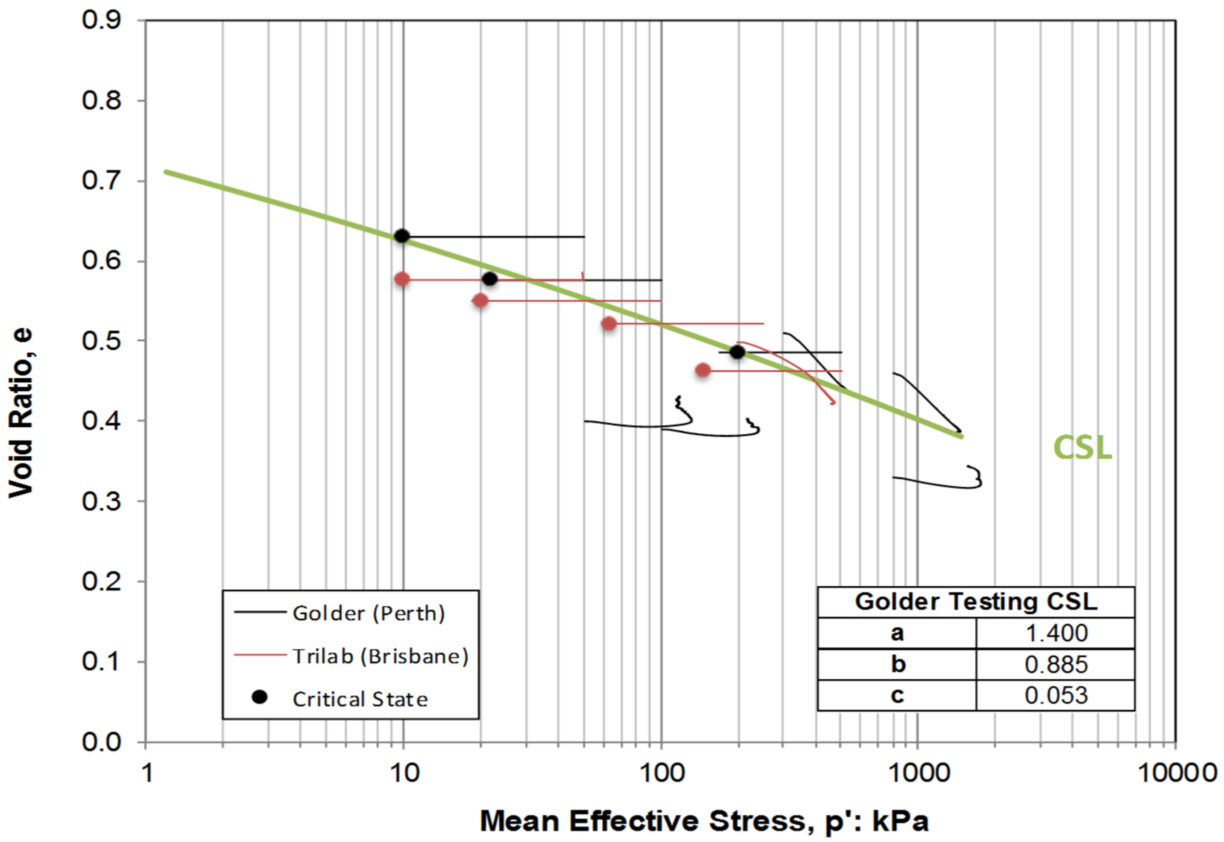
	As tested initial			at critical state	
	p0	e0	psi0	pc	ec
RunOut_sa1-CIU	50.1	0.630	0.085	10	0.630
RunOut_sa2-CIU	101.0	0.576	0.066	22	0.576
RunOut_sa3-CIU	501.6	0.486	0.057	202	0.486

Trilab (Brisbane) Testing

	As tested initial	
Test ID	p0	e0
18110416-CID	198.2	0.499

	As tested initial	
	p0	e0
18080184A-CIU	99.3	0.550
18080184B-CIU	250.3	0.522
18100437-CIU	49.6	0.586
18100438-CIU	498.3	0.463

Mtc	1.50
N	0.23
χ**tc**	4.6



Job number	H356804			**NTSF Failure Review**	**Newcrest**
Ref					NTSF
By	TMY	IAG	19-Mar-19	**Tailings Critical State**	
Revision		A	19-Mar-19	**Properties Summary**	**Figure 1**

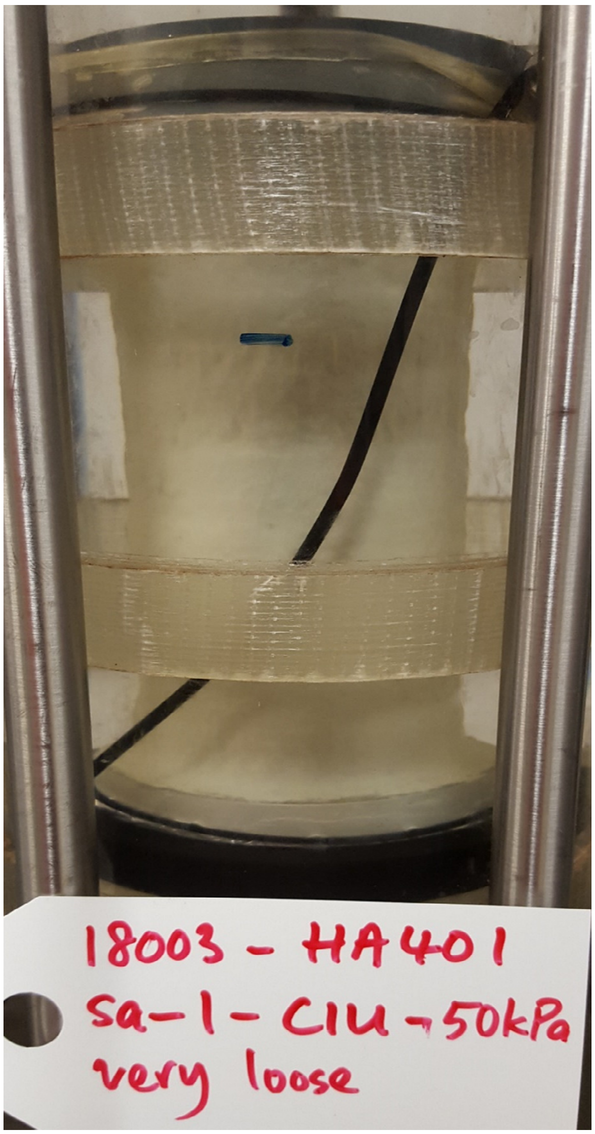
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

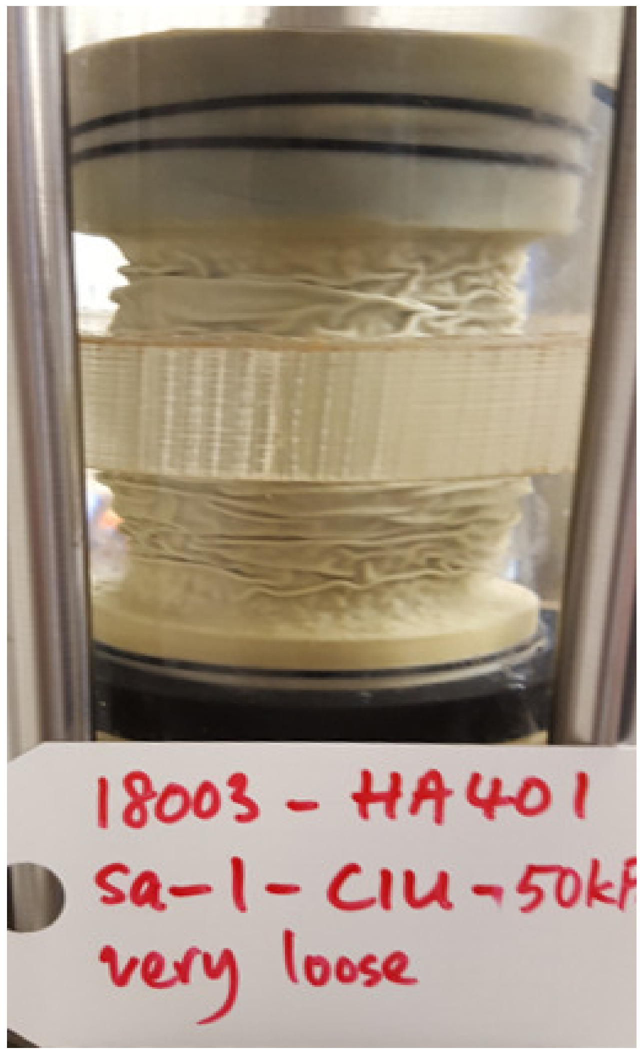
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-1 CIU very loose 50kPa

Initial Height (mm):	144.1	Final Liquor Content (%):	23.2%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.6	Final Dry Density (t/m^3):	1.67	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.63	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

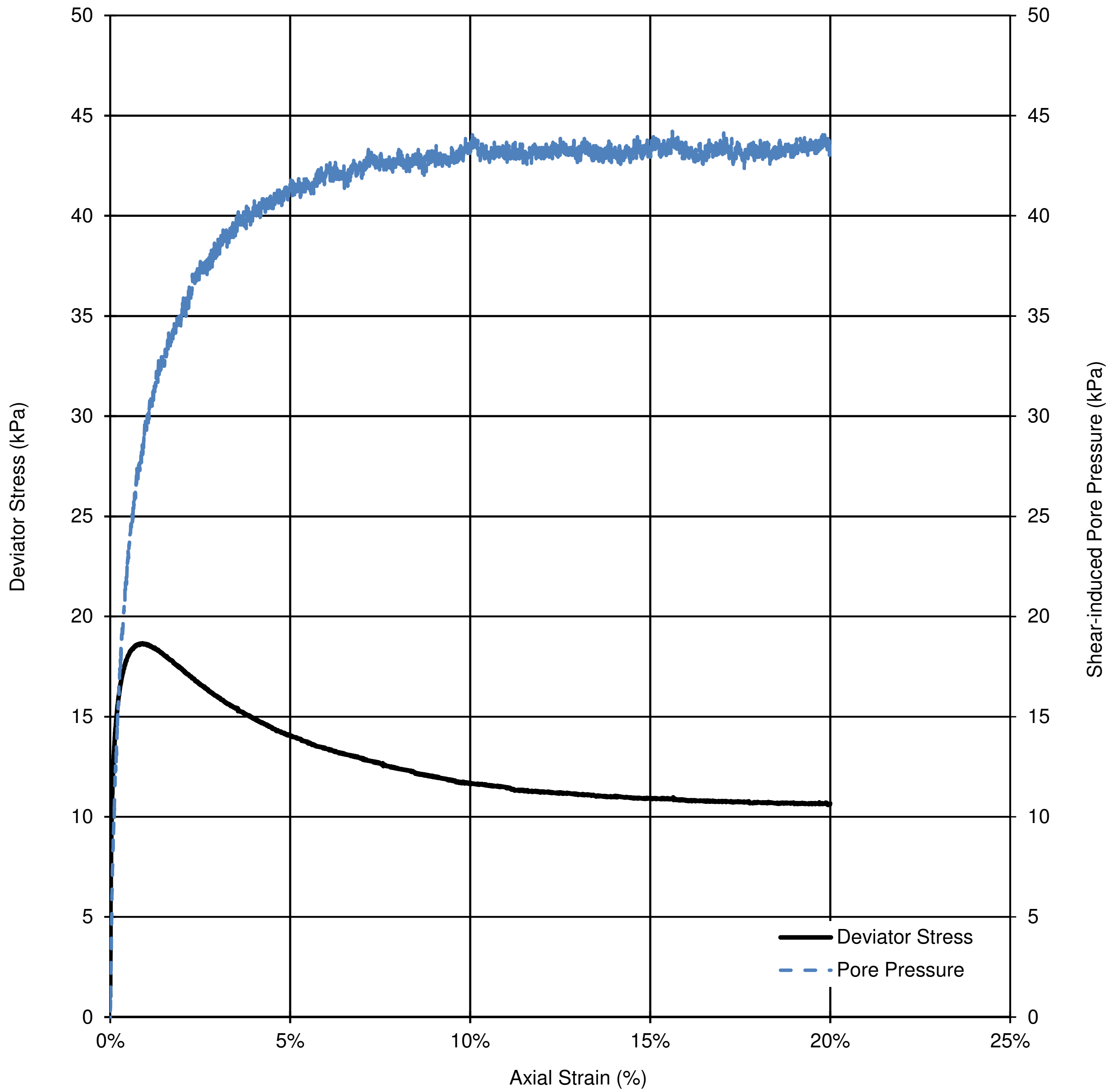
Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-1 CIU very loose 50kPa

Initial Height (mm):	144.1	Final Liquor Content (%):	23.2%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.6	Final Dry Density (t/m^3):	1.67	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.63	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Triaxial Test Report

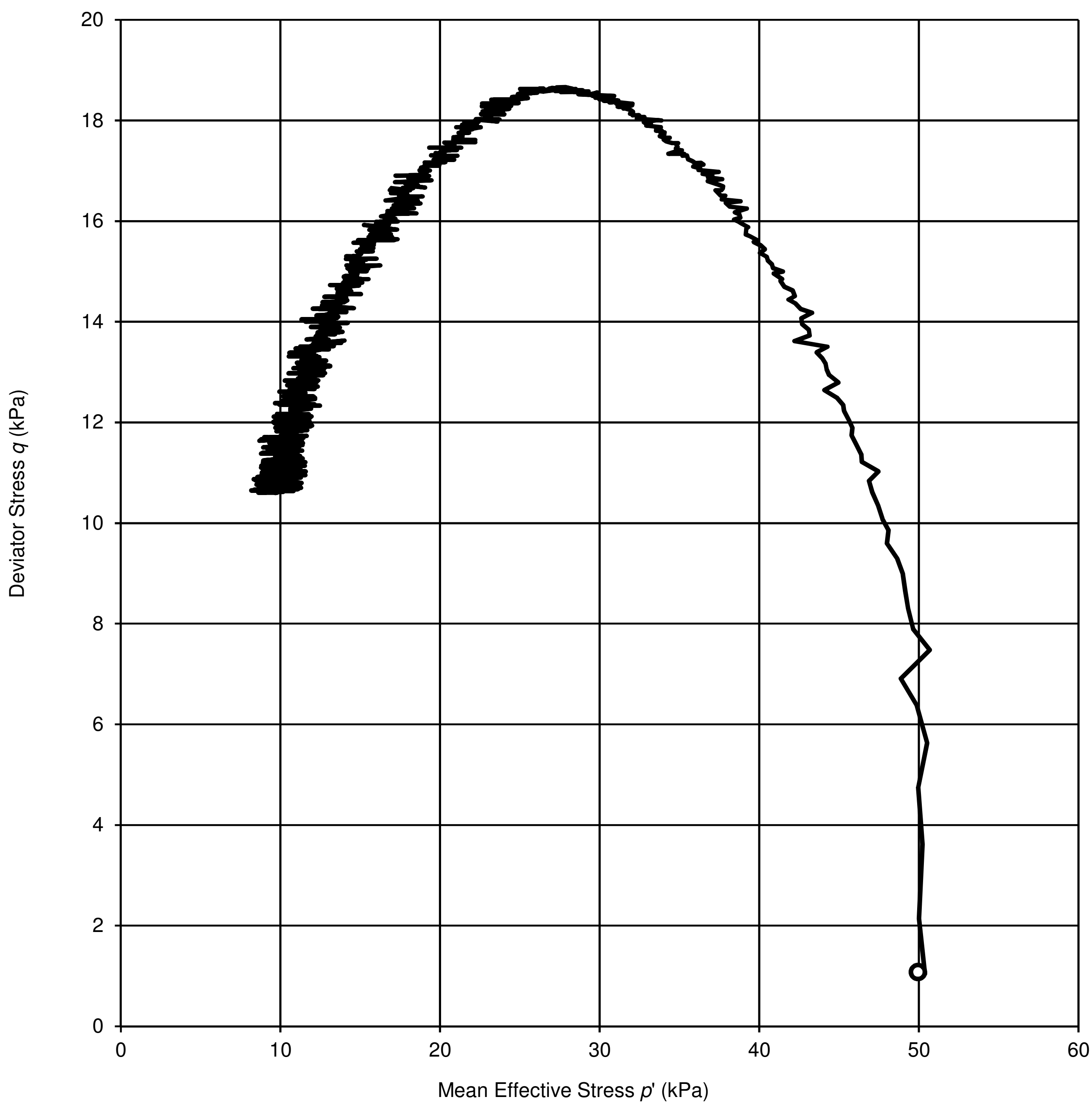
Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-1 CIU very loose 50kPa

Initial Height (mm):	144.1	Final Liquor Content (%):	23.2%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.6	Final Dry Density (t/m^3):	1.67	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.63	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

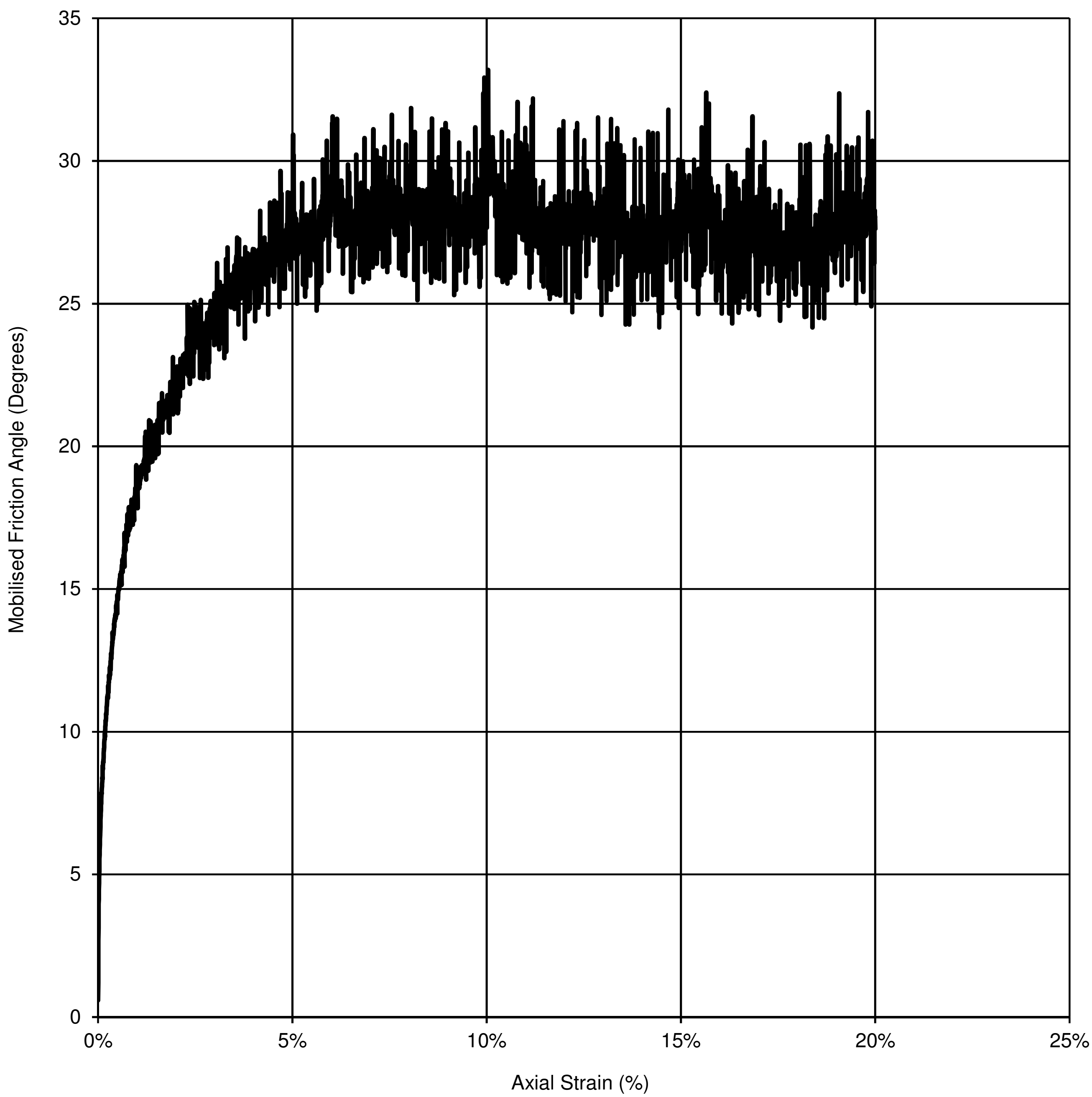
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-1 CIU very loose 50kPa

Initial Height (mm):	144.1	Final Liquor Content (%):	23.2%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.6	Final Dry Density (t/m^3):	1.67	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.63	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

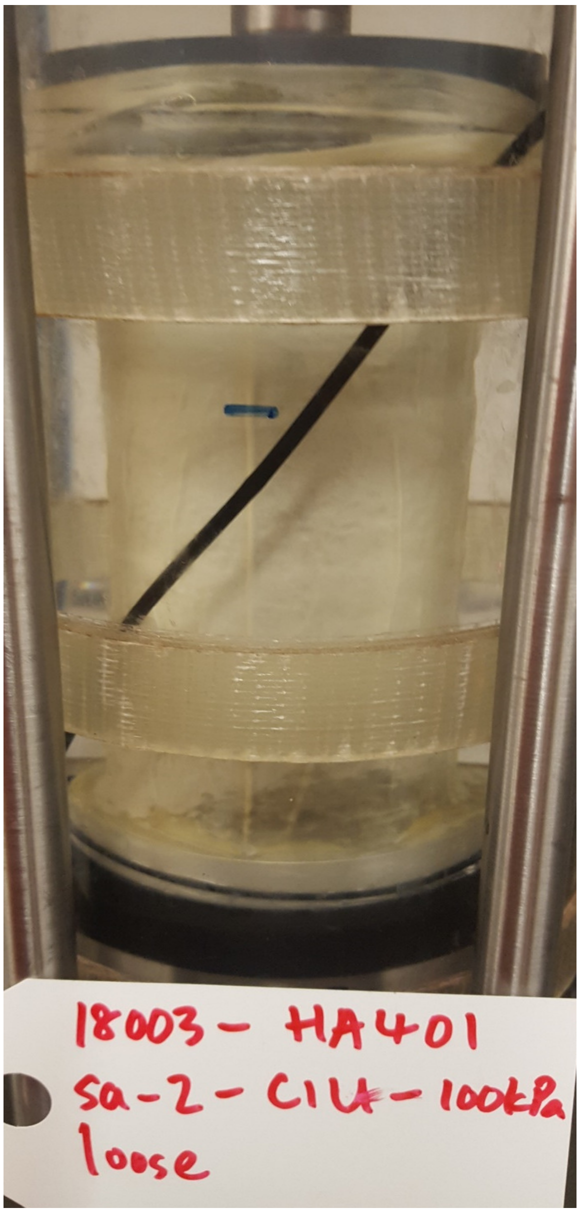
Isotropically Consolidated Undrained (CIU)

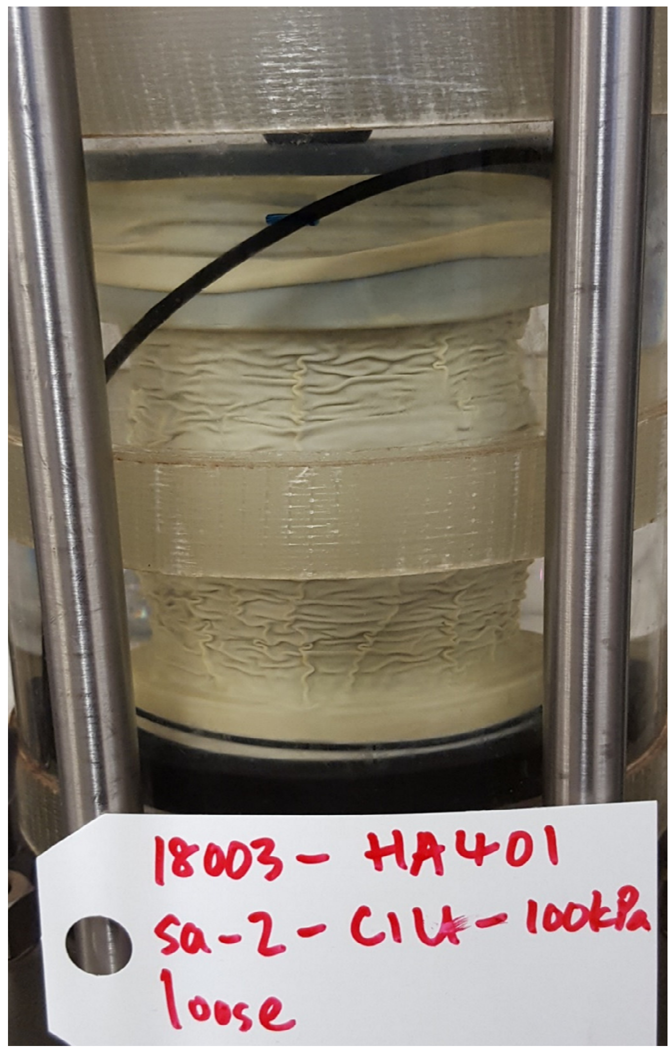
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	20/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-2 CIU loose 100kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	21.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	63.6	Final Dry Density (t/m^3):	1.73	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.58	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97





Sample Before Test	Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	20/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-2 CIU loose 100kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	21.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	63.6	Final Dry Density (t/m^3):	1.73	B Response (%):	99%
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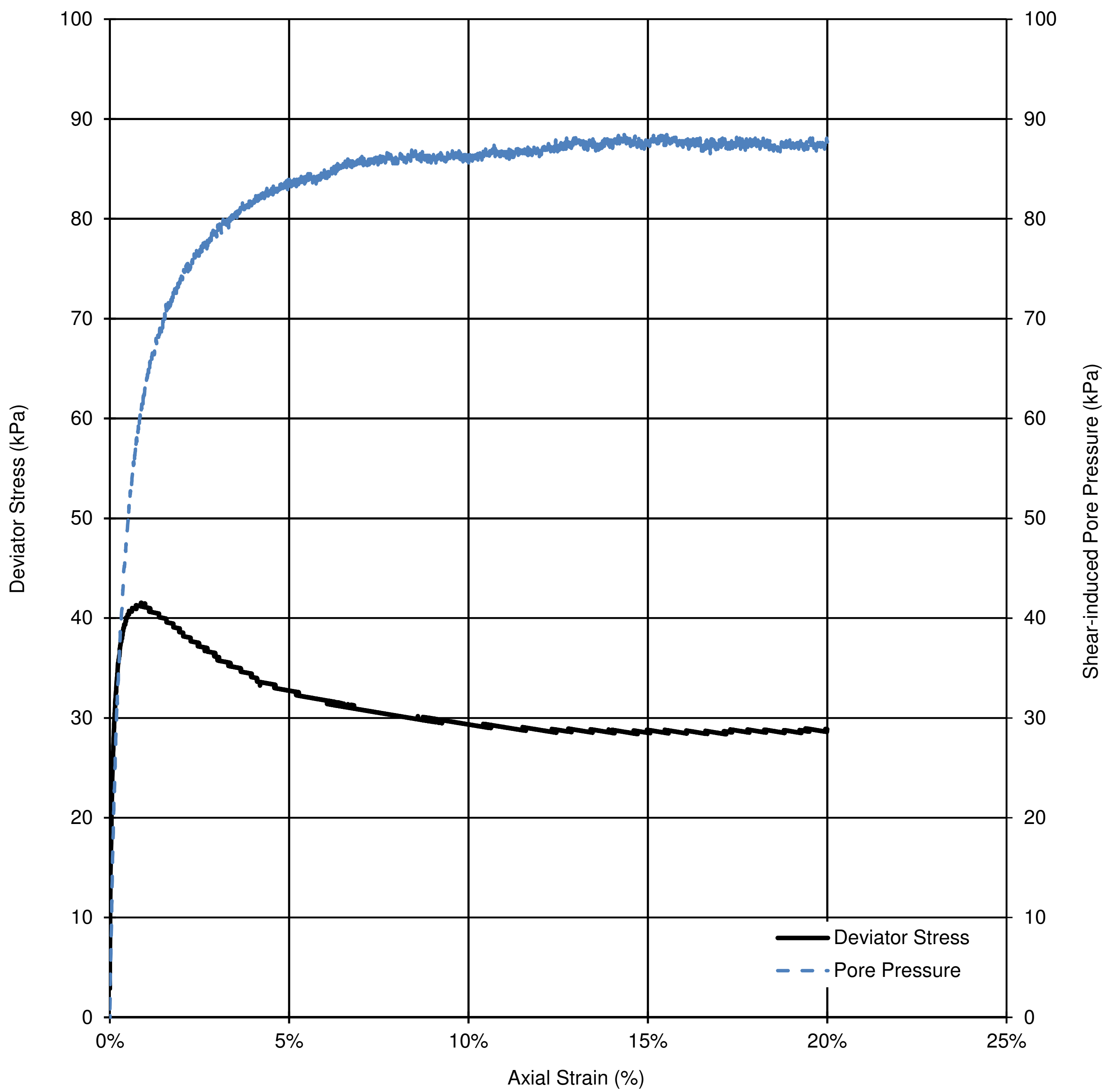
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



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		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

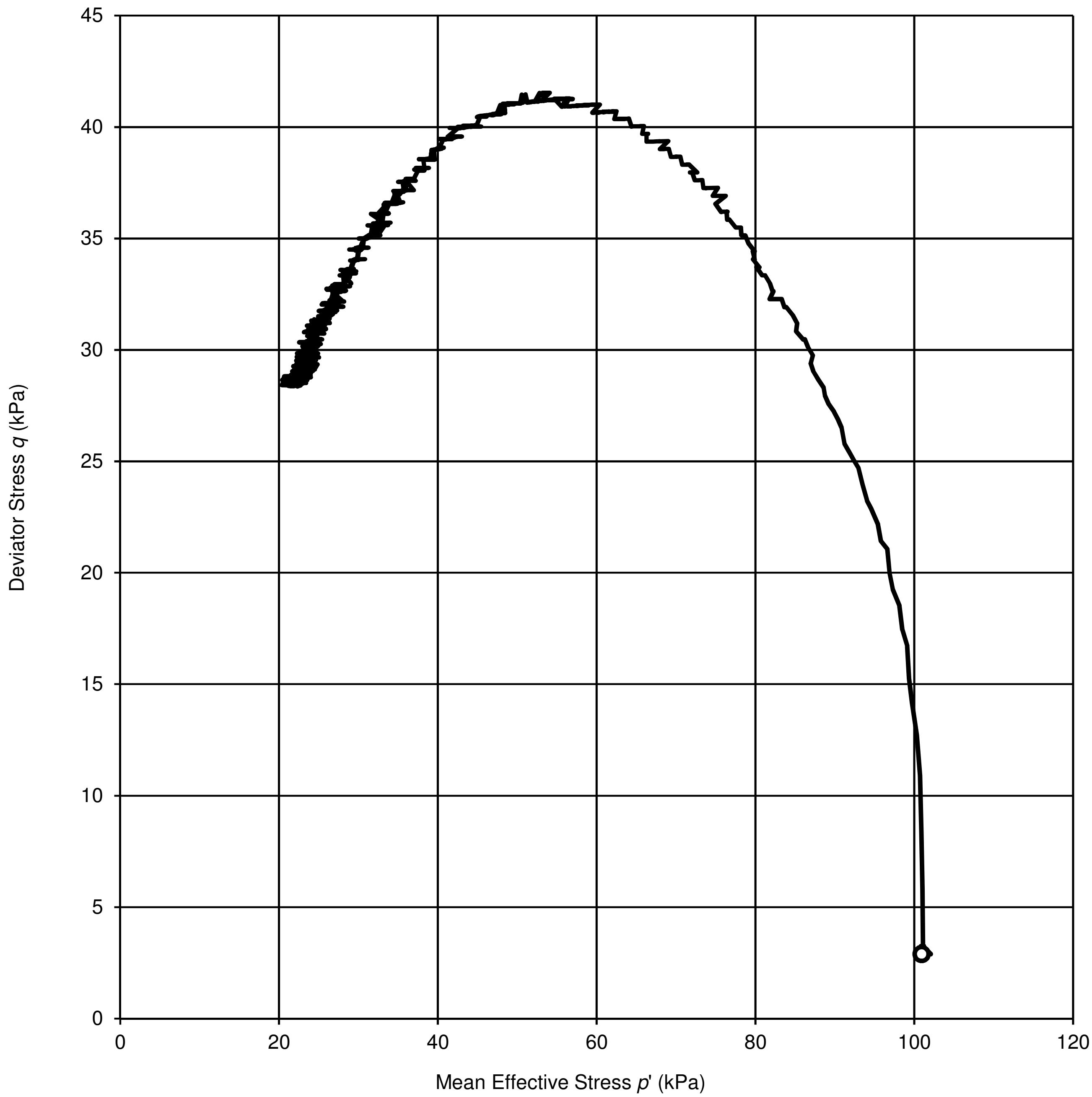
Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	20/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-2 CIU loose 100kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	21.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	63.6	Final Dry Density (t/m^3):	1.73	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.58	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	20/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-2 CIU loose 100kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	21.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	63.6	Final Dry Density (t/m^3):	1.73	B Response (%):	99%
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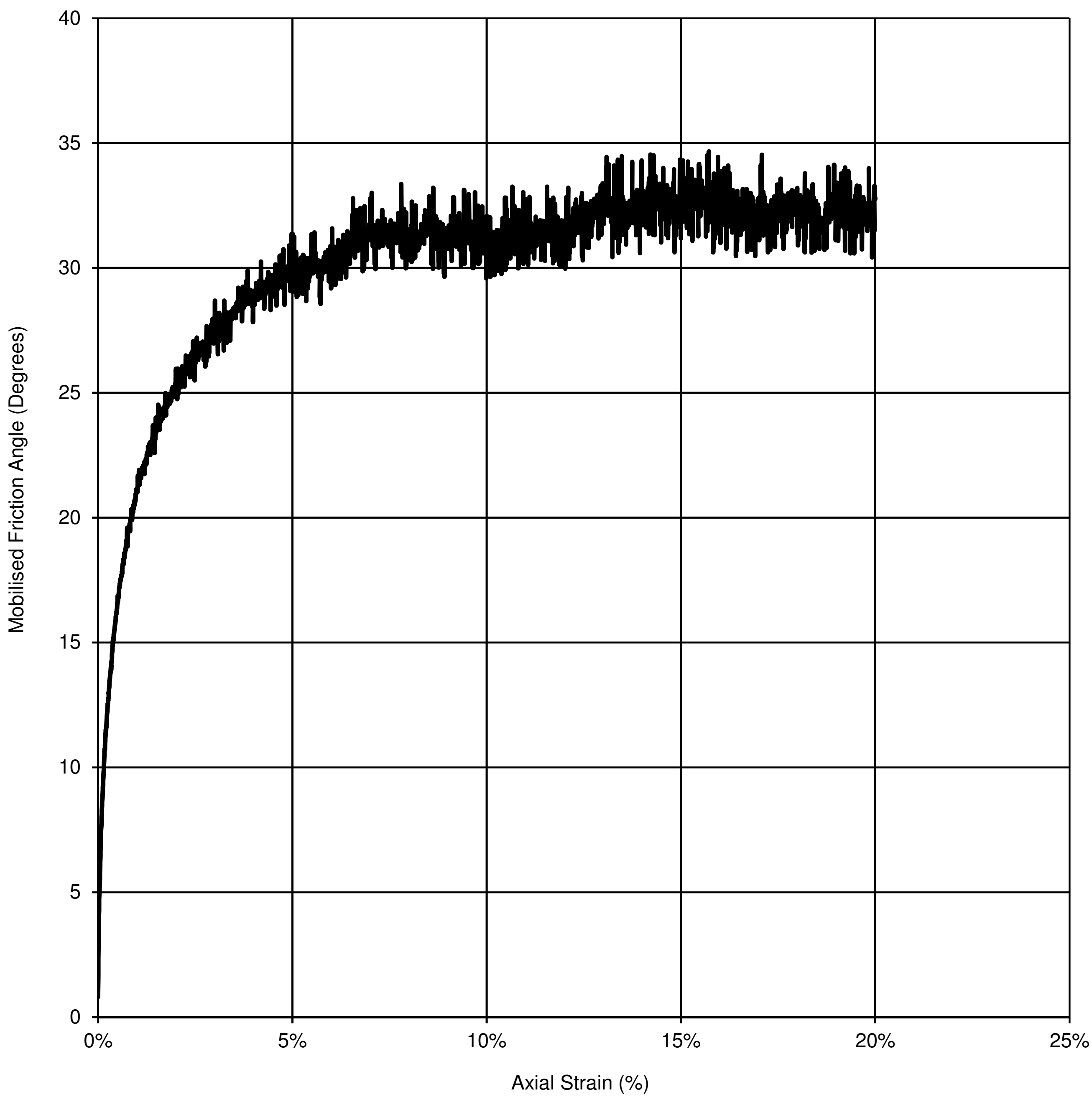
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-3 CIU loose 500kPa

Initial Height (mm):	147.2	Final Liquor Content (%):	17.8%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	66.2	Final Dry Density (t/m^3):	1.84	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.49	Mean Effective Consolidation Stress (kPa):	502
Initial Dry Density (t/m^3):	1.20	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-3 CIU loose 500kPa

Initial Height (mm):	147.2	Final Liquor Content (%):	17.8%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	66.2	Final Dry Density (t/m^3):	1.84	B Response (%):	99%
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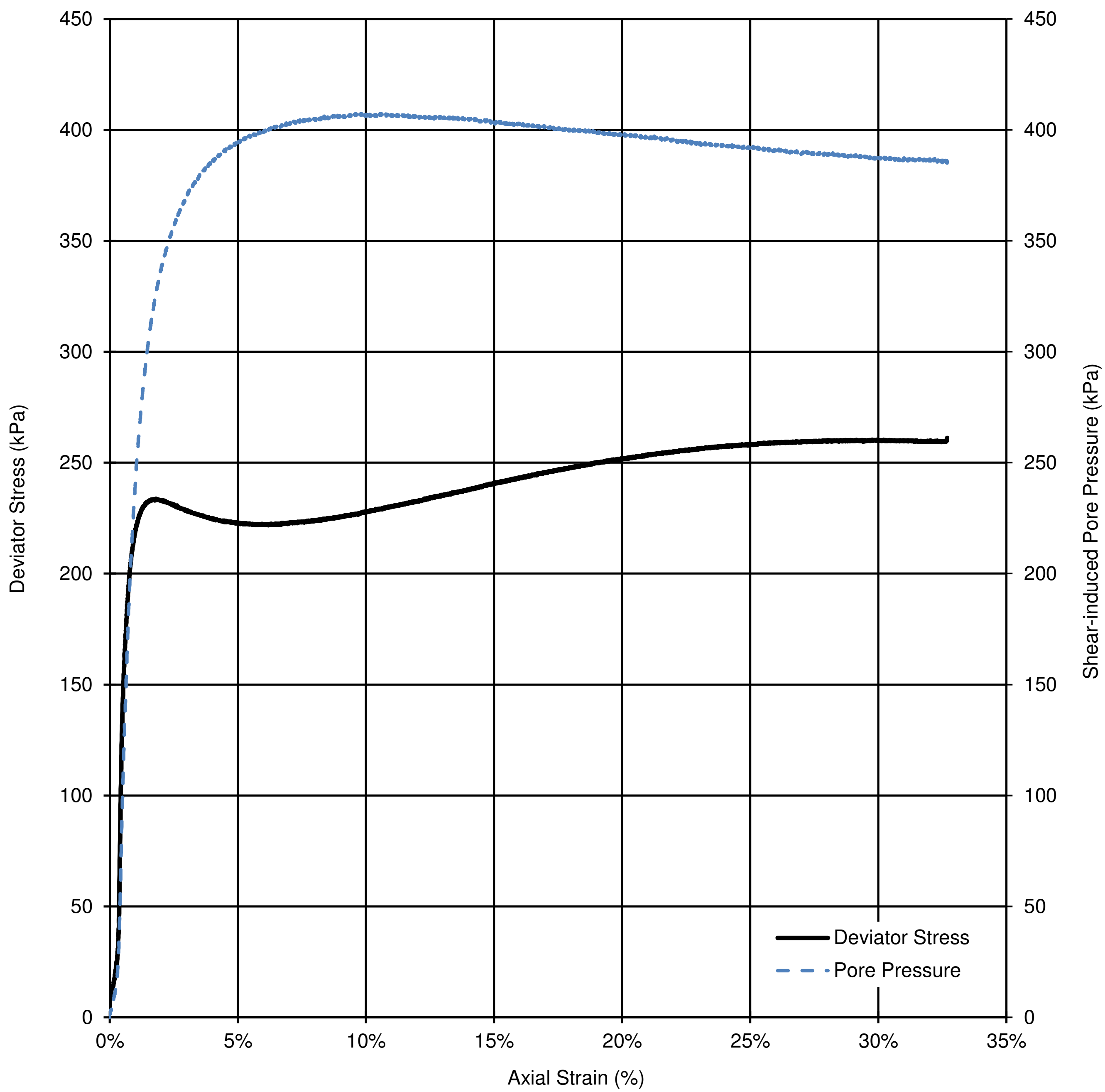
Initial Dry Density (t/m^3):	1.20	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

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Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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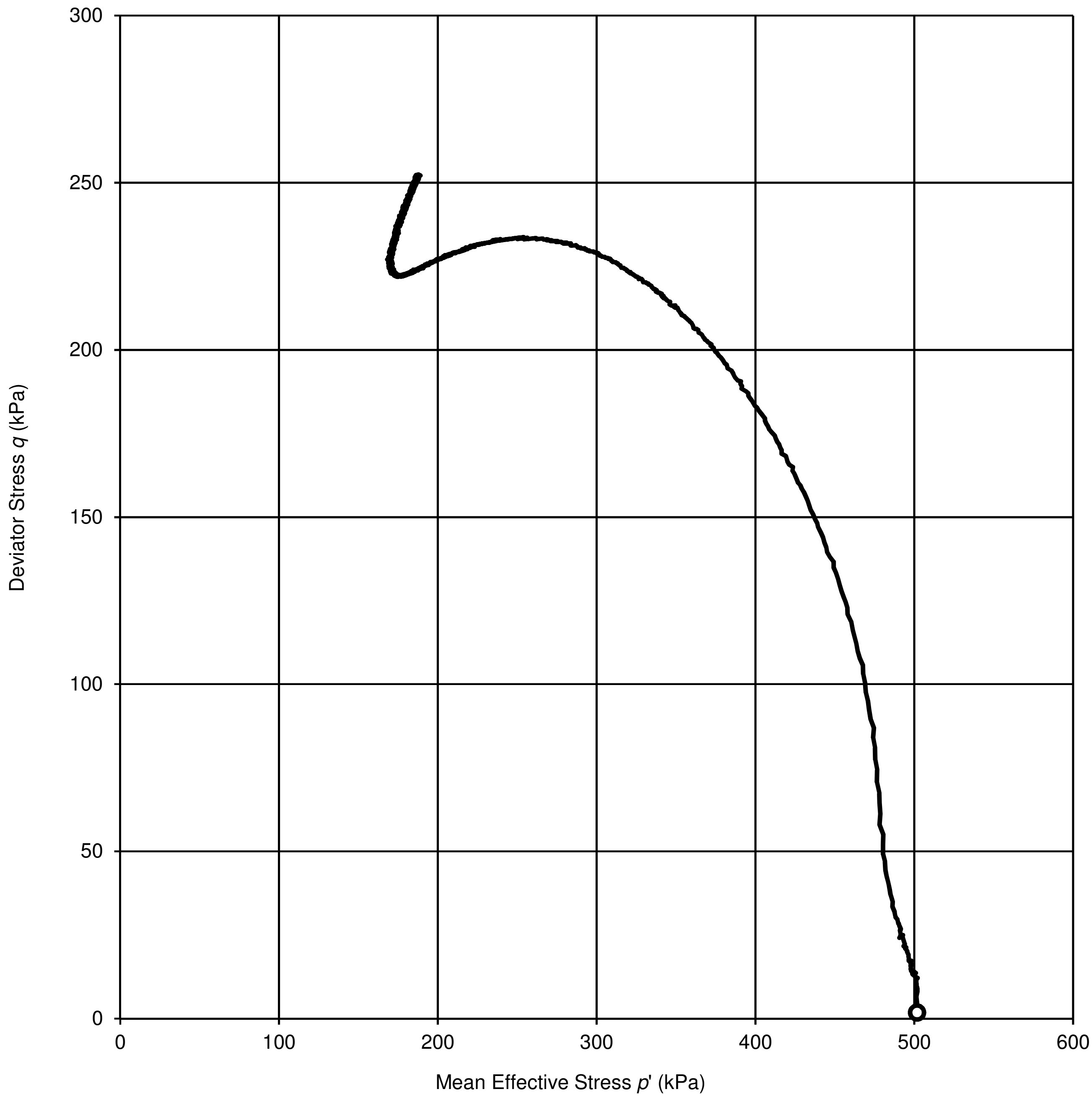
Initial Dry Density (t/m^3):	1.20	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

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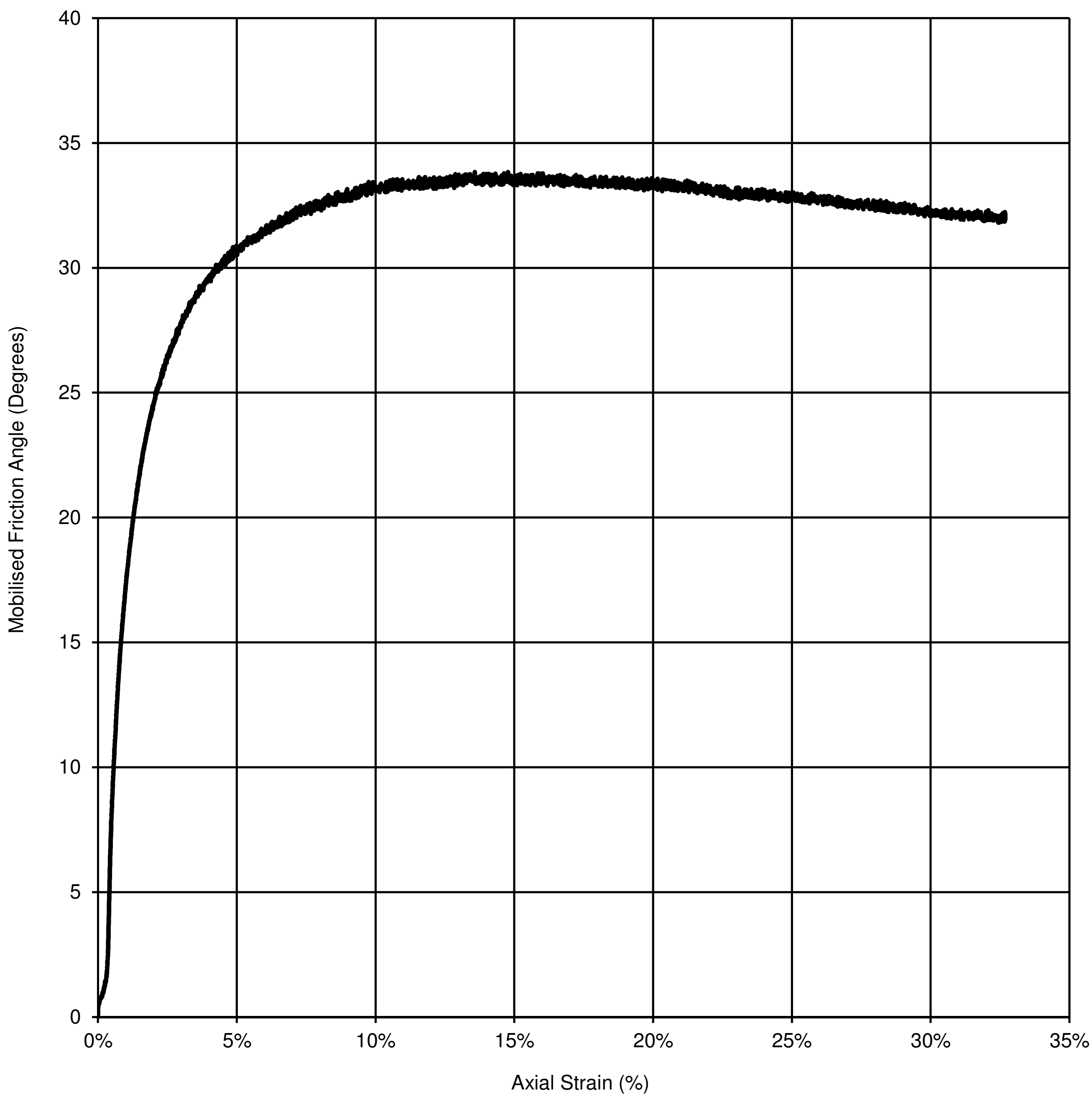
Initial Dry Density (t/m^3):	1.20	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

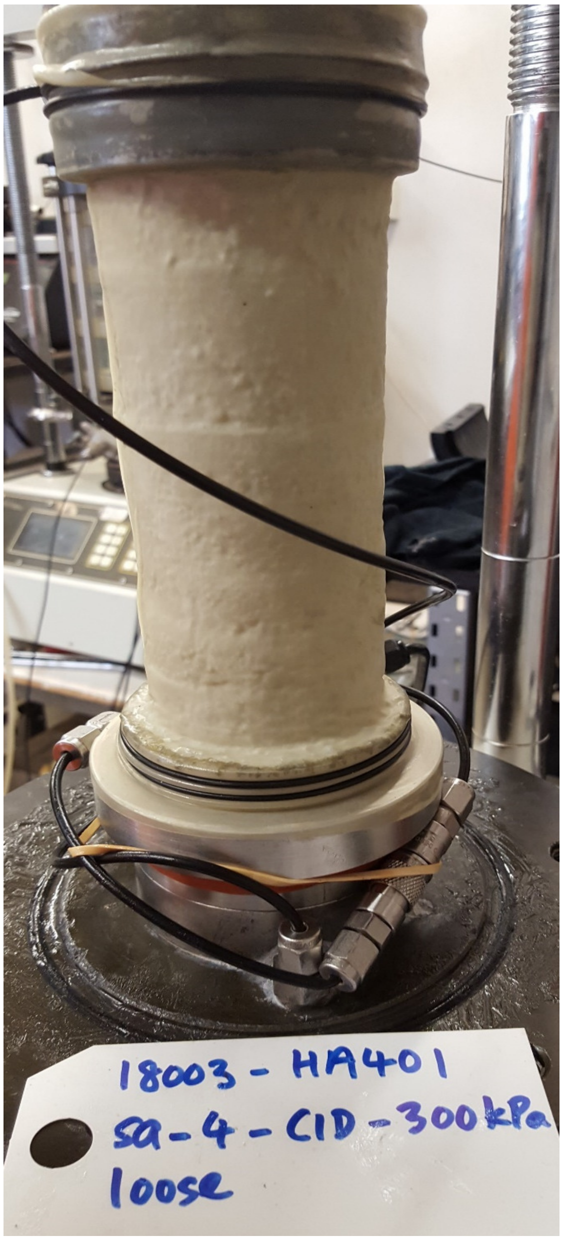
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-4 CID loose 300kPa

Initial Height (mm):	147.7	Final Liquor Content (%):	15.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	65.7	Final Dry Density (t/m^3):	1.90	B Response (%):	97%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.43	Mean Effective Consolidation Stress (kPa):	301
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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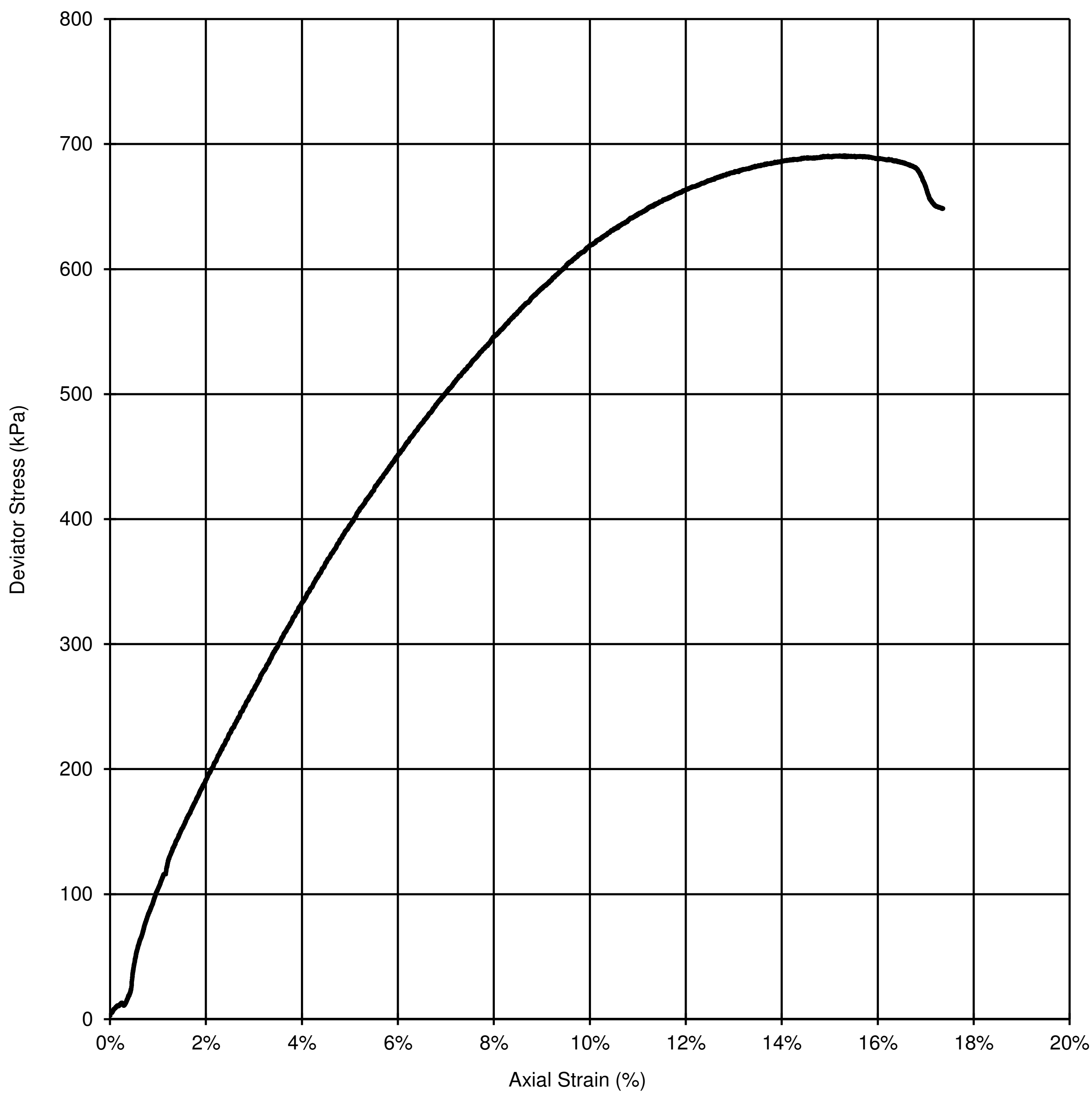

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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/06/2018
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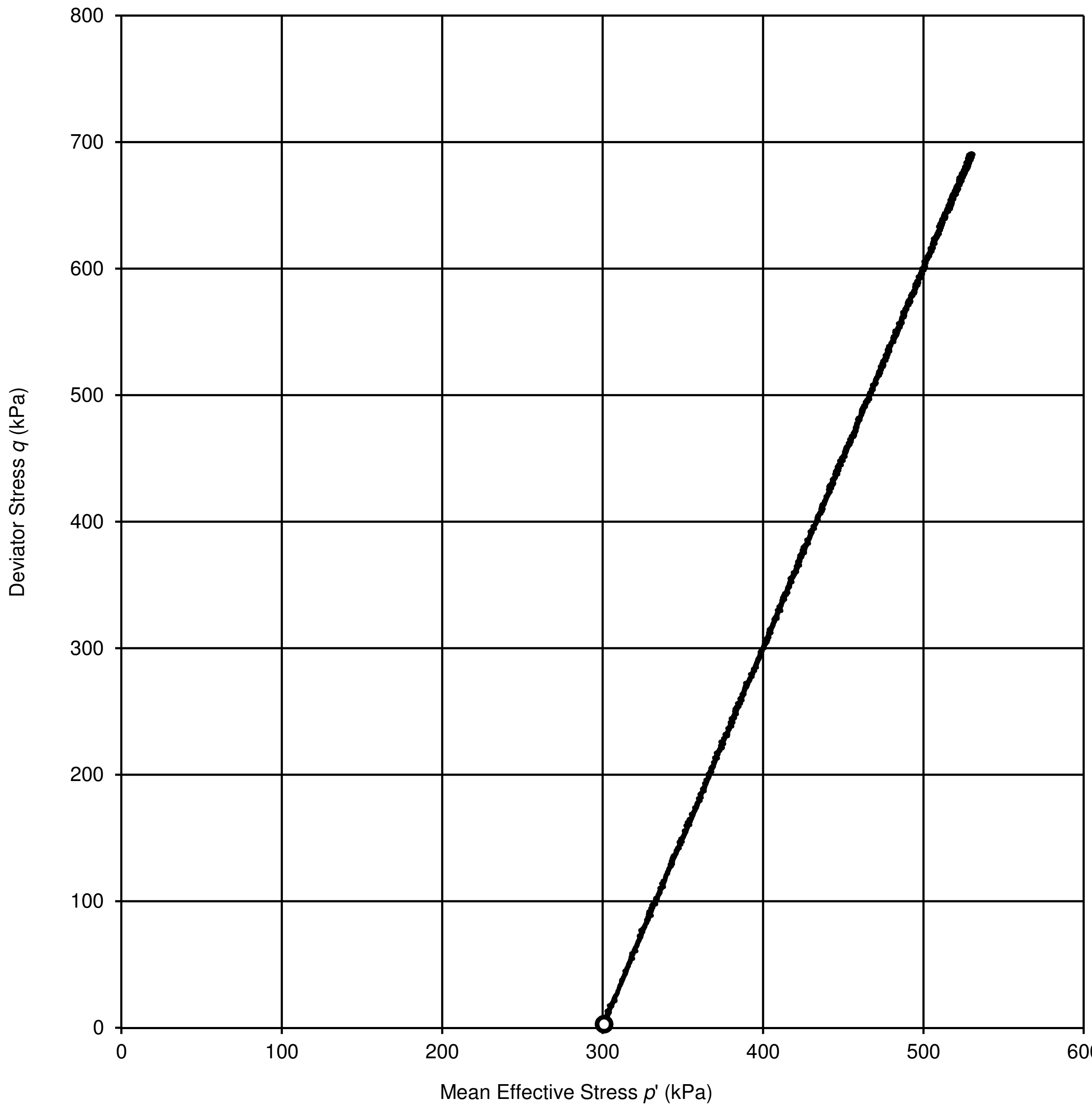
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



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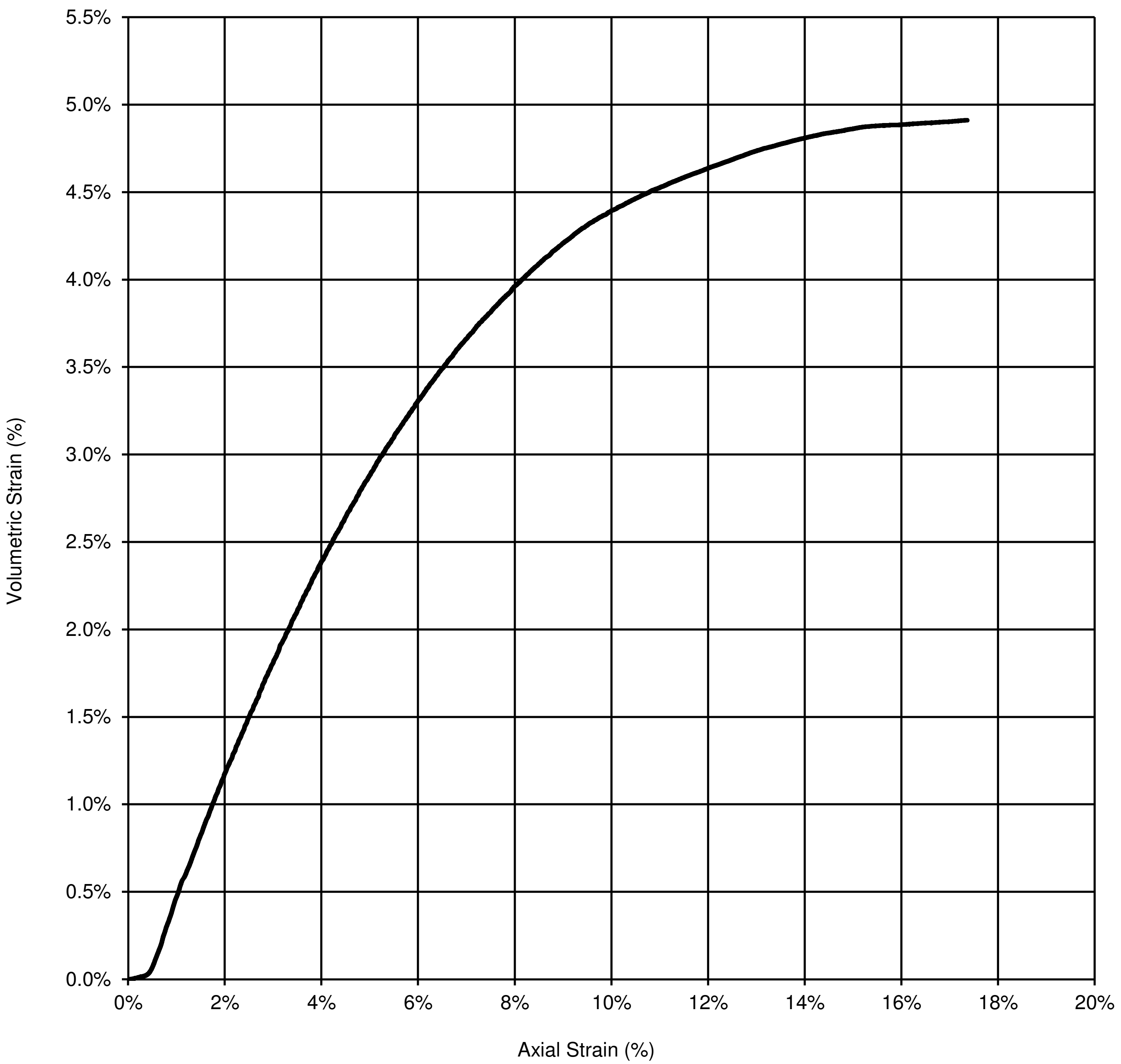
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-4 CID loose 300kPa

Initial Height (mm):	147.7	Final Liquor Content (%):	15.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	65.7	Final Dry Density (t/m^3):	1.90	B Response (%):	97%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.43	Mean Effective Consolidation Stress (kPa):	301
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
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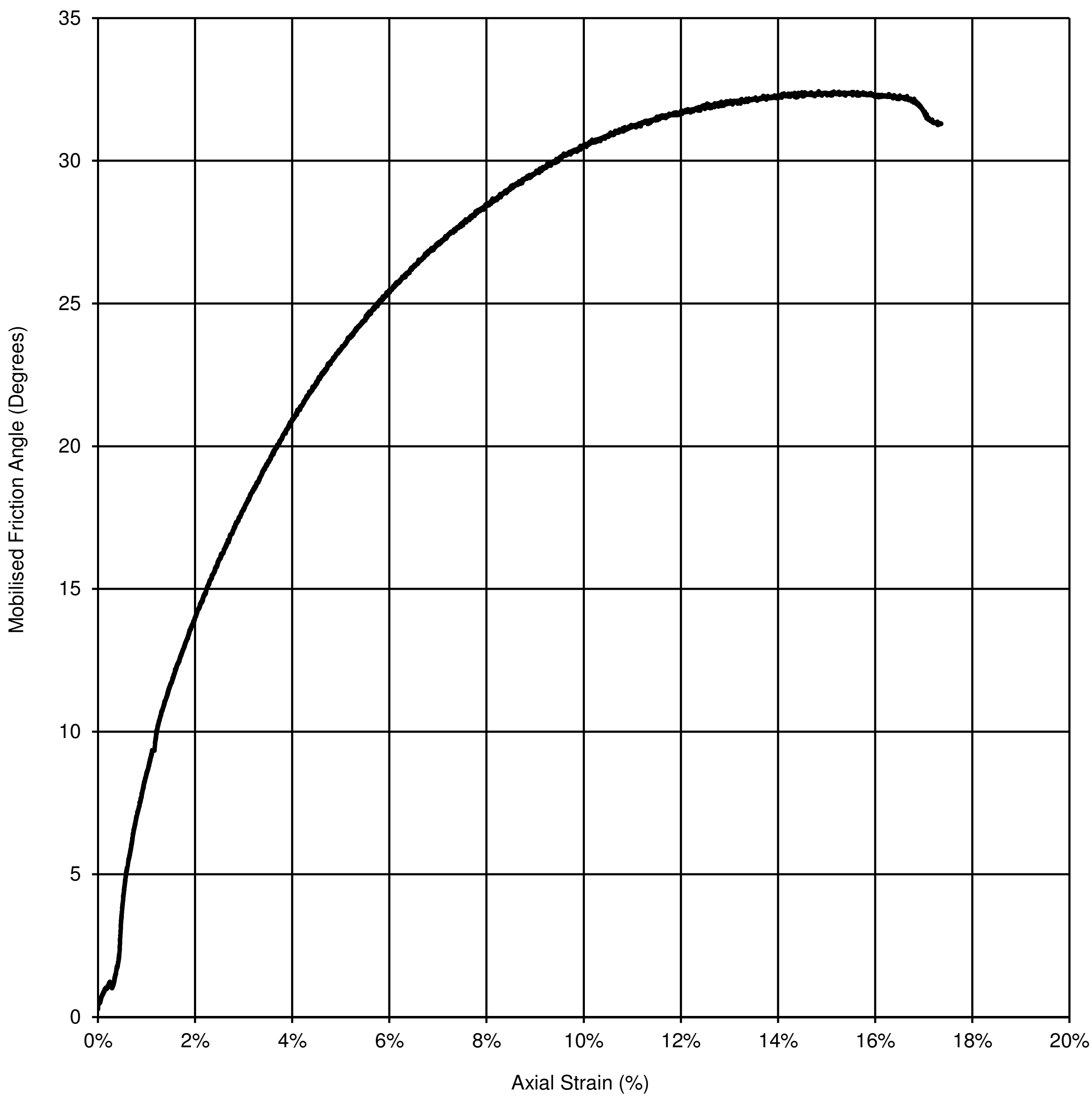

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Triaxial Test Report

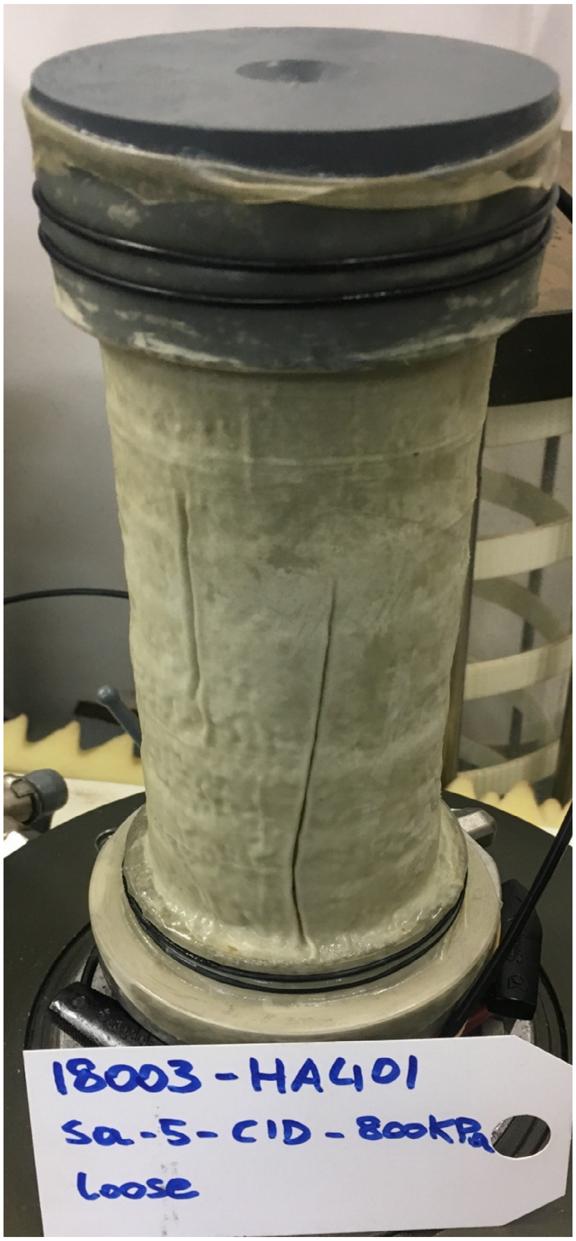
Isotropically Consolidated Drained (CID)

GOLDER

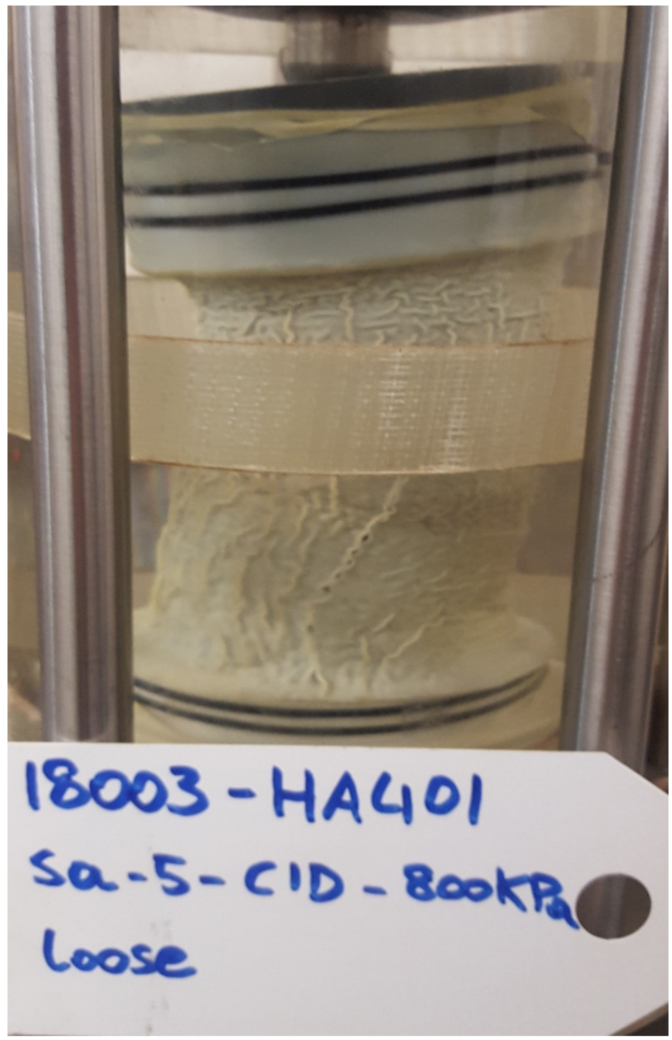
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-5 CID loose 800kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	14.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	66.4	Final Dry Density (t/m^3):	1.97	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.39	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.19	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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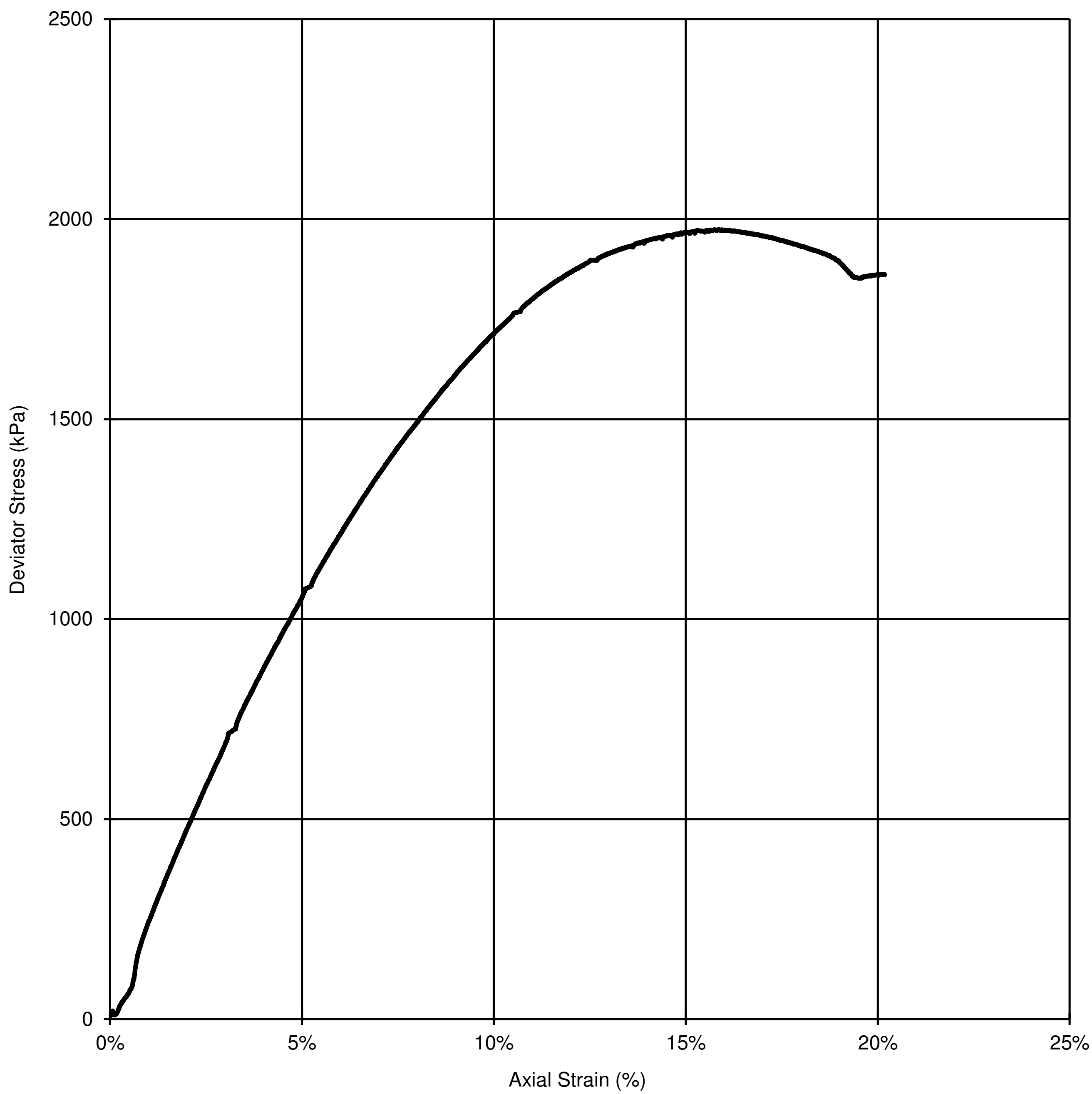
Initial Dry Density (t/m^3):	1.19	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-5 CID loose 800kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	14.2%	Strain Rate (mm/min):	0.015
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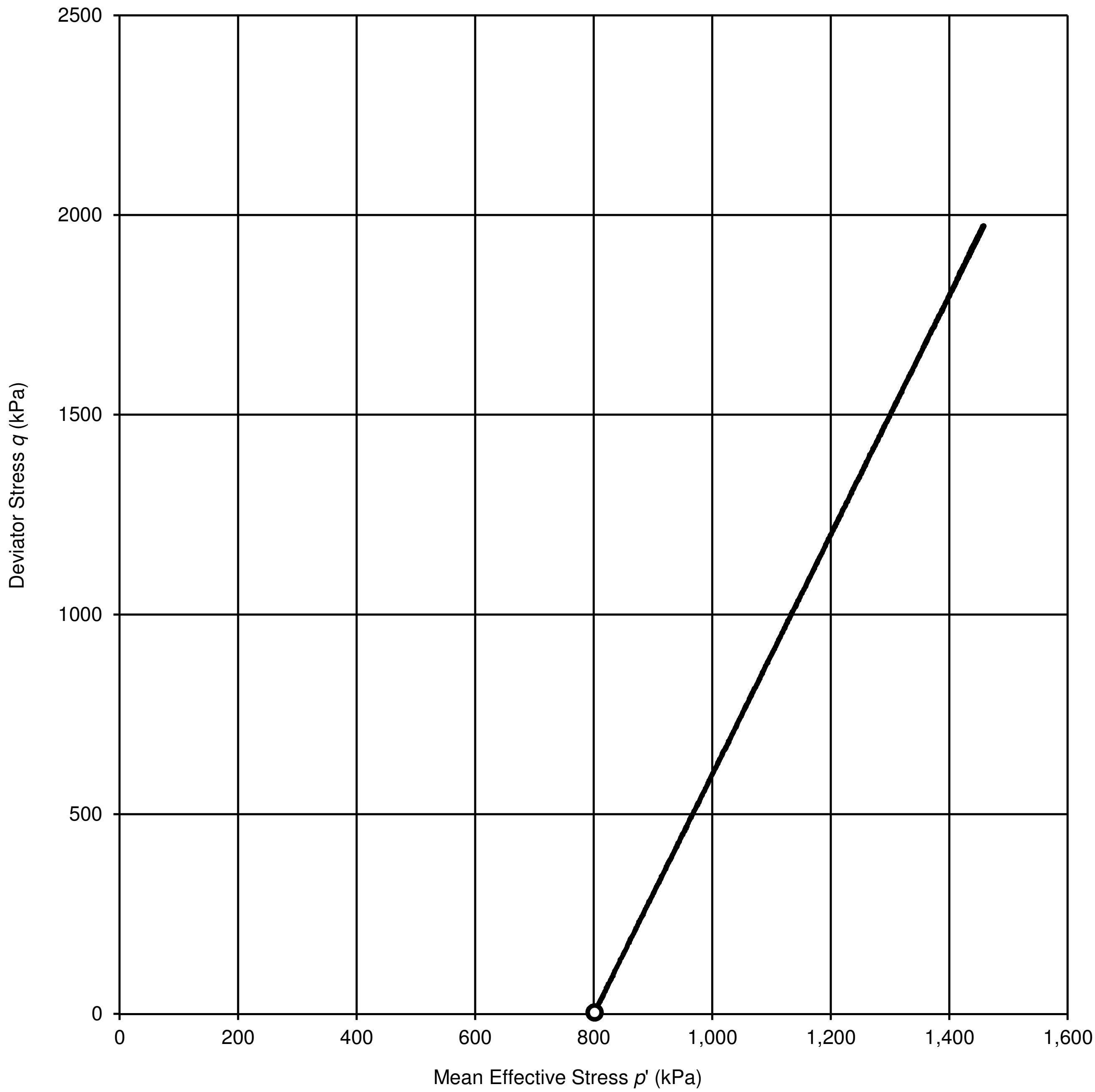
Initial Dry Density (t/m^3):	1.19	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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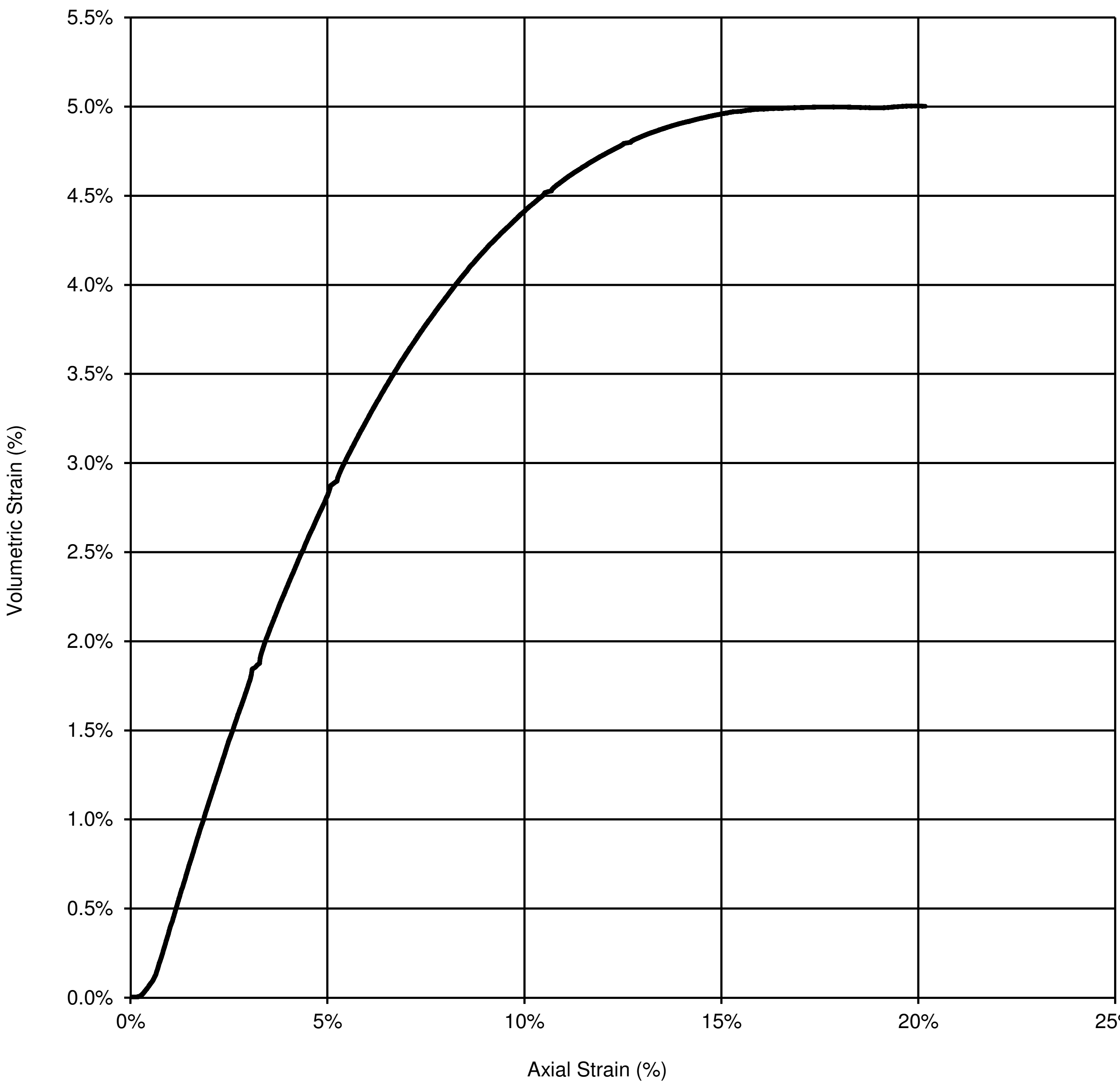
Location:	Cadia Mine	**Test ID:**	18003 - sa-5 CID loose 800kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	14.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	66.4	Final Dry Density (t/m^3):	1.97	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.39	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.19	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

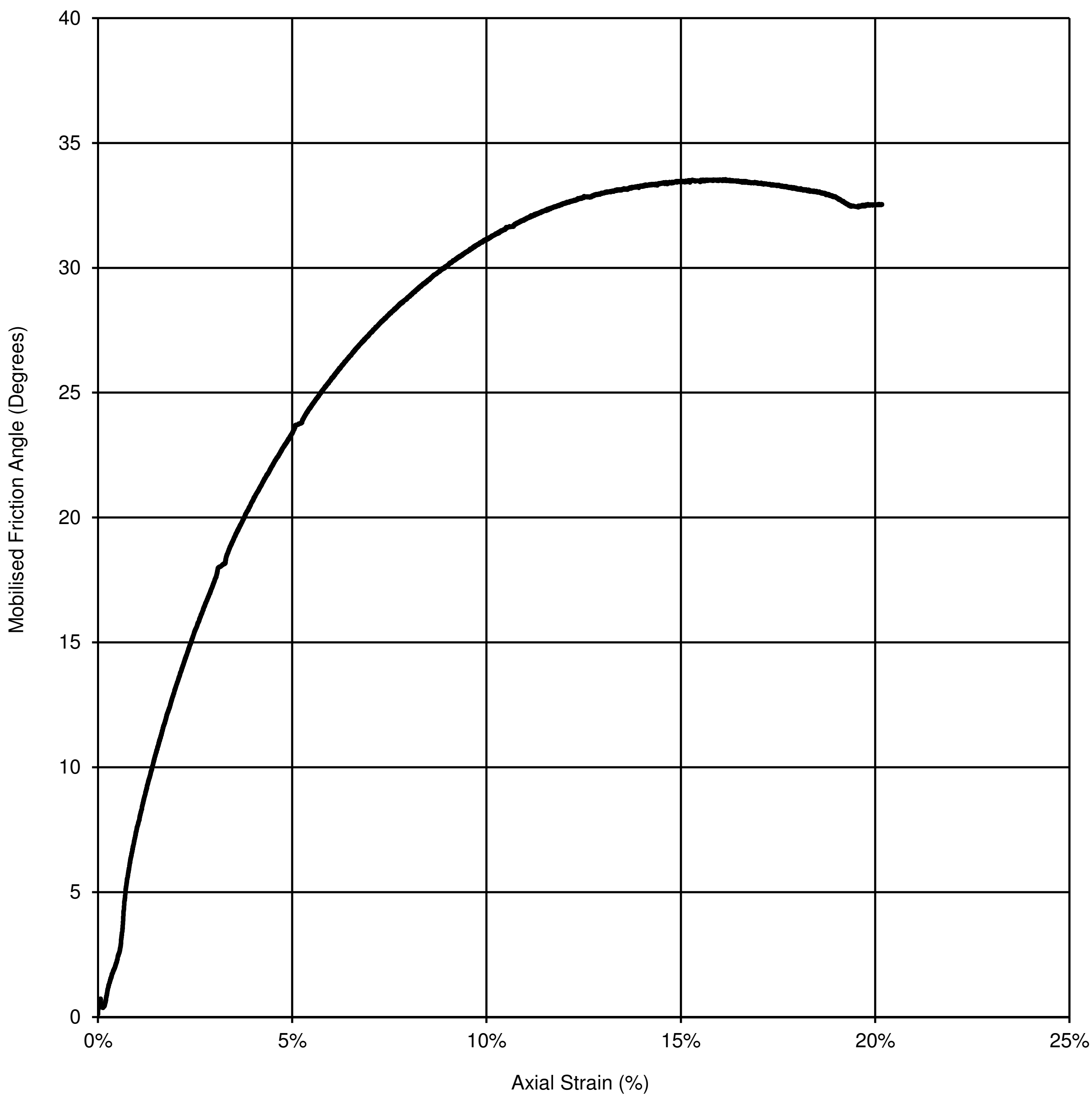
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-5 CID loose 800kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	14.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	66.4	Final Dry Density (t/m^3):	1.97	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.39	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.19	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

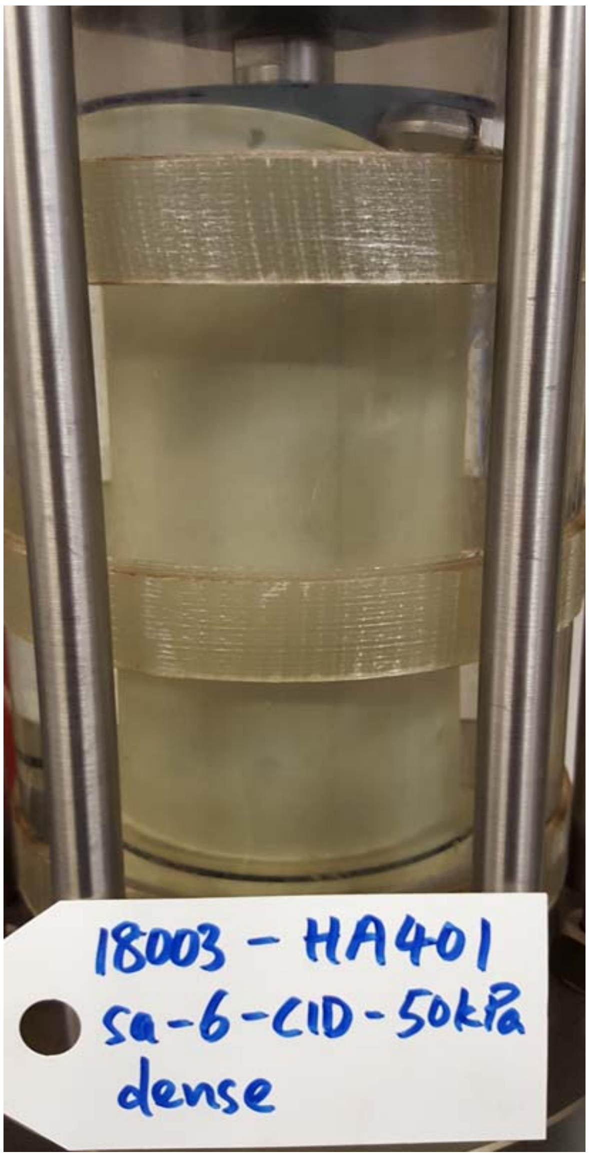
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-6 CID dense 50kPa

Initial Height (mm):	160.8	Final Liquor Content (%):	15.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.90	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.43	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

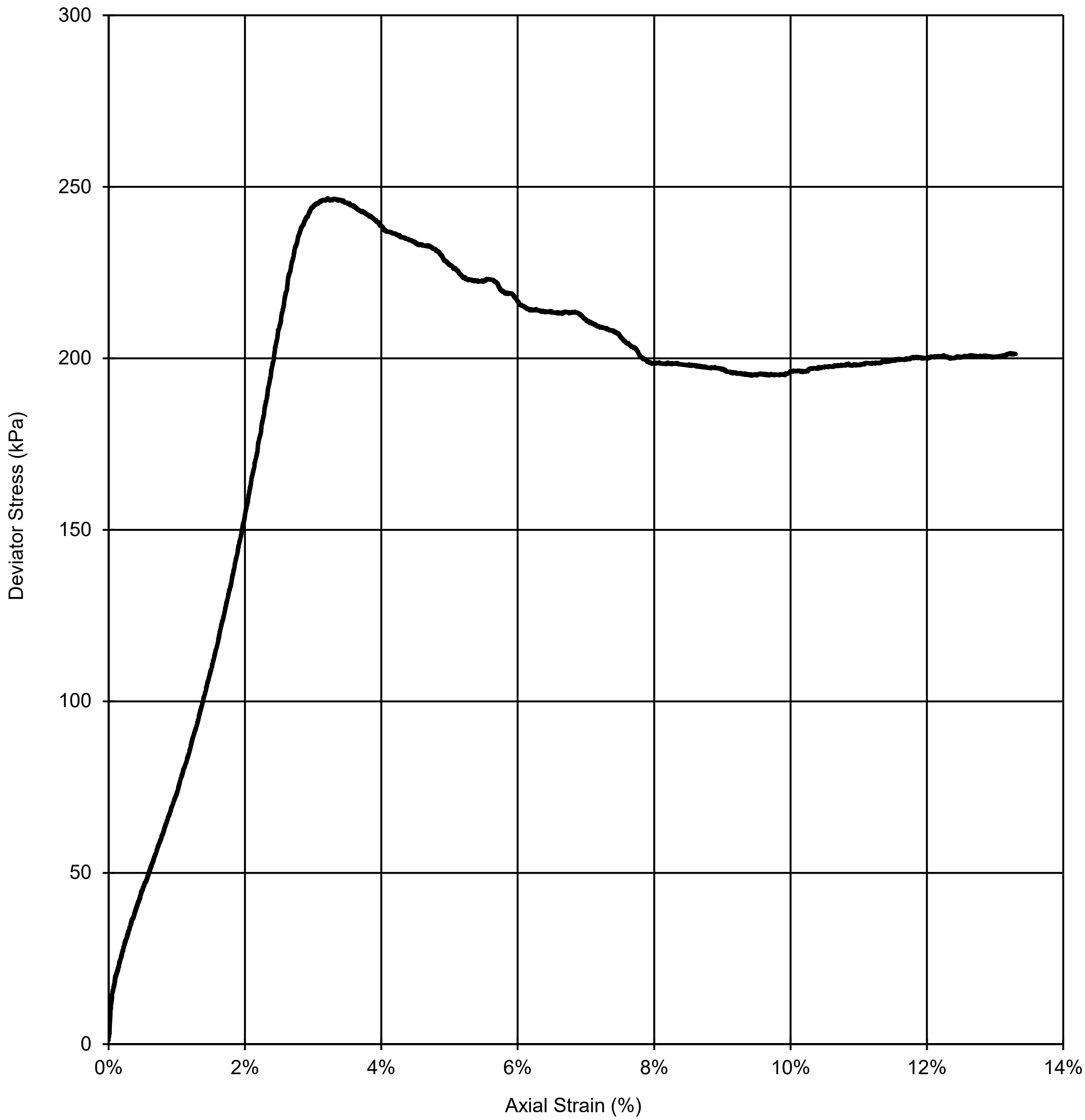
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-6 CID dense 50kPa

Initial Height (mm):	160.8	Final Liquor Content (%):	15.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.90	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.43	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



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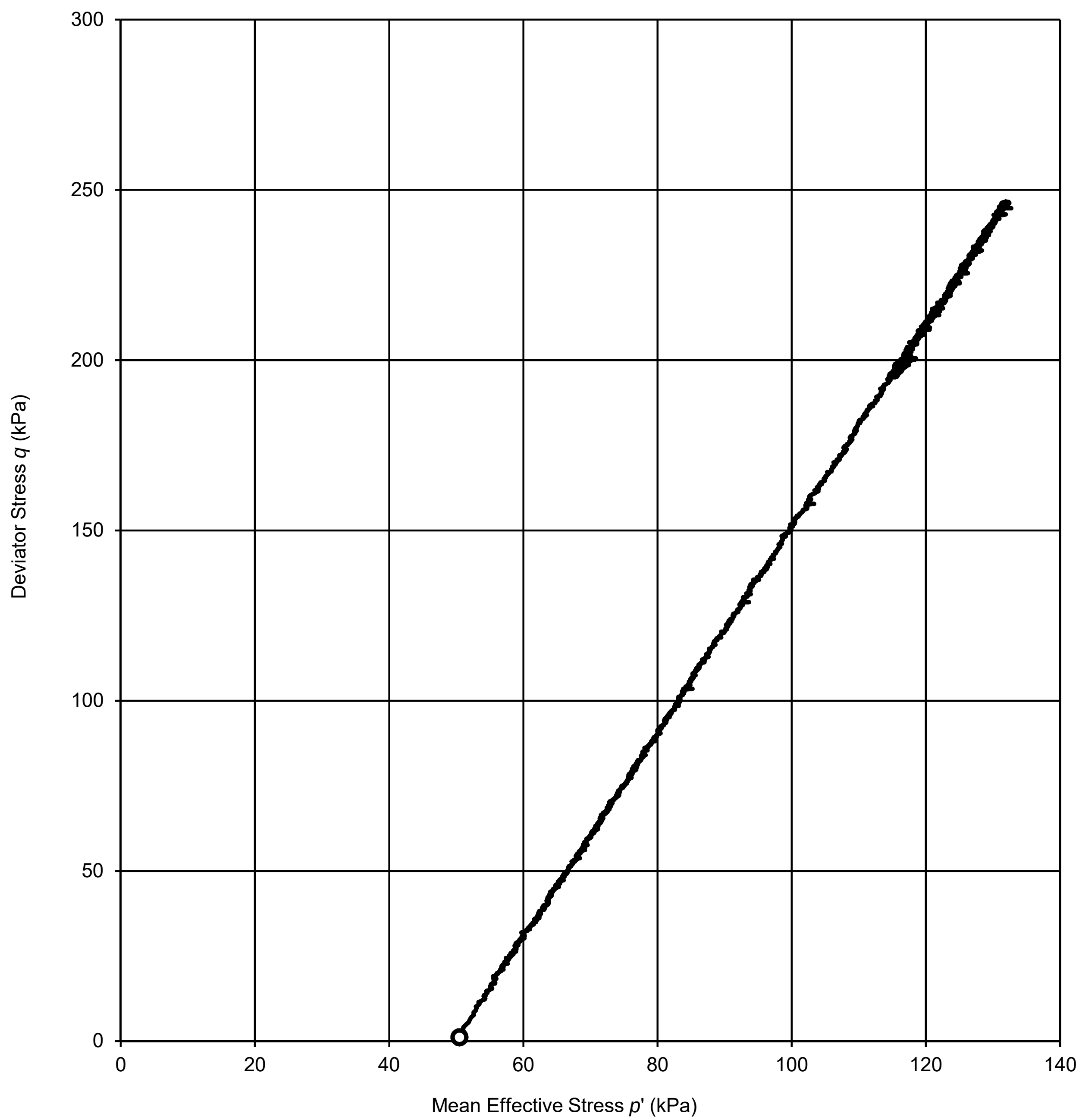
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-6 CID dense 50kPa

Initial Height (mm):	160.8	Final Liquor Content (%):	15.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.90	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.43	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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Triaxial Test Report

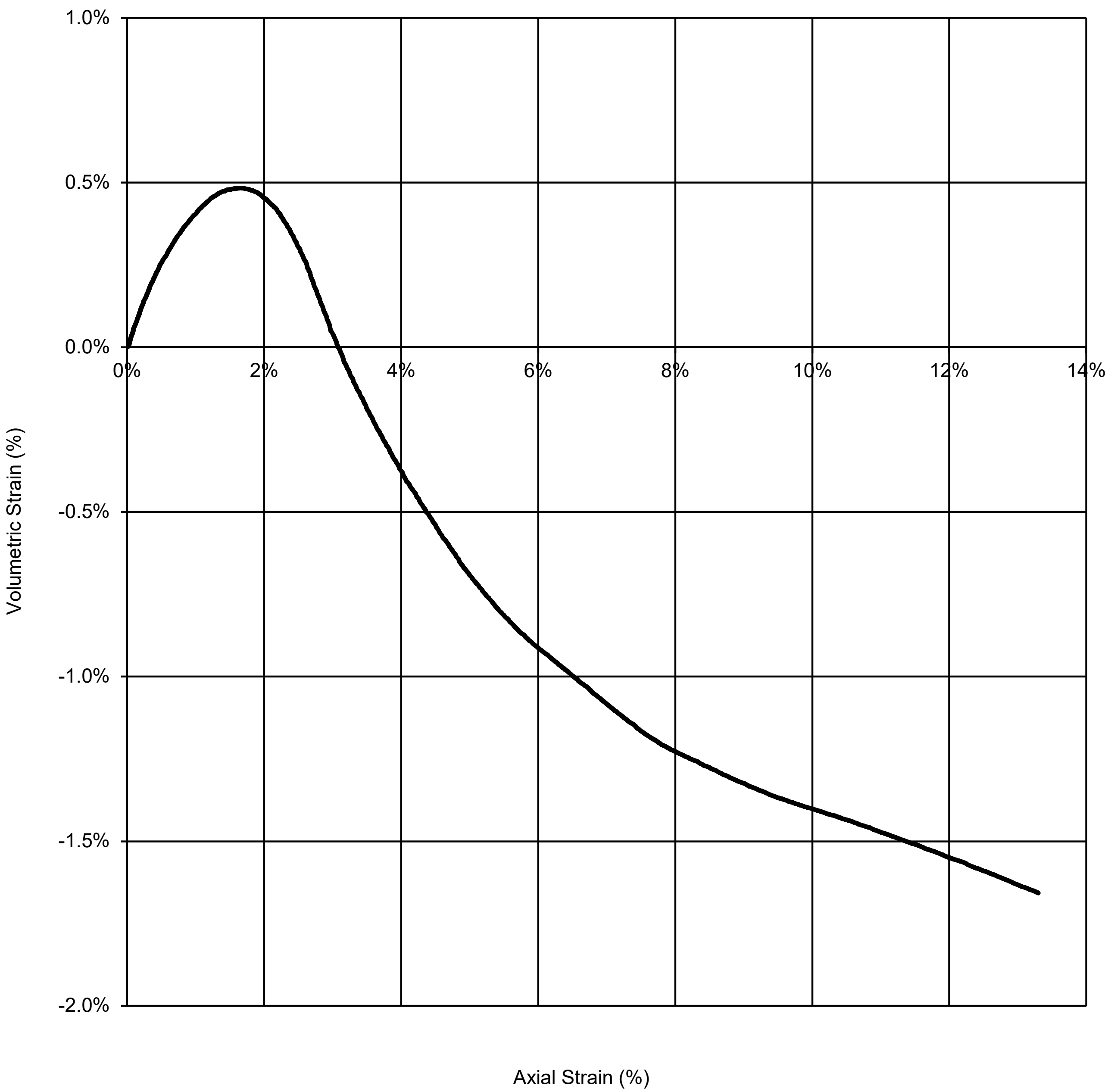
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-6 CID dense 50kPa

Initial Height (mm):	160.8	Final Liquor Content (%):	15.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.90	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.43	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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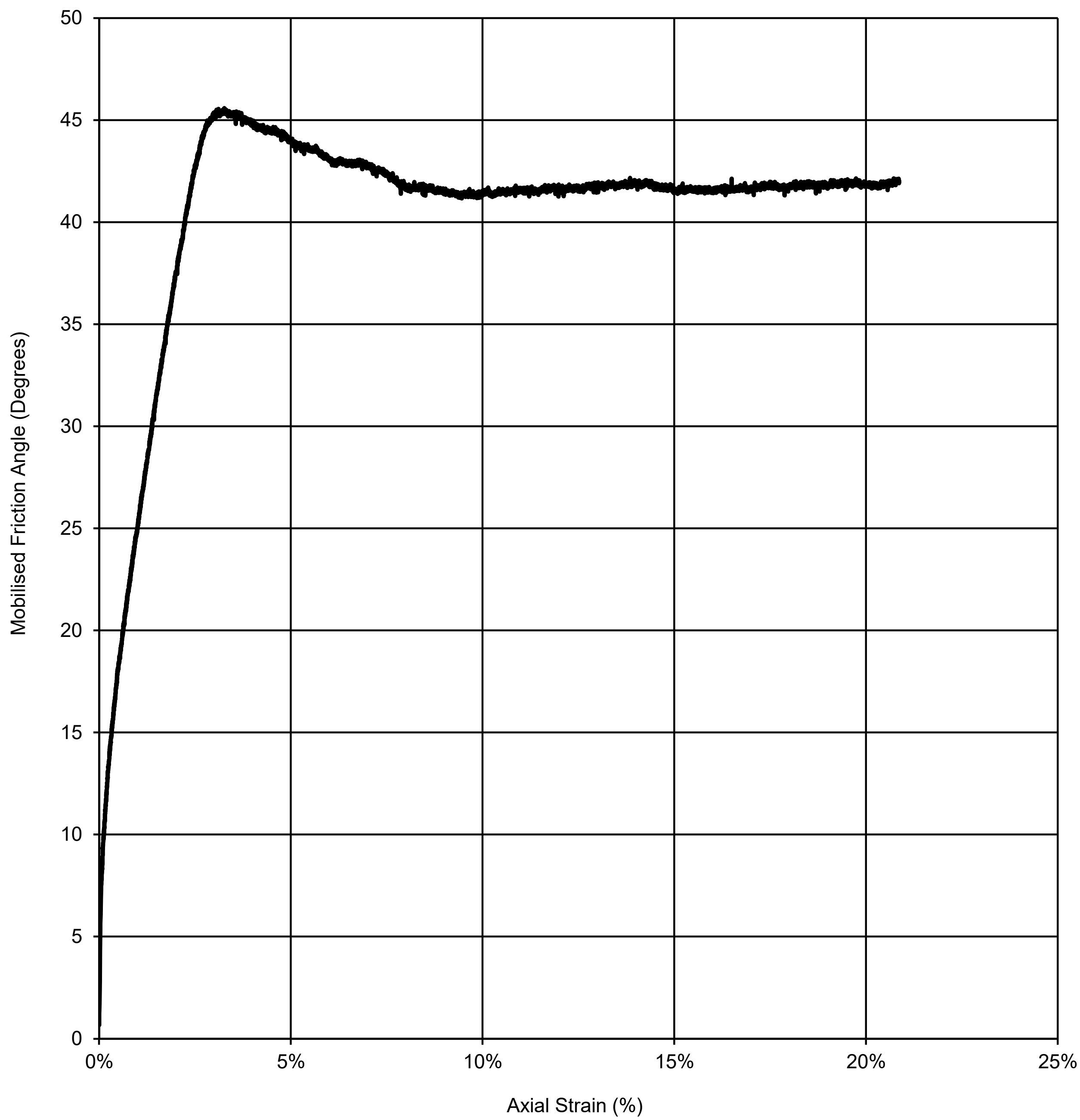
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-6 CID dense 50kPa

Initial Height (mm):	160.8	Final Liquor Content (%):	15.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.90	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.43	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

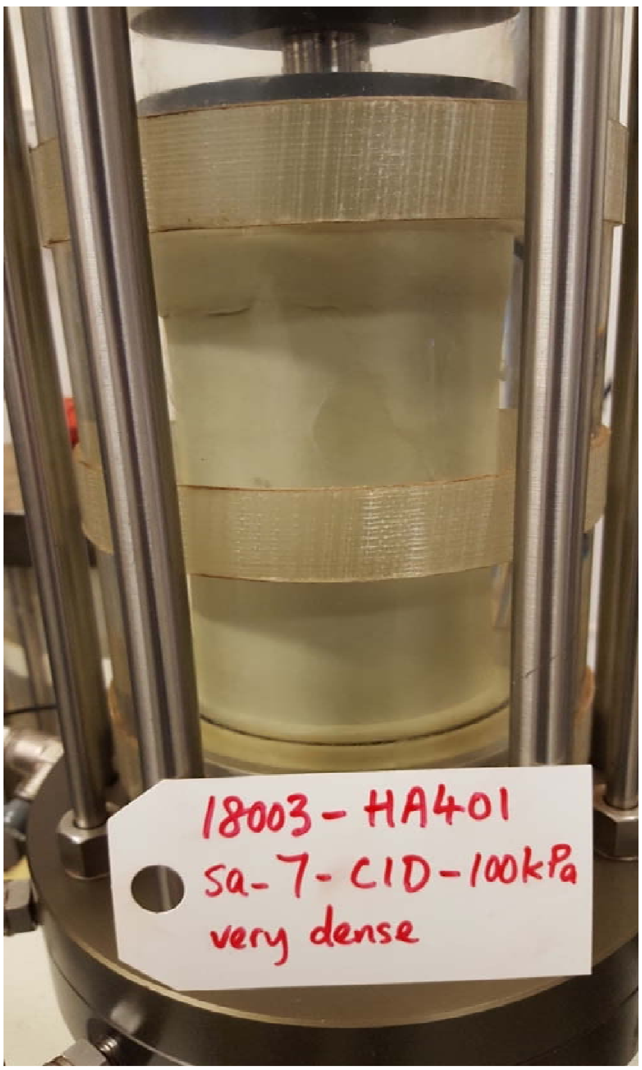
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-7 CID very dense 100kPa

Initial Height (mm):	159.9	Final Liquor Content (%):	15.0%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.94	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.41	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.94	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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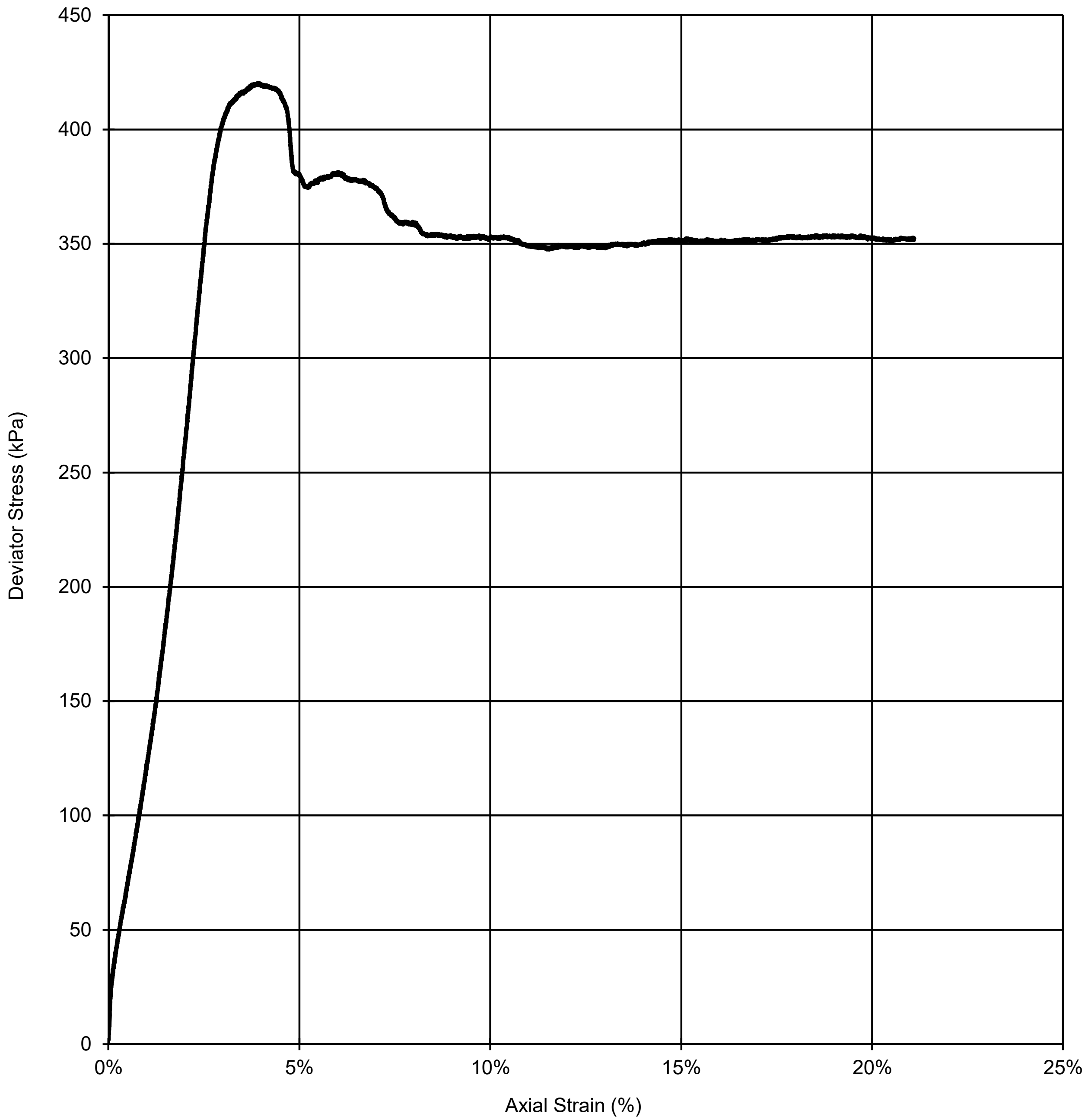
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-7 CID very dense 100kPa

Initial Height (mm):	159.9	Final Liquor Content (%):	15.0%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.94	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.41	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.94	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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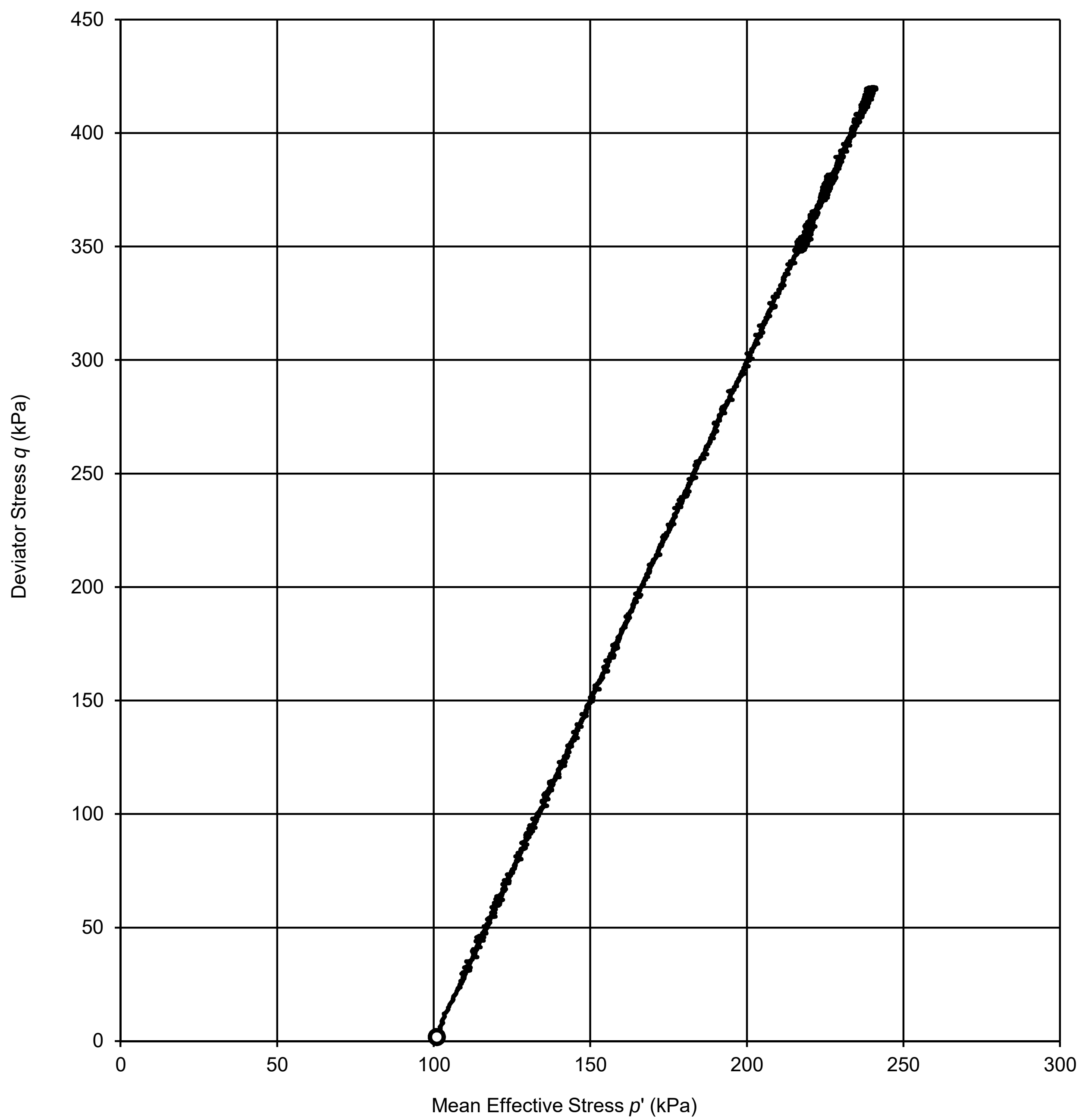
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-7 CID very dense 100kPa

Initial Height (mm):	159.9	Final Liquor Content (%):	15.0%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.94	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.41	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.94	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

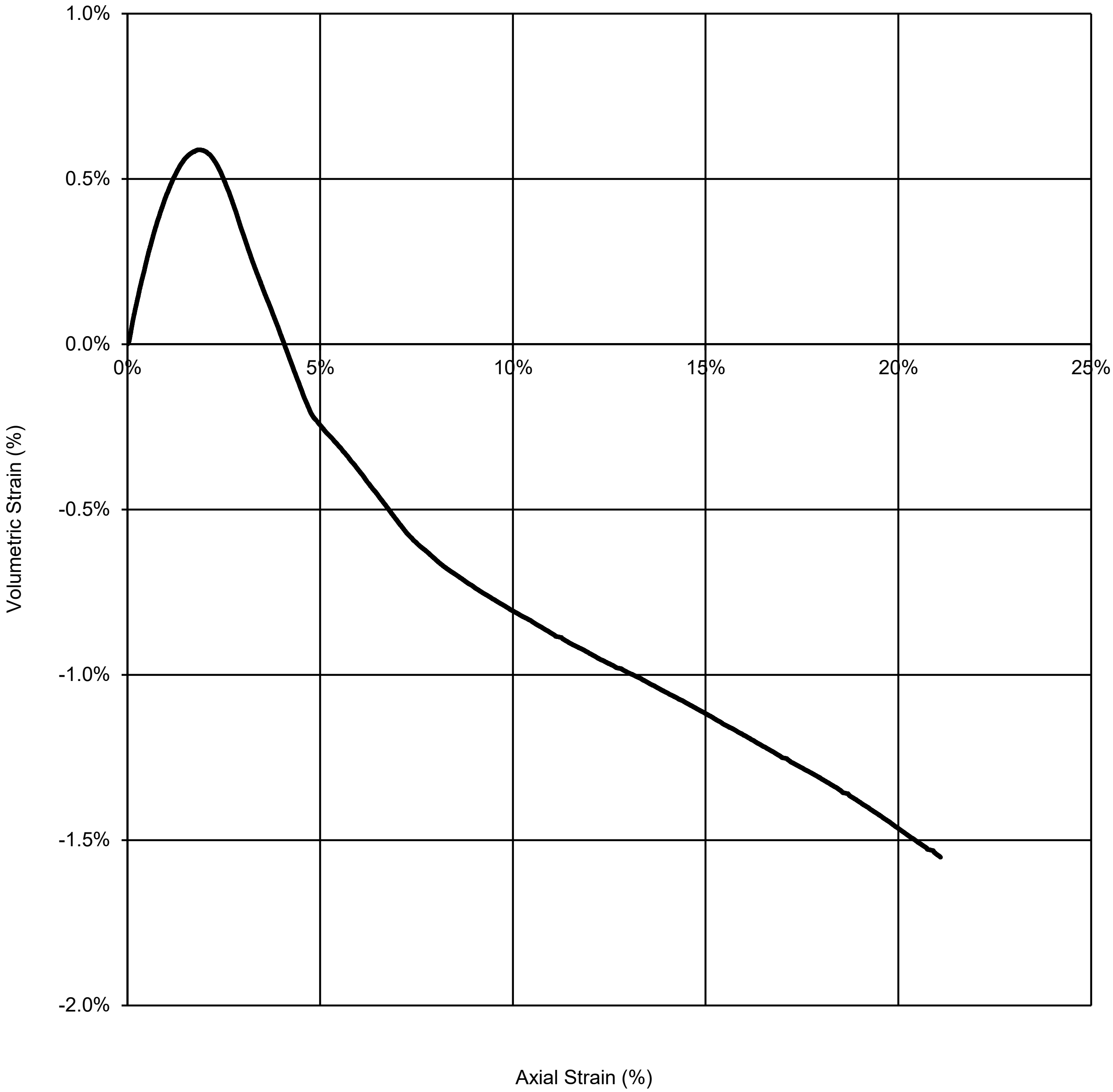
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-7 CID very dense 100kPa

Initial Height (mm):	159.9	Final Liquor Content (%):	15.0%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.94	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.41	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.94	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

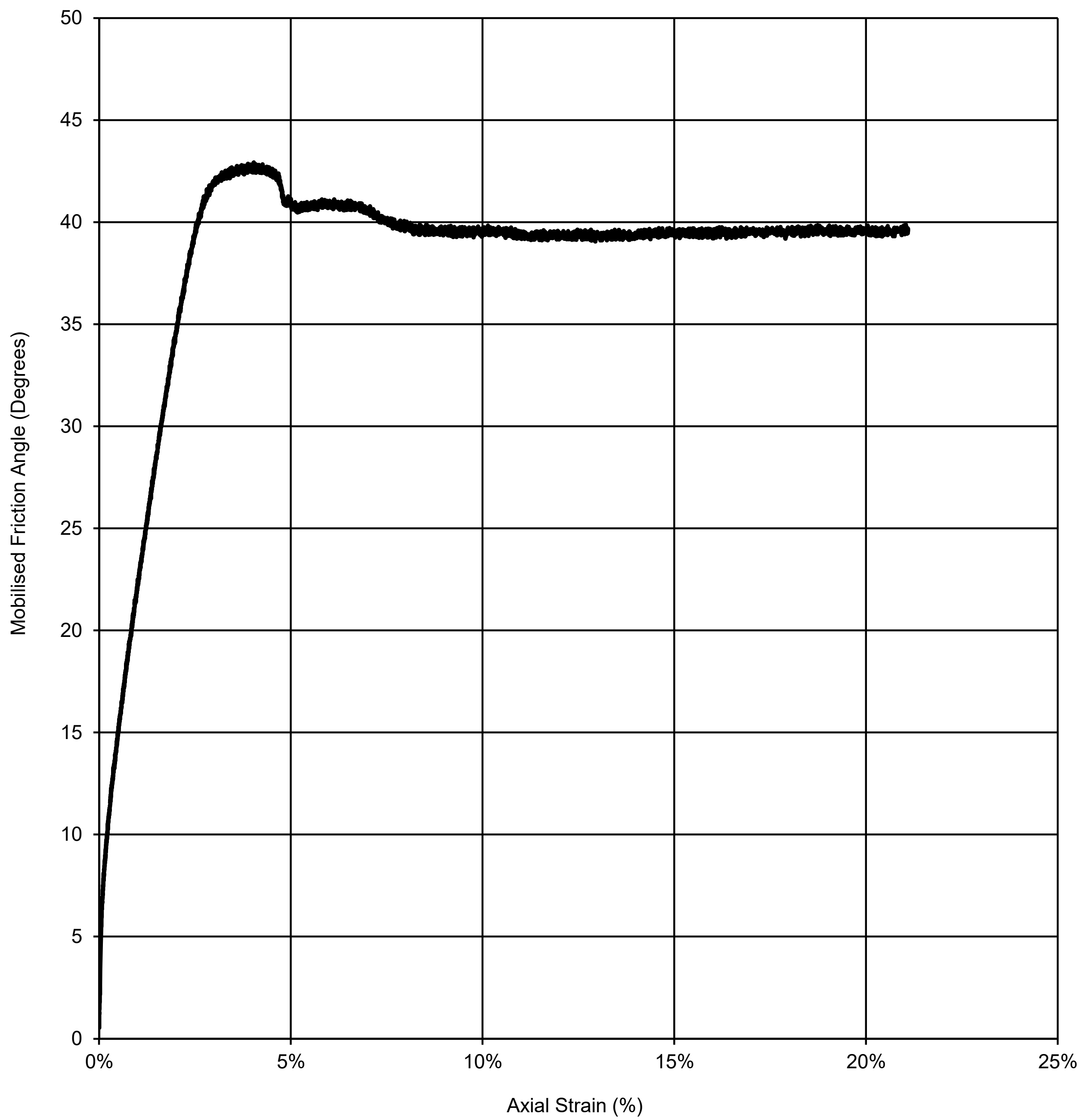
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-7 CID very dense 100kPa

Initial Height (mm):	159.9	Final Liquor Content (%):	15.0%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.5	Final Dry Density (t/m^3):	1.94	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.41	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.94	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-8 CID very dense 800kPa

Initial Height (mm):	149.3	Final Liquor Content (%):	12.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.6	Final Dry Density (t/m^3):	2.04	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.34	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	2.00	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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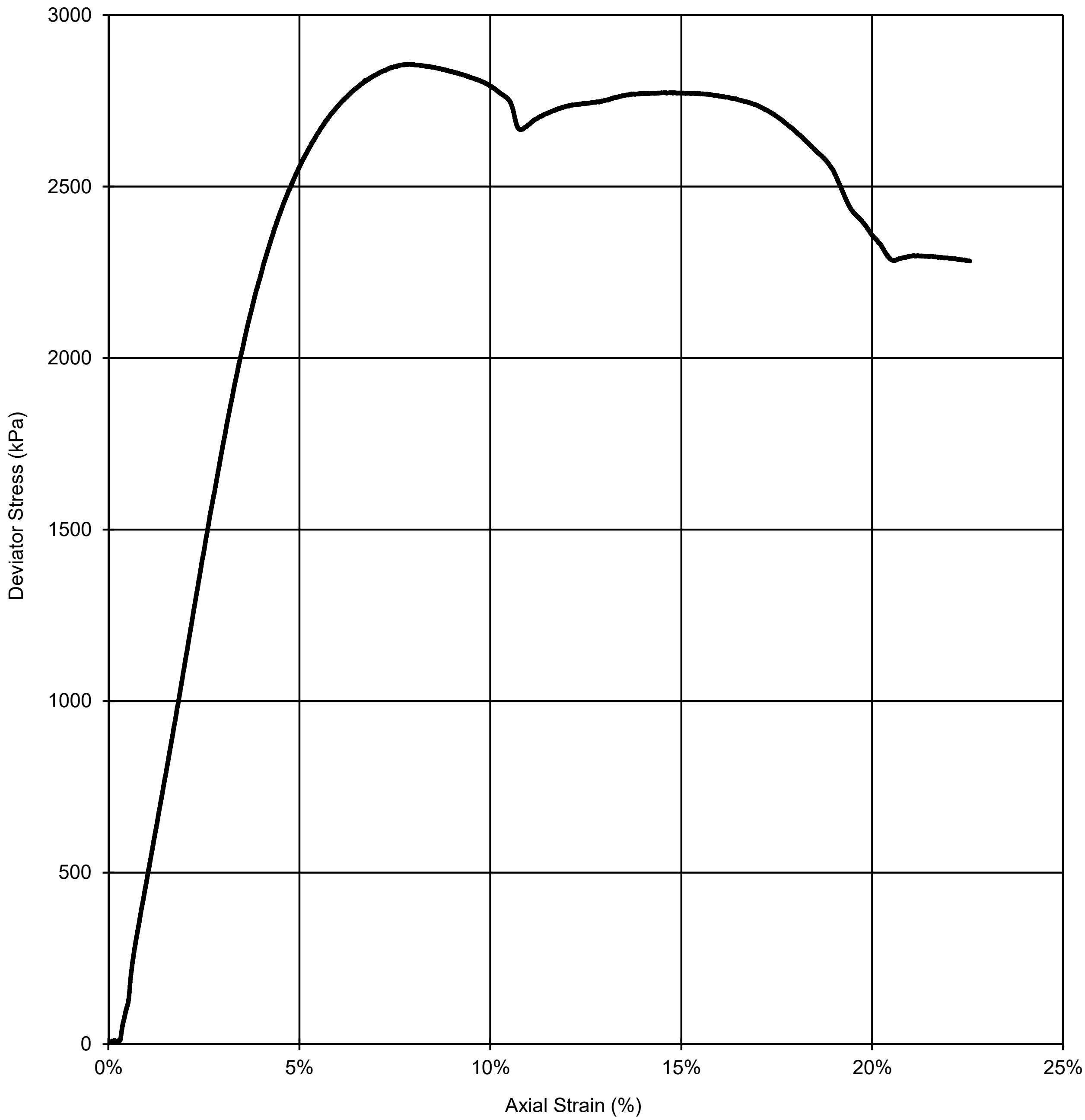
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-8 CID very dense 800kPa

Initial Height (mm):	149.3	Final Liquor Content (%):	12.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.6	Final Dry Density (t/m^3):	2.04	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.34	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	2.00	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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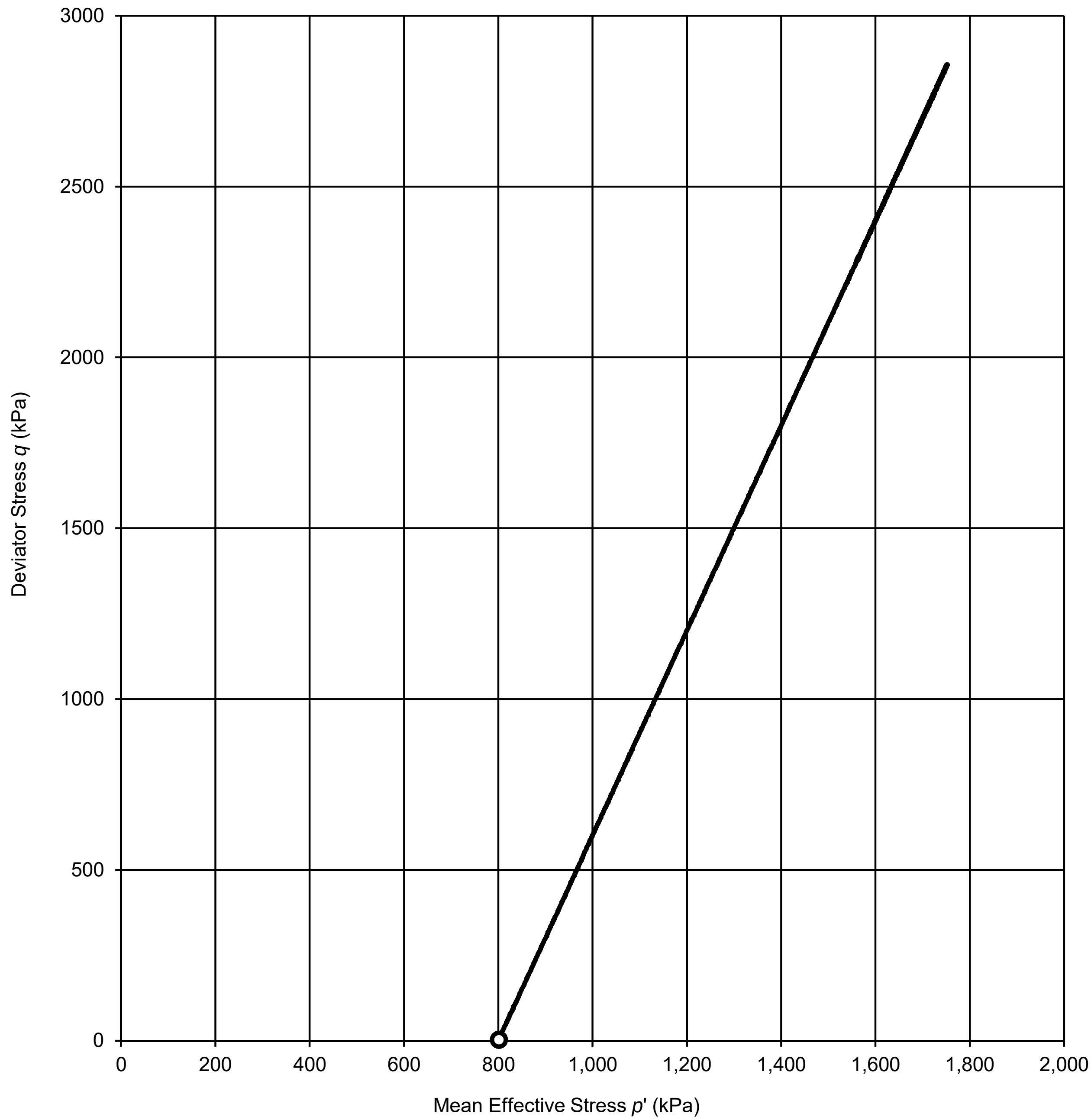
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-8 CID very dense 800kPa

Initial Height (mm):	149.3	Final Liquor Content (%):	12.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.6	Final Dry Density (t/m^3):	2.04	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.34	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	2.00	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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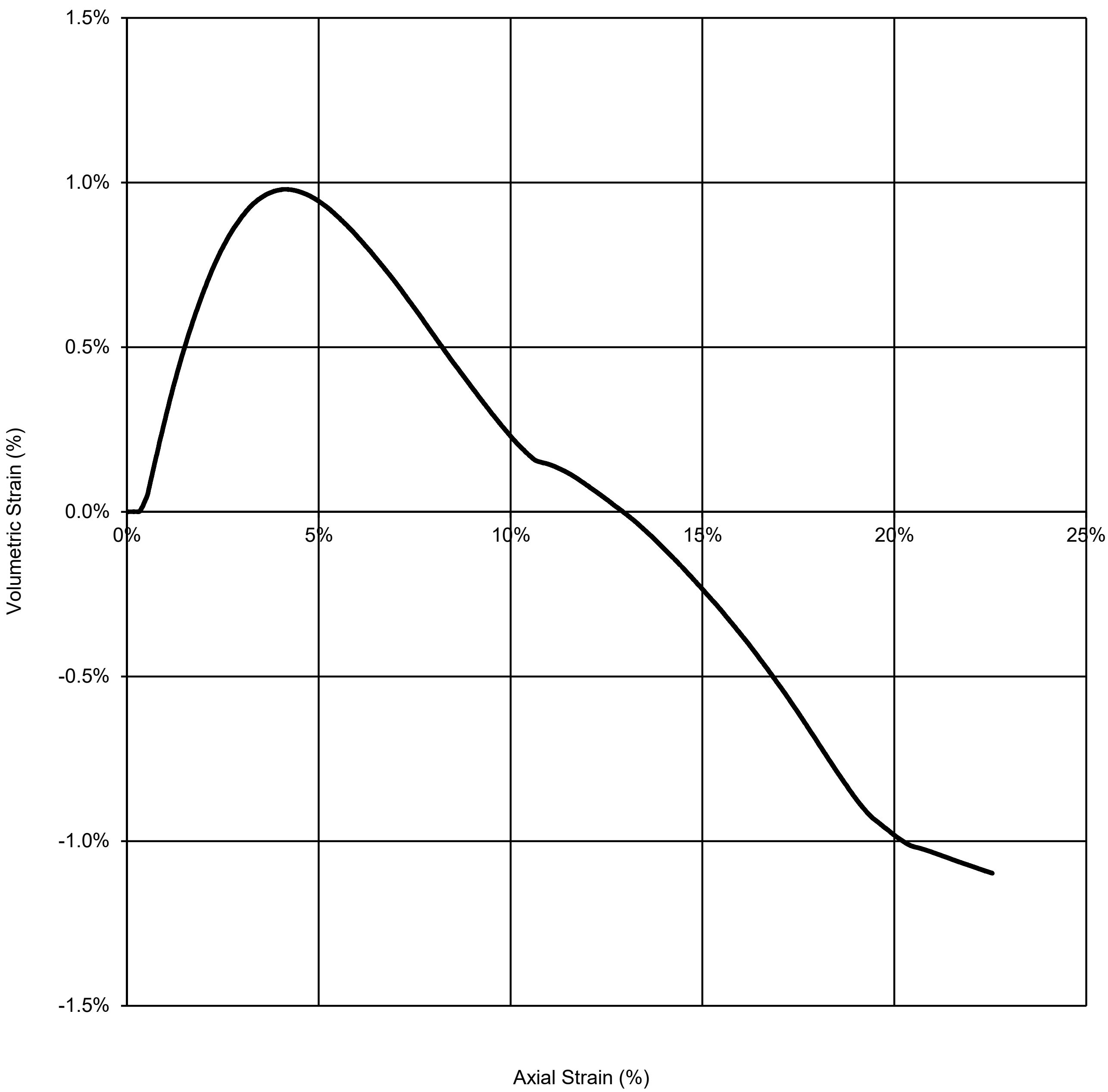
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-8 CID very dense 800kPa

Initial Height (mm):	149.3	Final Liquor Content (%):	12.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.6	Final Dry Density (t/m^3):	2.04	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.34	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	2.00	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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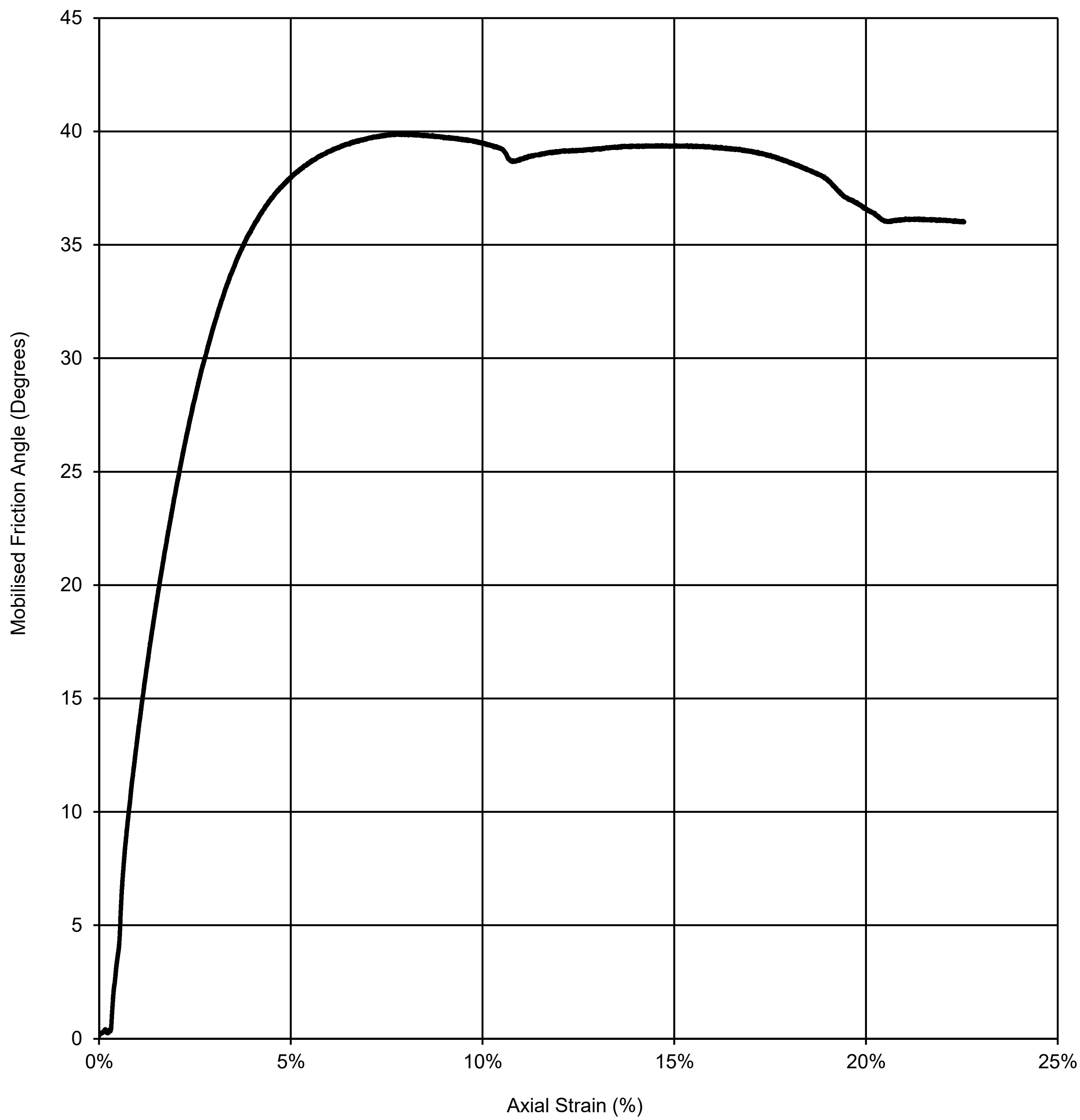
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-8 CID very dense 800kPa

Initial Height (mm):	149.3	Final Liquor Content (%):	12.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	72.6	Final Dry Density (t/m^3):	2.04	B Response (%):	96%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.34	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	2.00	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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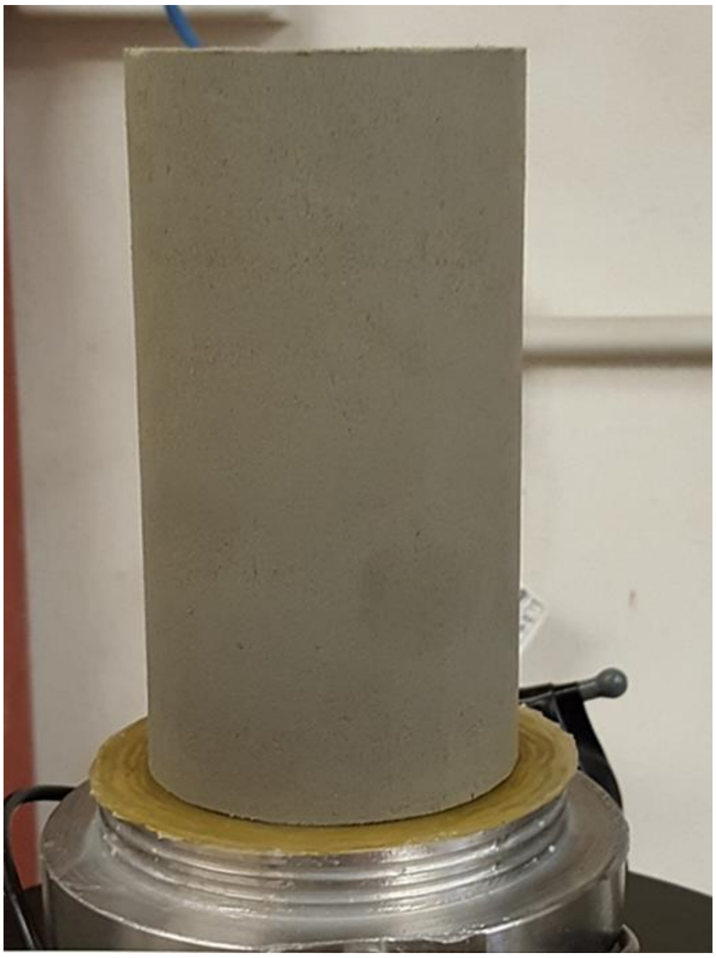
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-9 CID dense 1300kPa

Initial Height (mm):	125.7	Final Liquor Content (%):	13.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	2.01	B Response (%):	96%
Trimmings GWC (%):	13.5%	Final Void Ratio (-):	0.36	Mean Effective Consolidation Stress (kPa):	1301
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

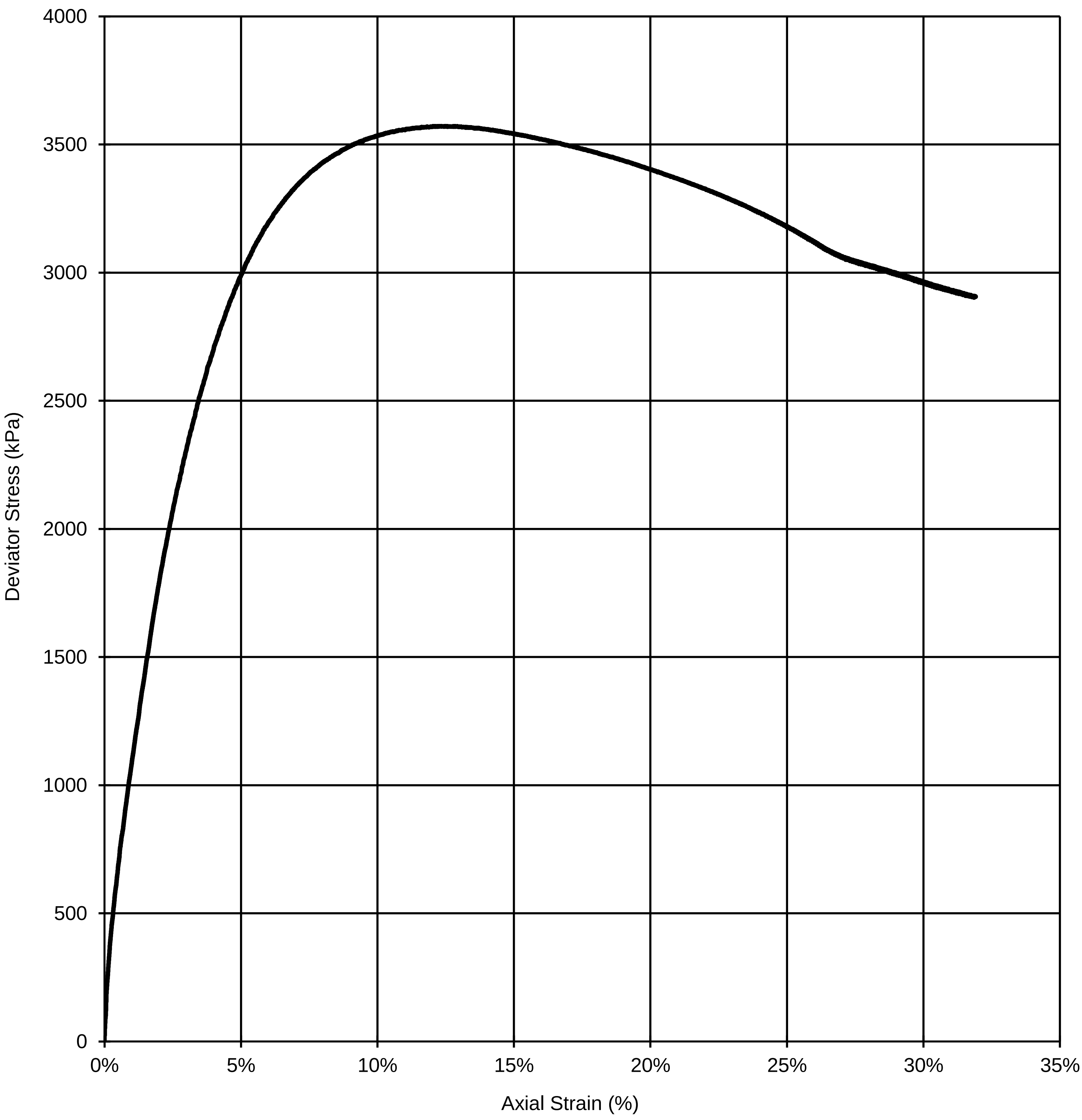
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-9 CID dense 1300kPa

Initial Height (mm):	125.7	Final Liquor Content (%):	13.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	2.01	B Response (%):	96%
Trimmings GWC (%):	13.5%	Final Void Ratio (-):	0.36	Mean Effective Consolidation Stress (kPa):	1301
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

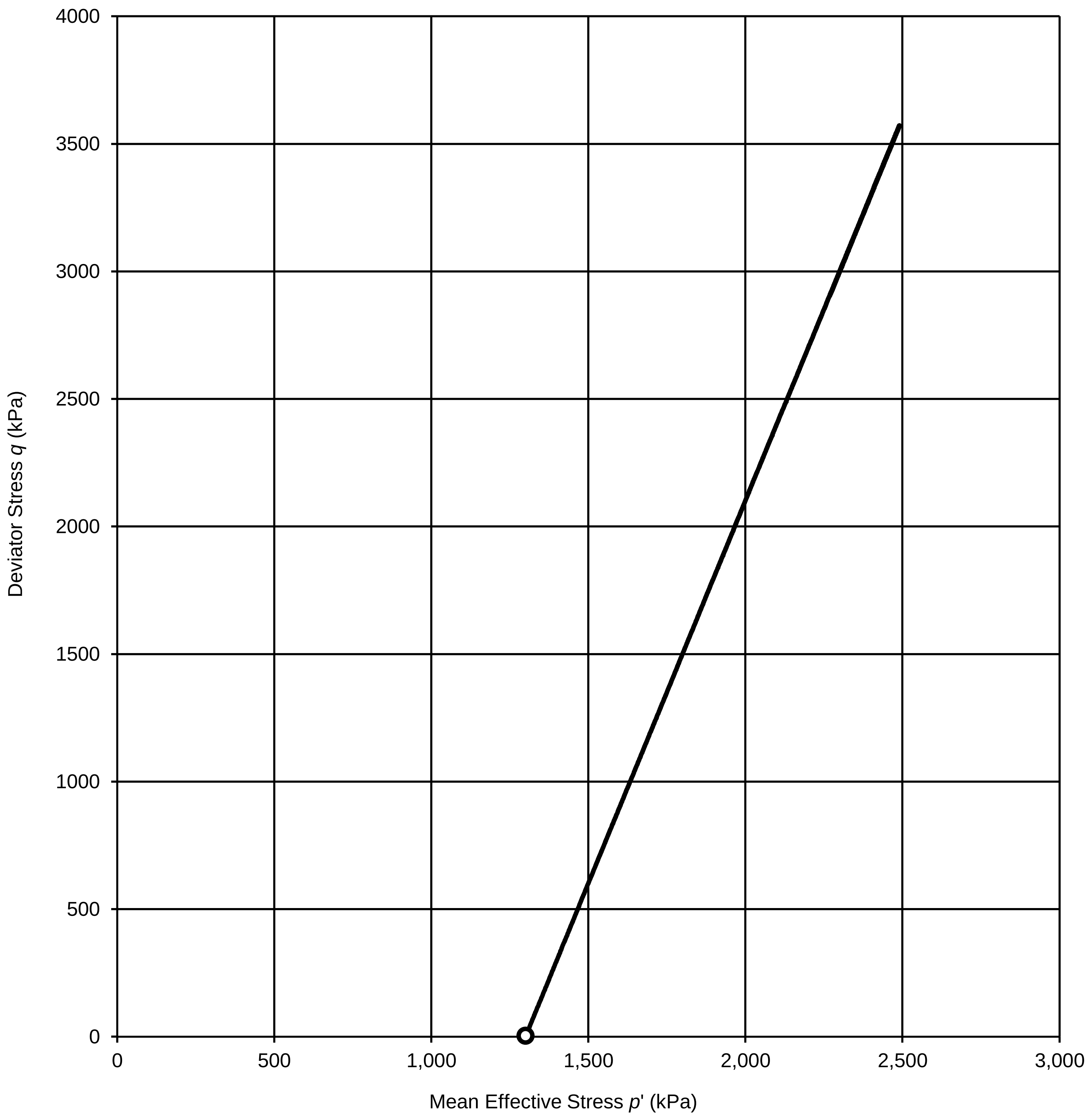
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-9 CID dense 1300kPa

Initial Height (mm):	125.7	Final Liquor Content (%):	13.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	2.01	B Response (%):	96%
Trimmings GWC (%):	13.5%	Final Void Ratio (-):	0.36	Mean Effective Consolidation Stress (kPa):	1301
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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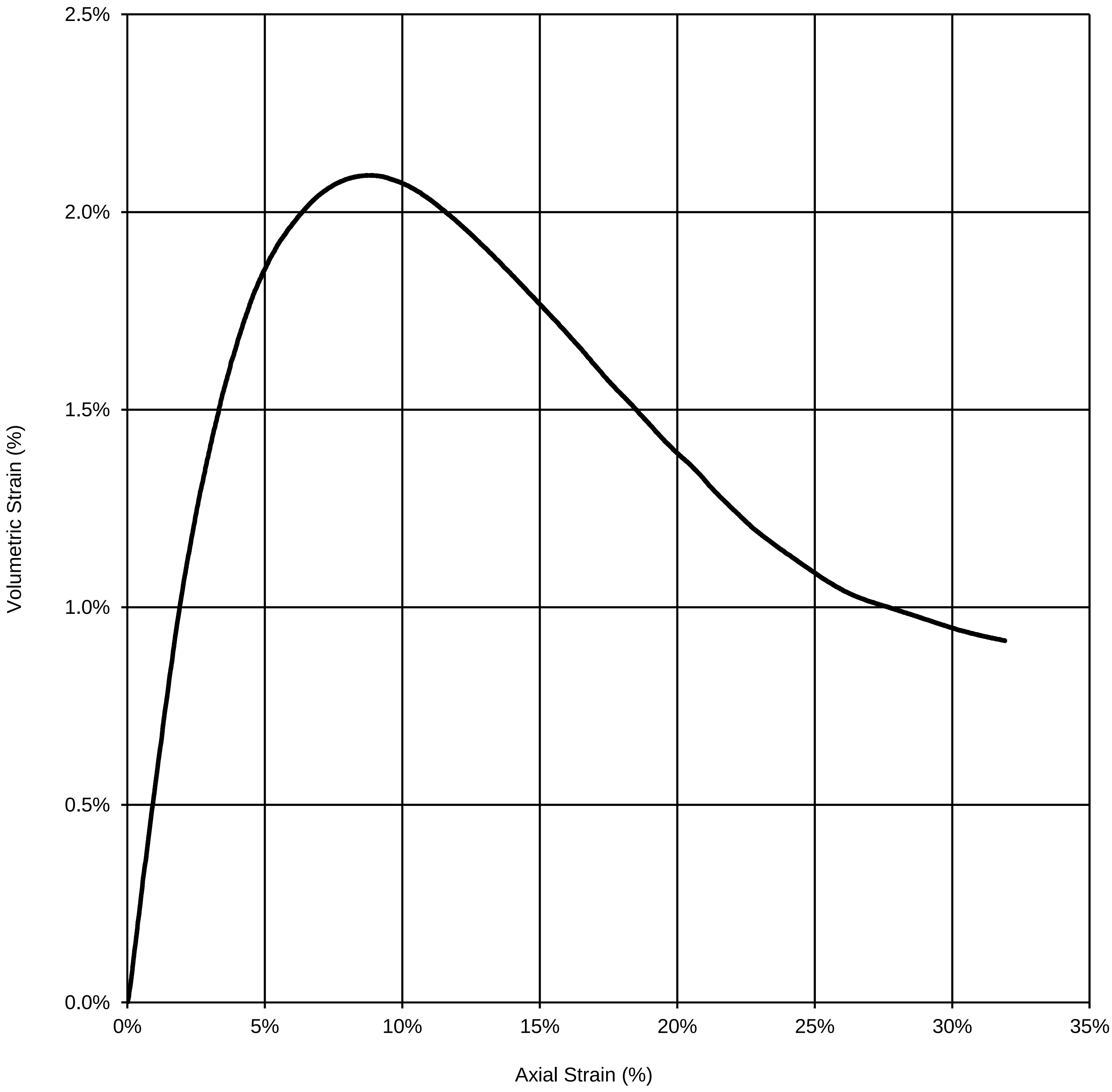
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-9 CID dense 1300kPa

Initial Height (mm):	125.7	Final Liquor Content (%):	13.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	2.01	B Response (%):	96%
Trimmings GWC (%):	13.5%	Final Void Ratio (-):	0.36	Mean Effective Consolidation Stress (kPa):	1301
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
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Client:	Hatch	**Date:**	28/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-9 CID dense 1300kPa

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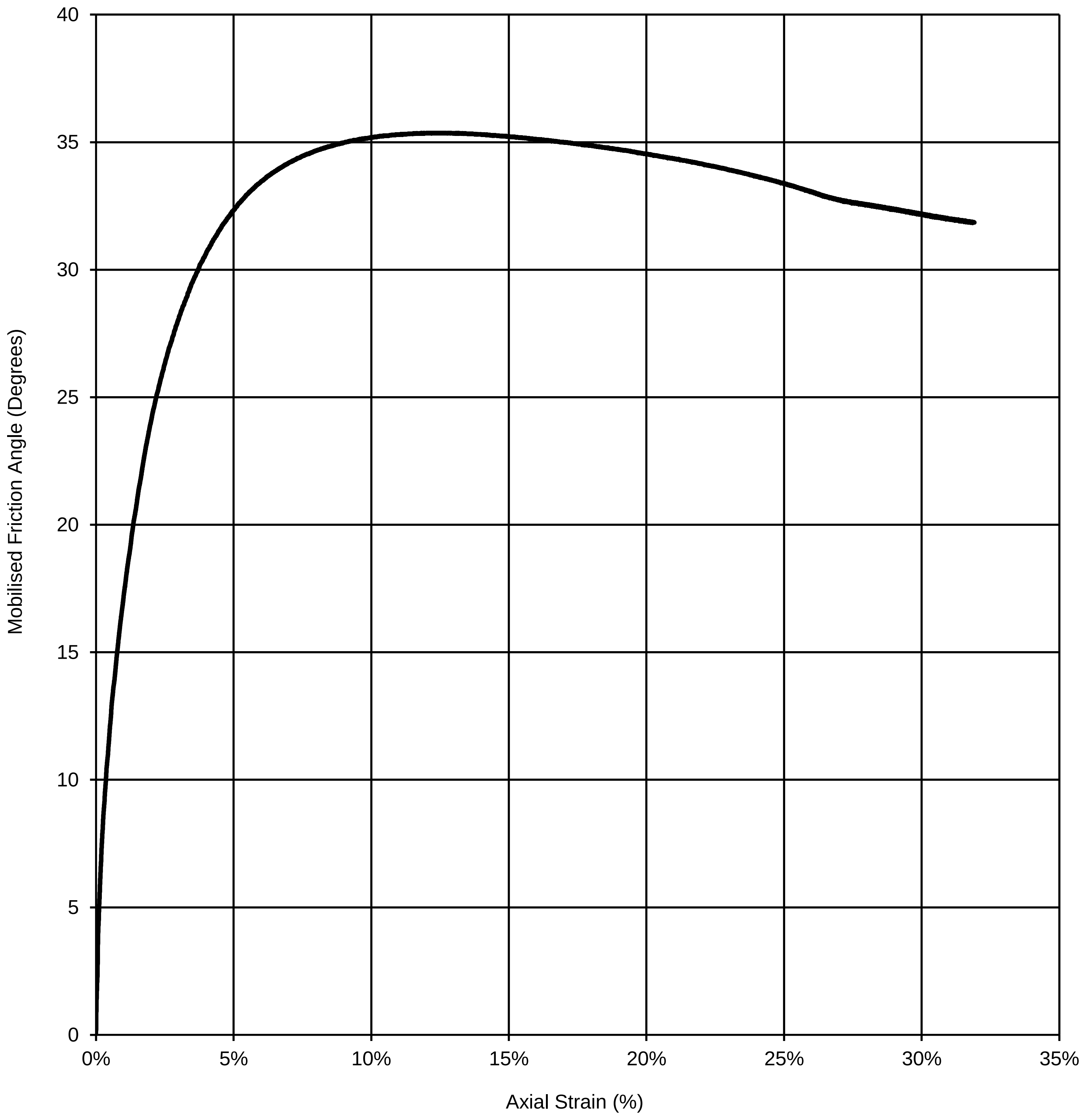
Trimmings GWC (%):	13.5%	Final Void Ratio (-):	0.36	Mean Effective Consolidation Stress (kPa):	1301
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18080184A - CU
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	1/10/2018
		Report Date:	8/10/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	HA401	**Depth (m):**	0.00-2.00
Description:	Tailings		

SAMPLE & TEST DETAILS

Initial Height:	152.1	mm	Initial Moisture Content:	10.0	%	Rate of Strain:	0.013	%/min
Initial Diameter:	76.1	mm	Final Moisture Content:	21.5	%	B Response:	99	%
L/D Ratio:	2.0 : 1		Wet Density:	1.88	t/m^3	Target Void Ratio:	0.600	
			Dry Density:	1.71	t/m^3	Final Void Ratio:	0.550	
						Freezing Void Ratio :	0.551	

Sample Type: Single Individual Remoulded Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
101 kPa	600 kPa	499 kPa	499 kPa	51 kPa	171 kPa	103 kPa	1.660	68 kPa	1.07 %

FAILURE ENVELOPES

Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

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Laboratory Number 9926

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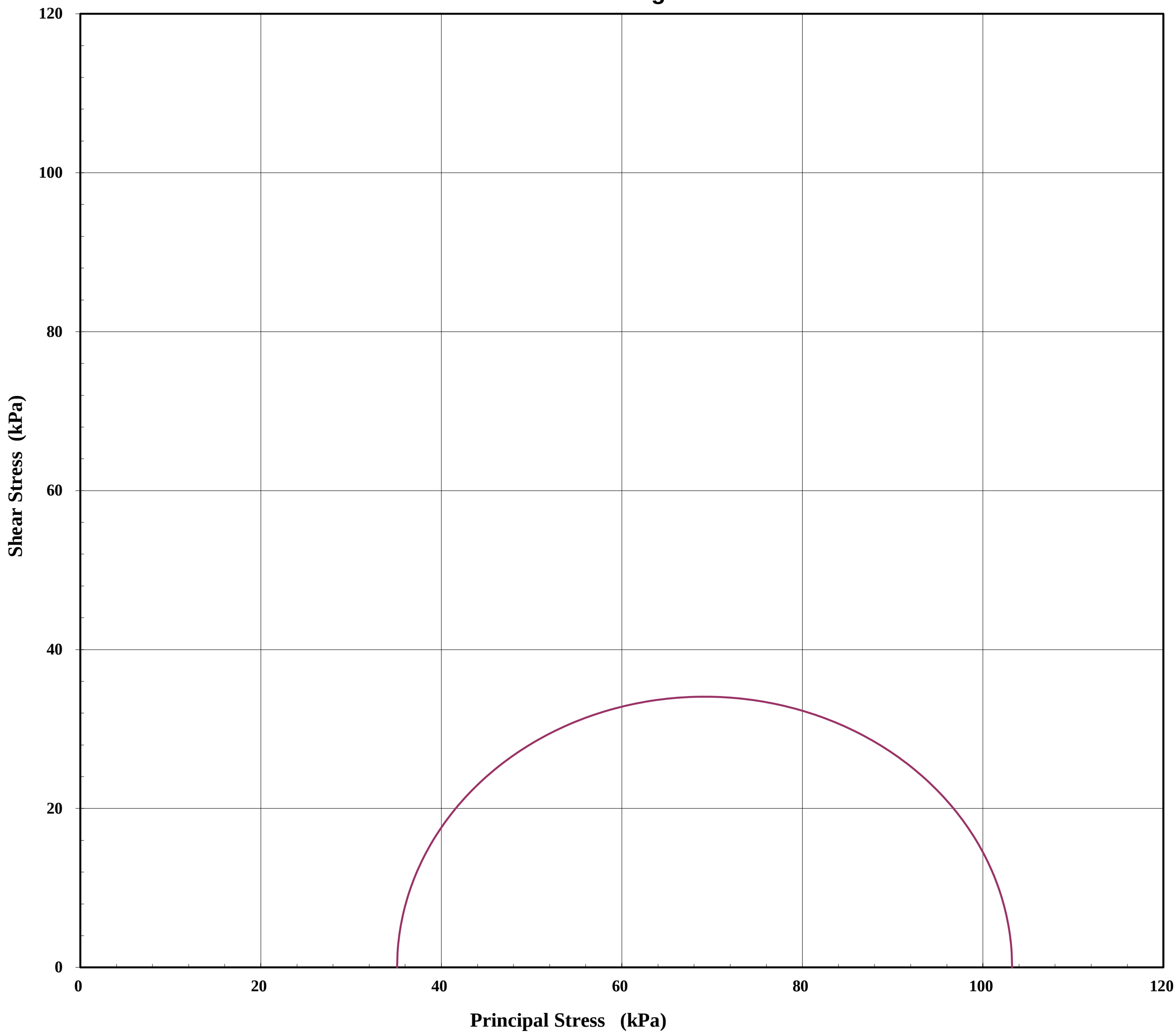
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184A - CU

Mohr Circle Diagram



Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

Note: Graph not to scale

REP03001

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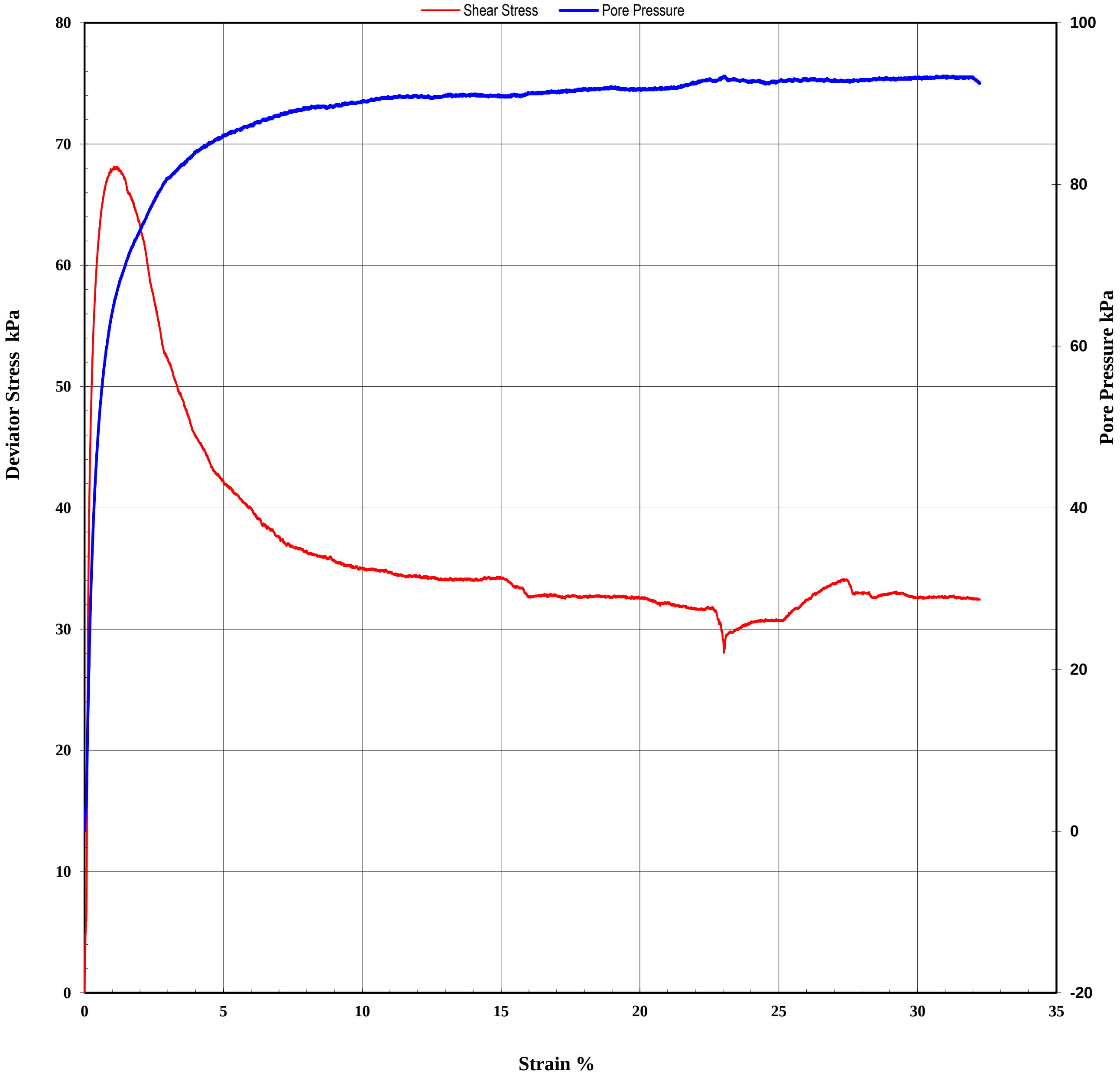
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184A - CU

Stress/Strain & Pore Pressure/Strain Diagram



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Note: Graph not to scale

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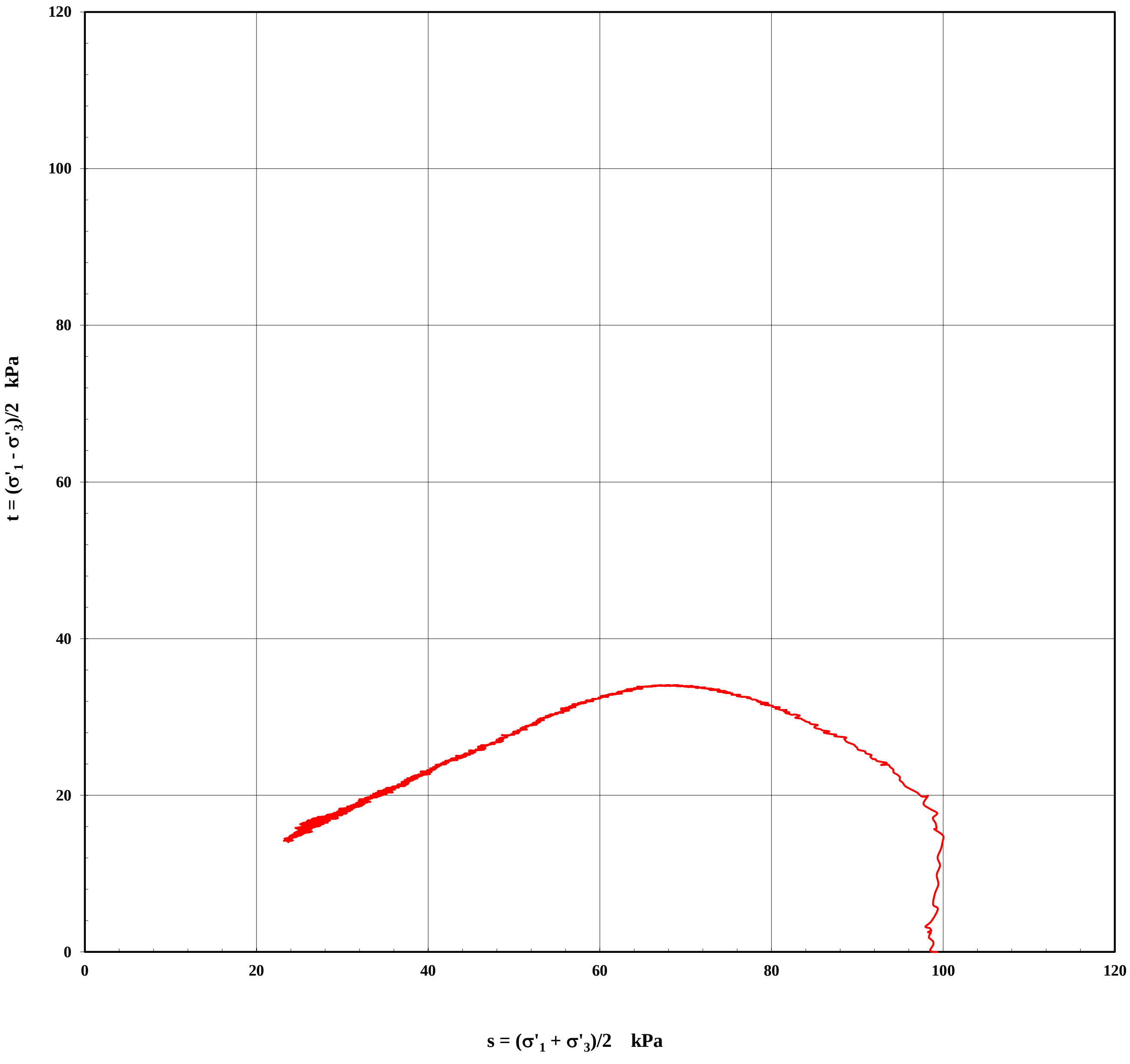
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080184A - CU

MIT Method - Effective Stress Path



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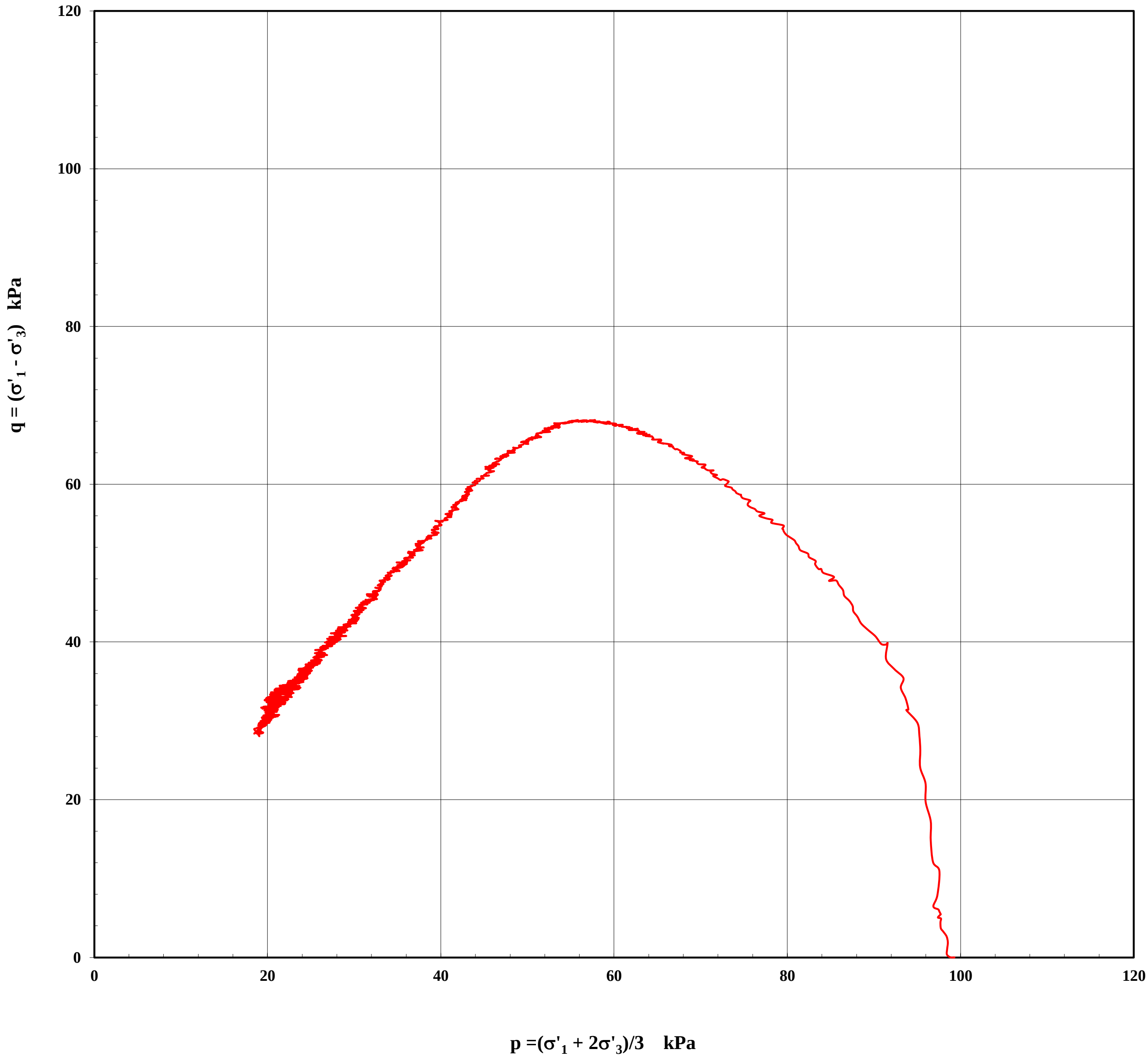
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080184A - CU

Cambridge Method - Effective Stress Path



Remarks:

Sample/s supplied by the client

Note: Graph not to scale

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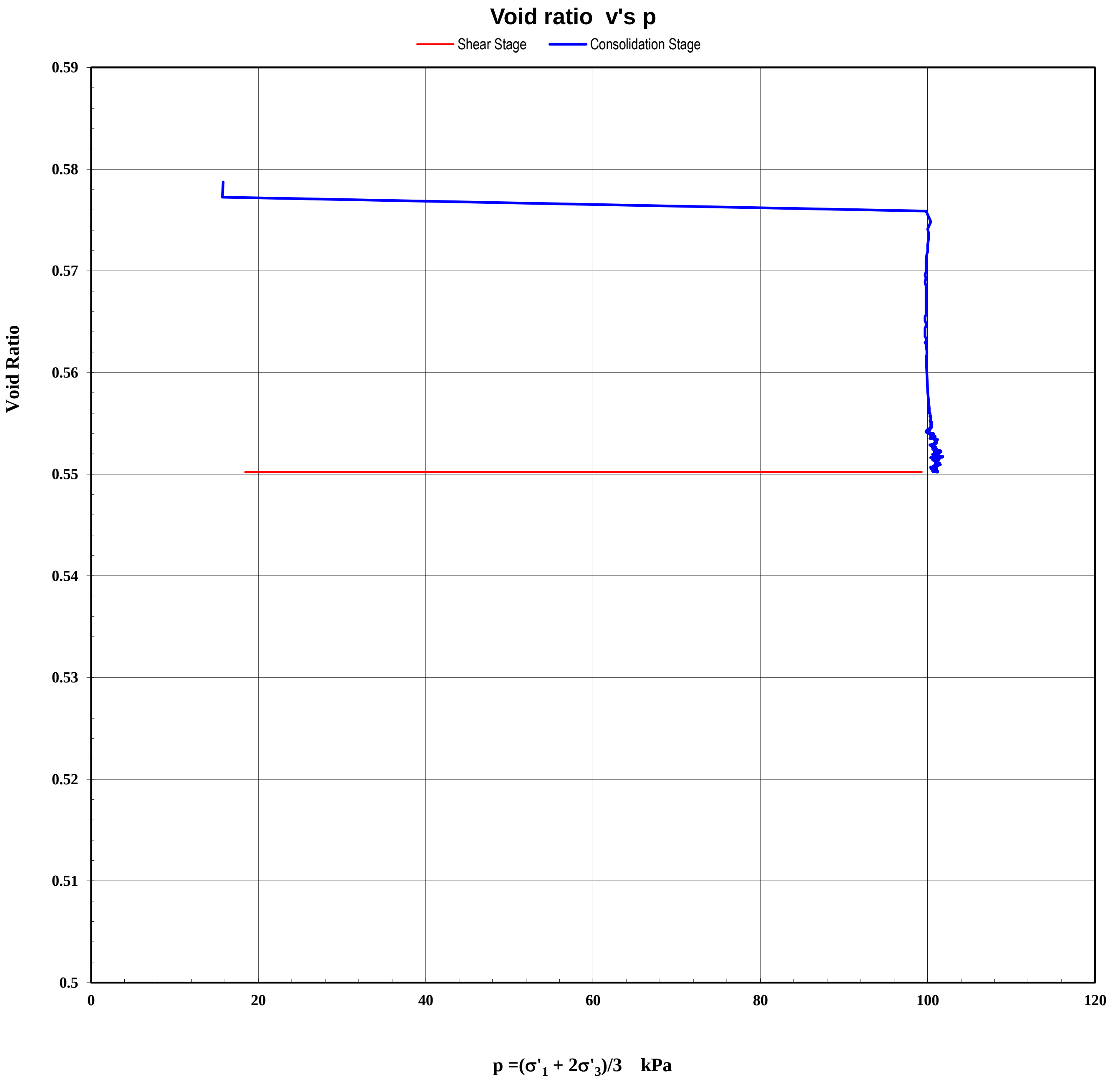
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184A - CU



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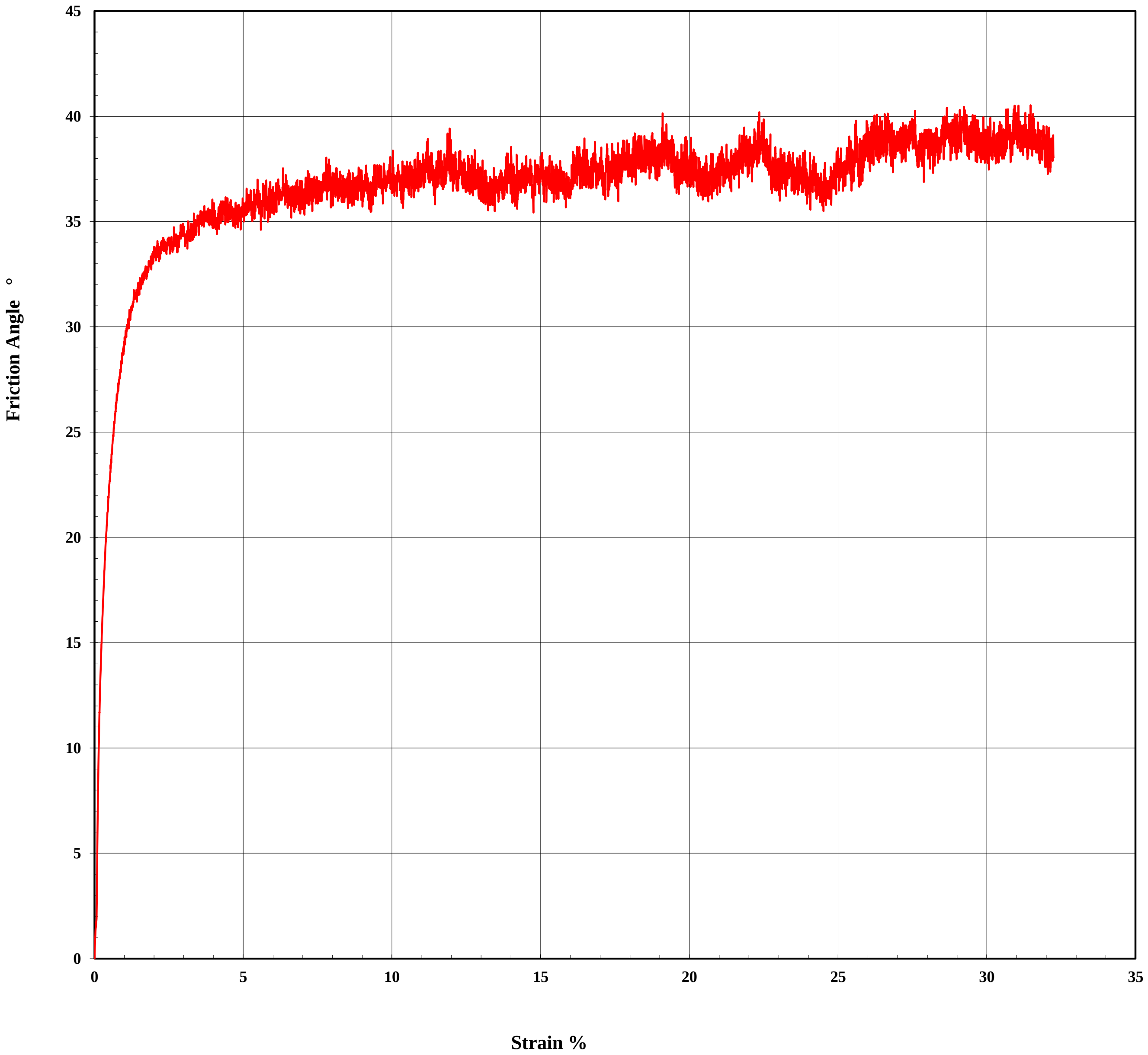
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184A - CU

Friction Angle v's Axial Strain



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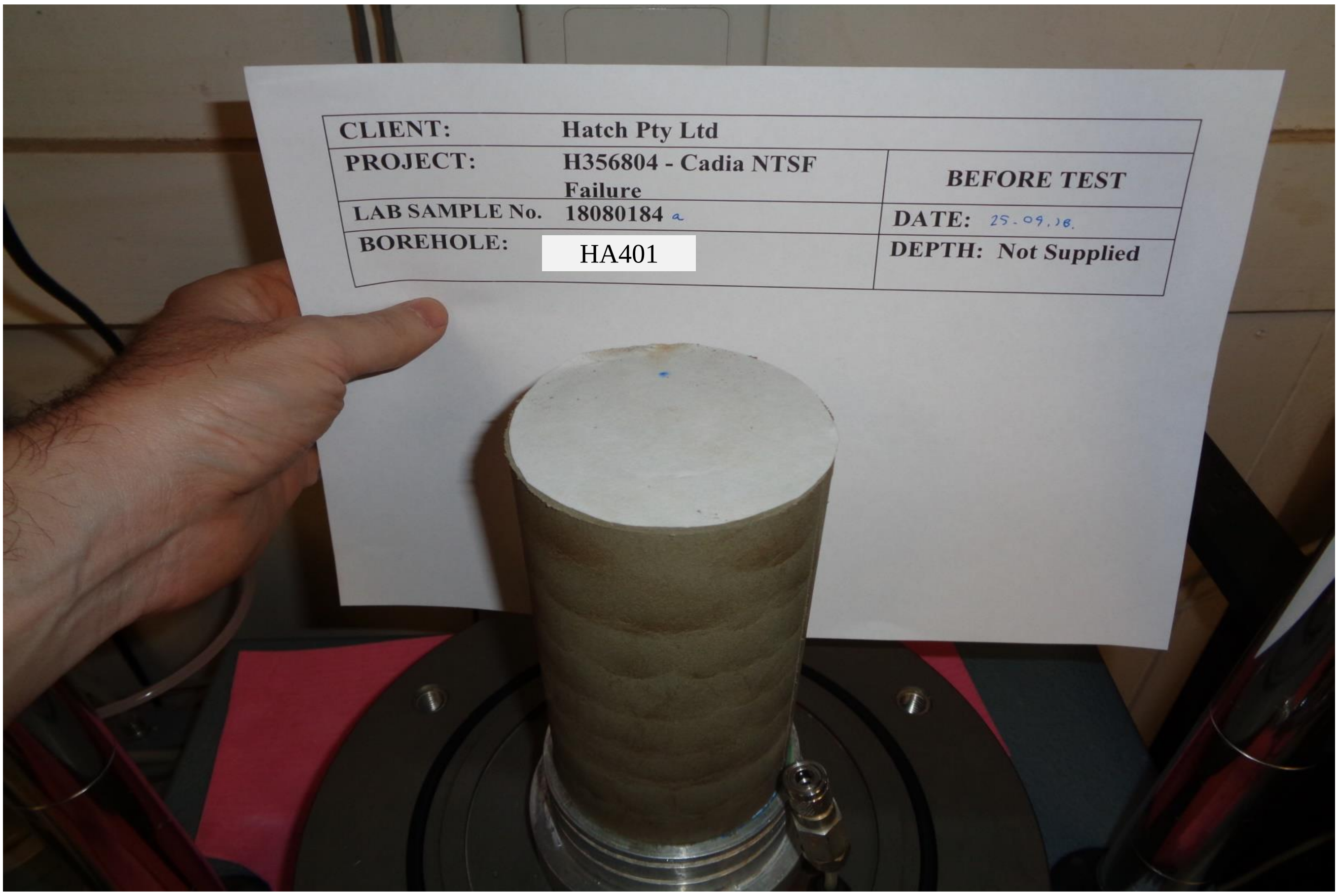
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184A - CU



Remarks:

Sample/s supplied by the client

Note: Photo not to scale

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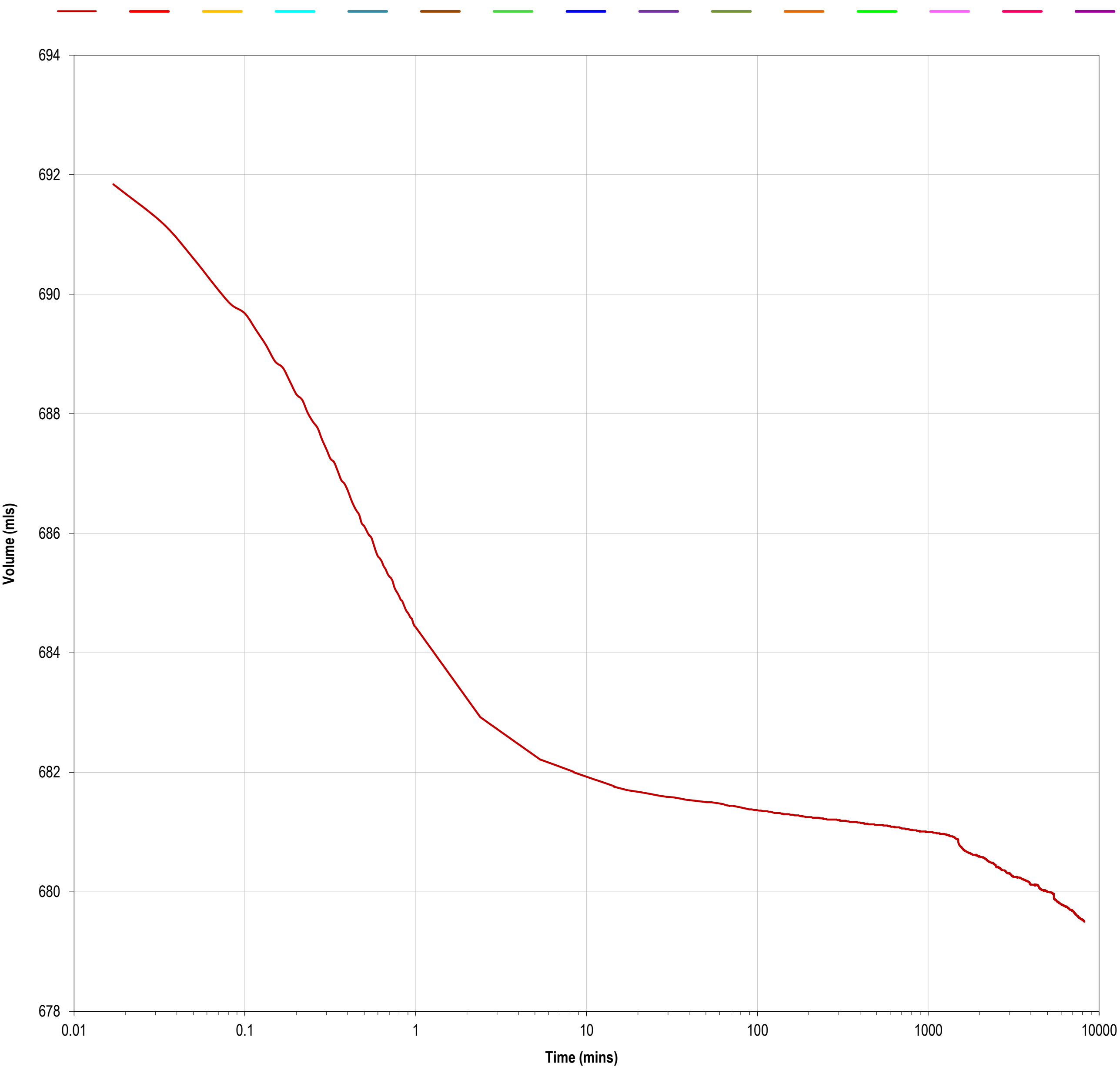
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184A - CU

Volume v's Time (Log Scale)



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Sample/s supplied by the client

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18080184B - CU
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	24/09/2018
		Report Date:	8/10/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	HA401	**Depth (m):**	0.00-2.00
Description:	Tailings		

SAMPLE & TEST DETAILS

Initial Height:	152.2	mm	Initial Moisture Content:	10.0	%	Rate of Strain:	0.013	%/min
Initial Diameter:	76.1	mm	Final Moisture Content:	19.5	%	B Response:	99	%
L/D Ratio:	2.0 : 1		Wet Density:	1.94	t/m^3	Target Void Ratio:	0.550	
			Dry Density:	1.76	t/m^3	Final Void Ratio:	0.527	
						Freezing Void Ratio:	0.522	

Sample Type: Single Individual Remoulded Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
253 kPa	751 kPa	498 kPa	498 kPa	14 kPa	247 kPa	84 kPa	2.945	163 kPa	1.23 %

FAILURE ENVELOPES

Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

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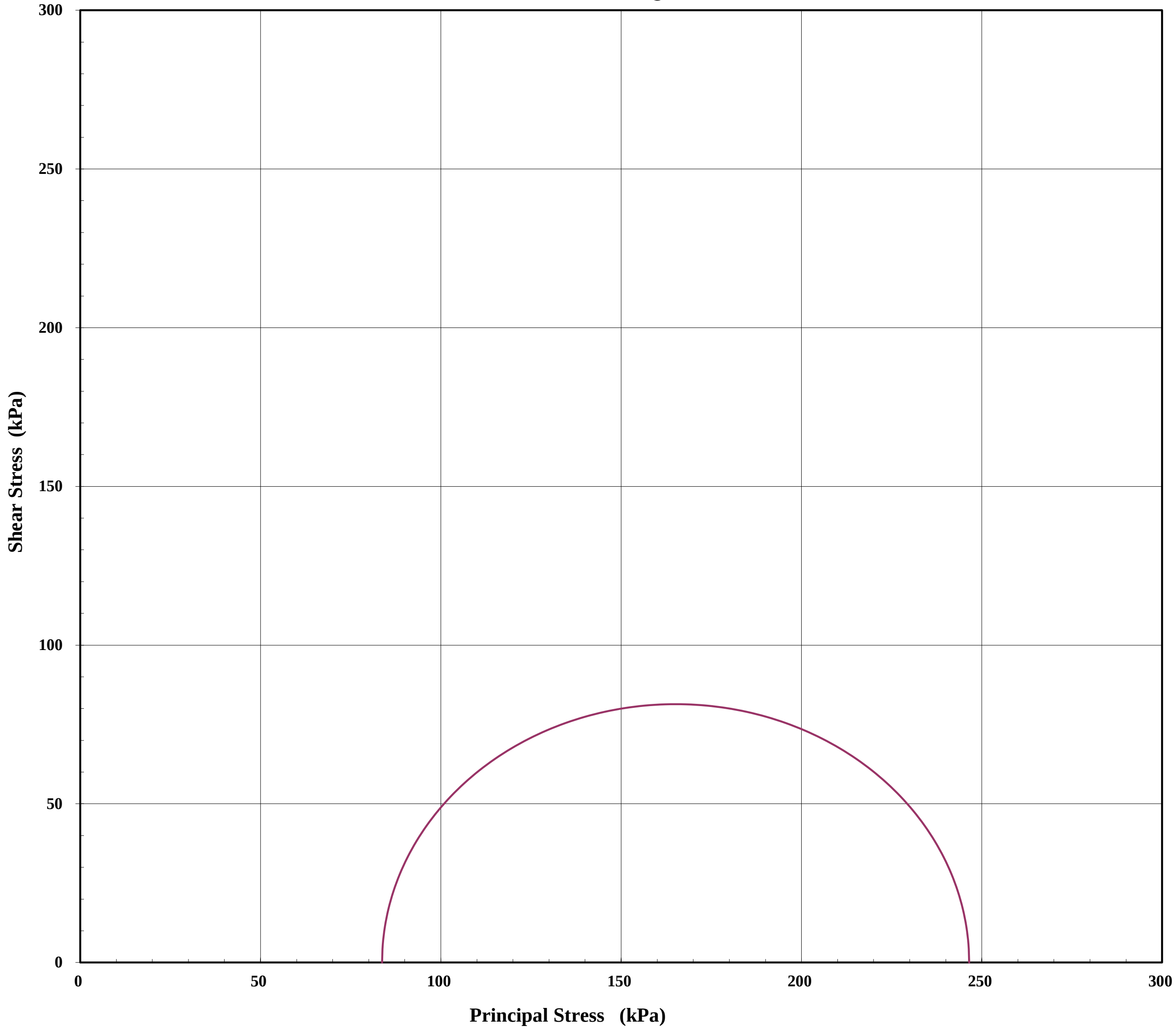
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184B - CU

Mohr Circle Diagram



Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

Note: Graph not to scale

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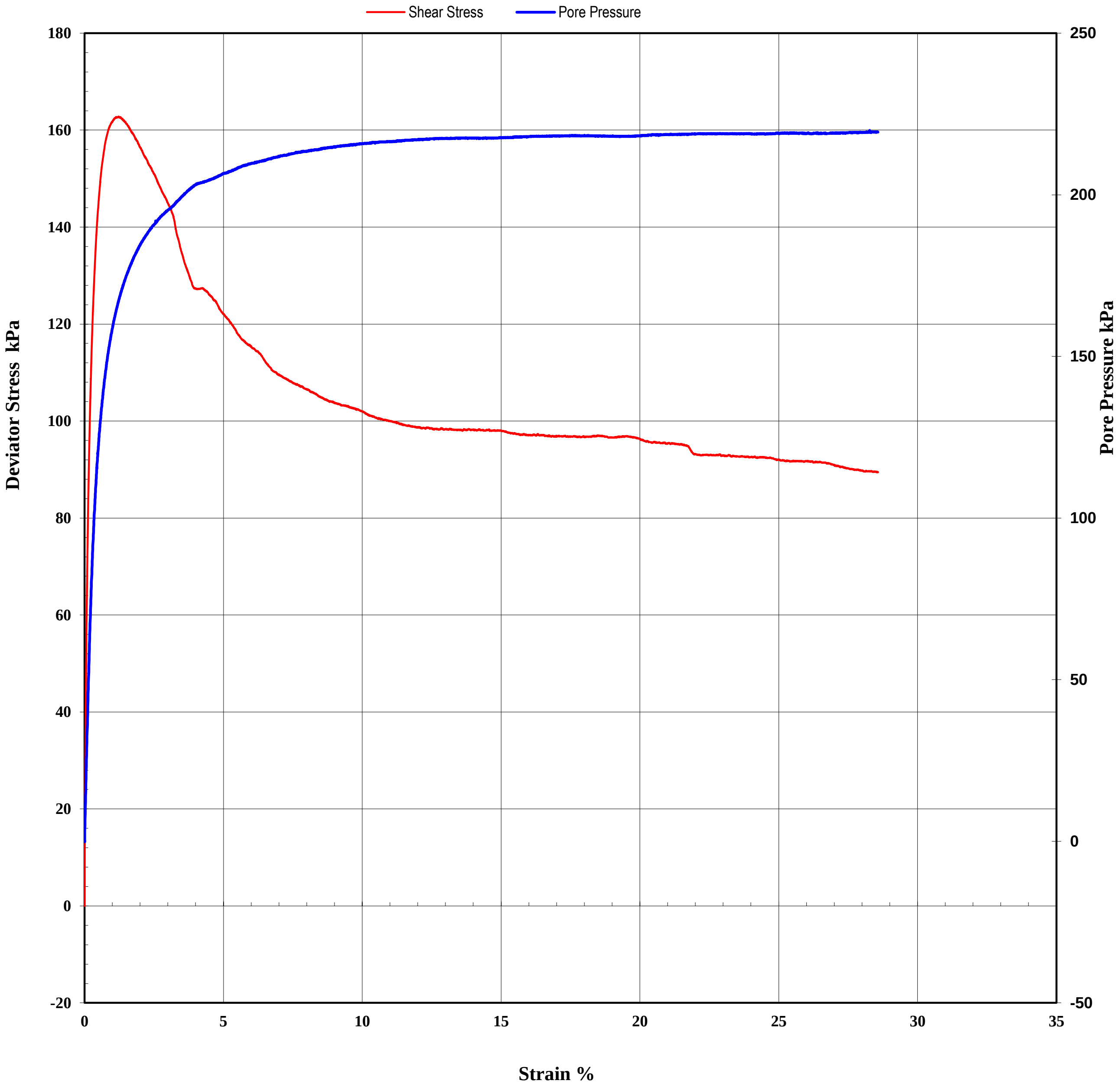
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184B - CU

Stress/Strain & Pore Pressure/Strain Diagram



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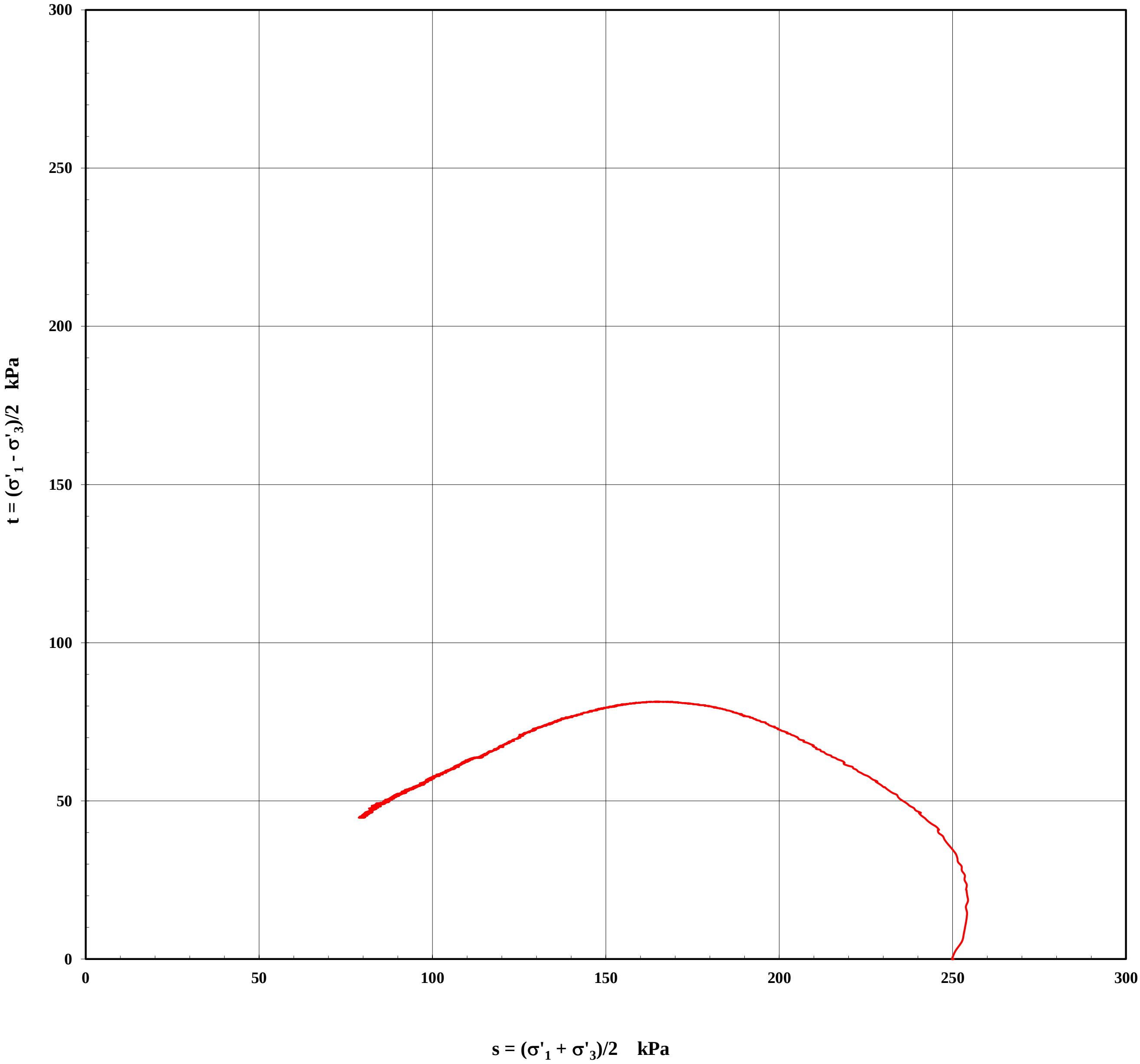
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184B - CU

MIT Method - Effective Stress Path



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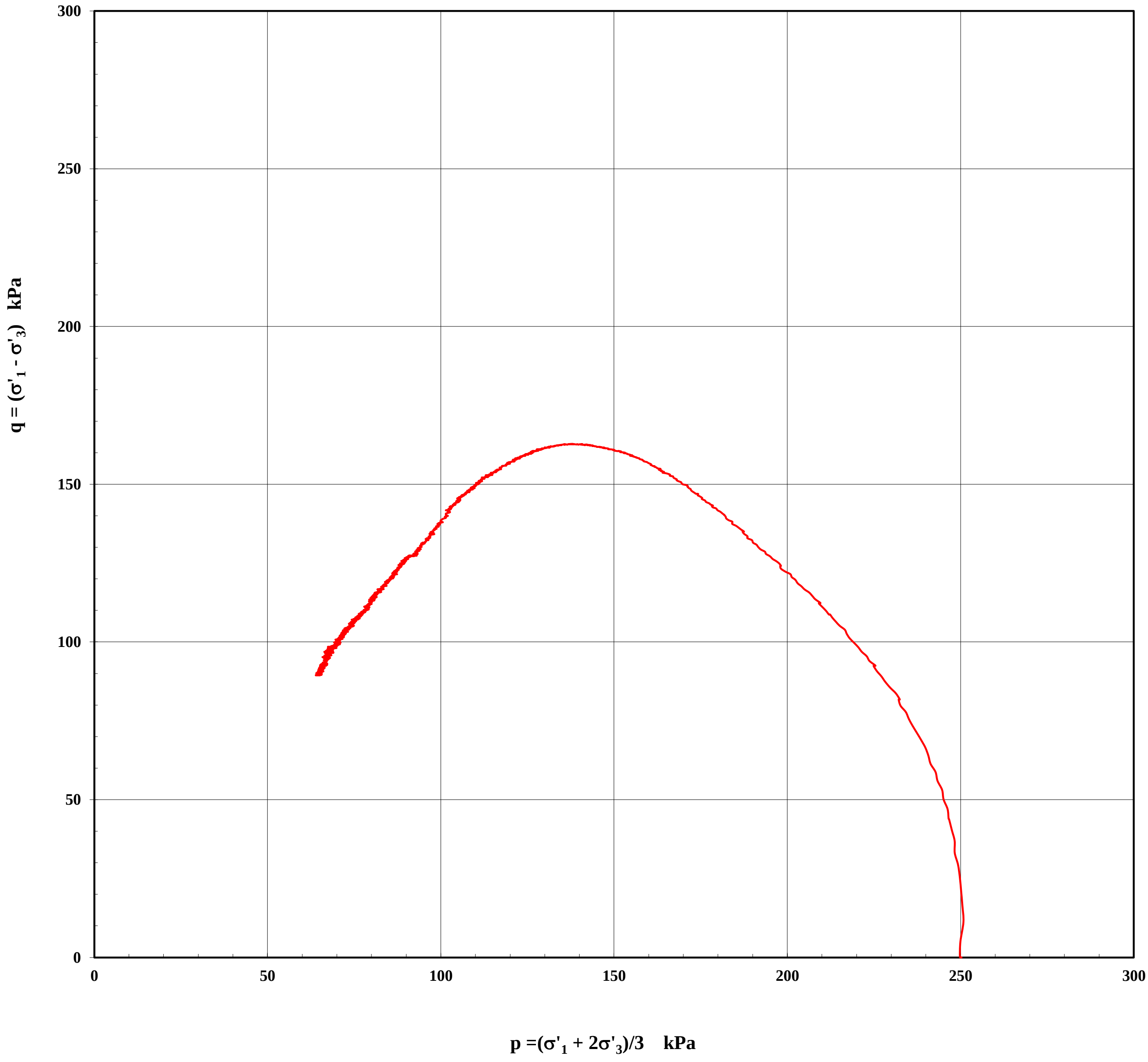
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080184B - CU

Cambridge Method - Effective Stress Path



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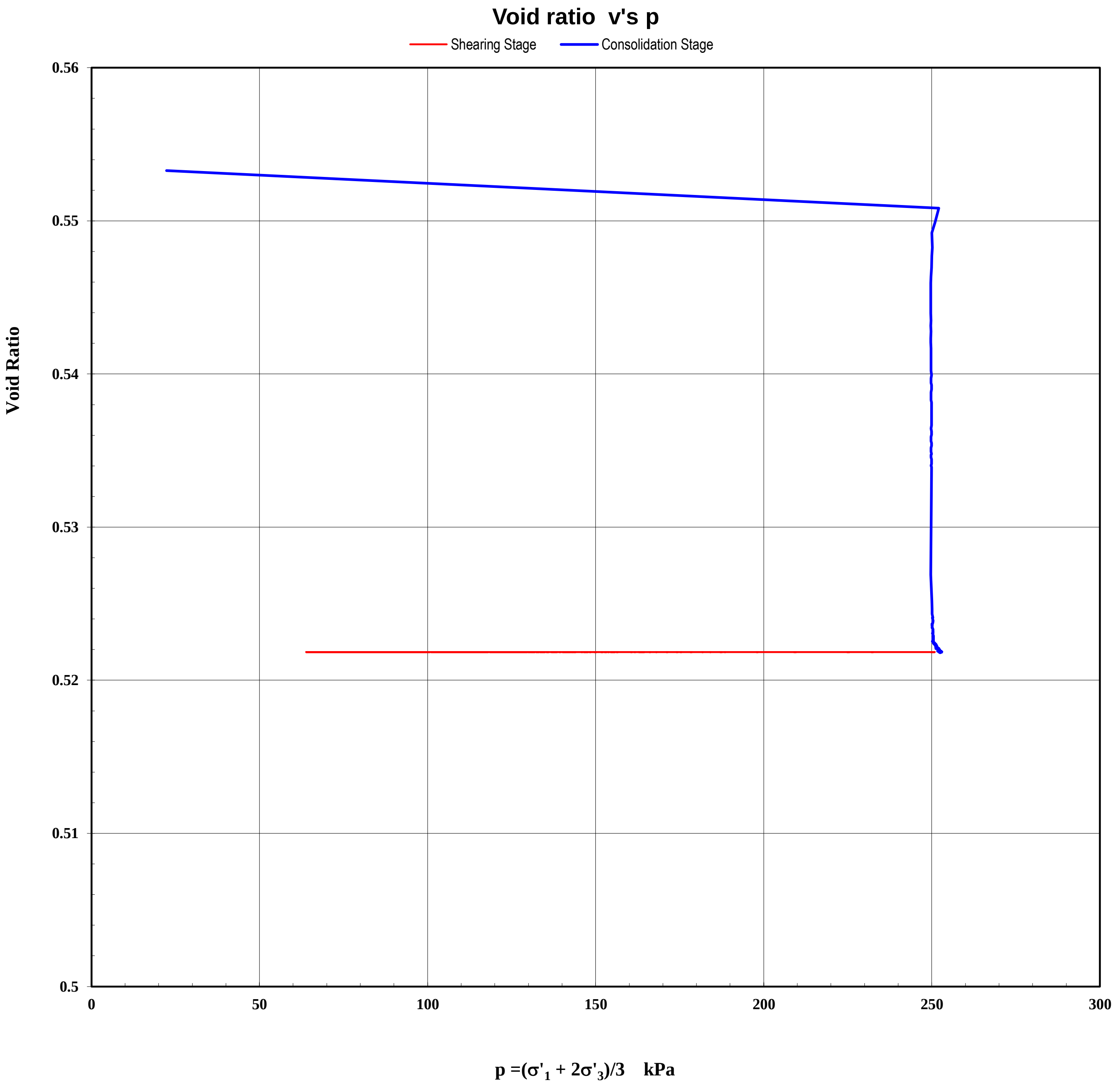

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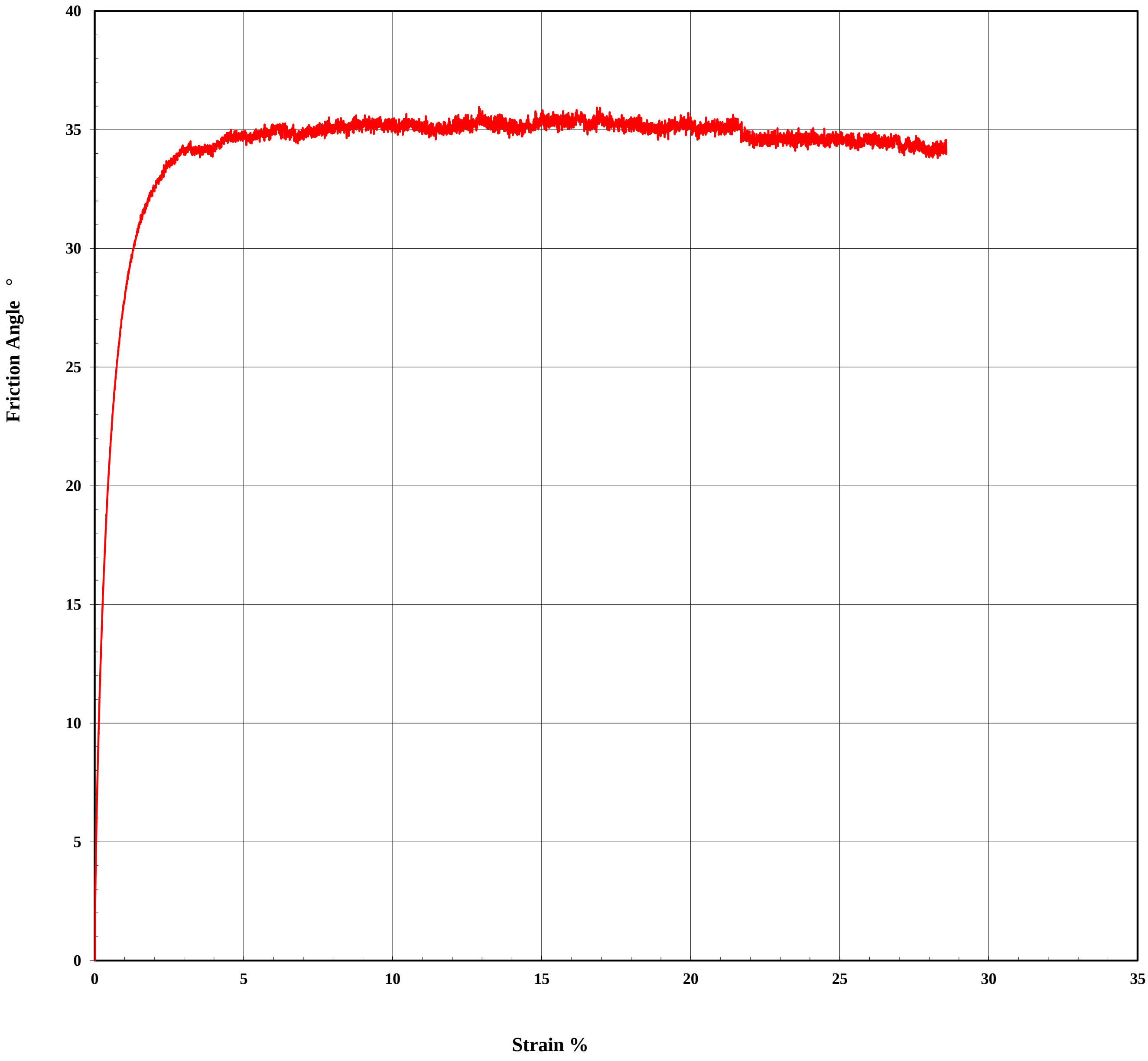
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080184B - CU

Friction Angle v's Axial Strain



Remarks:
Sample/s supplied by the client

Note: Graph not to scale

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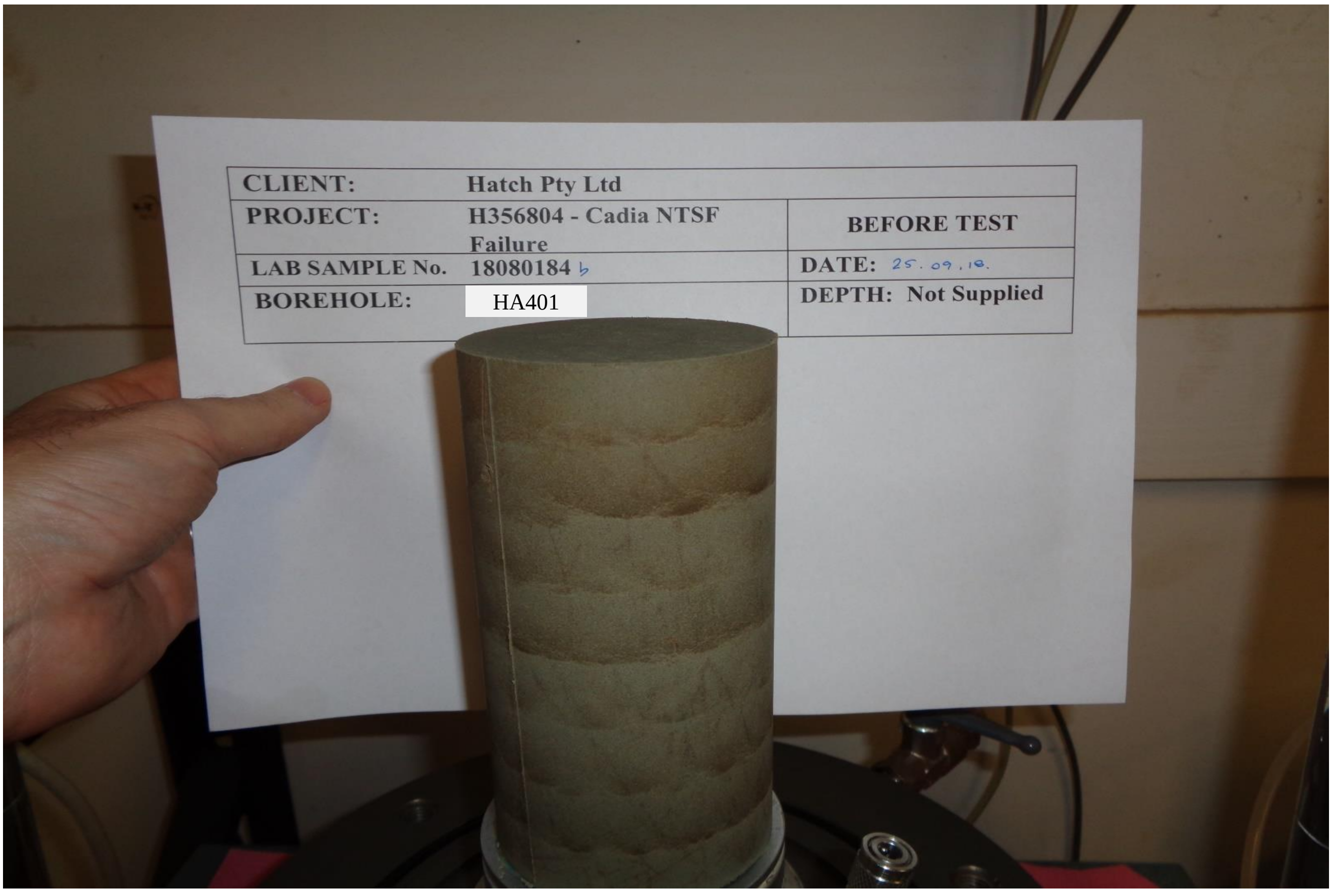
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184B - CU



Remarks:
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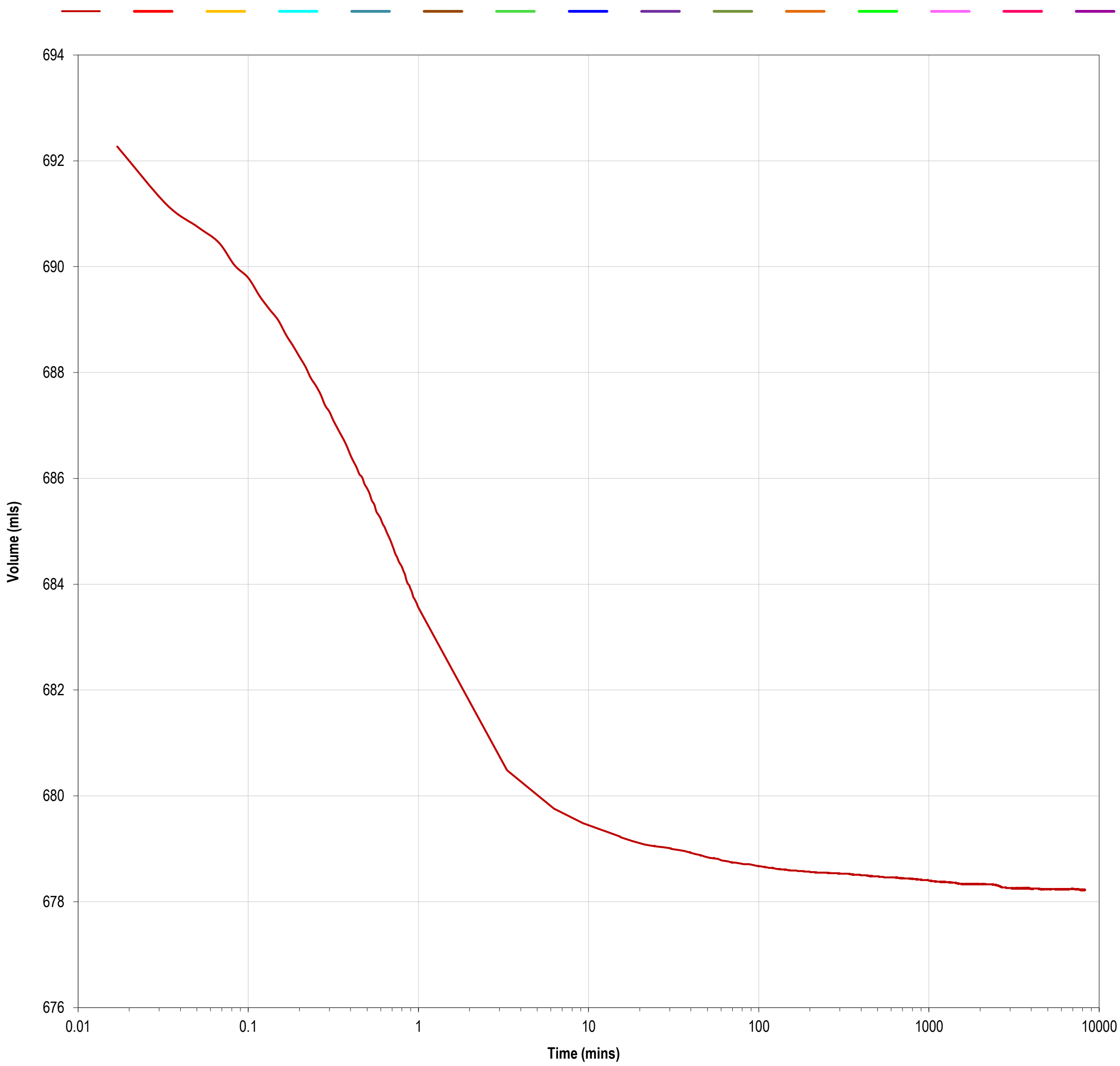
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080184B - CU

Volume v's Time (Log Scale)



Remarks: 0

Sample/s supplied by the client

Note: Graph not to scale

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

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Laboratory Number
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Trilab
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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18100437A - CU
		Workorder No.	0005014
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	16/10/2018
		Report Date:	24/10/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	HA401	**Depth (m):**	0.00-2.00
Description:	-		

SAMPLE & TEST DETAILS

Initial Height:	152.1	mm	Initial Moisture Content:	9.8	%	Rate of Strain:	0.013	%/min
Initial Diameter:	76.3	mm	Final Moisture Content:	22.1	%	B Response:	98	%
L/D Ratio:	2.0 : 1		Wet Density:	1.79	t/m^3	Target Void Ratio:	0.630	
			Dry Density:	1.63	t/m^3	Final Void Ratio:	0.586	
						Freezing Void Ratio :	0.602	

Sample Type: Single Individual Remoulded Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
51 kPa	550 kPa	499 kPa	499 kPa	33 kPa	43 kPa	16 kPa	2.593	26 kPa	1.33 %

FAILURE ENVELOPES

Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

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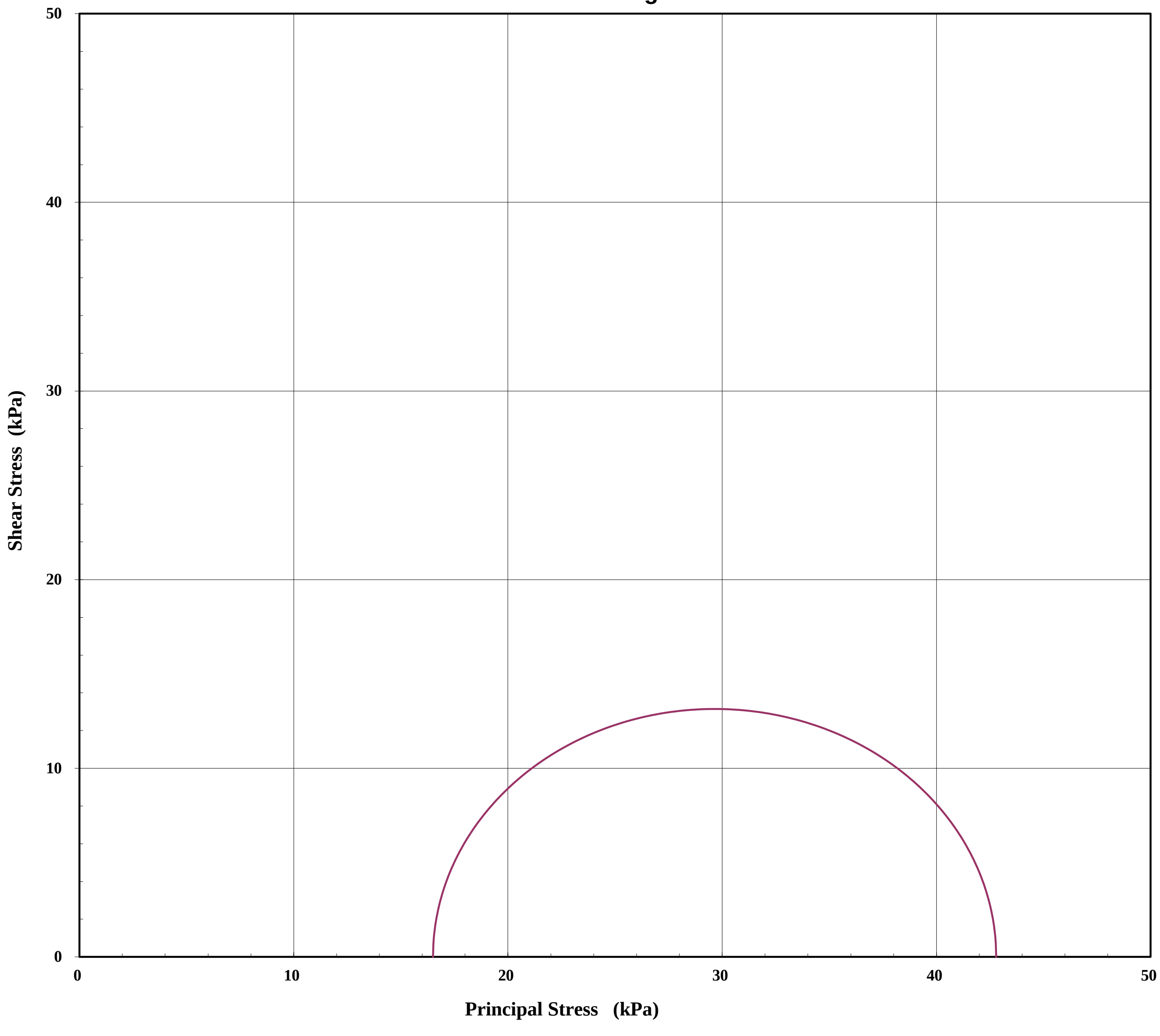
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100437A - CU

Mohr Circle Diagram



Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

Note: Graph not to scale

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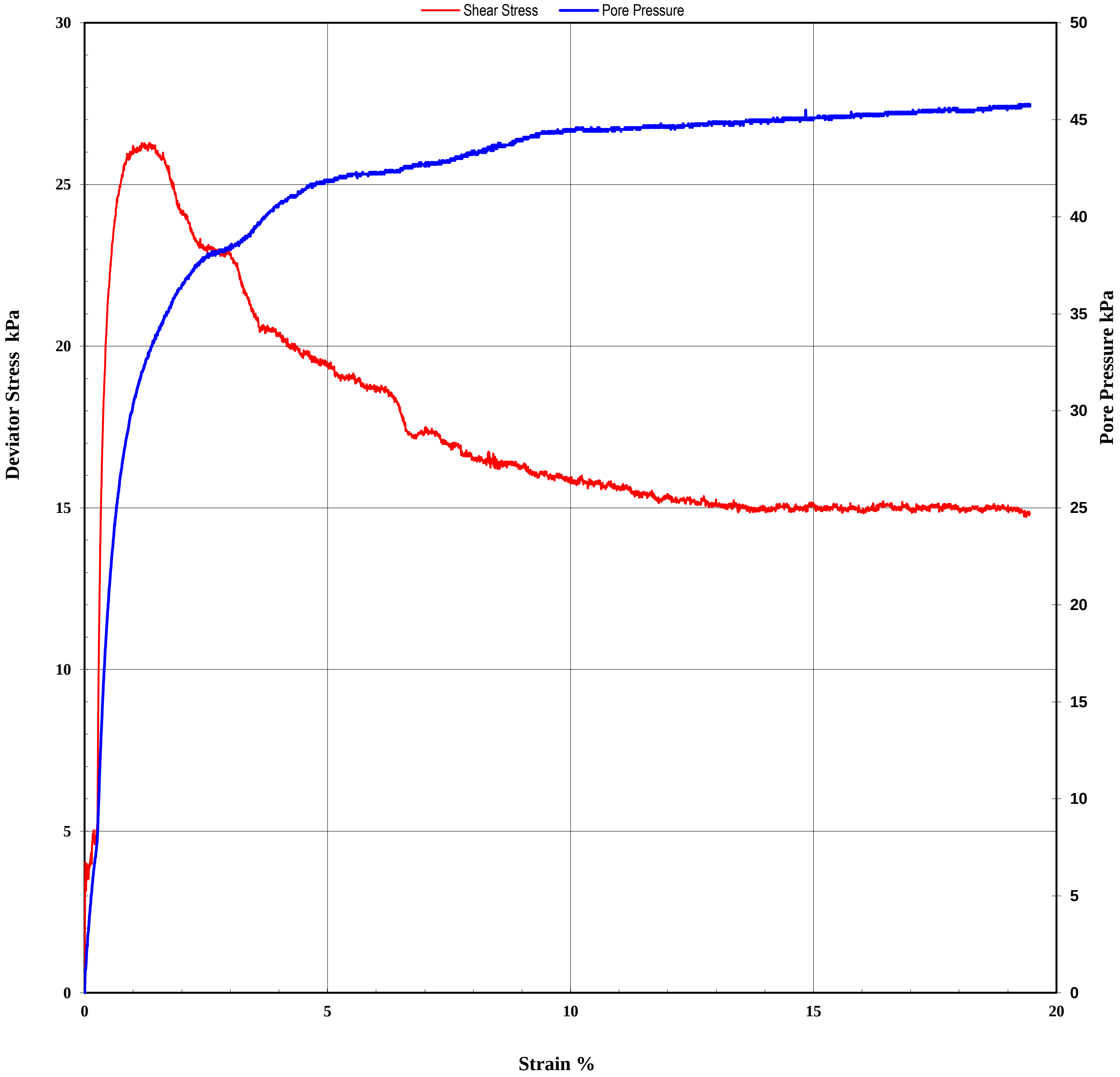
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100437A - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks:

Sample/s supplied by the client

Note: Graph not to scale

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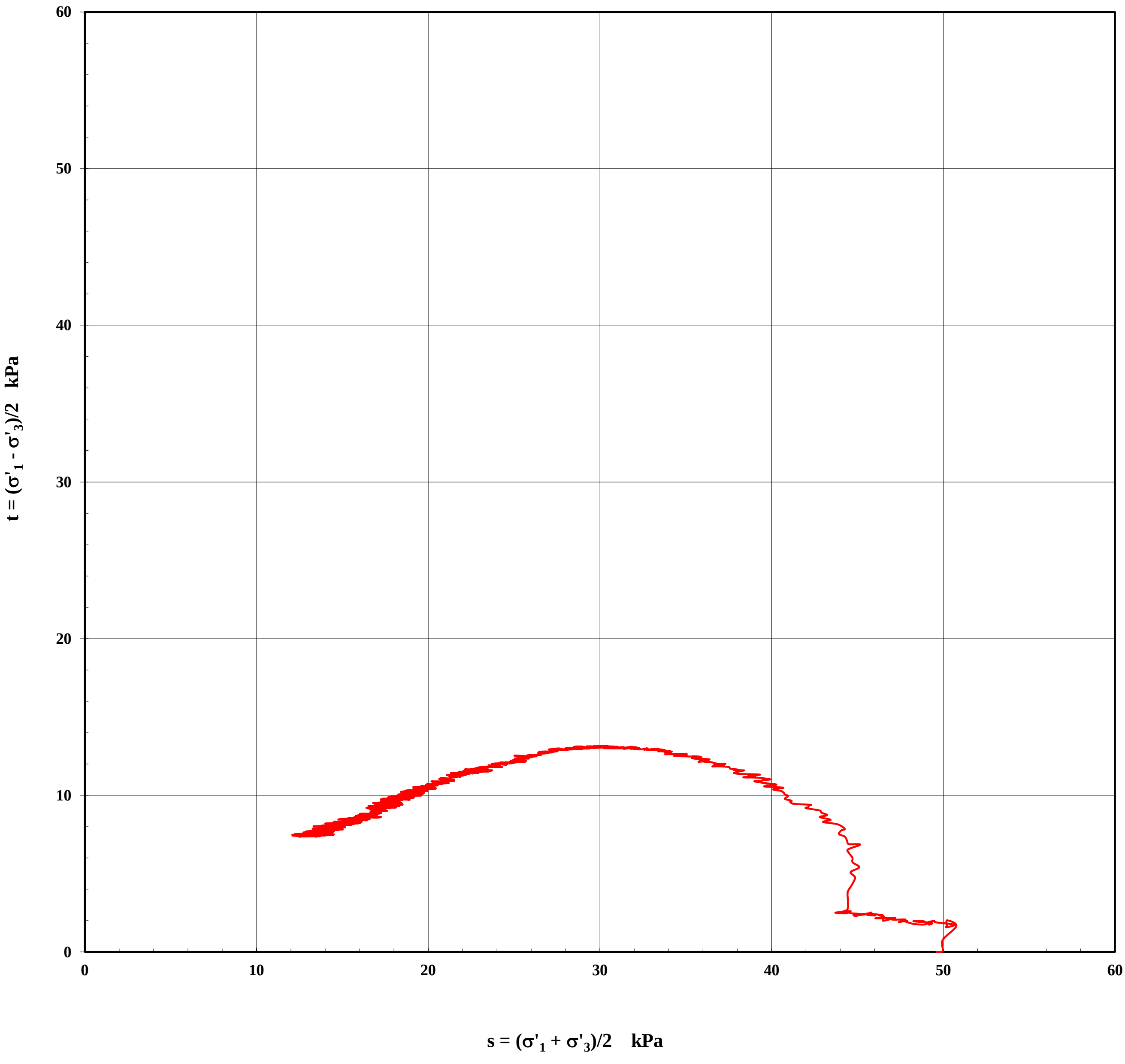
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100437A - CU

MIT Method - Effective Stress Path



Remarks:

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Note: Graph not to scale

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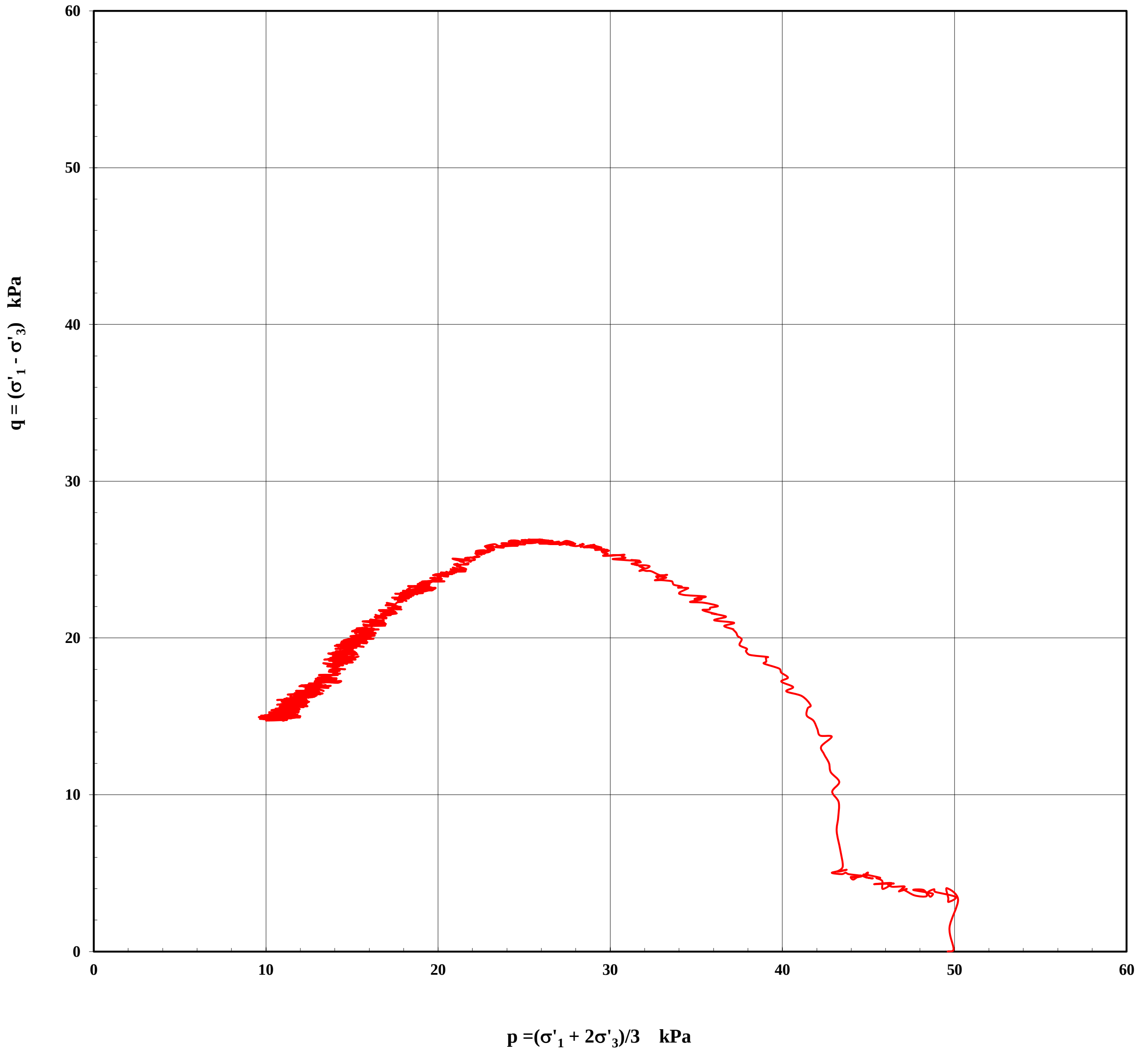
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18100437A - CU

Cambridge Method - Effective Stress Path



Remarks:

Sample/s supplied by the client

Note: Graph not to scale

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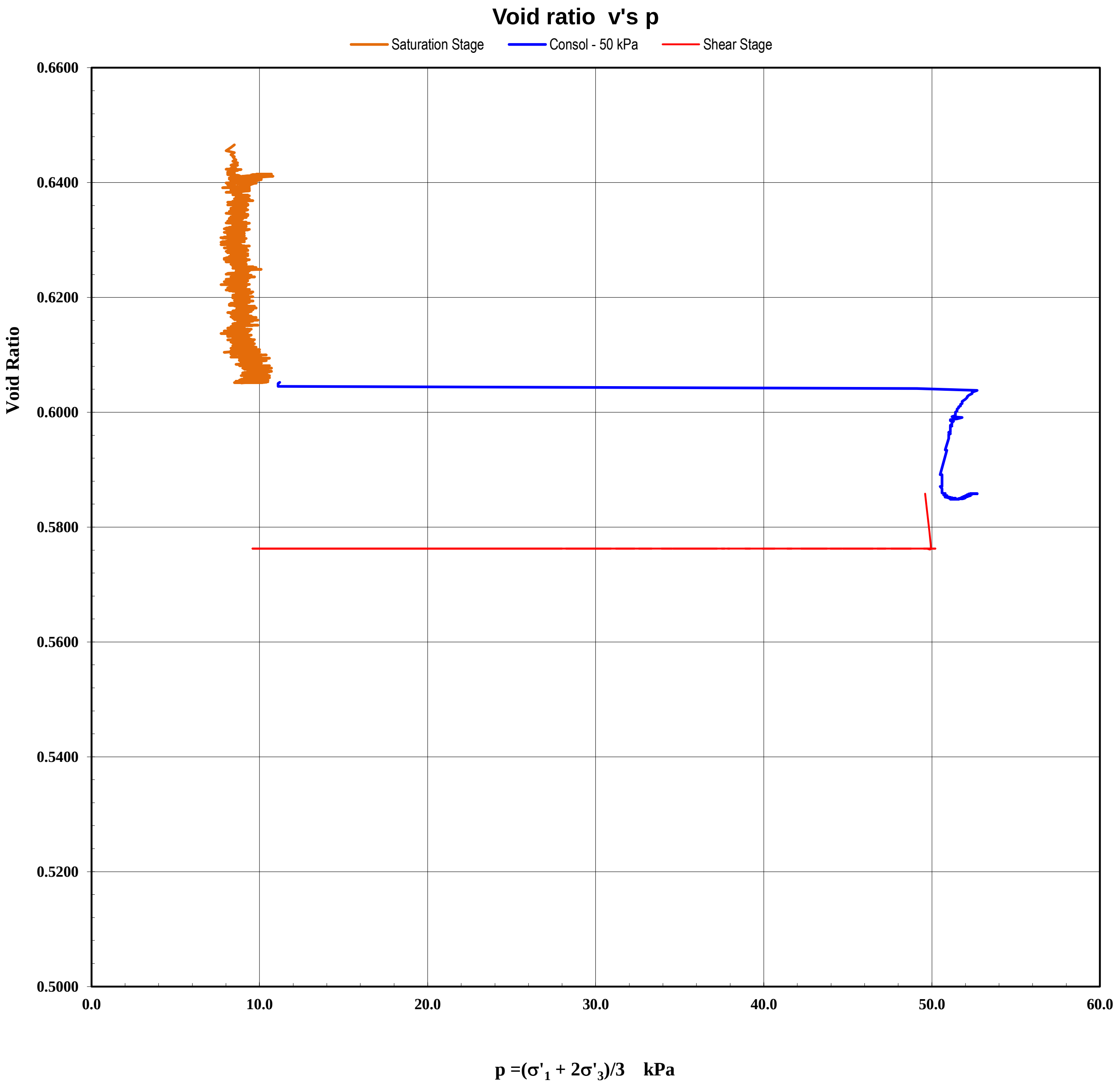
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18100437A - CU



Remarks:

Sample/s supplied by the client

Note: Graph not to scale

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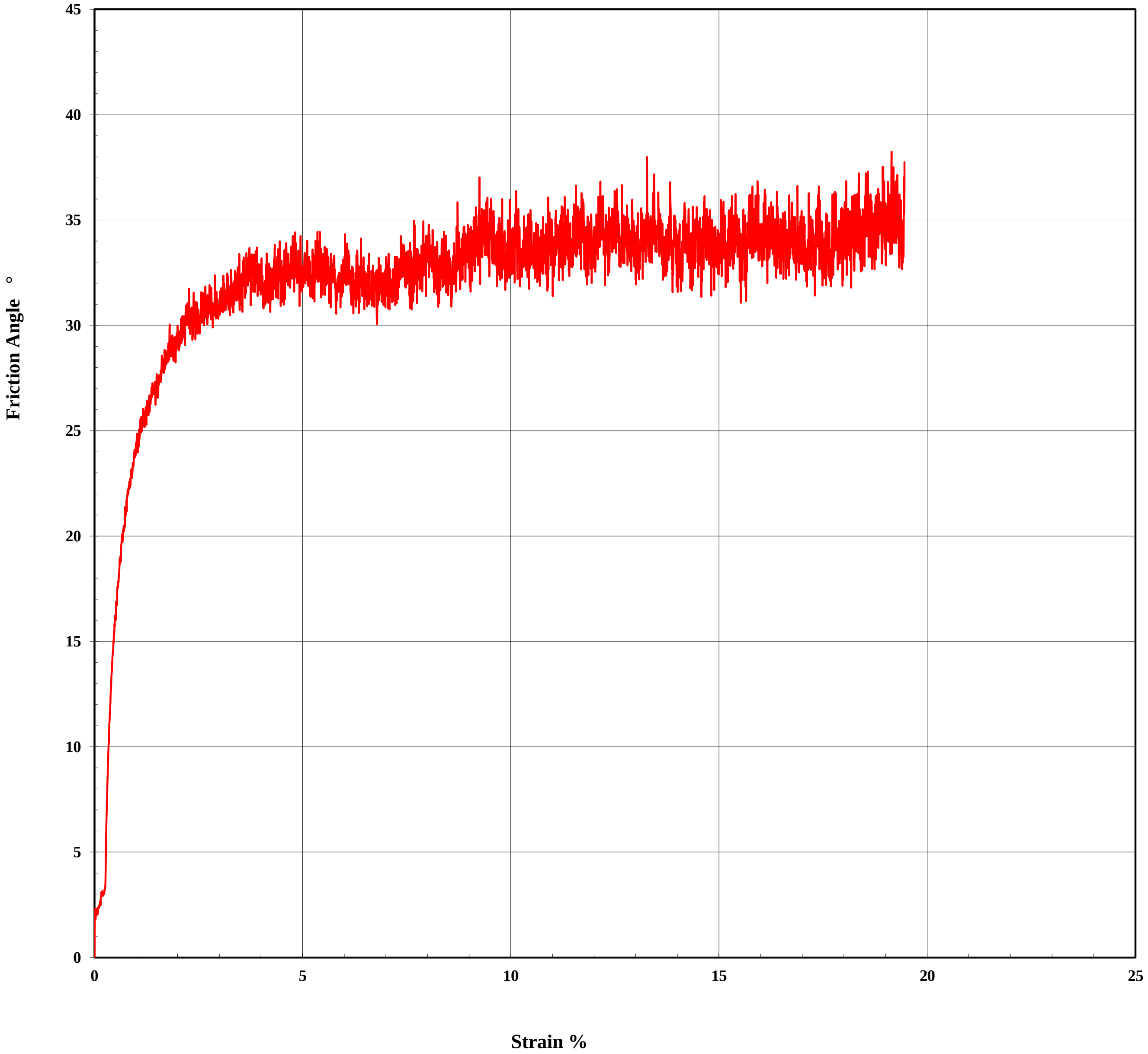
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100437A - CU

Friction Angle v's Axial Strain



Remarks:
Sample/s supplied by the client

Note: Graph not to scale

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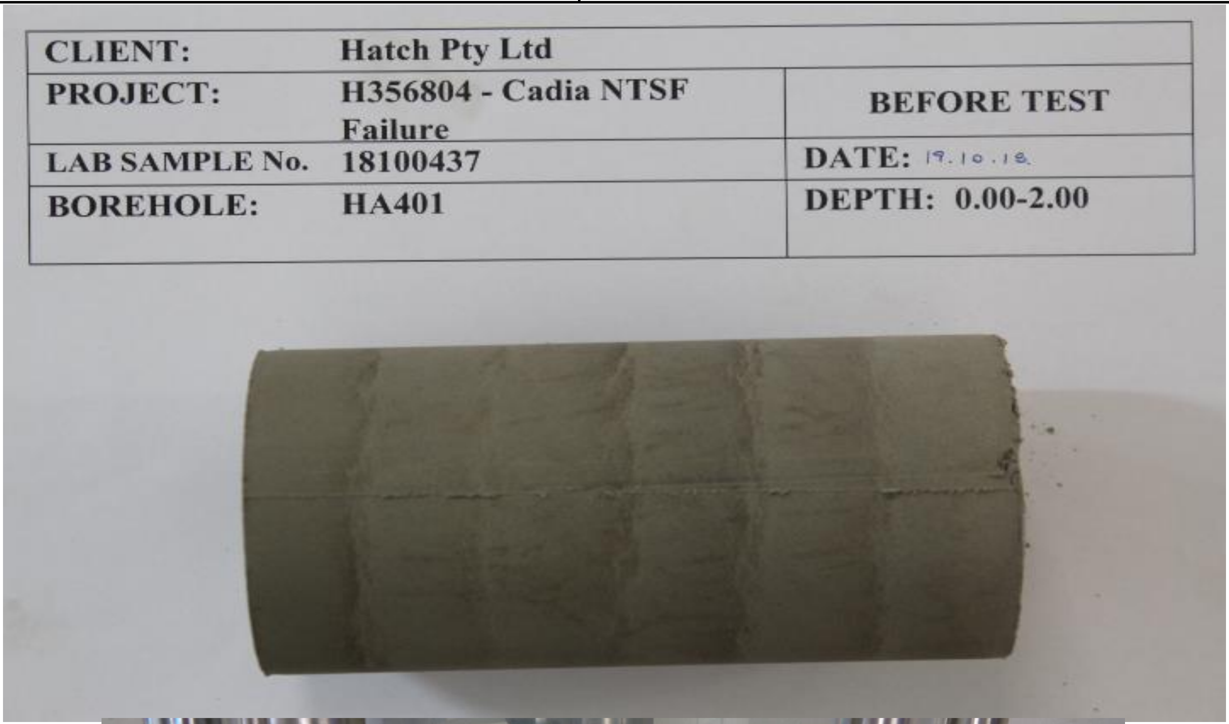
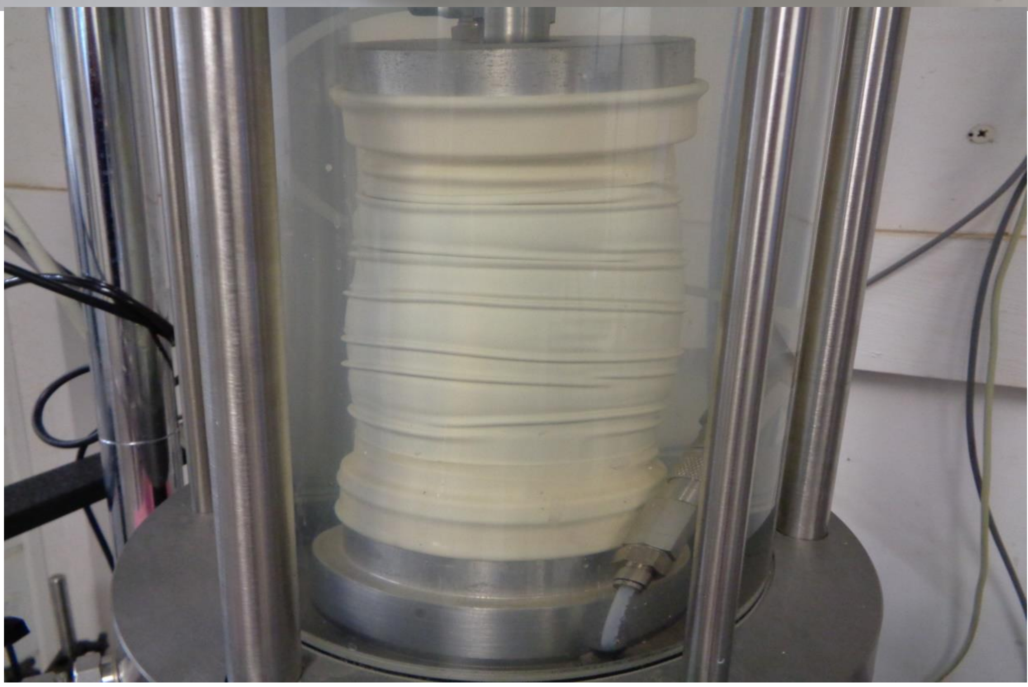
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100437A - CU





Remarks:

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Note: Photo not to scale

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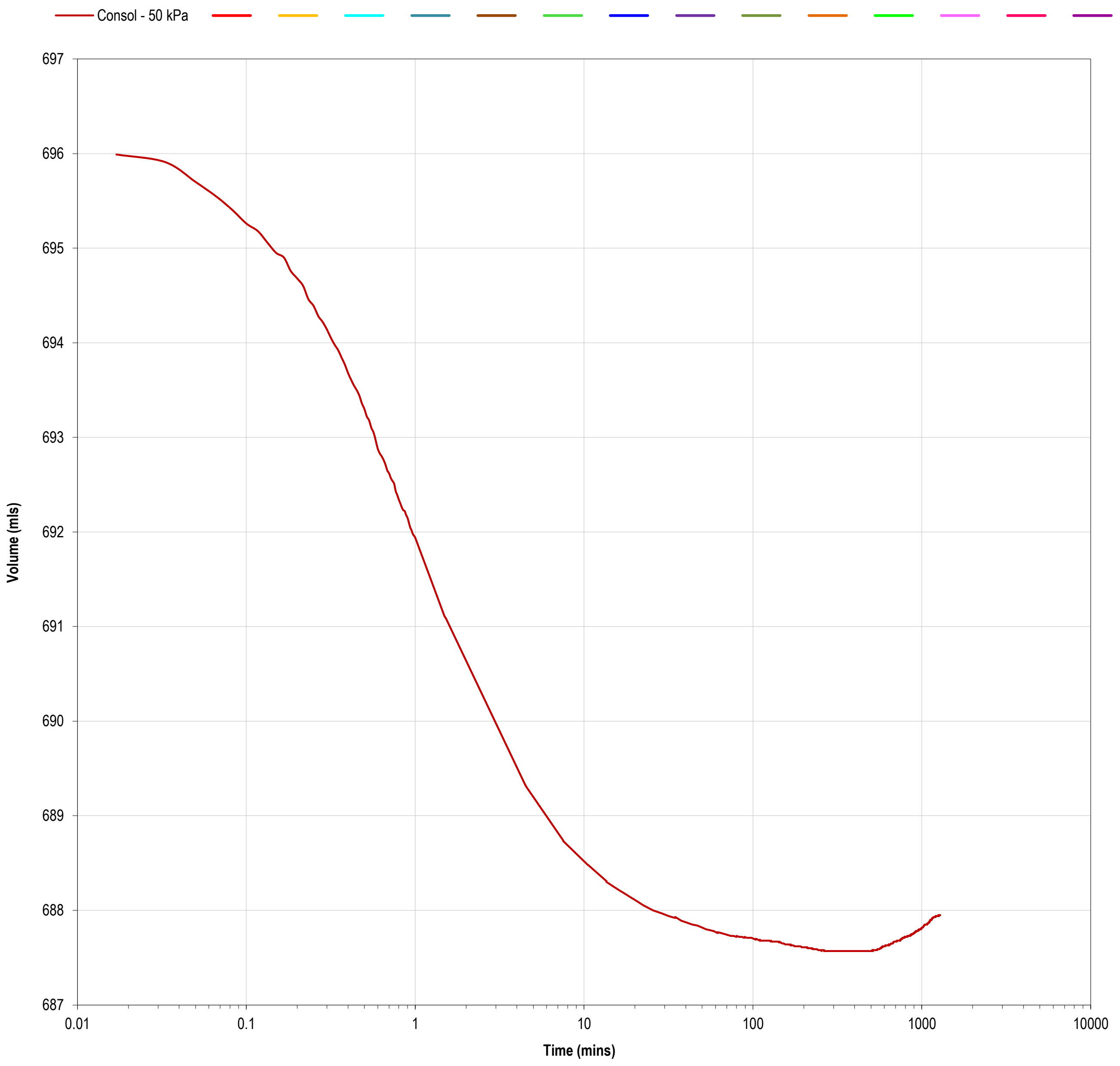
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100437A - CU

Volume v's Time (Log Scale)



Remarks:

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Note: Graph not to scale

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18100438A - CU
		Workorder No.	0005014
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	16/10/2018
		Report Date:	24/10/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	HA401	**Depth (m):**	0.00-2.00
Description:	-		

SAMPLE & TEST DETAILS

Initial Height:	152.7	mm	Initial Moisture Content:	9.8	%	Rate of Strain:	0.013	%/min
Initial Diameter:	76.4	mm	Final Moisture Content:	17.7	%	B Response:	99	%
L/D Ratio:	2.0 : 1		Wet Density:	1.98	t/m^3	Target Void Ratio:	0.470	
			Dry Density:	1.80	t/m^3	Final Void Ratio:	0.463	
						Freezing Void Ratio :	0.484	

Sample Type: Single Individual Remoulded Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
501 kPa	999 kPa	498 kPa	499 kPa	316 kPa	582 kPa	181 kPa	3.215	401 kPa	1.21 %

FAILURE ENVELOPES

Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

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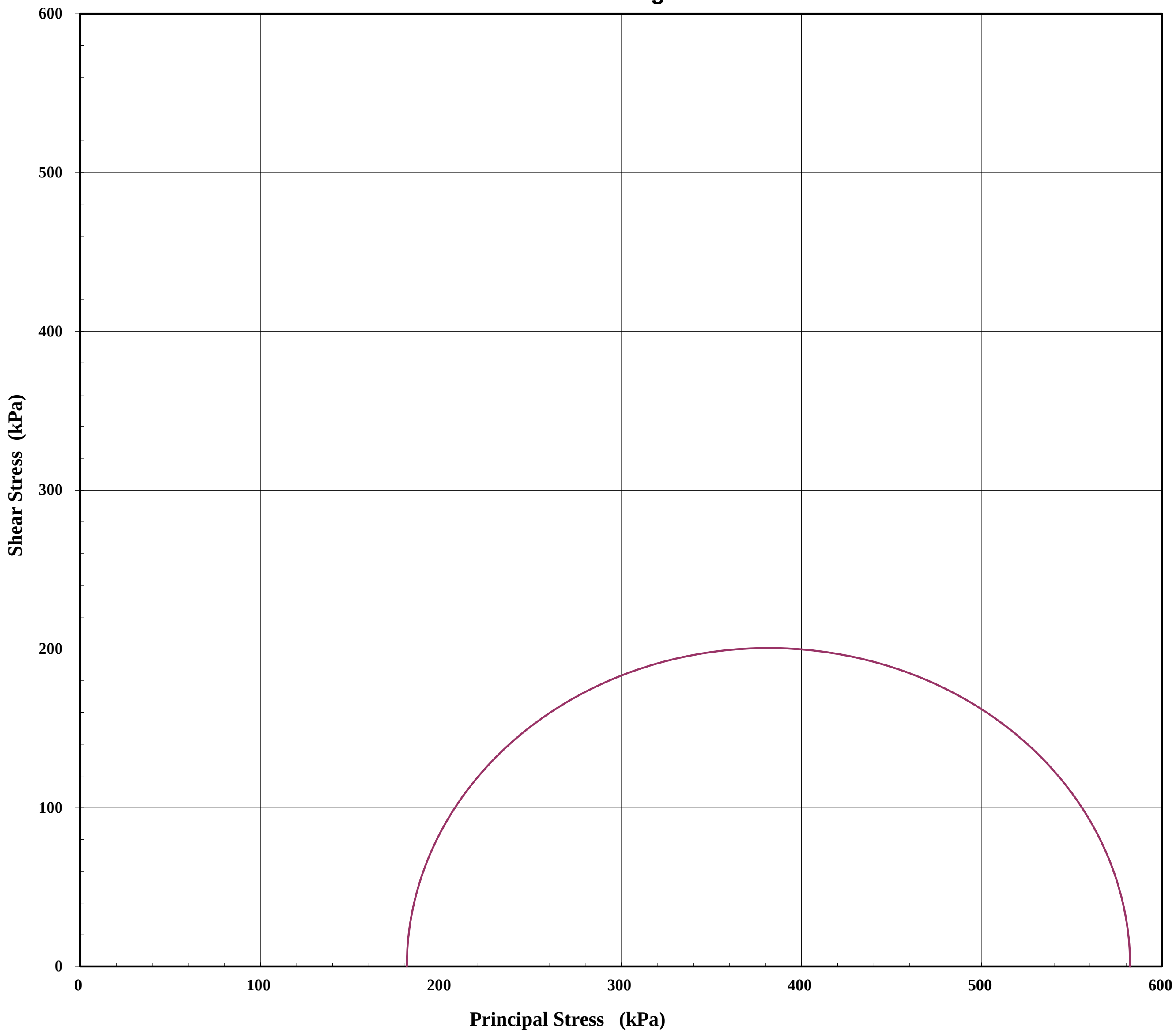
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18100438A - CU

Mohr Circle Diagram



Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

Note: Graph not to scale

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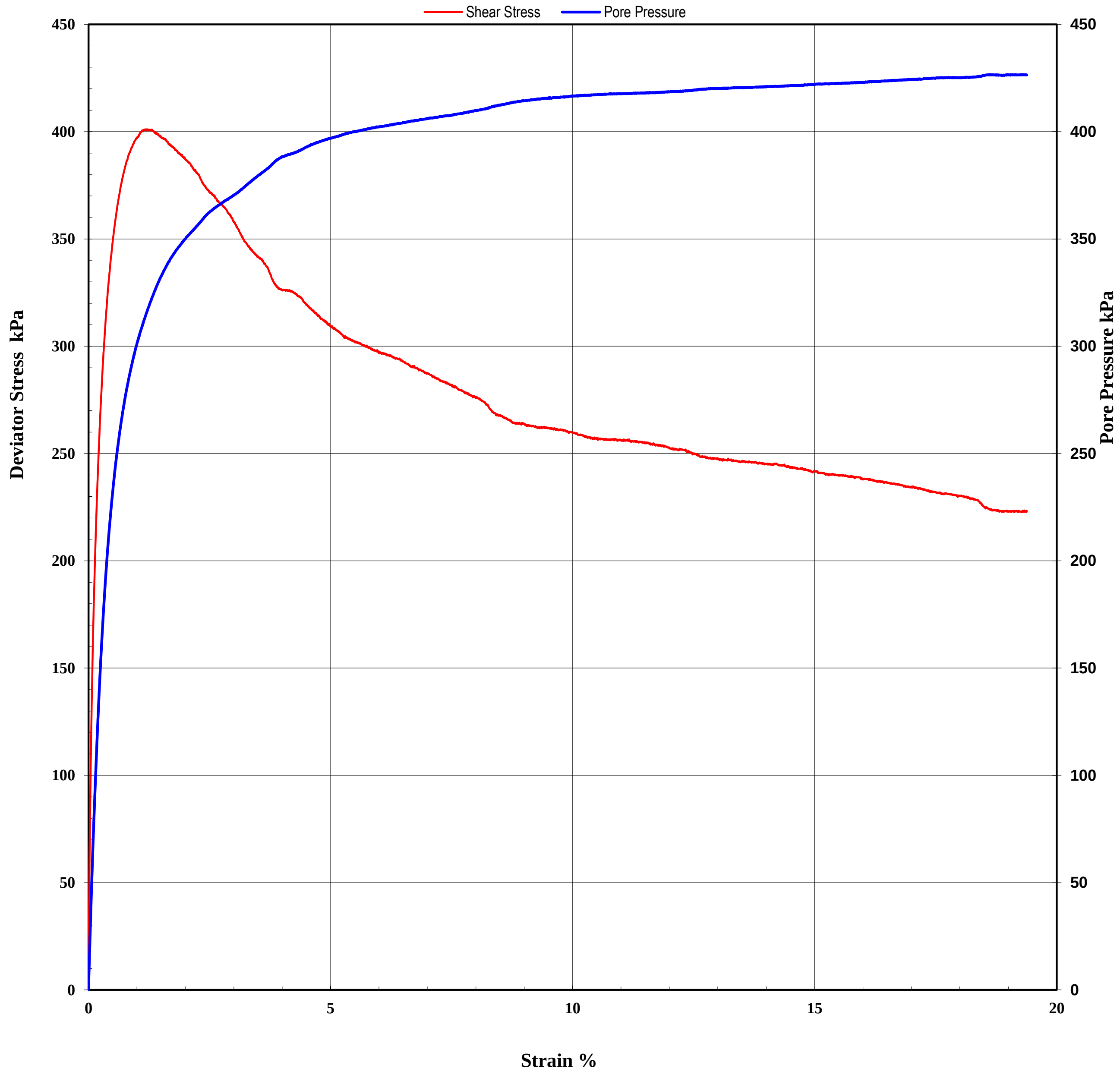
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100438A - CU

Stress/Strain & Pore Pressure/Strain Diagram



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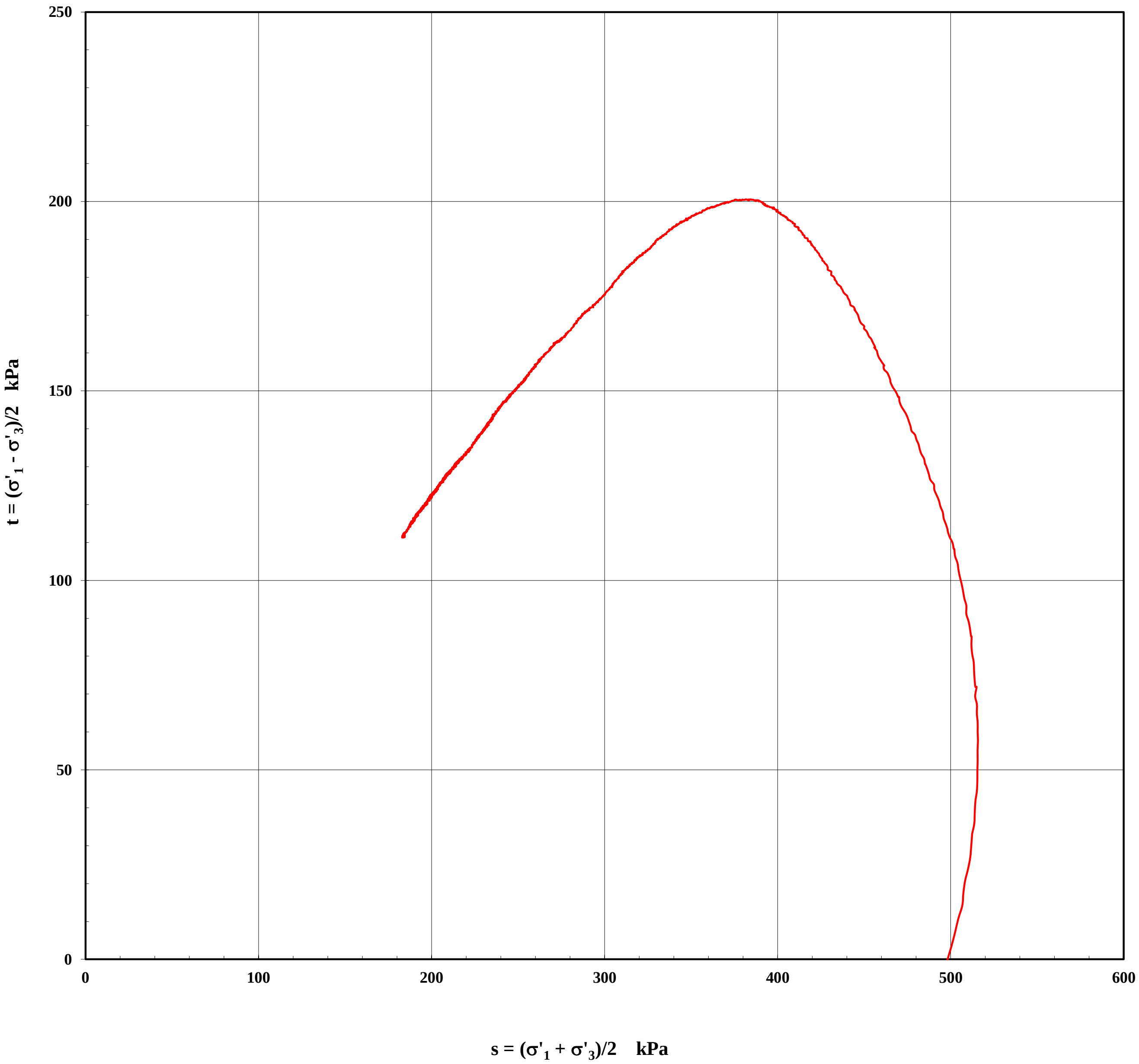
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18100438A - CU

MIT Method - Effective Stress Path



Remarks:

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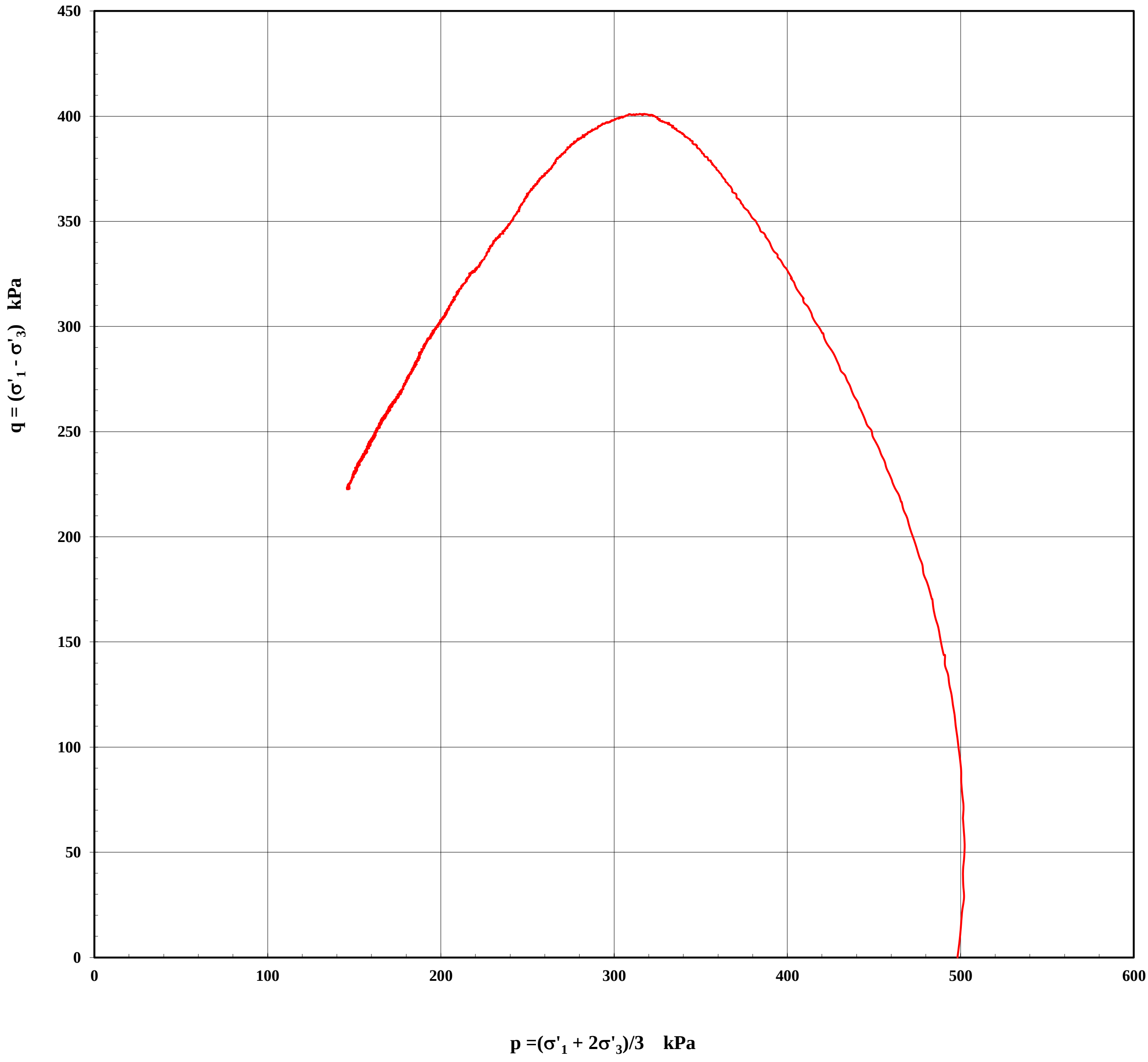
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100438A - CU

Cambridge Method - Effective Stress Path



Remarks:

Sample/s supplied by the client

Note: Graph not to scale

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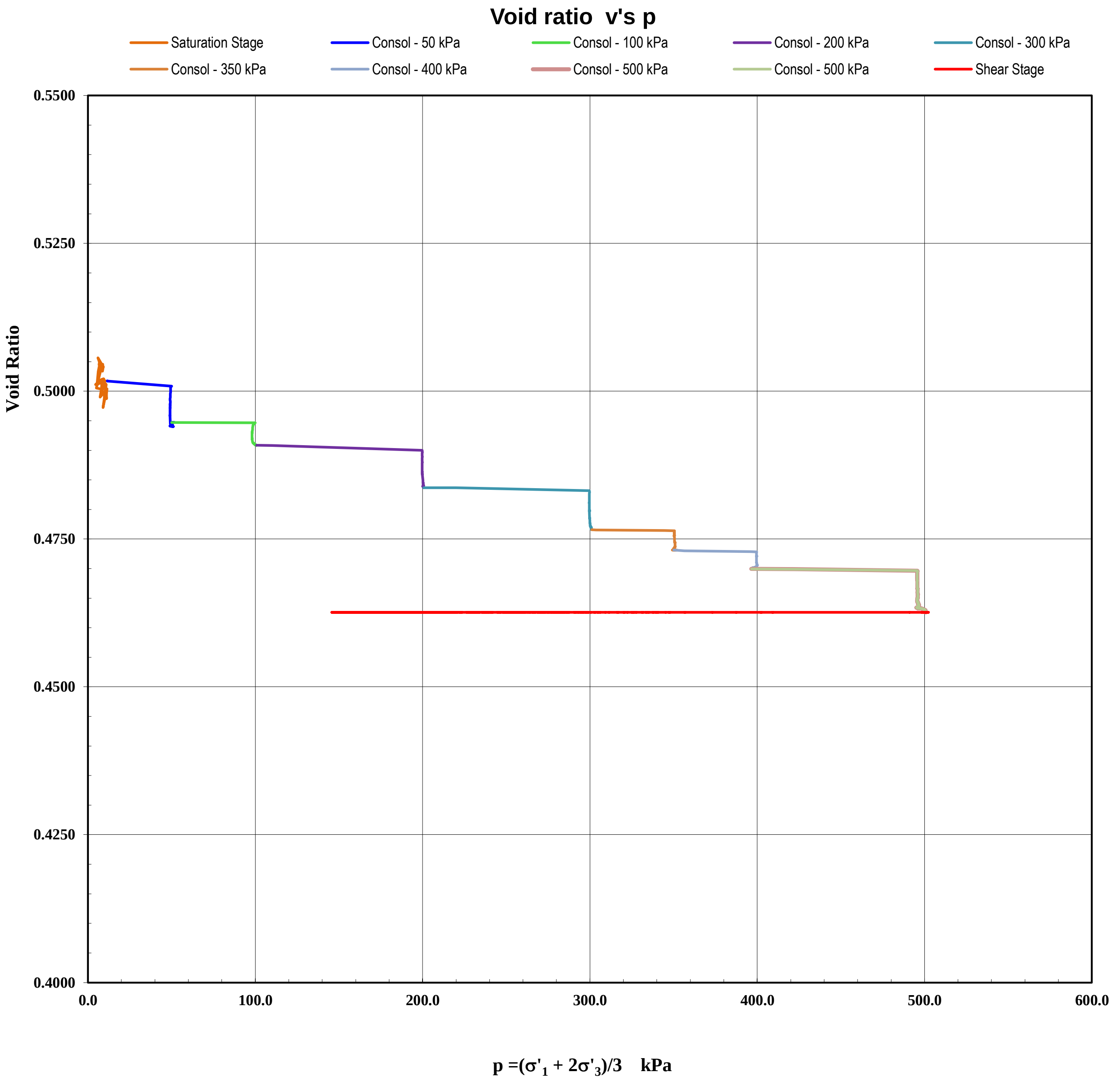
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18100438A - CU



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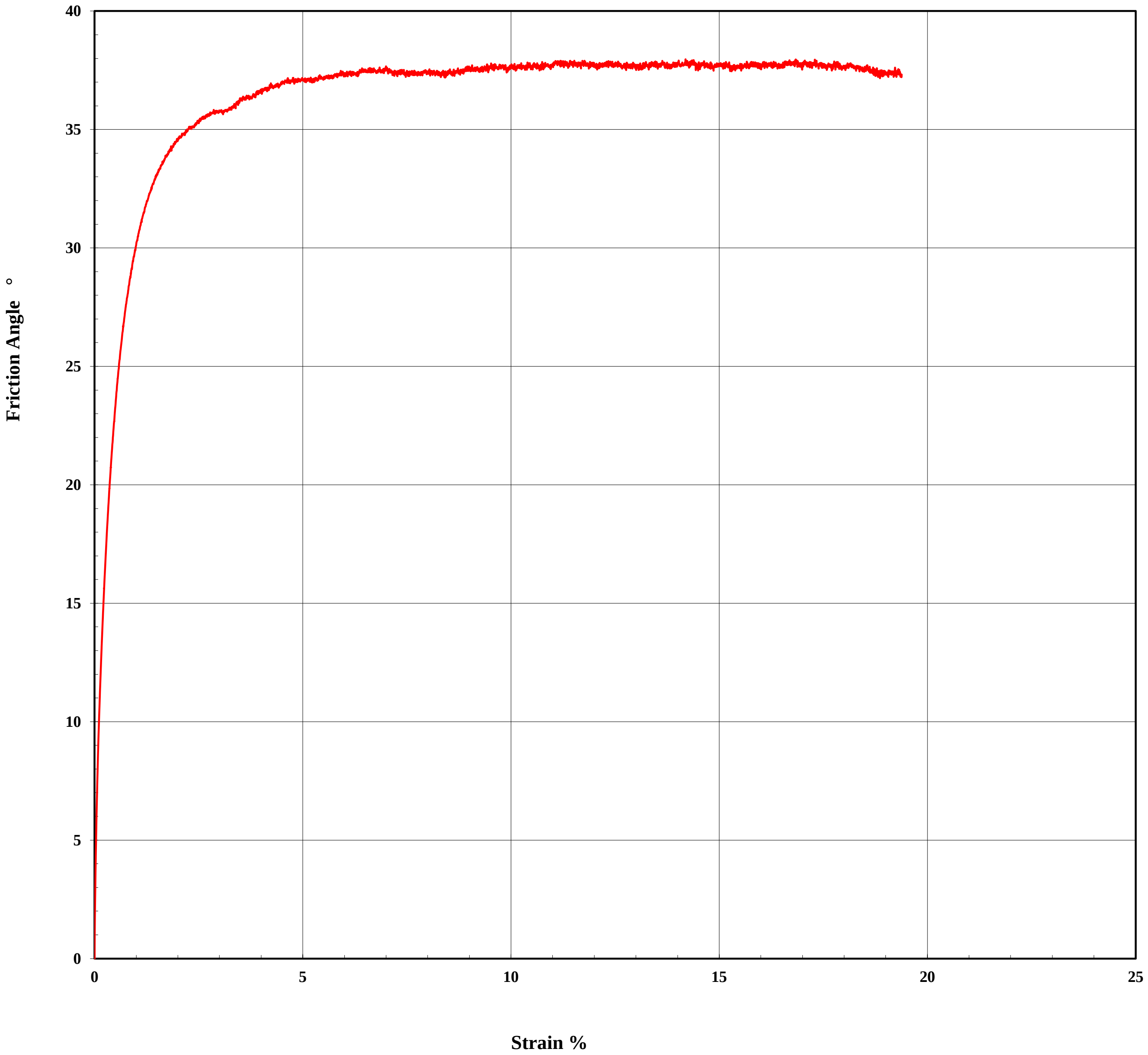
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100438A - CU

Friction Angle v's Axial Strain



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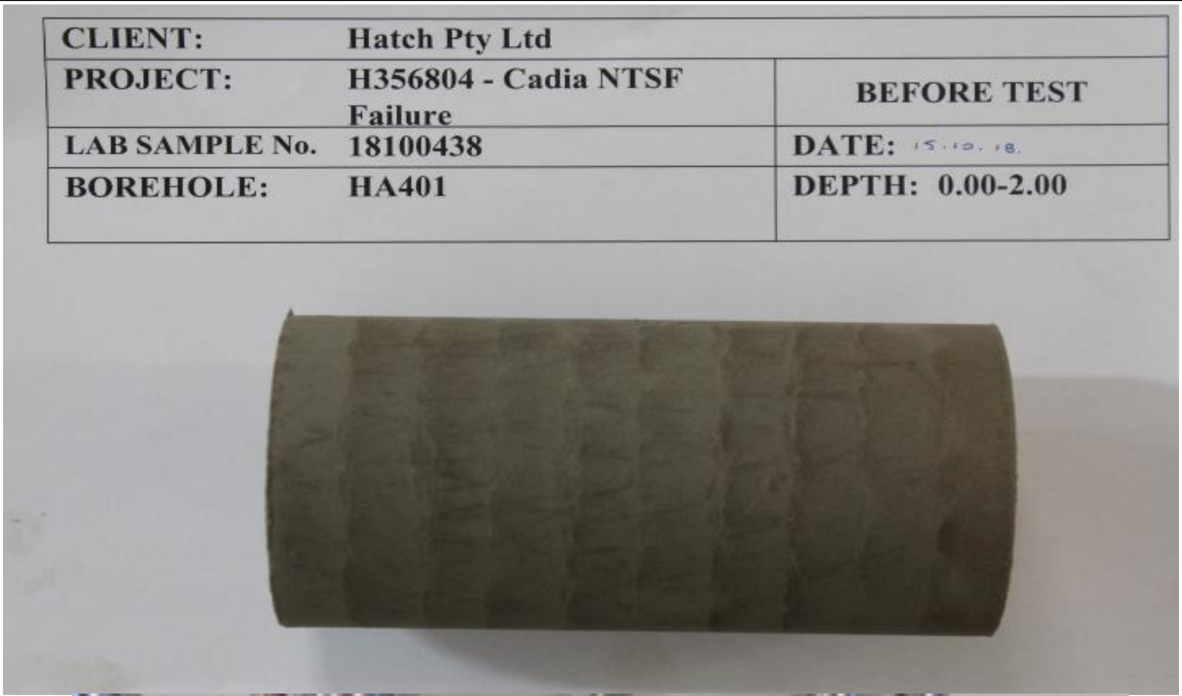
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100438A - CU



Remarks:

Sample/s supplied by the client

Note: Photo not to scale

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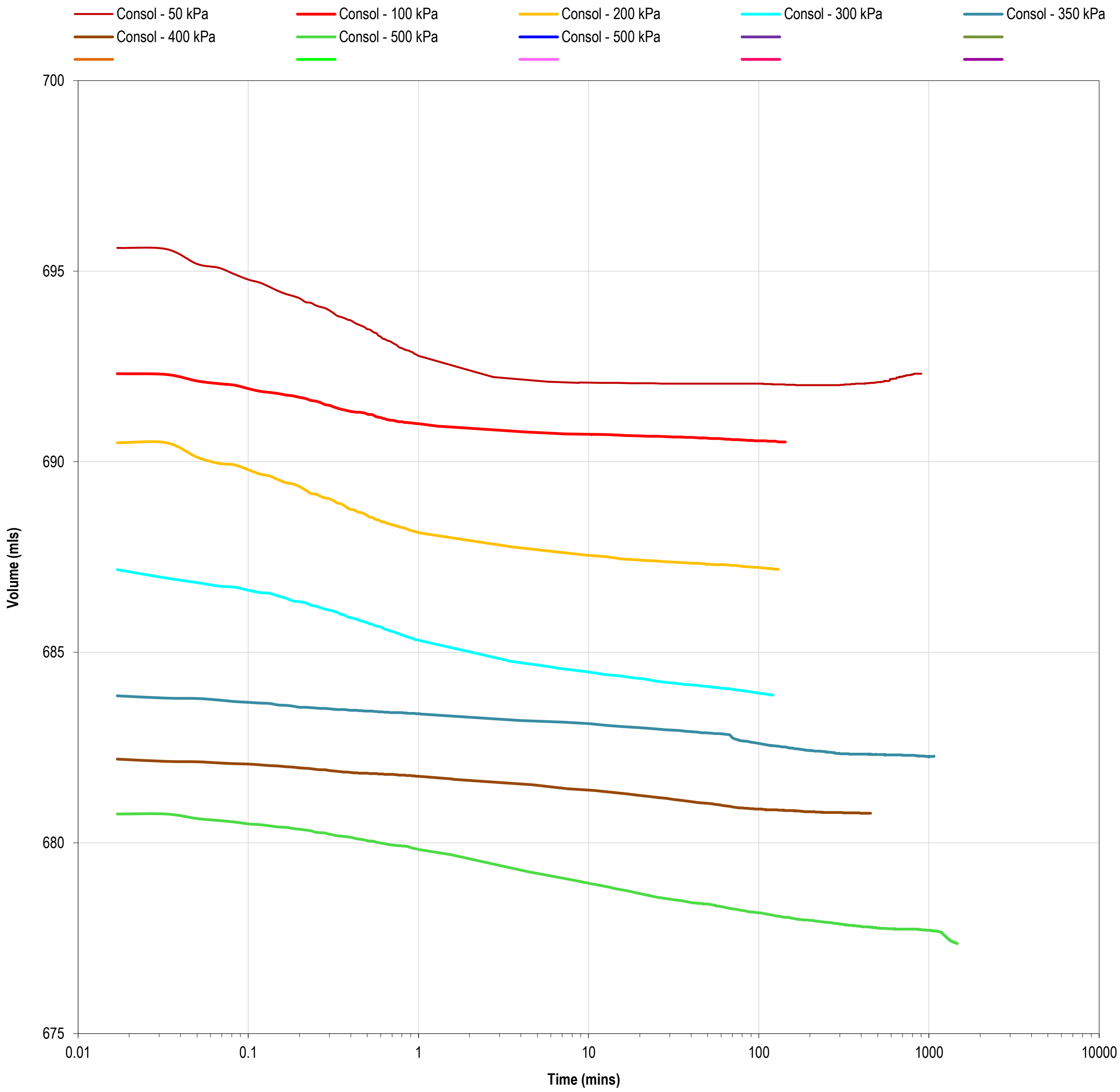
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18100438A - CU

Volume v's Time (Log Scale)



Remarks:

Sample/s supplied by the client

Note: Graph not to scale

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TRIAXIAL TEST REPORT

Test Method: ASTM D7181

Client:	Hatch Pty Ltd	**Report No.:**	18110416 - CD
		Workorder No.	0005143
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	26/11/2018
		Report Date:	6/12/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	HA401	**Depth (m):**	0.00-2.00
Description:	-		

SAMPLE & TEST DETAILS

Initial Height:	150.9	mm	Initial Moisture Content:	8.8	%	Rate of Strain:	0.005	%/min
Initial Diameter:	75.1	mm	Final Moisture Content:	15.8	%	B Response:	98	%
L/D Ratio:	2.0 : 1		Wet Density:	1.93	t/m^3	Saturation Void Ratio:	0.525	
			Dry Density:	1.78	t/m^3	Final Void Ratio:	0.421	
						Freezing Void Ratio :	0.432	

Sample Type: Single Individual Remoulded Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses* σ'_1	σ'_3	σ'_1 / σ'_3	*Deviator Stress*	*Strain*
200 kPa	700 kPa	500 kPa	500 kPa	1 kPa	748 kPa	197 kPa	3.797	551 kPa	18.32 %

FAILURE ENVELOPES

Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
T. Lockhart

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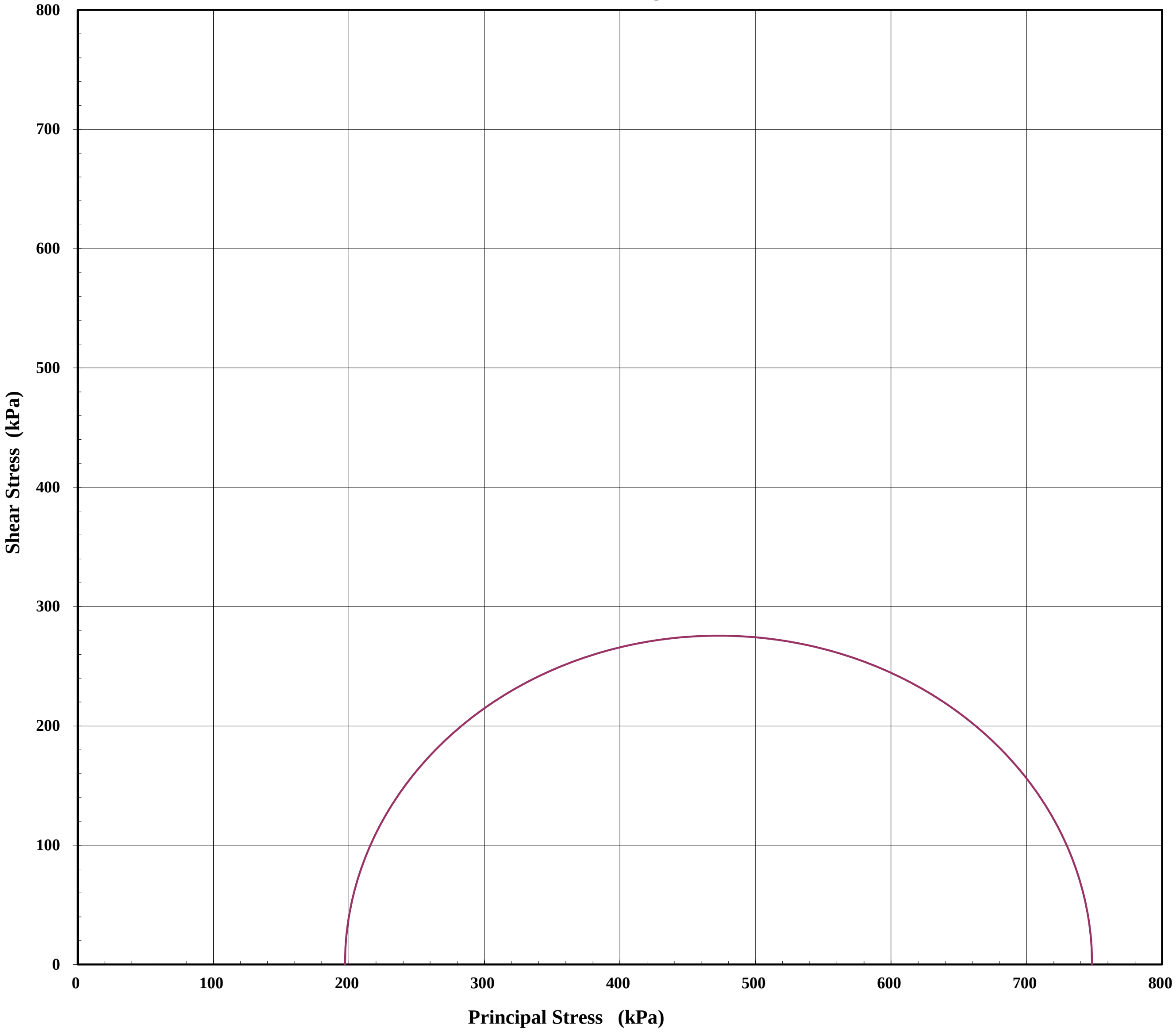
TRIAXIAL TEST REPORT

Test Method: ASTM D7181

Client: Hatch Pty Ltd	**Report No.:** 18110416 - CD

Mohr Circle Diagram



Interpretation between stages :
Cohesion C' (kPa) :
Angle of Shear Resistance Φ' (Degrees) :
Failure Criteria: Peak Deviator Stress

Remarks:
Sample/s supplied by the client

Note: Graph not to scale

REP03001

Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory

T. Lockhart

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory Number
9926

Trilab
Soil Rock Calibration

Brisbane
346A Bilsen Road,
Geebung
QLD 4034
Ph: +61 7 3265 5656

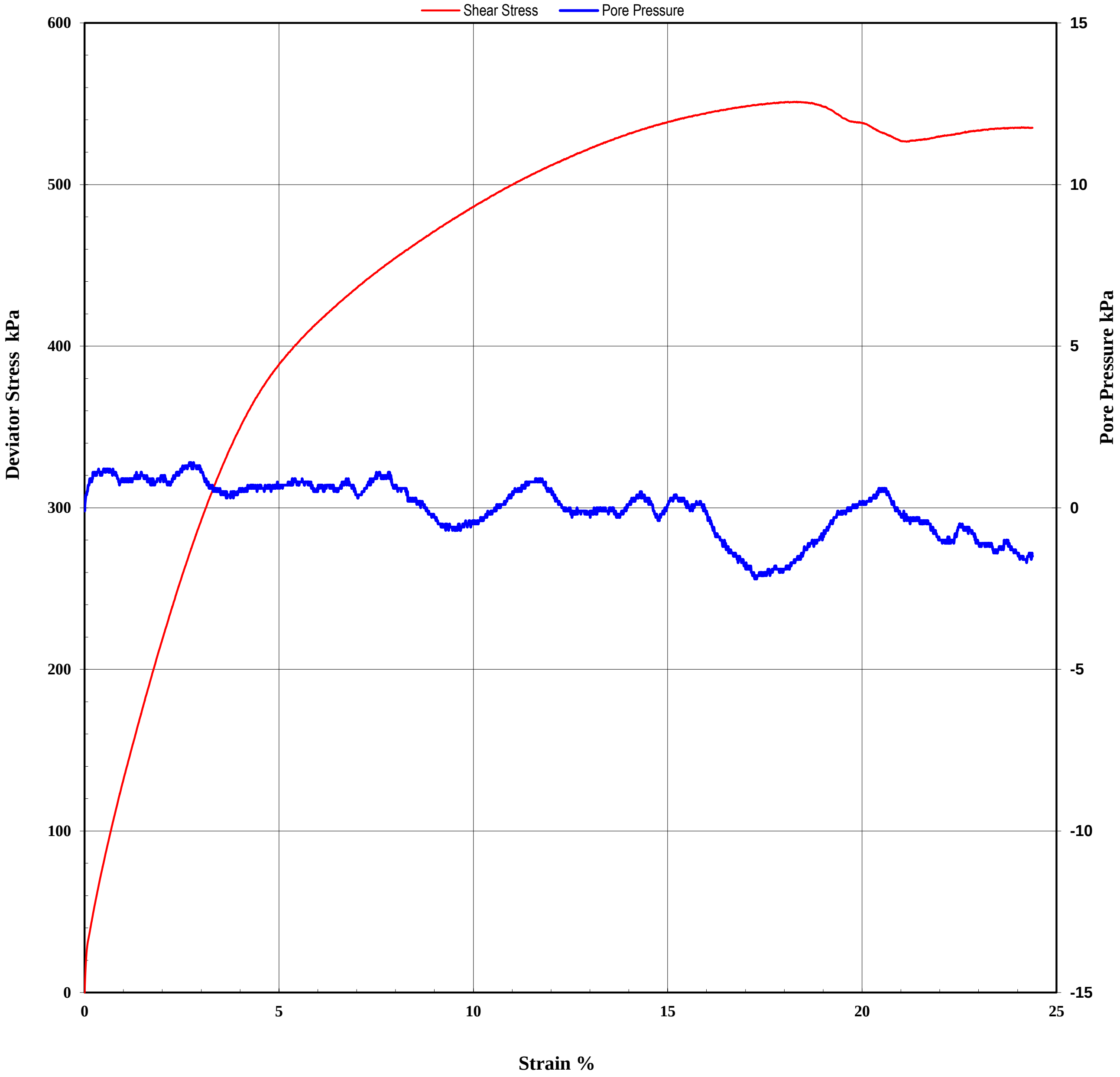
Perth
2 Kimmer Place,
Queens Park
WA 6107
Ph: +61 8 9258 8323

TRIAXIAL TEST REPORT

Test Method: ASTM D7181

Client:	Hatch Pty Ltd	**Report No.:**	18110416 - CD

Stress/Strain & Pore Pressure/Strain Diagram



Remarks:

Sample/s supplied by the client

Note: Graph not to scale

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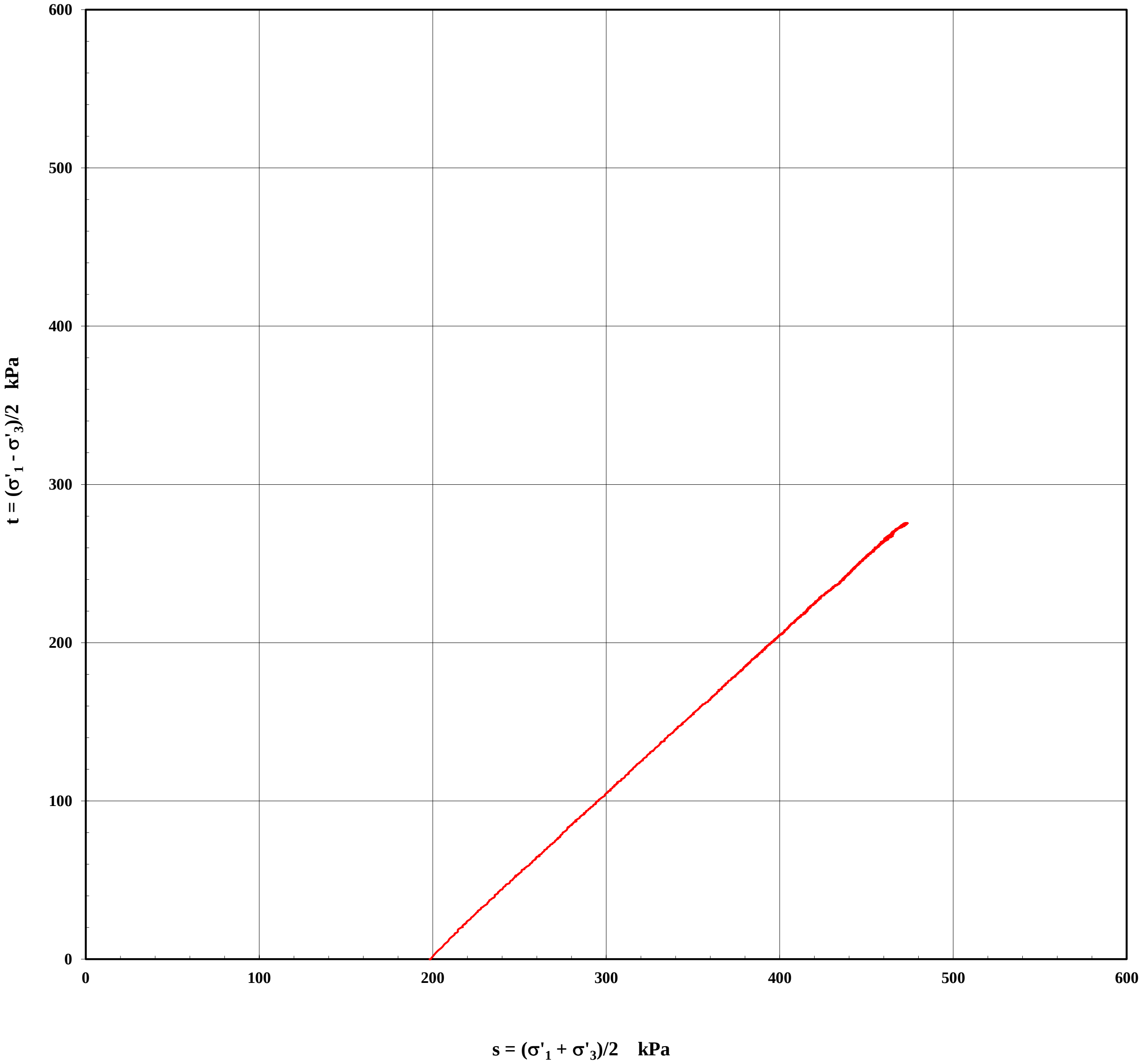
TRIAXIAL TEST REPORT

Test Method: ASTM D7181

Client: Hatch Pty Ltd	**Report No.:** 18110416 - CD

MIT Method - Effective Stress Path



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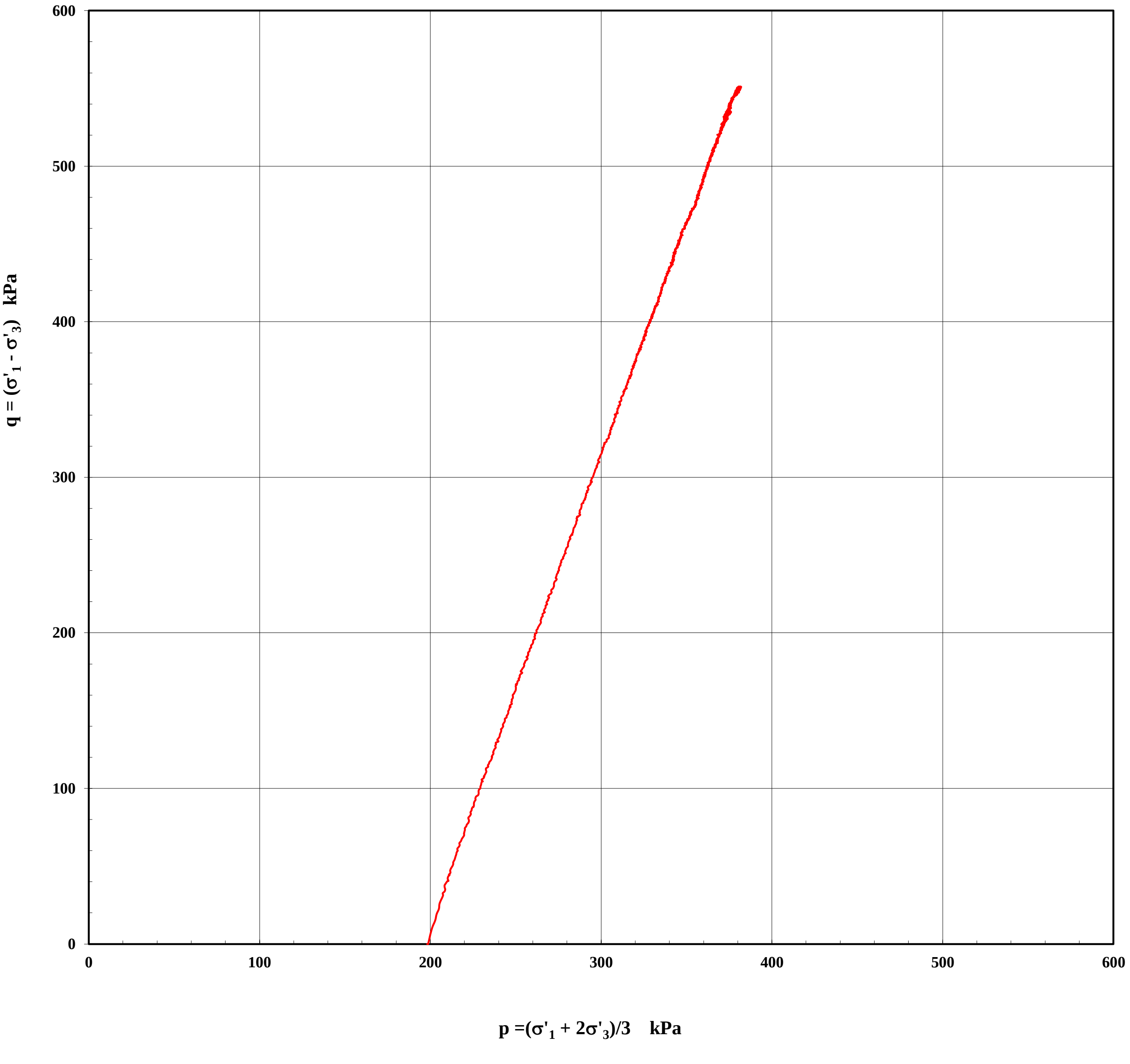
TRIAXIAL TEST REPORT

Test Method: ASTM D7181

Client: Hatch Pty Ltd	**Report No.:** 18110416 - CD

Cambridge Method - Effective Stress Path



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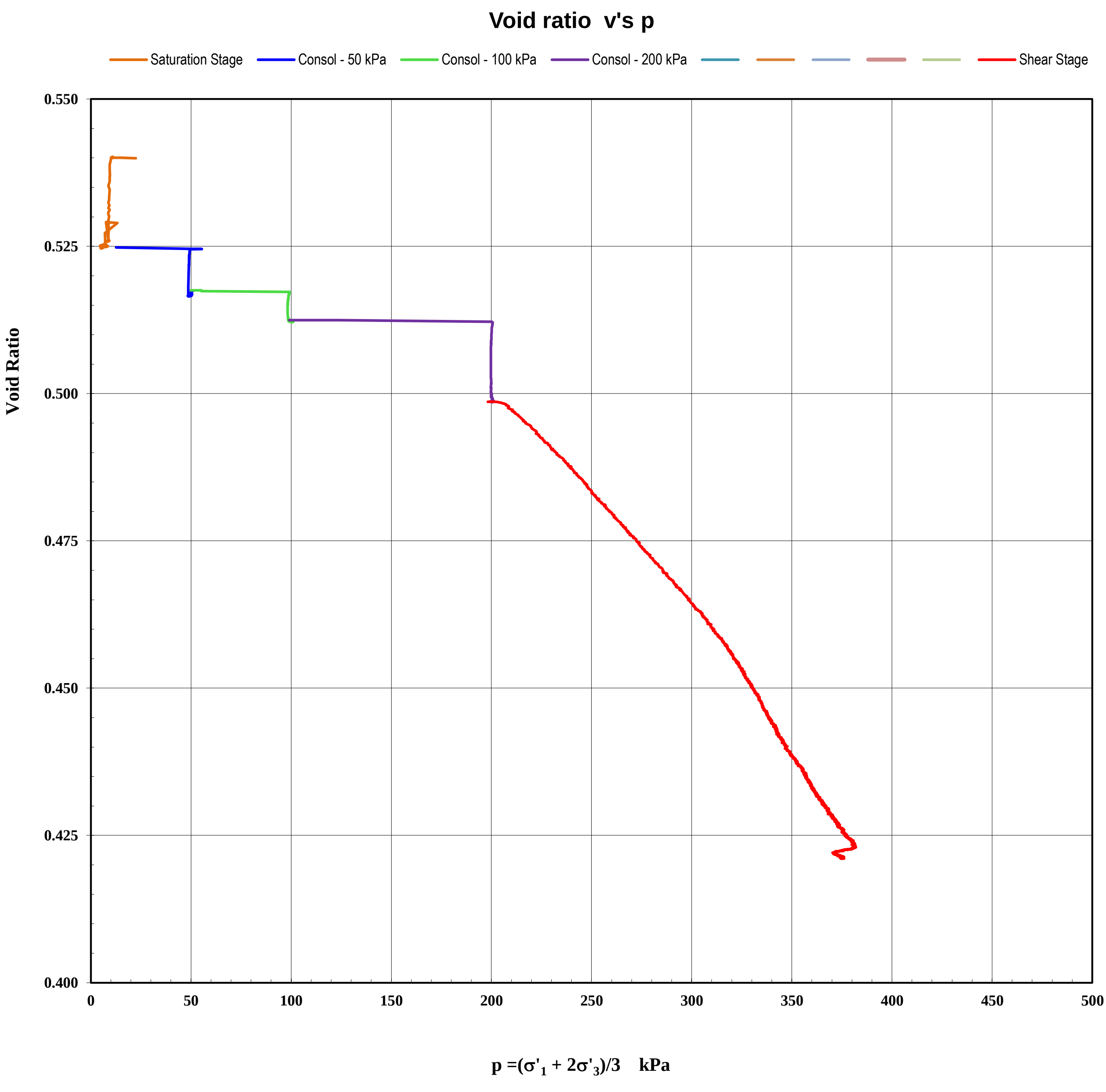
Client: Hatch Pty Ltd

Report No.: 18110416 - CD



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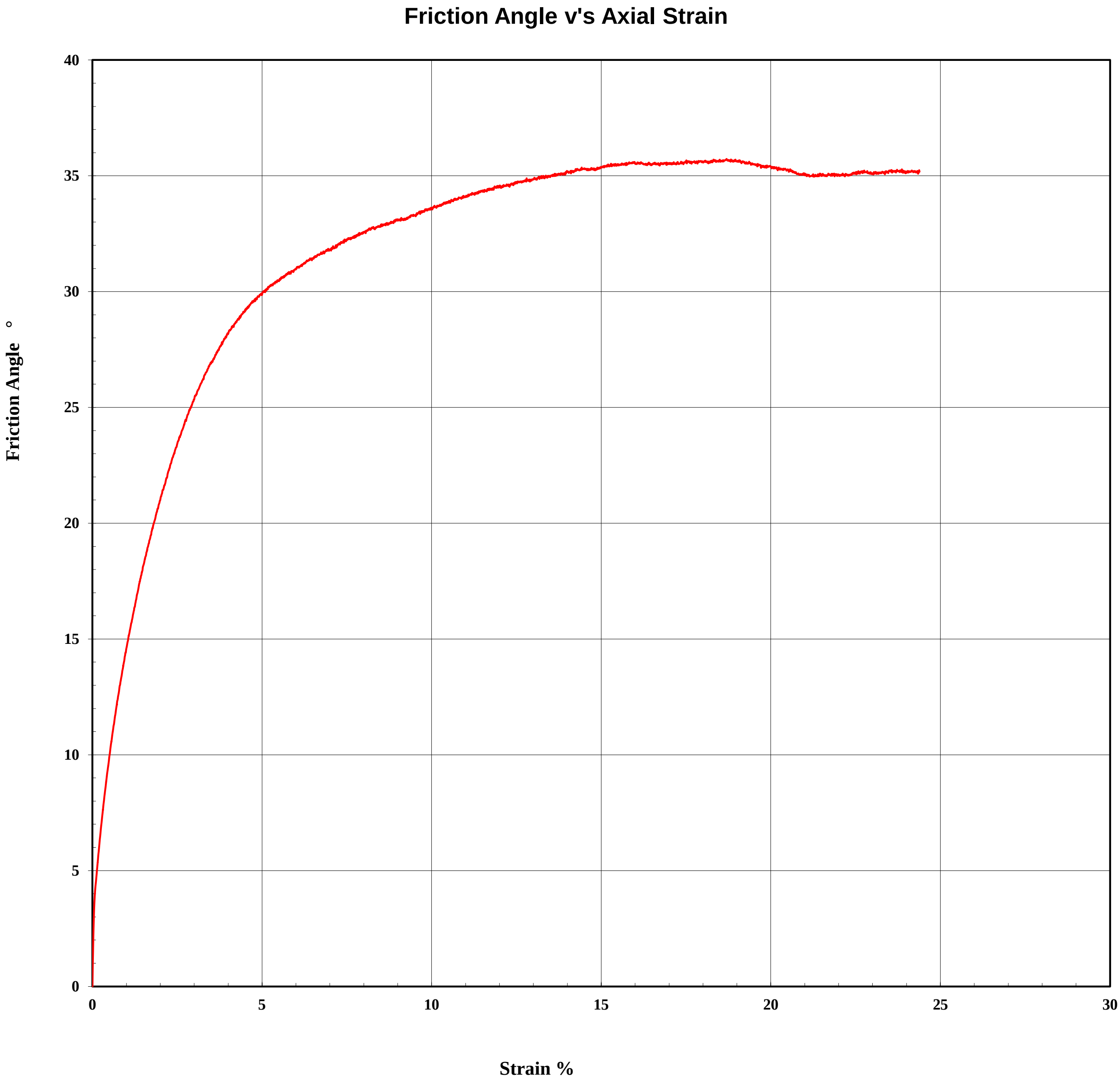

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Test Method: ASTM D7181

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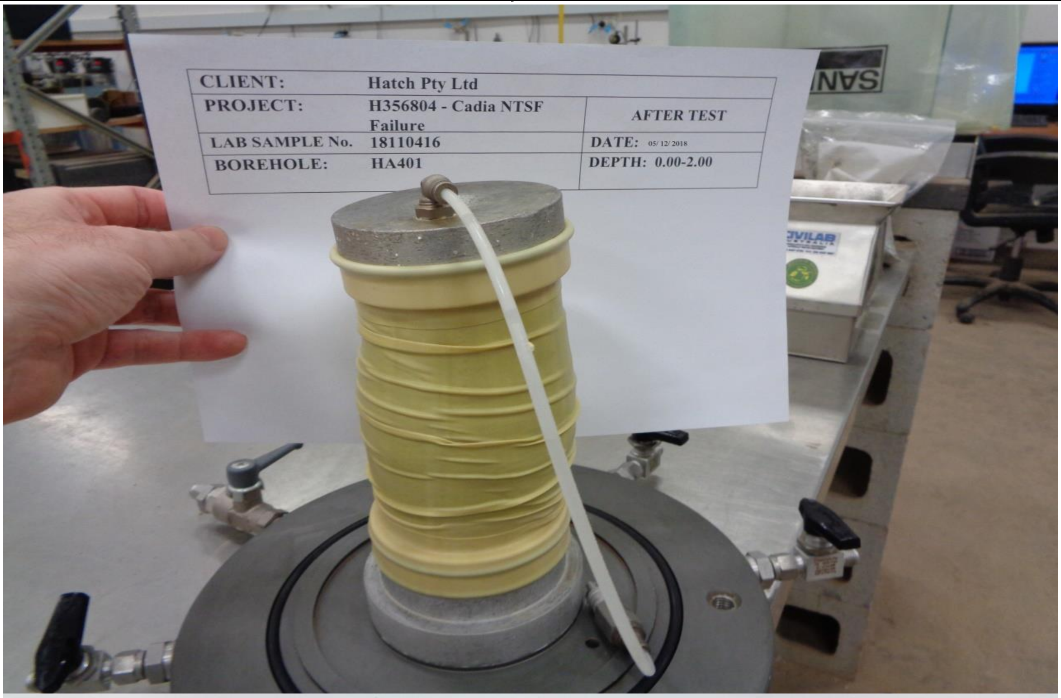

Remarks:
Sample/s supplied by the client

Note: Photo not to scale

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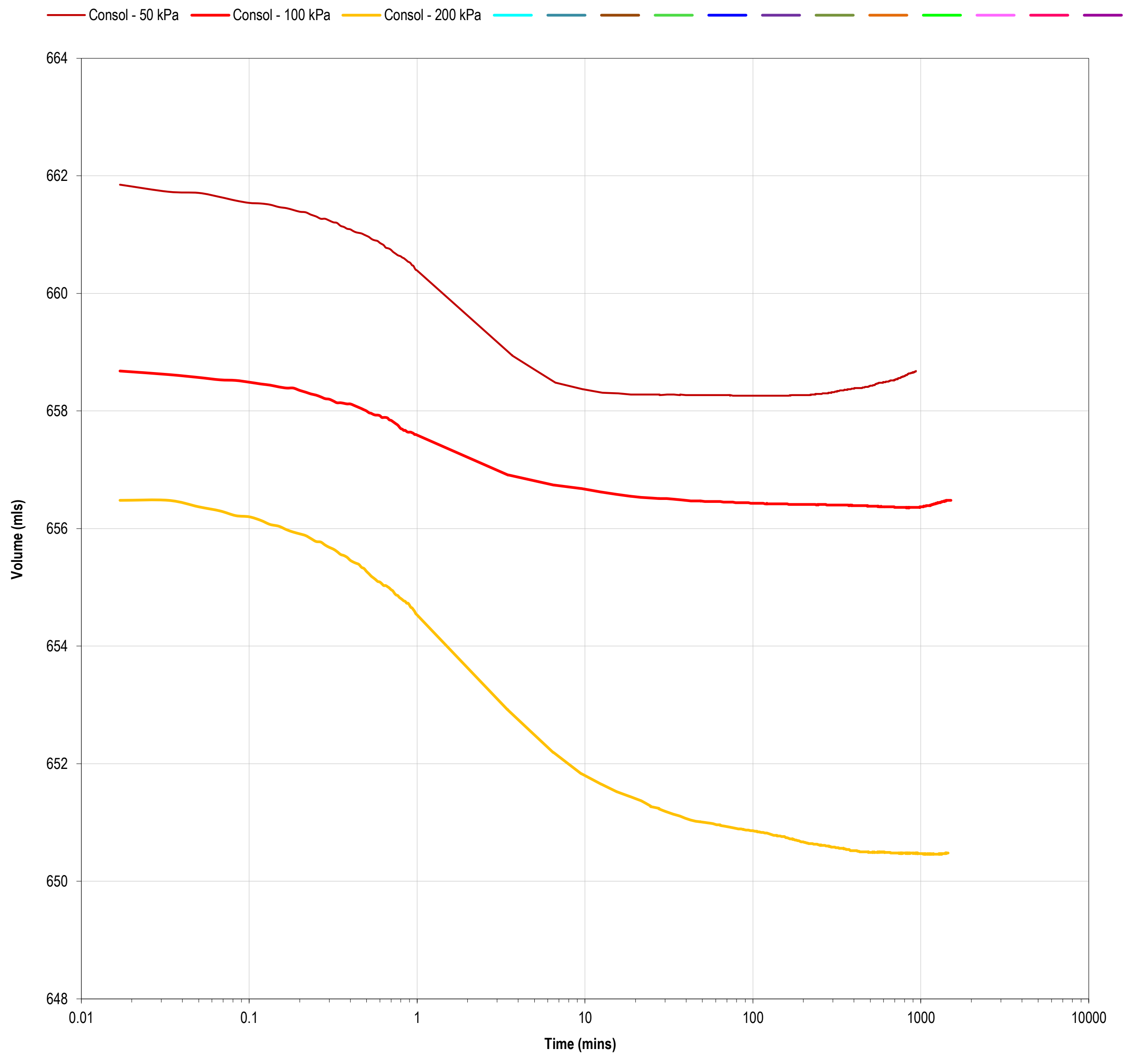
TRIAXIAL TEST REPORT

Test Method: ASTM D7181

Client: Hatch Pty Ltd	**Report No.:** 18110416 - CD

Volume v's Time (Log Scale)



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Annexure EF
HA 402 – CSL Test Certificates

Triaxial Test Report

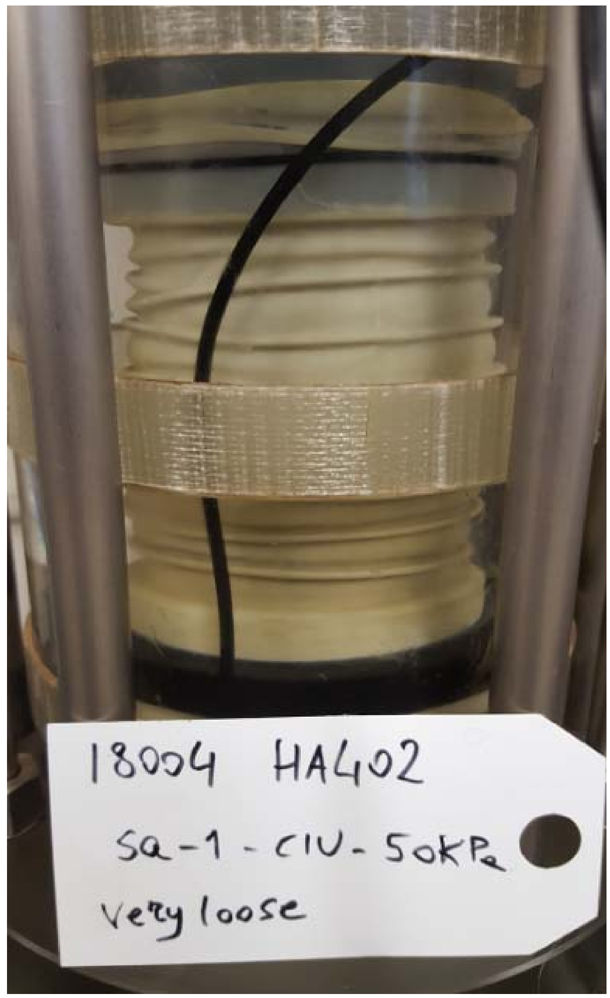
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	5/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-1 CIU very loose 50kPa

Initial Height (mm):	148.2	Final Liquor Content (%):	31.8%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	68.0	Final Dry Density (t/m^3):	1.43	B Response (%):	95%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.84	Mean Effective Consolidation Stress (kPa):	50
Initial Dry Density (t/m^3):	1.18	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98

Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	5/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-1 CIU very loose 50kPa

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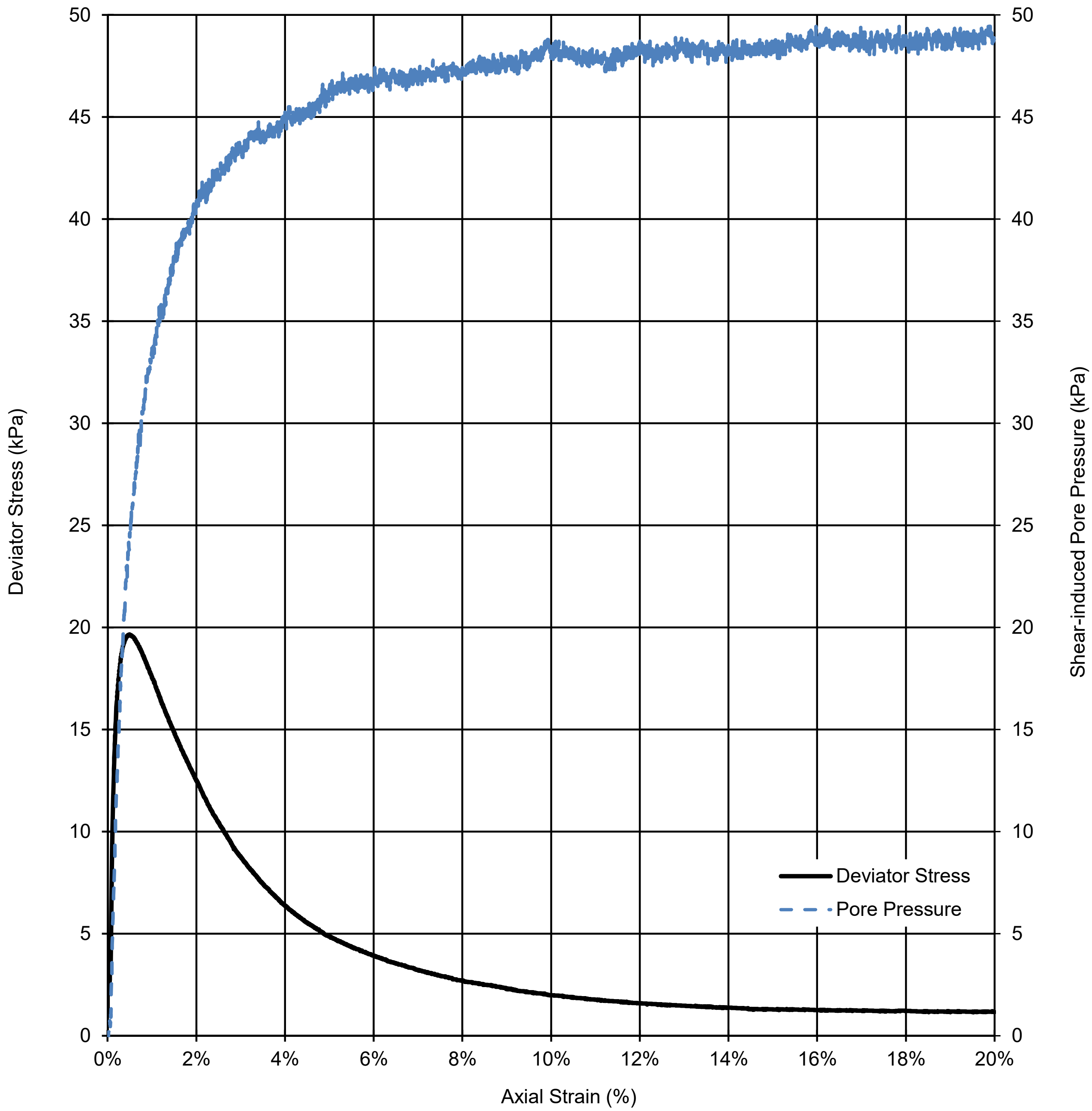

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

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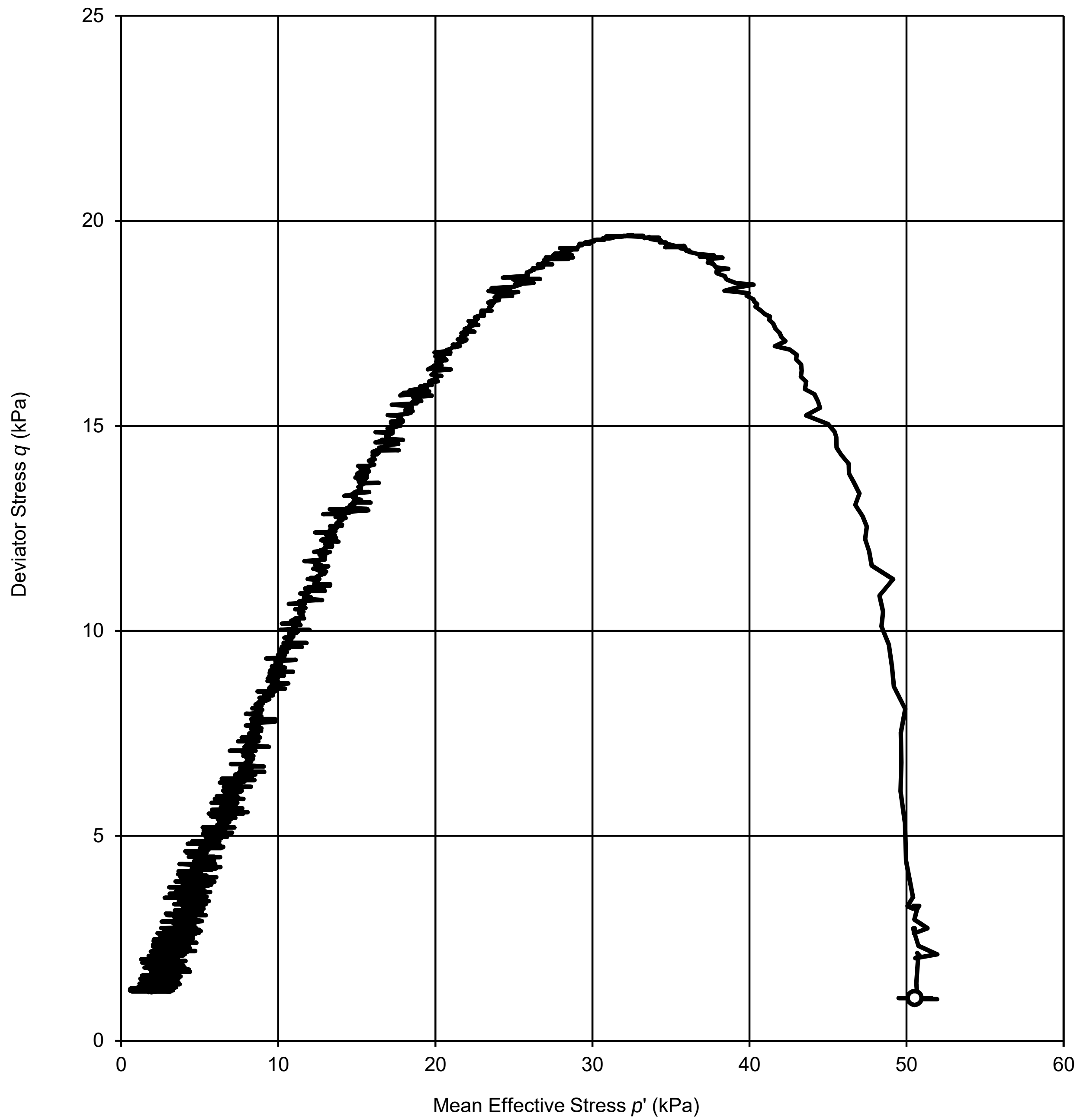

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	29/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-2 CIU loose 100kPa

Initial Height (mm):	148.8	Final Liquor Content (%):	30.6%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	67.8	Final Dry Density (t/m^3):	1.46	B Response (%):	97%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.80	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.18	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	29/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-2 CIU loose 100kPa

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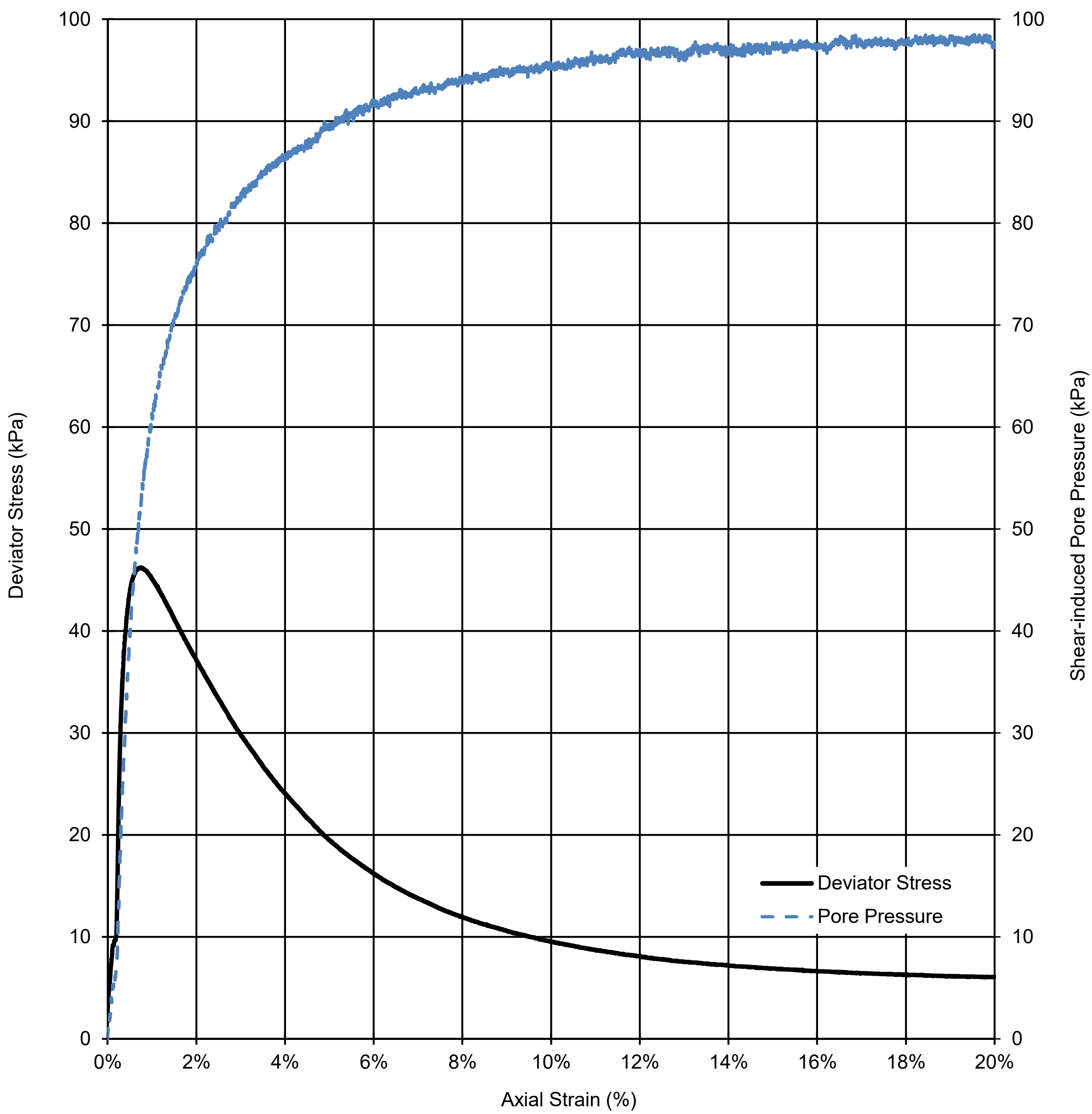

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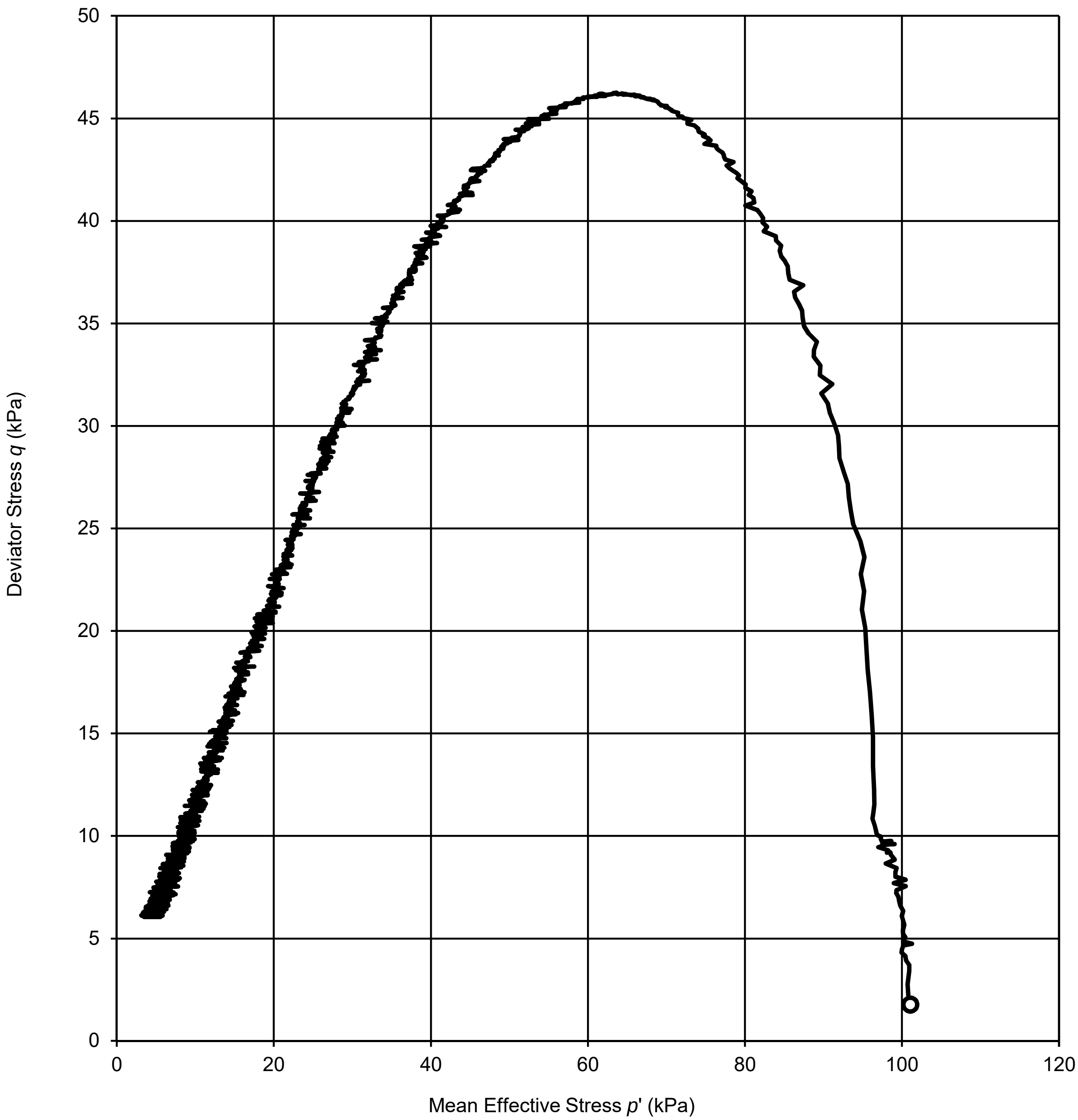
Initial Dry Density (t/m^3):	1.18	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



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Triaxial Test Report

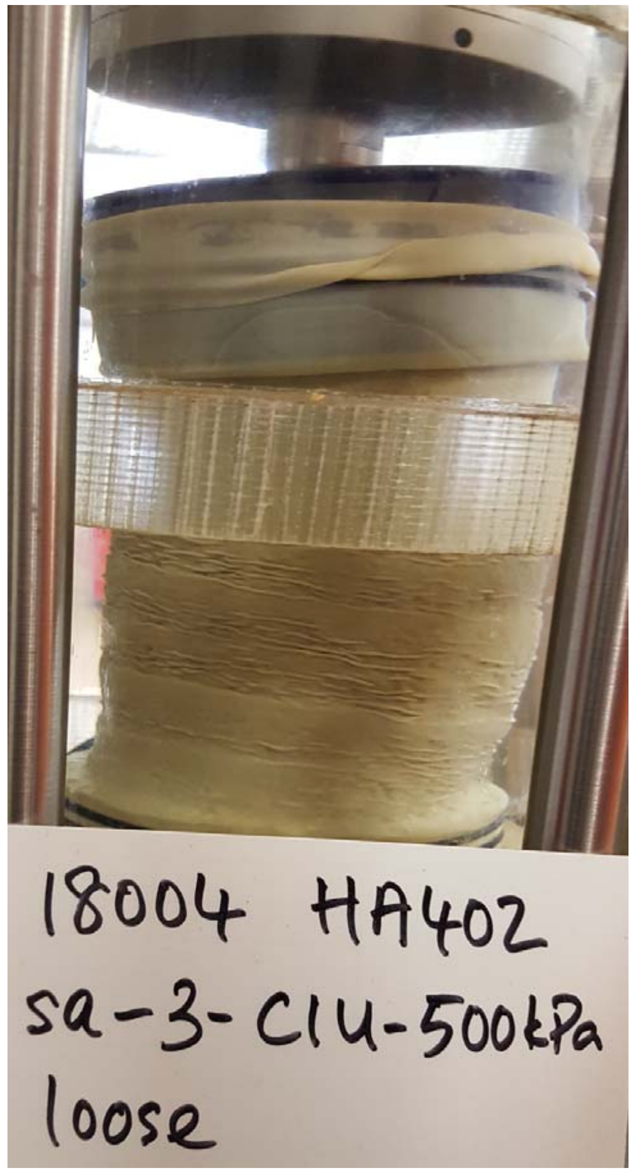
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	3/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-3 CIU loose 500kPa

Initial Height (mm):	148.4	Final Liquor Content (%):	27.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.0	Final Dry Density (t/m^3):	1.54	B Response (%):	97%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.71	Mean Effective Consolidation Stress (kPa):	500
Initial Dry Density (t/m^3):	1.15	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test



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Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	3/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-3 CIU loose 500kPa

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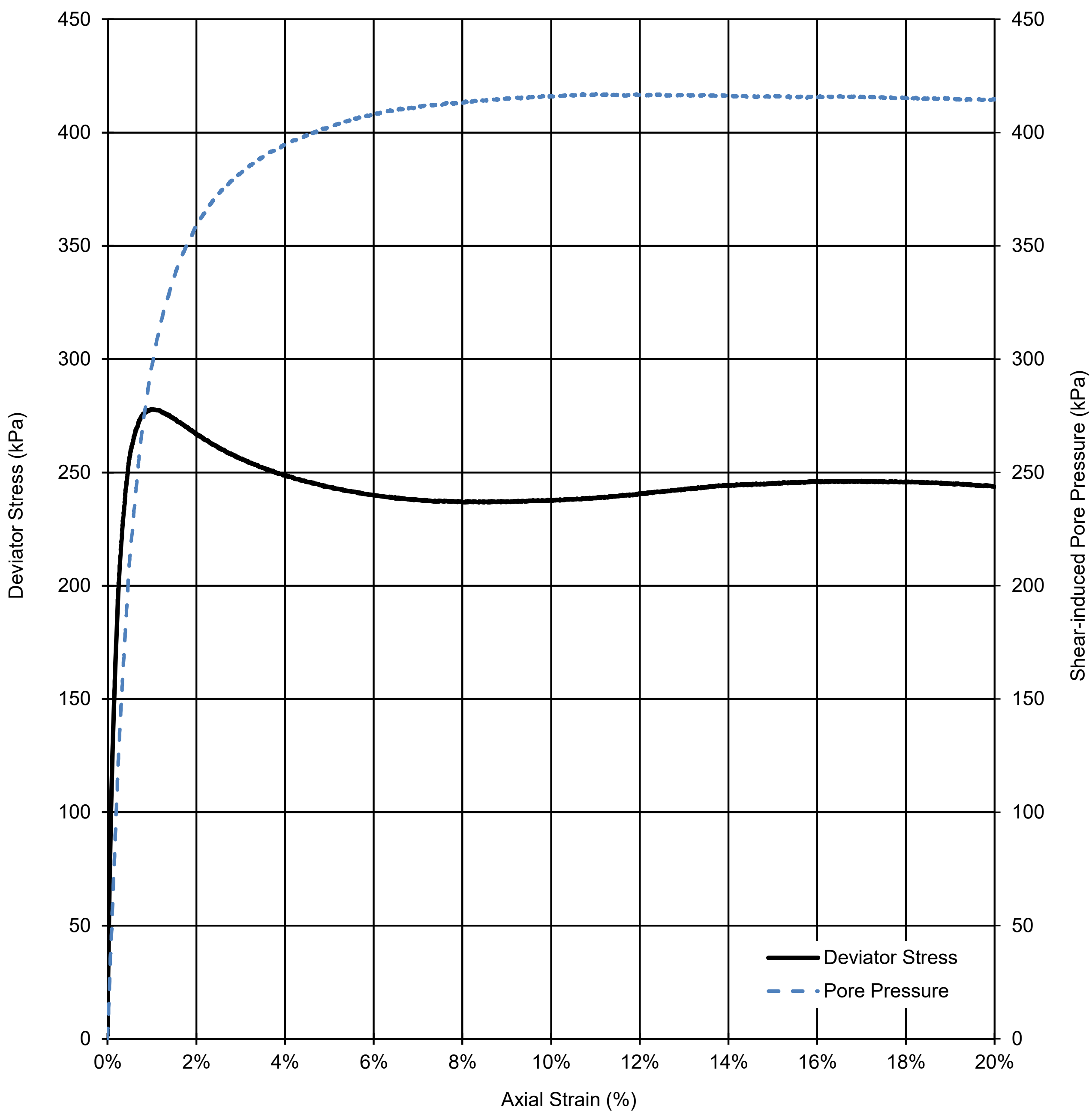

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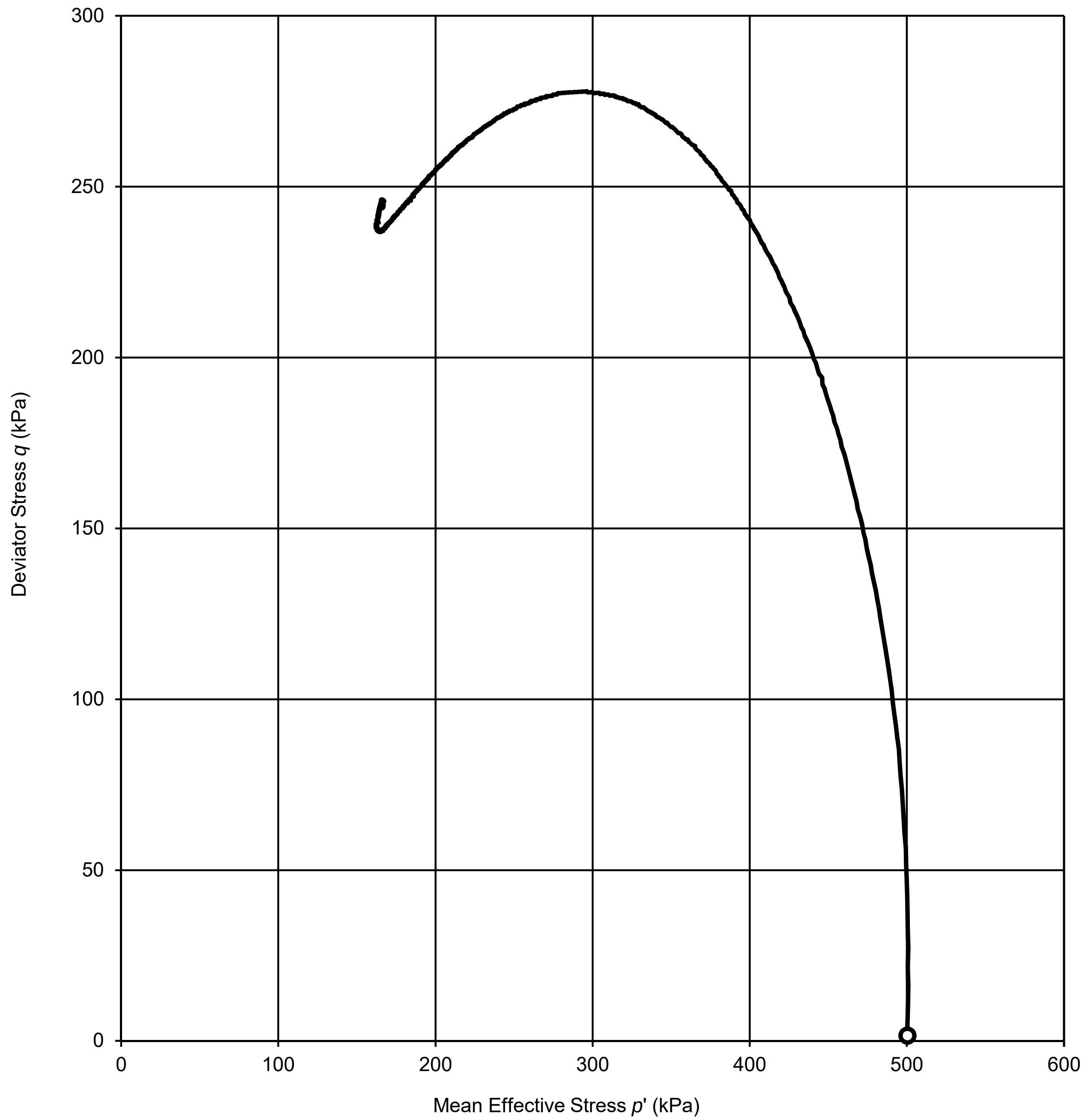

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	3/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-3 CIU loose 500kPa

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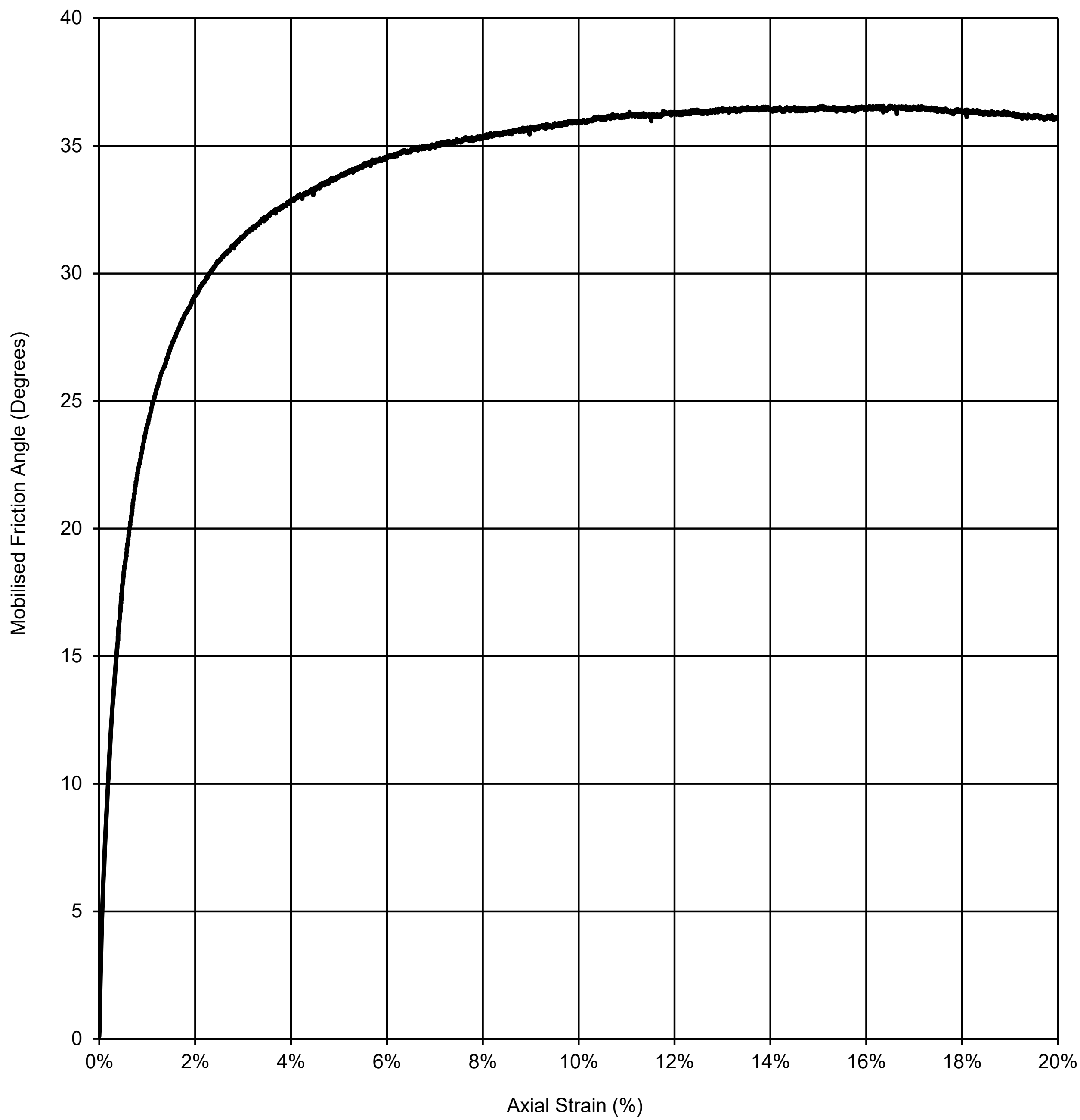
Initial Dry Density (t/m^3):	1.15	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

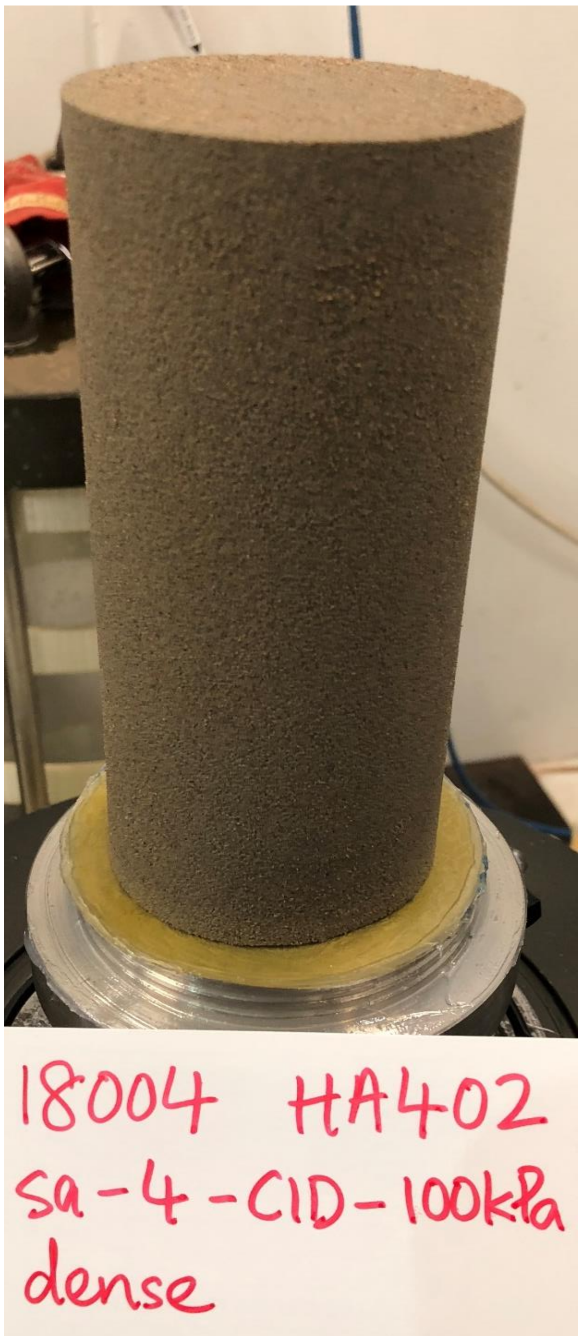
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-4 CID dense 100kPa

Initial Height (mm):	144.4	Final Liquor Content (%):	25.1%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.6	Final Dry Density (t/m^3):	1.58	B Response (%):	97%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.66	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.64	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-4 CID dense 100kPa

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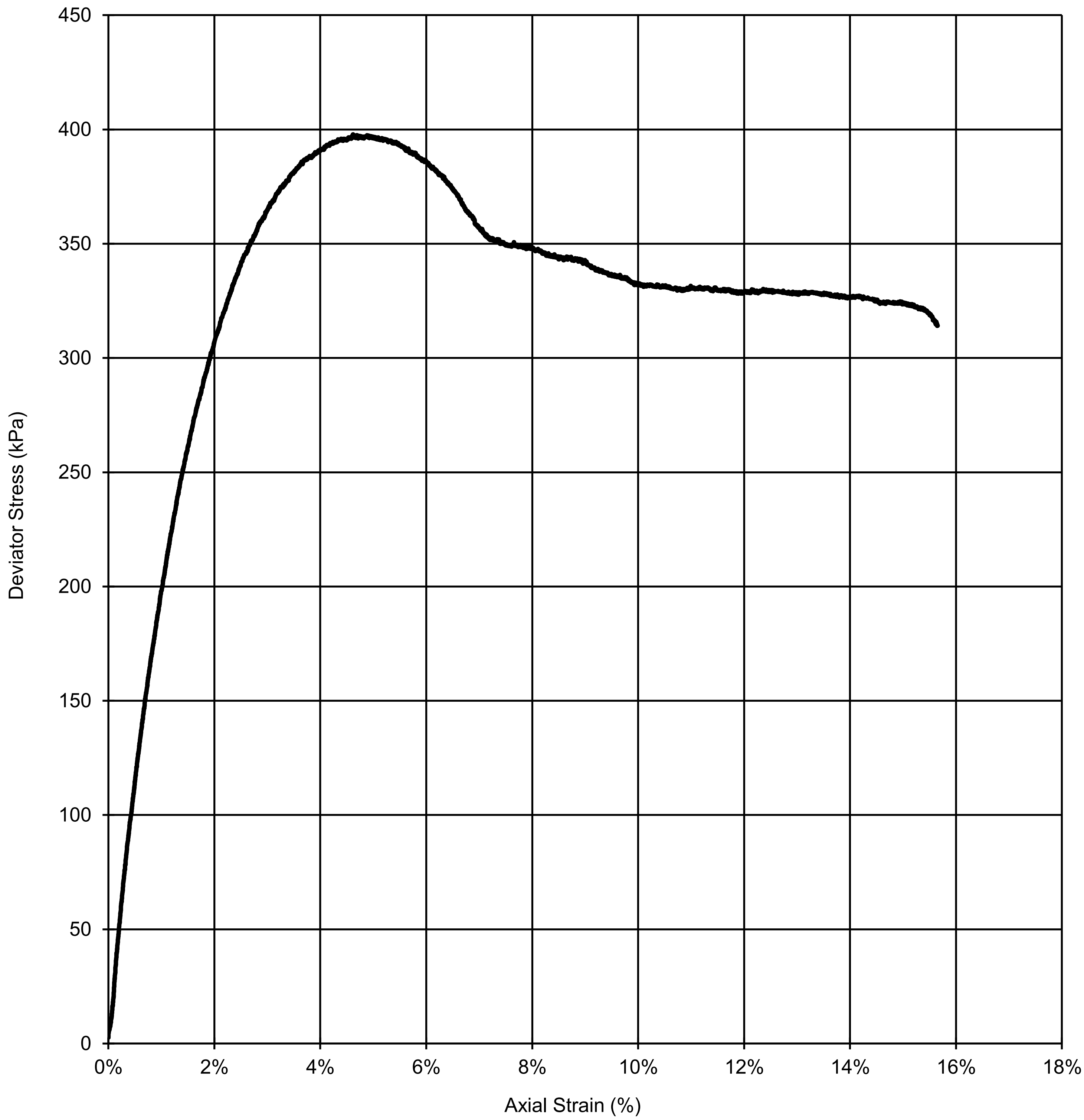

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

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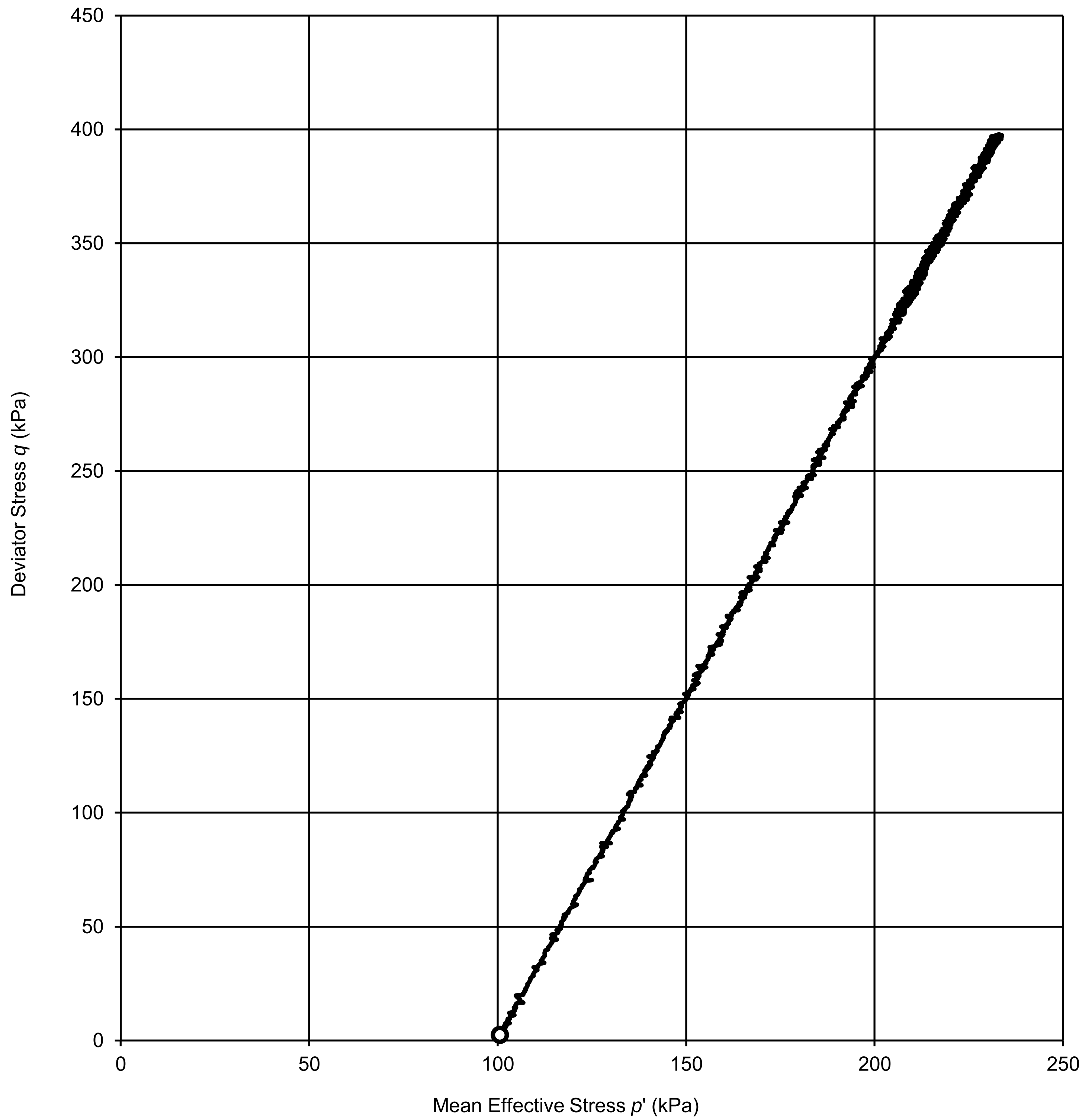

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Triaxial Test Report

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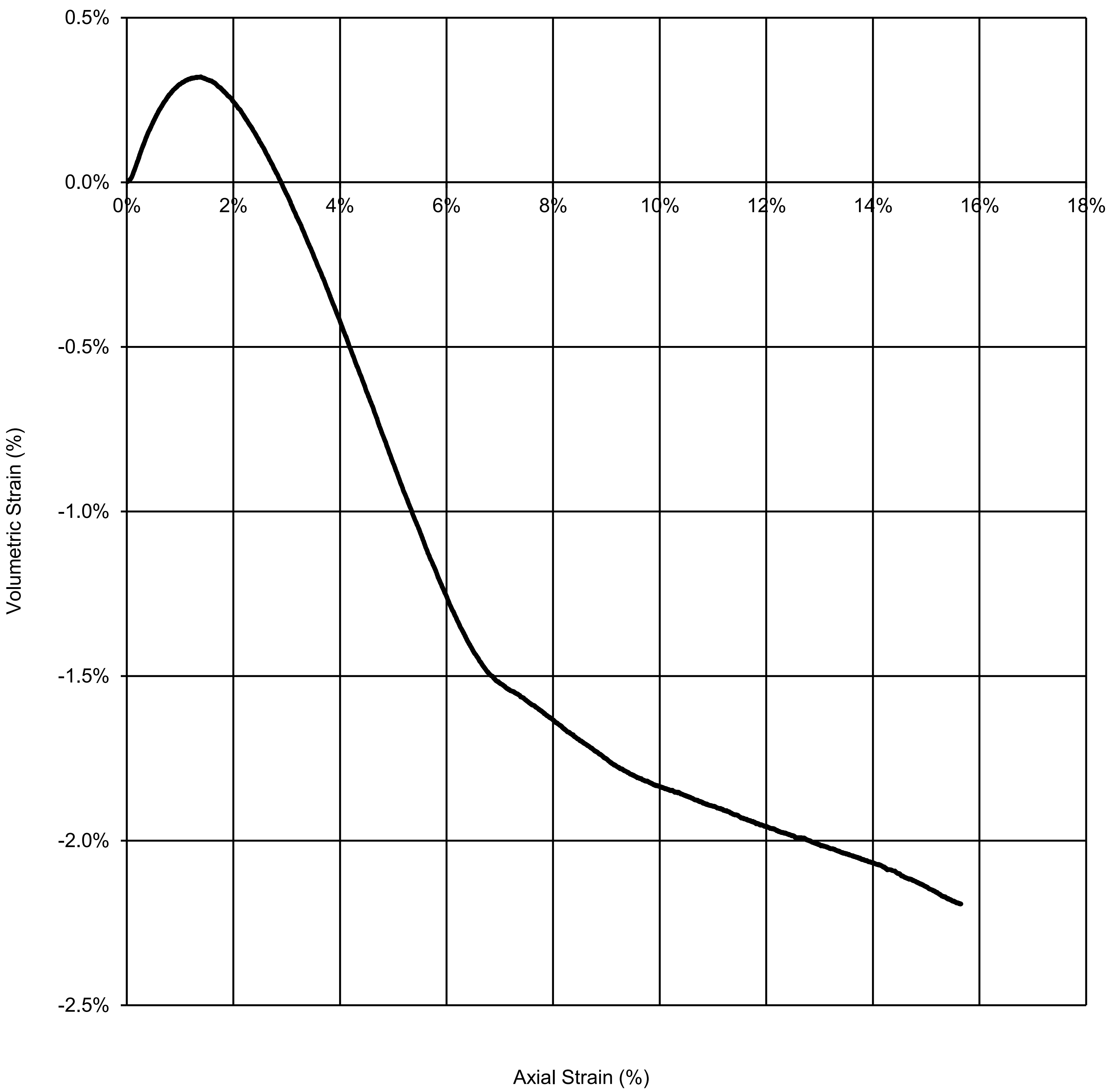
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-4 CID dense 100kPa

Initial Height (mm):	144.4	Final Liquor Content (%):	25.1%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.6	Final Dry Density (t/m^3):	1.58	B Response (%):	97%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.66	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.64	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Triaxial Test Report

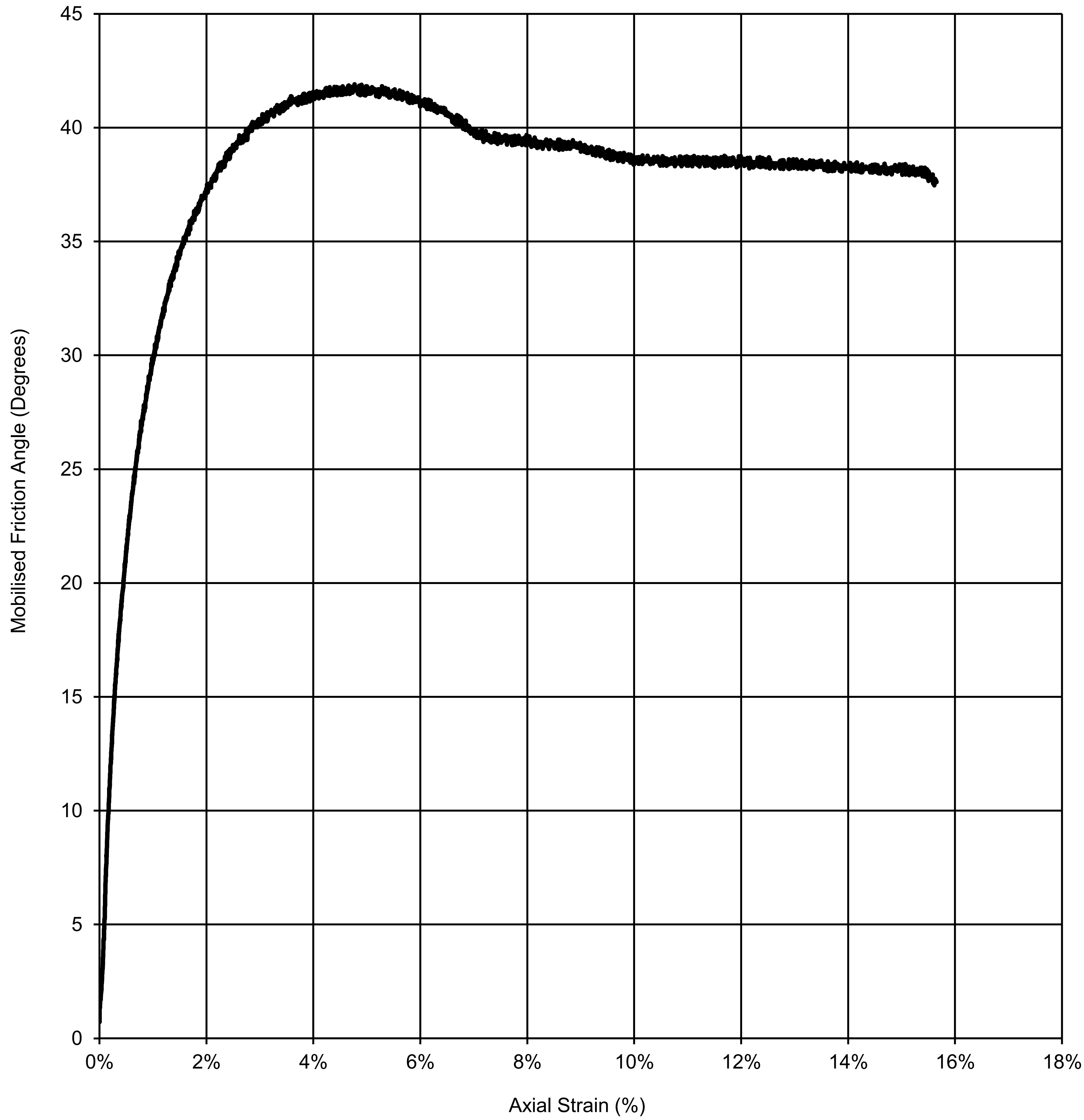
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-4 CID dense 100kPa

Initial Height (mm):	144.4	Final Liquor Content (%):	25.1%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.6	Final Dry Density (t/m^3):	1.58	B Response (%):	97%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.66	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.64	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

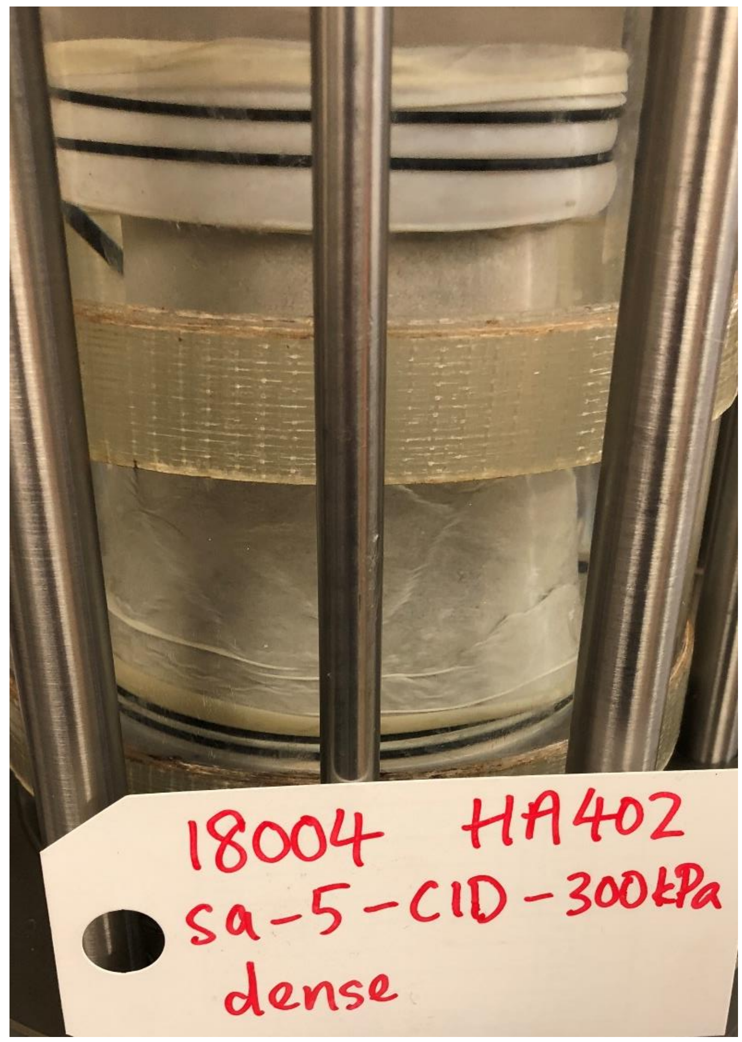
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-5 CID dense 300kPa

Initial Height (mm):	126.8	Final Liquor Content (%):	22.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.66	B Response (%):	96%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.58	Mean Effective Consolidation Stress (kPa):	301
Initial Dry Density (t/m^3):	1.72	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99

Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

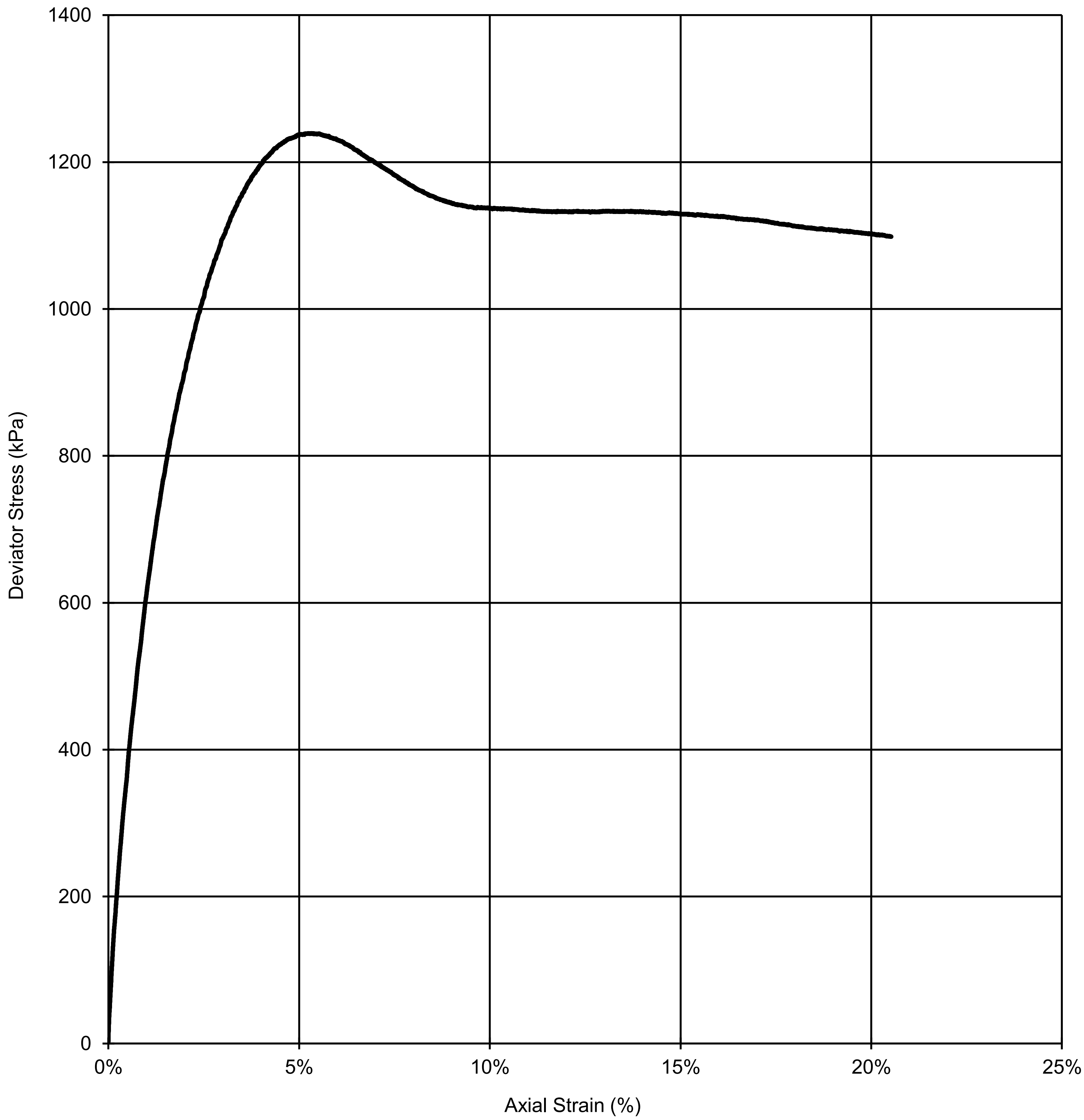
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-5 CID dense 300kPa

Initial Height (mm):	126.8	Final Liquor Content (%):	22.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.66	B Response (%):	96%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.58	Mean Effective Consolidation Stress (kPa):	301
Initial Dry Density (t/m^3):	1.72	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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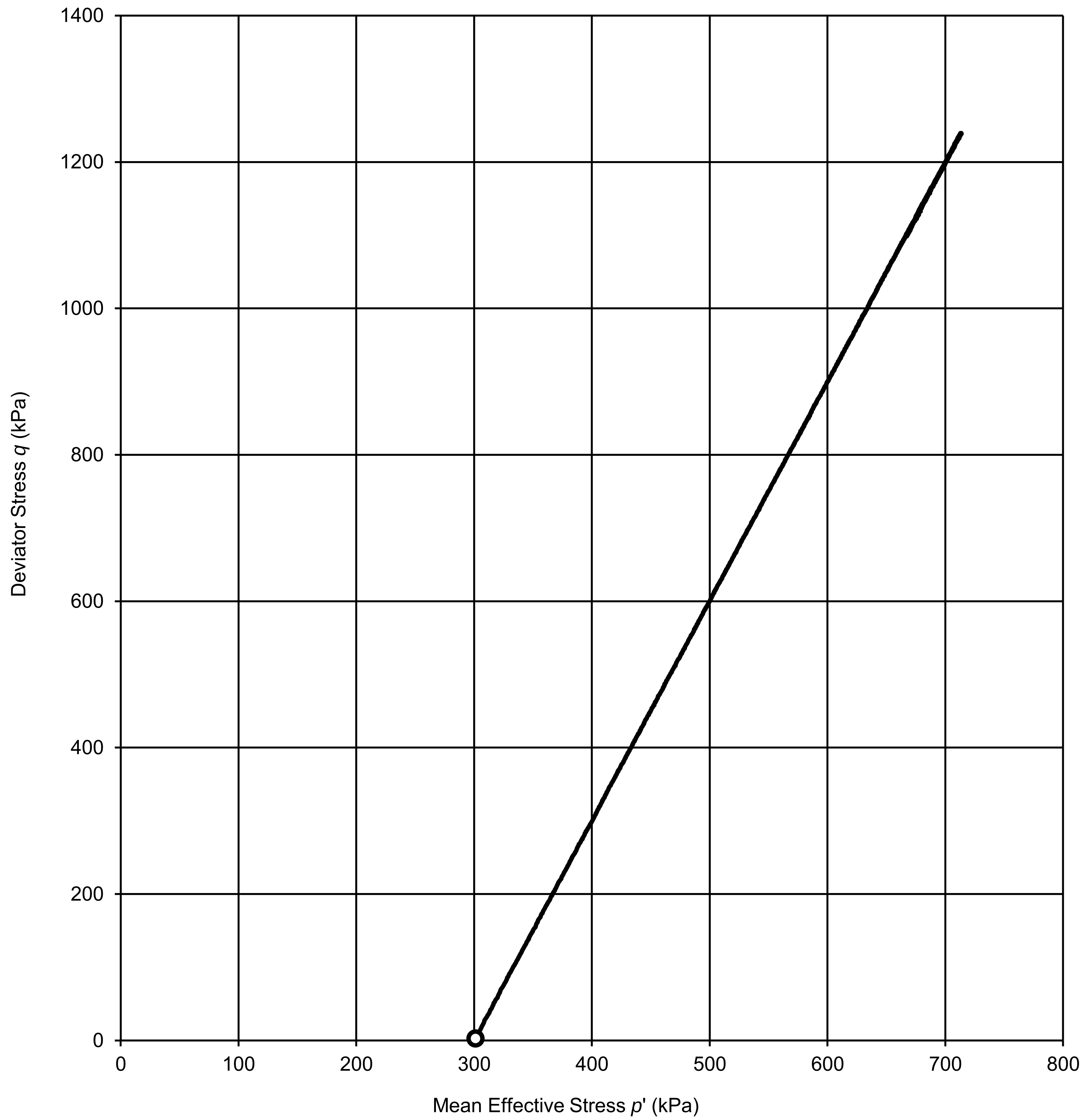
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-5 CID dense 300kPa

Initial Height (mm):	126.8	Final Liquor Content (%):	22.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.66	B Response (%):	96%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.58	Mean Effective Consolidation Stress (kPa):	301
Initial Dry Density (t/m^3):	1.72	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

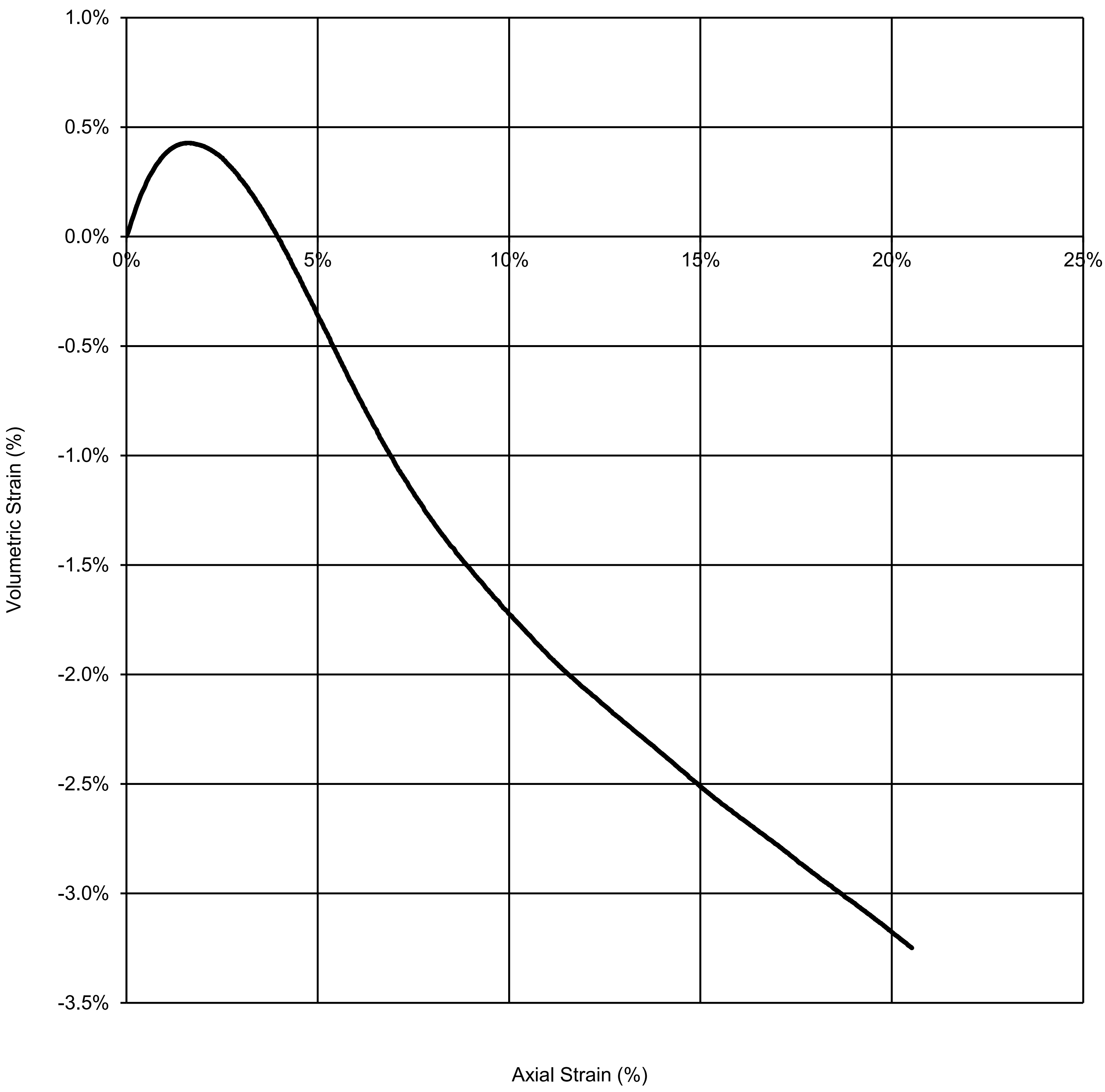
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-5 CID dense 300kPa

Initial Height (mm):	126.8	Final Liquor Content (%):	22.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.66	B Response (%):	96%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.58	Mean Effective Consolidation Stress (kPa):	301
Initial Dry Density (t/m^3):	1.72	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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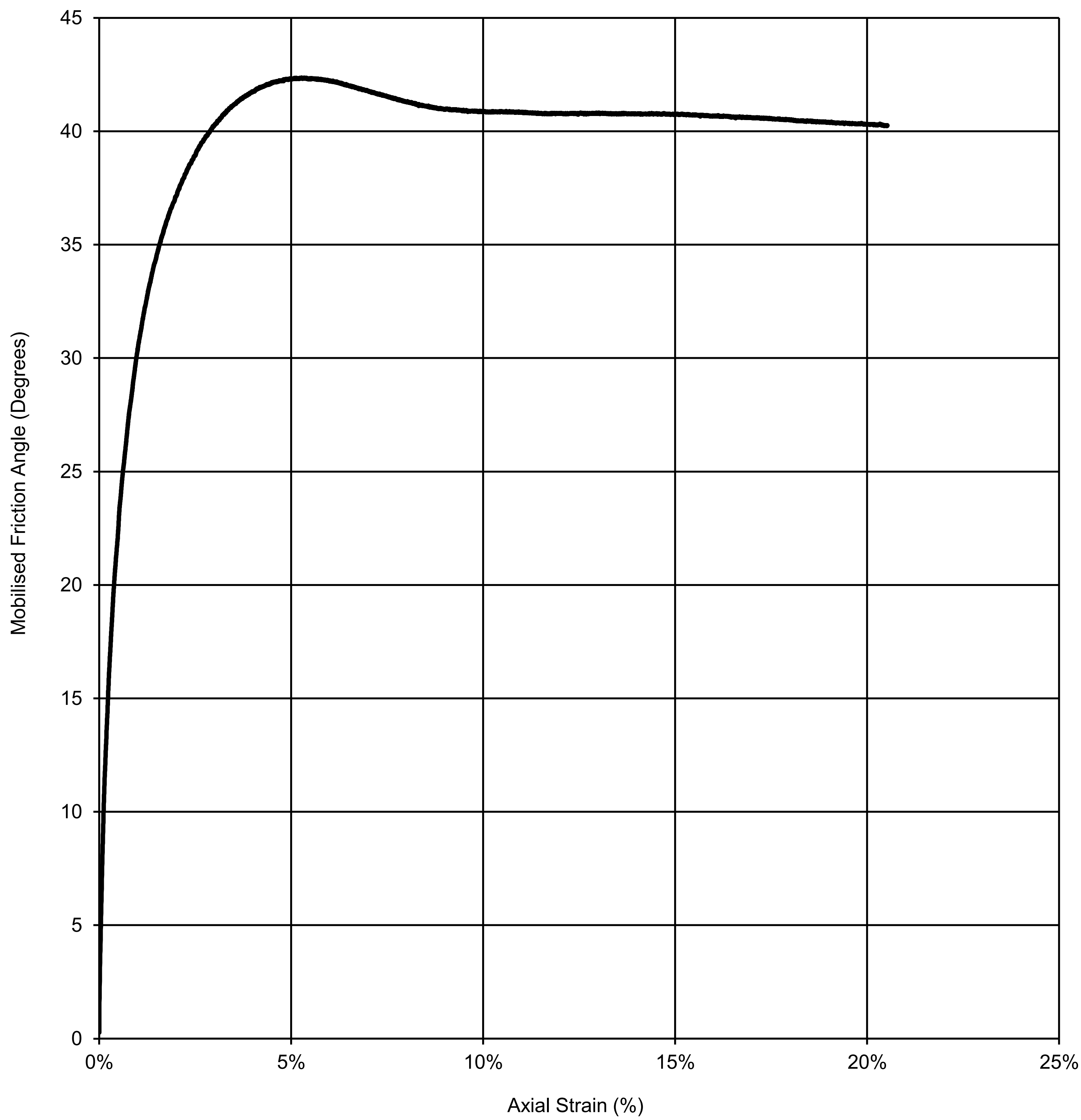
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-5 CID dense 300kPa

Initial Height (mm):	126.8	Final Liquor Content (%):	22.2%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.66	B Response (%):	96%
Trimmings GWC (%):	20.0%	Final Void Ratio (-):	0.58	Mean Effective Consolidation Stress (kPa):	301
Initial Dry Density (t/m^3):	1.72	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-6 CID very dense 800kPa

Initial Height (mm):	142.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.71	B Response (%):	96%
Trimmings GWC (%):	23.0%	Final Void Ratio (-):	0.54	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.65	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

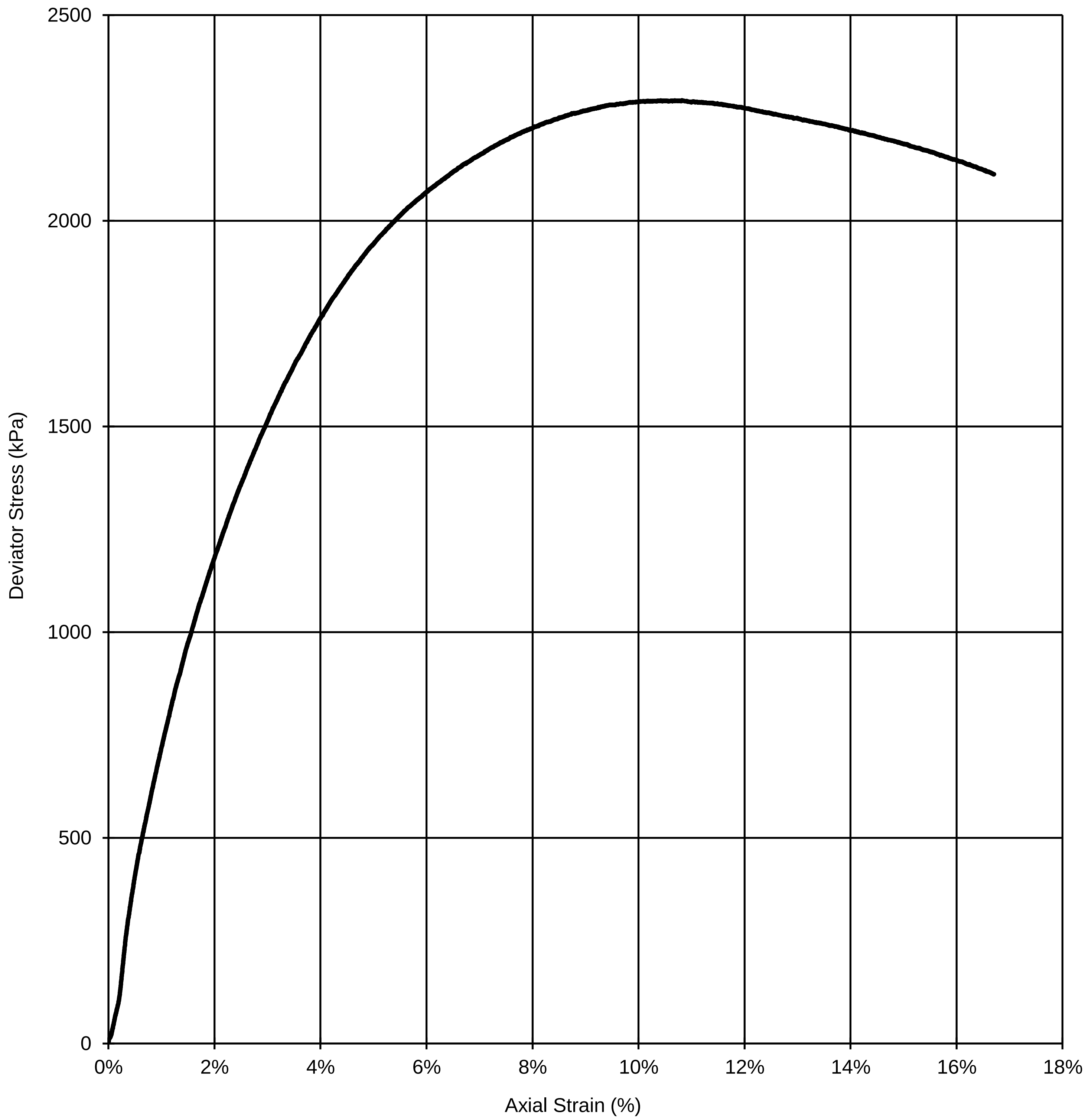
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-6 CID very dense 800kPa

Initial Height (mm):	142.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.71	B Response (%):	96%
Trimmings GWC (%):	23.0%	Final Void Ratio (-):	0.54	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.65	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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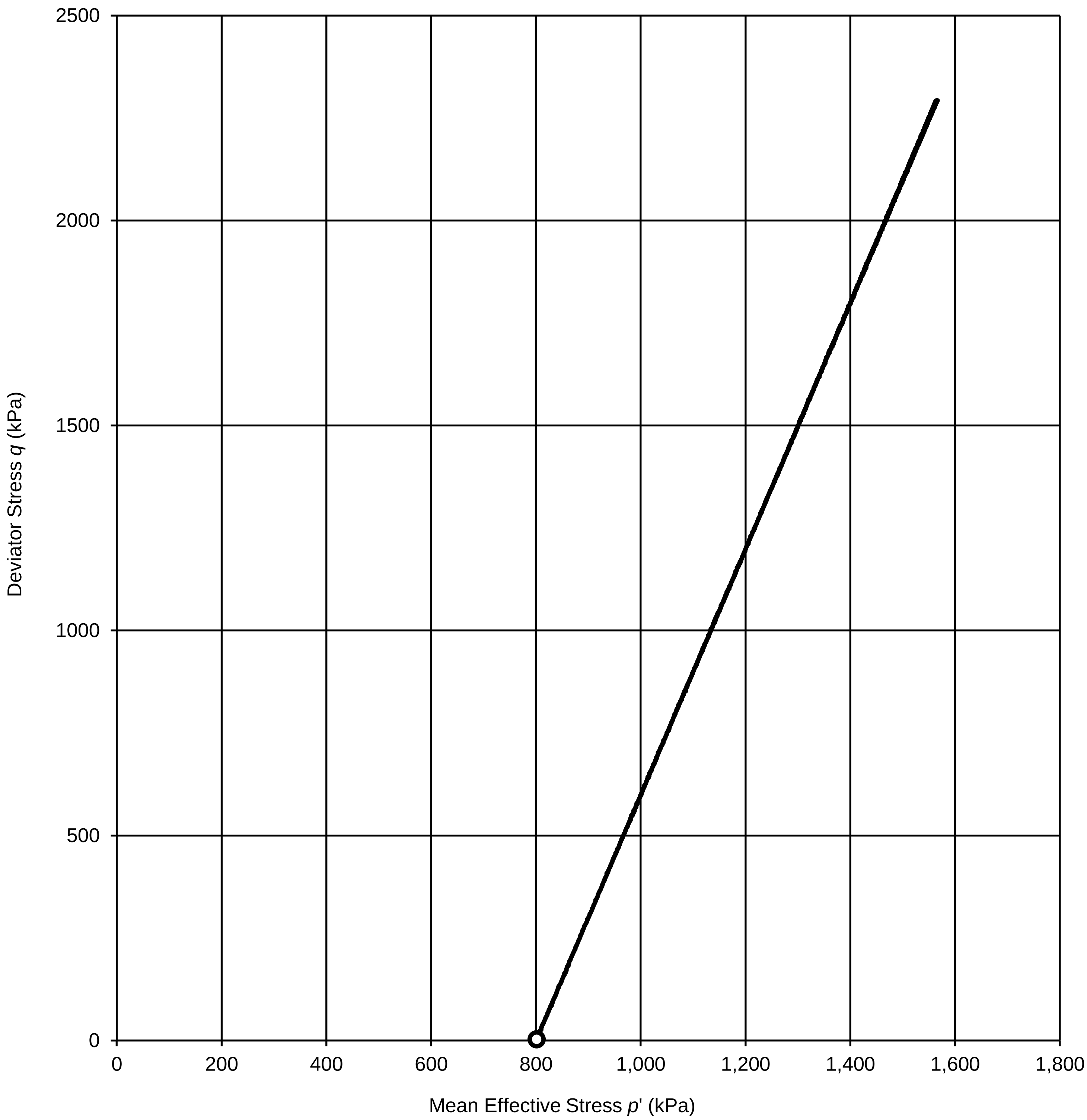
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-6 CID very dense 800kPa

Initial Height (mm):	142.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.71	B Response (%):	96%
Trimmings GWC (%):	23.0%	Final Void Ratio (-):	0.54	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.65	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

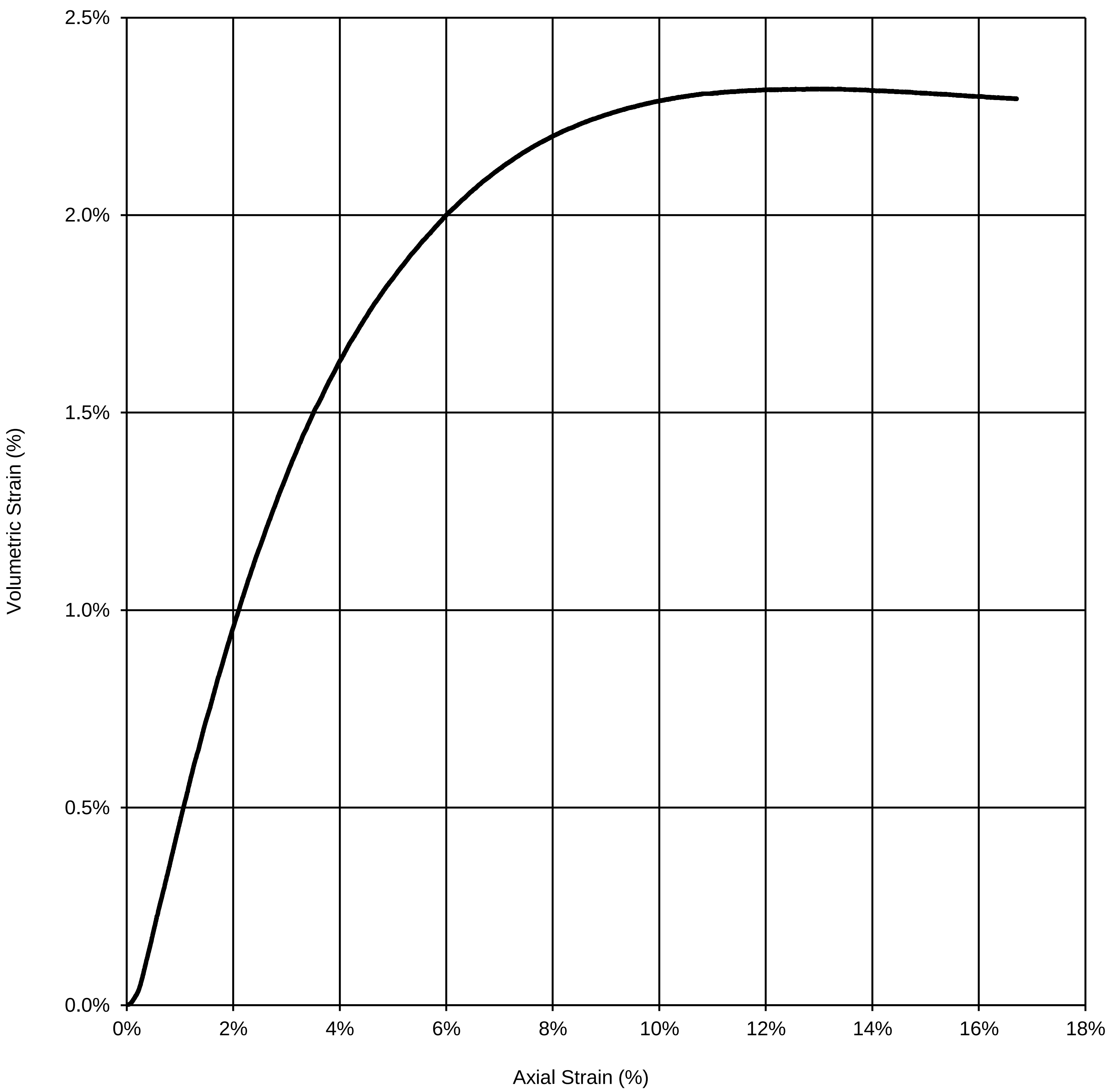
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-6 CID very dense 800kPa

Initial Height (mm):	142.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.71	B Response (%):	96%
Trimmings GWC (%):	23.0%	Final Void Ratio (-):	0.54	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.65	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

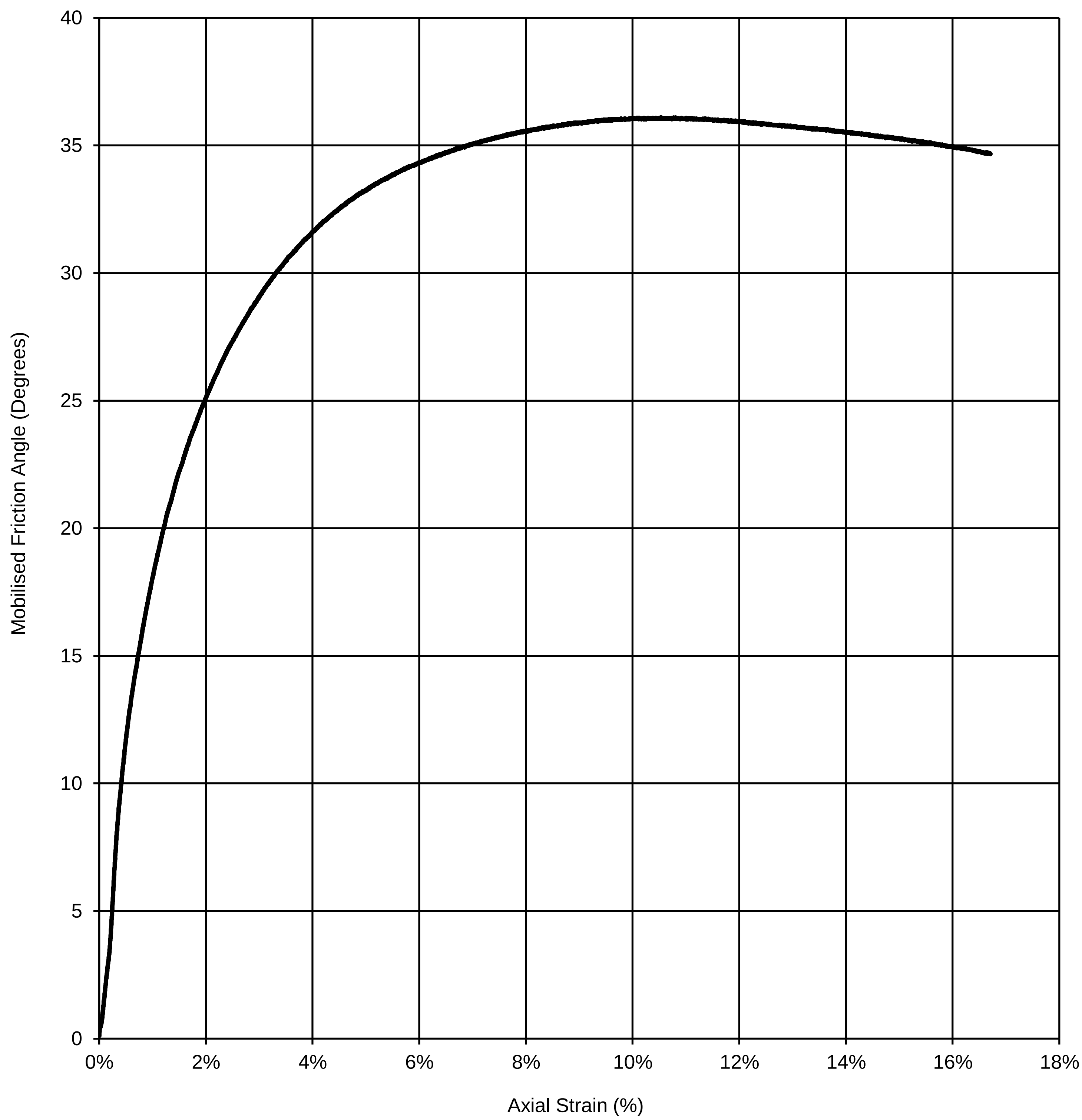
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-6 CID very dense 800kPa

Initial Height (mm):	142.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.71	B Response (%):	96%
Trimmings GWC (%):	23.0%	Final Void Ratio (-):	0.54	Mean Effective Consolidation Stress (kPa):	801
Initial Dry Density (t/m^3):	1.65	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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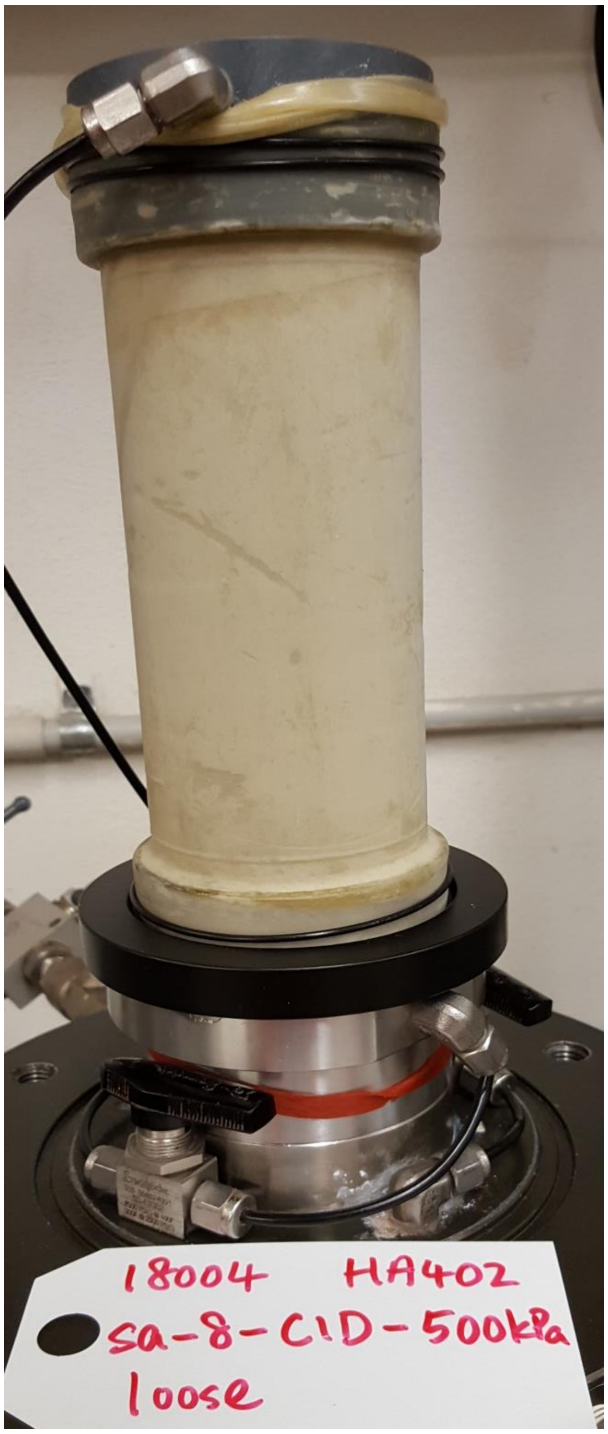
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-8 CID loose 500kPa

Initial Height (mm):	148.8	Final Liquor Content (%):	22.7%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	70.4	Final Dry Density (t/m^3):	1.65	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	501
Initial Dry Density (t/m^3):	1.26	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

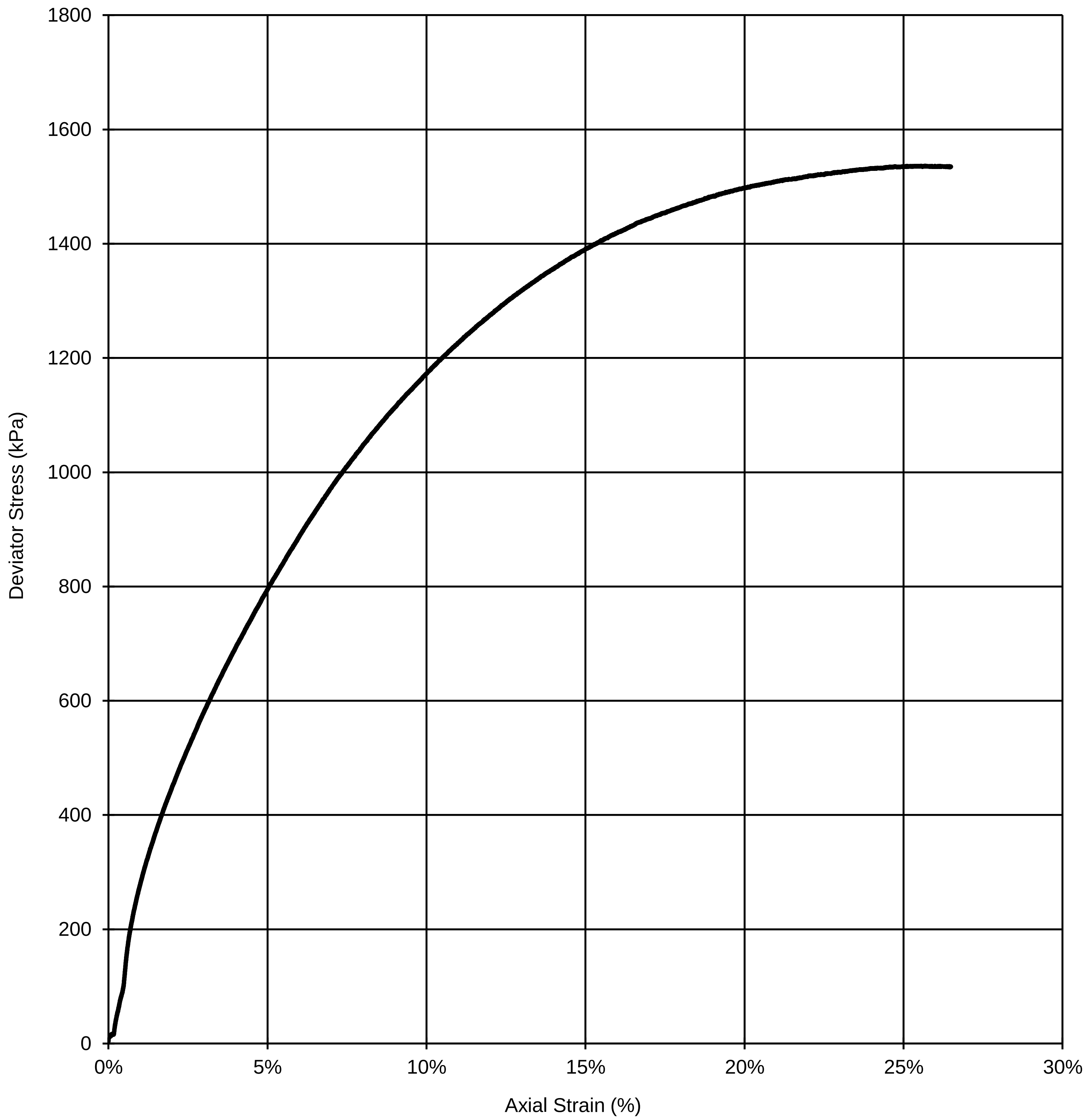
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-8 CID loose 500kPa

Initial Height (mm):	148.8	Final Liquor Content (%):	22.7%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	70.4	Final Dry Density (t/m^3):	1.65	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	501
Initial Dry Density (t/m^3):	1.26	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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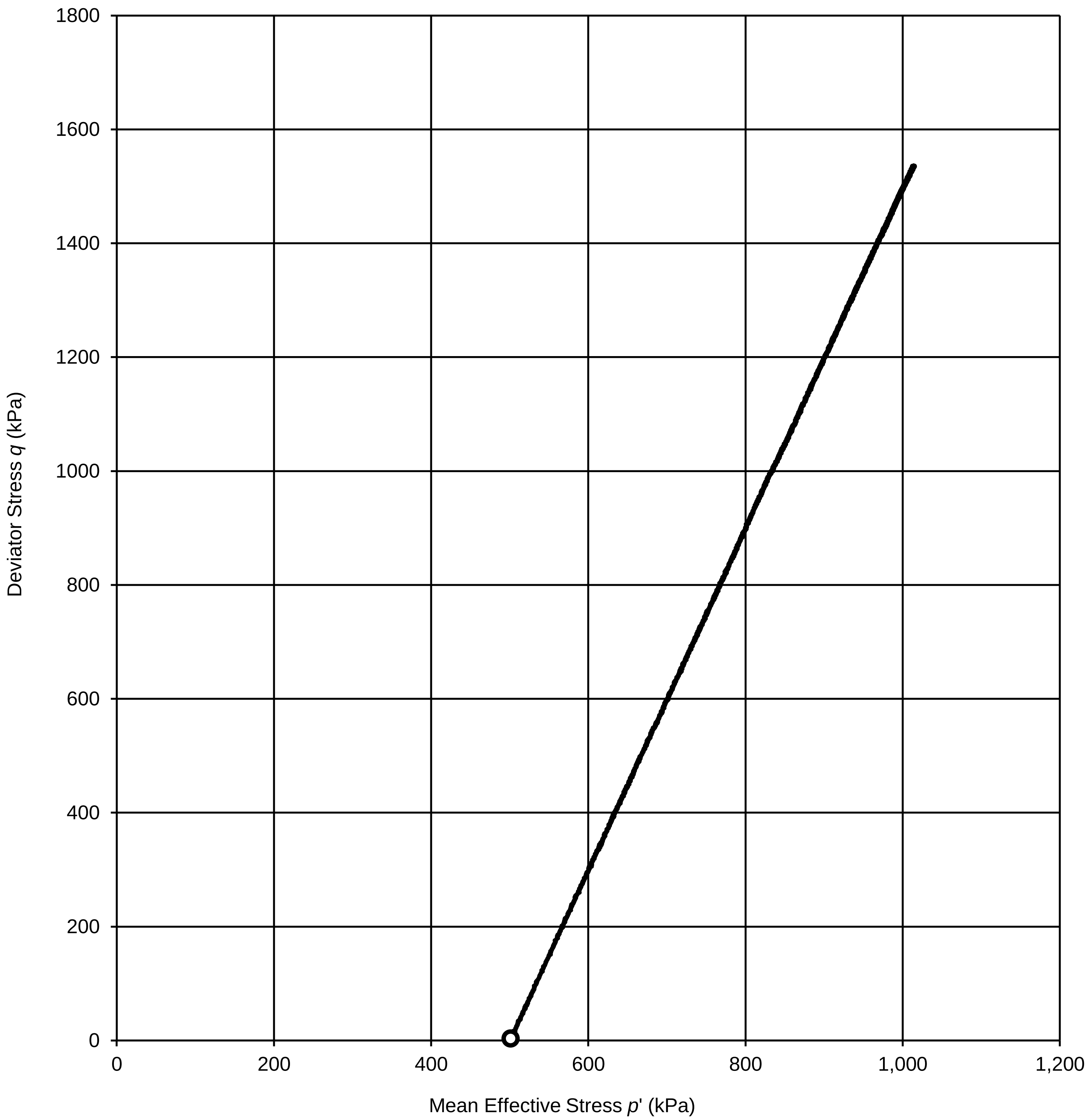
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-8 CID loose 500kPa

Initial Height (mm):	148.8	Final Liquor Content (%):	22.7%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	70.4	Final Dry Density (t/m^3):	1.65	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	501
Initial Dry Density (t/m^3):	1.26	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

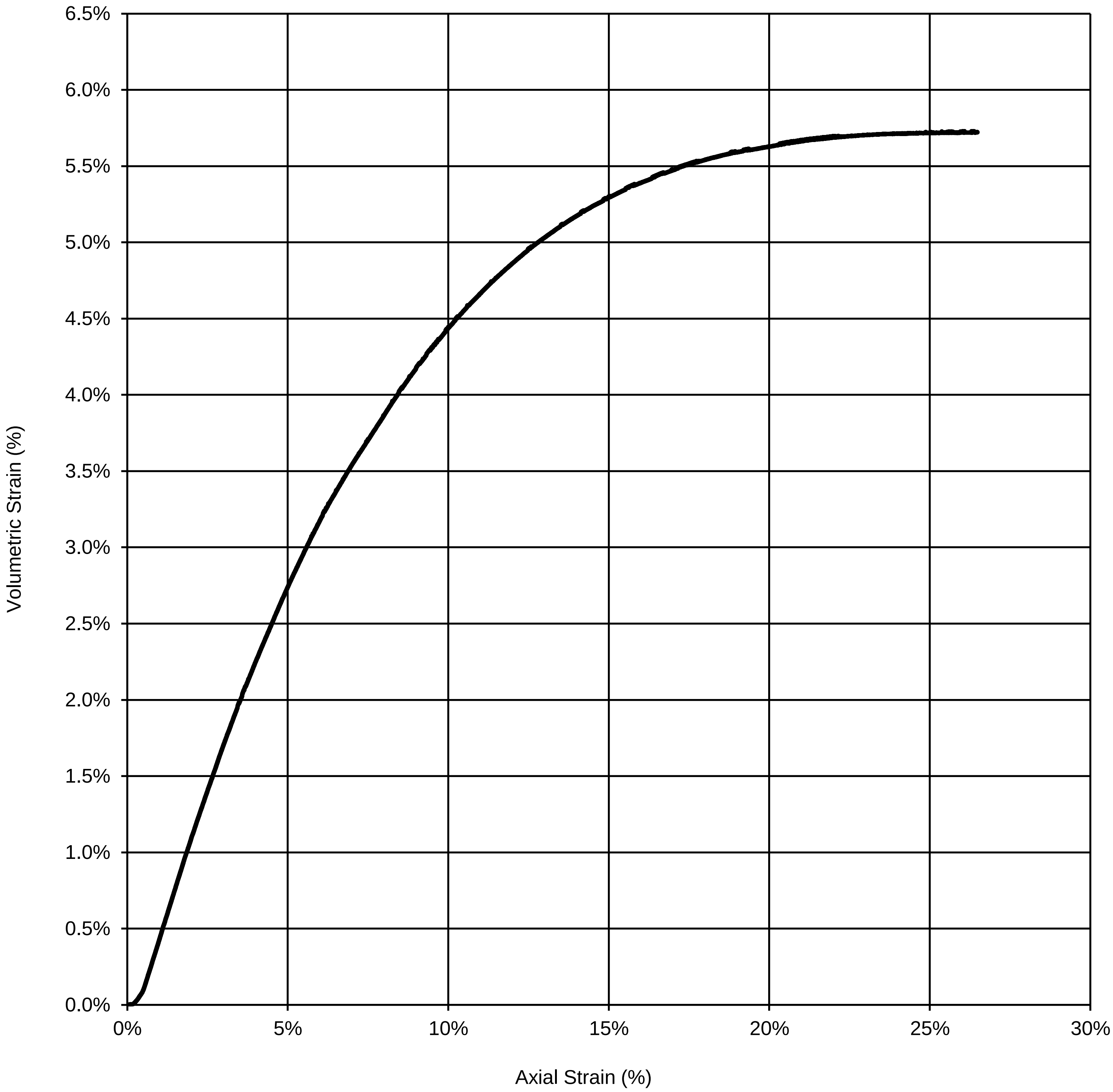
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-8 CID loose 500kPa

Initial Height (mm):	148.8	Final Liquor Content (%):	22.7%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	70.4	Final Dry Density (t/m^3):	1.65	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	501
Initial Dry Density (t/m^3):	1.26	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Triaxial Test Report

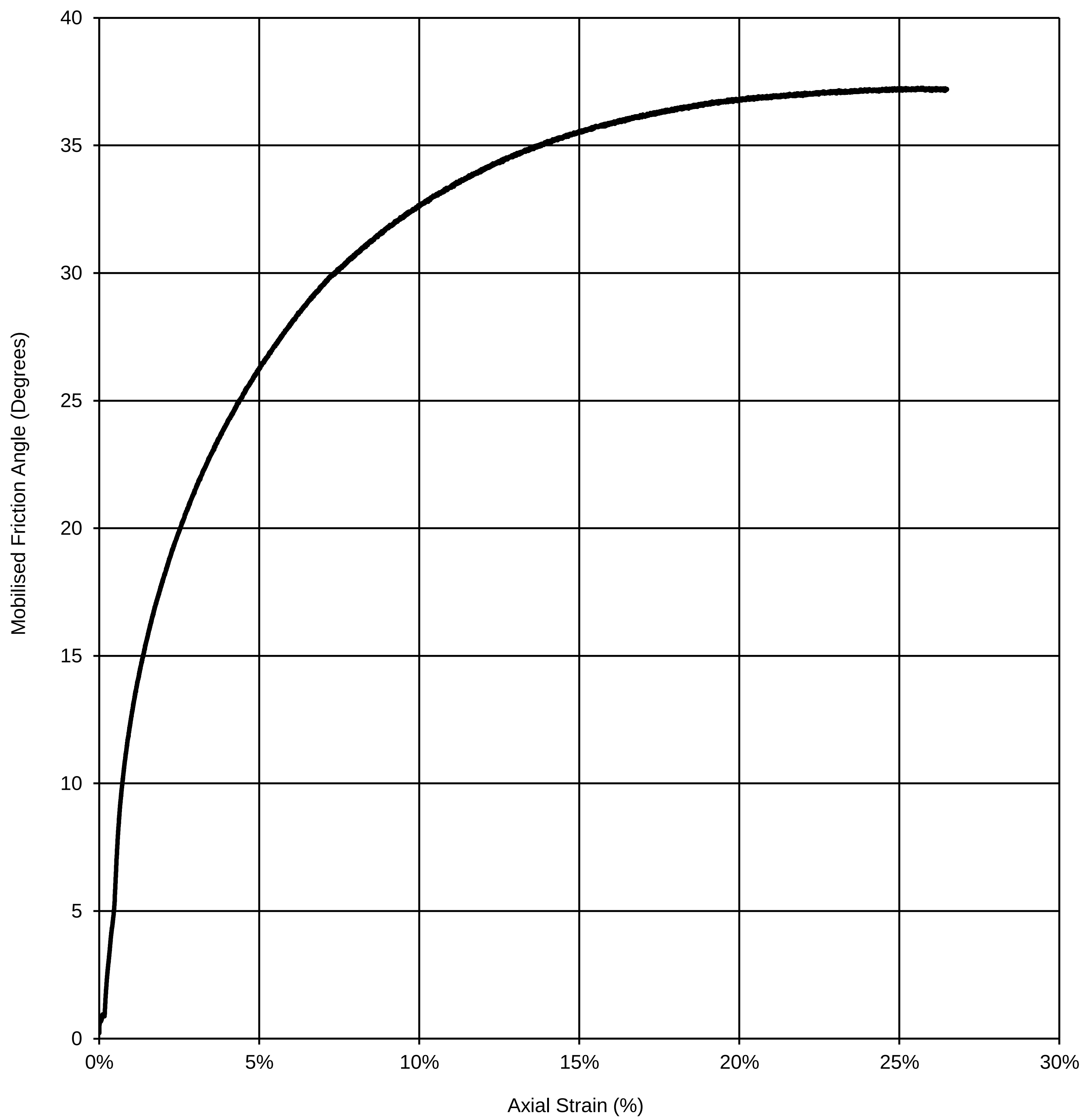
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	21/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA402 0m
Location:	Cadia Mine	**Test ID:**	18004 - sa-8 CID loose 500kPa

Initial Height (mm):	148.8	Final Liquor Content (%):	22.7%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	70.4	Final Dry Density (t/m^3):	1.65	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	501
Initial Dry Density (t/m^3):	1.26	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Annexure EG
TC 1 – CSL Test Certificates

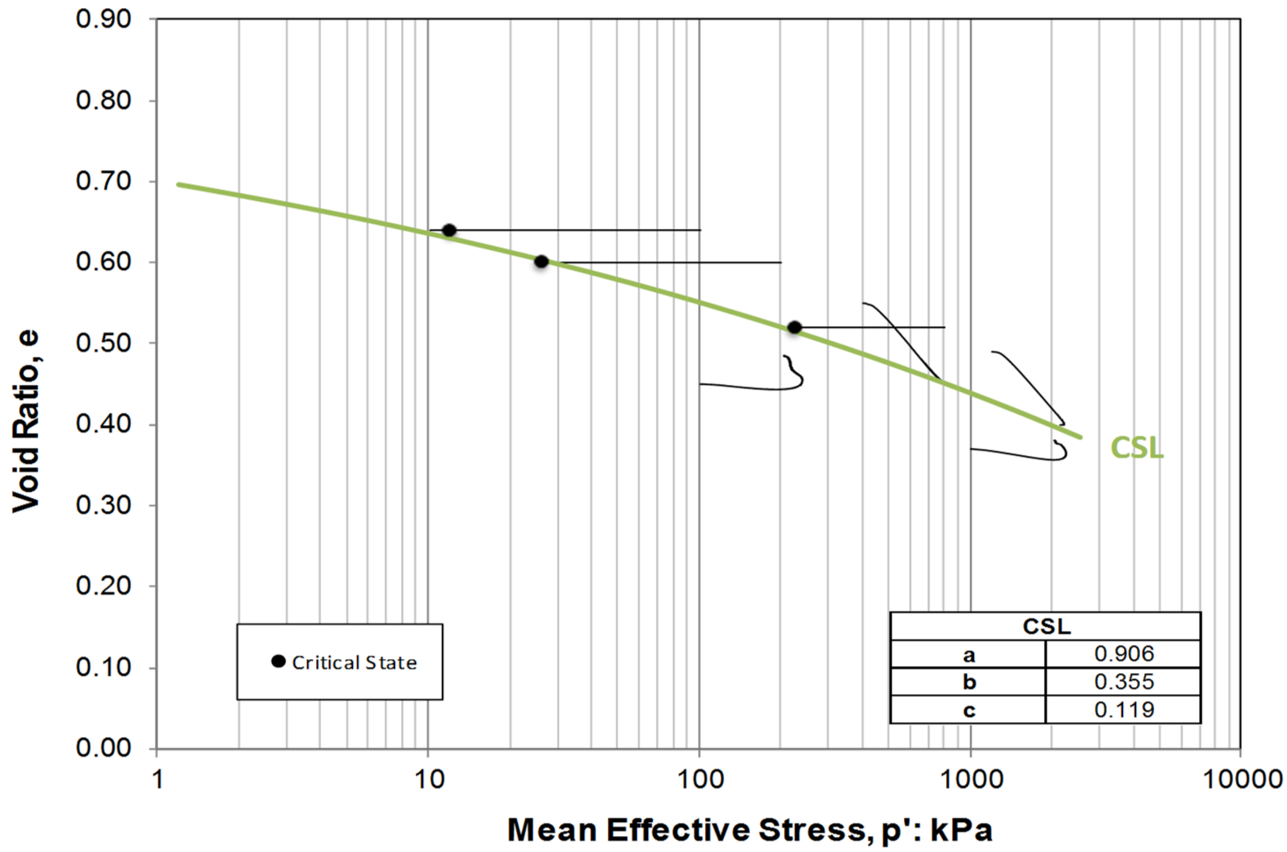
TC1

Golder (Perth) Testing

	As tested initial			At max dilation (=Dmin)		
Test ID	p0	e0	psi0	Dmin	eta_max	psi
si-4 CID 400 kPa	400.9	0.550	0.063	0.030	1.489	0.007
si-5 CID 1200 kPa	1201.9	0.490	0.062	0.000	1.373	0.000
si-6 CID 100 kPa	100.7	0.450	-0.100	-0.360	1.754	-0.047
si-7 CID 200 kPa	200.1	0.410	-0.110	-0.500	1.843	-0.042
si-8 CID 1000 kPa	1002.7	0.370	-0.069	-0.220	1.668	-0.033

	As tested initial			at critical state	
	p0	e0	psi0	pc	ec
si-1 CIU 100 kPa	101.1	0.640	0.100	12	0.640
si-2 CIU 200 kPa	200.6	0.600	0.092	26	0.600
si-3 CIU 800 kPa	800.2	0.520	0.075	224	0.520

Mtc	1.49
N	0.30
χ**tc**	8.0



Job number	H356804			NTSF Failure Review	Newcrest
Ref					NTSF
By	TMY	IAG	19-Mar-19	Tailings Critical State Properties Summary	
Revision	A		19-Mar-19		Figure 1

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-1 CIU very loose 100kPa

Initial Height (mm):	147.9	Final Liquor Content (%):	23.2%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.4	Final Dry Density (t/m^3):	1.67	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.64	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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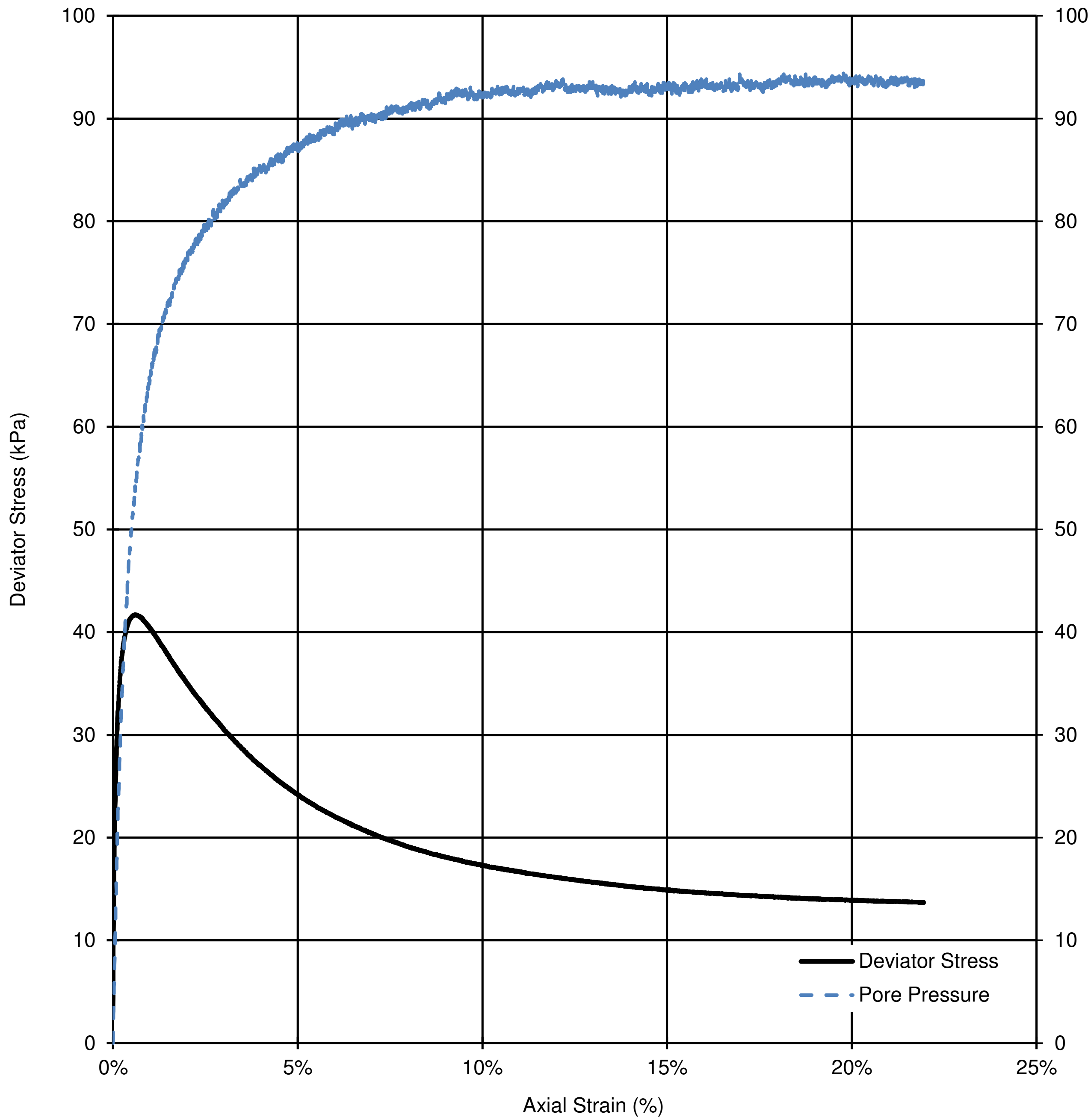
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-1 CIU very loose 100kPa

Initial Height (mm):	147.9	Final Liquor Content (%):	23.2%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.4	Final Dry Density (t/m^3):	1.67	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.64	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

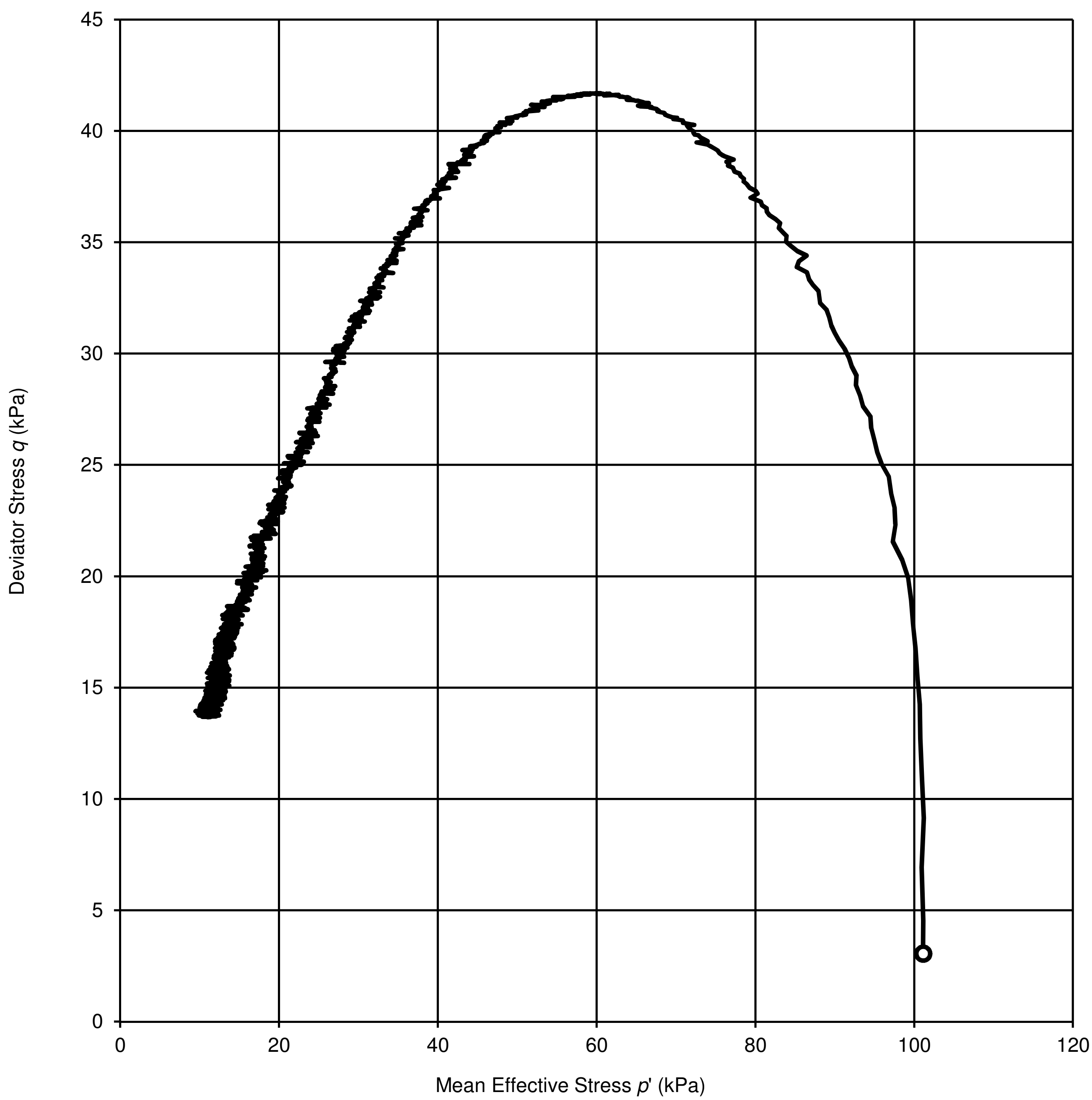
Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-1 CIU very loose 100kPa

Initial Height (mm):	147.9	Final Liquor Content (%):	23.2%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.4	Final Dry Density (t/m^3):	1.67	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.64	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



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		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-1 CIU very loose 100kPa

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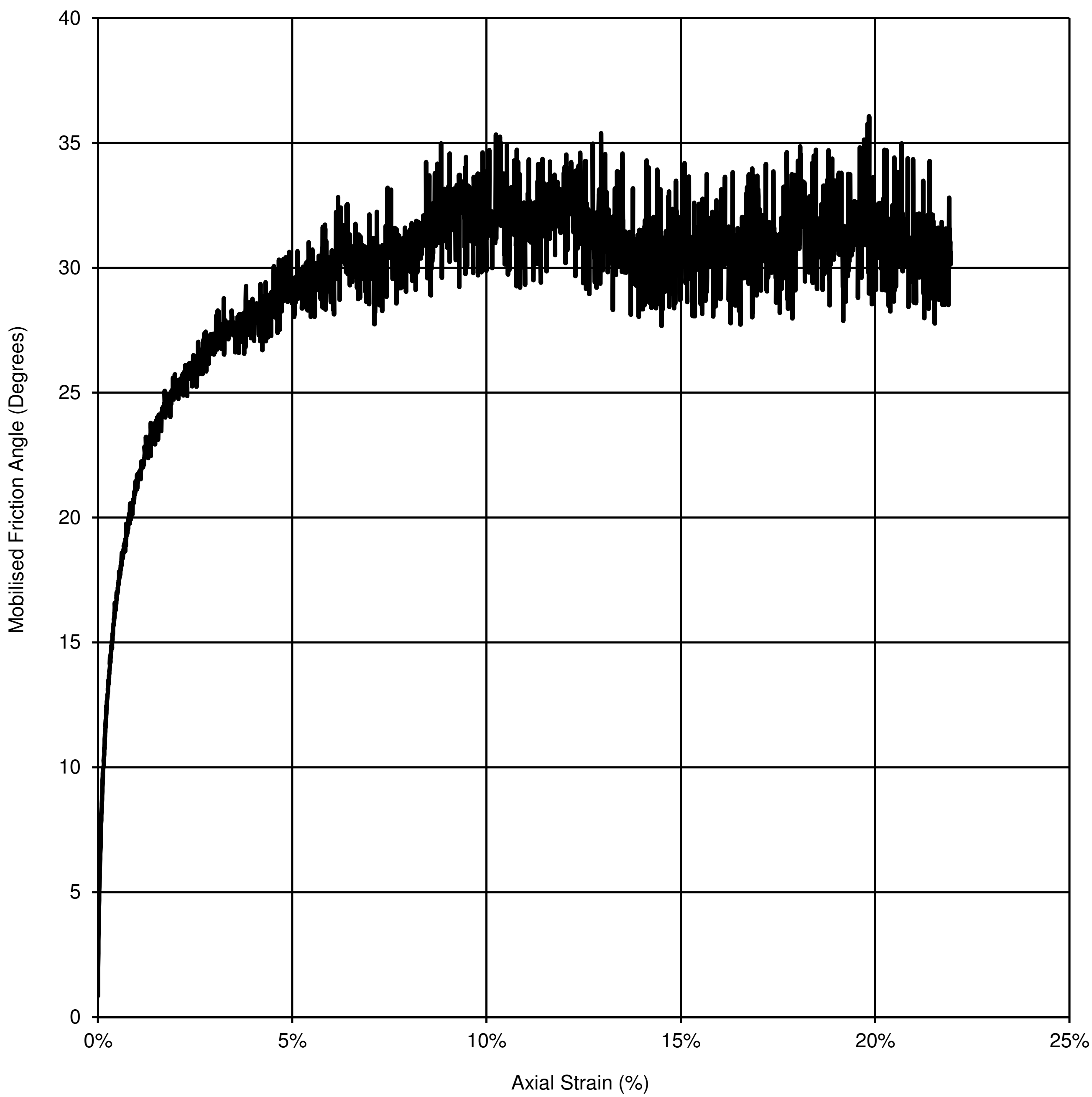
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.64	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

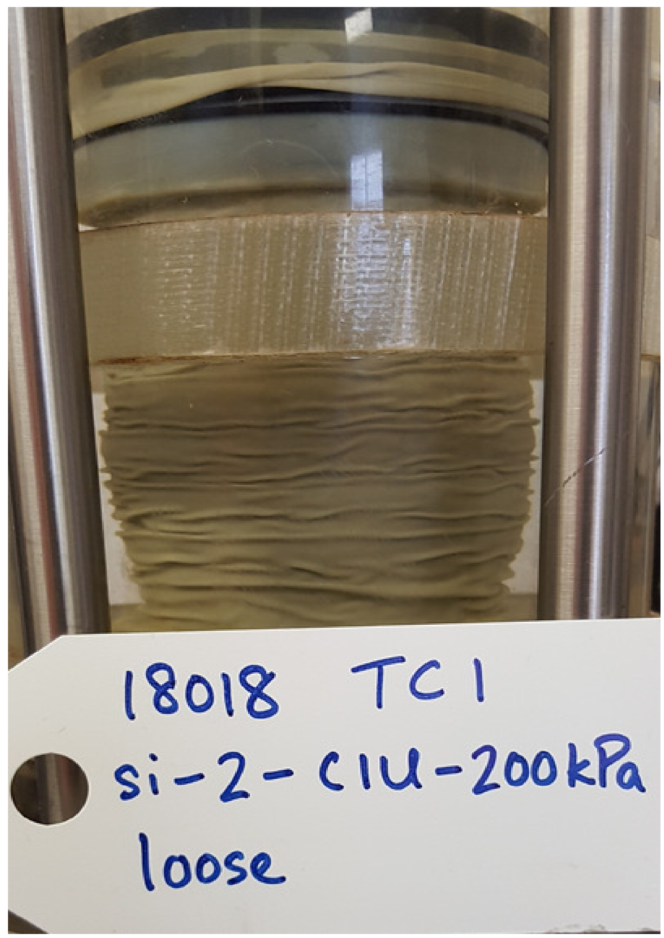
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-2 CIU loose 200kPa

Initial Height (mm):	147.5	Final Liquor Content (%):	22.0%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.71	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99

Sample Before Test



Sample After Test

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		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-2 CIU loose 200kPa

Initial Height (mm):	147.5	Final Liquor Content (%):	22.0%	Strain Rate (mm/min):	0.03
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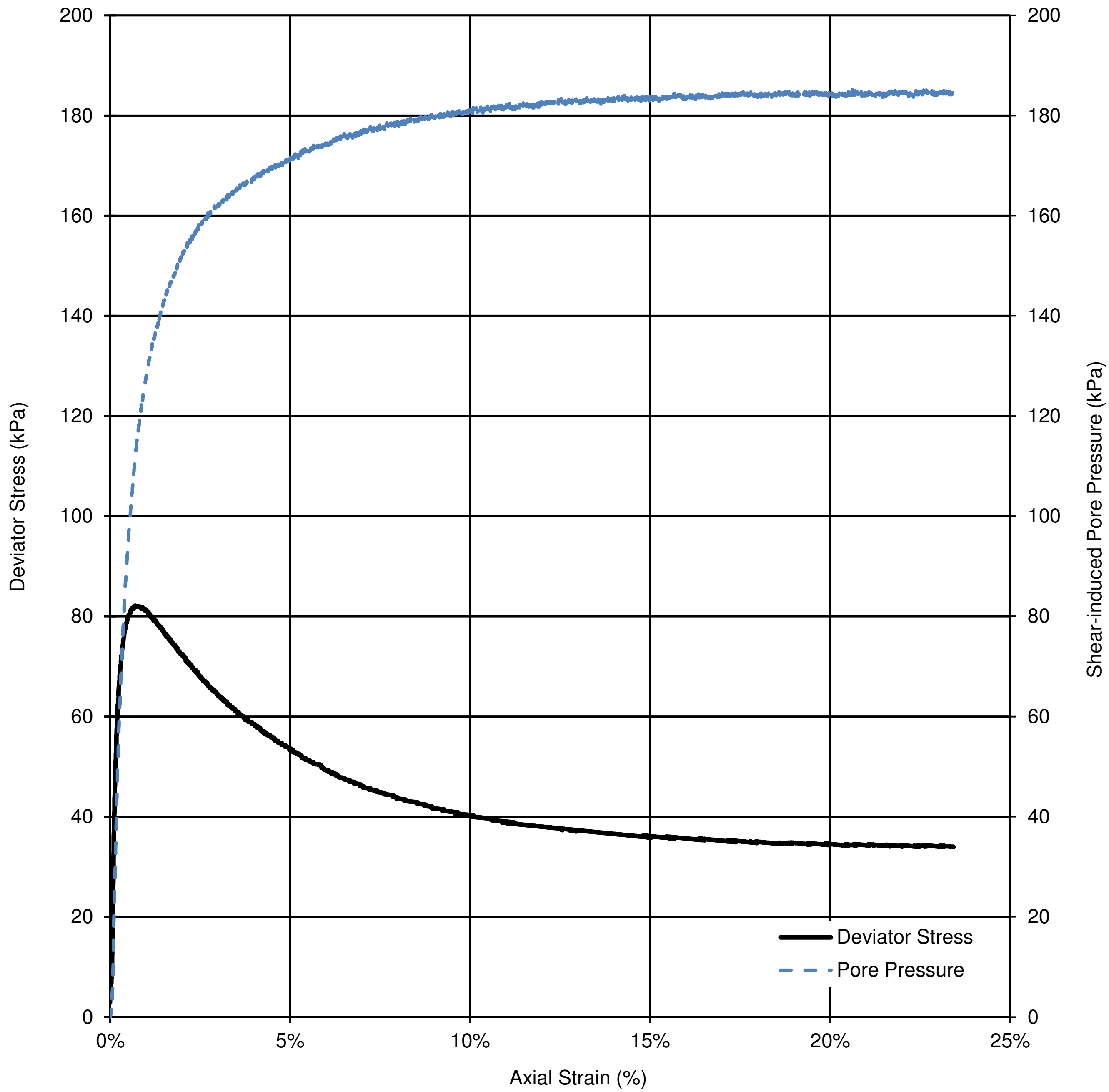
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

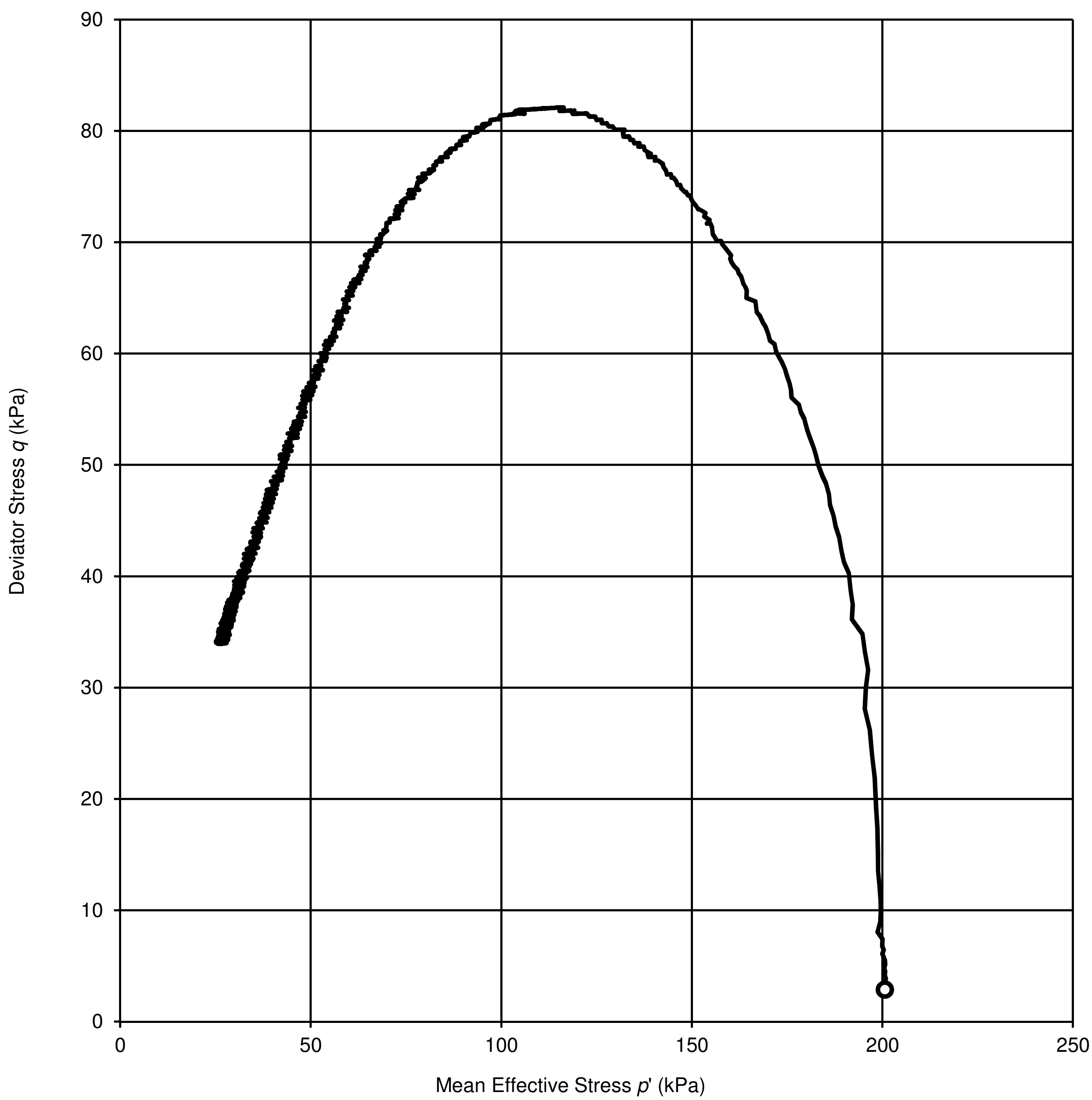
Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-2 CIU loose 200kPa

Initial Height (mm):	147.5	Final Liquor Content (%):	22.0%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.71	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



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		Reviewed by:	R. Fanni / D. Reid

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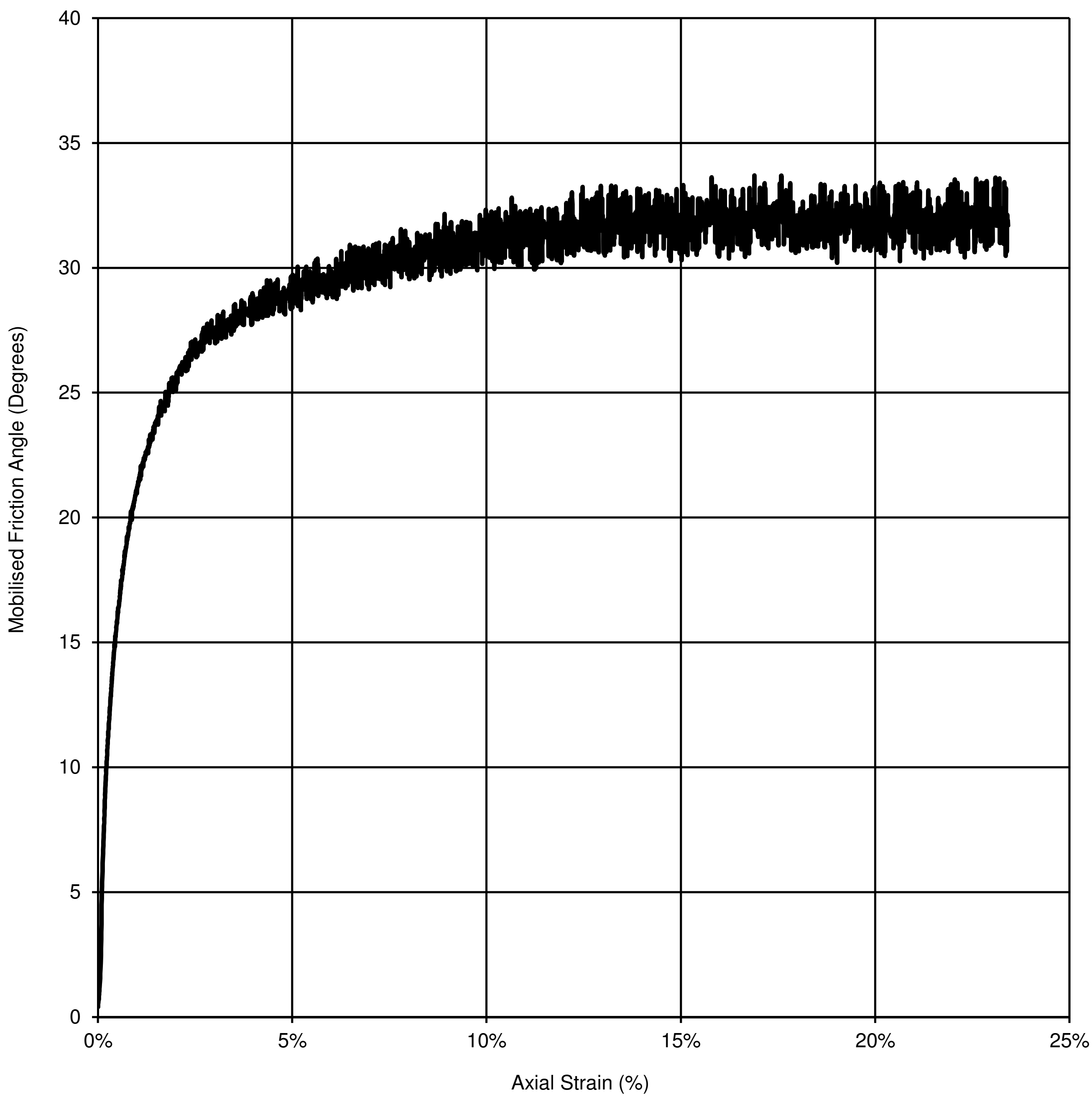
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-2 CIU loose 200kPa

Initial Height (mm):	147.5	Final Liquor Content (%):	22.0%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.71	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.60	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



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Triaxial Test Report

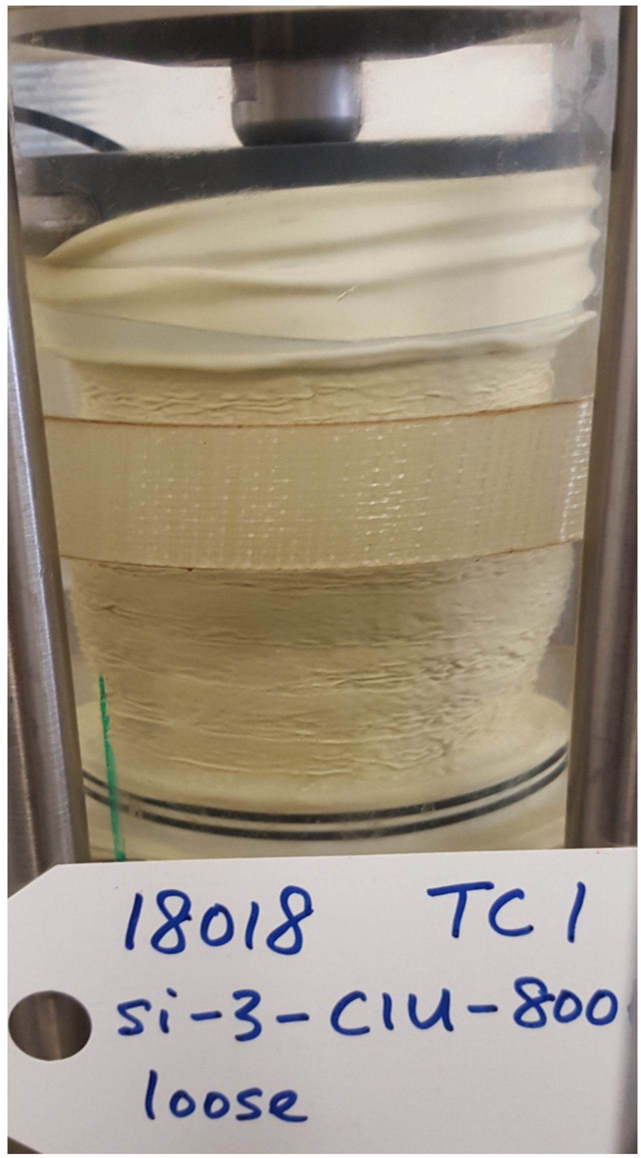
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	26/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-3 CIU loose 800kPa

Initial Height (mm):	148.5	Final Liquor Content (%):	19.0%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.4	Final Dry Density (t/m^3):	1.80	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	800
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

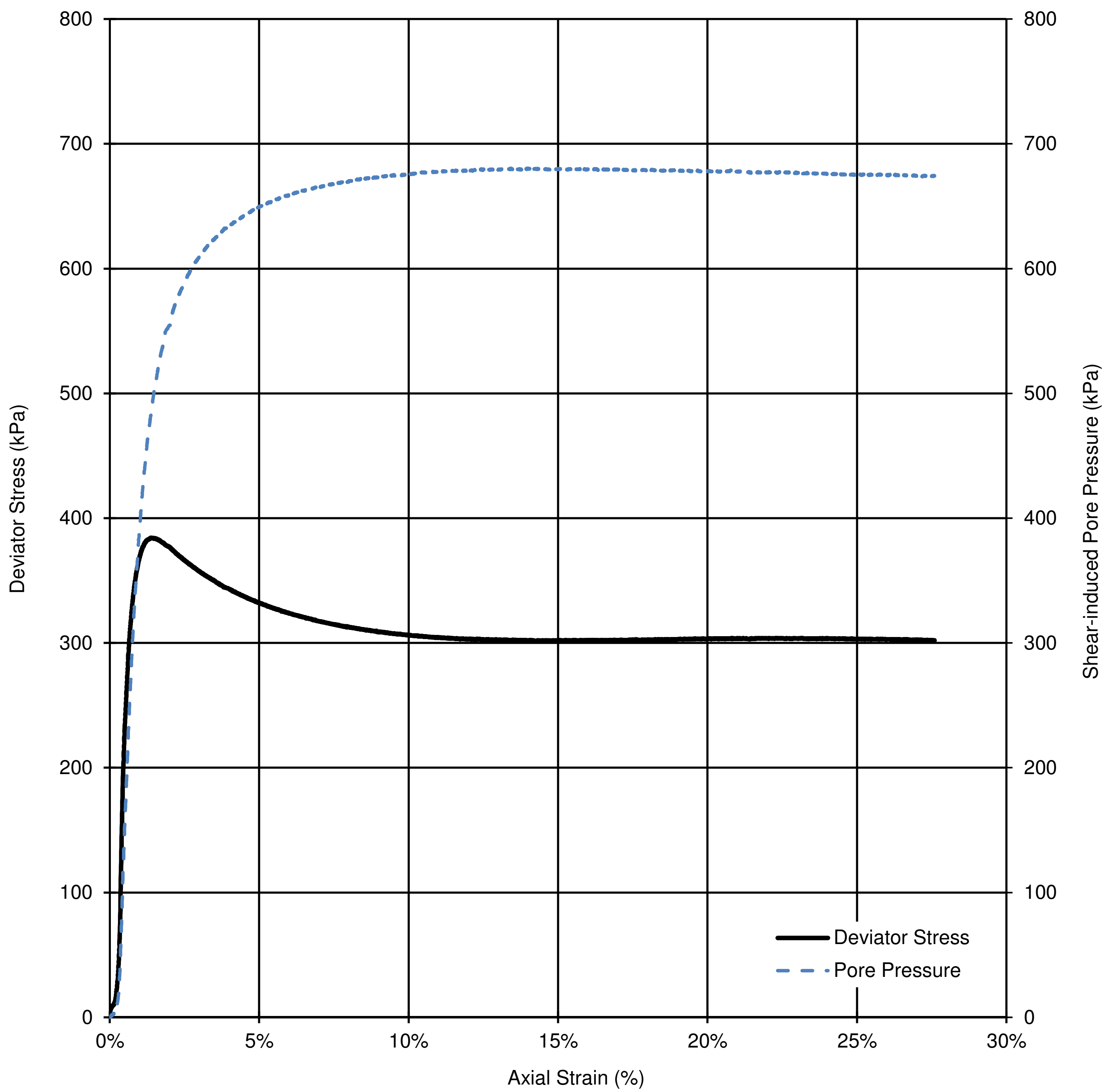
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	26/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-3 CIU loose 800kPa

Initial Height (mm):	148.5	Final Liquor Content (%):	19.0%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.4	Final Dry Density (t/m^3):	1.80	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	800
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

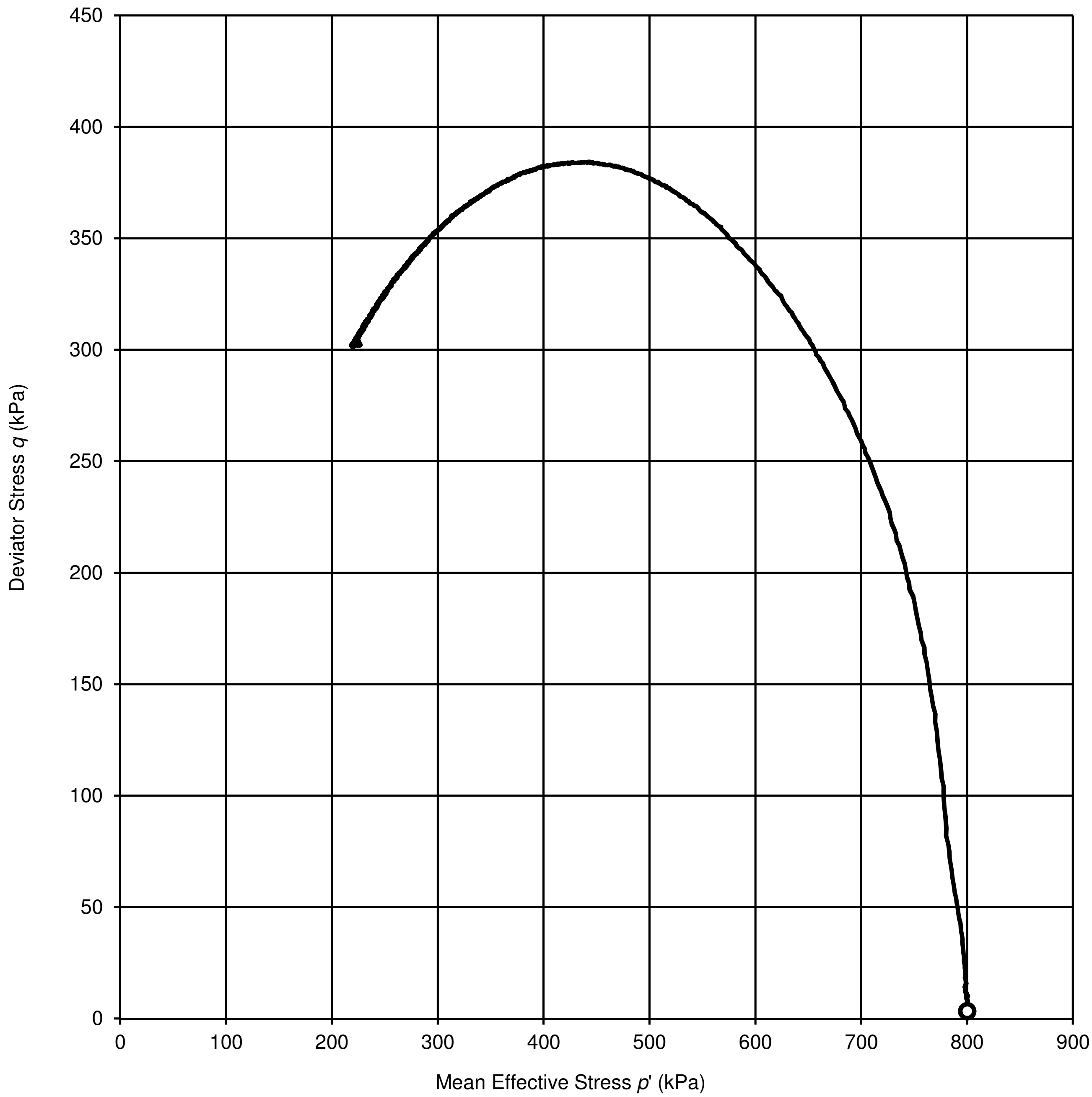
Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	26/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-3 CIU loose 800kPa

Initial Height (mm):	148.5	Final Liquor Content (%):	19.0%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.4	Final Dry Density (t/m^3):	1.80	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	800
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

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Location:	Cadia Mine	**Test ID:**	18018 - si-3 CIU loose 800kPa

Initial Height (mm):	148.5	Final Liquor Content (%):	19.0%	Strain Rate (mm/min):	0.03
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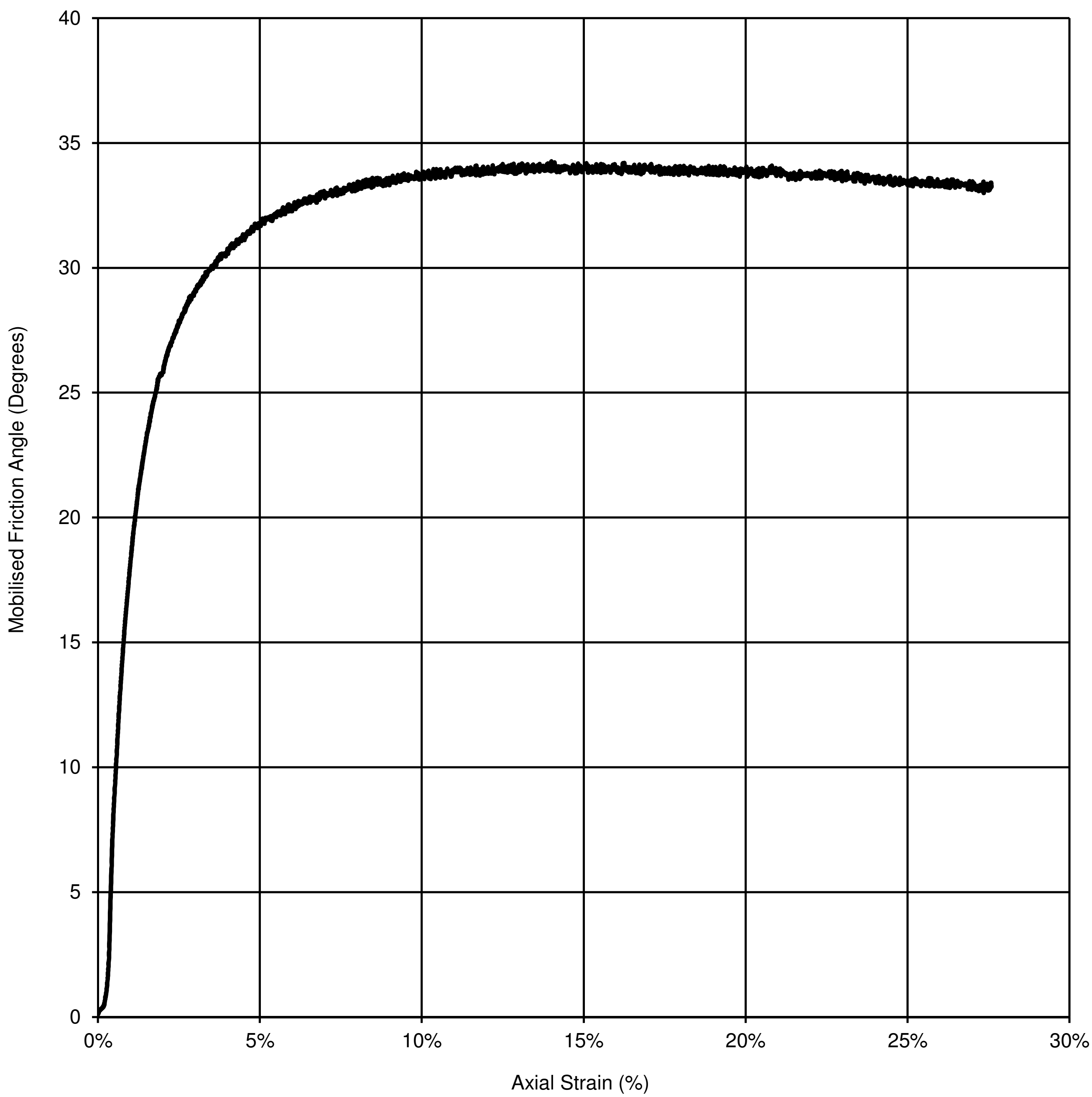
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	800
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

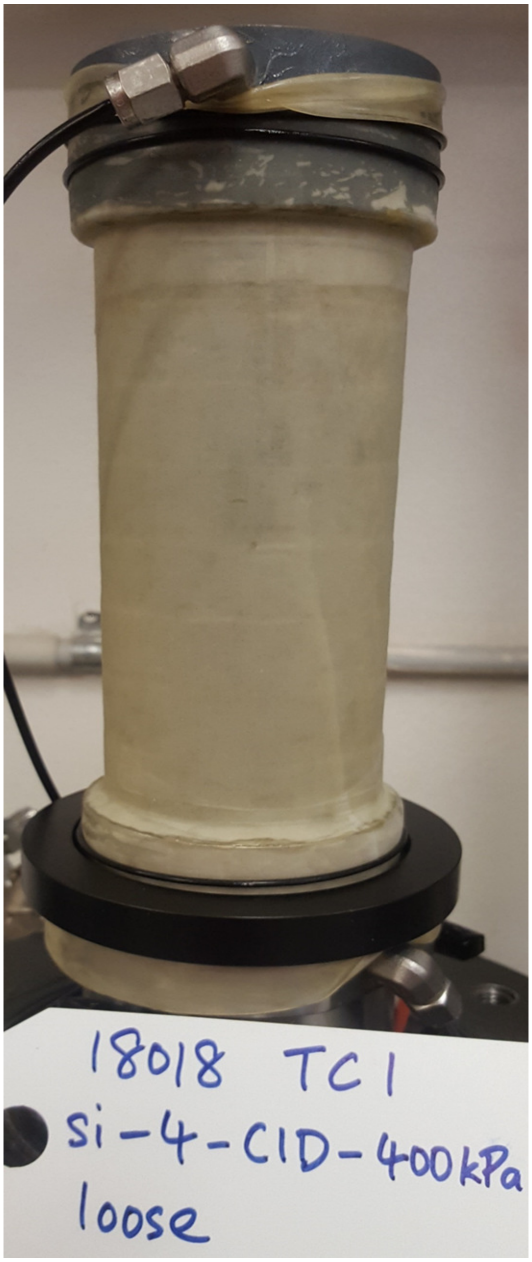
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-4 CID loose 400kPa

Initial Height (mm):	147.9	Final Liquor Content (%):	16.6%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	68.7	Final Dry Density (t/m^3):	1.89	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.45	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Sample Before Test

Sample After Test

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		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

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Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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Location:	Cadia Mine	**Test ID:**	18018 - si-4 CID loose 400kPa

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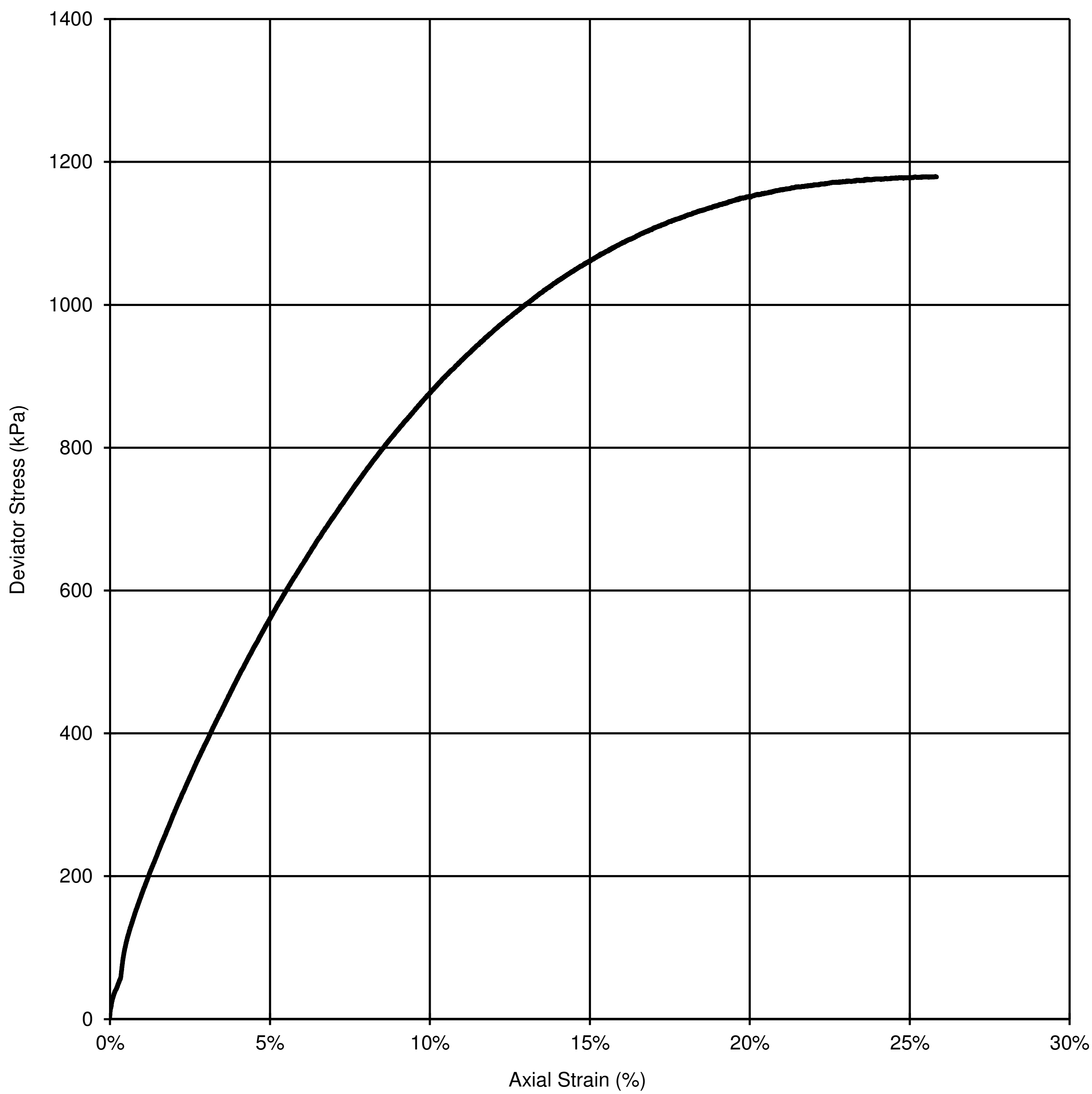
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



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		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

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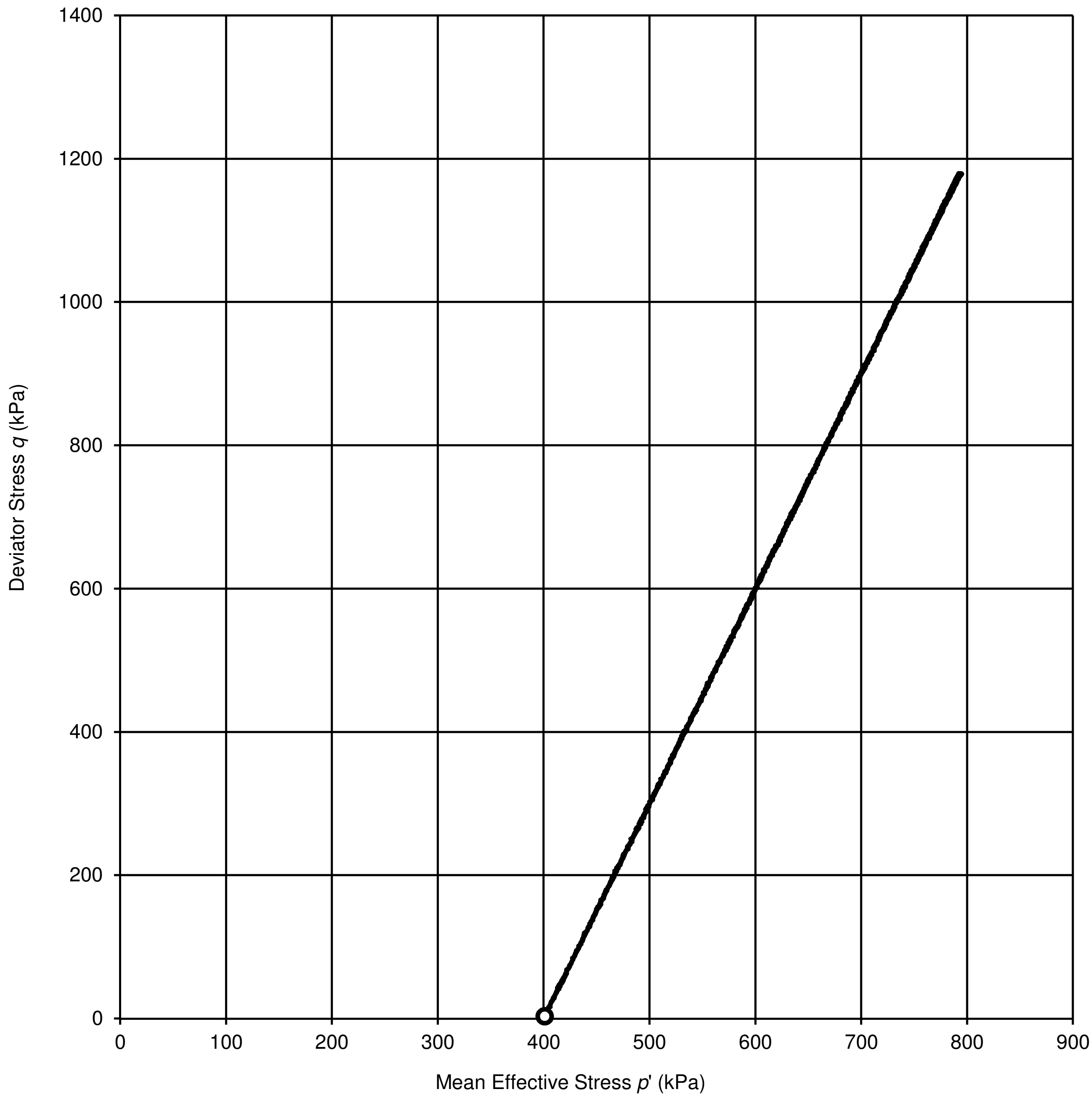
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.45	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



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		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

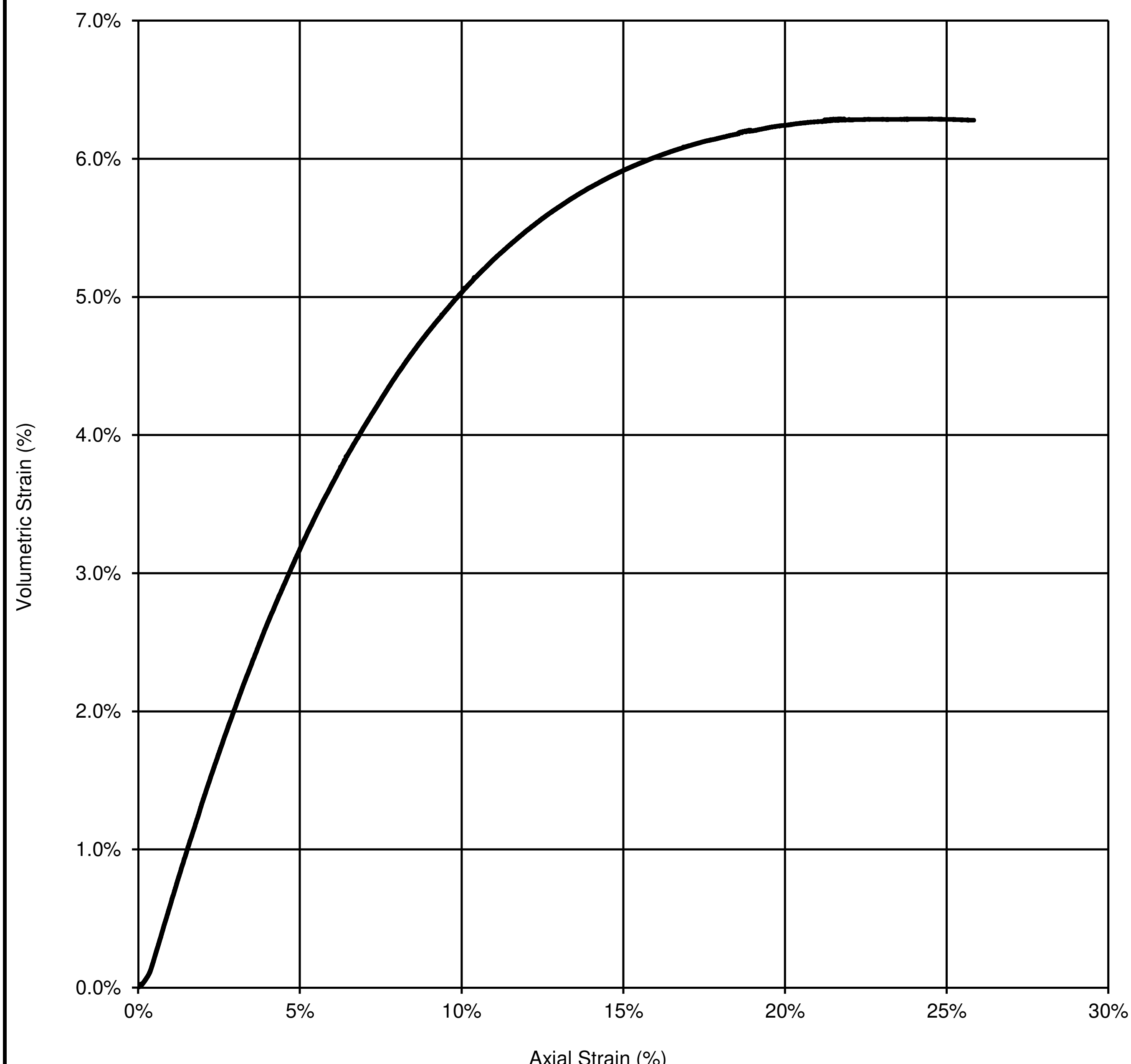
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-4 CID loose 400kPa

Initial Height (mm):	147.9	Final Liquor Content (%):	16.6%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	68.7	Final Dry Density (t/m^3):	1.89	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.45	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

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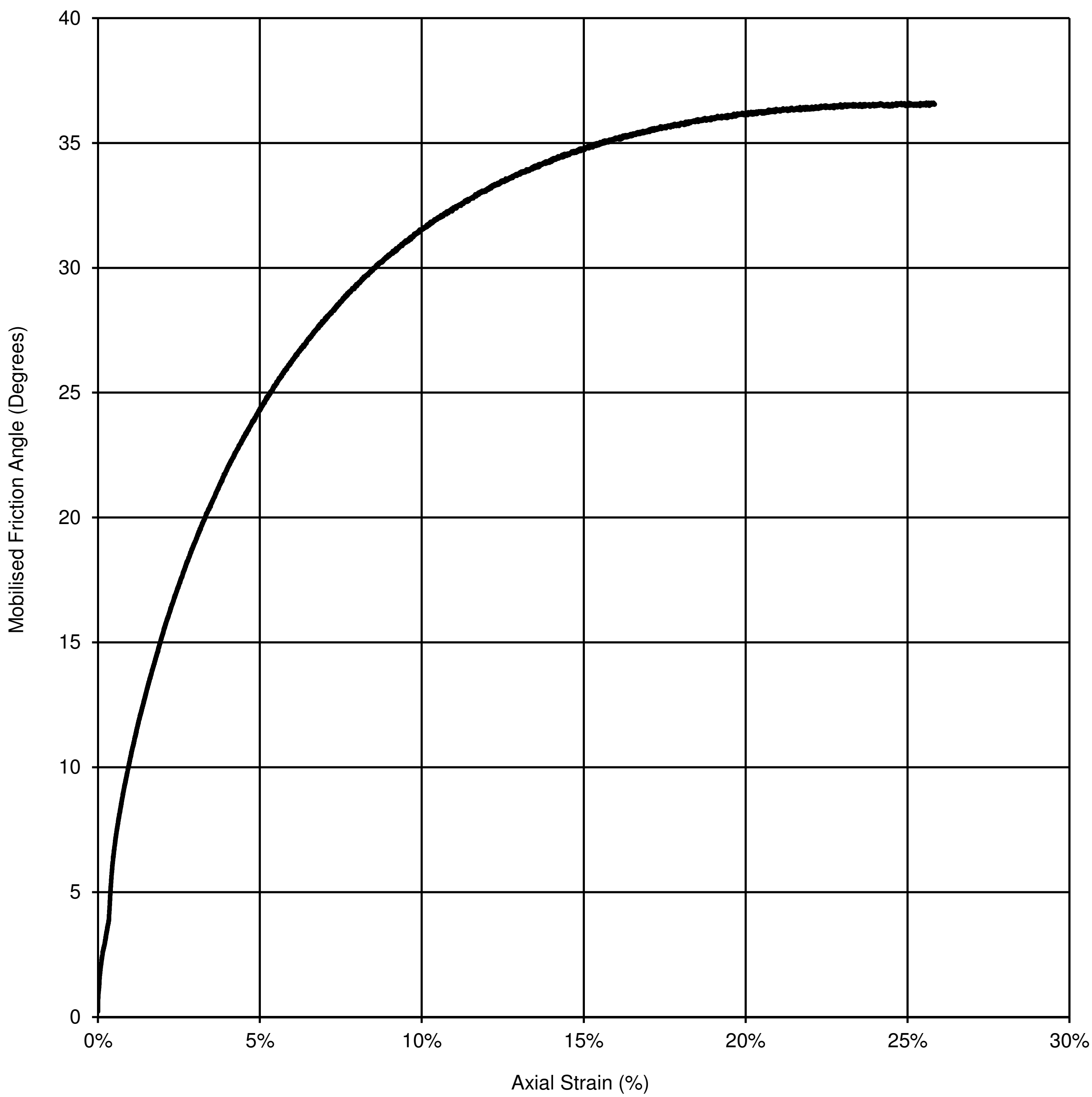
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-4 CID loose 400kPa

Initial Height (mm):	147.9	Final Liquor Content (%):	16.6%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	68.7	Final Dry Density (t/m^3):	1.89	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.45	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



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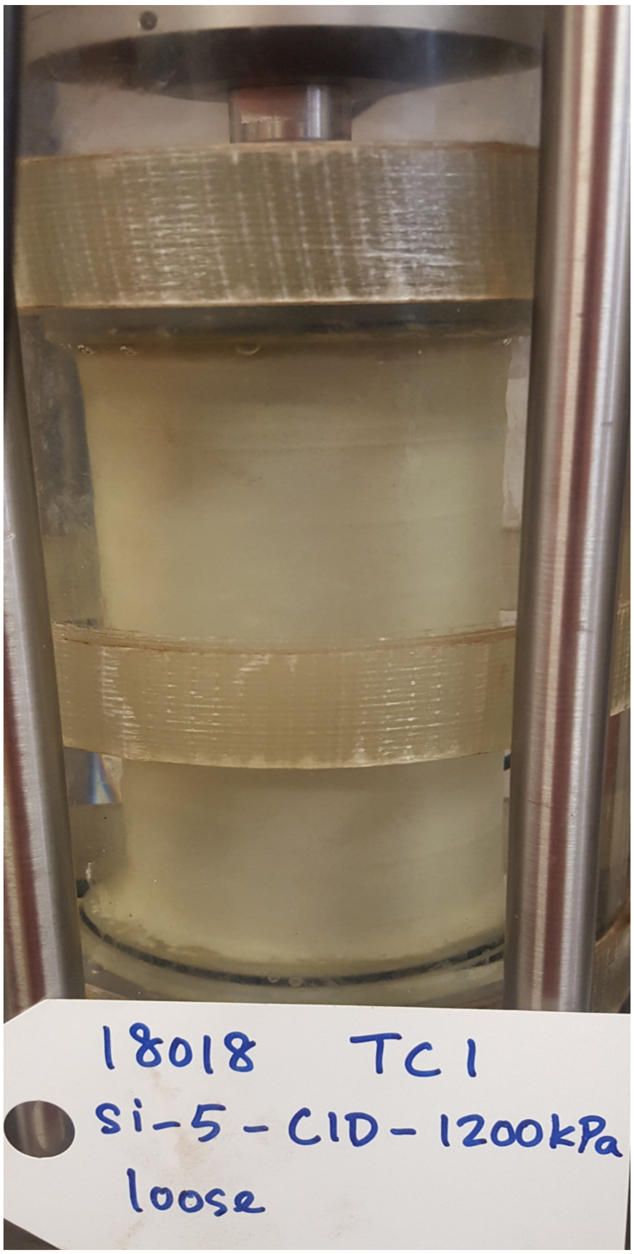
Triaxial Test Report

Isotropically Consolidated Drained (CID)

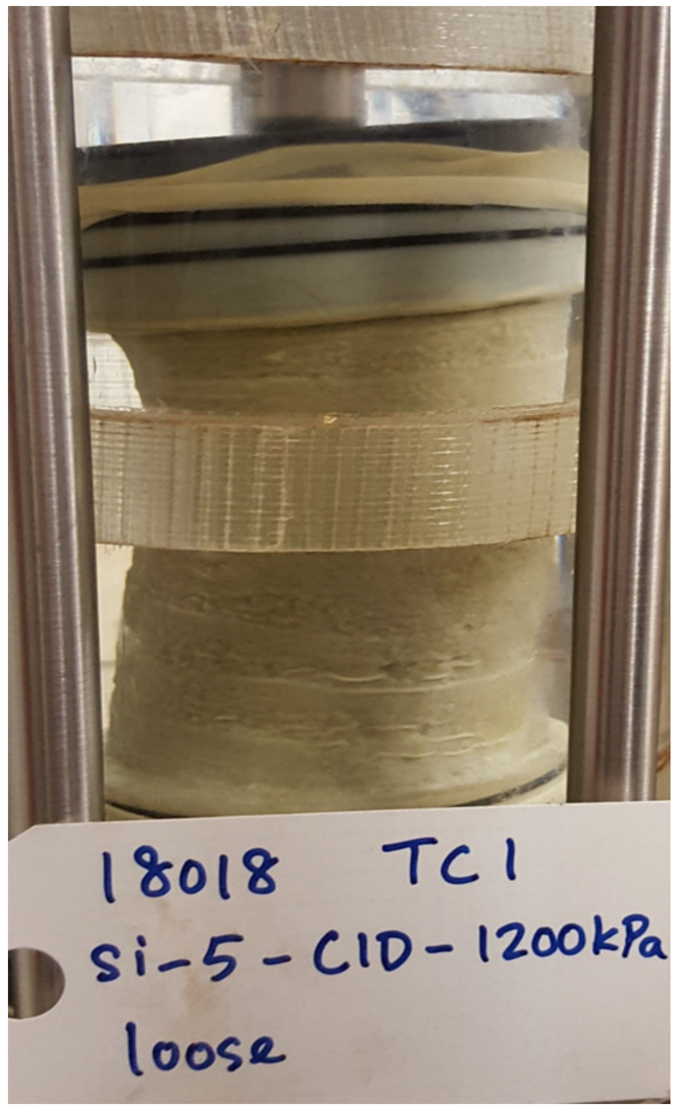
GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-5 CID loose 1200kPa

Initial Height (mm):	148.1	Final Liquor Content (%):	14.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.96	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.40	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

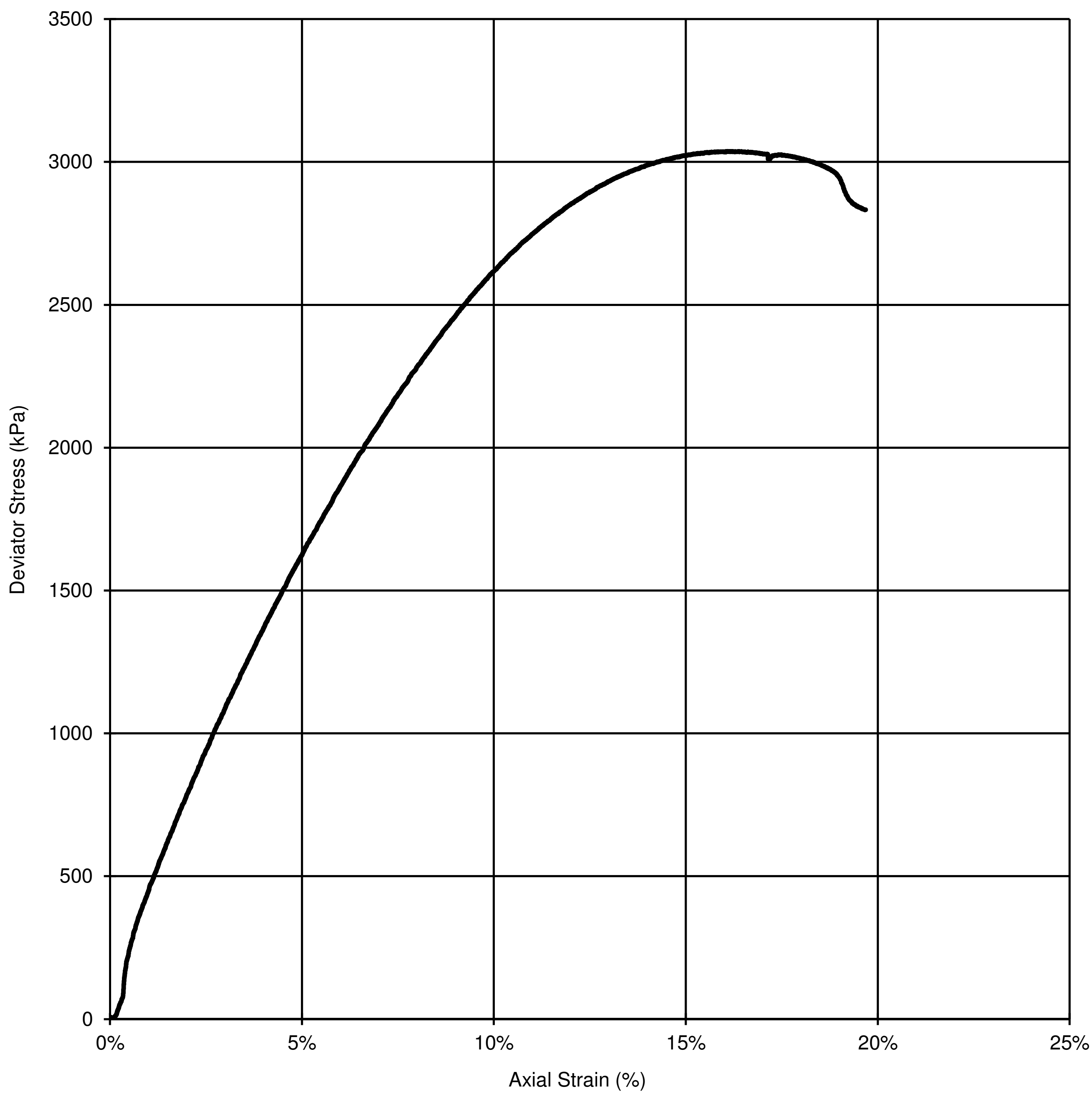
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-5 CID loose 1200kPa

Initial Height (mm):	148.1	Final Liquor Content (%):	14.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.96	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.40	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

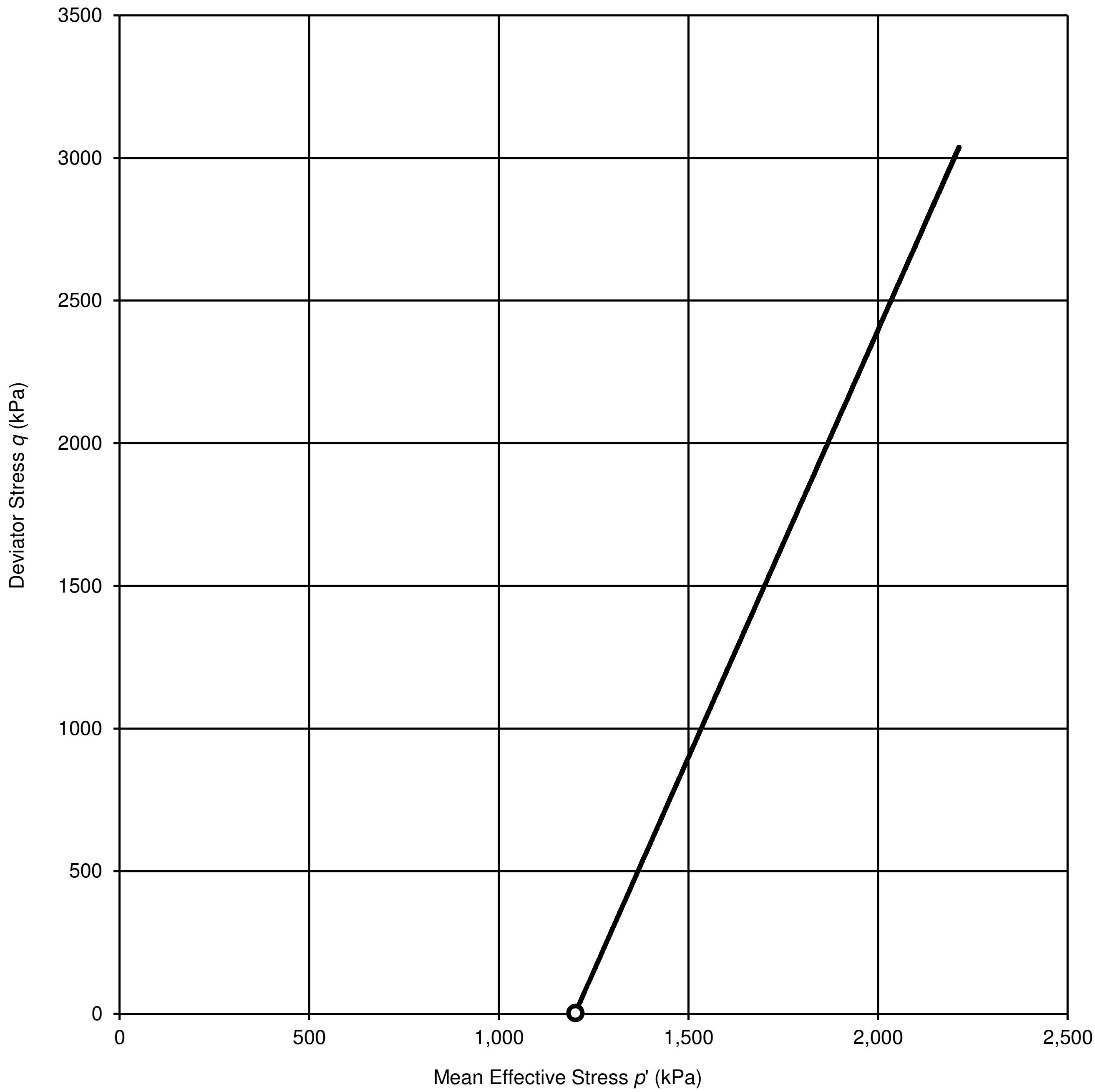
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-5 CID loose 1200kPa

Initial Height (mm):	148.1	Final Liquor Content (%):	14.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.96	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.40	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

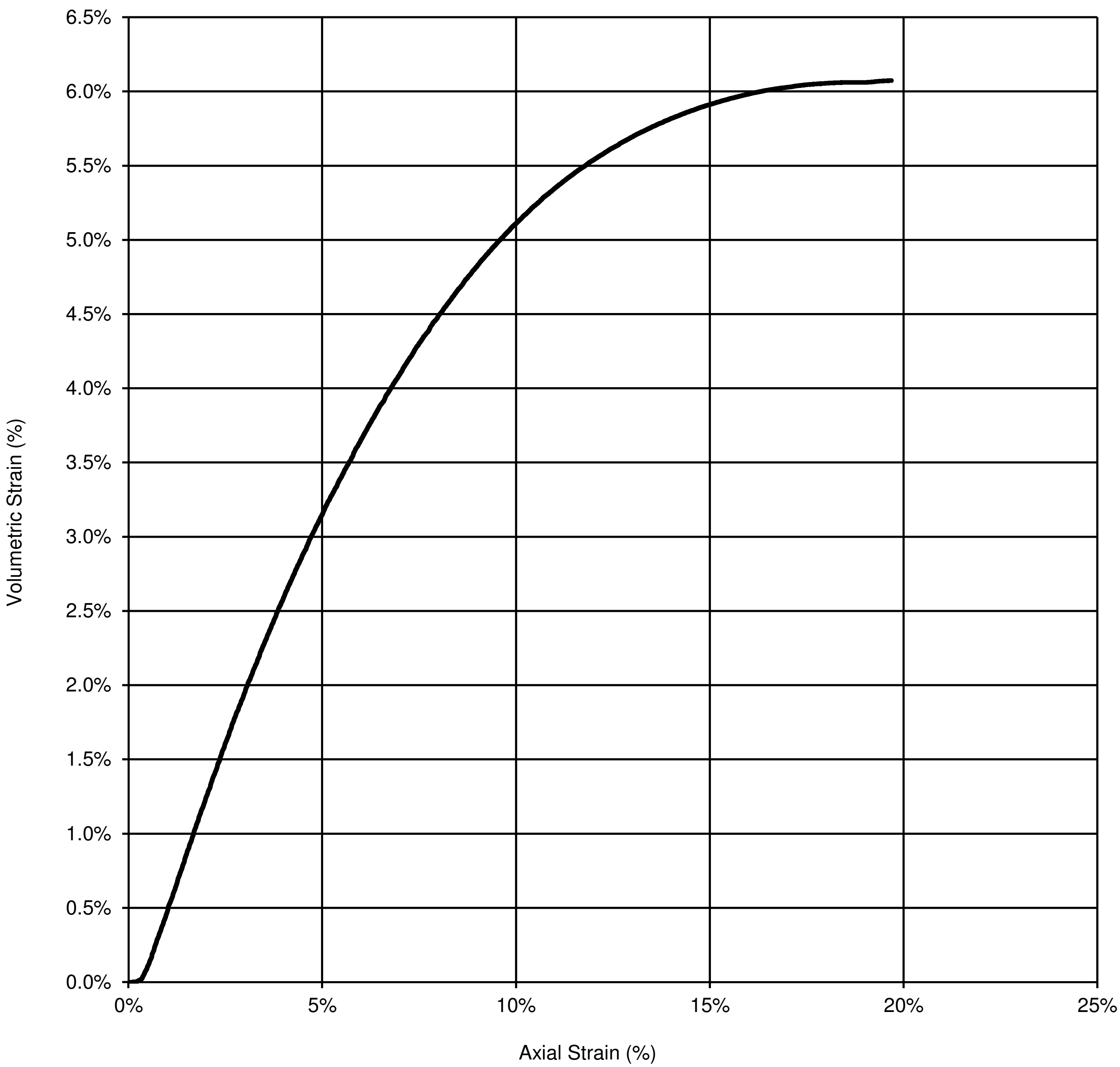
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-5 CID loose 1200kPa

Initial Height (mm):	148.1	Final Liquor Content (%):	14.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.96	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.40	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-5 CID loose 1200kPa

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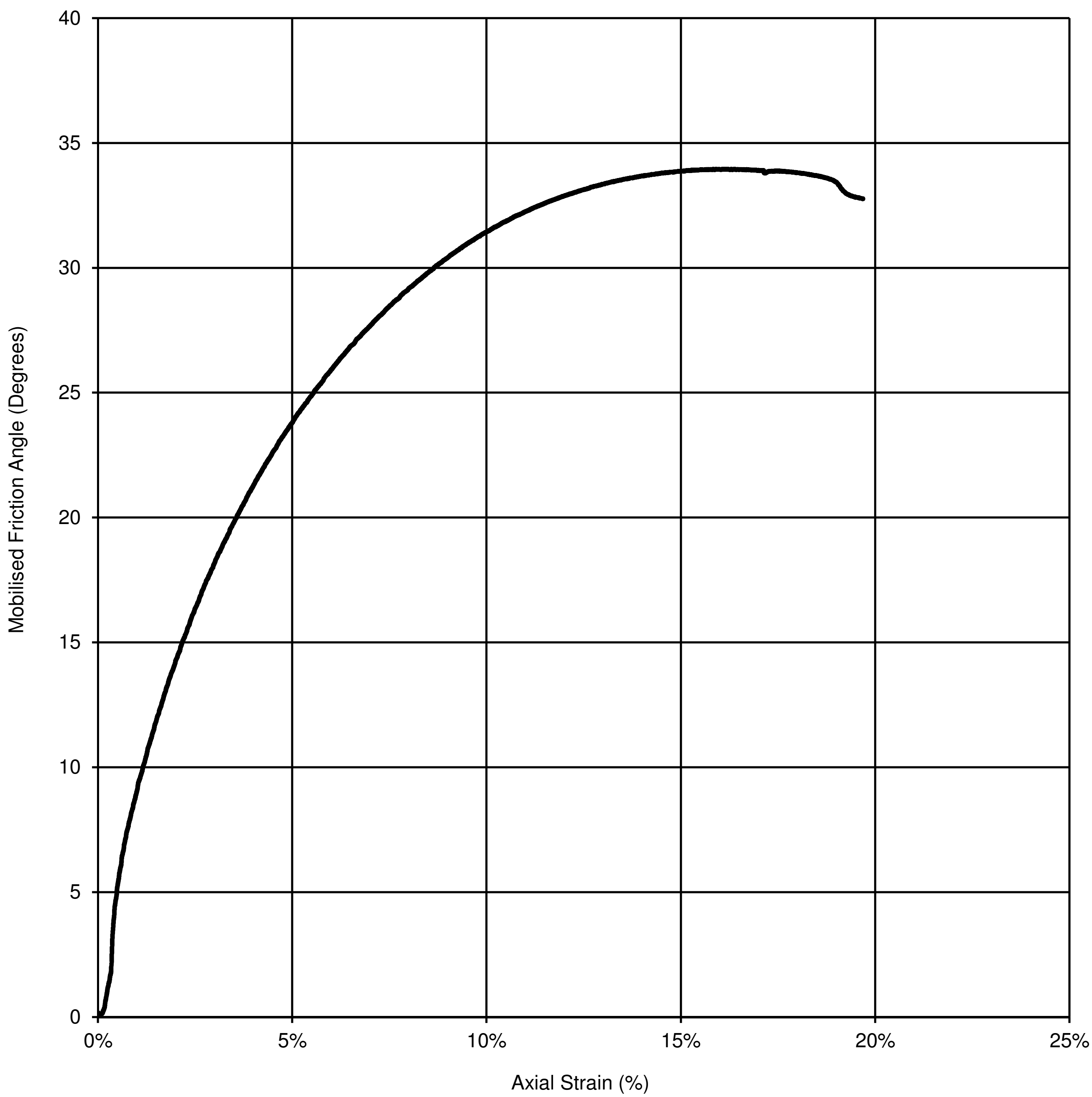
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.96	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.40	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.23	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

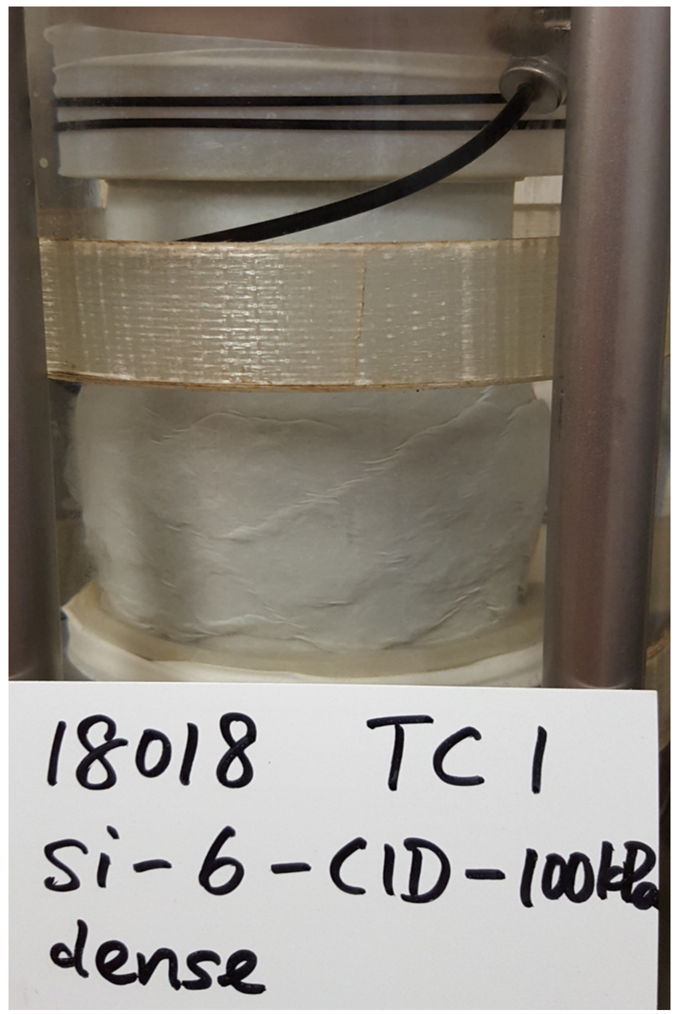
Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-6 CID dense 100kPa

Initial Height (mm):	127.5	Final Liquor Content (%):	17.8%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.84	B Response (%):	98%
Trimmings GWC (%):	14.4%	Final Void Ratio (-):	0.49	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.85	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97

Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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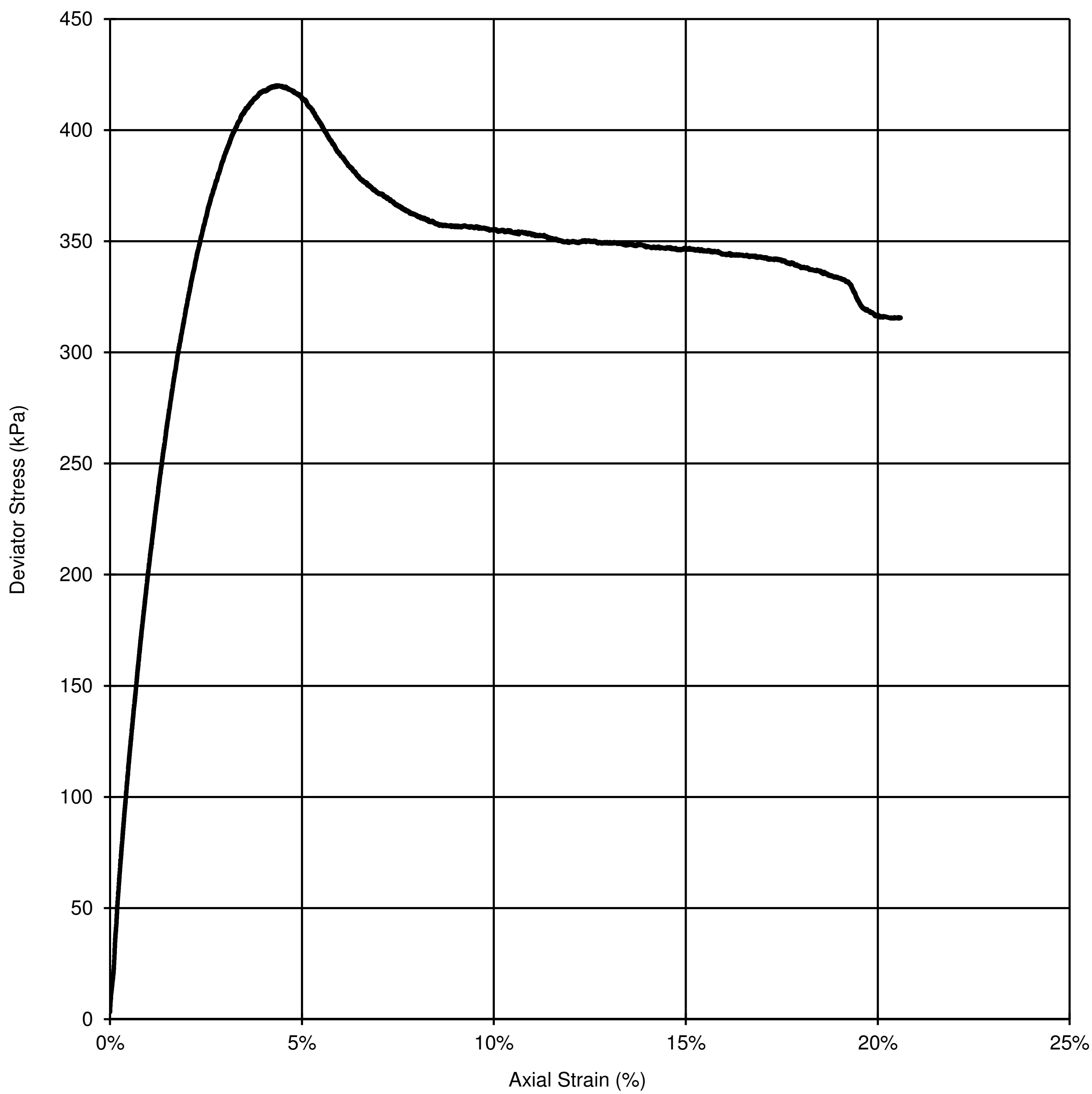
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-6 CID dense 100kPa

Initial Height (mm):	127.5	Final Liquor Content (%):	17.8%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.8	Final Dry Density (t/m^3):	1.84	B Response (%):	98%
Trimmings GWC (%):	14.4%	Final Void Ratio (-):	0.49	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.85	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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Location:	Cadia Mine	**Test ID:**	18018 - si-6 CID dense 100kPa

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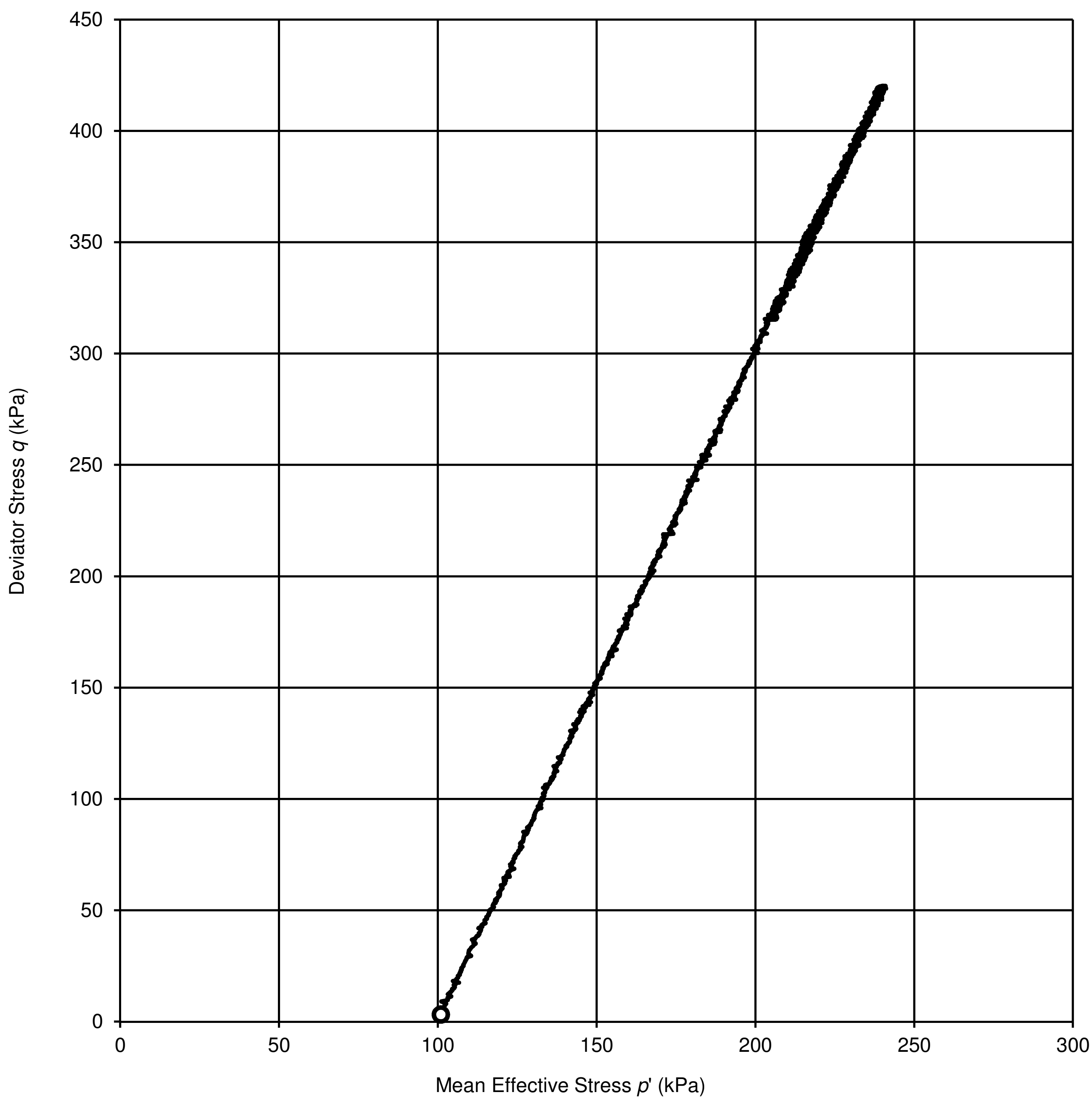
Initial Dry Density (t/m^3):	1.85	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-6 CID dense 100kPa

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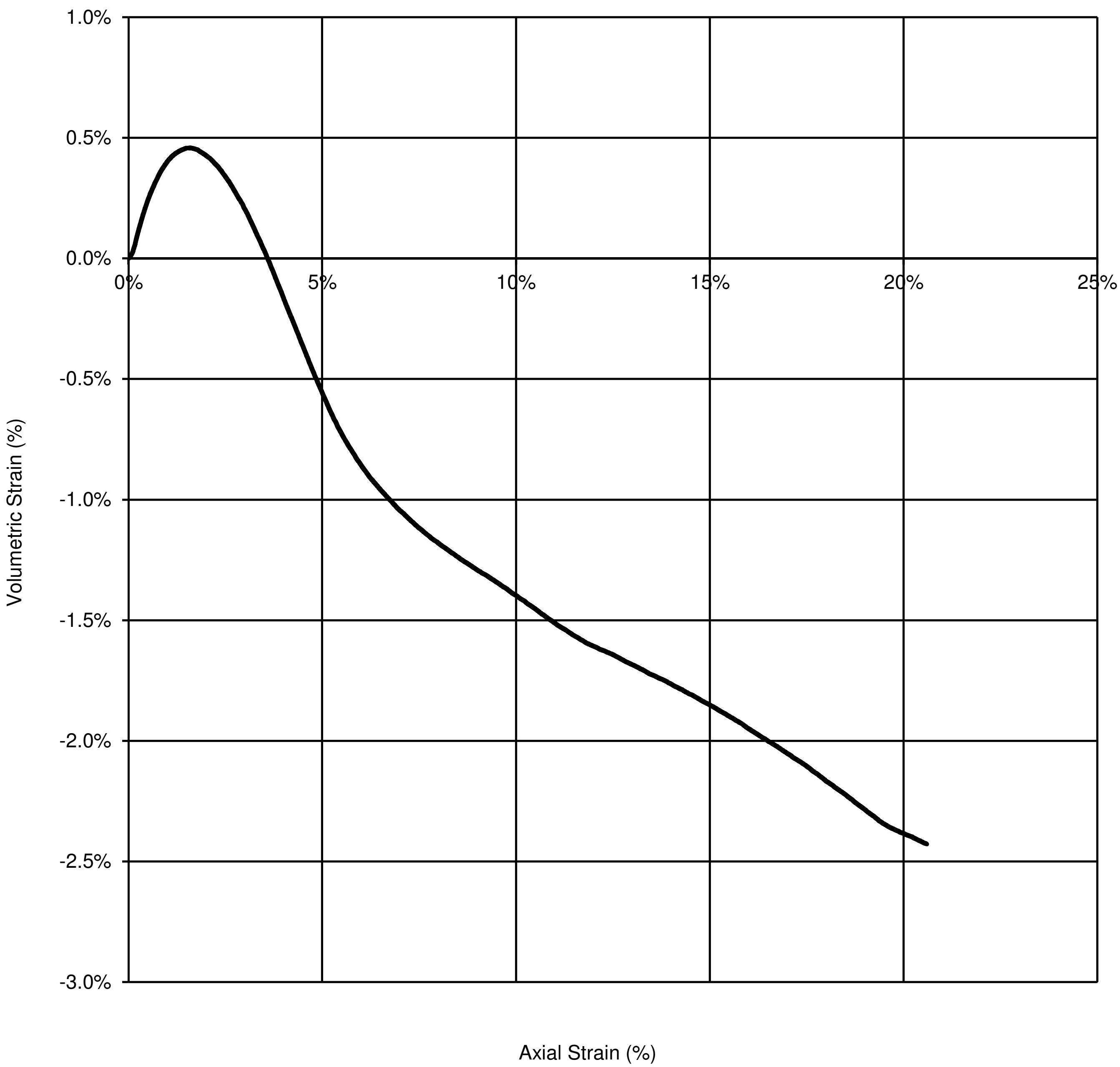

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-6 CID dense 100kPa

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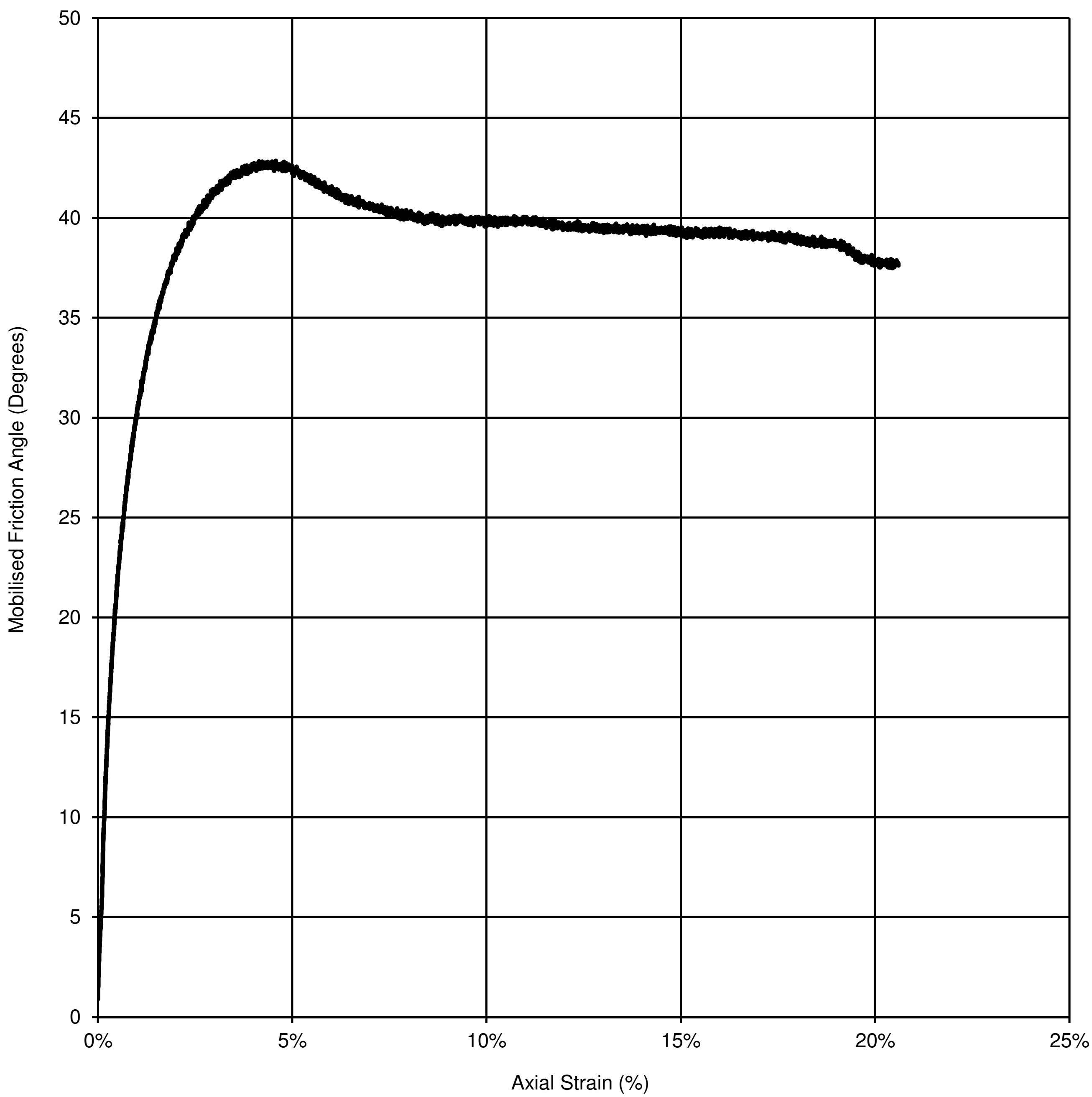
Initial Dry Density (t/m^3):	1.85	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

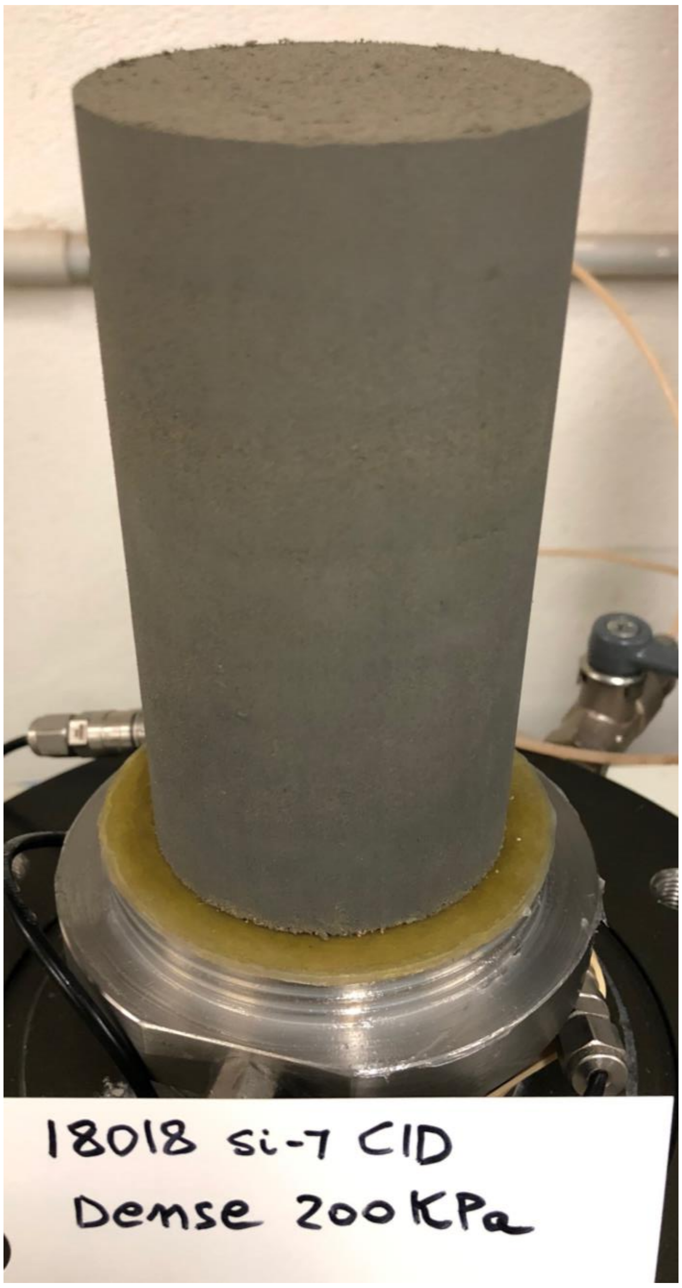
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-7 CID dense 200kPa

Initial Height (mm):	127.1	Final Liquor Content (%):	16.4%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.9	Final Dry Density (t/m^3):	1.89	B Response (%):	95%
Trimmings GWC (%):	12.0%	Final Void Ratio (-):	0.45	Mean Effective Consolidation Stress (kPa):	200
Initial Dry Density (t/m^3):	1.94	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a dense condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-7 CID dense 200kPa

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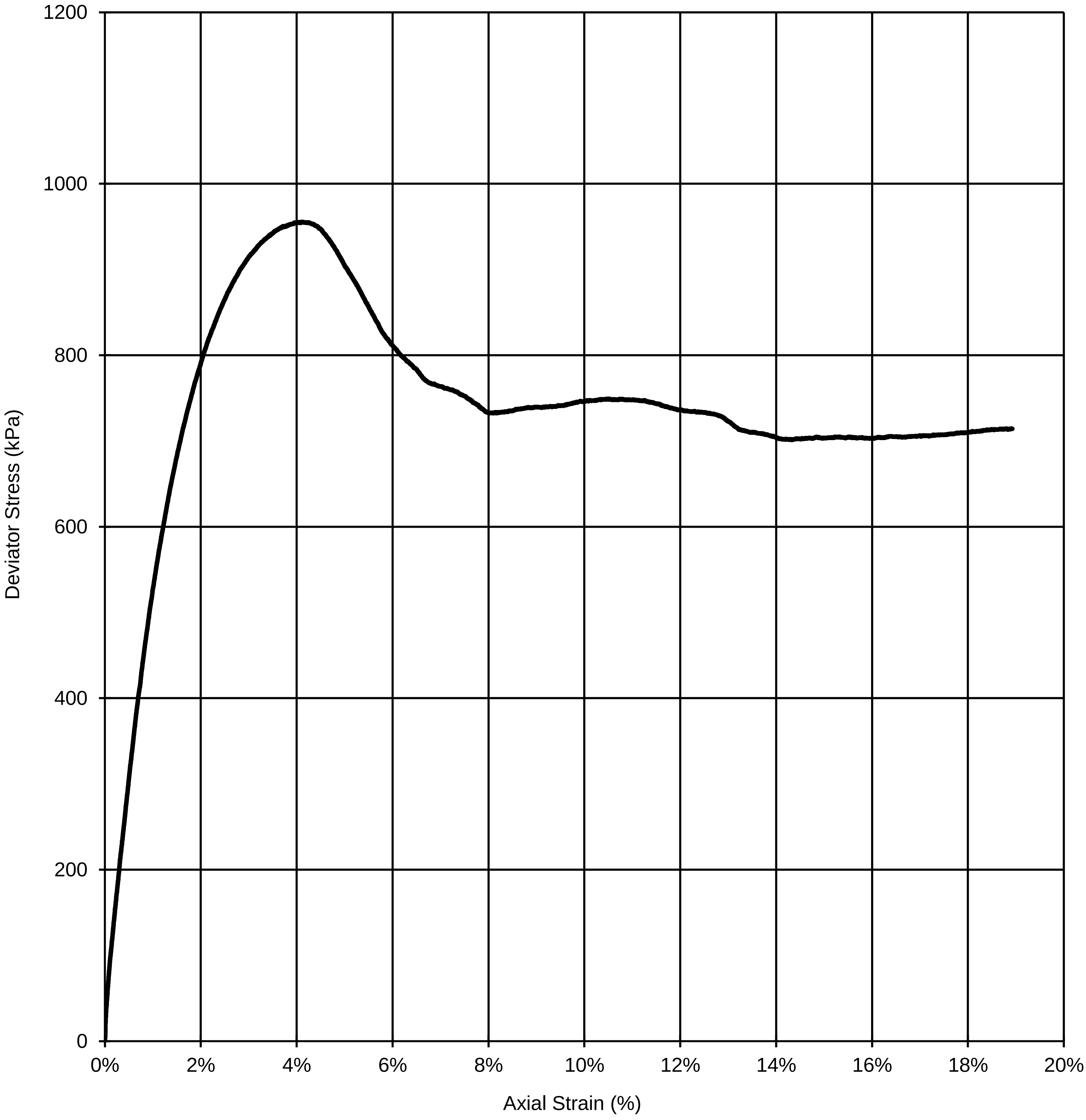

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		Reviewed by:	R. Fanni

Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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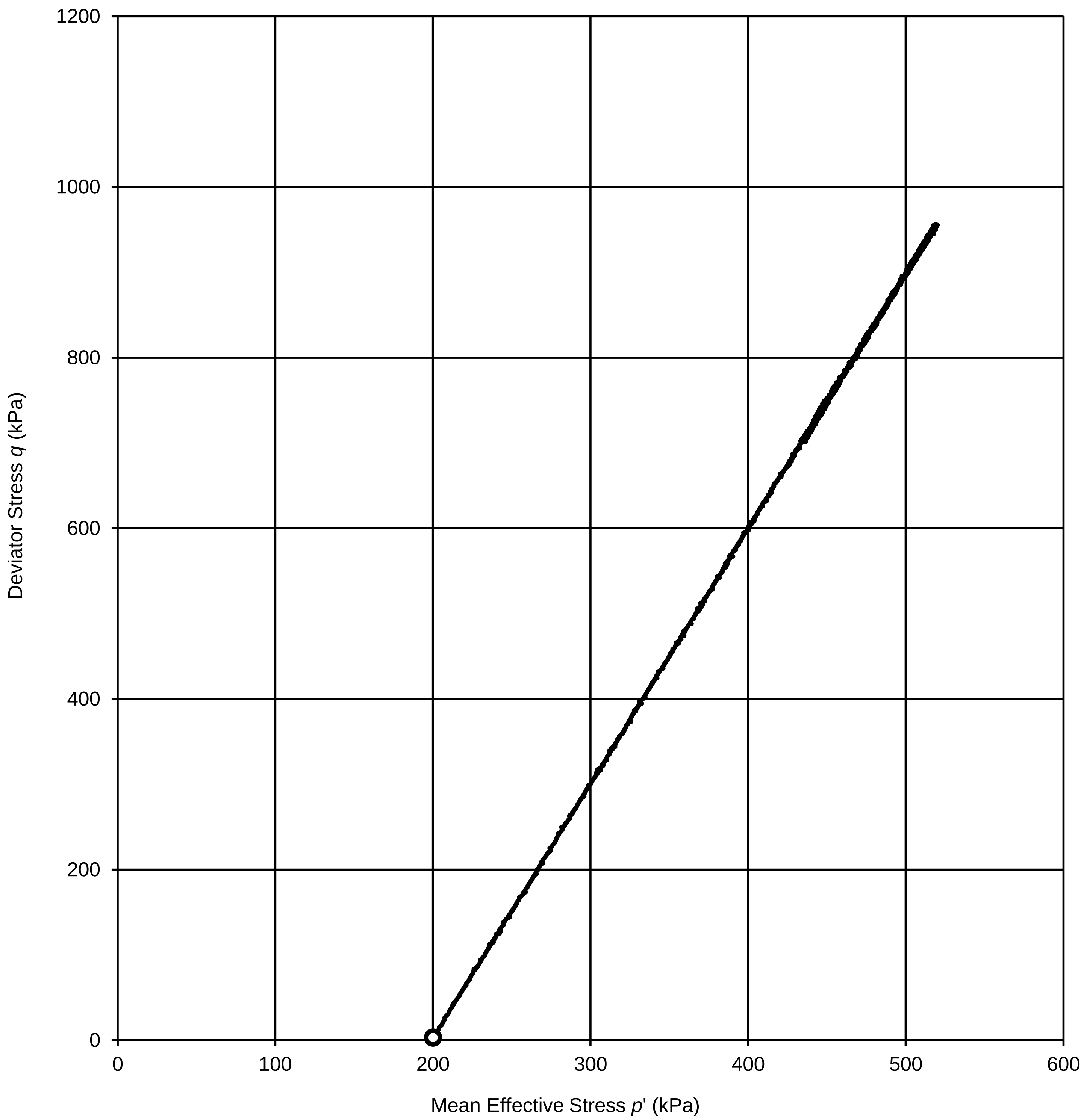

Preparation Notes:	Sample was moist tamped to a dense condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	16/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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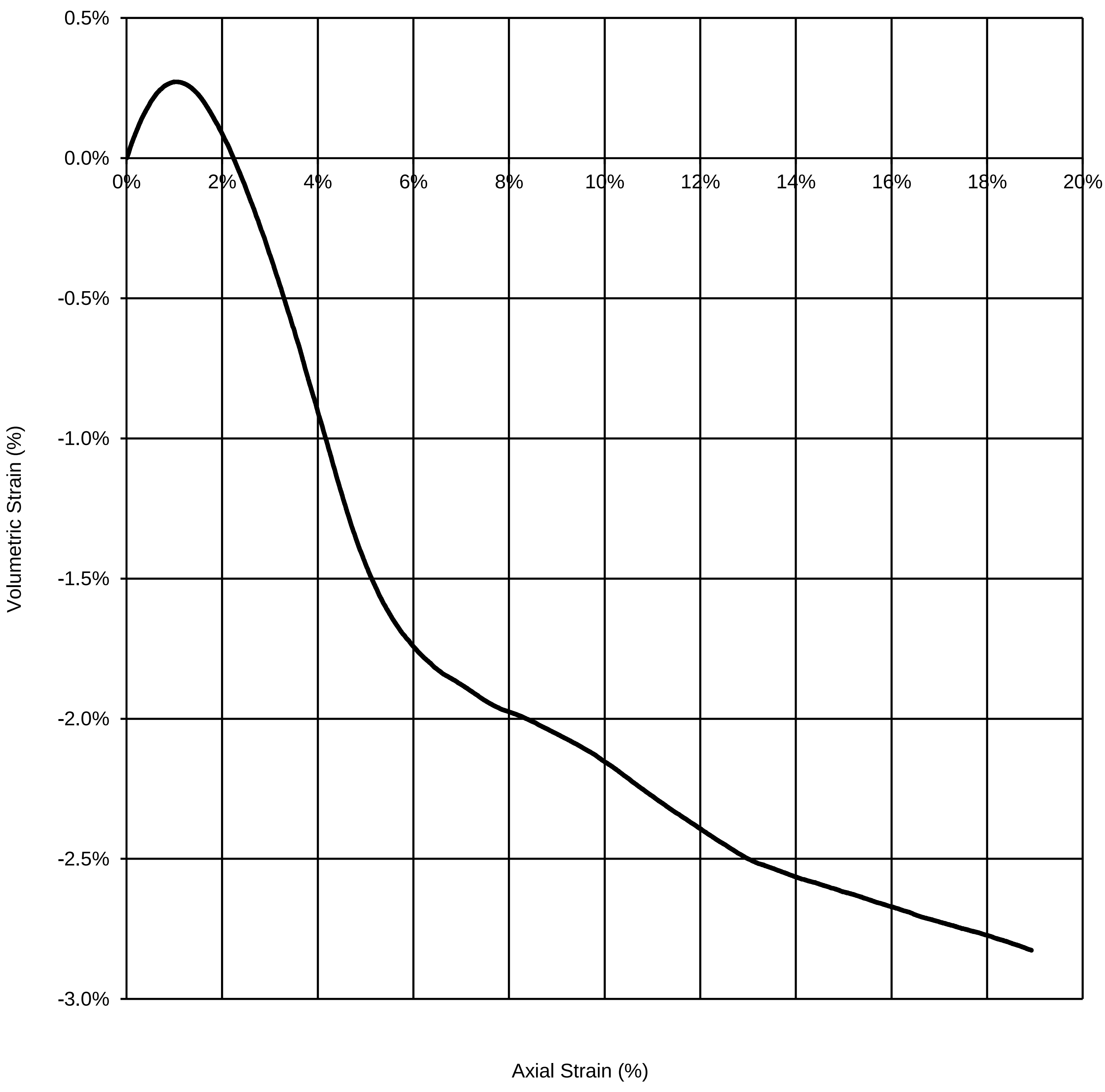

Preparation Notes:	Sample was moist tamped to a dense condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

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Triaxial Test Report

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Perth Laboratory
84 Guthrie Street, Osborne Park

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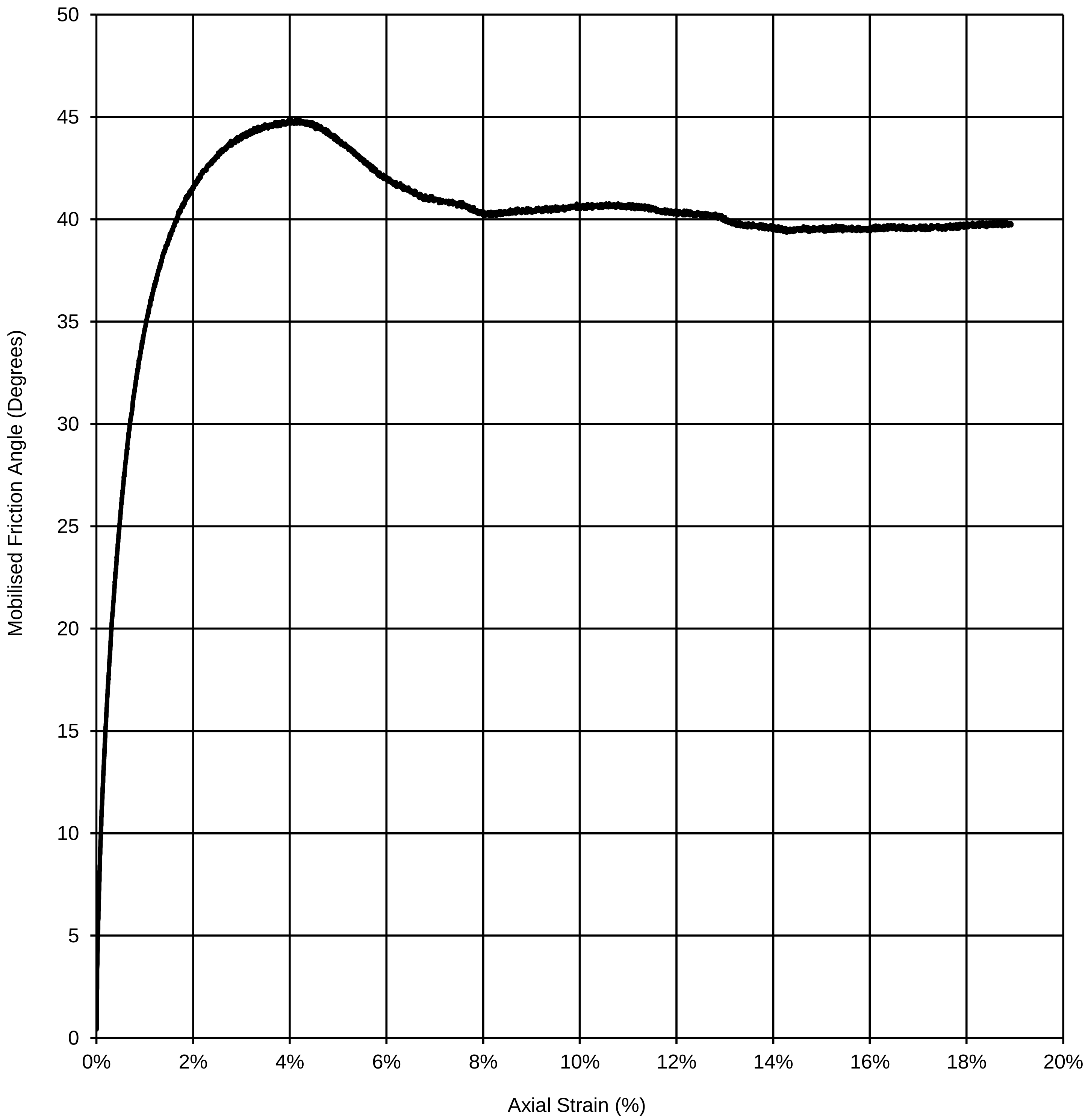

Preparation Notes:	Sample was moist tamped to a dense condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

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Triaxial Test Report

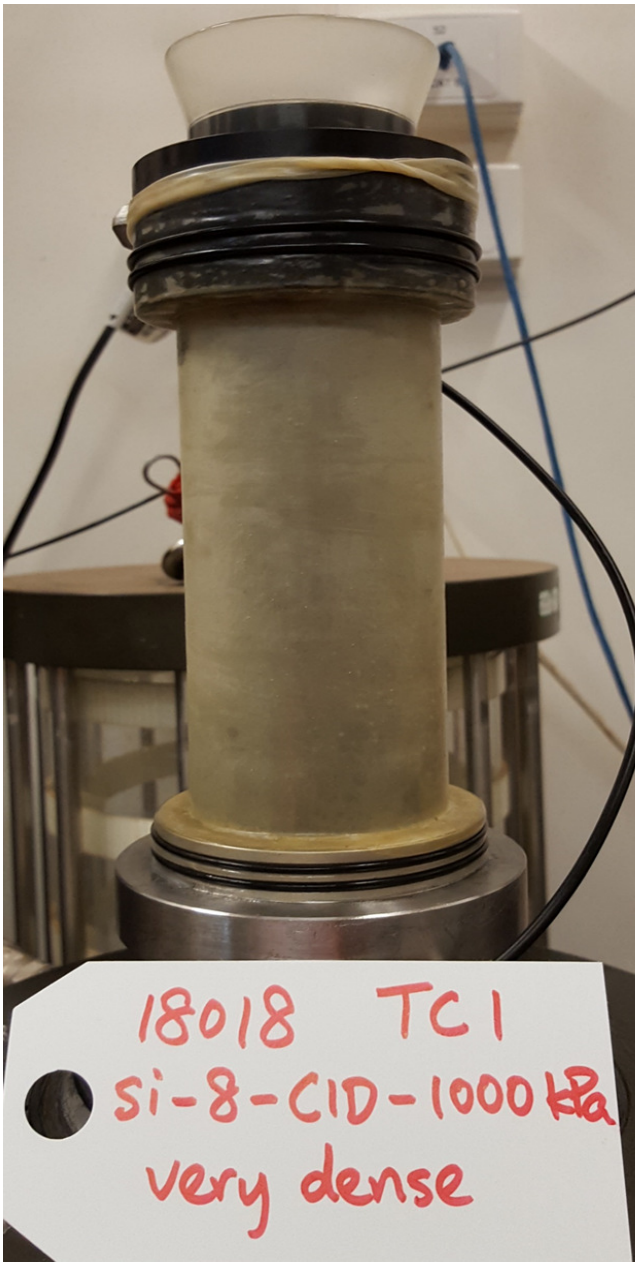
Isotropically Consolidated Drained (CID)

GOLDER

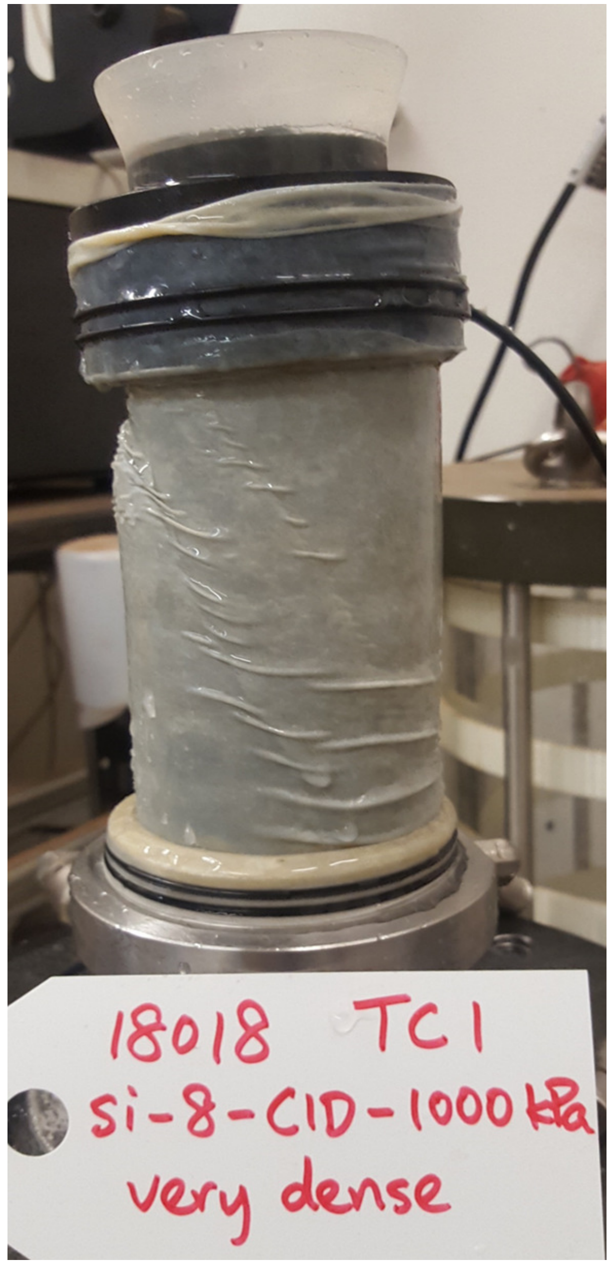
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-8 CID very dense 1000kPa

Initial Height (mm):	130.2	Final Liquor Content (%):	13.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	63.0	Final Dry Density (t/m^3):	1.98	B Response (%):	97%
Trimmings GWC (%):	12.0%	Final Void Ratio (-):	0.38	Mean Effective Consolidation Stress (kPa):	1002
Initial Dry Density (t/m^3):	1.98	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-8 CID very dense 1000kPa

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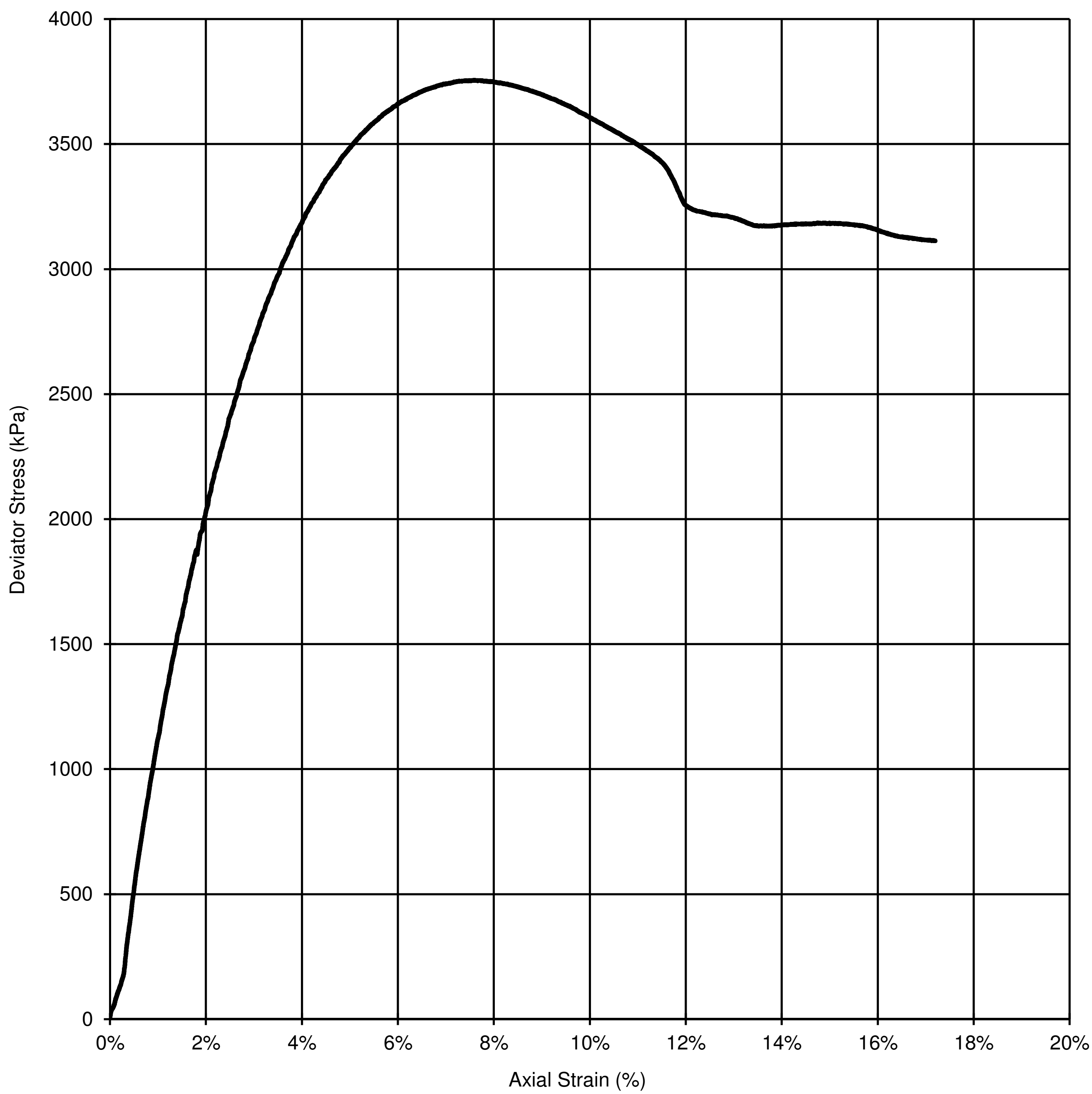
Initial Dry Density (t/m^3):	1.98	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-8 CID very dense 1000kPa

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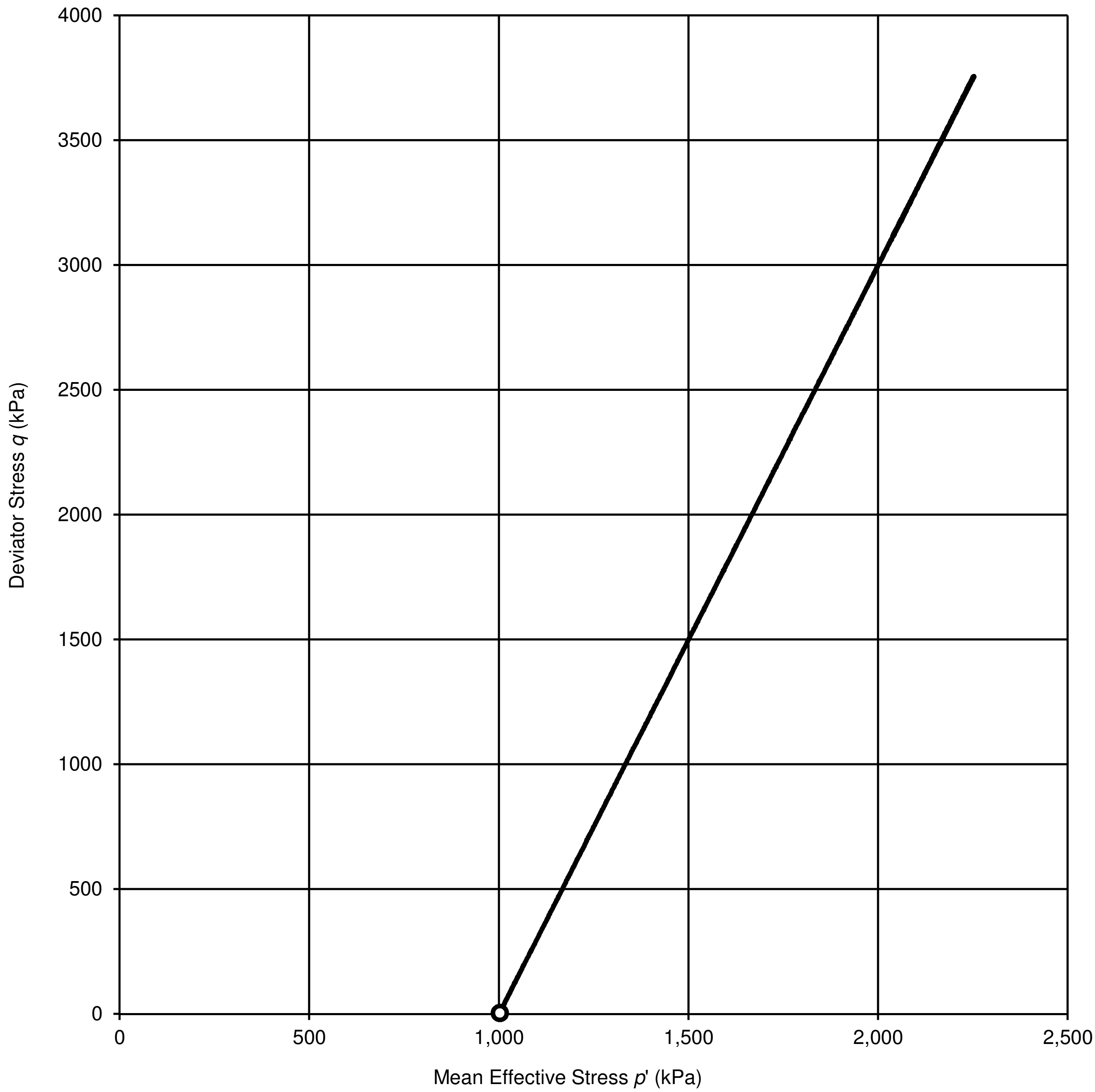
Initial Dry Density (t/m^3):	1.98	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	27/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-8 CID very dense 1000kPa

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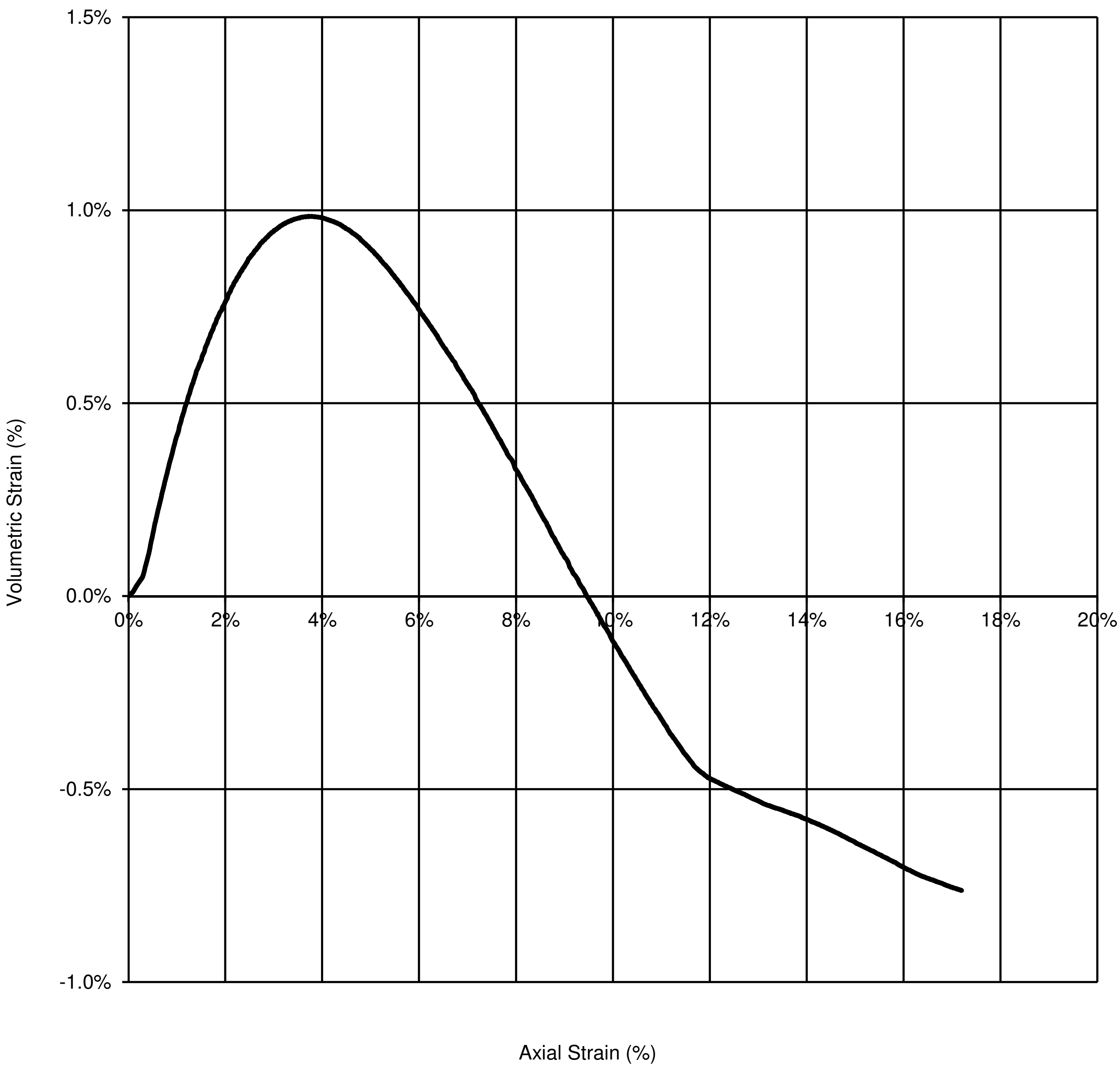

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	30/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-8 CID very dense 1000kPa

Initial Height (mm):	130.2	Final Liquor Content (%):	13.9%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	63.0	Final Dry Density (t/m^3):	1.98	B Response (%):	97%
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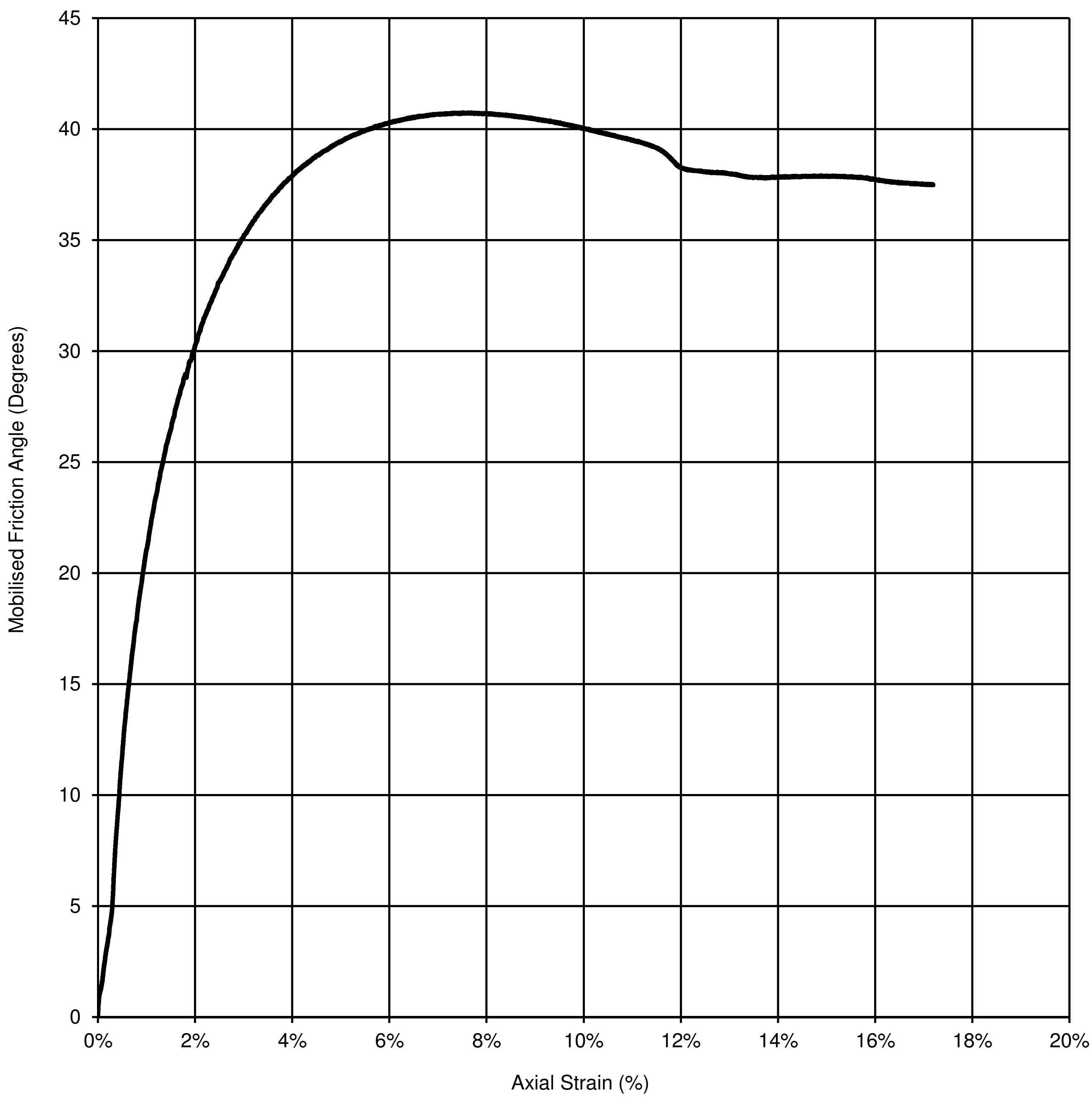
Initial Dry Density (t/m^3):	1.98	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Annexure EH
TS2 – CSL Test Certificates

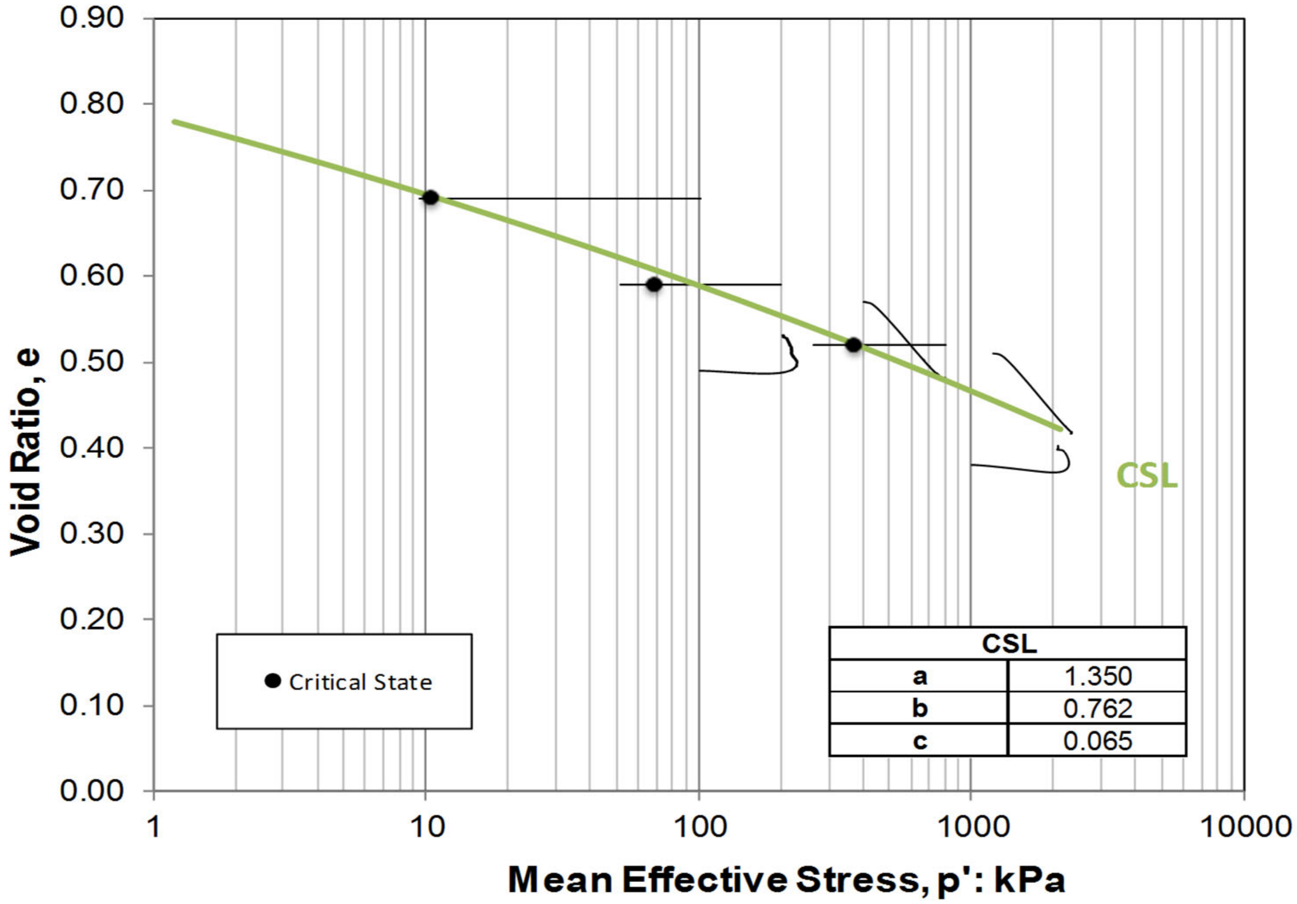
TS2

Golder (Perth) Testing

	As tested initial			At max dilation (=Dmin)		
Test ID	p0	e0	psi0	Dmin	eta_max	psi
sa-4 CID 400 kPa	401.4	0.570	0.065	-0.030	1.502	0.013
sa-5 CID 1200 kPa	1201.5	0.510	0.063	0.010	1.458	0.004
sa-6 CID 100 kPa	101.0	0.490	-0.087	-0.320	1.703	-0.043
sa-8 CID 1000 kPa	1001.9	0.380	-0.077	-0.280	1.683	-0.029

	As tested initial			at critical state	
	p0	e0	psi0	pc	ec
sa-1 CIU 100 kPa	101.7	0.690	0.113	11	0.690
sa-2 CIU 200 kPa	201.2	0.590	0.049	69	0.590
sa-3 CIU 800 kPa	800.7	0.520	0.051	375	0.520

Mtc	1.48
N	0.30
χ**tc**	8.7



Job number	H356804		NTSF Failure Review	Newcrest
Ref				NTSF
By	TMY	IAG	19-Mar-19	Tailings Critical State Properties Summary	
Revision	A	19-Mar-19		Figure 1

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

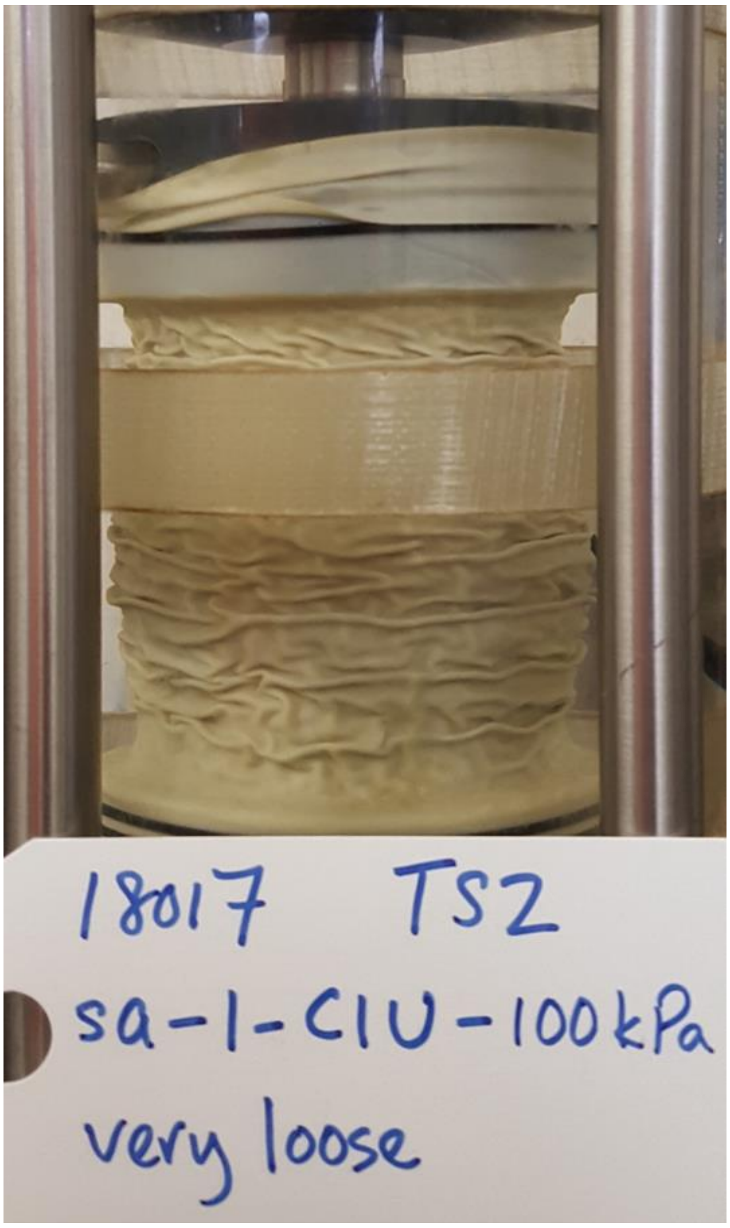
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-1 CIU very loose 100kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	25.6%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	64.7	Final Dry Density (t/m^3):	1.59	B Response (%):	99%
Trimmings GWC (%):	11.4%	Final Void Ratio (-):	0.69	Mean Effective Consolidation Stress (kPa):	102
Initial Dry Density (t/m^3):	1.18	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97

Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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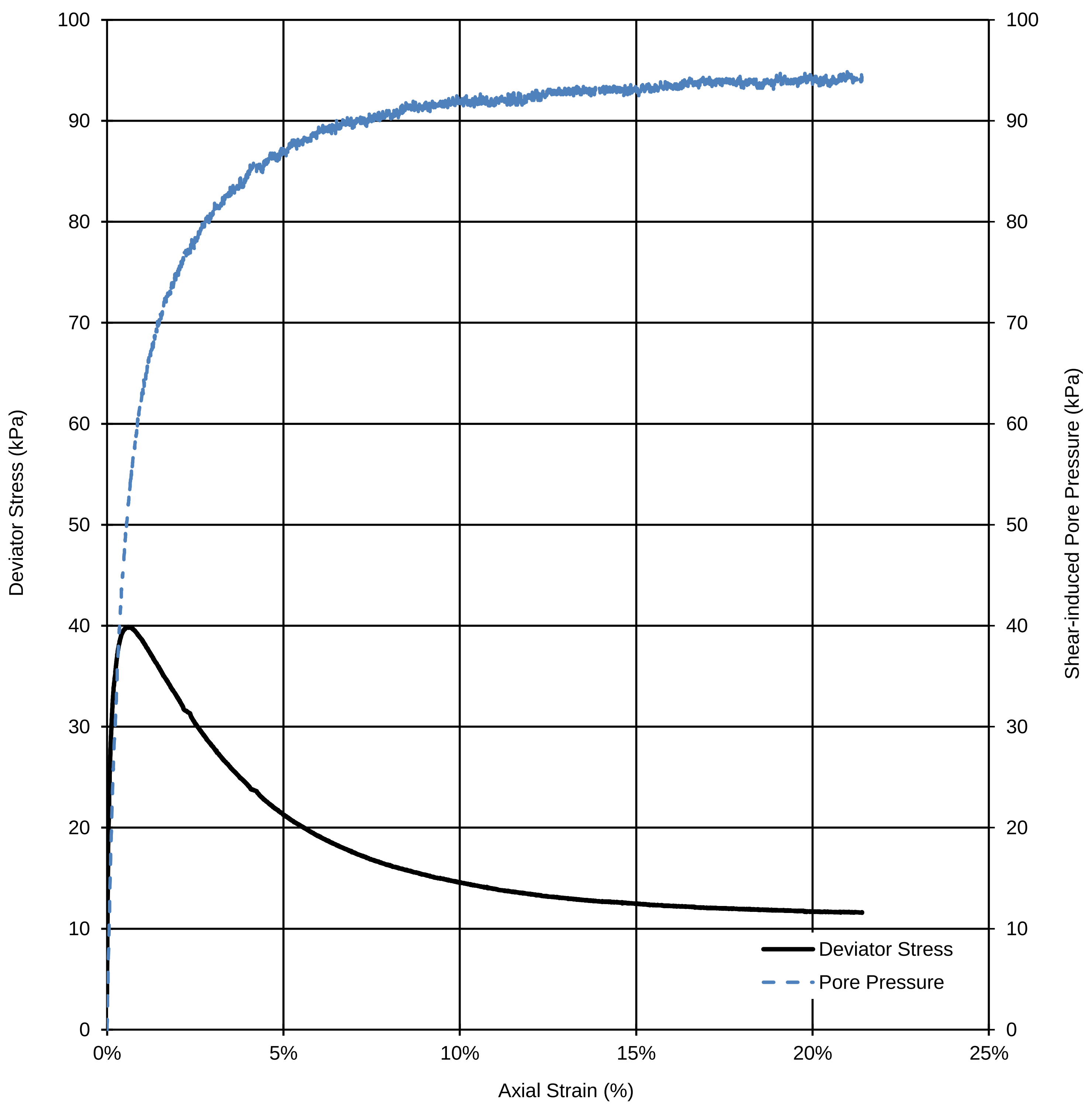
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-1 CIU very loose 100kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	25.6%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	64.7	Final Dry Density (t/m^3):	1.59	B Response (%):	99%
Trimmings GWC (%):	11.4%	Final Void Ratio (-):	0.69	Mean Effective Consolidation Stress (kPa):	102
Initial Dry Density (t/m^3):	1.18	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

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Location:	Cadia Mine	**Test ID:**	18017 - sa-1 CIU very loose 100kPa

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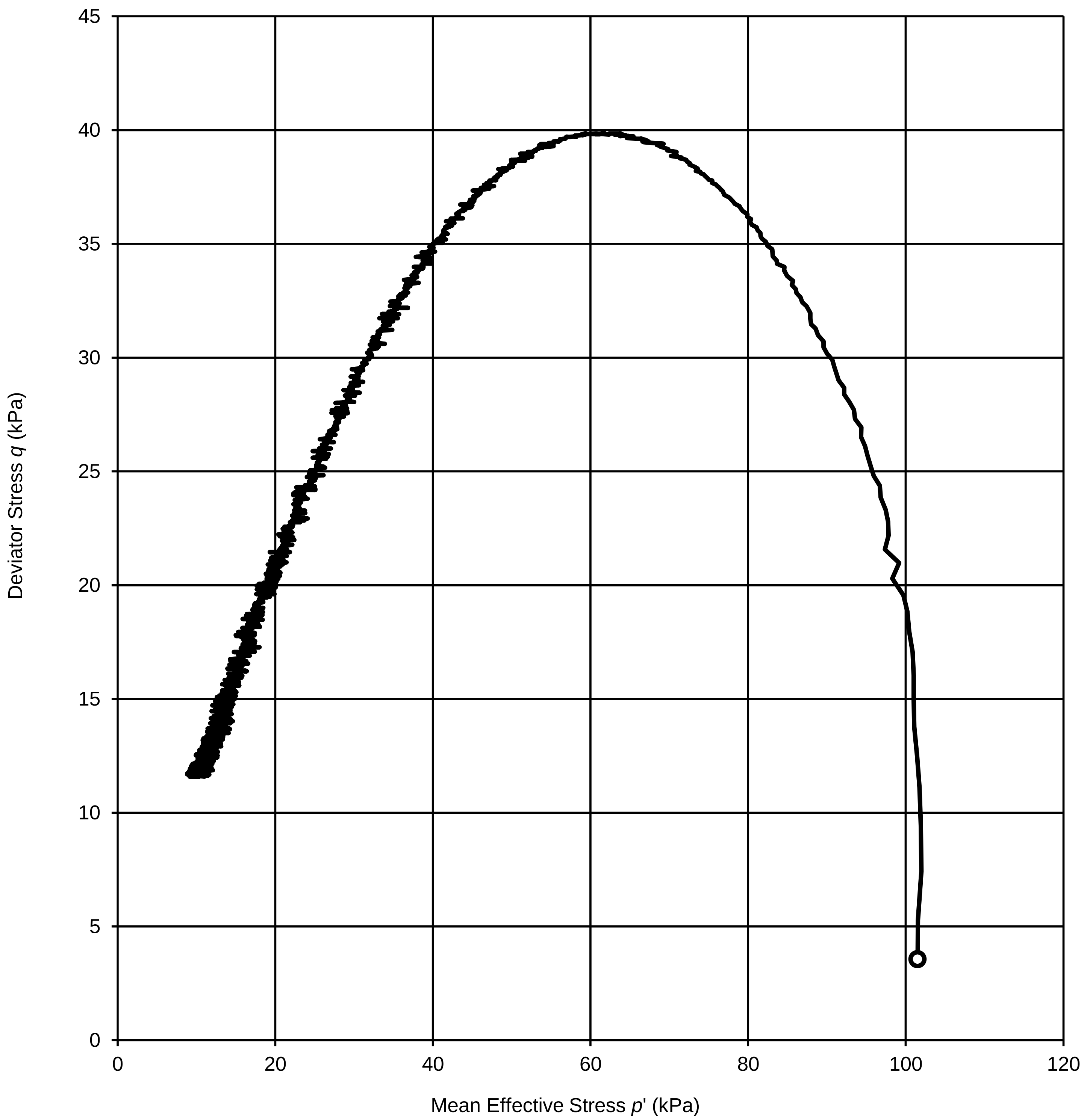
Initial Dry Density (t/m^3):	1.18	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

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Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-1 CIU very loose 100kPa

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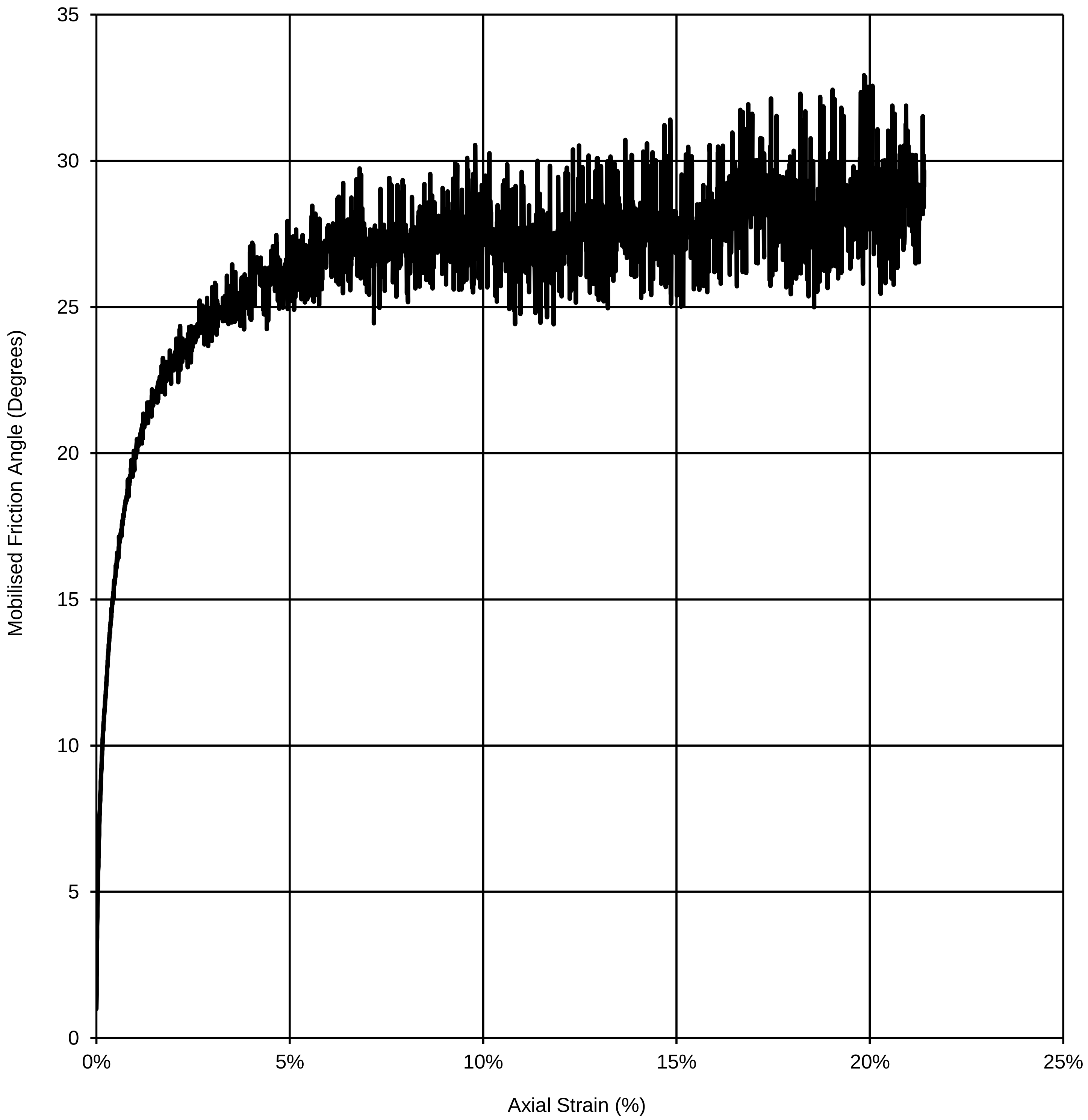
Trimmings GWC (%):	11.4%	Final Void Ratio (-):	0.69	Mean Effective Consolidation Stress (kPa):	102
Initial Dry Density (t/m^3):	1.18	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	1/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-2 CIU loose 200kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	22.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	65.4	Final Dry Density (t/m^3):	1.69	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.59	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	1/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-2 CIU loose 200kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	22.1%	Strain Rate (mm/min):	0.03
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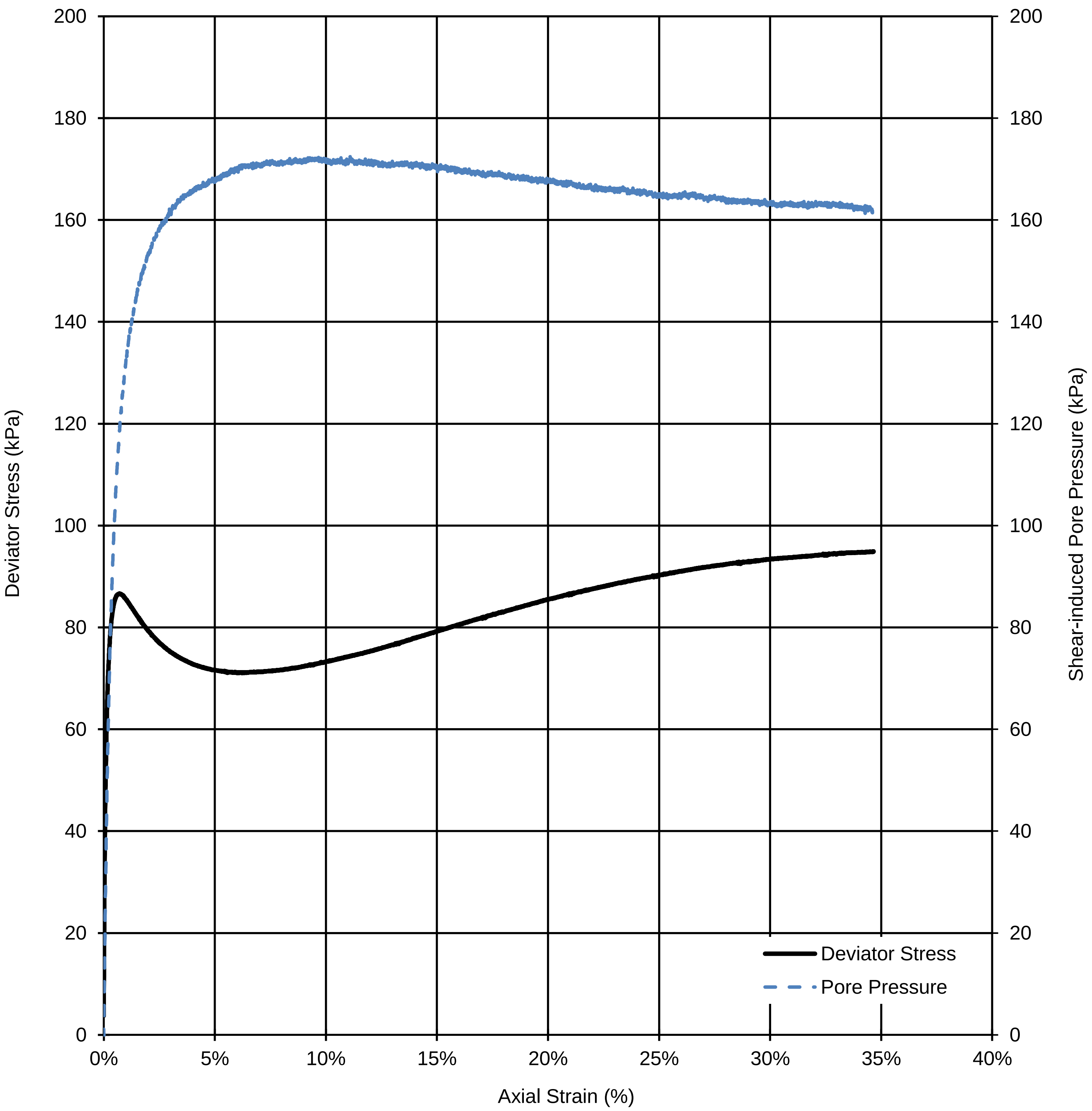
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.59	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



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		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

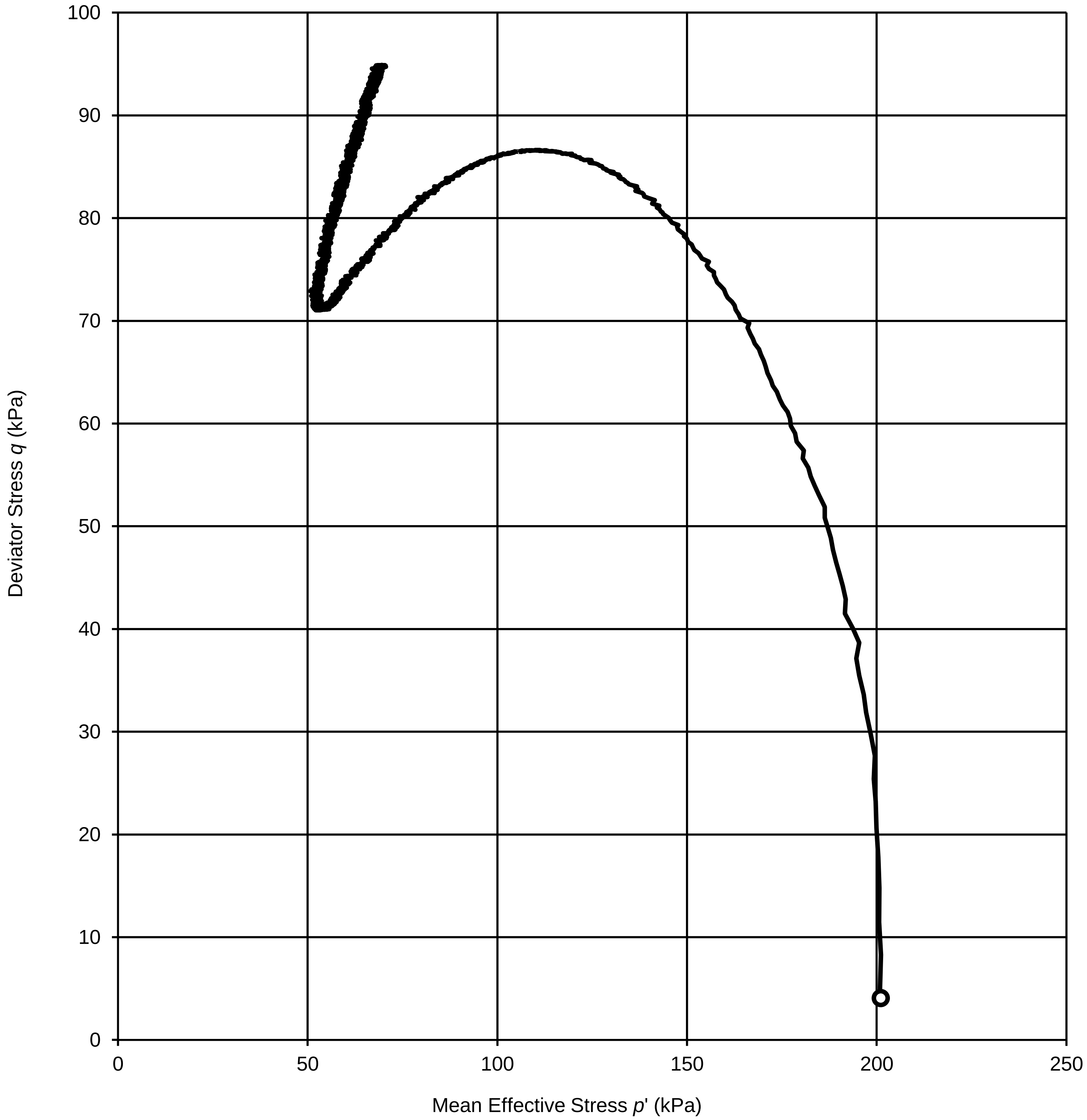
Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	1/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-2 CIU loose 200kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	22.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	65.4	Final Dry Density (t/m^3):	1.69	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.59	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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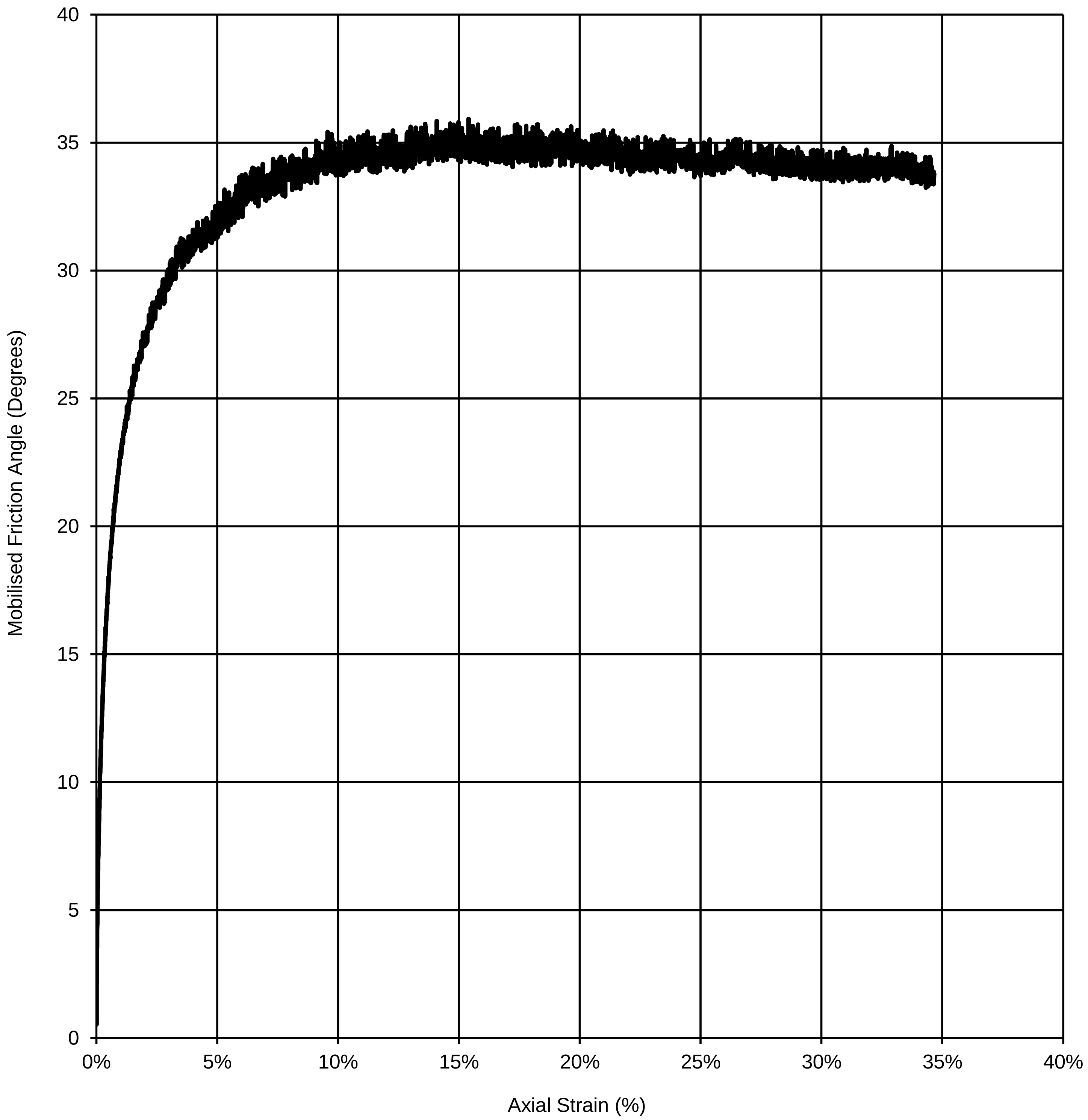
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	1/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-2 CIU loose 200kPa

Initial Height (mm):	147.1	Final Liquor Content (%):	22.1%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	65.4	Final Dry Density (t/m^3):	1.69	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.59	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.98



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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	31/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-3 CIU loose 800kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	19.4%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	65.7	Final Dry Density (t/m^3):	1.77	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	800
Initial Dry Density (t/m^3):	1.27	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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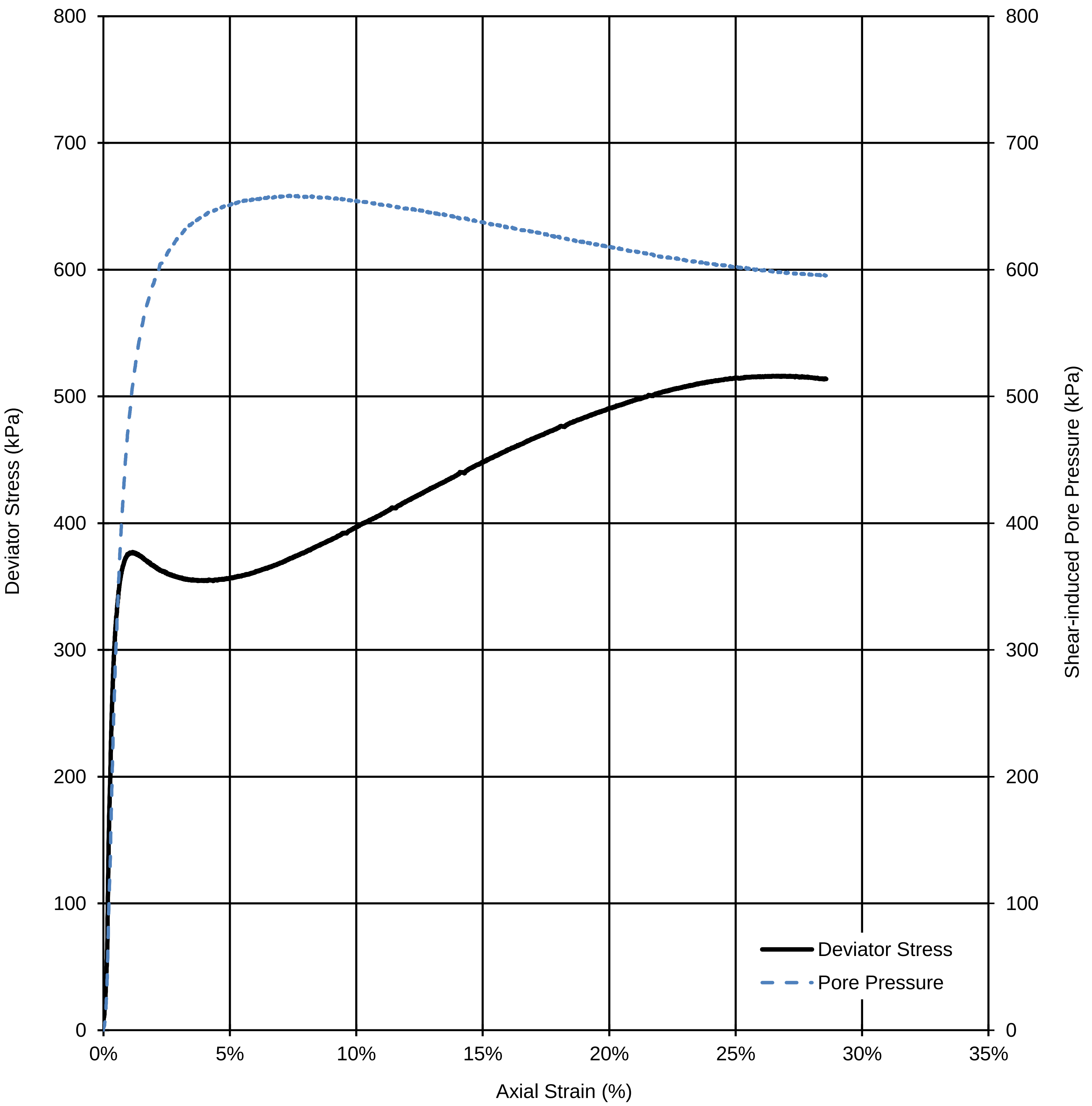
Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	31/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-3 CIU loose 800kPa

Initial Height (mm):	146.7	Final Liquor Content (%):	19.4%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	65.7	Final Dry Density (t/m^3):	1.77	B Response (%):	99%
Trimmings GWC (%):	6.6%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	800
Initial Dry Density (t/m^3):	1.27	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	31/07/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-3 CIU loose 800kPa

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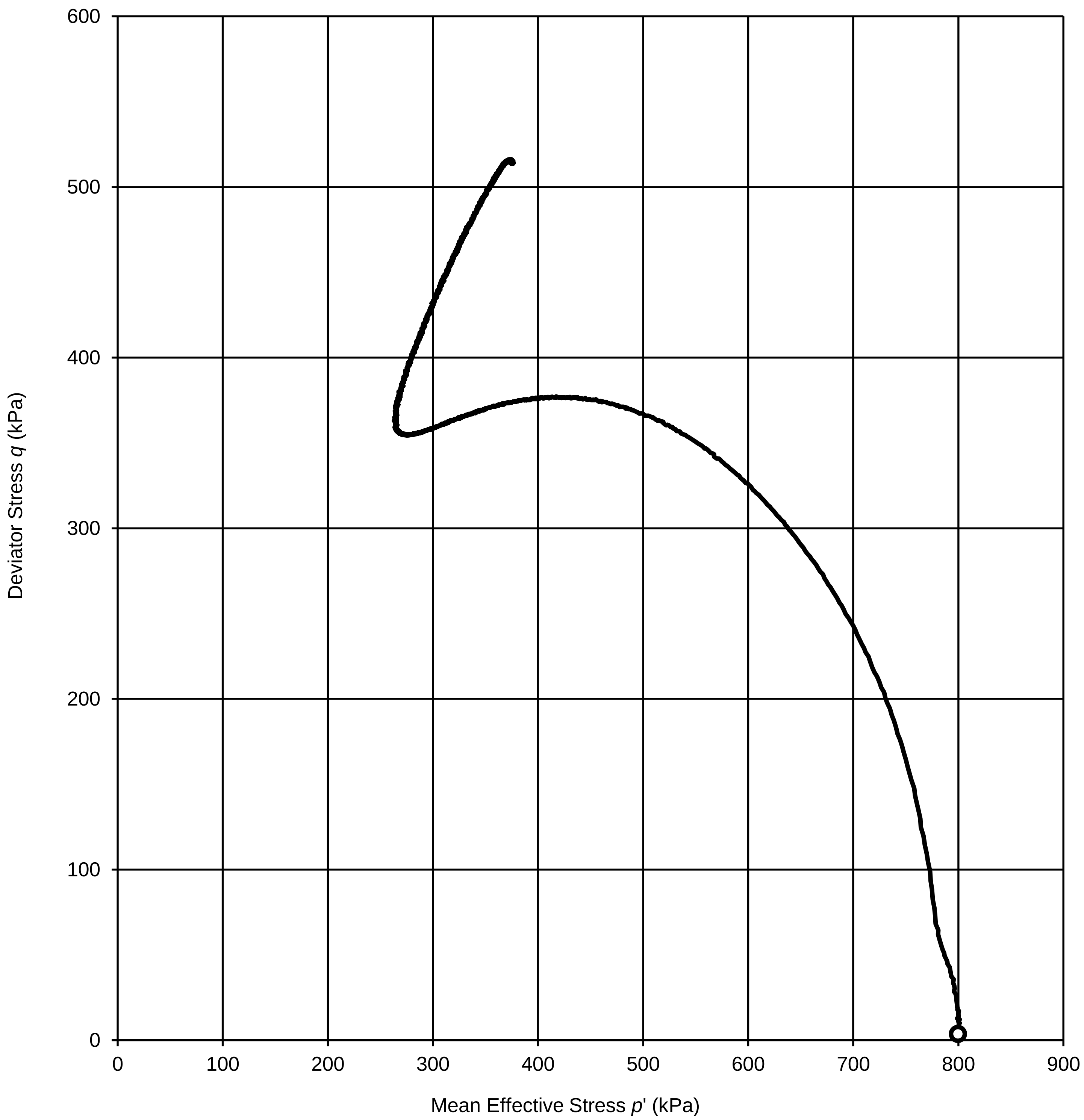

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

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Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-3 CIU loose 800kPa

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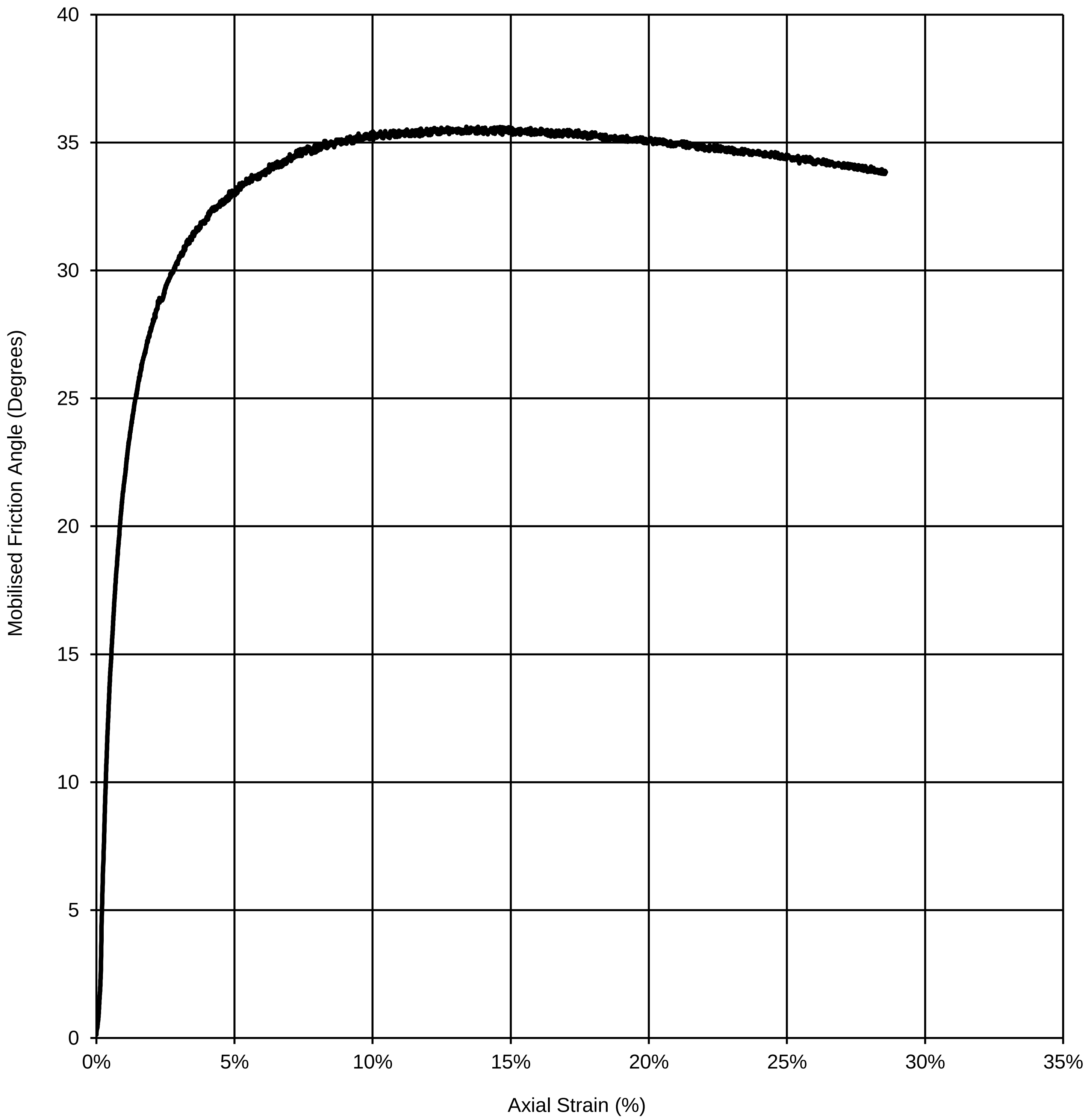
Initial Dry Density (t/m^3):	1.27	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-4 CID loose 400kPa

Initial Height (mm):	147.7	Final Liquor Content (%):	17.8%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	65.8	Final Dry Density (t/m^3):	1.82	B Response (%):	99%
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.48	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni D. Reid

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Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
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Location:	Cadia Mine	**Test ID:**	18017 - sa-4 CID loose 400kPa

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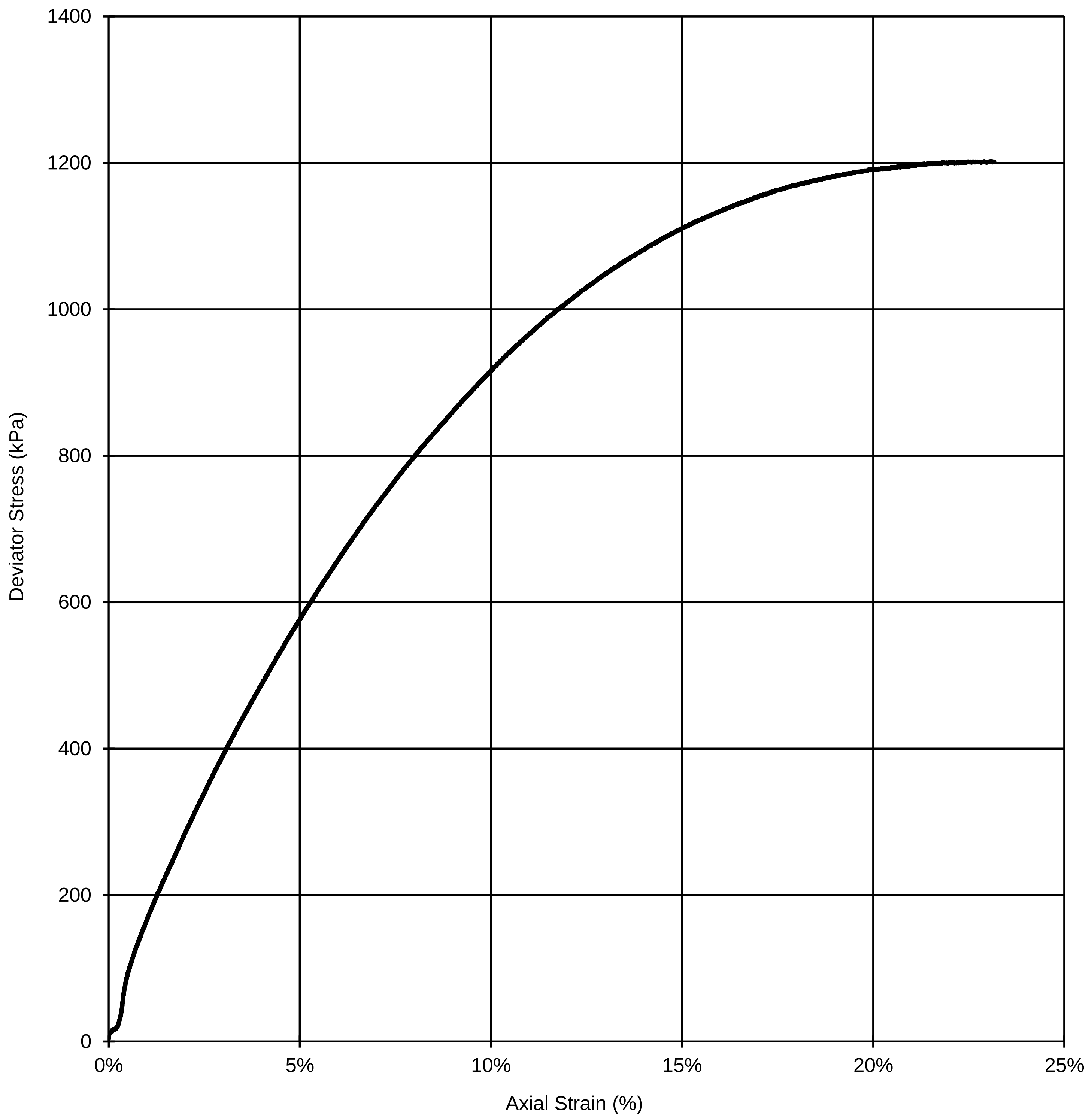
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.48	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



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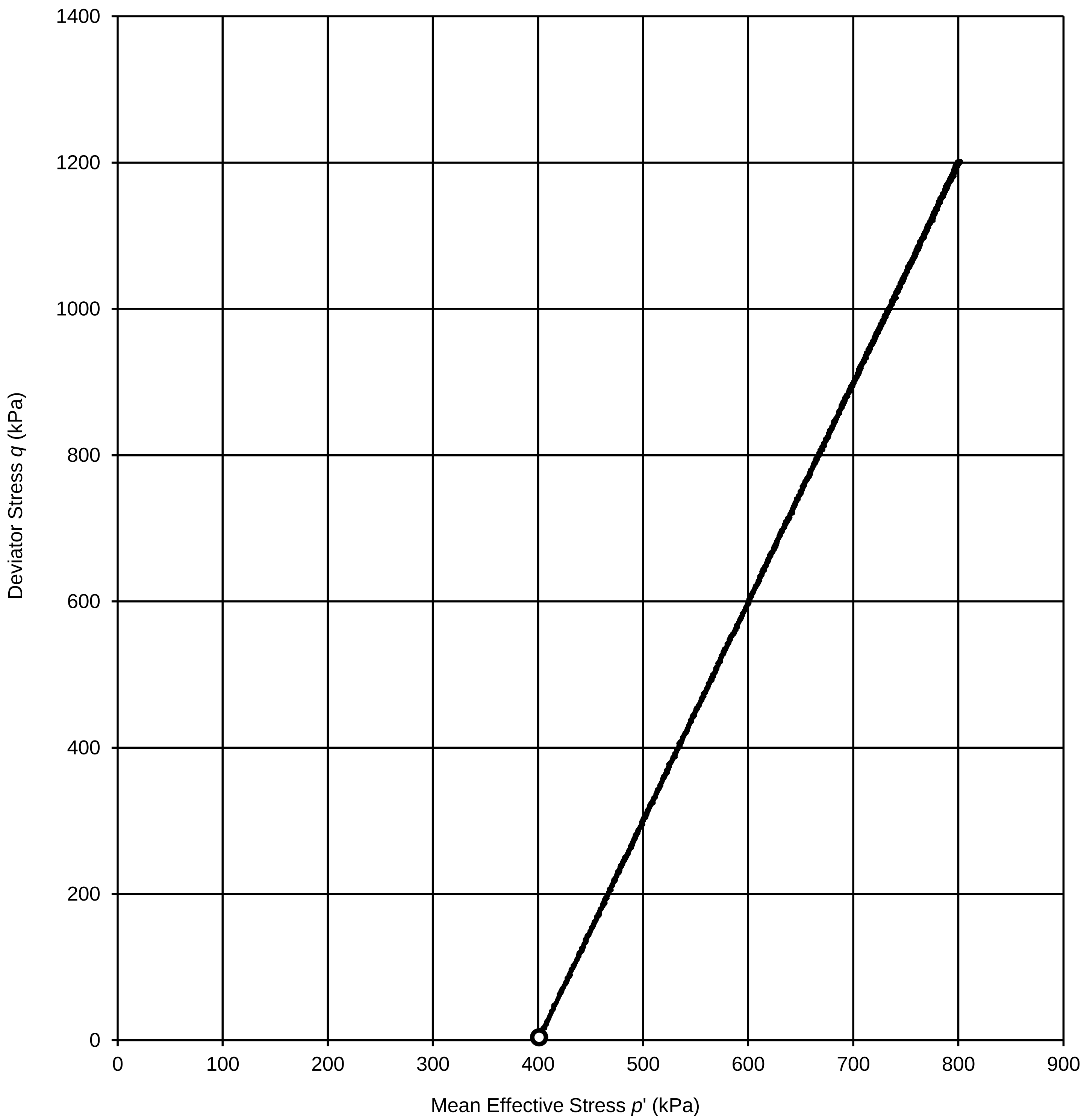

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Triaxial Test Report

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Perth Laboratory
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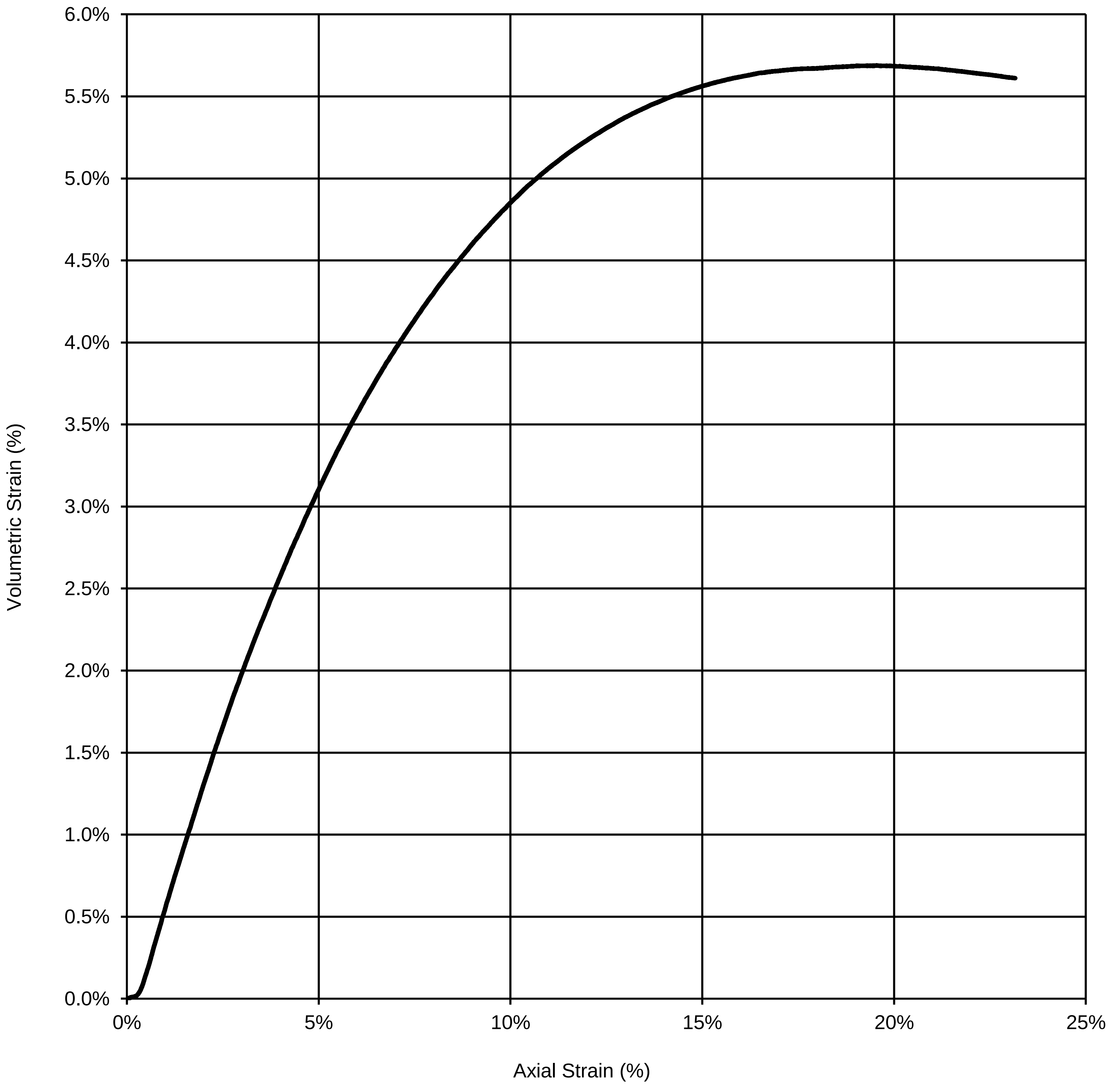
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.48	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Drained (CID)

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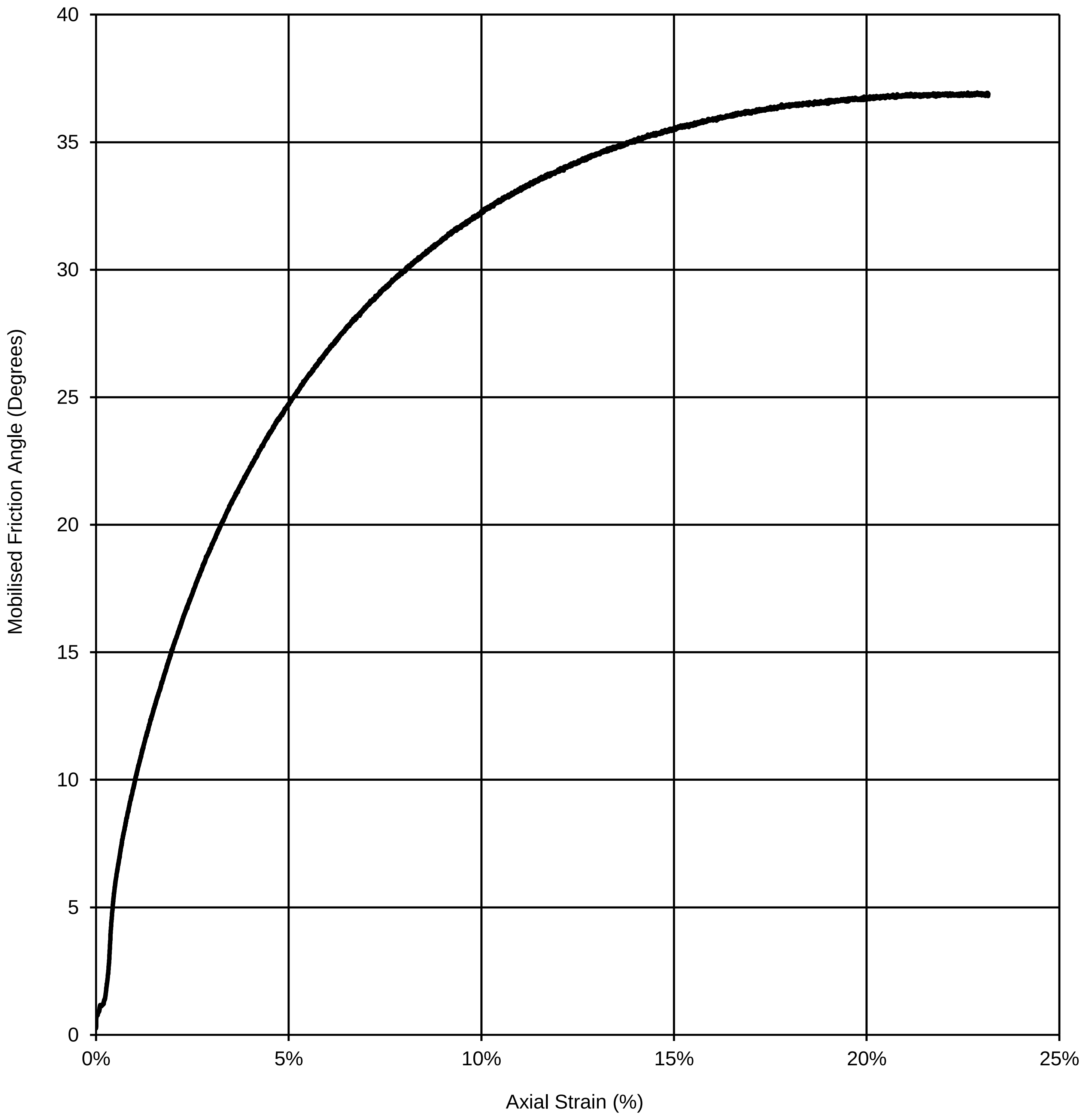
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.48	Mean Effective Consolidation Stress (kPa):	401
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

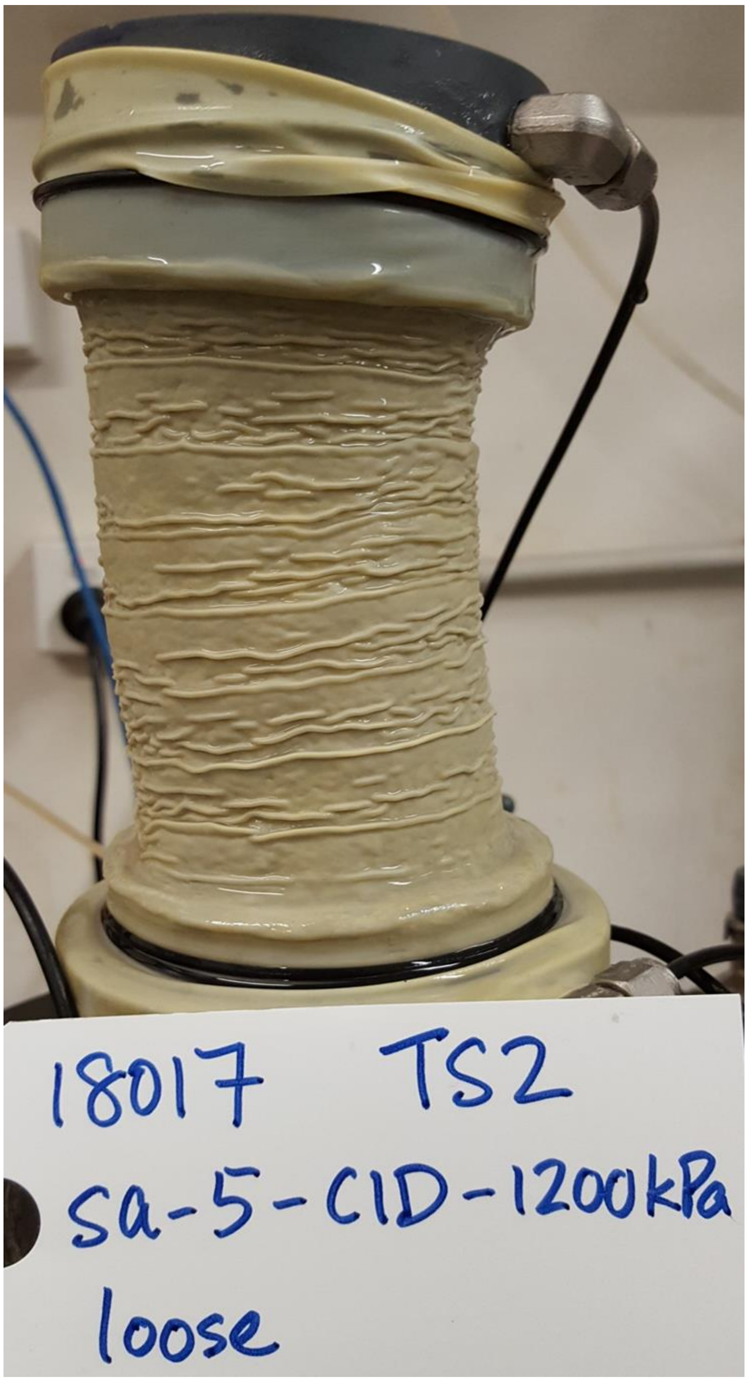
Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-5 CID loose 1200kPa

Initial Height (mm):	145.9	Final Liquor Content (%):	15.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	66.1	Final Dry Density (t/m^3):	1.90	B Response (%):	99%
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.42	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni D. Reid

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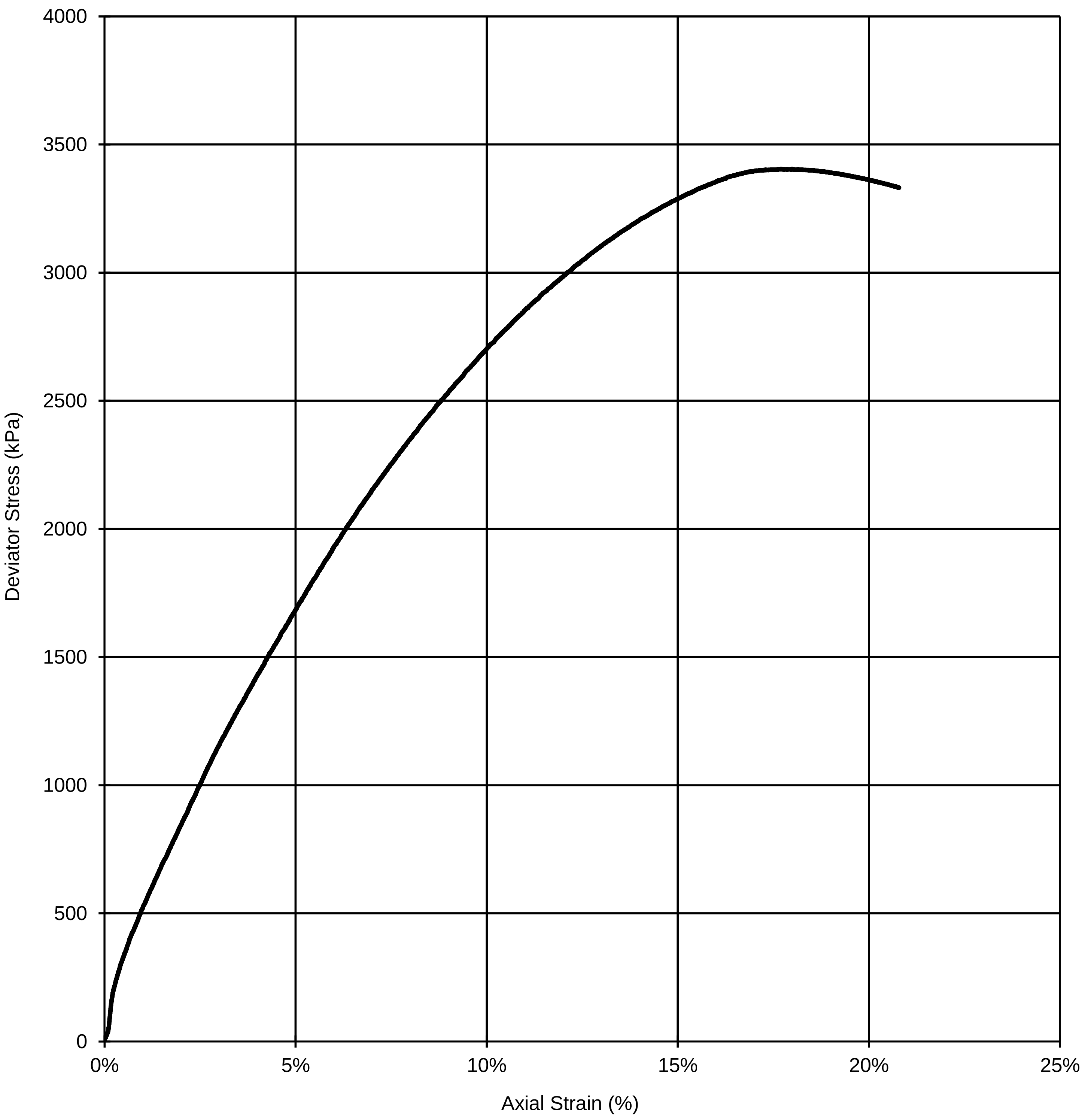
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-5 CID loose 1200kPa

Initial Height (mm):	145.9	Final Liquor Content (%):	15.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	66.1	Final Dry Density (t/m^3):	1.90	B Response (%):	99%
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.42	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni D. Reid

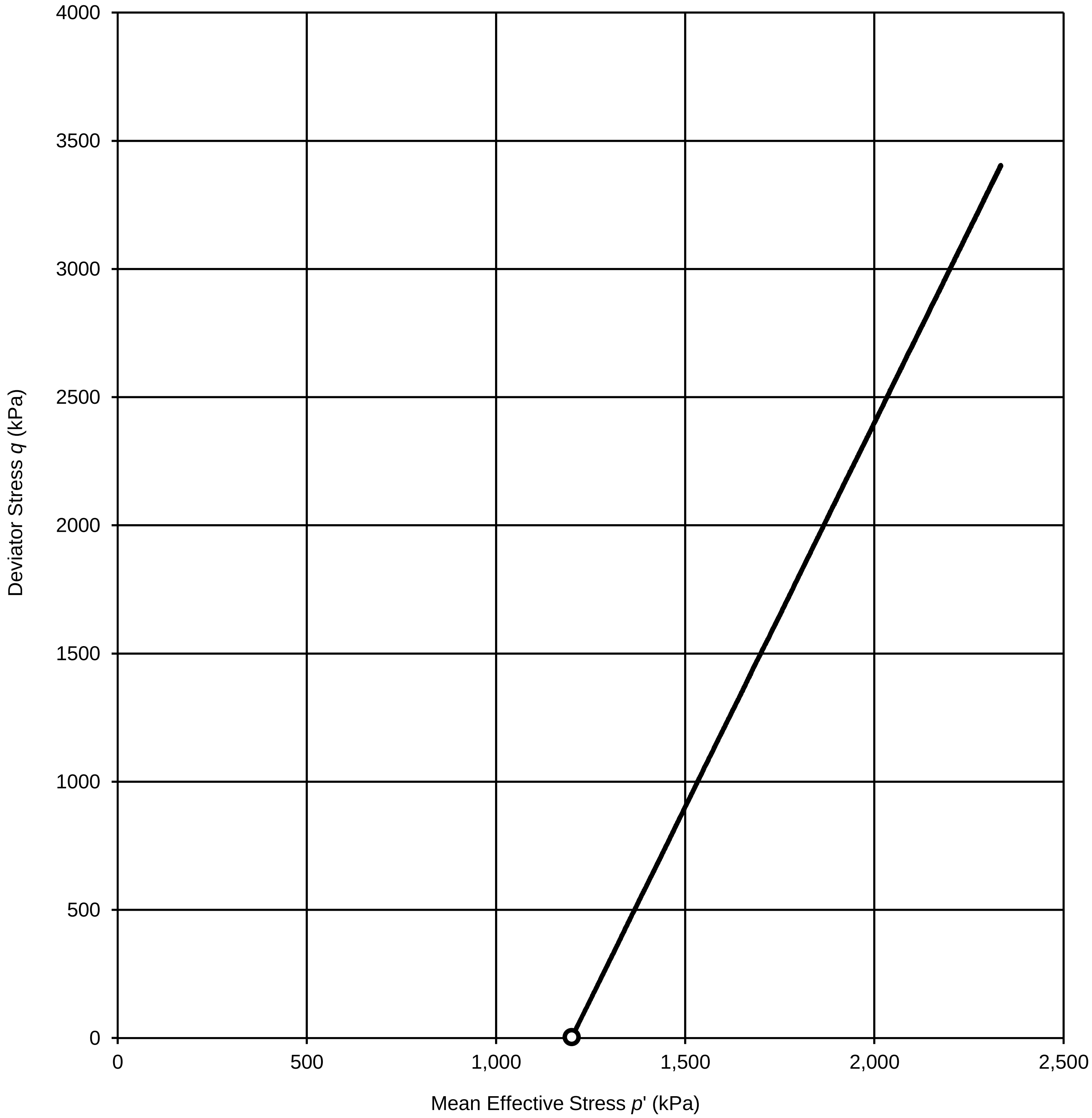
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-5 CID loose 1200kPa

Initial Height (mm):	145.9	Final Liquor Content (%):	15.5%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	66.1	Final Dry Density (t/m^3):	1.90	B Response (%):	99%
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.42	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-5 CID loose 1200kPa

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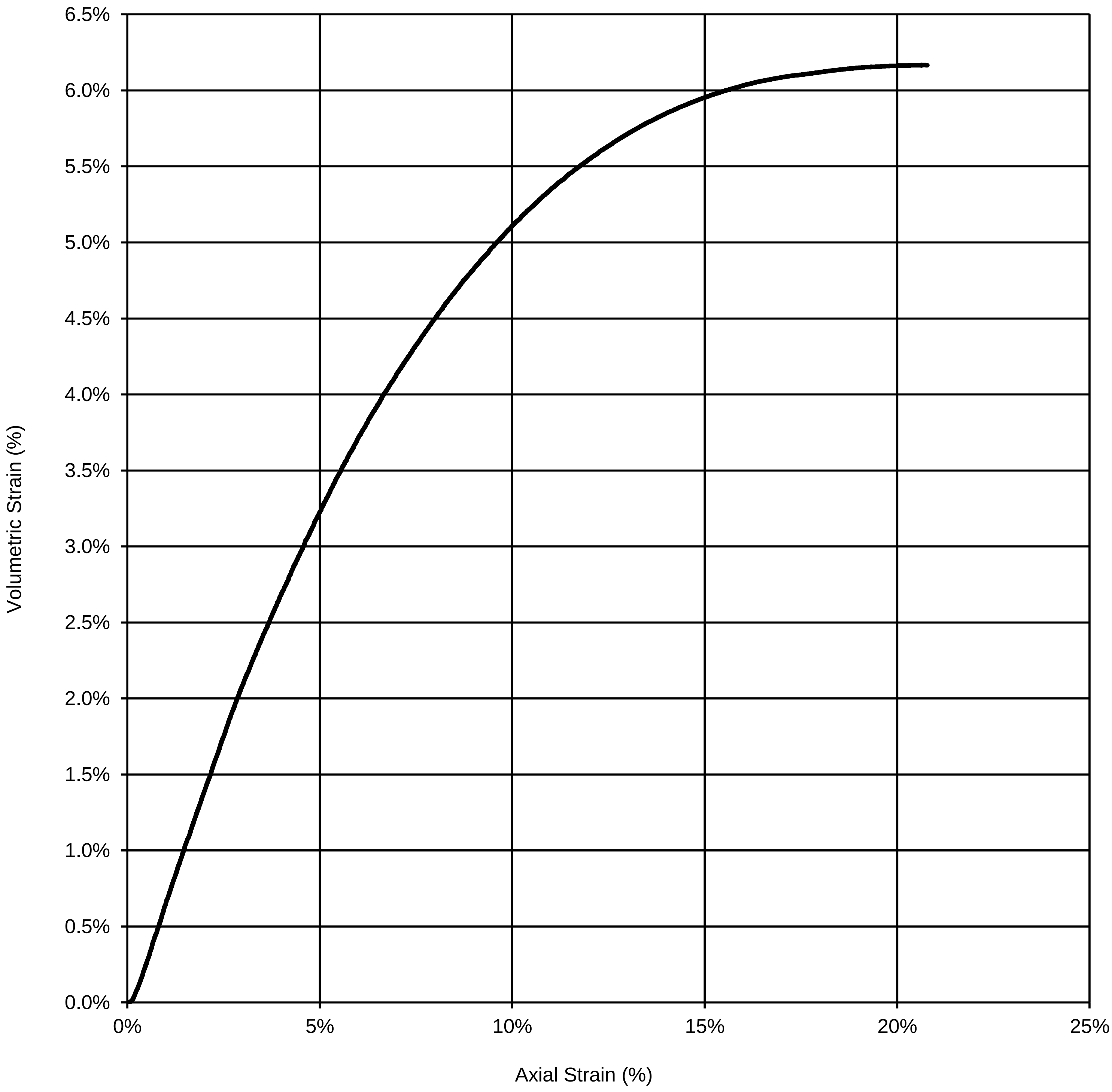
Initial Diameter (mm):	66.1	Final Dry Density (t/m^3):	1.90	B Response (%):	99%
Trimmings GWC (%):	8.1%	Final Void Ratio (-):	0.42	Mean Effective Consolidation Stress (kPa):	1201
Initial Dry Density (t/m^3):	1.25	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni D. Reid

Triaxial Test Report

Isotropically Consolidated Drained (CID)

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84 Guthrie Street, Osborne Park

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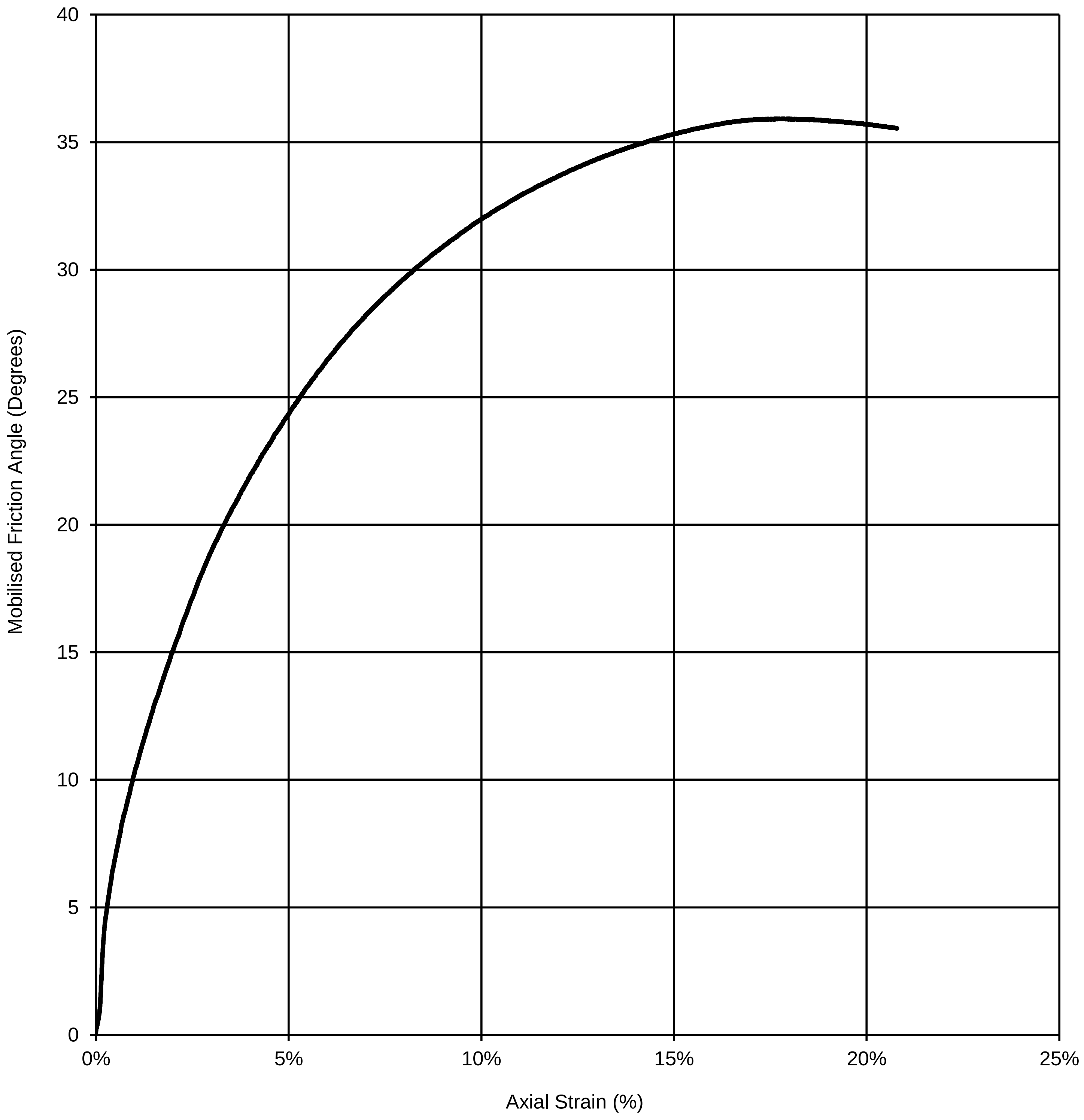

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
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Triaxial Test Report

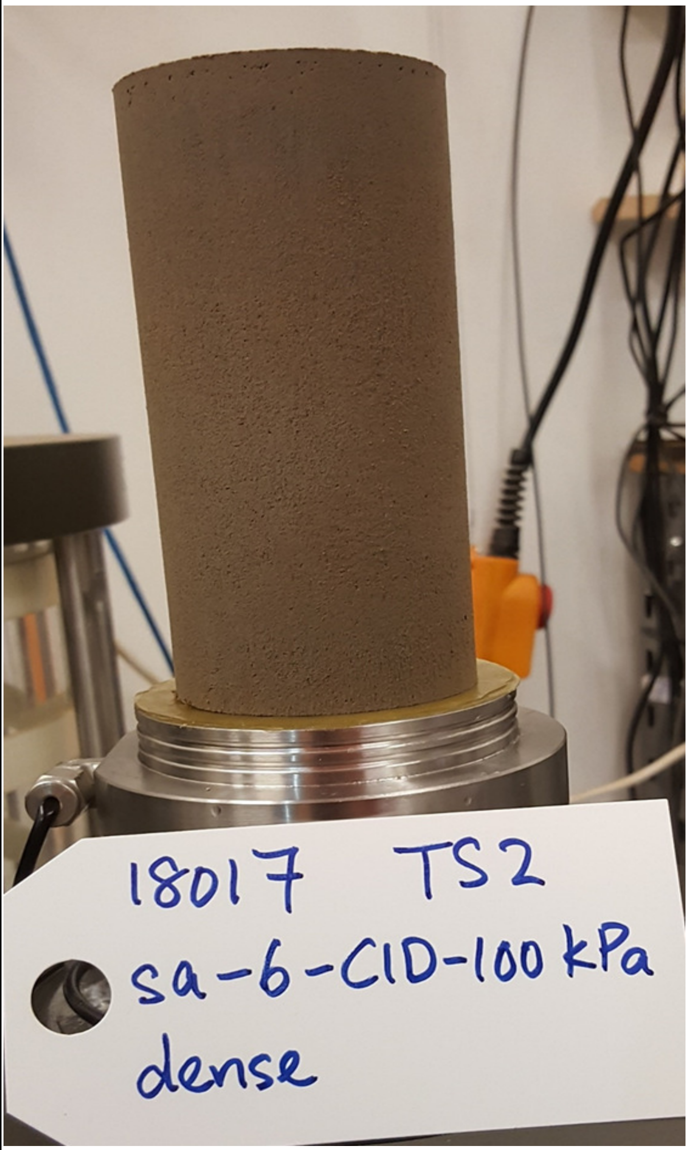
Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-6 CID dense 100kPa

Initial Height (mm):	128.4	Final Liquor Content (%):	19.6%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.9	Final Dry Density (t/m^3):	1.76	B Response (%):	97%
Trimmings GWC (%):	-	Final Void Ratio (-):	0.53	Mean Effective Consolidation Stress (kPa):	101
Initial Dry Density (t/m^3):	1.81	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

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84 Guthrie Street, Osborne Park

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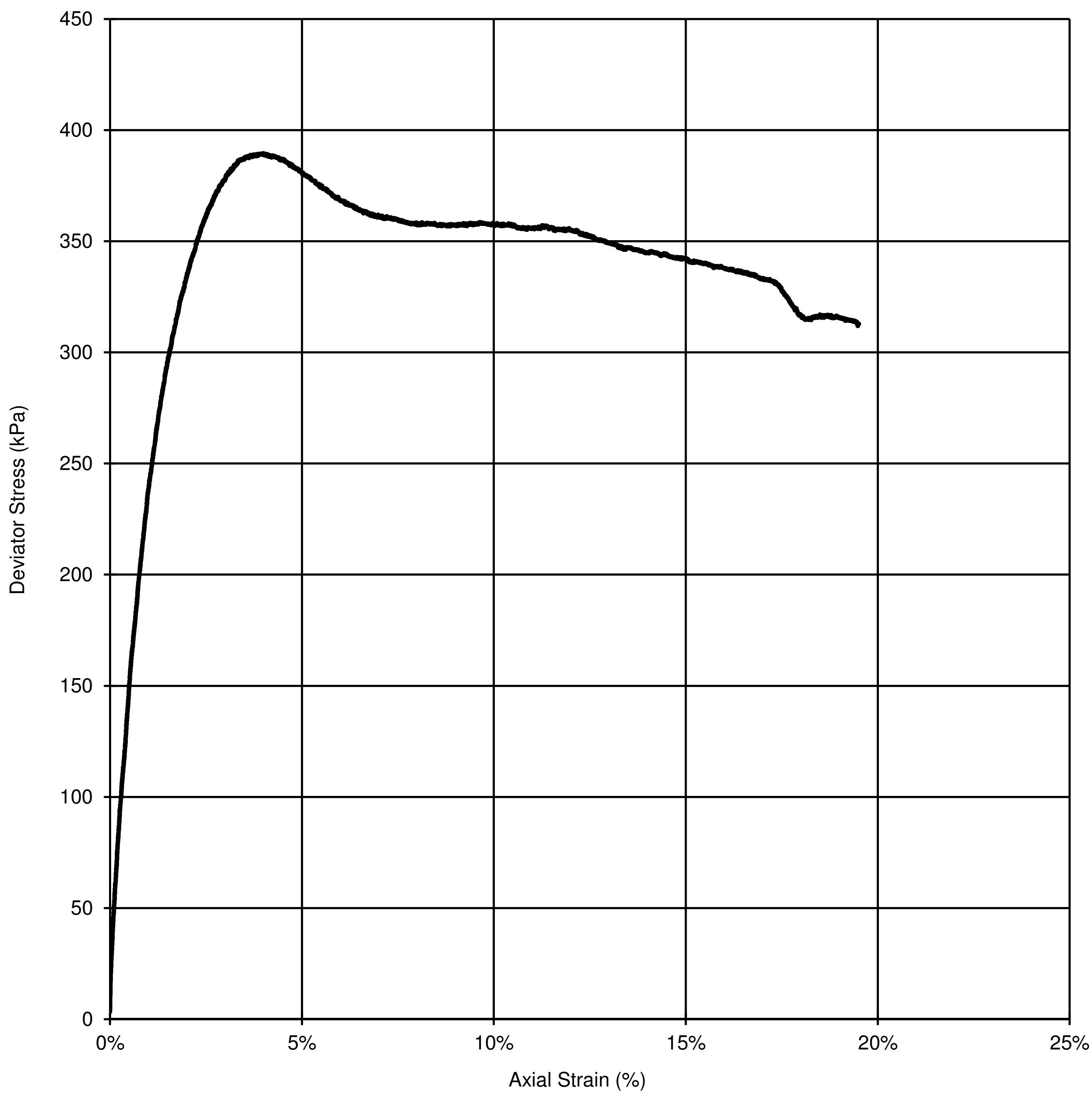
Initial Dry Density (t/m^3):	1.81	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.97



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Triaxial Test Report

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GOLDER

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84 Guthrie Street, Osborne Park

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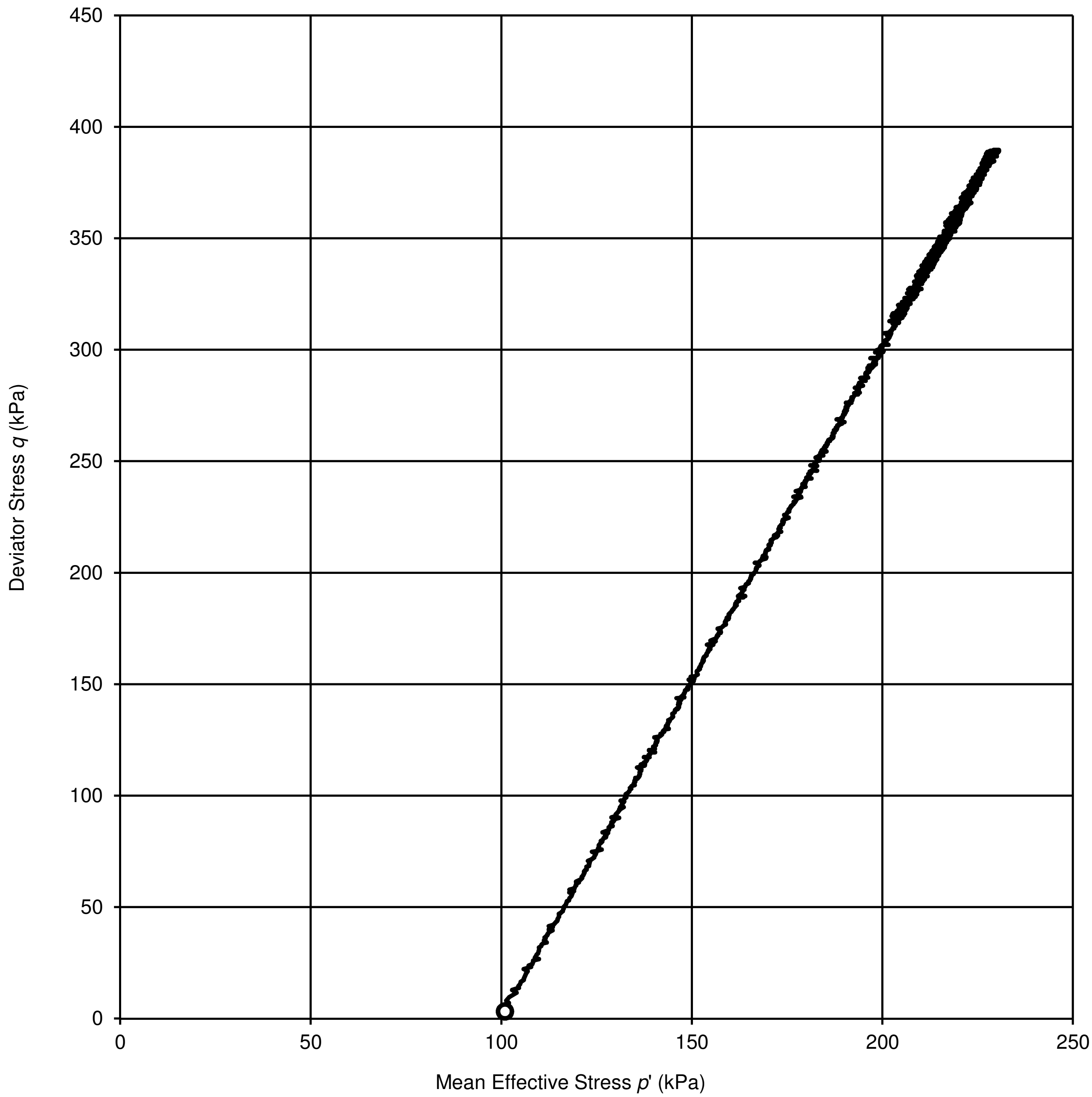

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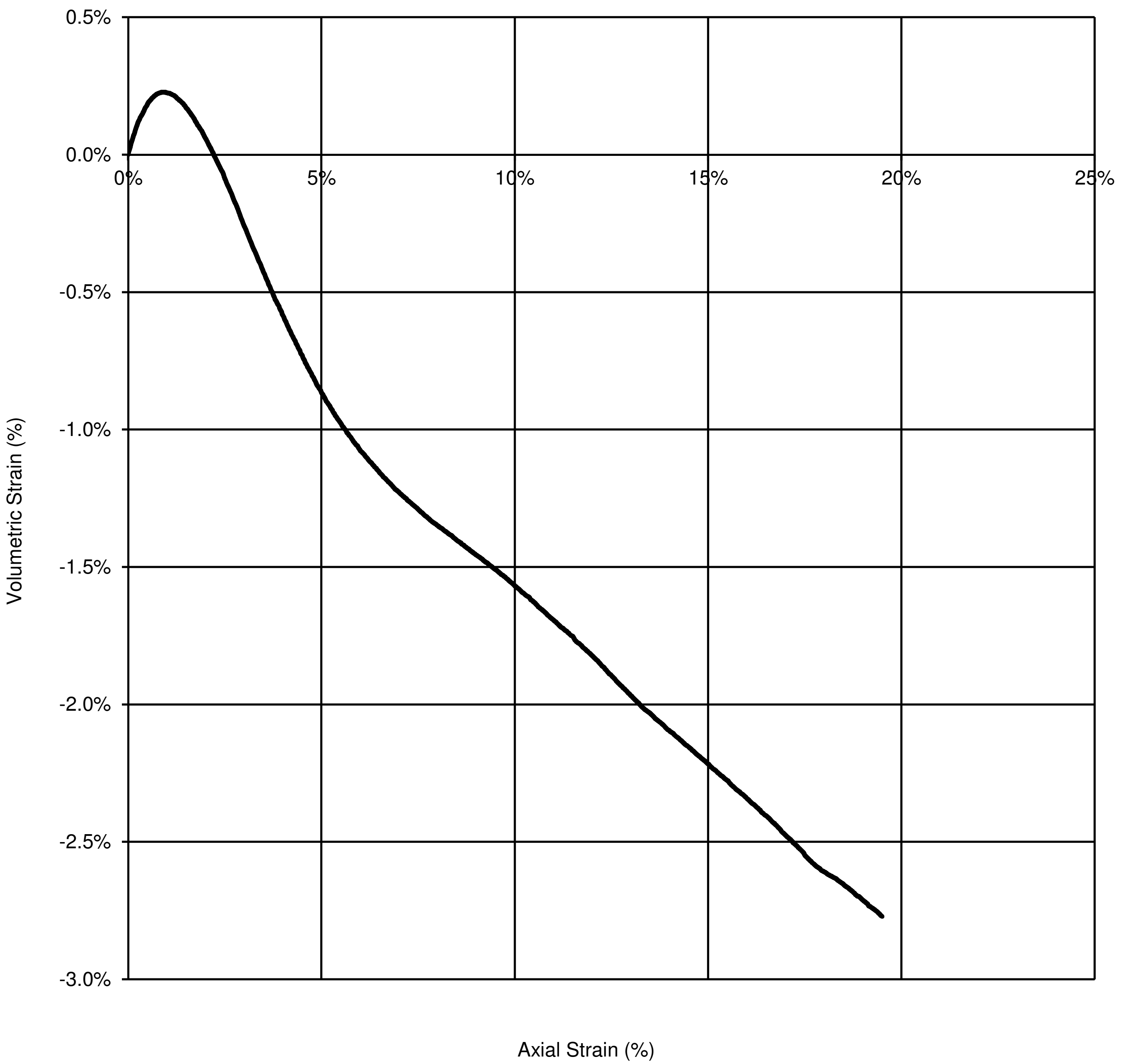

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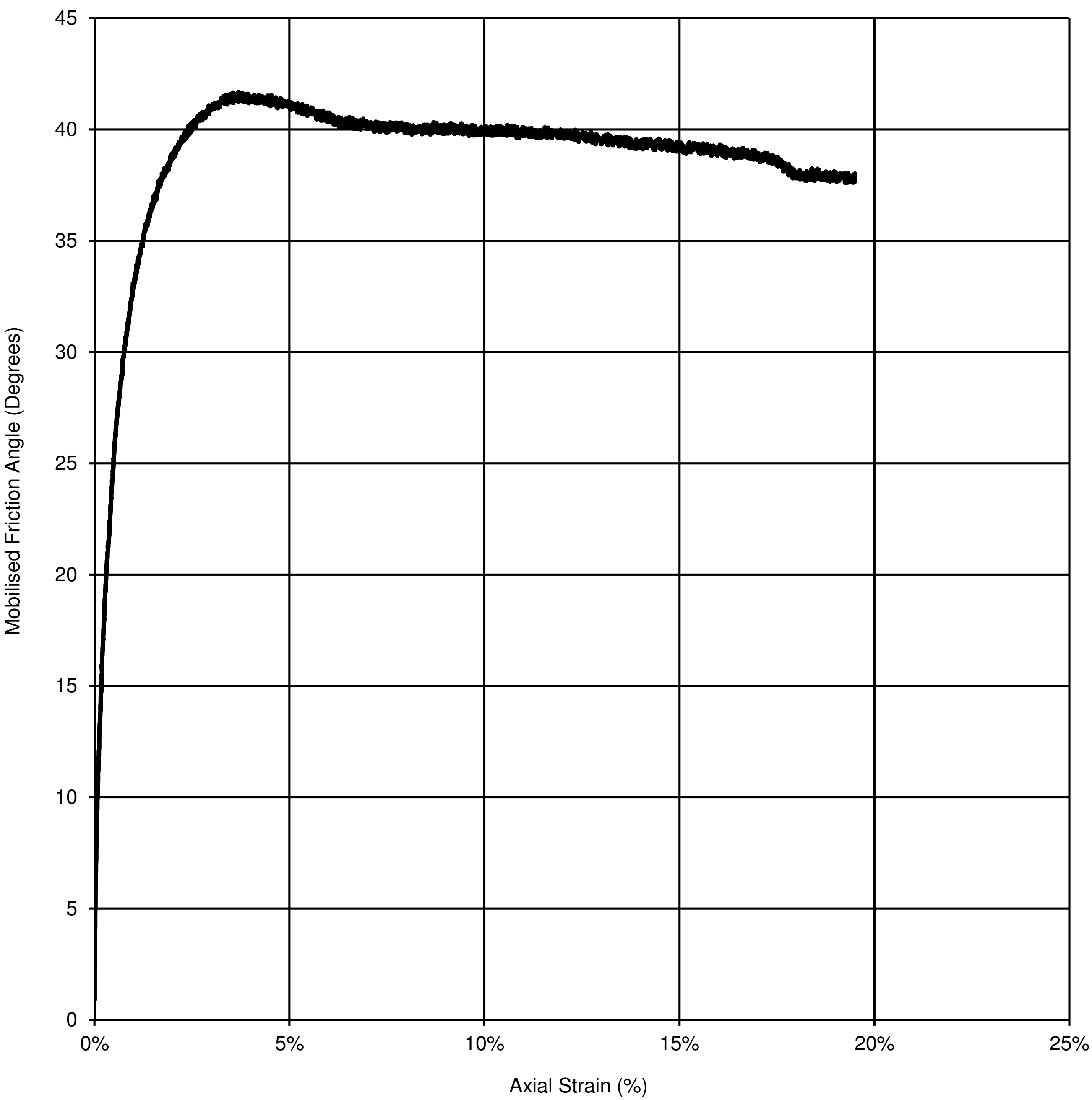

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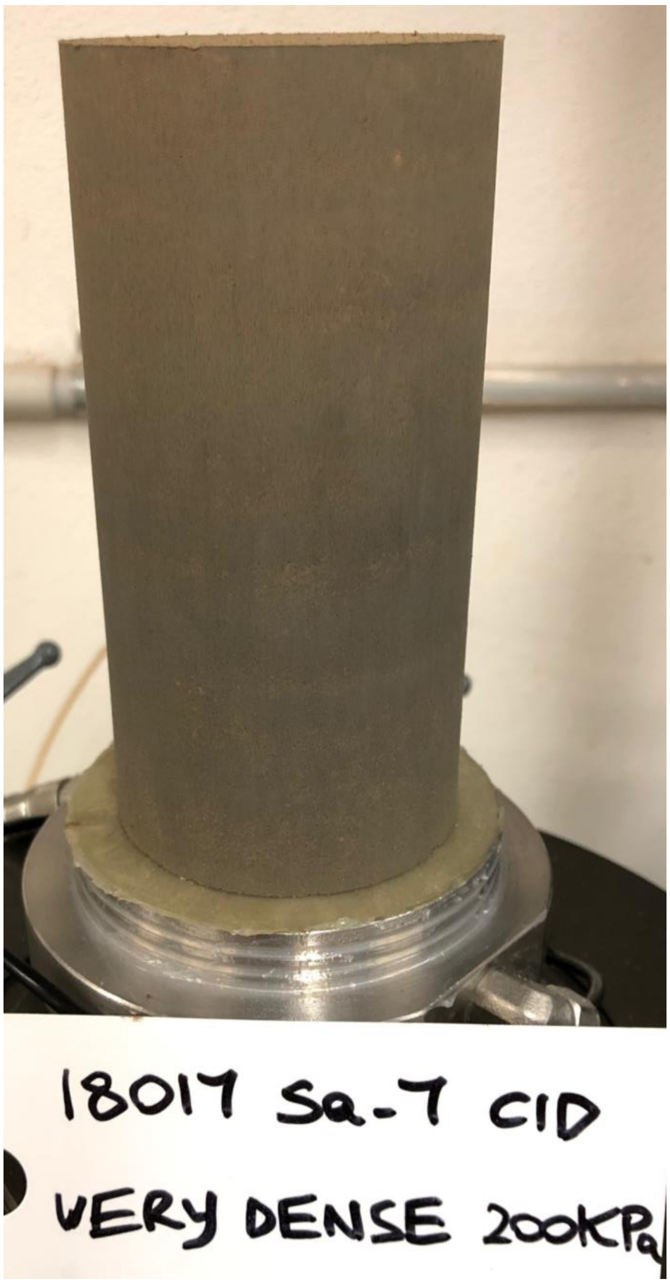
Triaxial Test Report

Isotropically Consolidated Drained (CID)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-7 CID very dense 200kPa

Initial Height (mm):	129.0	Final Liquor Content (%):	16.7%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	63.0	Final Dry Density (t/m^3):	1.85	B Response (%):	96%
Trimmings GWC (%):	12.2%	Final Void Ratio (-):	0.45	Mean Effective Consolidation Stress (kPa):	201
Initial Dry Density (t/m^3):	1.93	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a dense condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
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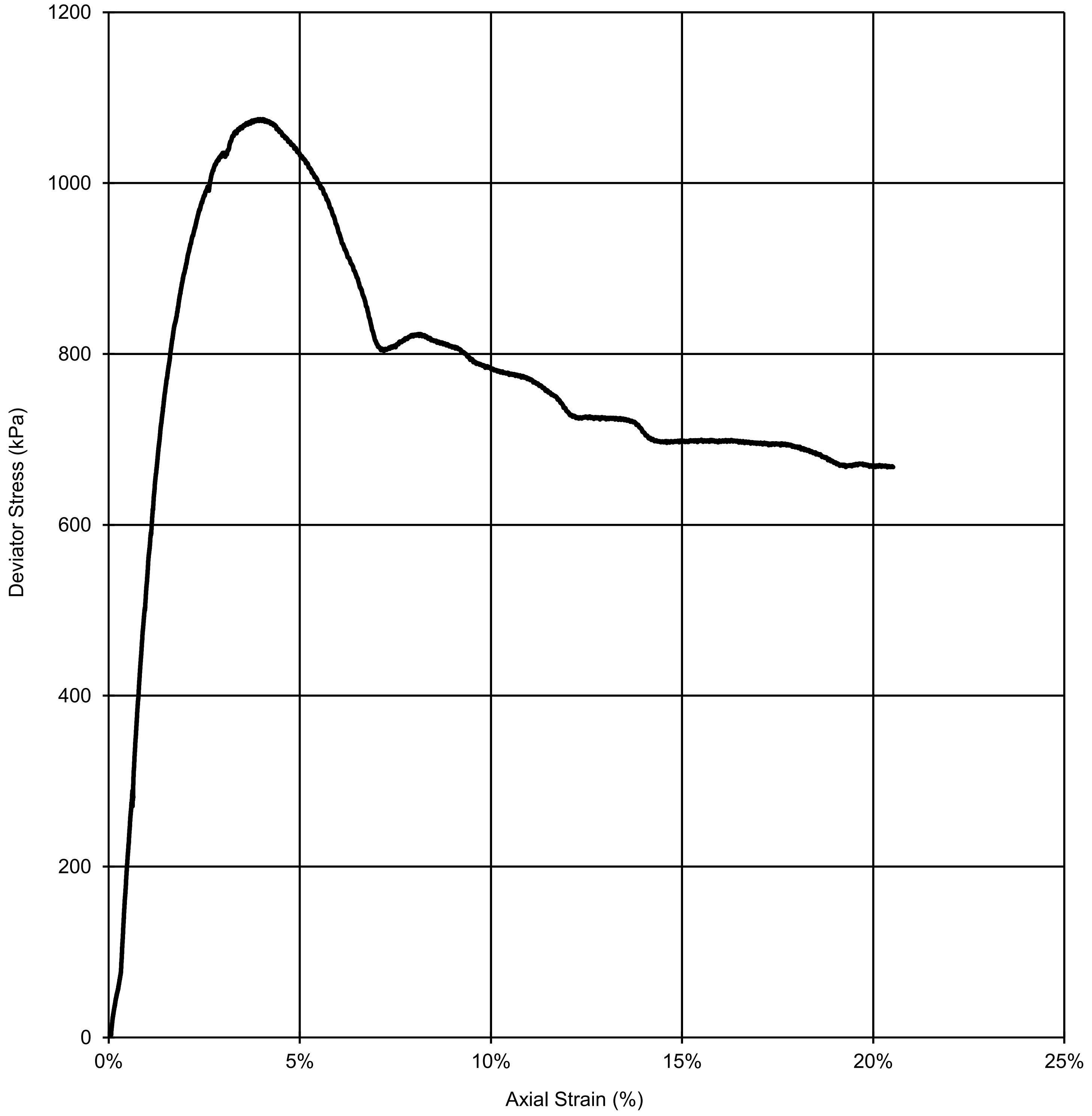

Preparation Notes:	Sample was moist tamped to a dense condition	Tested by:	K. Koh
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Triaxial Test Report

Isotropically Consolidated Drained (CID)

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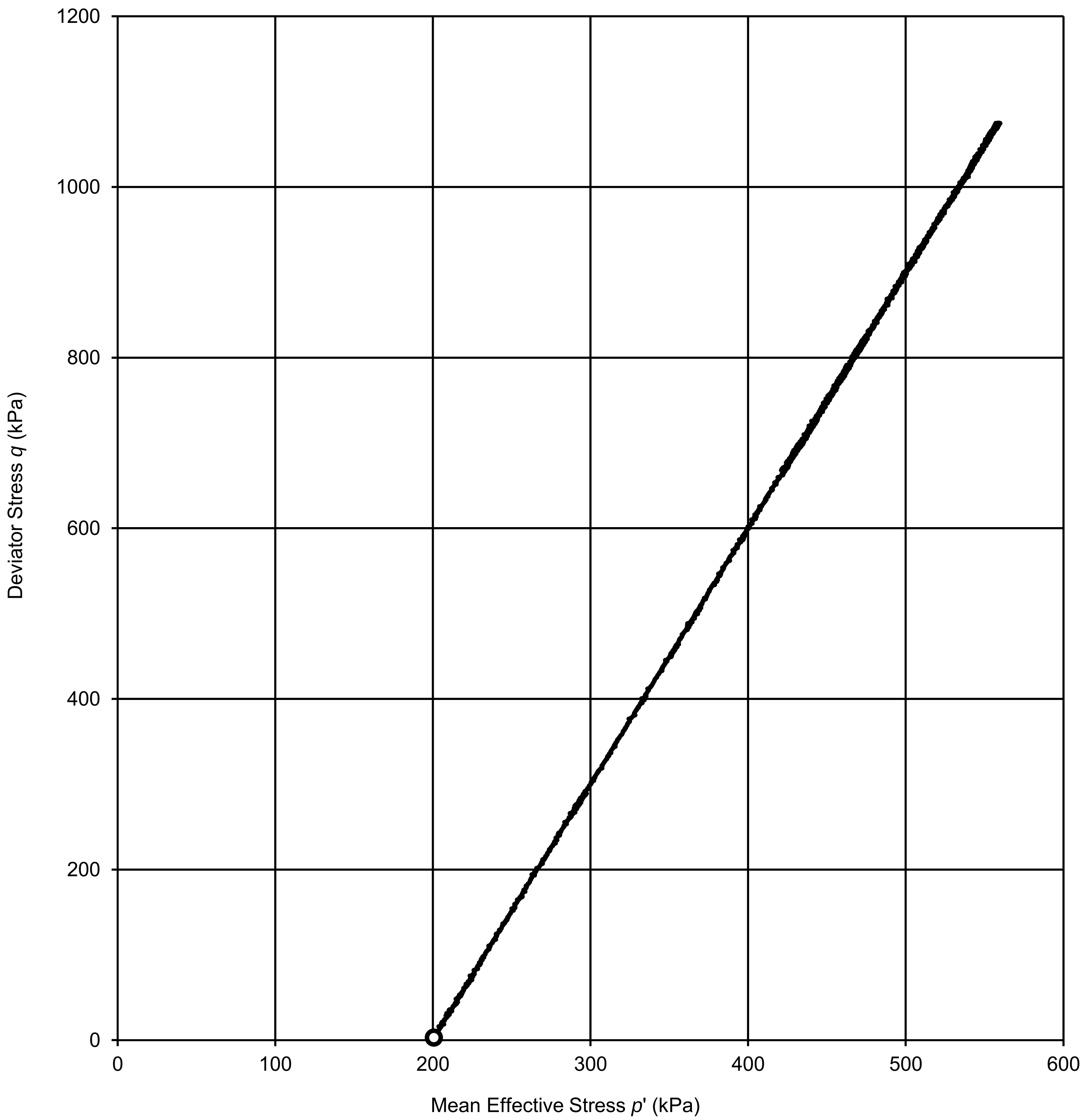

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Triaxial Test Report

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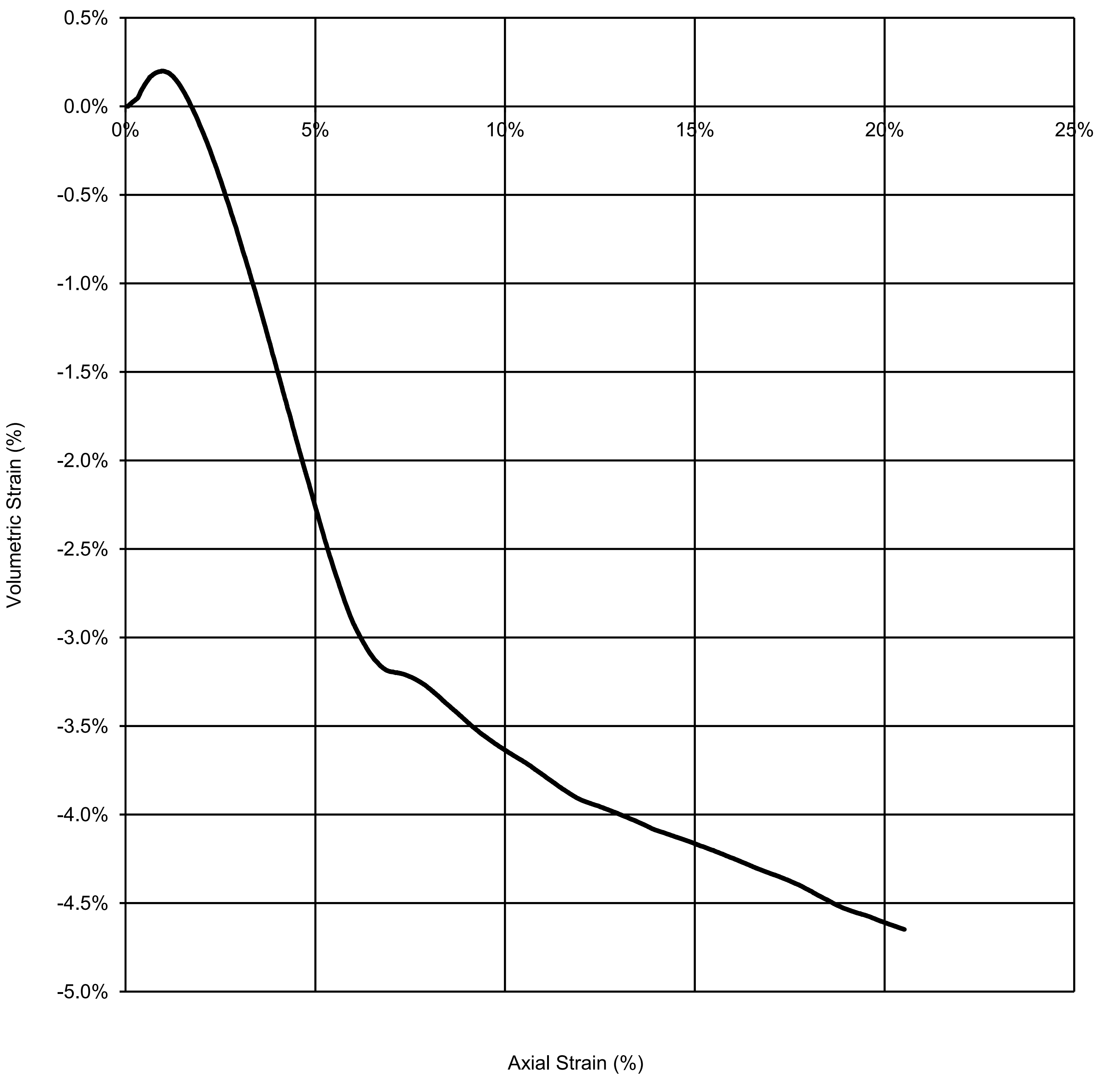

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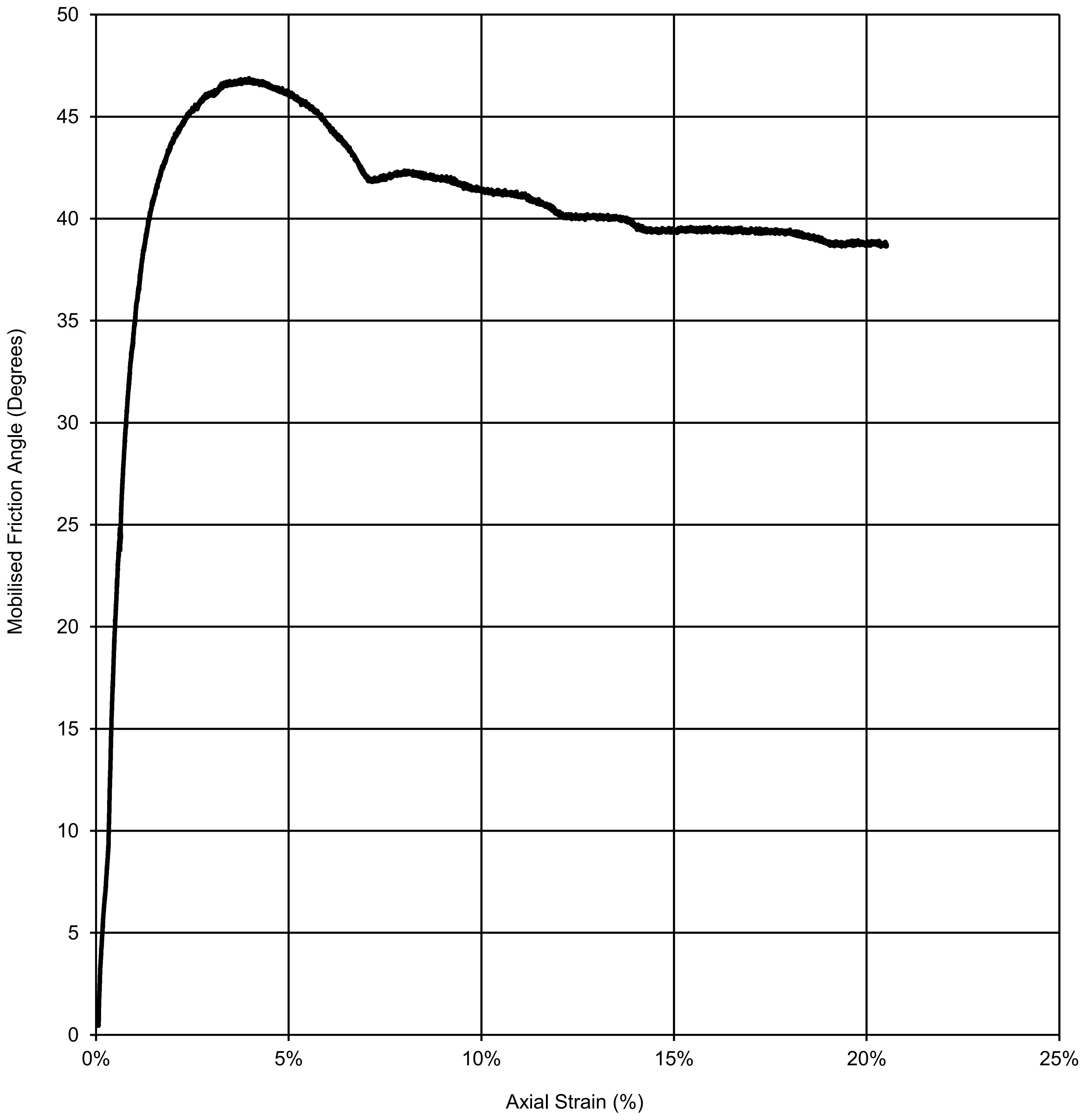

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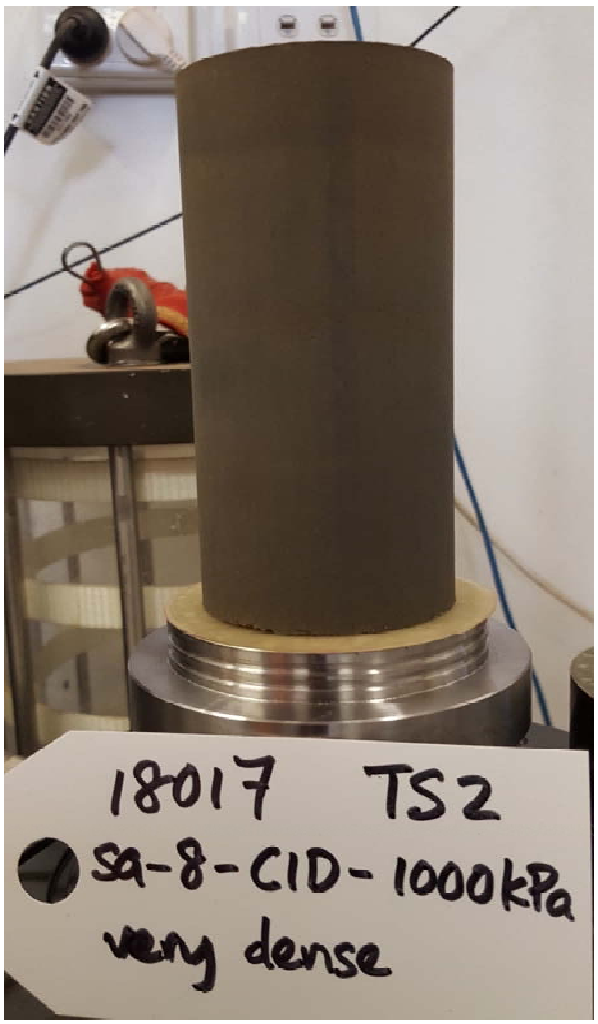
Triaxial Test Report

Isotropically Consolidated Drained (CID)

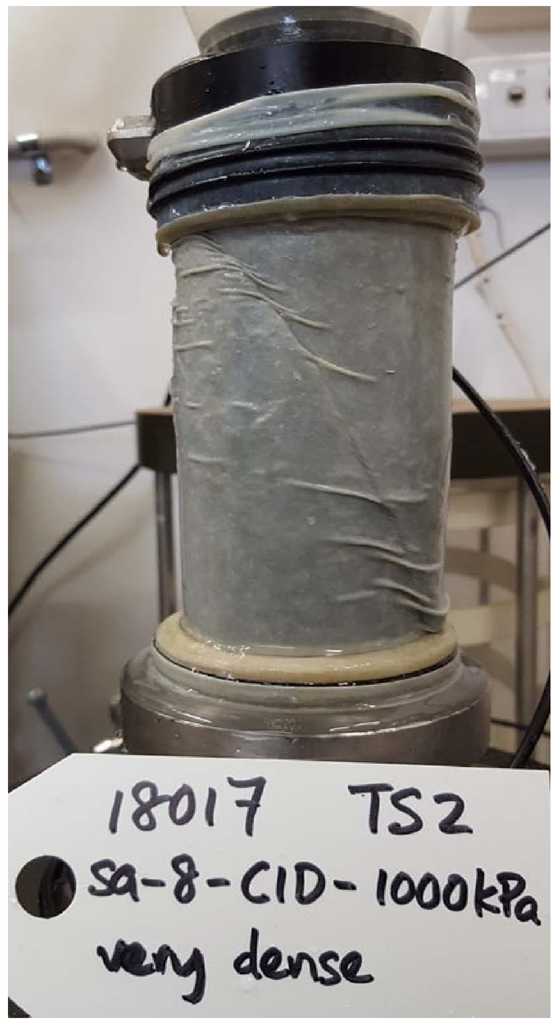
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	5/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TS2
Location:	Cadia Mine	**Test ID:**	18017 - sa-8 CID very dense 1000kPa

Initial Height (mm):	129.3	Final Liquor Content (%):	14.8%	Strain Rate (mm/min):	0.015
Initial Diameter (mm):	62.9	Final Dry Density (t/m^3):	1.93	B Response (%):	97%
Trimmings GWC (%):	12.3%	Final Void Ratio (-):	0.40	Mean Effective Consolidation Stress (kPa):	1001
Initial Dry Density (t/m^3):	1.95	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Sample Before Test



Sample After Test

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
		Reviewed by:	R.Fanni

Triaxial Test Report

Isotropically Consolidated Drained (CID)

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

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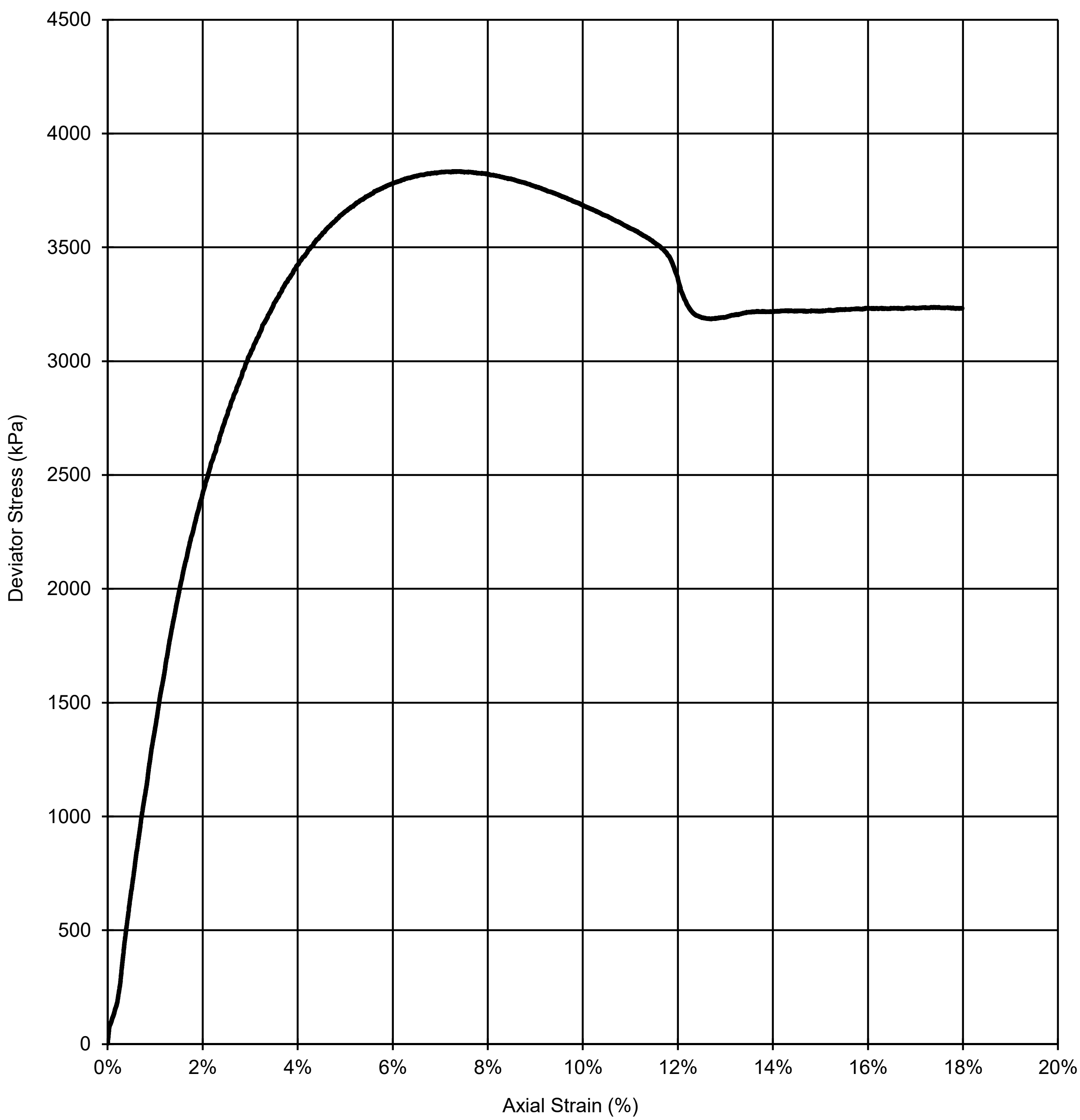

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Triaxial Test Report

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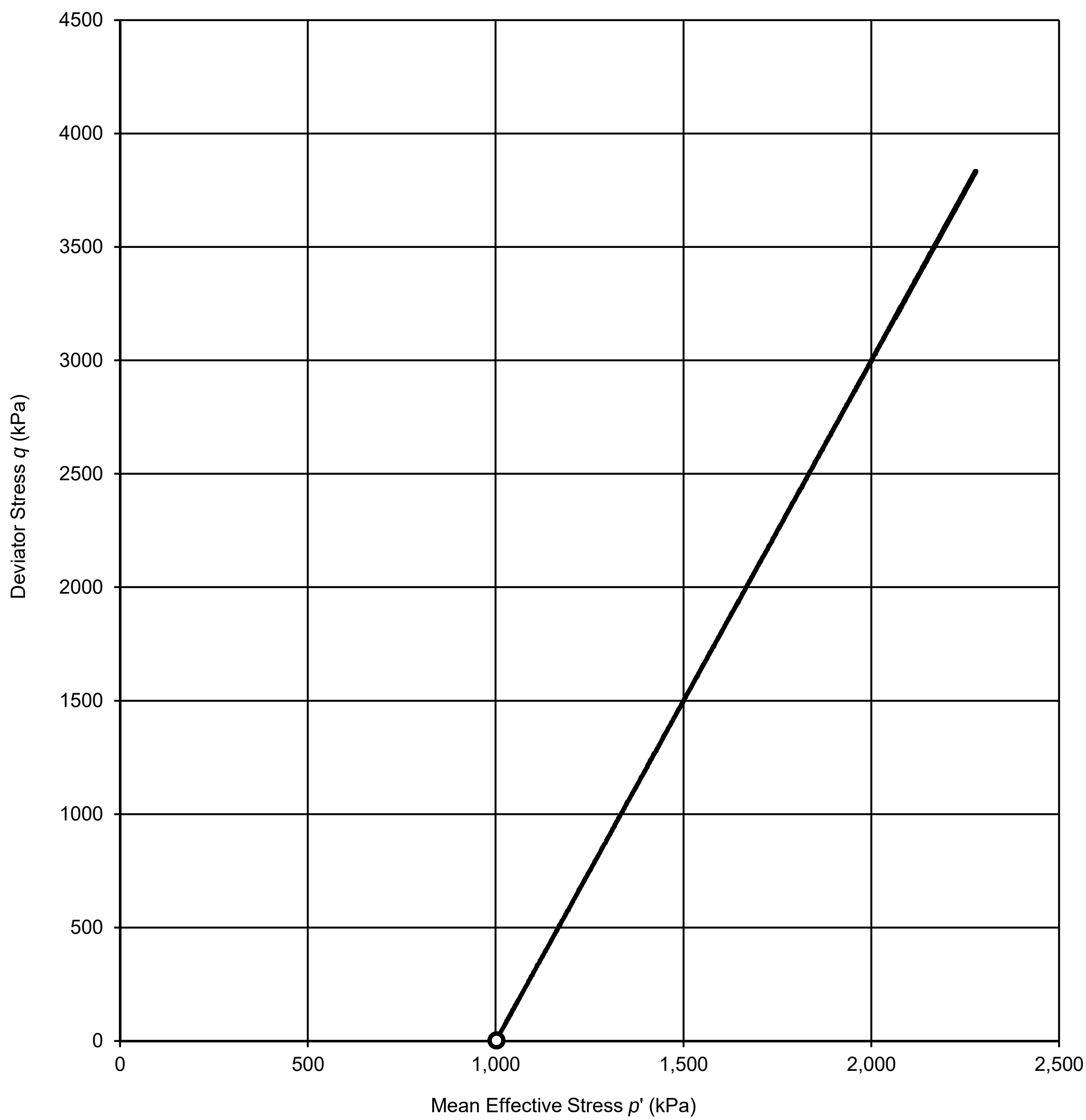

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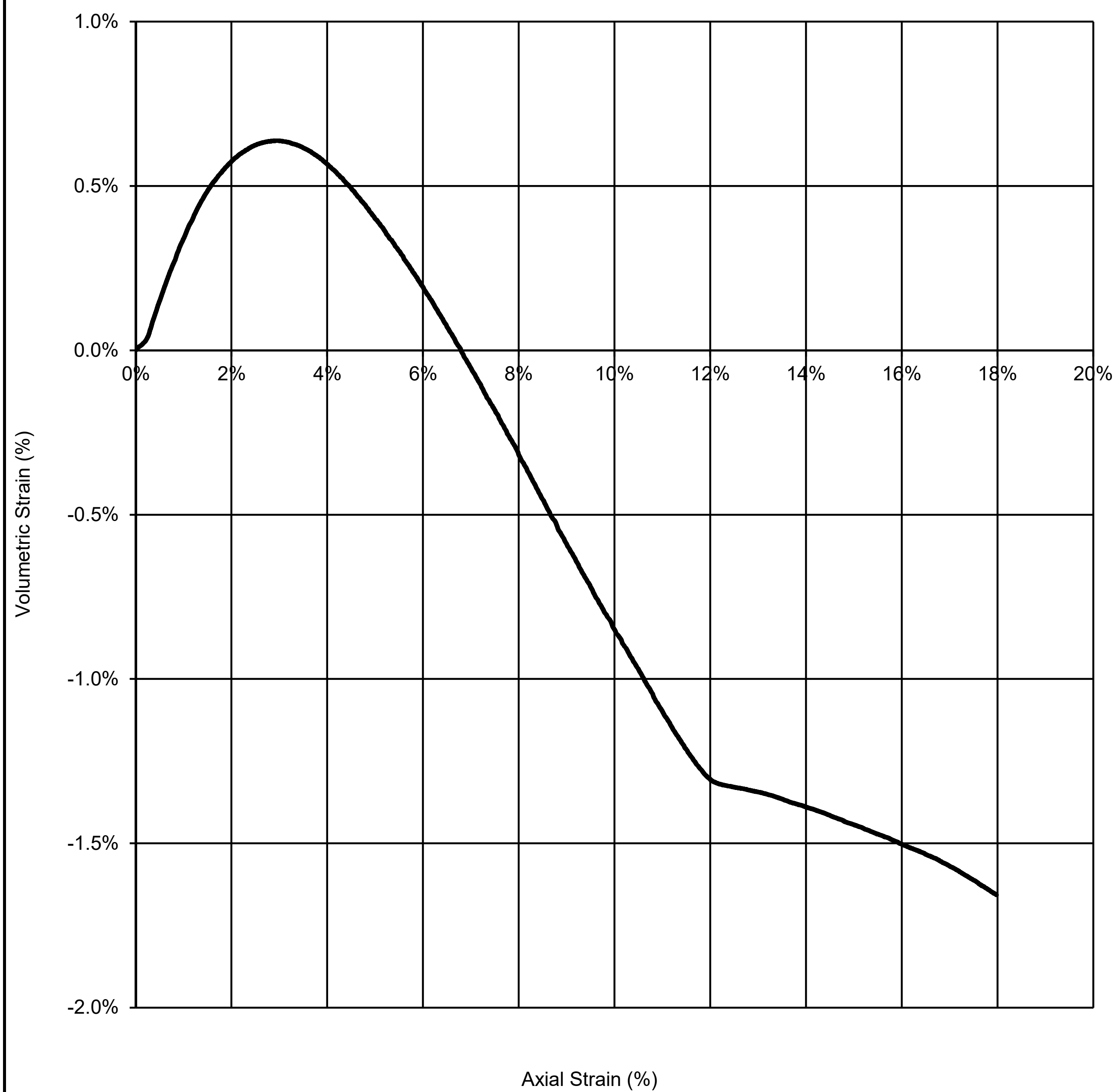

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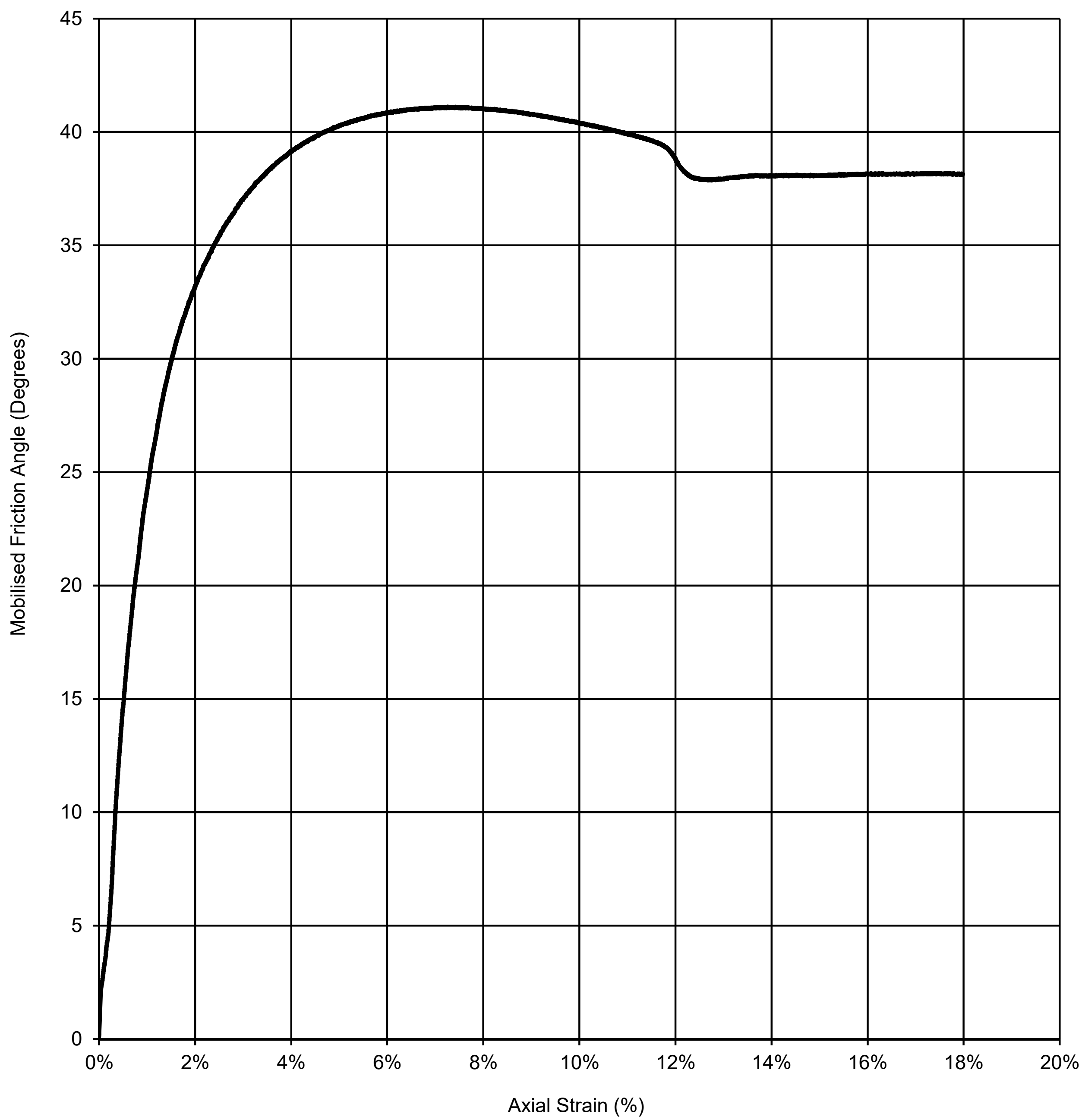

Preparation Notes:	Sample was moist tamped	Tested by:	K. Koh
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Annexure EI
TC2 – CSL Test Certificates

Klohn Crippen Berger

Triaxial CIU Test - Summary

(ASTM D4767)

PROJECT NO. :	A03353A01	DATE :	2019-01-18
PROJECT :	NWM CVO NTSF	TESTED BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
Details:	ei = 0.85		

SPECIMEN INFORMATION	UNITS	Initial	Vacuum	Saturation	B-value	End of 1st Consolidation	End of 2nd Consolidation	End of 3rd Consolidation	At Maximum Stress Ratio	End of Shear		
Specimen Height	mm	140.01	140.27	137.00	136.47	134.82	133.72	132.58	115.27	95.19		
Specimen Diameter	mm	69.80	69.64	67.09	67.22	66.41	65.92	65.45	70.19	77.25		
Area	cm^2	38.26	38.09	35.35	35.49	34.64	34.13	33.65	38.70	46.86		
Volume	cm^3	535.75	534.28	484.28	484.28	467.06	456.42	446.08	446.08	446.08		
Wet Weight	g	836.76	836.76	974.56	981.51	964.28	953.65	943.31	943.31	943.31		
Water Content	%	6.65	6.65	24.21	25.10	22.90	21.55	20.23	20.23	20.23		
Dry Weight	g	784.59	784.59	784.59	784.59	784.59	784.59	784.59	784.59	784.59		
Wet Density	g/cm^3	1.562	1.566	2.012	2.027	2.065	2.089	2.115	2.115	2.115		
Dry Density	g/cm^3	1.464	1.468	1.620	1.620	1.680	1.719	1.759	1.759	1.759		
Specific Gravity of Solids	-	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73		
Solids Volume	cm^3	287.394	287.394	287.394	287.394	287.394	287.394	287.394	287.394	287.394		
Void Volume	cm^3	248.353	246.890	196.890	196.890	179.662	169.029	158.688	158.688	158.688		
Water Volume	cm^3	52.175	52.175	189.975	196.926	179.698	169.065	158.724	158.724	158.724		
Void Ratio (e)	-	0.864	0.859	0.685	0.685	0.625	0.588	0.552	0.552	0.552		
Saturation Ratio (Sr)	%	21.01	21.13	96.49	100.02	100.02	100.02	100.02	100.02	100.02		
Effective Confining Stress	kPa					50	100	200				

Shearing (CU)		
Skempton's B Parameter		0.98
Back Pressure before shearing	kPa	600.0
Confining Stress (σ_3') before shearing	kPa	200
Shear Strain Rate	mm / min	0.0185

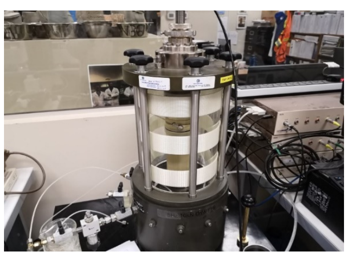
At Maximum Stress Ratio		
Axial Stain	%	13.06
Deviator Stress	kPa	133.8
Φ '	º	37.5
c' (assumed)	kPa	0

At Maximum Deviator Stress:		
Axial Stain	%	28.19
Deviator Stress	kPa	177.5
Φ '	º	35.8
c' (assumed)	kPa	0

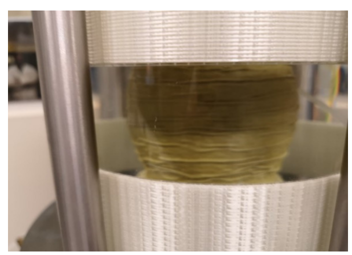
Note: *using cambridge method*

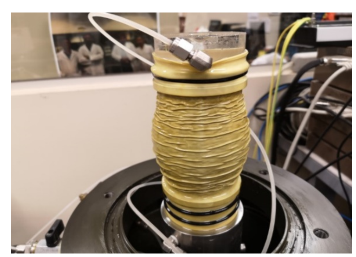
Test Photos:

Before Test



After Test



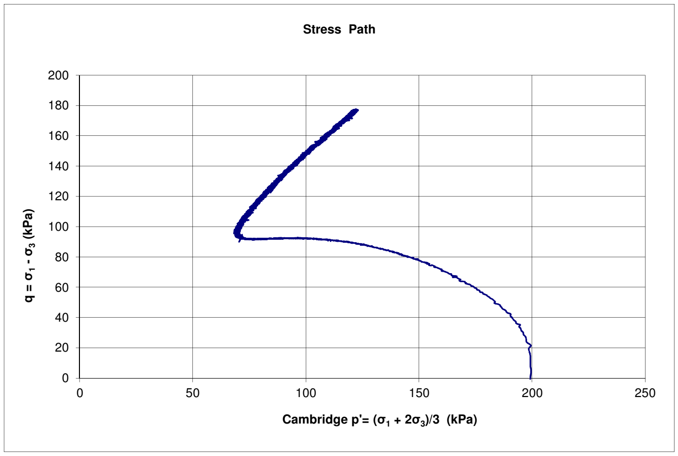


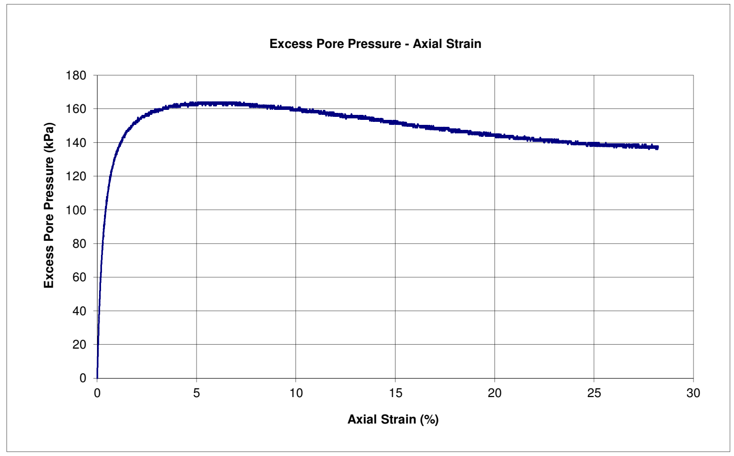
Klohn Crippen Berger

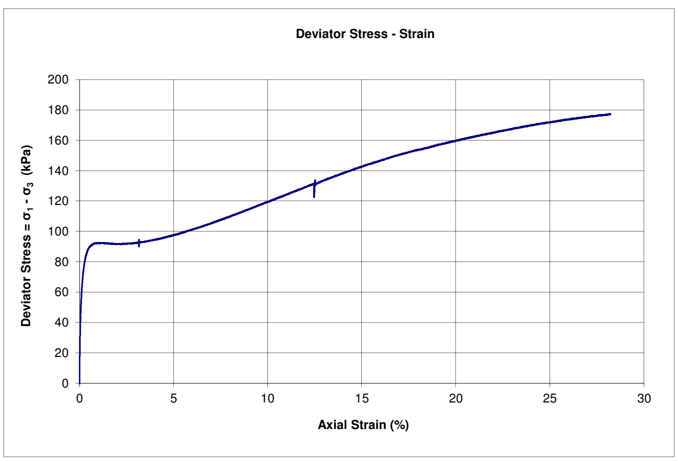
Triaxial CIU Test - Charts

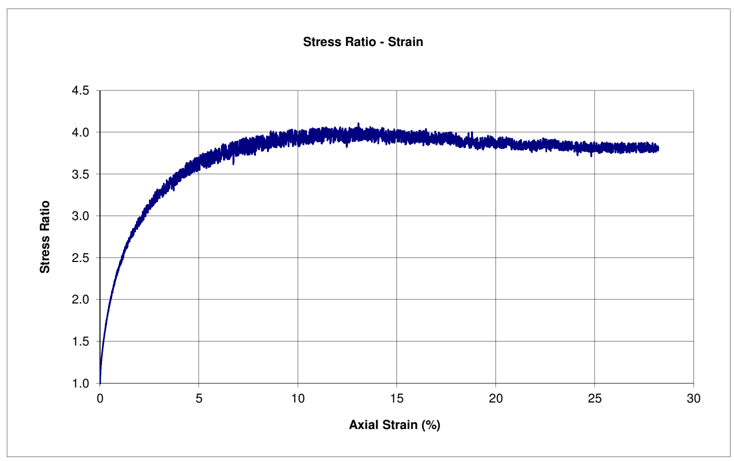
(ASTM D4767)

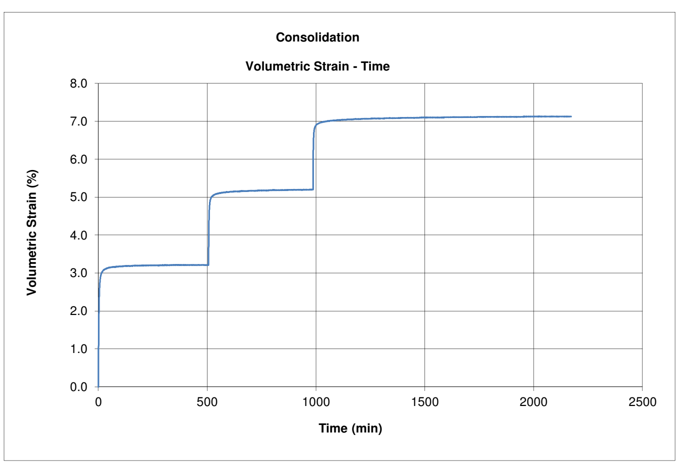
PROJECT NO. :	A03353A01	DATE :	2019-01-18
PROJECT :	NWM CVO NTSF	TEST BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
Details:	ei = 0.85		

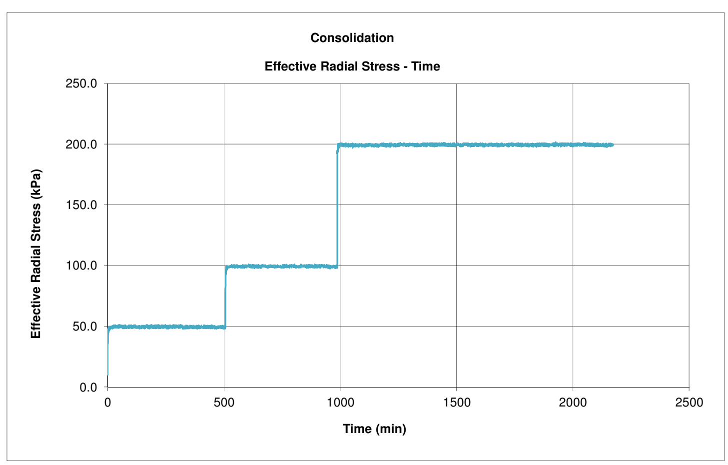




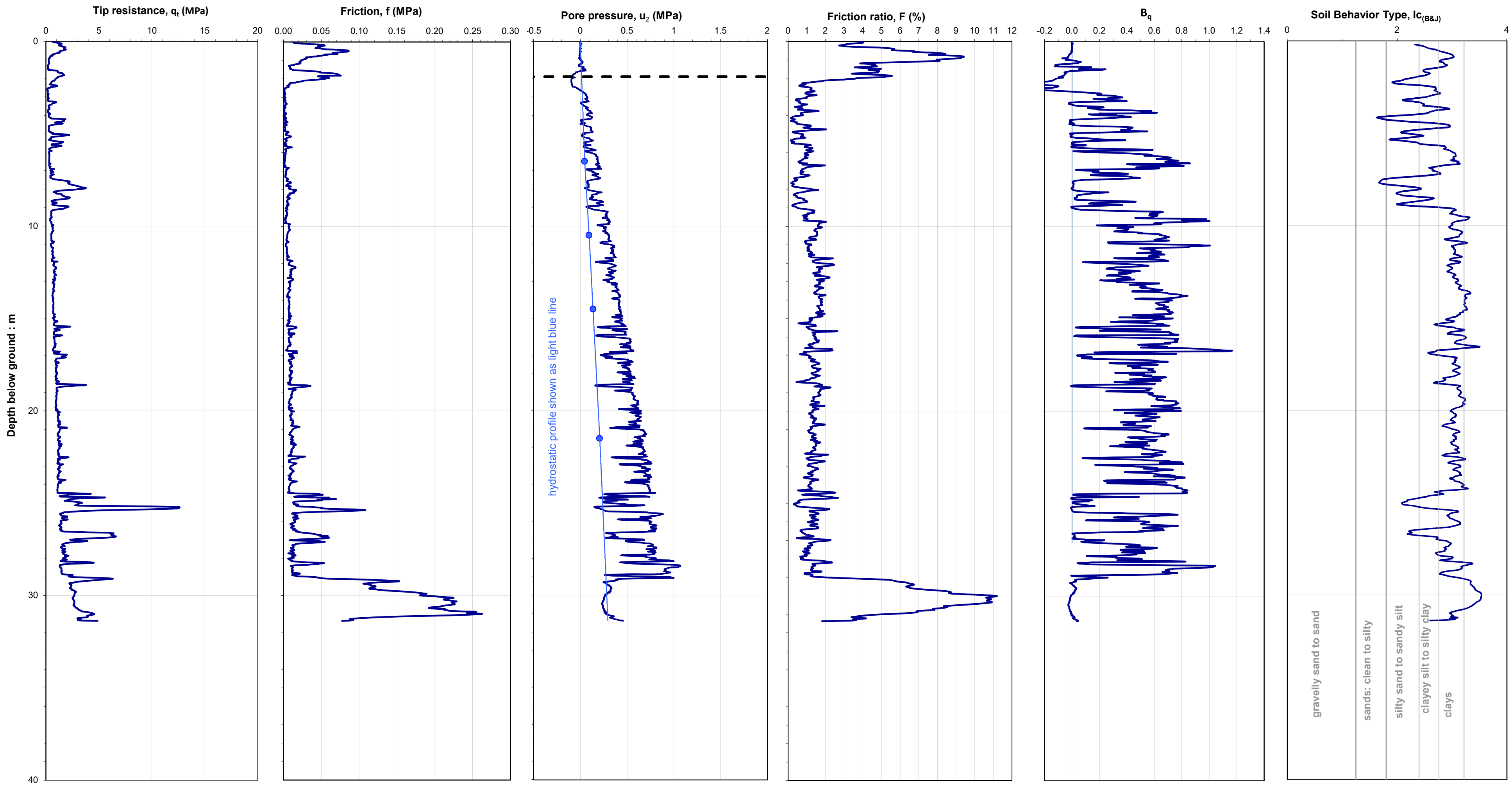








Annexure EJ
Interpreted CPTu



Test Information

Test code:	CPT-N1-1
Depth to Water:	1.9 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

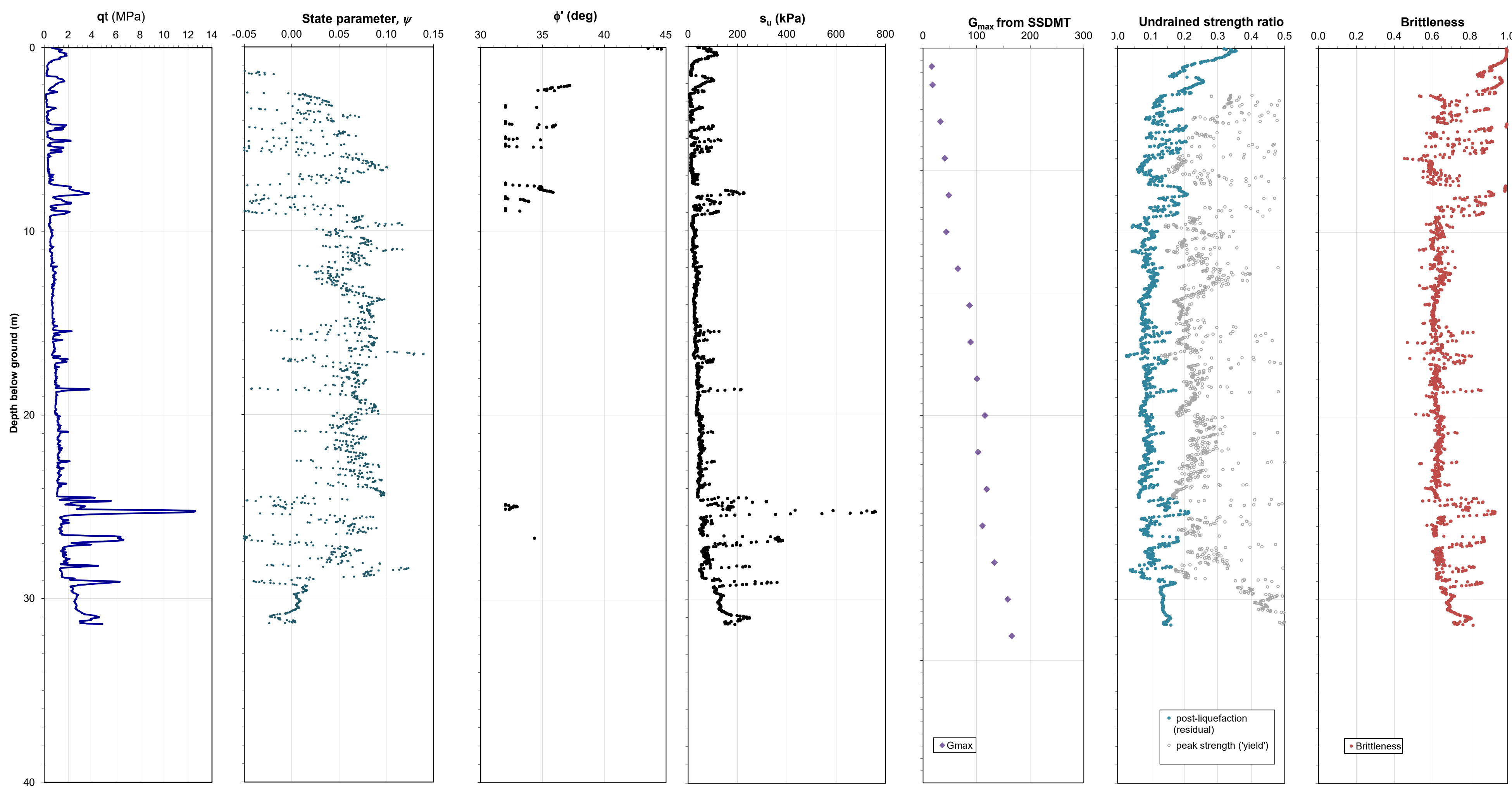
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N1-1

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ1**



Test Information

Test code:	CPT-N1-1
Depth to Water:	1.9 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

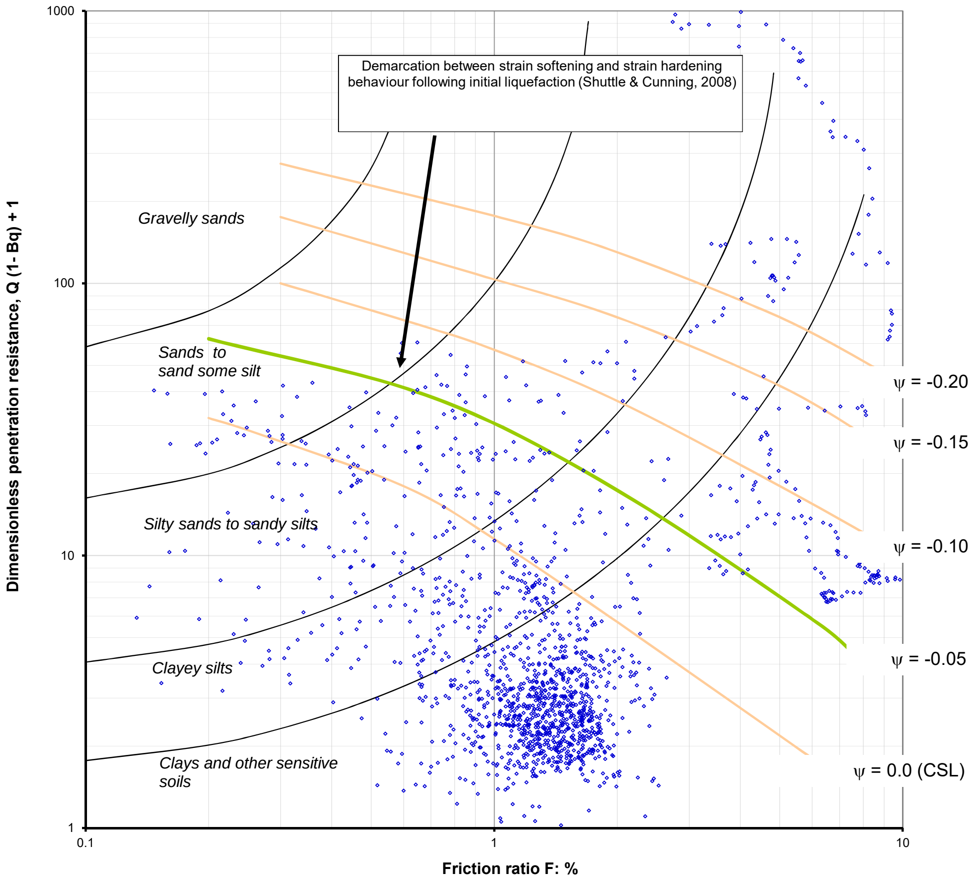
Interpreted Results of CPTu Sounding CPT-N1-1

Drawn by: BM

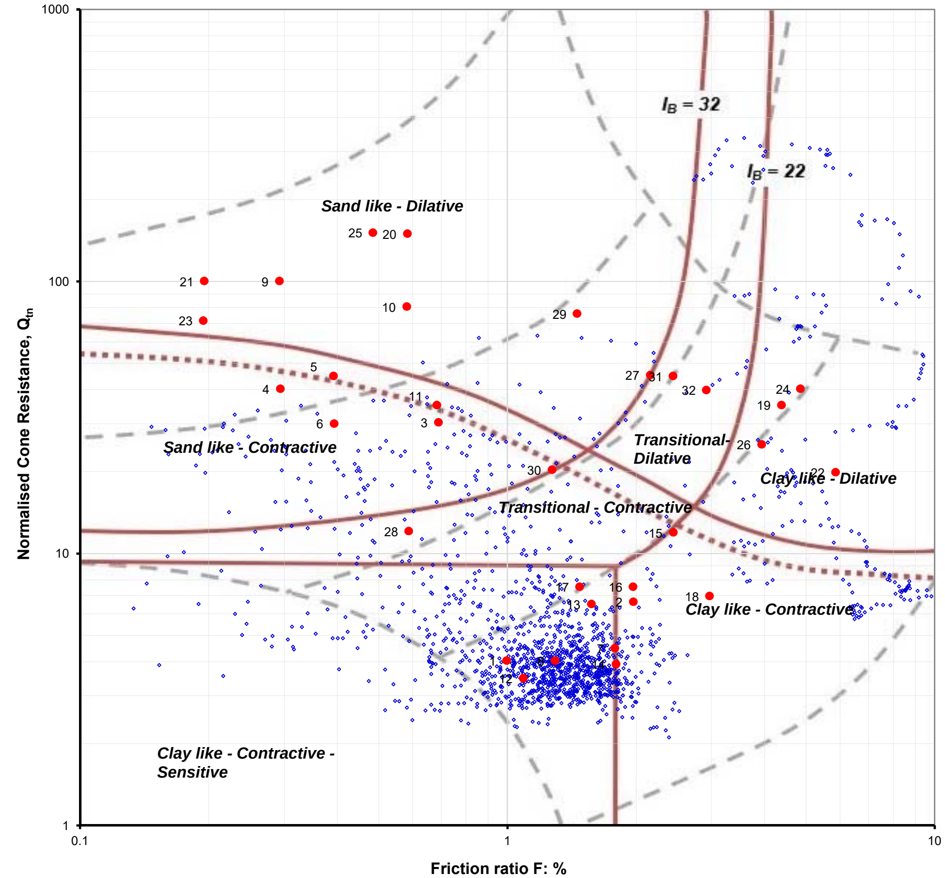
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ2



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*F*r (Roberston, 2016)

Test Information

Test code:	CPT-N1-1
Depth to Water:	1.9 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

- **Unit A**
- **Unit B**
- **Unit C**
- Hydrostatic pressure
- Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

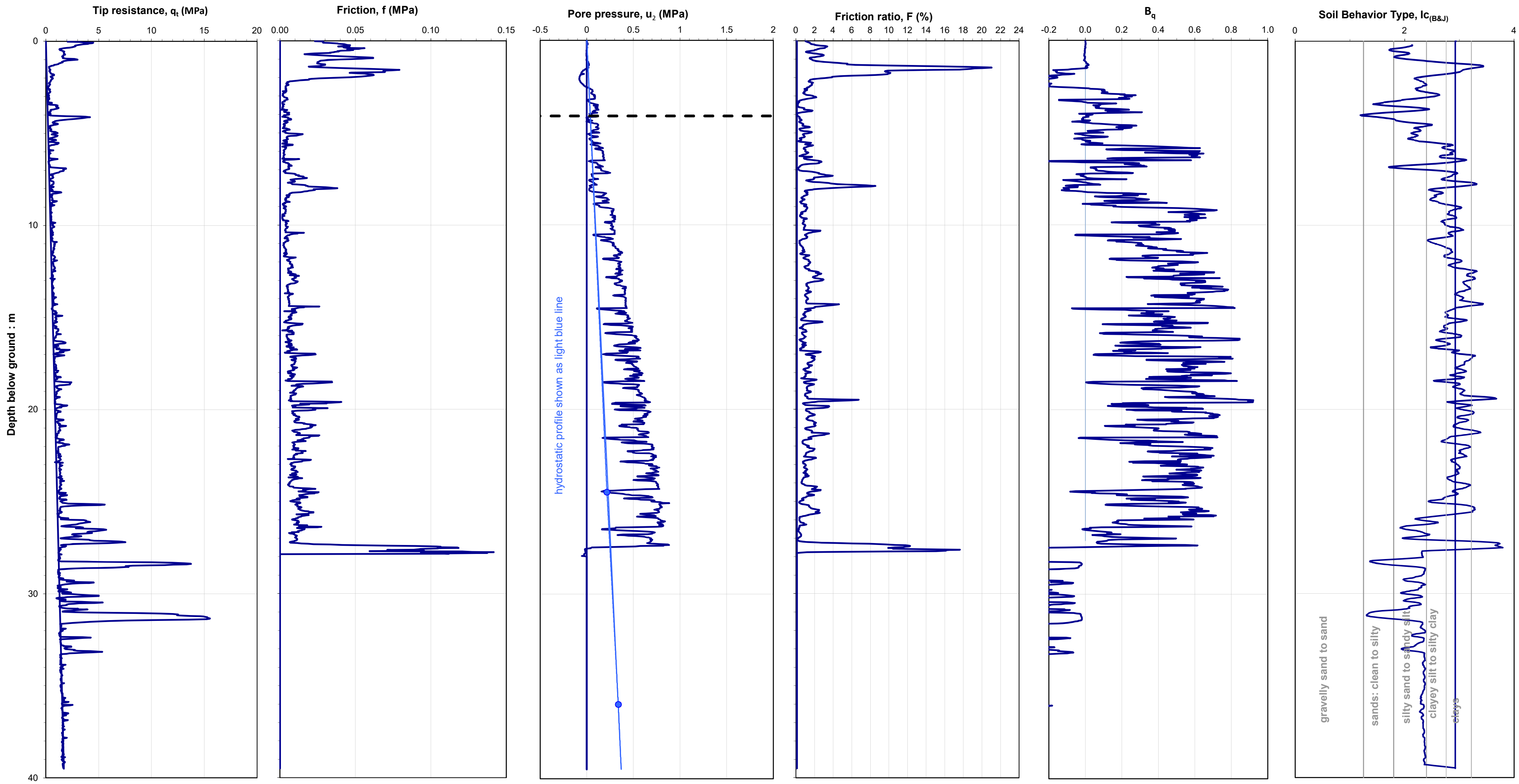
Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N1-1

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ3



Test Information

Test code:	CPT-N2-1
Depth to Water:	4.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

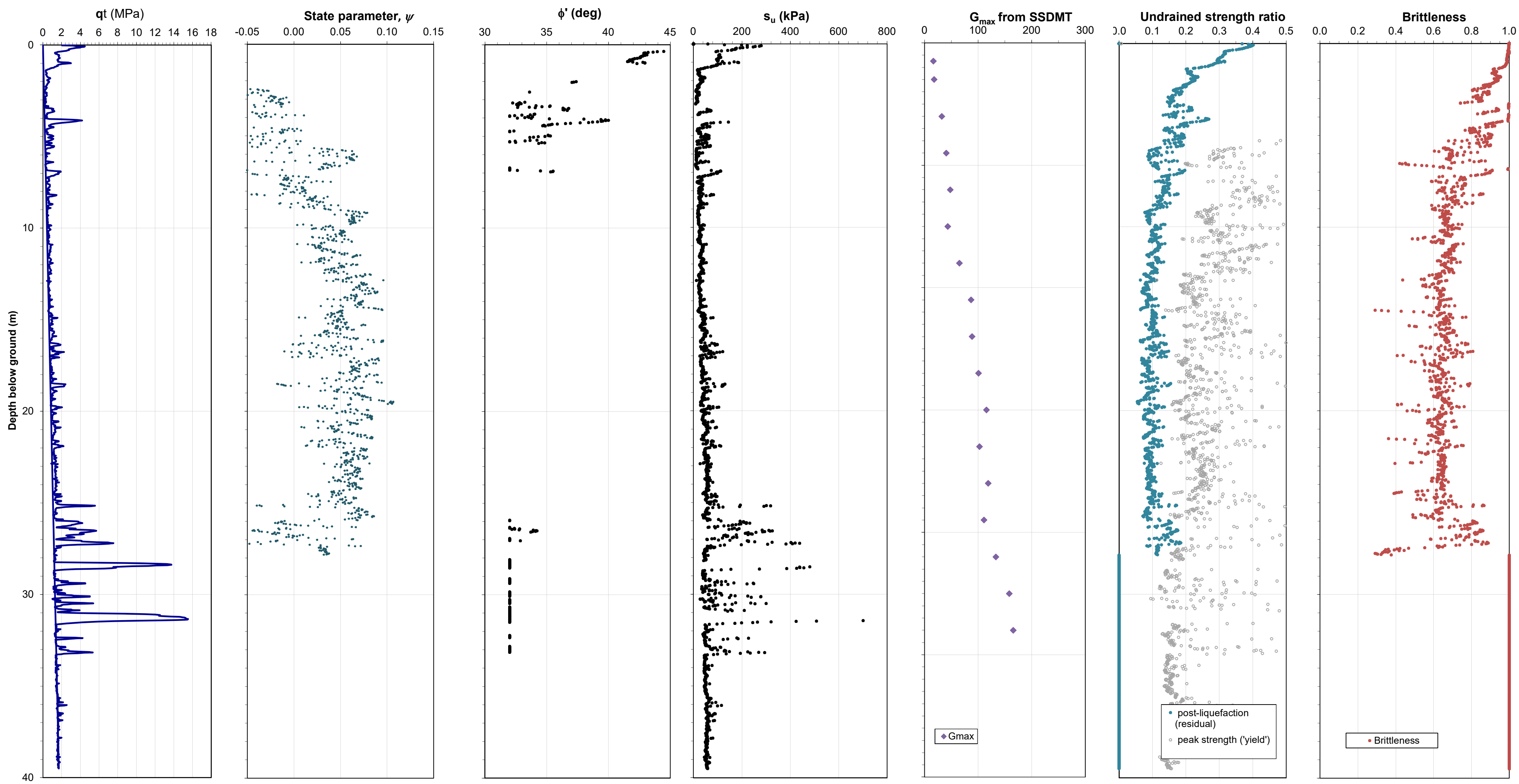
Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N2-1

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ4



Test Information

Test code:	CPT-N2-1
Depth to Water:	4.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

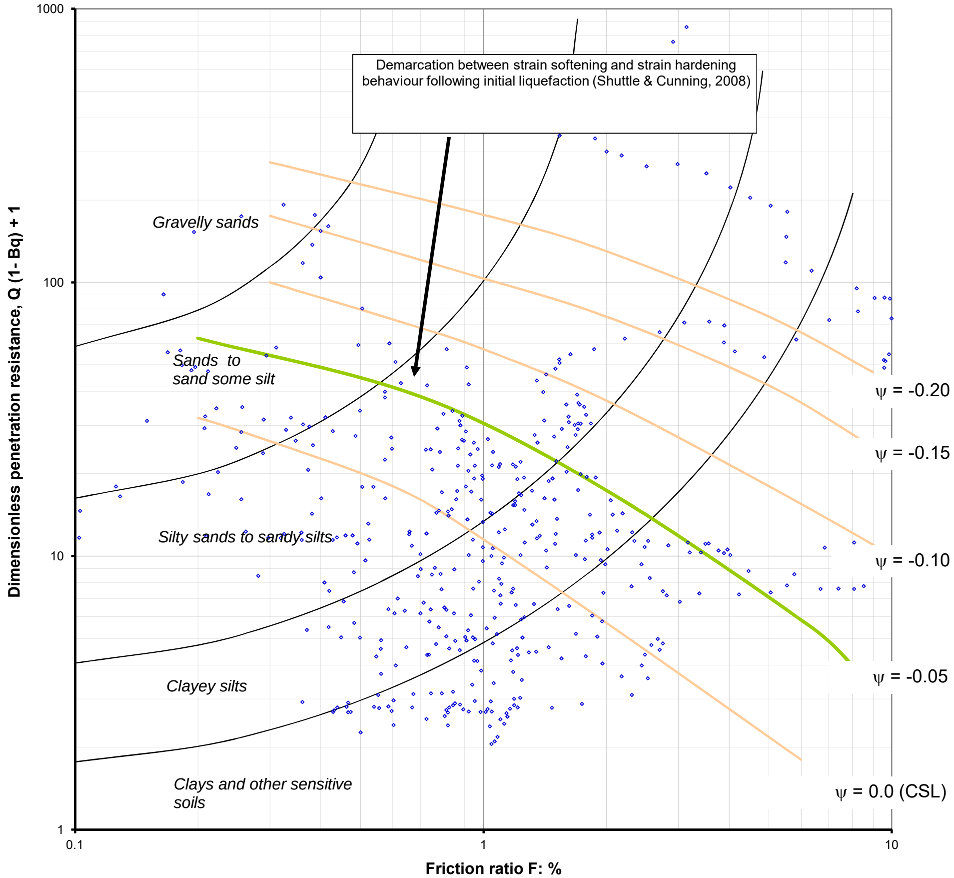
Interpreted Results of CPTu Sounding CPT-N2-1

Drawn by: BM

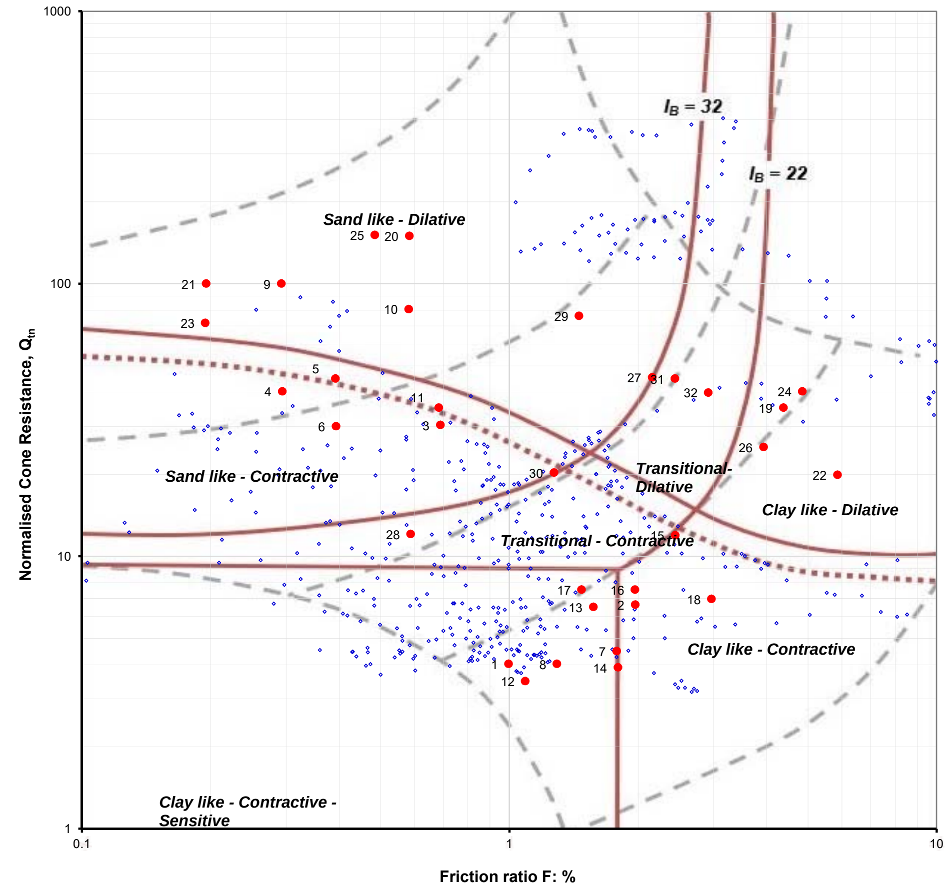
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ5



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N2-1
Depth to Water:	4.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

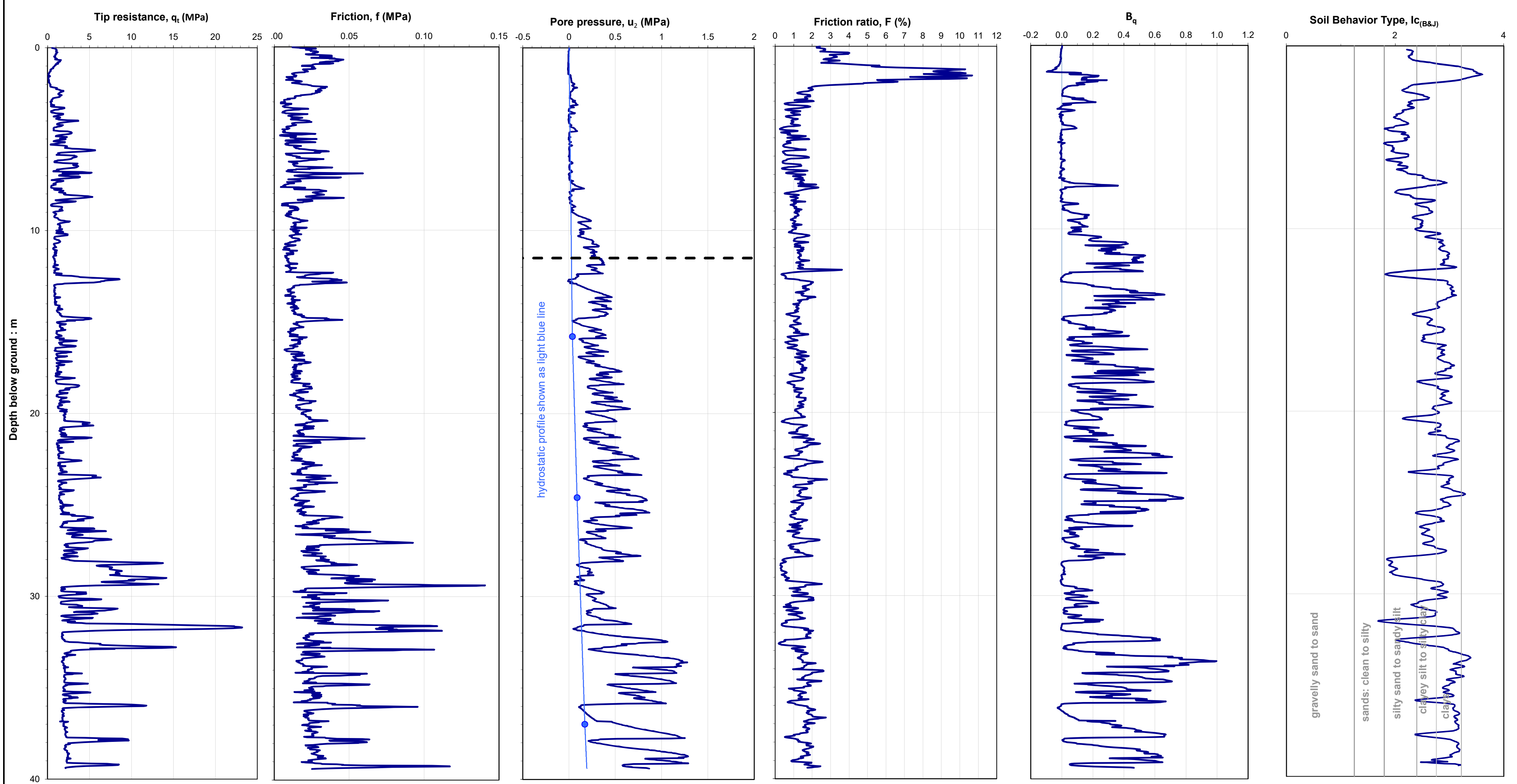
Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016)
Plot for CPT-N2-1

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ46**



Test Information

Test code:	CPT-N3-1
Depth to Water:	11.5 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

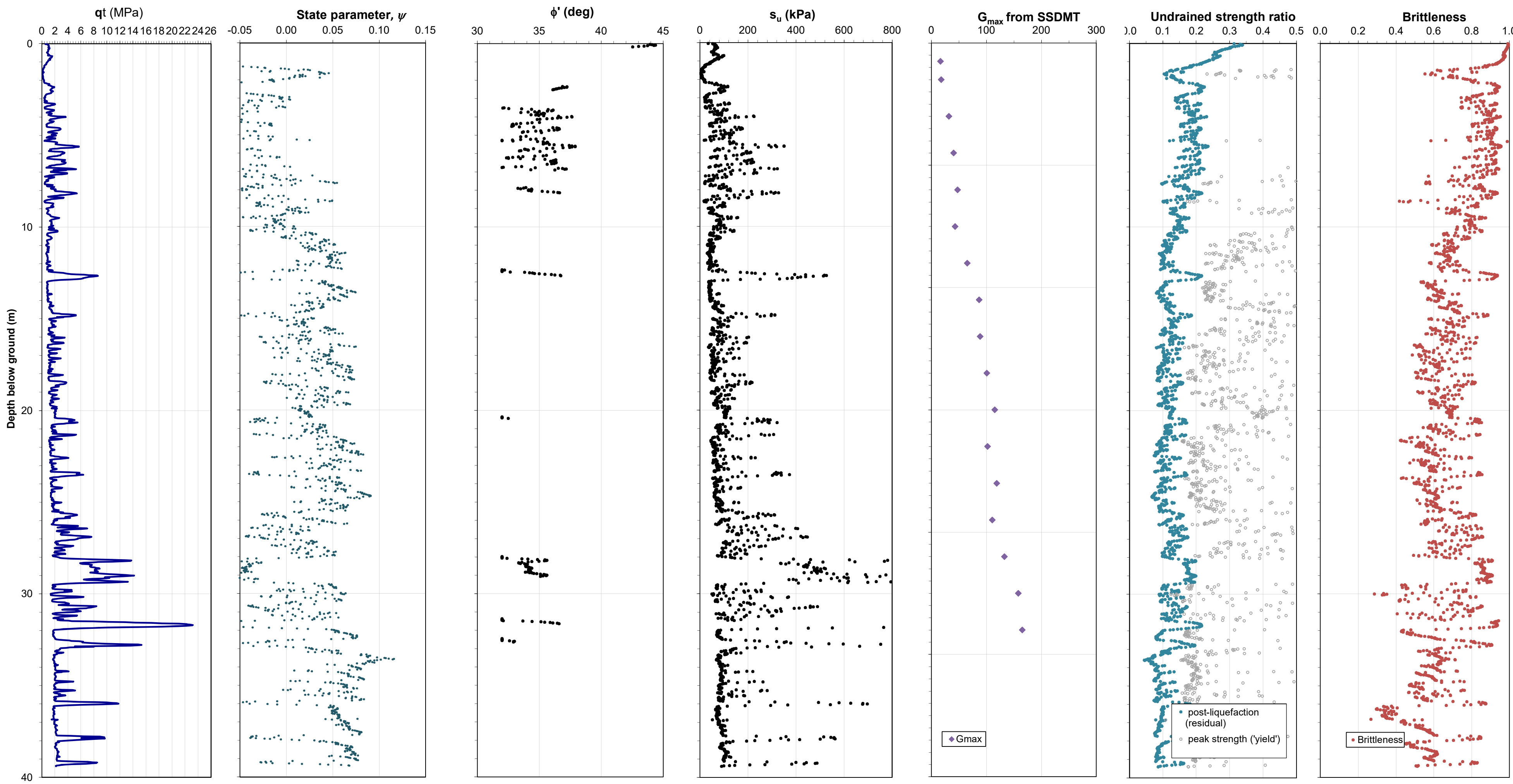
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N3-1

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ7**



Test Information

Test code:	CPT-N3-1
Depth to Water:	11.5 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure

Independent Technical Review Board

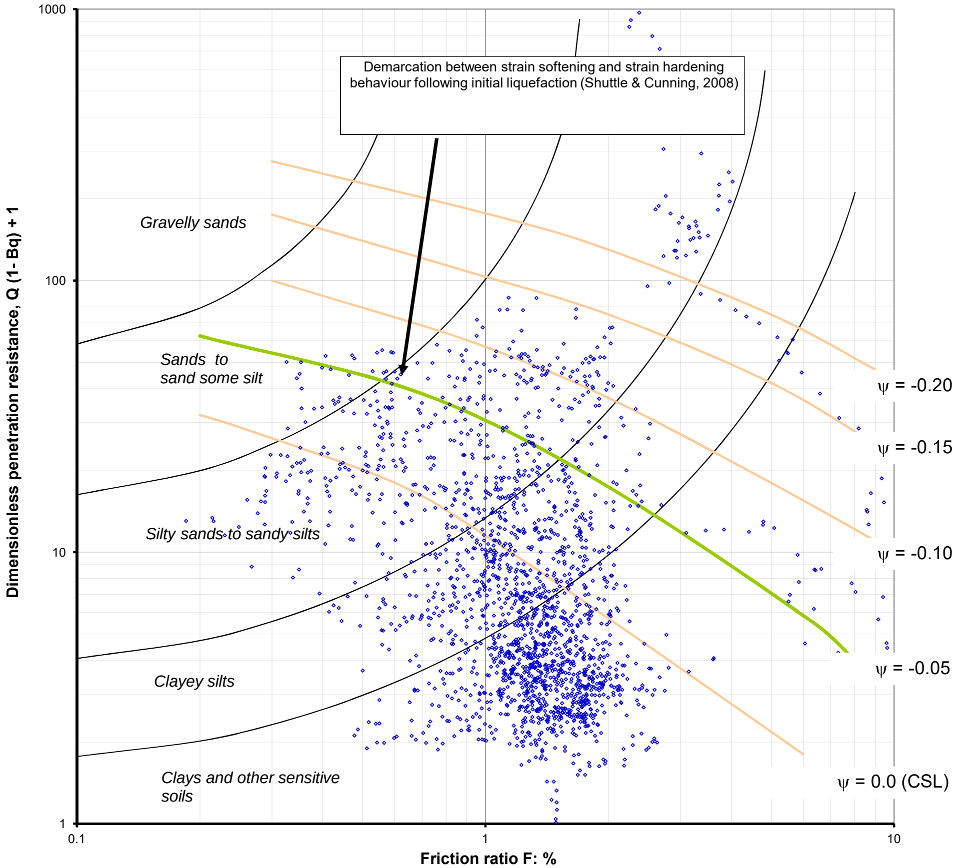
Interpreted Results of CPTu Sounding CPT-N3-1

Drawn by: BM

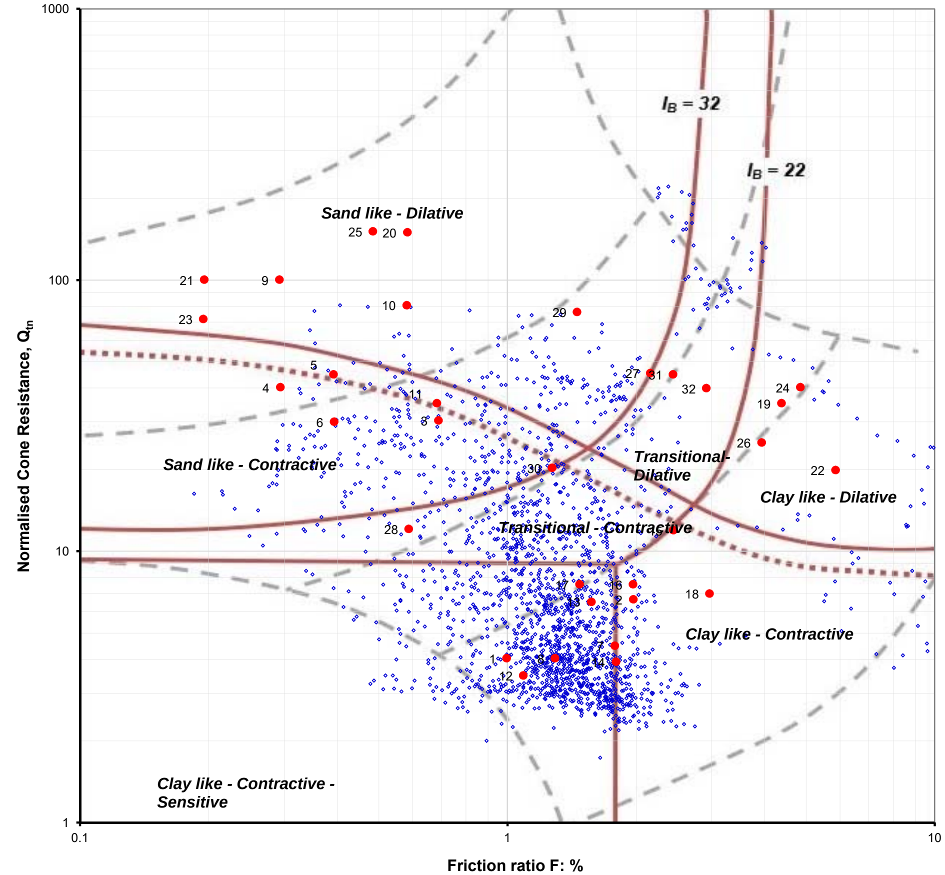
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ8



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N3-1
Depth to Water:	11.5 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

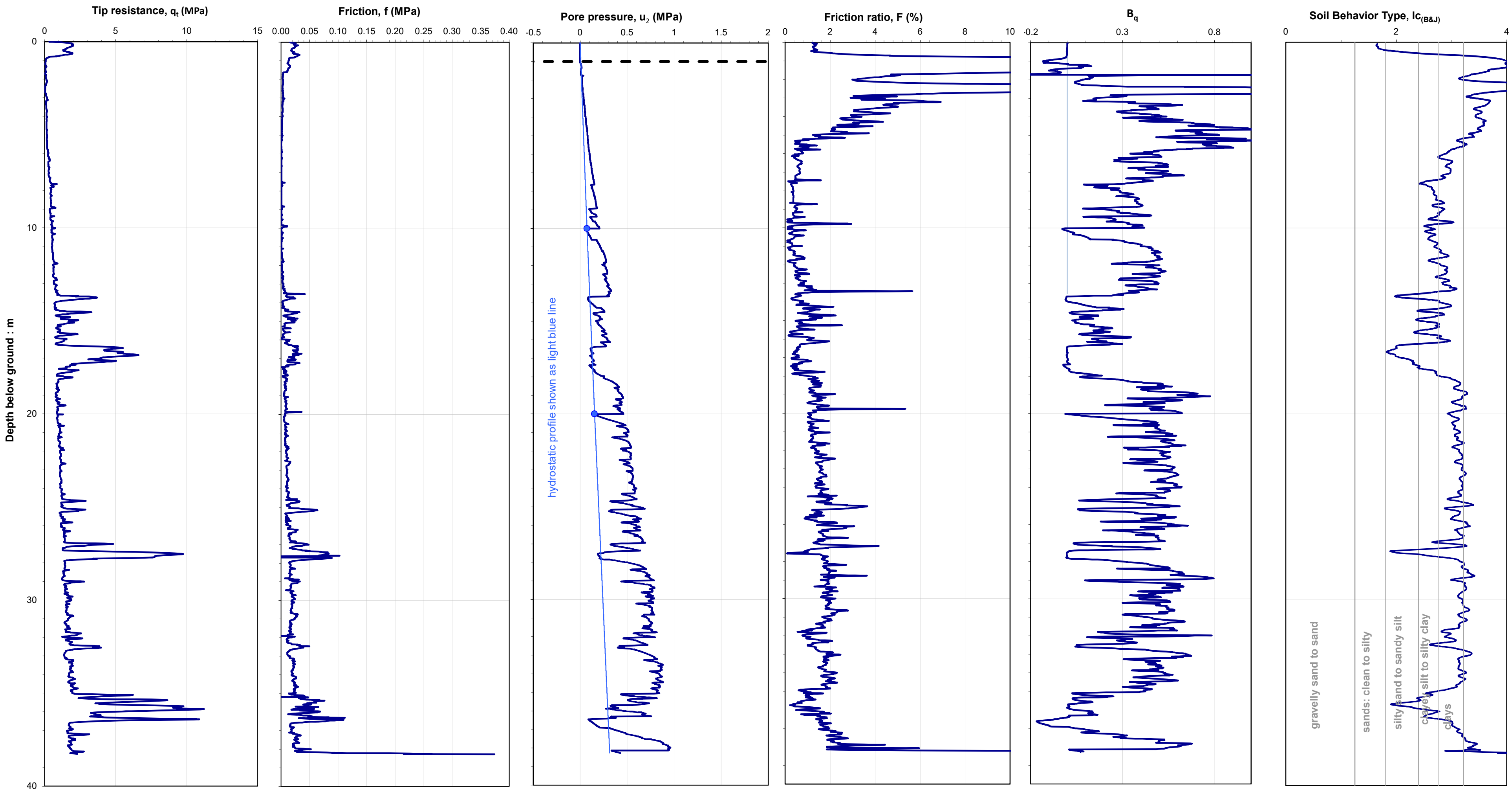
Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016)
Plot for CPT-N3-1

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ9**



Test Information

Test code:	CPT-N01
Depth to Water:	1.0 m
Coordinates:	55 H 0685192, 6291423
Date tested:	14/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

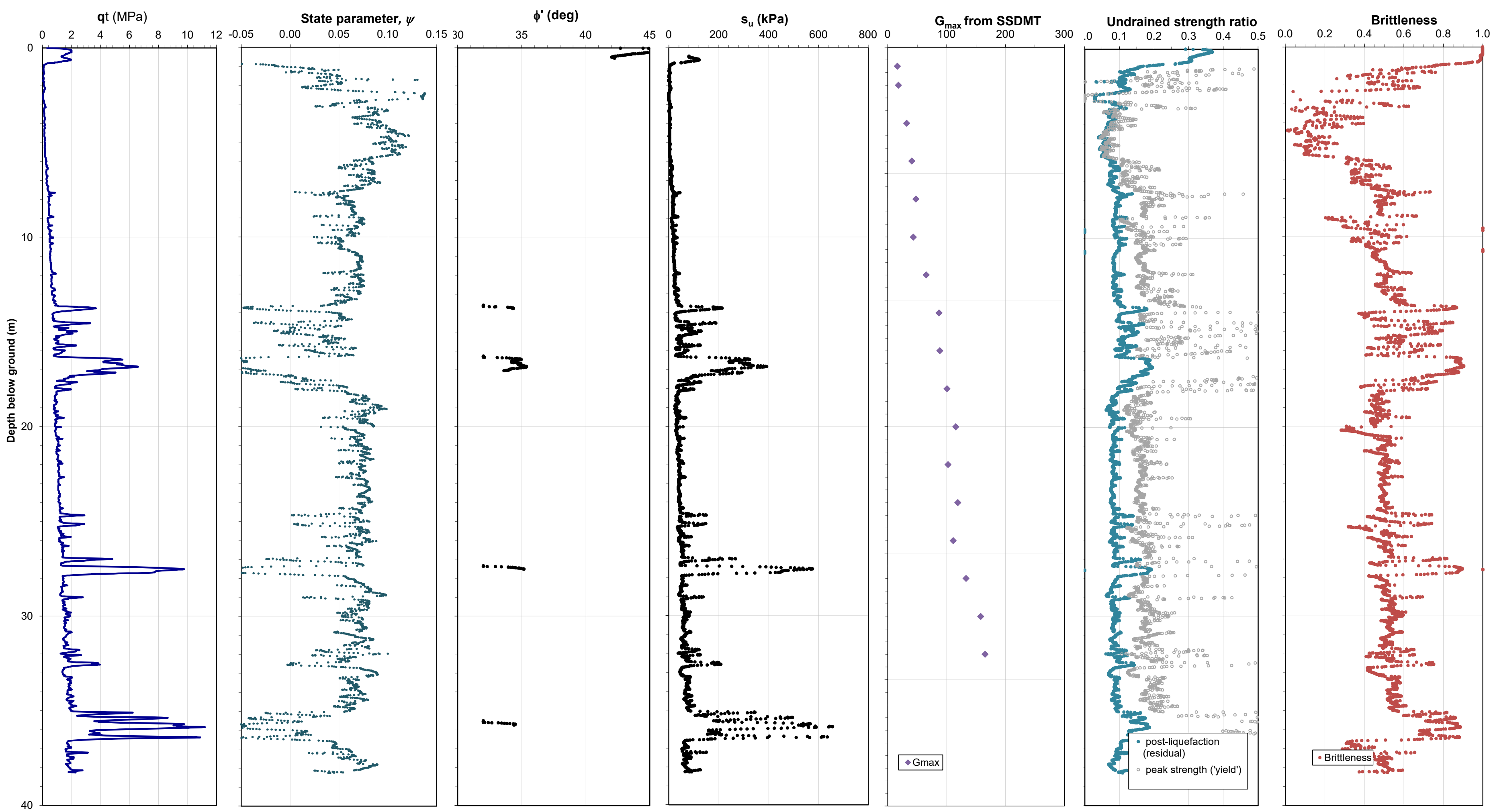
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N01

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ10**



Test Information

Test code:	CPT-N01
Depth to Water:	1.0 m
Coordinates:	55 H 0685192, 6291423
Date tested:	14/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

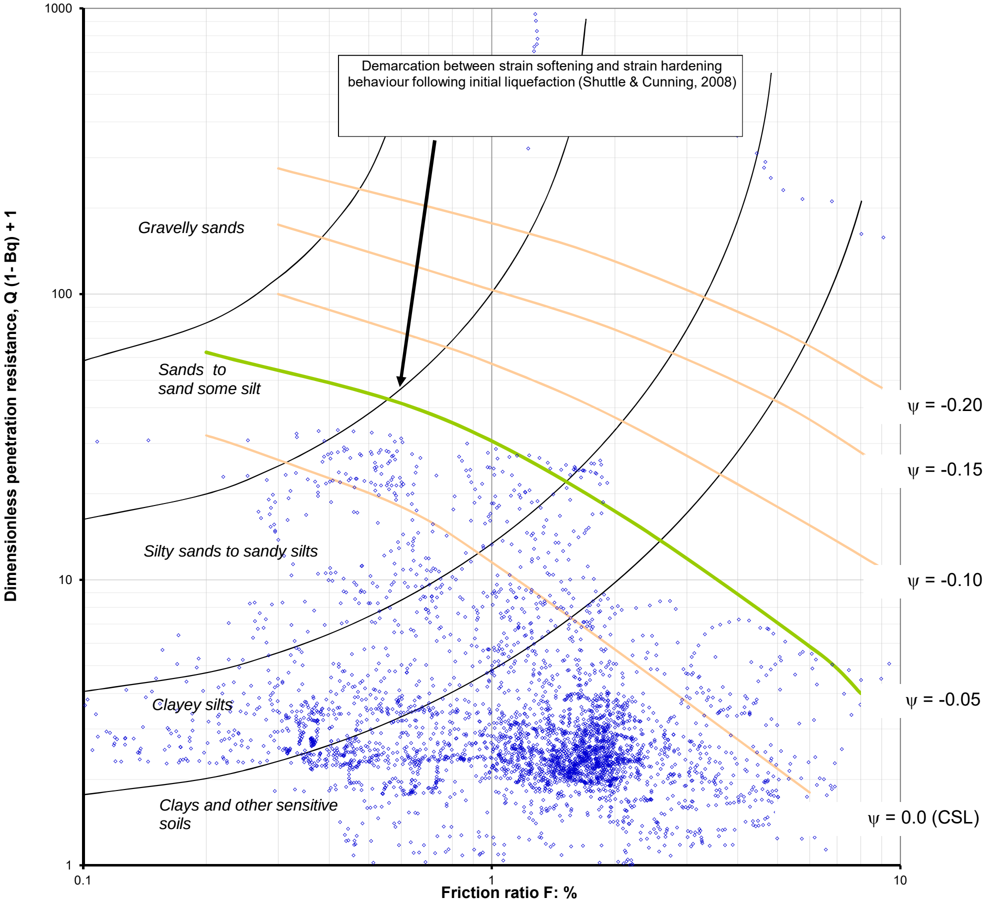
Interpretation of CPTu Sounding CPT-N01

Drawn by: BM

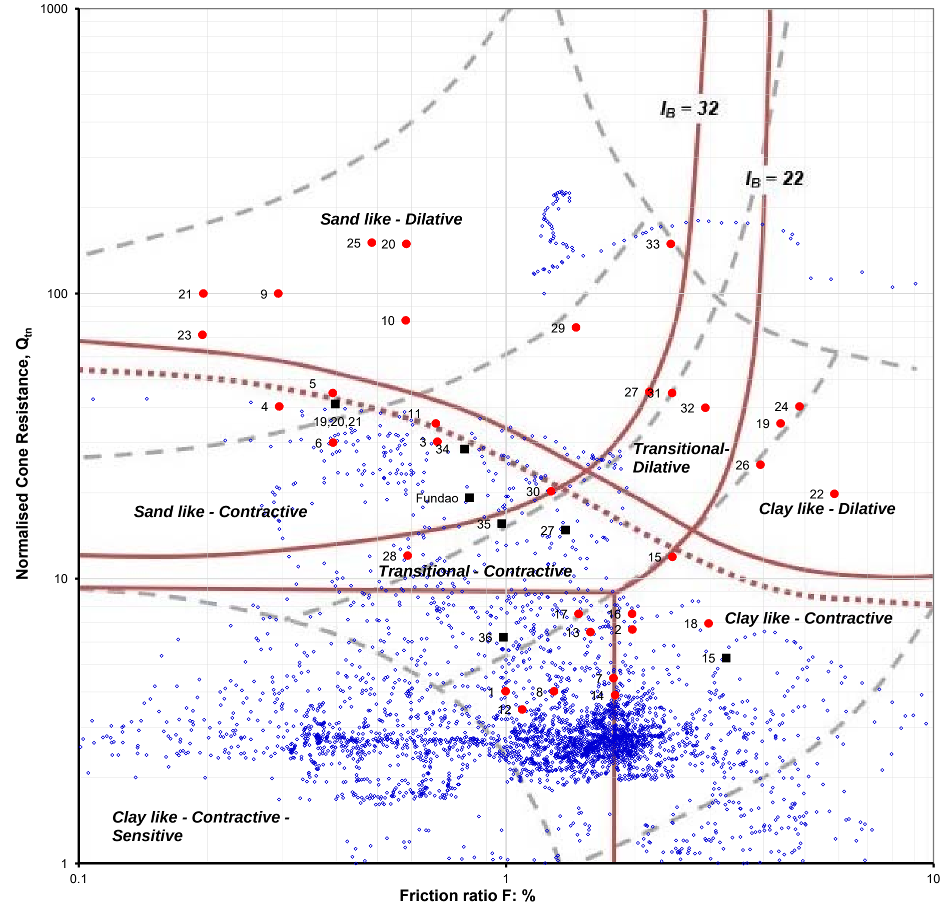
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ11



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on Q tn–Fr (Roberston, 2016)

Test Information

Test code:	CPT-N01
Depth to Water:	1.0 m
Coordinates:	55 H 0685192, 6291423
Date tested:	14/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

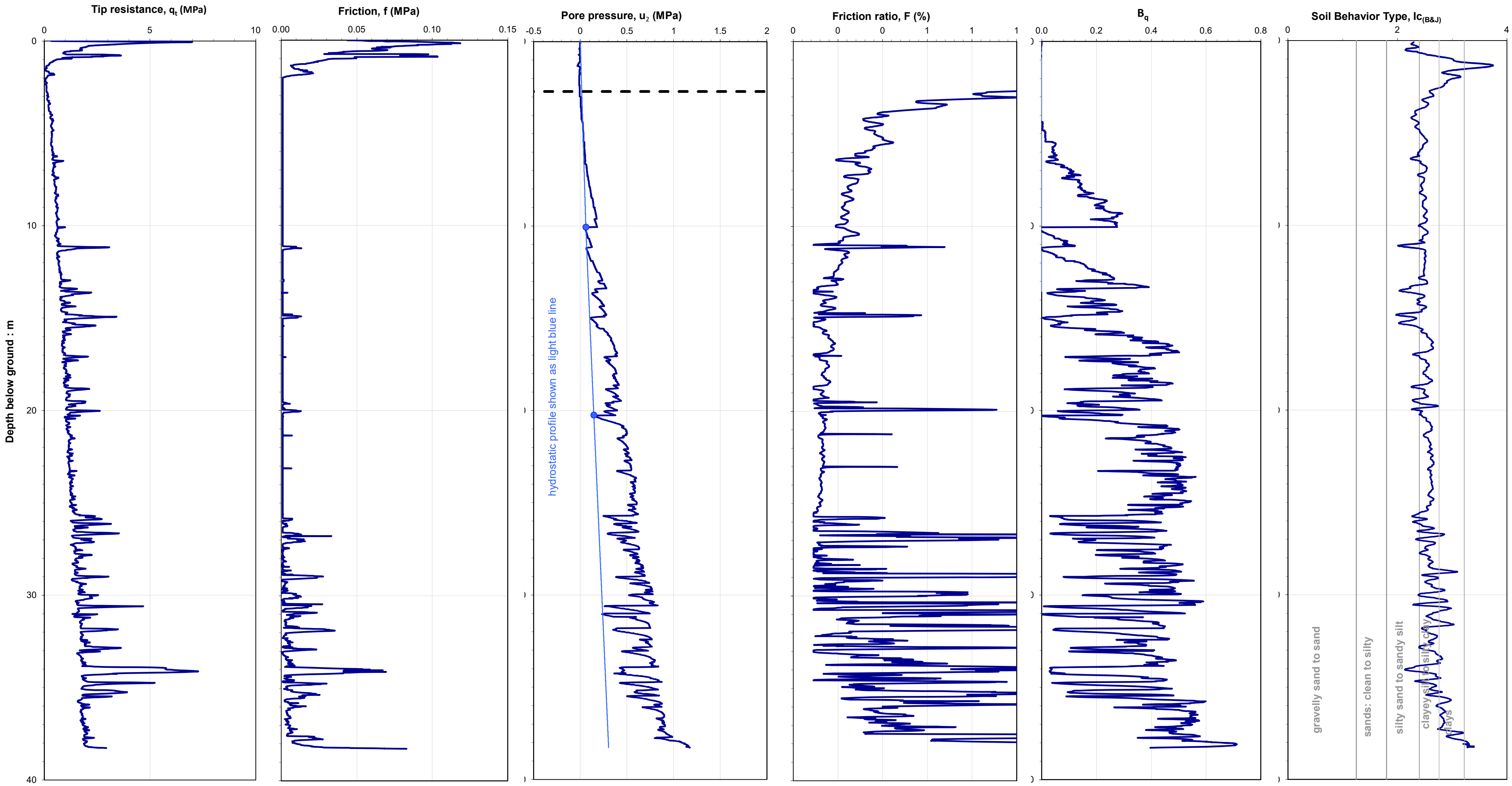
Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N01

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ12



Test Information

Test code:	CPT-N02
Depth to Water:	2.7 m
Coordinates:	55 H 0685192, 6291423
Date tested:	12/1/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

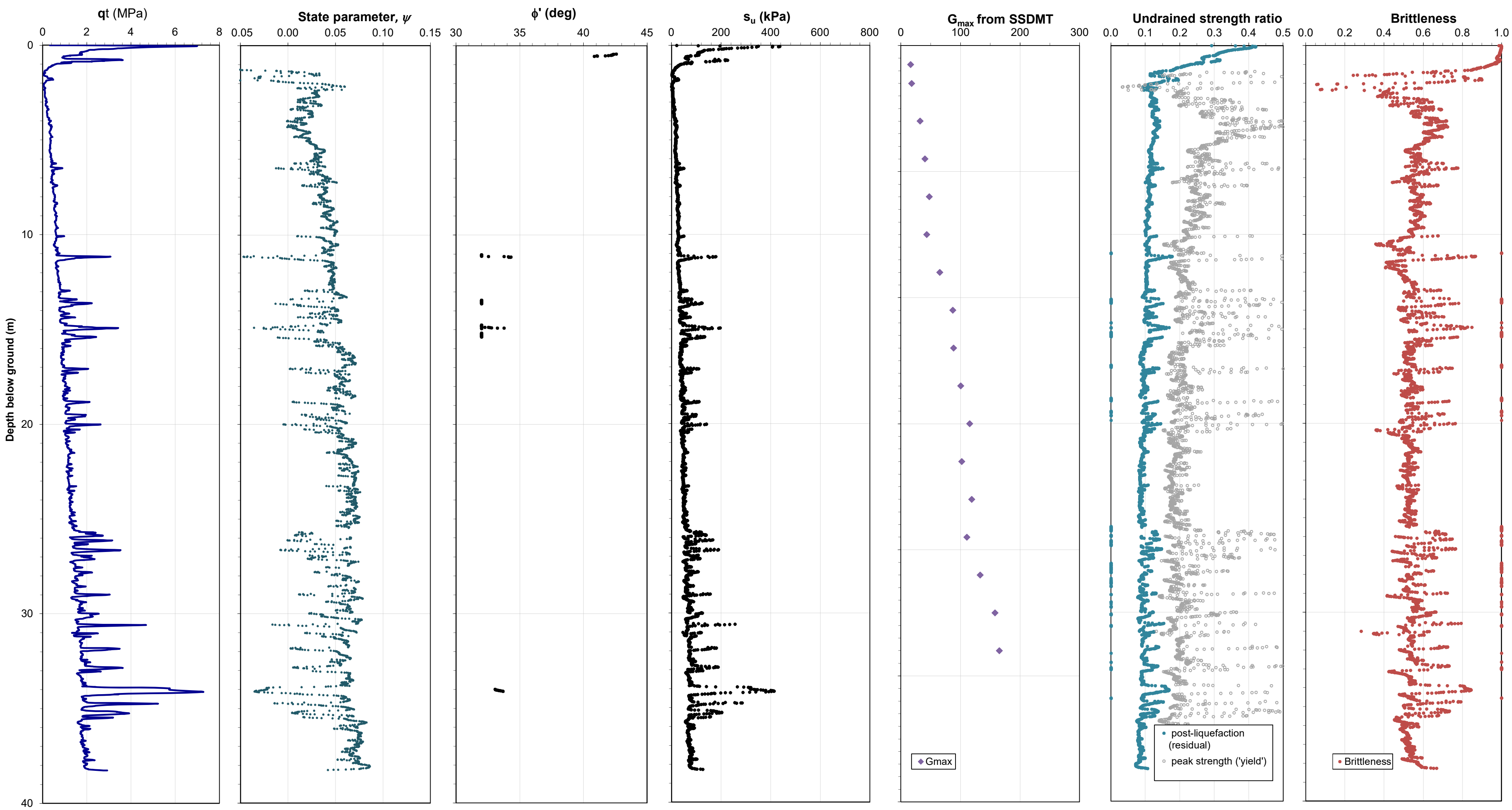
Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N02

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ13



Test Information

Test code:	CPT-N02
Depth to Water:	2.7 m
Coordinates:	55 H 0685192, 6291423
Date tested:	12/1/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

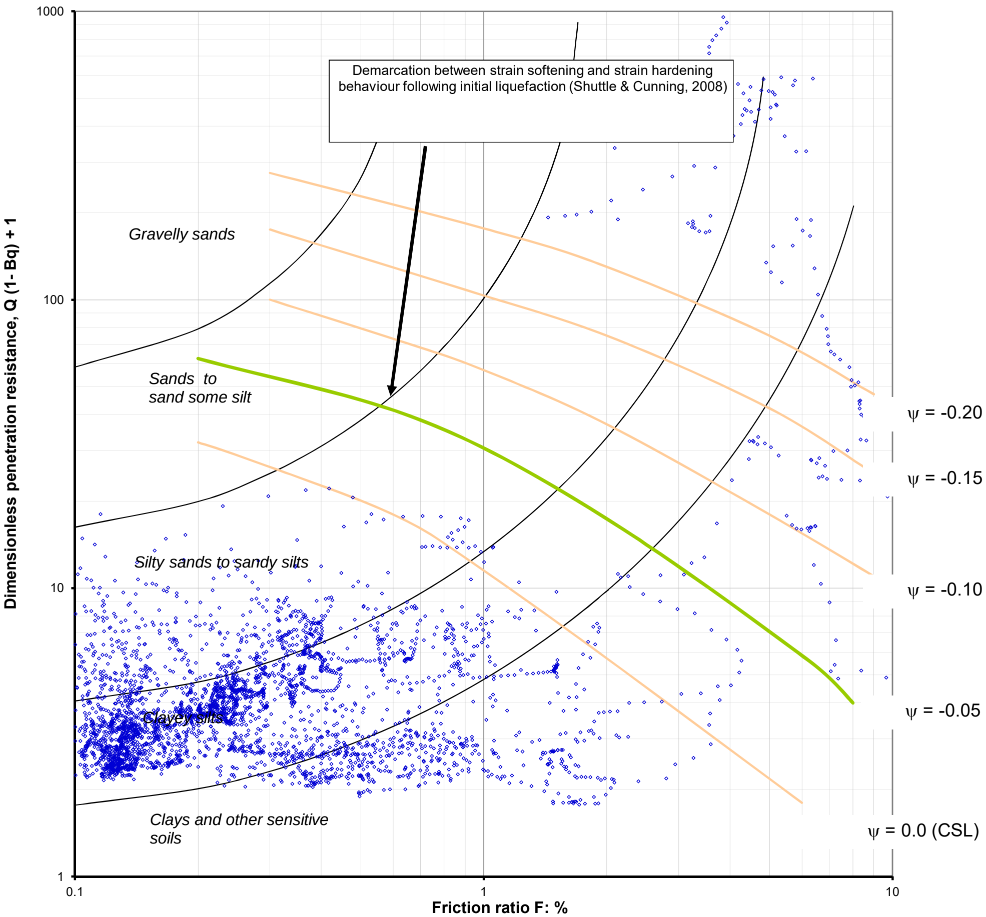
Cadia NTSF Failure
Independent Technical Review Board

Interpretation of CPTu Sounding CPT-N02

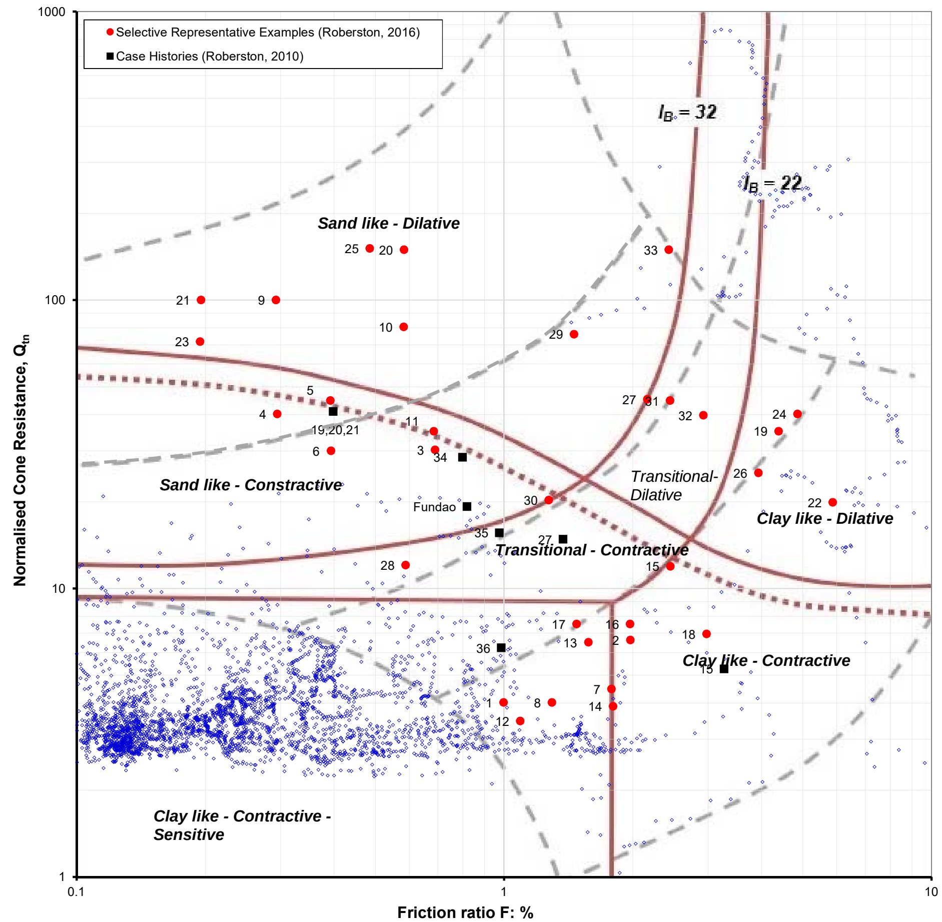
Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ14



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N02
Depth to Water:	2.7 m
Coordinates:	55 H 0685192, 6291423
Date tested:	12/1/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

Notes:

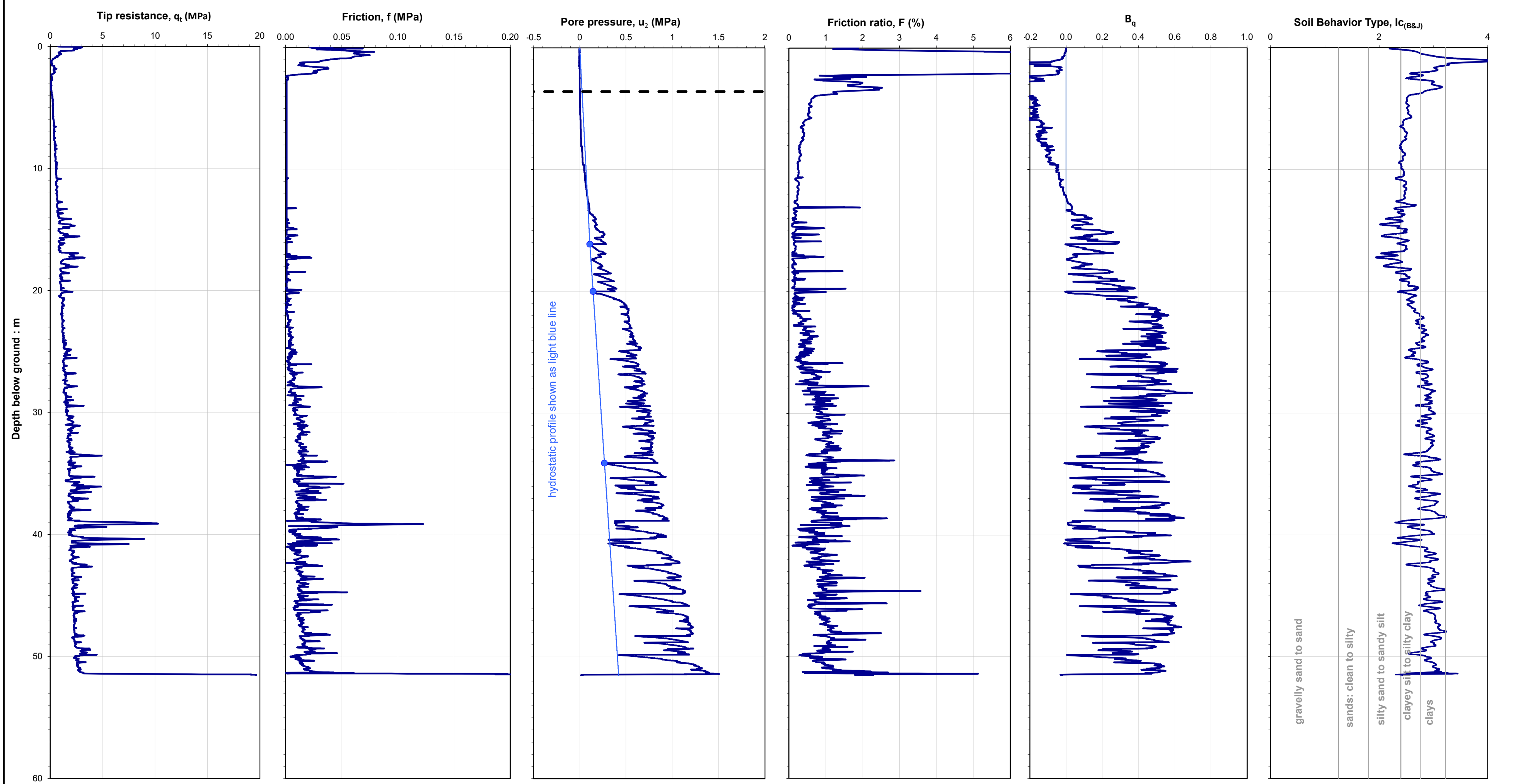
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3
Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N02

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ15



Test Information

Test code:	CPT-N03
Depth to Water:	3.6 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

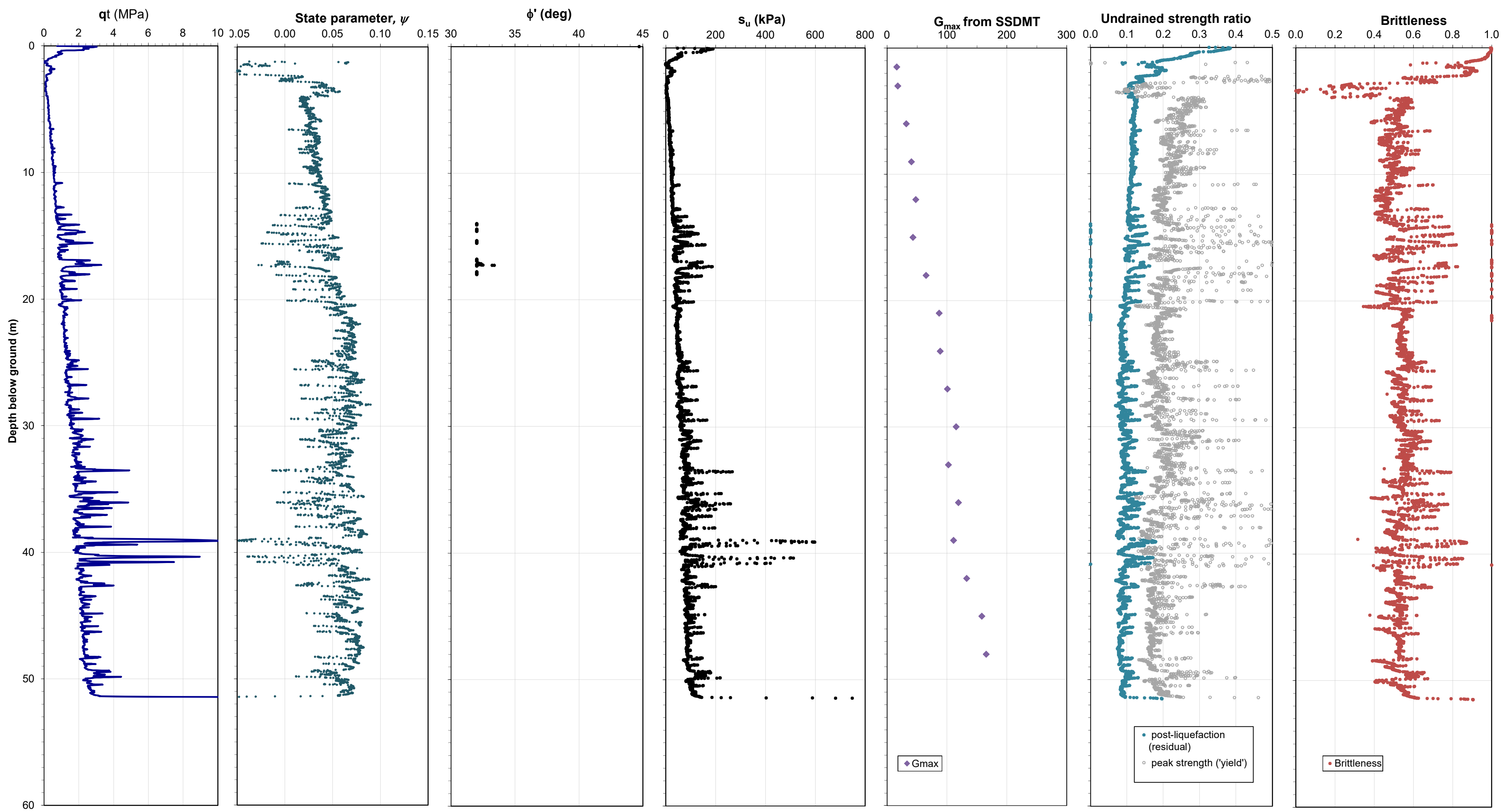
Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N03

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ16



Test Information

Test code:	CPT-N03
Depth to Water:	3.6 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

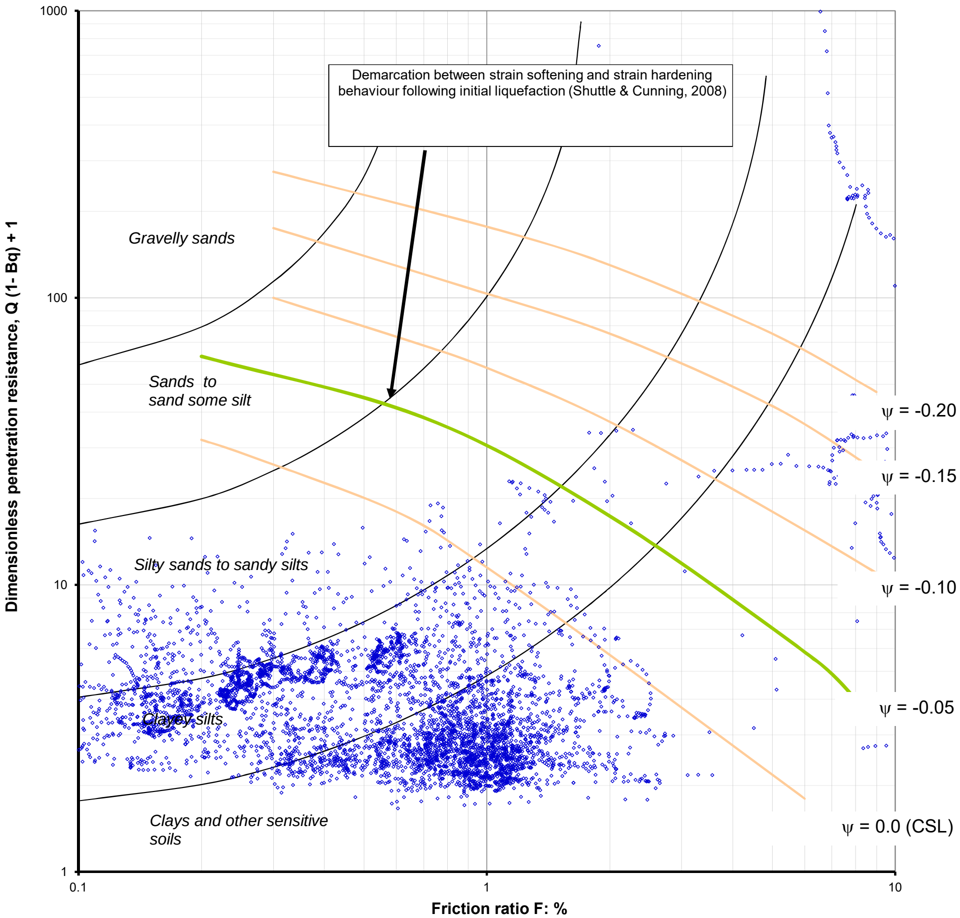
Cadia NTSF Failure
Independent Technical Review Board

Interpretation of CPTu Sounding CPT-N03

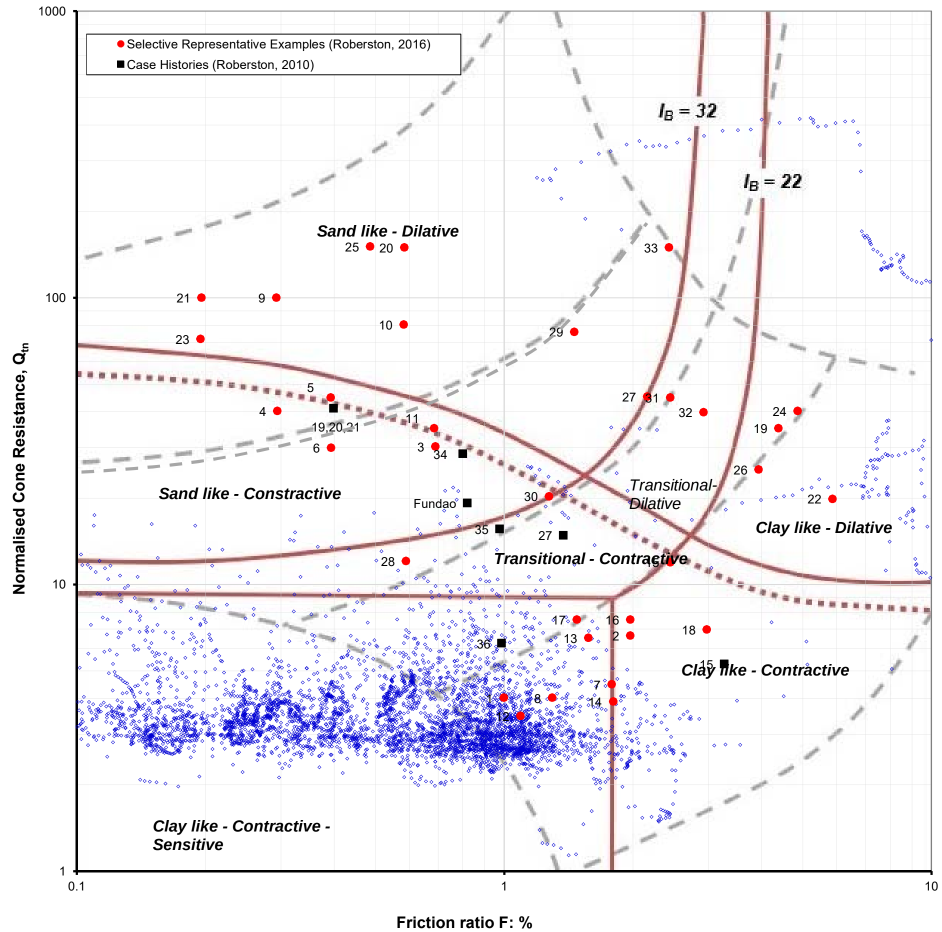
Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ17



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N03
Depth to Water:	3.6 m
Coordinates:	55 H 0685192, 6291423
Date tested:	13/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

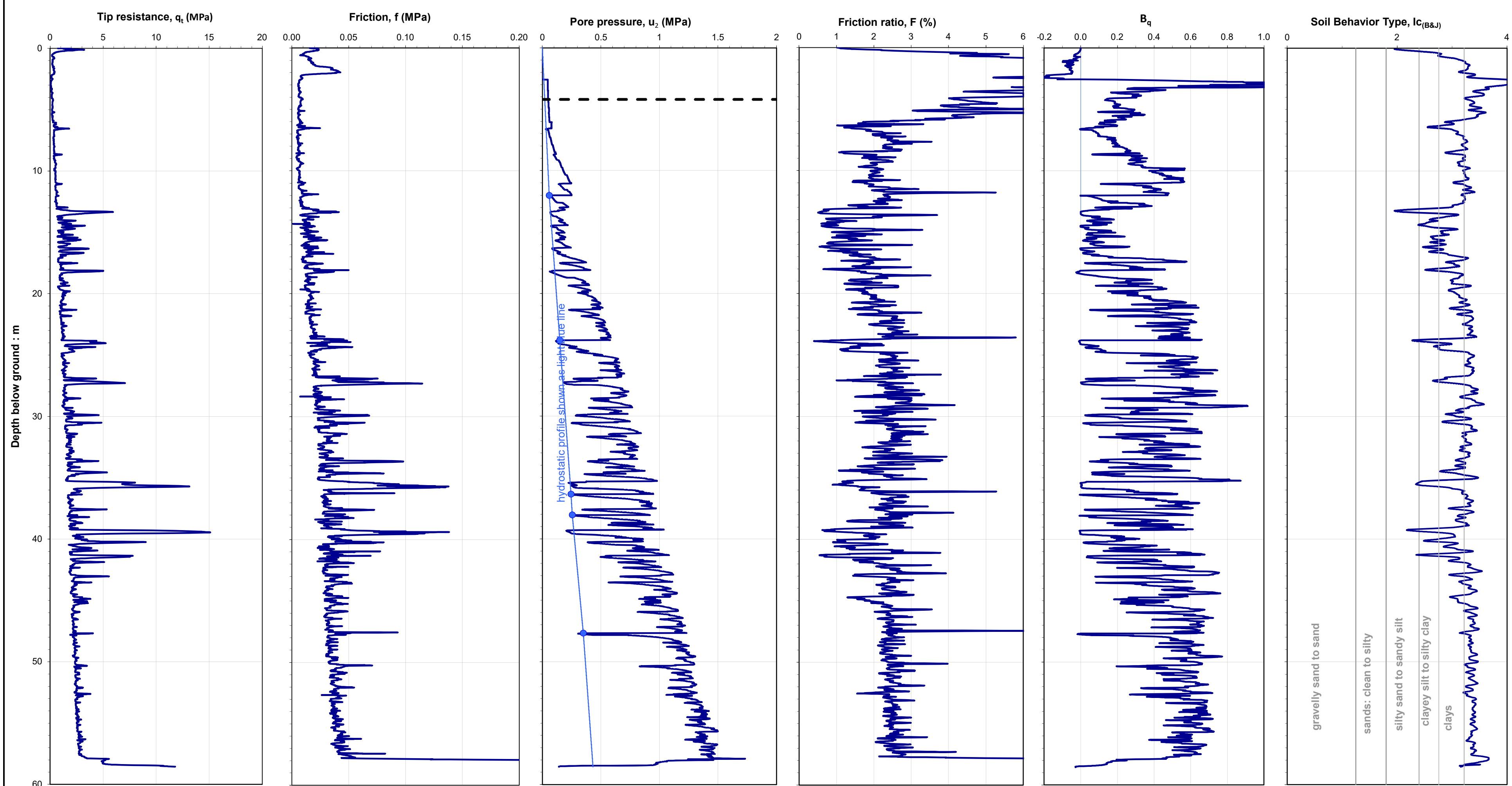
Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N03

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ18



Test Information

Test code:	CPT-N04
Depth to Water:	4.2
Coordinates:	55 H 0685517, 6291152
Date tested:	16/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

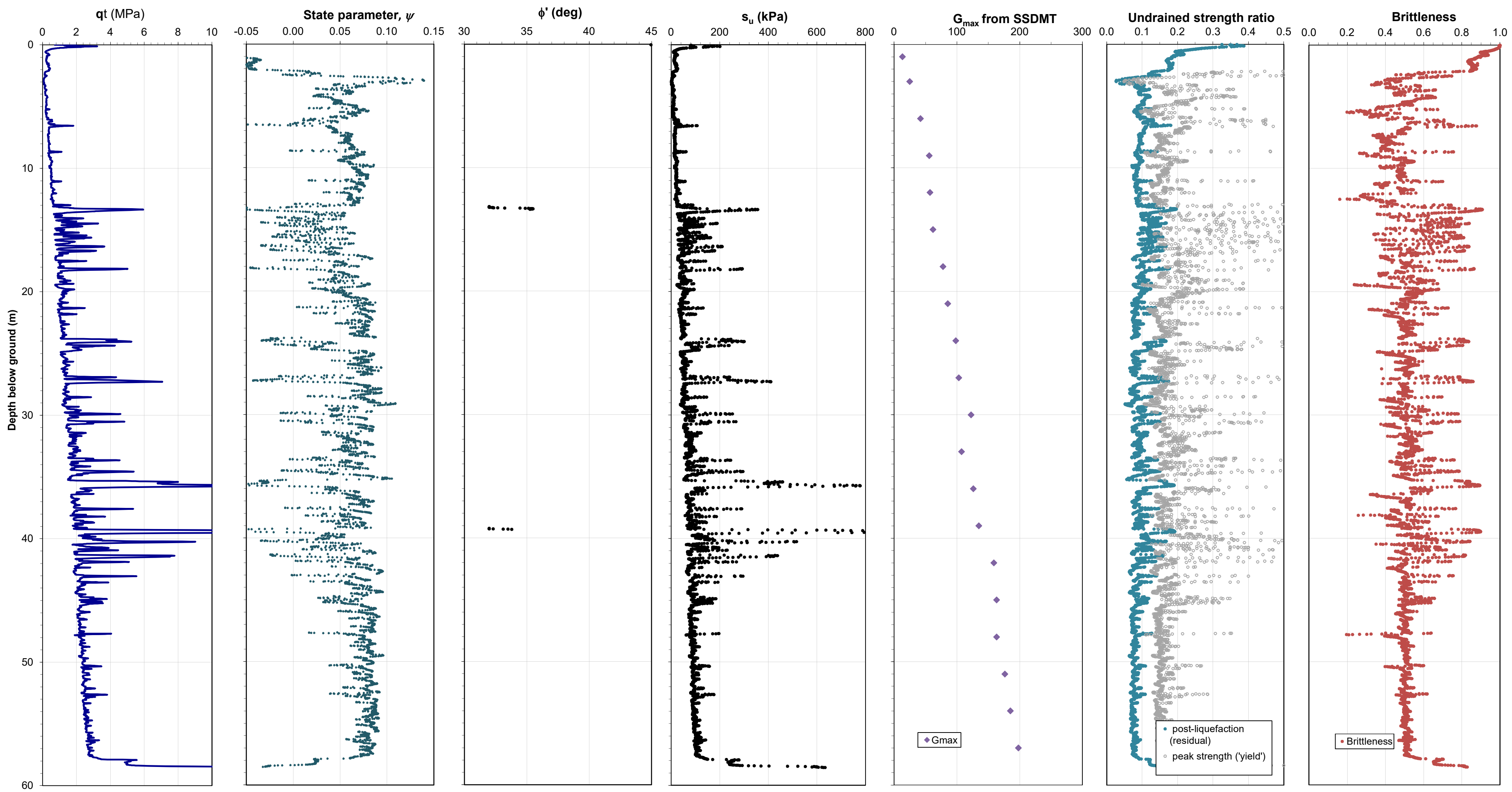
Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N04

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ19



Test Information

Test code:	CPT-N04
Depth to Water:	4.2 m
Coordinates:	55 H 0685517, 6291152
Date tested:	16/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

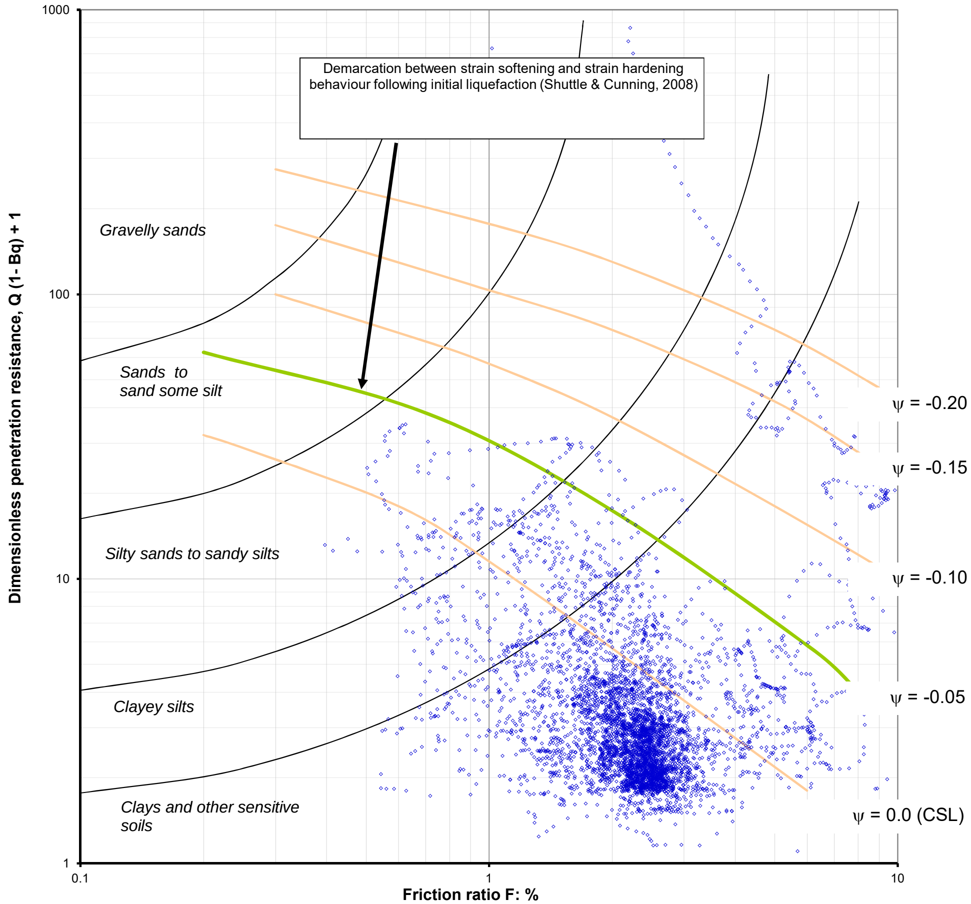
Interpreted Results of CPTu Sounding CPT-N04

Drawn by: BM

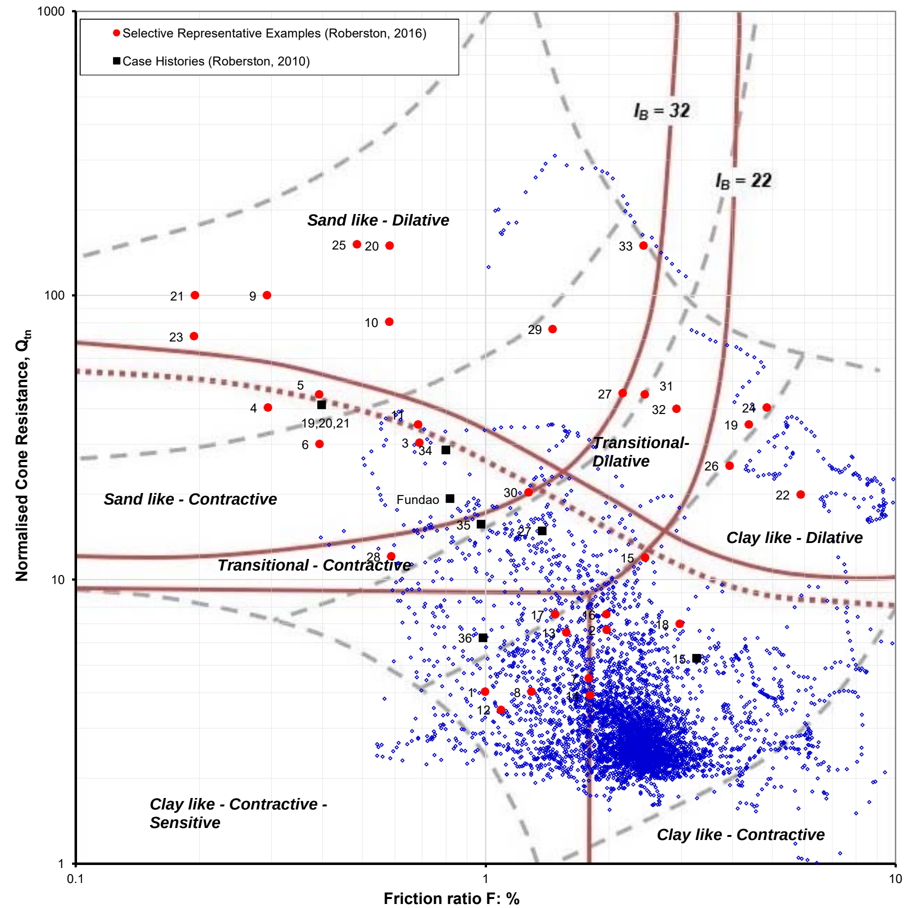
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ20



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N04
Depth to Water:	4.2 m
Coordinates:	55 H 0685517, 6291152
Date tested:	16/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

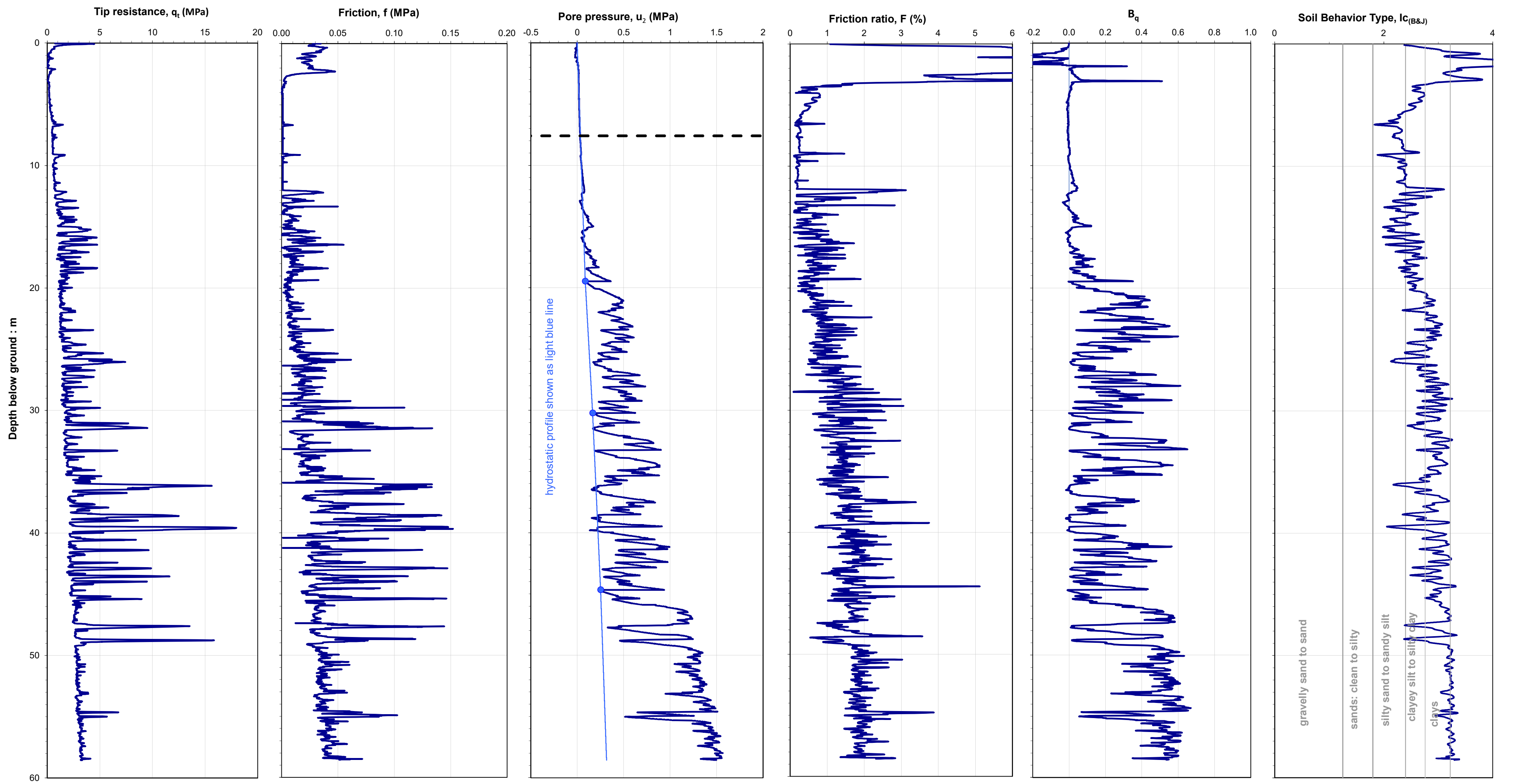
Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N04

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ21**



Test Information

Test code:	CPT-N05
Depth to Water:	7.6 m
Coordinates:	55 H 0685836, 6290978
Date tested:	16/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

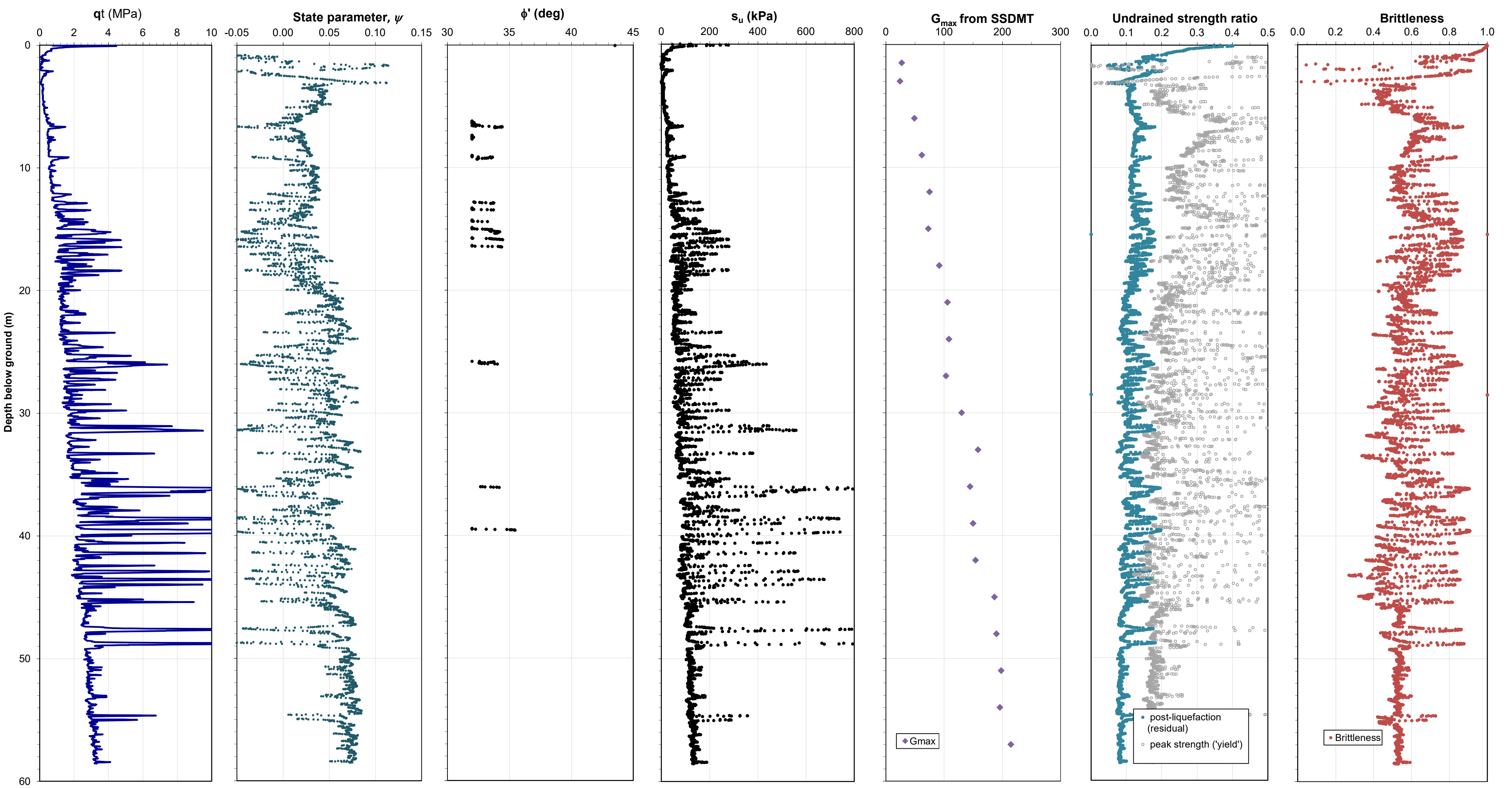
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N04

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ22**



Test Information

Test code:	CPT-N05
Depth to Water:	7.6 m
Coordinates:	55 H 085836, 6290978
Date tested:	16/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

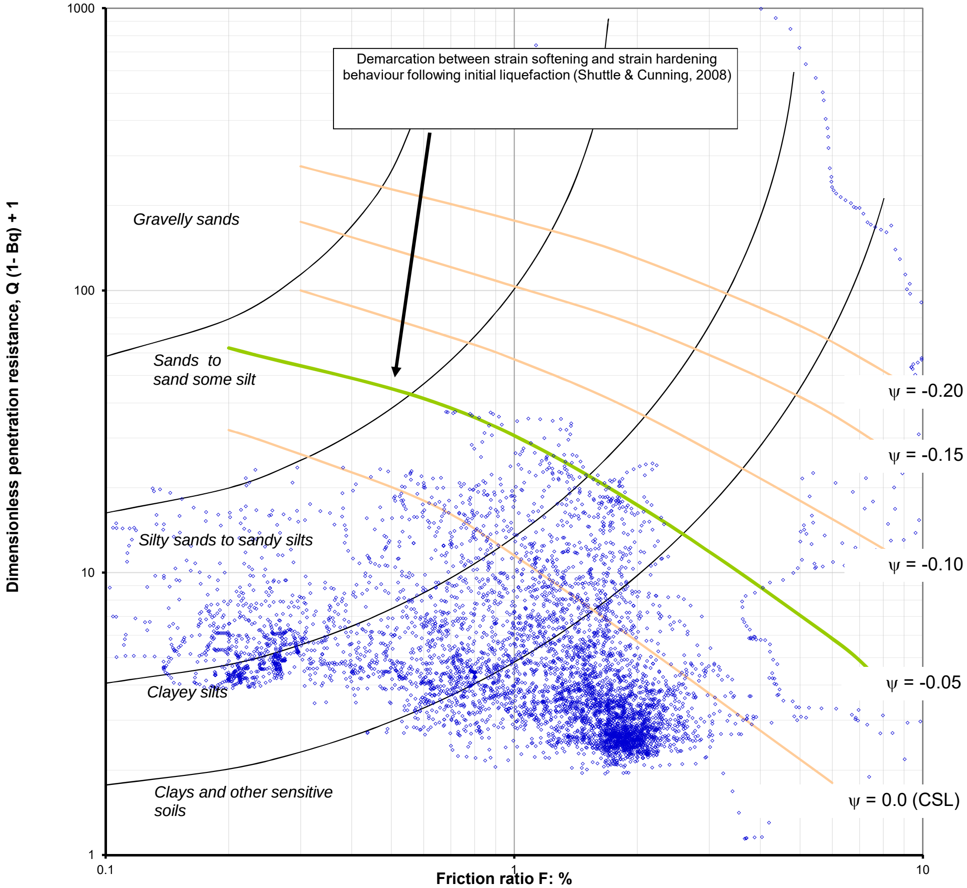
Cadia NTSF Failure
Independent Technical Review Board

Interpreted Results of CPTu Sounding CPT-N05

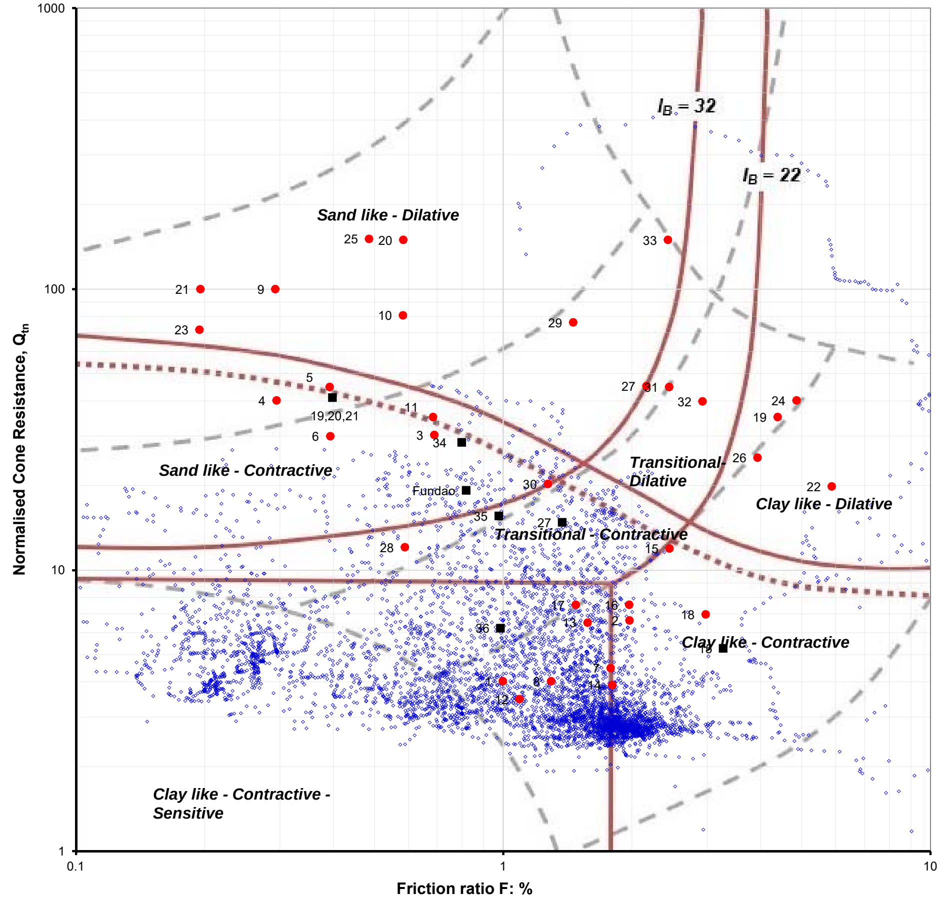
Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ23



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on Q tn–Fr (Roberston, 2016)

Test Information

Test code:	CPT-N05
Depth to Water:	7.6 m
Coordinates:	55 H 085836, 6290978
Date tested:	16/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

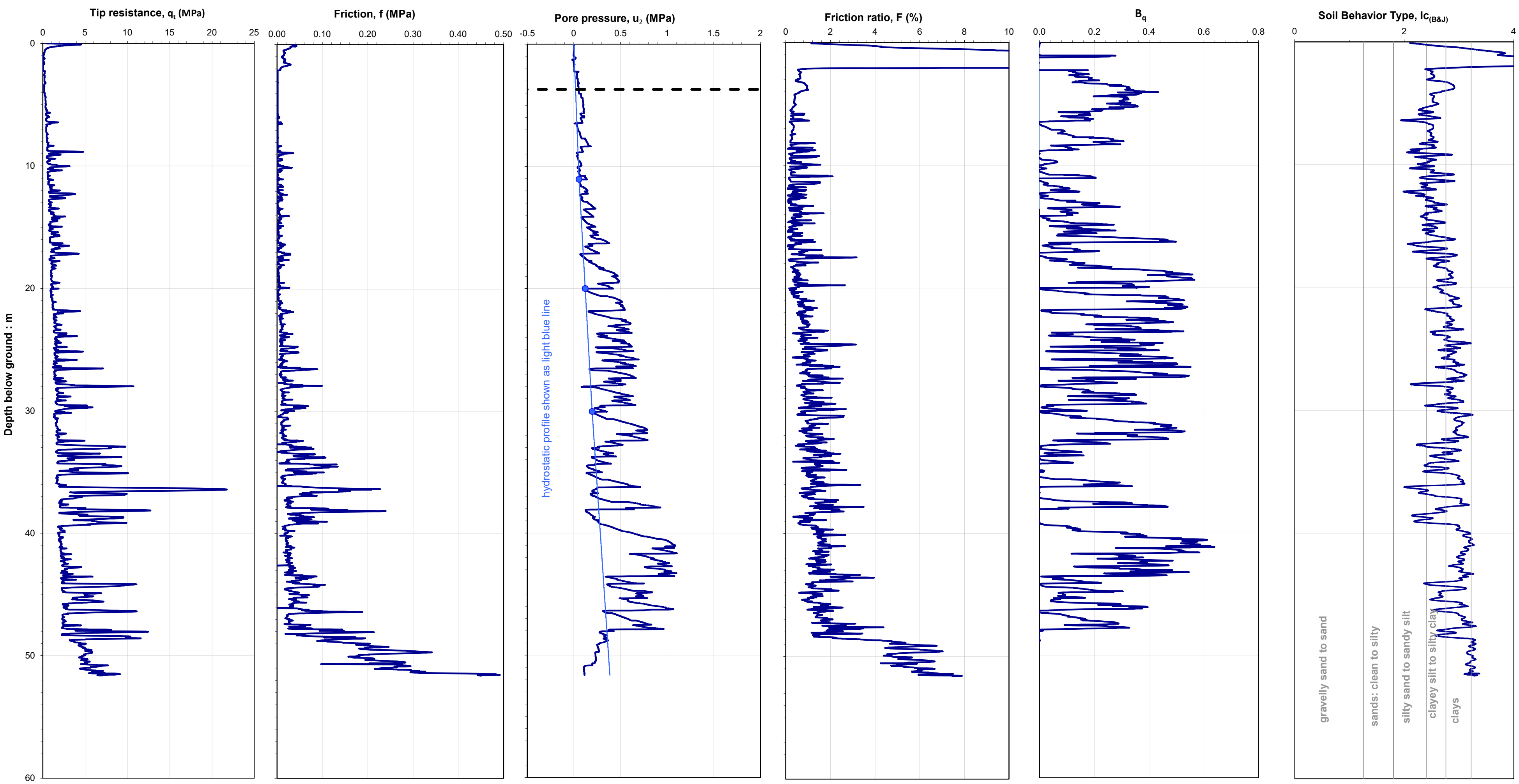
Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure

Independent Technical Review Board

Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N05

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ24**



Test Information

Test code:	CPT-N06
Depth to Water:	3.7 m
Coordinates:	55 H 0685192, 6291423
Date tested:	17/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

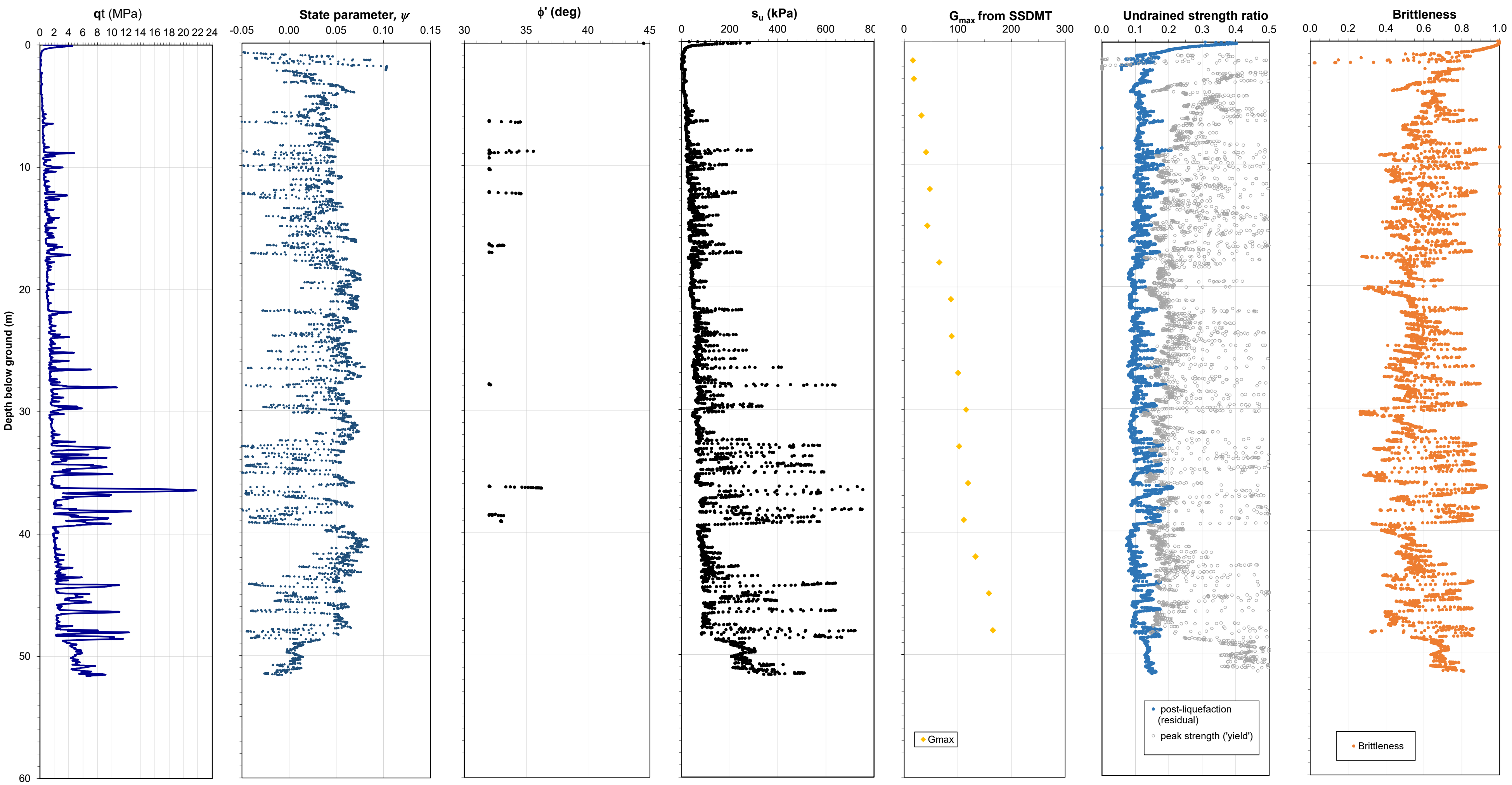
Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N06

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ25



Test Information

Test code:	CPT-N06
Depth to Water:	3.7 m
Coordinates:	55 H 0685192, 6291423
Date tested:	17/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

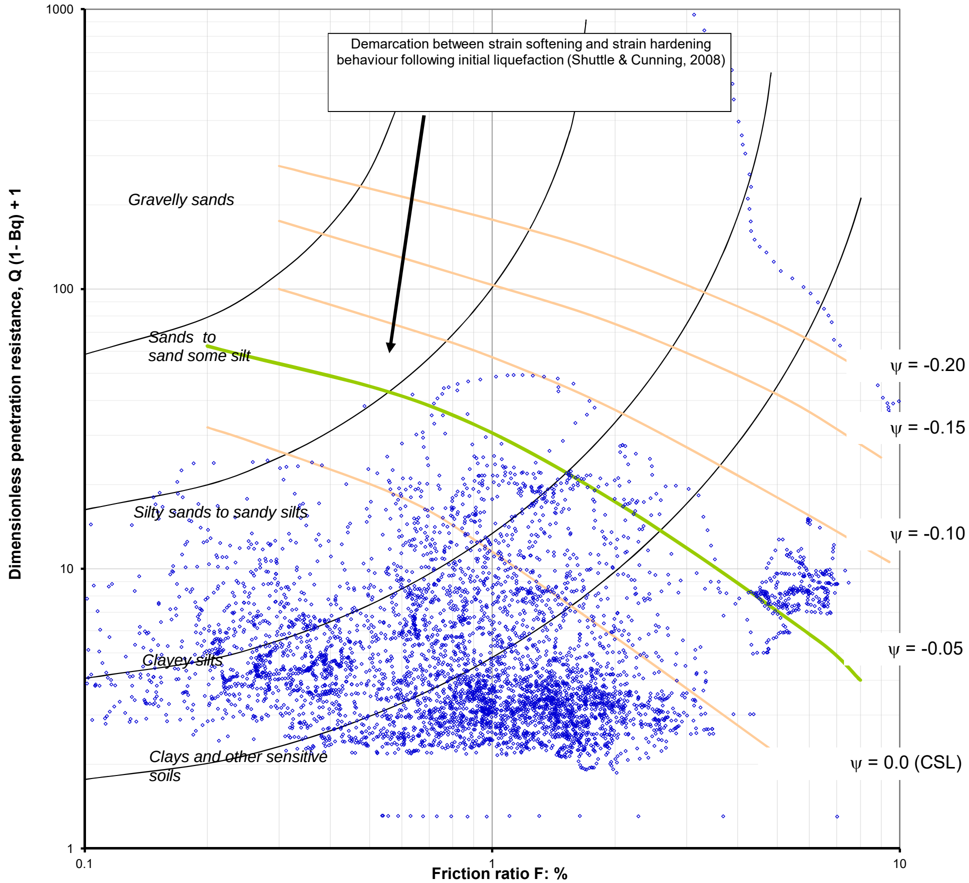
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

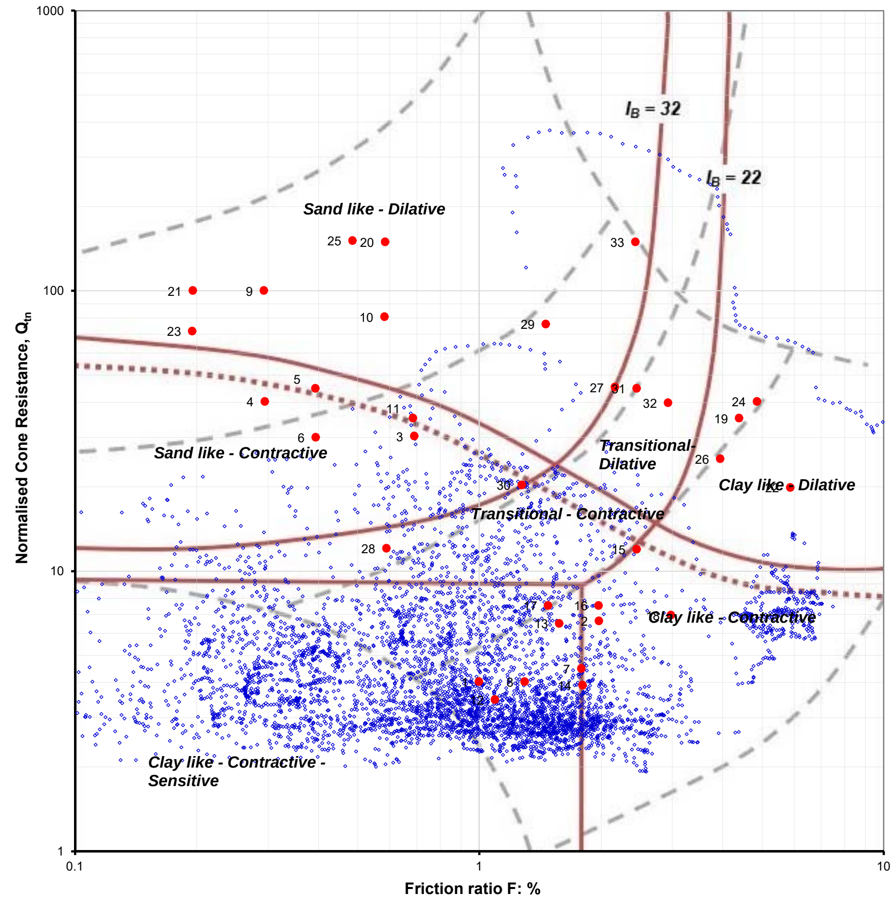
Cadia NTSF Failure
Independent Technical Review Board

Interpreted Results of CPTu Sounding CPT-N06

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ26**



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N06
Depth to Water:	3.7 m
Coordinates:	55 H 0685192, 6291423
Date tested:	17/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

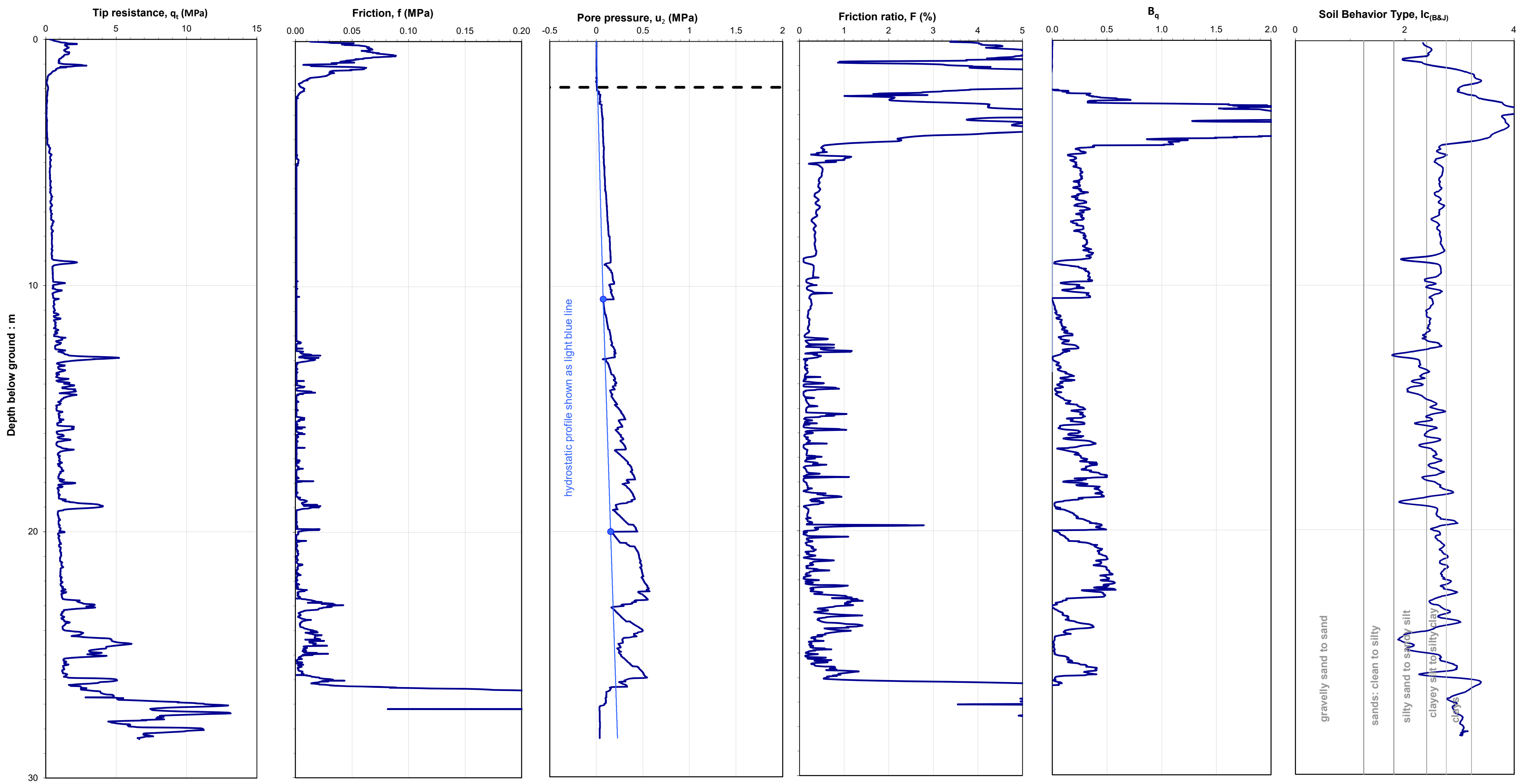
Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N06

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ27



Test Information

Test code:	CPT-N07
Depth to Water:	1.9 m
Coordinates:	55 H 0685192, 6291423
Date tested:	17/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A
Unit B
Unit C
Hydrostatic pressure
Water table depth

Notes:

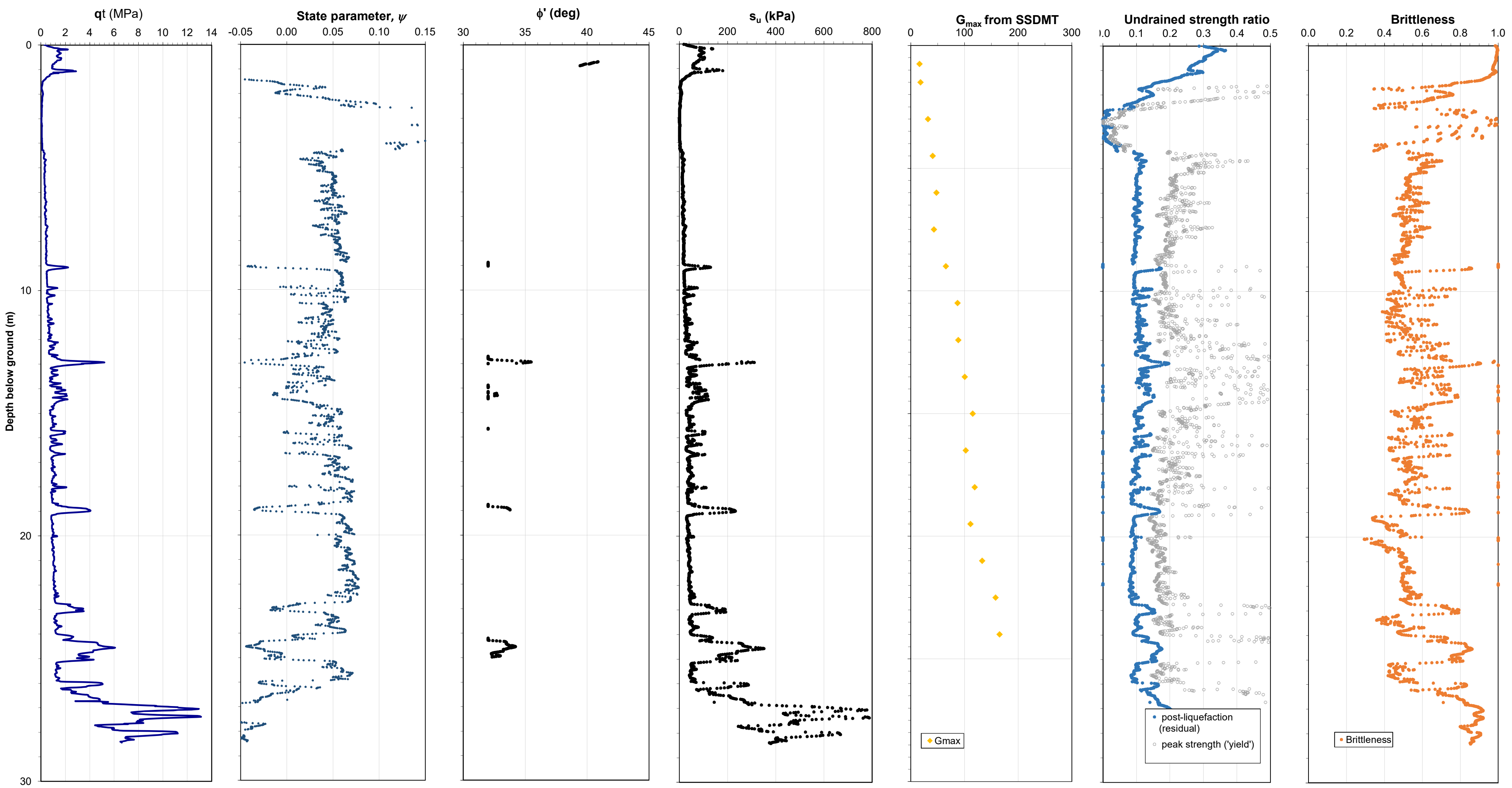
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N07

Drawn by: BM	APPENDIX E - ANNEXURE EJ	**FIGURE EJ28**
Reviewed by: IG		



Test Information

Test code:	CPT-N07
Depth to Water:	1.9 m
Coordinates:	55 H 0685192, 6291423
Date tested:	17/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

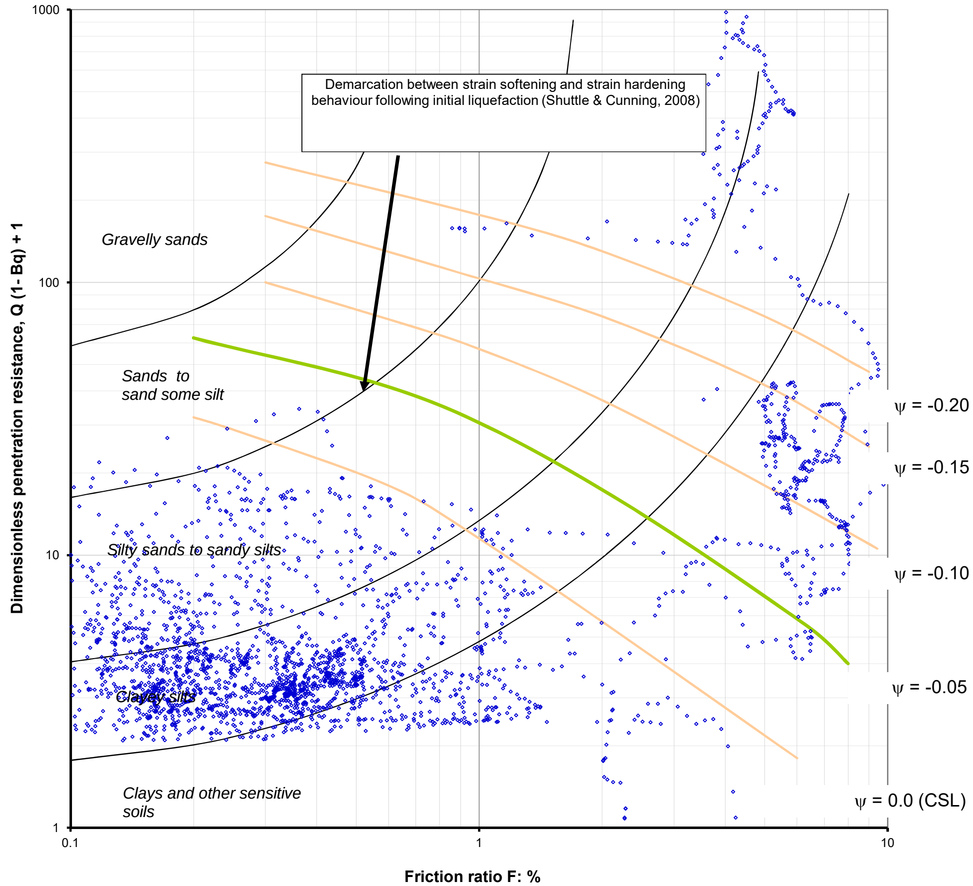
Cadia NTSF Failure
Independent Technical Review Board

Interpreted Results of CPTu Sounding CPT-N07

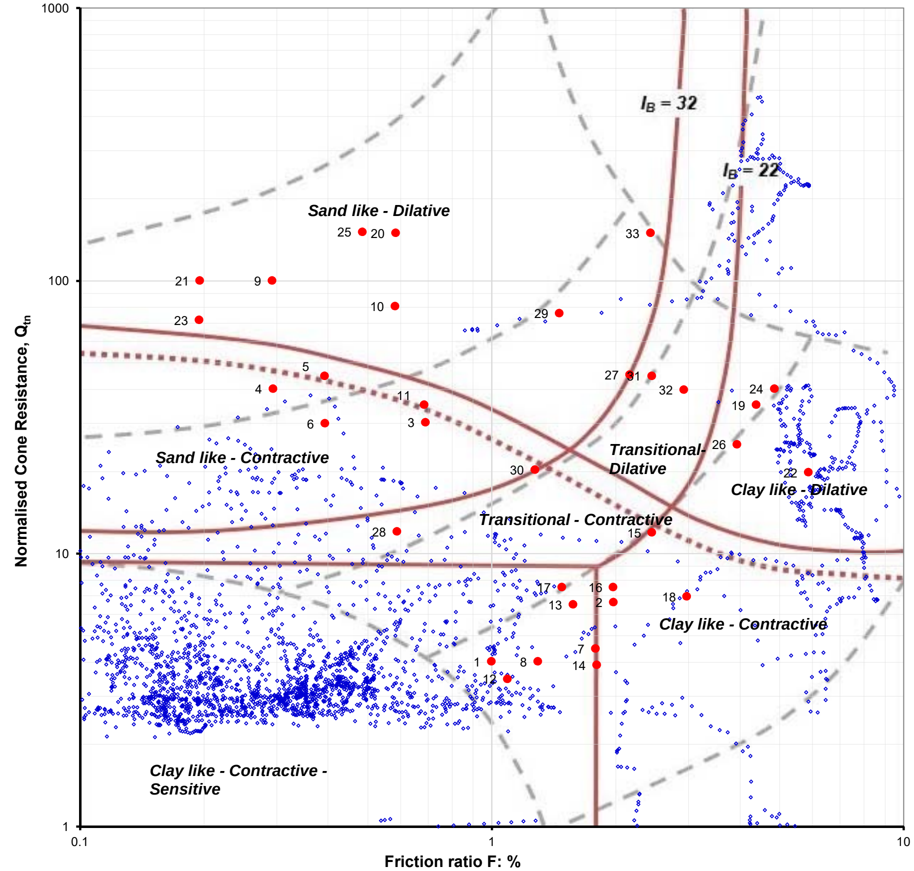
Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ29



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N07
Depth to Water:	1.9 m
Coordinates:	55 H 0685192, 6291423
Date tested:	17/01/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure

Independent Technical Review Board

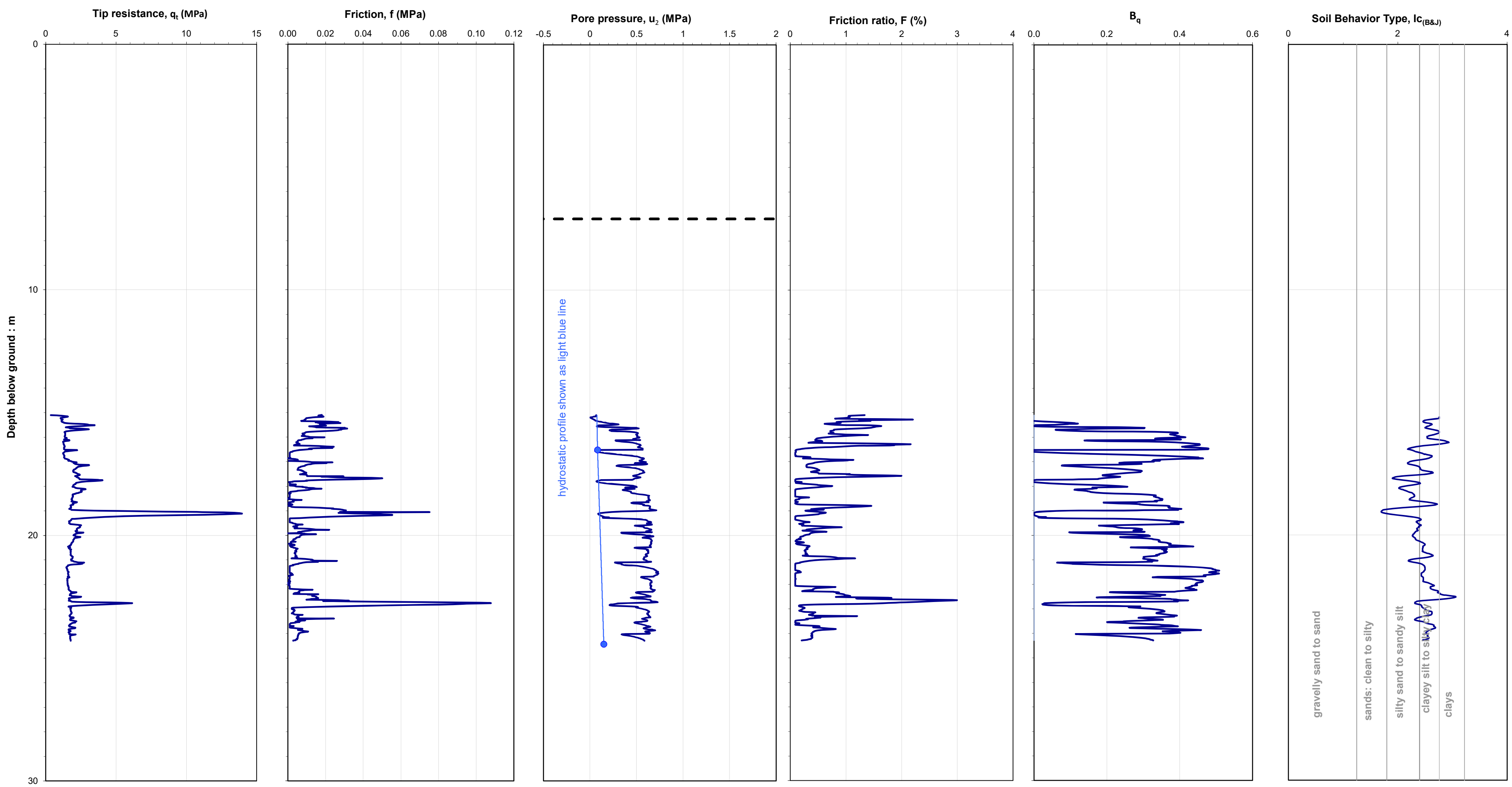
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N07

Drawn by: BM

Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ30



Test Information

Test code:	CPT-N08A
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	11/2/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

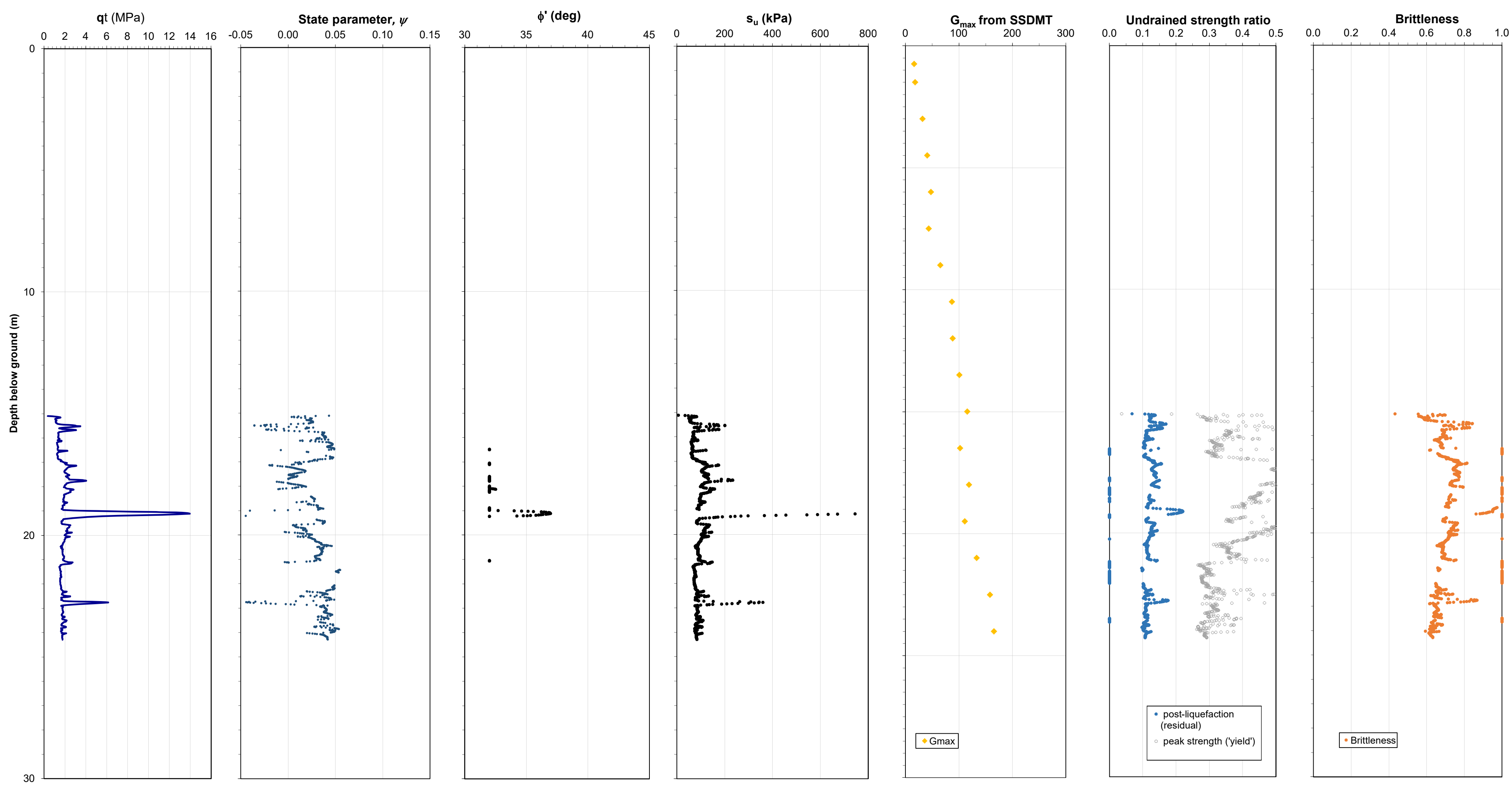
Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N08A

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ31**



Test Information

Test code:	CPT-N08A
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	11/2/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure

Independent Technical Review Board

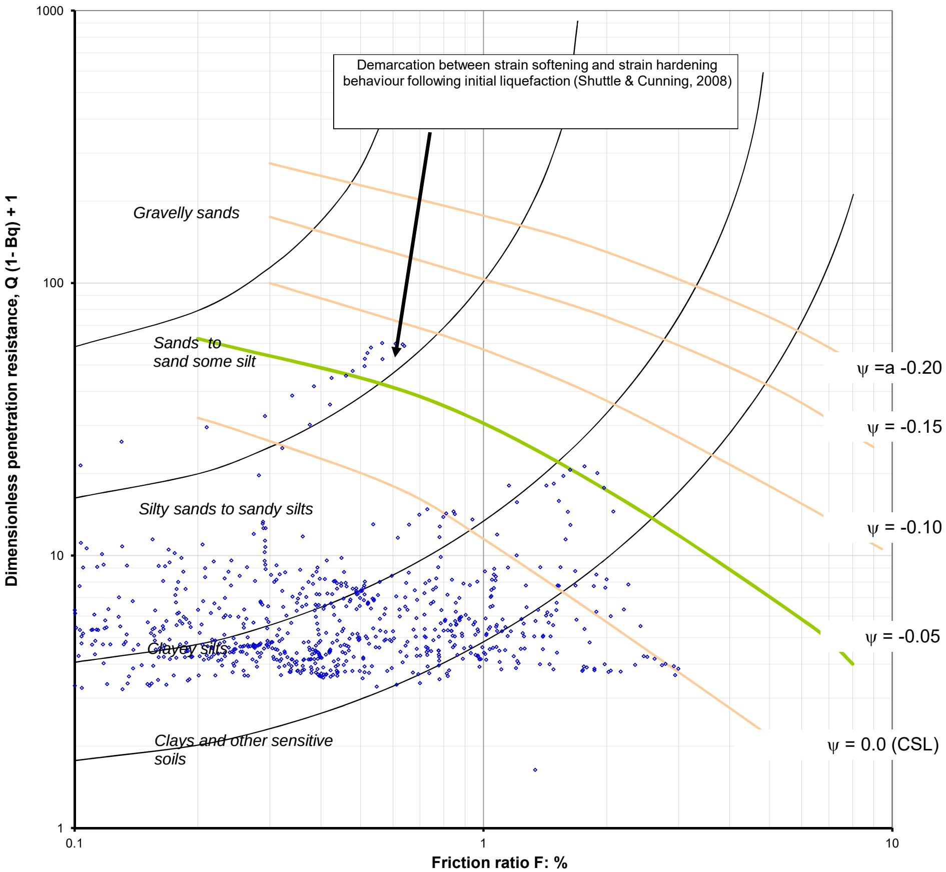
Interpreted Results of CPTu Sounding CPT-N08A

Drawn by: BM

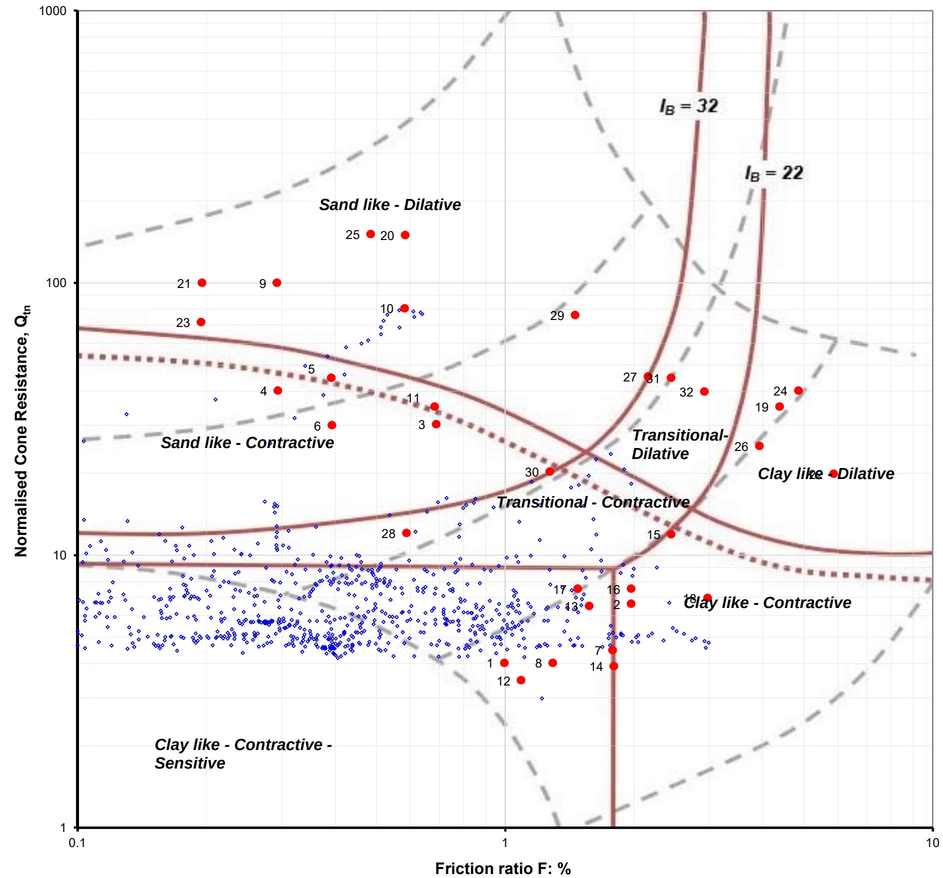
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ32



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N08A
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	11/2/2017
Contractor:	Insitu Geotech Services

Legend

- **Unit A**
- **Unit B**
- **Unit C**
- Hydrostatic pressure
- Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

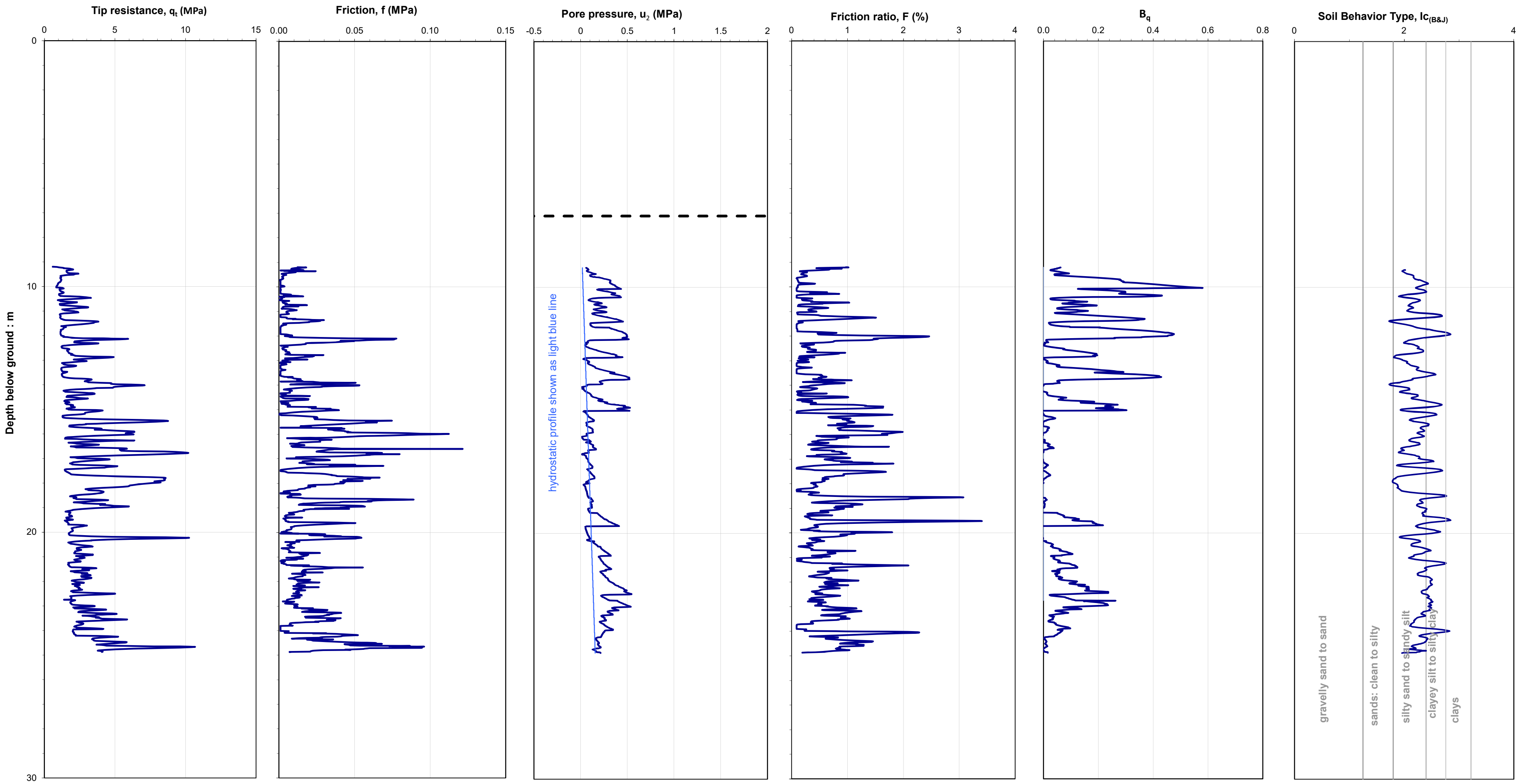
Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016)
Plot for CPT-N08A

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ33



Test Information

Test code:	CPT-N09
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	10/2/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure

Independent Technical Review Board

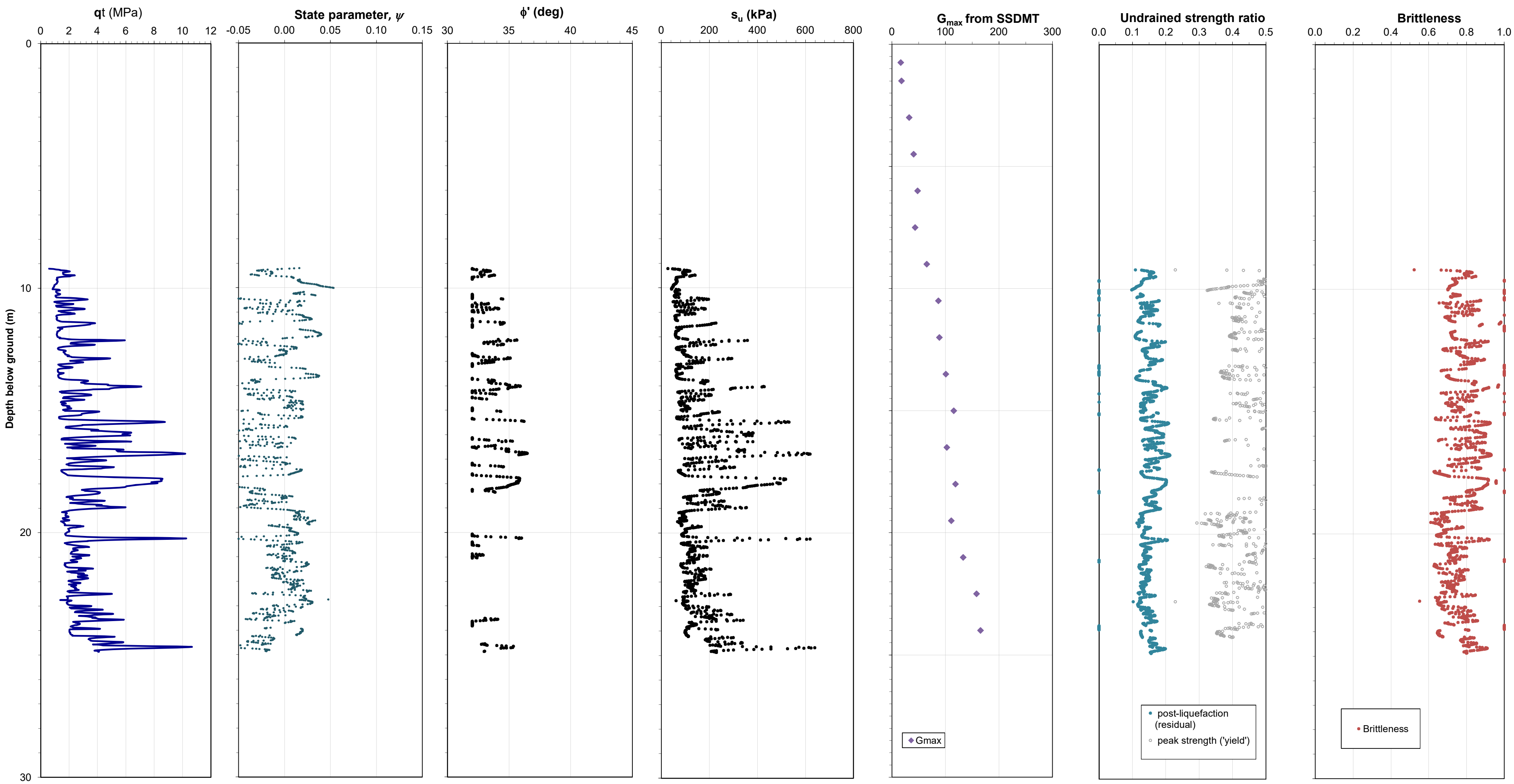
Results of CPTu Sounding CPT-N09

Drawn by: BM

Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ34



Test Information

Test code:	CPT-N09
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	10/2/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

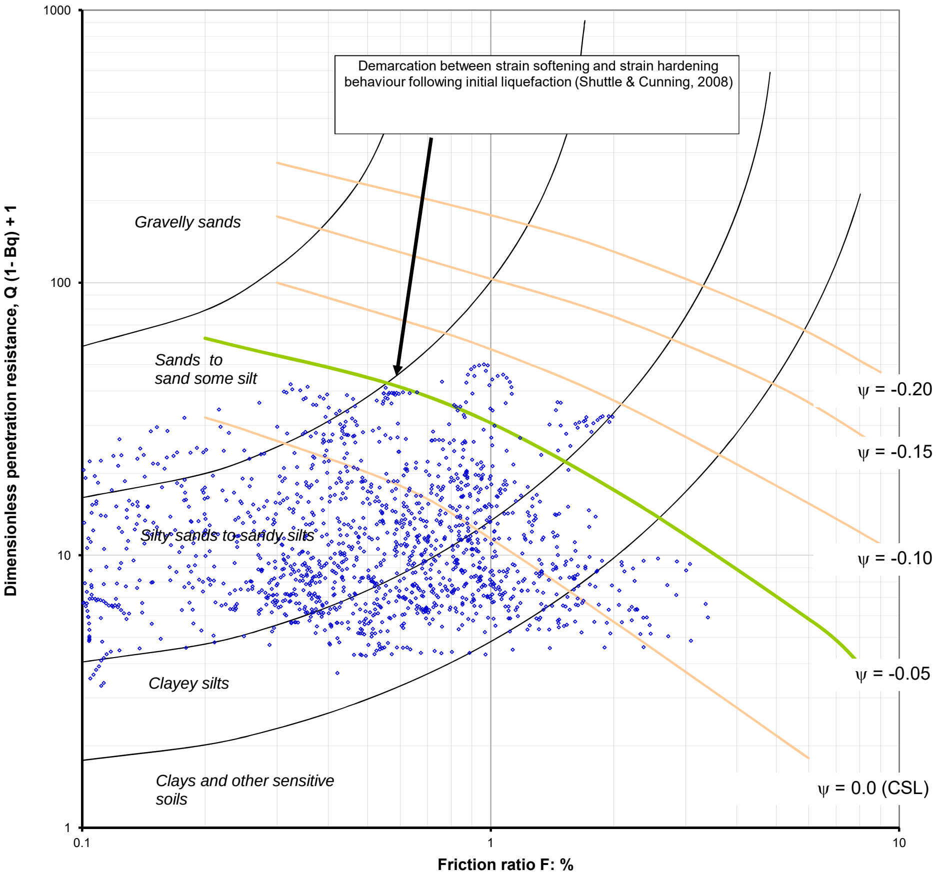
Cadia NTSF Failure
Independent Technical Review Board

Interpreted Results of CPTu Sounding CPT-N09

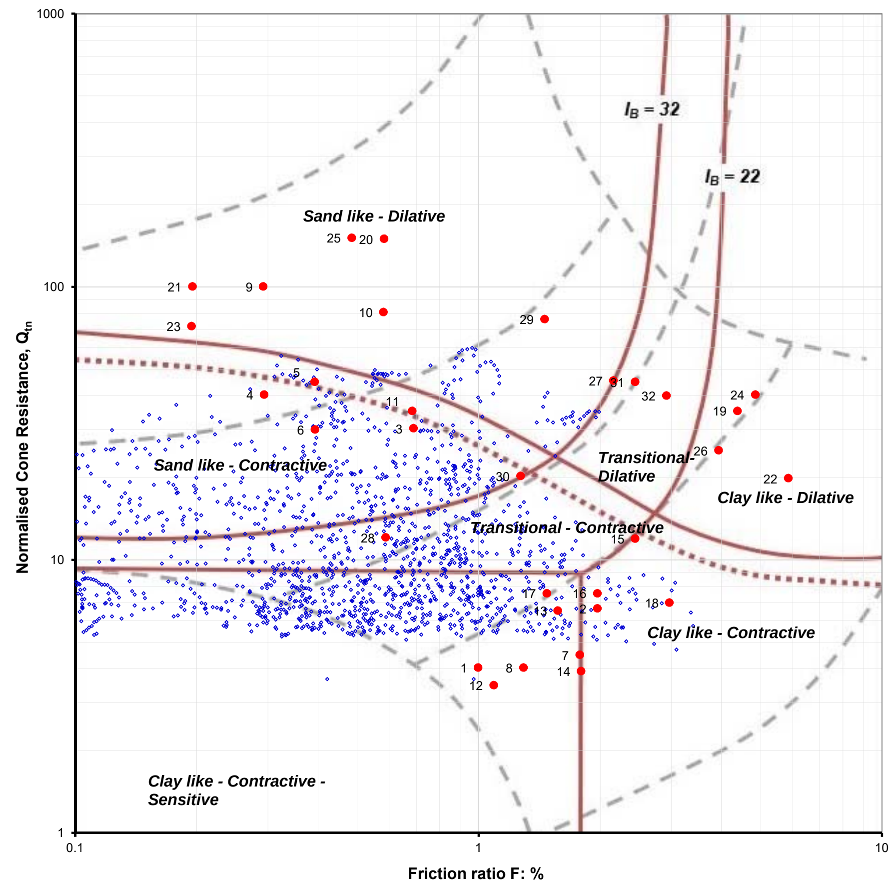
Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ35



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N09
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	10/2/2017
Contractor:	Insitu Geotech Services

Legend

- **Unit A**
- **Unit B**
- **Unit C**
- Hydrostatic pressure
- Water table depth

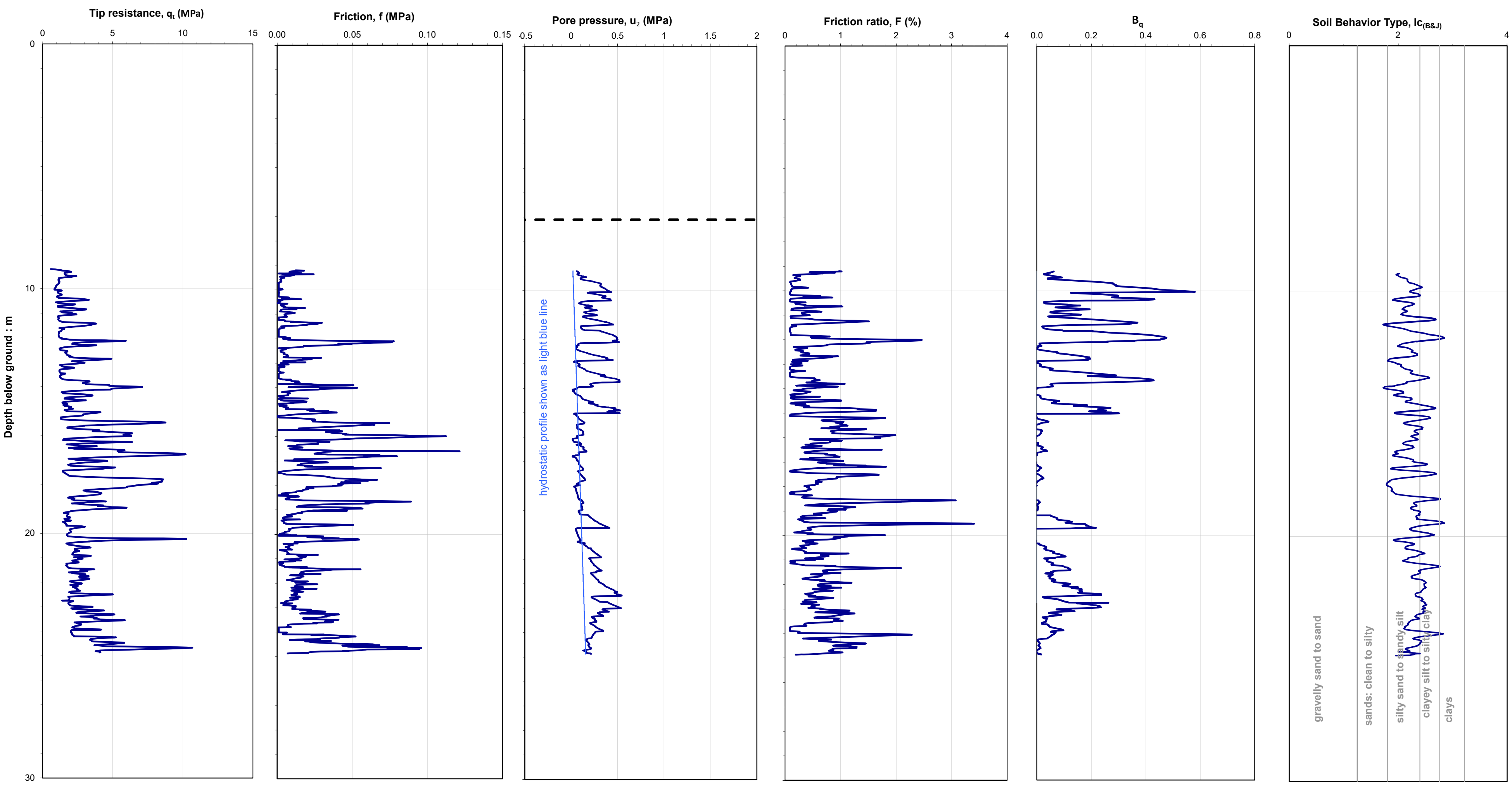
Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016) Plot for CPT-N09

Drawn by: BM Reviewed by: IG	APPENDIX E - ANNEXURE EJ	**FIGURE EJ36**



Test Information

Test code:	CPT-N10
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	10/2/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m³ above water and 19.5 kN/m³ below water; water unit weight 7.6 kN/m³

Geostatic stress ratio K_o = 0.7

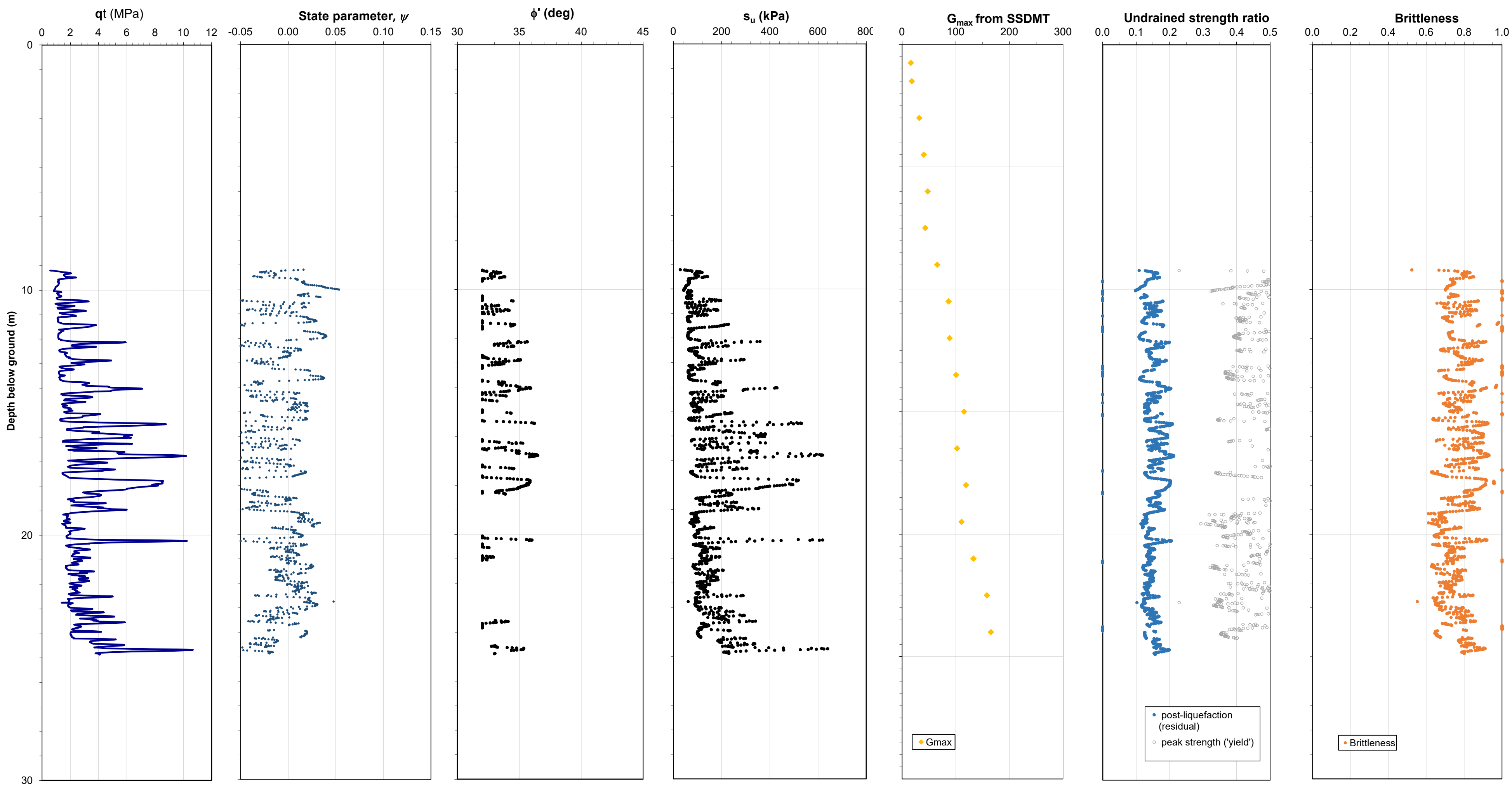
Cadia NTSF Failure
Independent Technical Review Board

Results of CPTu Sounding CPT-N09

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ37



Test Information

Test code:	CPT-N10
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	10/2/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board

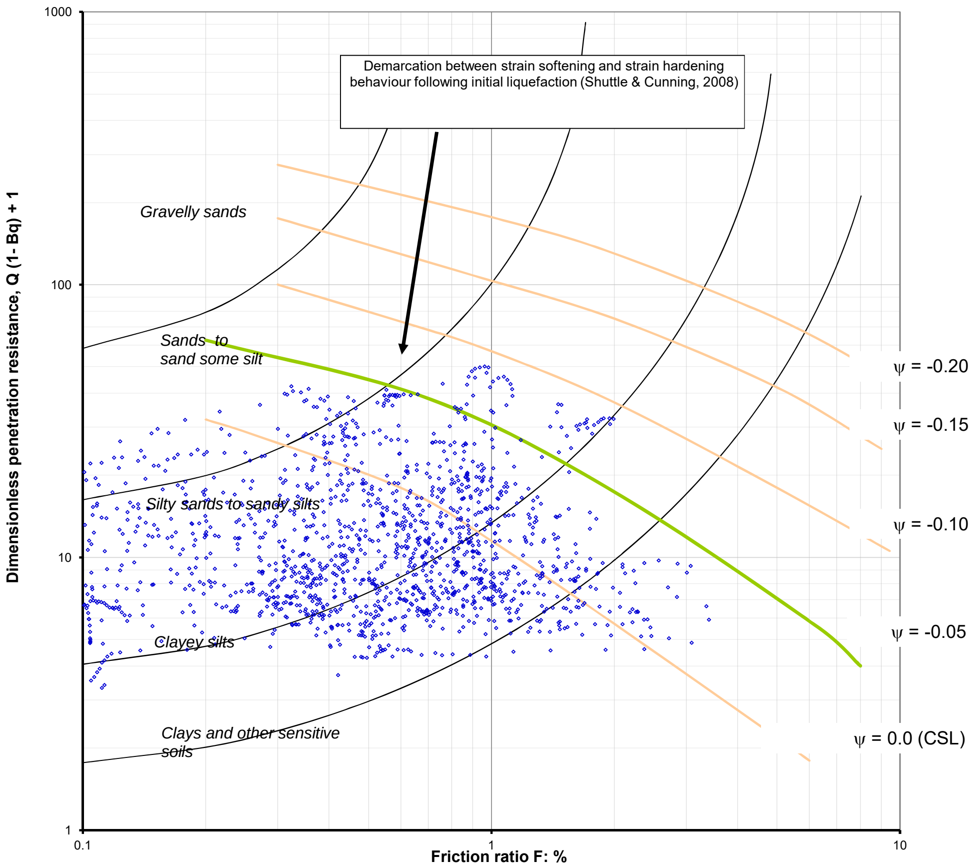
Interpreted Results of CPTu Sounding CPT-N10

Drawn by: BM

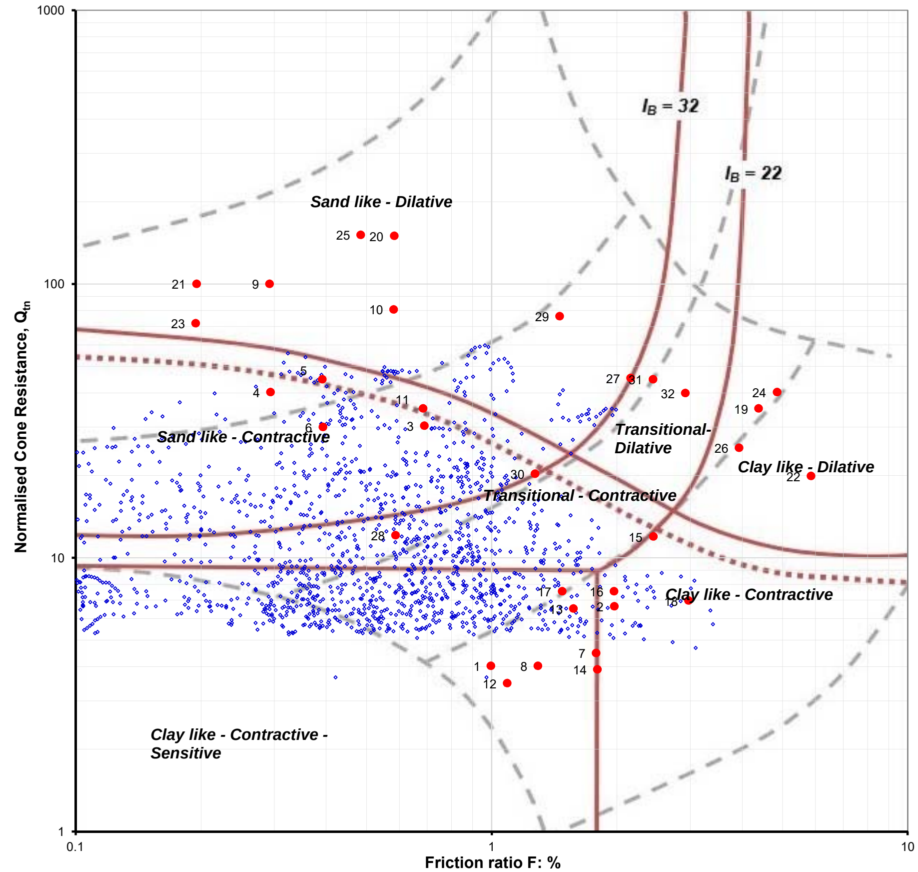
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ38



Screening-level liquefaction assessment chart for sand and silts showing Ic contours (Jefferies & Been 2016). State parameter contours based on (Shuttle & Cunning, 2008)



Updated SBTn chart based on *Q* tn–*Fr* (Roberston, 2016)

Test Information

Test code:	CPT-N10
Depth to Water:	7.1 m
Coordinates:	55 H 0685192, 6291423
Date tested:	10/2/2017
Contractor:	Insitu Geotech Services

Legend

Unit A

Unit B

Unit C

Hydrostatic pressure

Water table depth

Notes:

Soil unit weight 19.5 kN/m^3 above water and 19.5 kN/m^3 below water; water unit weight 7.6 kN/m^3

Geostatic stress ratio K_o = 0.7

Cadia NTSF Failure
Independent Technical Review Board
Shuttle and Cunning (2008) Classification Plot and Robertson (2016)
Plot for CPT-N10

Drawn by: BM
Reviewed by: IG

APPENDIX E - ANNEXURE EJ

FIGURE EJ39

Annexure EK
Oedometer Test Certificates

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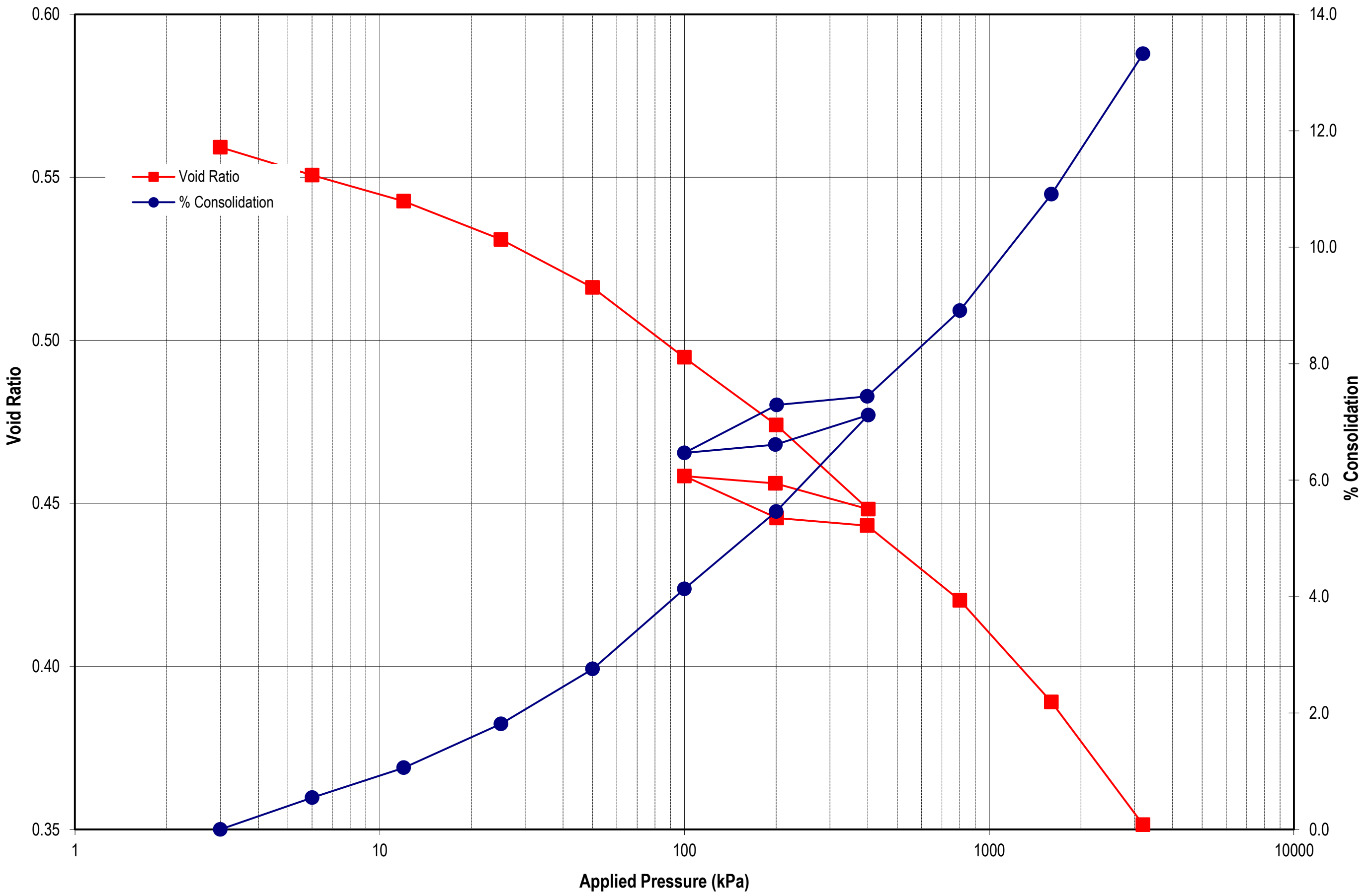
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080185-OED
		Workorder No.	4644
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	10/08/2018
		Report Date:	3/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE408 - DH401 - PS1	**Depth (m):**	11.00-11.50
Description:	SILTY SAND- grey		



Wet Density (t/m^3):	2.13	Initial Moisture (%):	22.2	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.72	Initial Voids Ratio:	0.561	Initial Degree of Saturation (%):	100.0
Undisturbed sample supplied by the client		Remarks:	Tested as Received		Page 1 of 2

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Hatch Pty Ltd

Report No.: 18080185-OED

Workorder No. 4644

Address: PO Box 425 SPRING HILL QLD 4004

Test Date: 10/08/2018

Report Date: 3/09/2018

Project: H356804 - Cadia NTSF Failure

Client Id.: CE408 - DH401 - PS1

Depth (m): 11.00-11.50

Description: SILTY SAND- grey

TEST RESULTS

Stage	Load (kPa)	Cc	k (m/s)	Cv (m^2/yr) t_{50}	Cv (m^2/yr) t_{90}	Mv ($kPa^{-1}x10^{-3}$)	C_a x 10^{-3}	% Consolidation
1	3-6	0.028	4.8E-09	4.95	8.53	1.826	0.48	0.5
2	6-12	0.027	3.1E-09	7.11	11.59	0.861	0.63	1.1
3	12-25	0.037	3.7E-09	12.50	20.58	0.584	0.71	1.8
4	25-50	0.049	4.7E-09	18.02	39.29	0.385	0.76	2.8
5	50-100	0.071	4.4E-09	33.55	50.45	0.283	1.17	4.1
6	100-200	0.069	2.3E-09	33.11	54.49	0.139	1.18	5.5
7	200-401	0.085	1.4E-09	41.63	51.16	0.087	1.59	7.1
8	401-199	0.026	9.8E-10	1.13	117.25	0.027	0.07	6.6
9	199-100	0.007	2.1E-10	7.40	43.46	0.015	0.10	6.5
10	100-201	0.042	3.2E-09	12.28	117.21	0.087	0.00	7.3
11	201-398	0.008	5.8E-11	0.08	23.12	0.008	0.47	7.4
12	398-801	0.076	8.8E-10	59.20	71.64	0.039	1.96	8.9
13	801-1602	0.104	6.7E-10	95.86	79.22	0.027	2.38	10.9
14	1602-3200	0.125	3.3E-10	93.11	62.22	0.017	2.62	13.3

Remarks: Tested as Received

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

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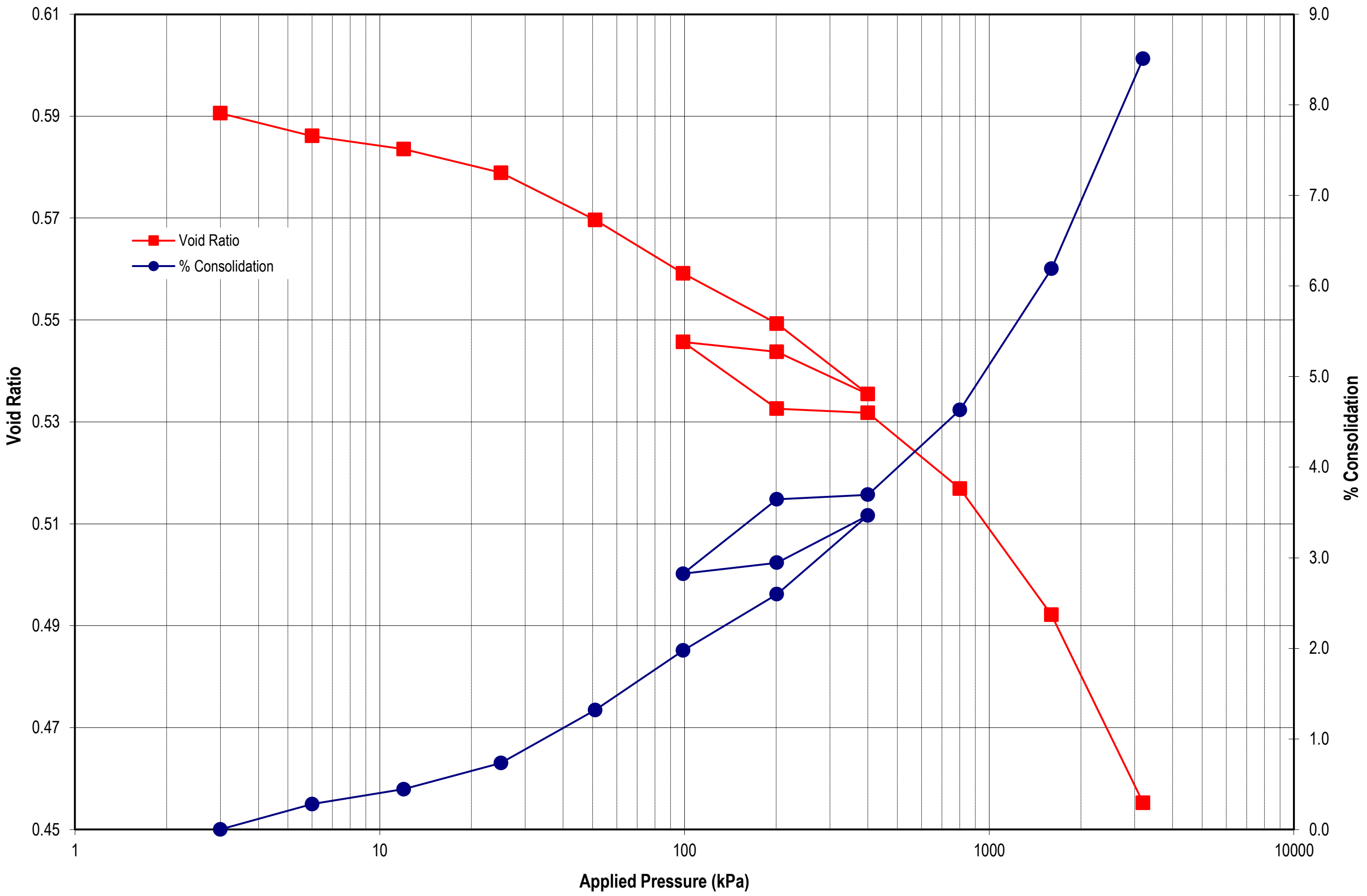
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080187-OED
		Workorder No.	4644
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	13/08/2018
		Report Date:	3/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE408 - DH401 - PS3	**Depth (m):**	25.00-25.45
Description:	SILTY SAND- grey		



Wet Density (t/m^3):	1.99	Initial Moisture (%):	19.2	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.66	Initial Voids Ratio:	0.591	Initial Degree of Saturation (%):	87.5
Undisturbed sample supplied by the client		Remarks:	Tested as Received	Page 1 of 2	

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080187-OED
		Workorder No.	4644
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	13/08/2018
		Report Date:	3/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE408 - DH401 - PS3	**Depth (m):**	25.00-25.45
Description:	SILTY SAND- grey		

TEST RESULTS

Stage	Load (kPa)	Cc	k (m/s)	Cv (m^2/yr) t_{50}	Cv (m^2/yr) t_{90}	Mv ($kPa^{-1}x10^{-3}$)	C_a x 10^{-3}	% Consolidation
1	3-6	0.015	2.5E-08	2.90	87.05	0.938	0.22	0.3
2	6-12	0.009	8.9E-09	29.36	105.07	0.273	0.50	0.4
3	12-25	0.015	1.9E-08	21.33	267.87	0.225	0.63	0.7
4	25-51	0.030	8.3E-09	47.30	117.77	0.226	0.82	1.3
5	51-99	0.036	2.5E-09	183.08	58.44	0.139	0.51	2.0
6	99-201	0.032	3.1E-09	200.83	160.89	0.062	1.06	2.6
7	201-400	0.046	1.3E-09	7.91	91.59	0.045	1.01	3.5
8	400-201	0.028	2.0E-09	162.24	237.20	0.027	0.06	2.9
9	201-99	0.006	2.4E-10	2.45	63.71	0.012	0.06	2.8
10	99-201	0.043	5.4E-09	144.70	210.19	0.083	0.08	3.6
11	201-400	0.003	8.0E-11	112.64	97.97	0.003	0.25	3.7
12	400-801	0.049	5.9E-10	4.86	78.13	0.024	1.18	4.6
13	801-1600	0.082	6.5E-10	112.89	102.19	0.020	1.99	6.2
14	1600-3200	0.123	4.8E-10	92.00	100.90	0.015	2.65	8.5

Remarks: Tested as Received

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

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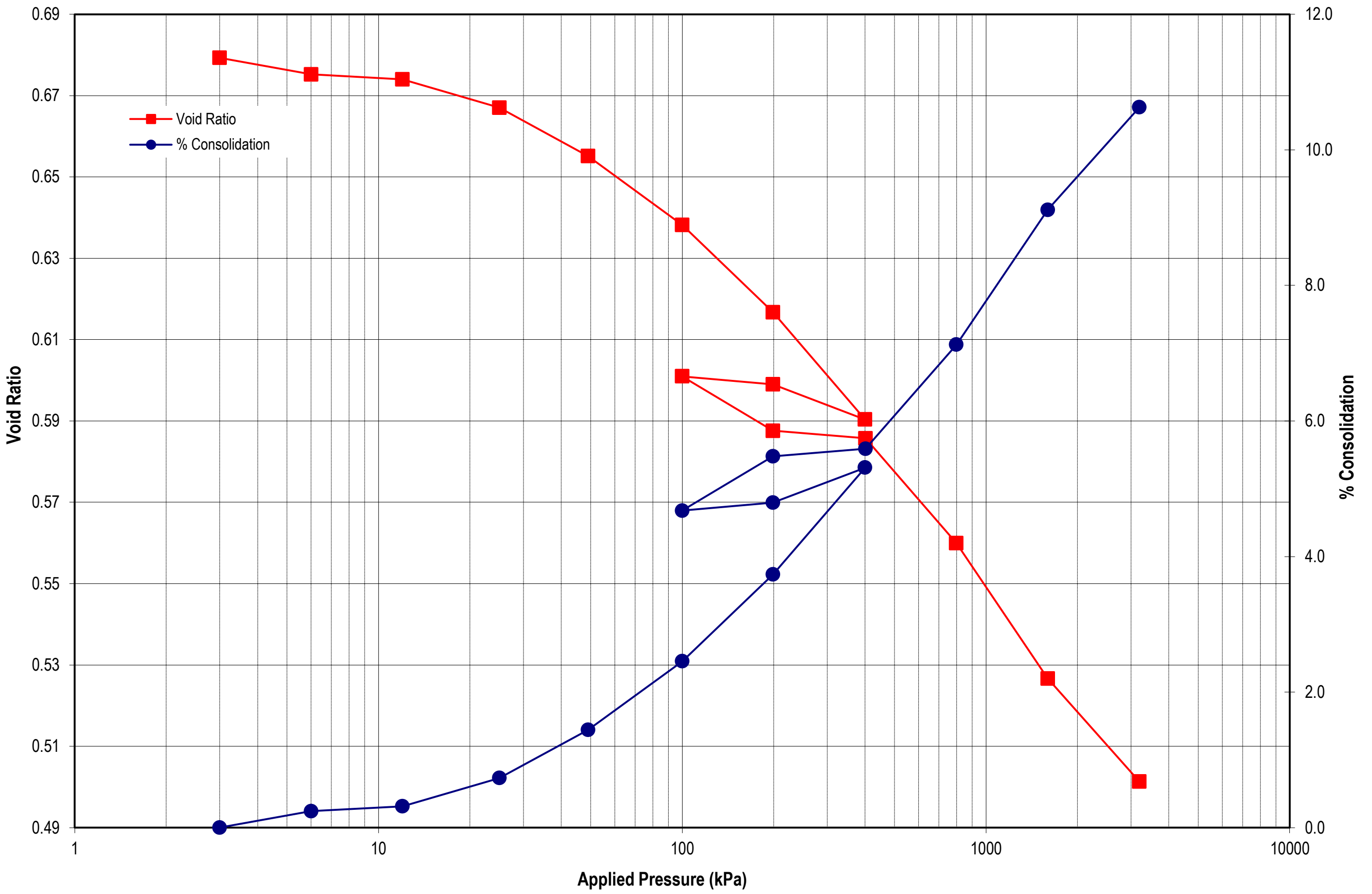
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080189-OED
		Workorder No.	4644
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	17/08/2018
		Report Date:	6/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE407 - DH402 - PS1	**Depth (m):**	12.00-12.45
Description:	SILTY SAND- grey		



Wet Density (t/m^3):	2.02	Initial Moisture (%):	25.0	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.70	Initial Voids Ratio:	0.674	Initial Degree of Saturation (%):	100.8
Undisturbed sample supplied by the client		Remarks:	Tested as Received		Page 1 of 2

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Hatch Pty Ltd

Report No.: 18080189-OED

Workorder No. 4644

Address: PO Box 425 SPRING HILL QLD 4004

Test Date: 17/08/2018

Report Date: 6/09/2018

Project: H356804 - Cadia NTSF Failure

Client Id.: CE407 - DH402 - PS1

Depth (m): 12.00-12.45

Description: SILTY SAND- grey

TEST RESULTS

Stage	Load (kPa)	Cc	k (m/s)	Cv (m^2/yr) t_{50}	Cv (m^2/yr) t_{90}	Mv ($kPa^{-1}x10^{-3}$)	C_a x 10^{-3}	% Consolidation
1	3-6	0.014	7.3E-09	2.18	28.79	0.813	0.22	0.2
2	6-12	0.004	1.8E-09	17.97	46.84	0.122	0.48	0.3
3	12-25	0.022	7.3E-09	36.20	73.42	0.320	0.61	0.7
4	25-49	0.041	8.3E-09	50.03	89.71	0.298	0.89	1.4
5	49-100	0.055	6.4E-09	93.57	102.77	0.201	1.32	2.5
6	100-199	0.072	4.1E-09	90.15	99.15	0.133	1.54	3.7
7	199-400	0.087	2.7E-09	100.77	105.38	0.081	1.84	5.3
8	400-199	0.029	1.1E-09	1.09	128.87	0.027	0.03	4.8
9	199-100	0.007	7.9E-11	1.67	20.63	0.012	0.08	4.7
10	100-199	0.045	4.5E-09	222.69	169.91	0.085	0.04	5.5
11	199-401	0.006	1.9E-10	182.86	105.83	0.006	0.26	5.6
12	401-799	0.086	5.5E-10	75.03	43.48	0.041	1.57	7.1
13	799-1599	0.111	5.6E-10	118.50	67.70	0.027	2.55	9.1
14	1599-3199	0.084	1.7E-10	65.38	51.35	0.010	2.39	10.6

Remarks: Tested as Received

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Authorised Signatory

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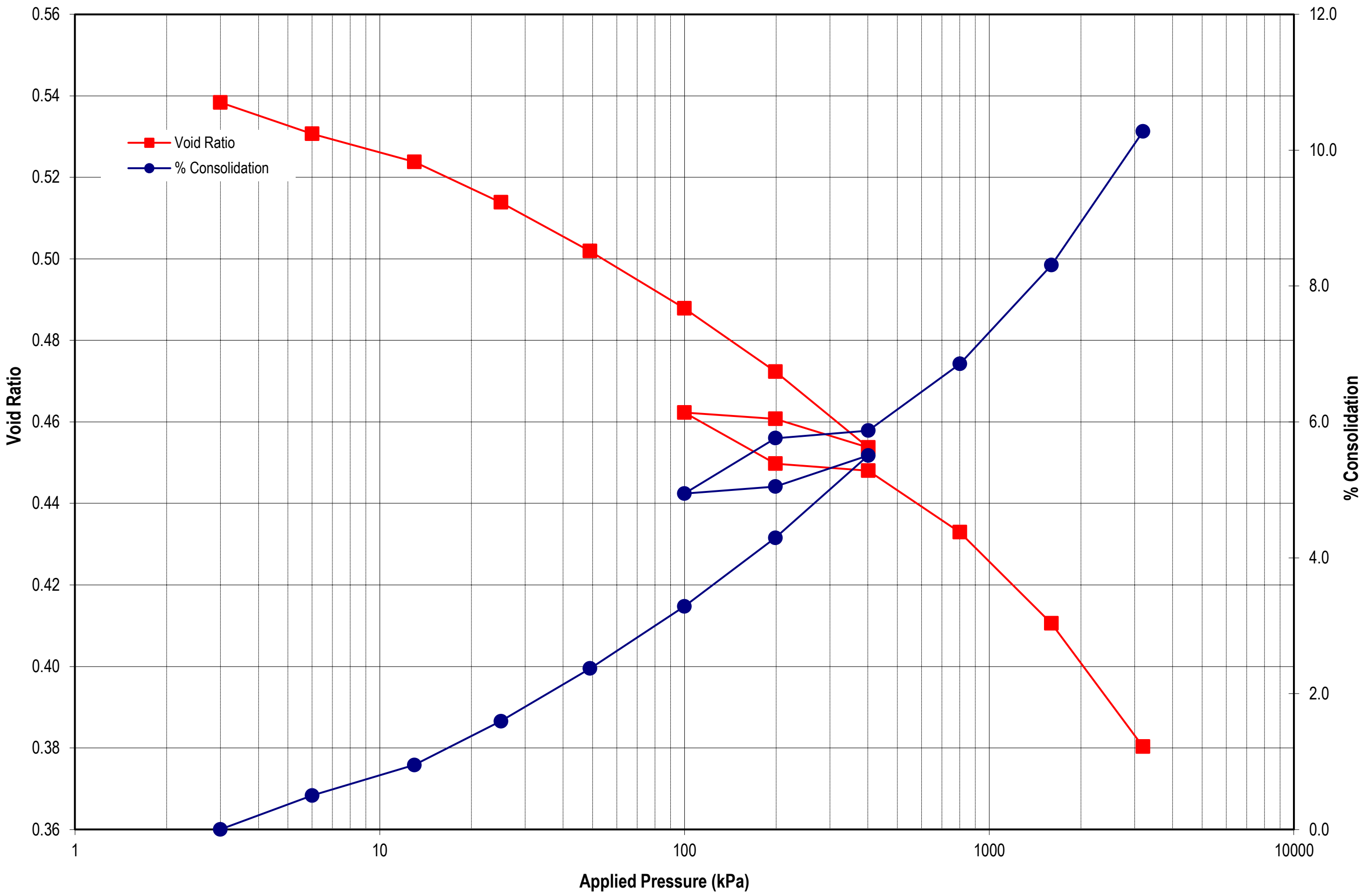
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080192-OED
		Workorder No.	4644
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	17/08/2018
		Report Date:	6/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE413 - DH404 - PS2	**Depth (m):**	25.95-26.40
Description:	SILTY SAND- grey		



Wet Density (t/m^3):	2.20	Initial Moisture (%):	23.5	Test Condition: Inundated on load	
Particle Density (t/m^3):	2.74	Initial Voids Ratio:	0.538	Initial Degree of Saturation (%):	100.0
Undisturbed sample supplied by the client		Remarks: Tested as Received		Page 1 of 2	

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Tested at Trilab Brisbane Laboratory.

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OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client: Hatch Pty Ltd

Report No.: 18080192-OED

Workorder No. 4644

Address: PO Box 425 SPRING HILL QLD 4004

Test Date: 17/08/2018

Report Date: 6/09/2018

Project: H356804 - Cadia NTSF Failure

Client Id.: CE413 - DH404 - PS2

Depth (m): 25.95-26.40

Description: SILTY SAND- grey

TEST RESULTS

Stage	Load (kPa)	Cc	k (m/s)	Cv (m^2/yr) t_{50}	Cv (m^2/yr) t_{90}	Mv ($kPa^{-1}x10^{-3}$)	C_a x 10^{-3}	% Consolidation
1	3-6	0.026	1.5E-08	14.54	28.22	1.668	0.39	0.5
2	6-13	0.021	1.1E-08	18.16	54.72	0.644	0.59	0.9
3	13-25	0.035	9.2E-09	46.86	54.69	0.543	0.99	1.6
4	25-49	0.041	5.4E-09	66.80	53.54	0.328	1.17	2.4
5	49-100	0.045	4.5E-09	76.71	78.88	0.183	1.34	3.3
6	100-199	0.052	3.0E-09	78.89	90.05	0.106	1.43	4.3
7	199-401	0.061	1.4E-09	9.52	71.18	0.063	1.08	5.5
8	401-199	0.023	3.7E-10	53.26	50.07	0.024	0.05	5.0
9	199-100	0.005	2.6E-10	142.00	76.19	0.011	0.09	4.9
10	100-199	0.042	1.5E-09	161.04	55.59	0.087	0.00	5.8
11	199-401	0.006	3.6E-10	262.71	199.93	0.006	0.16	5.9
12	401-801	0.050	4.6E-10	63.54	57.11	0.026	1.59	6.9
13	801-1601	0.074	5.6E-10	101.28	93.07	0.020	2.10	8.3
14	1601-3200	0.101	2.1E-10	68.93	49.56	0.013	2.40	10.3

Remarks: Tested as Received

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Laboratory Number 9926

Annexure EL
Bender Element Test Certificates

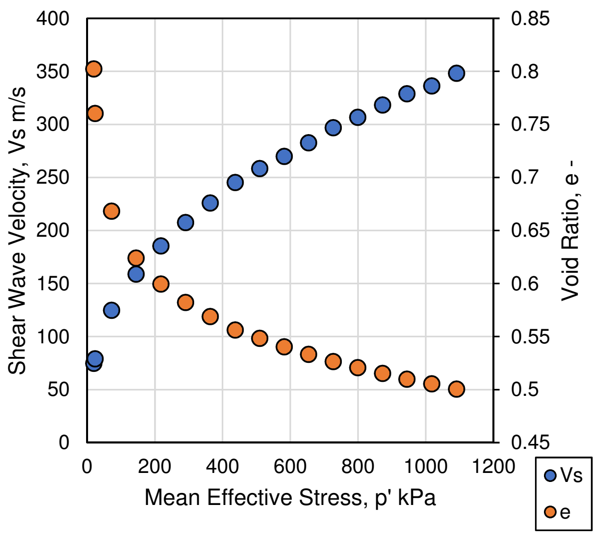
Shear Wave Velocity Measurement on Triaxial Specimen
Test Report

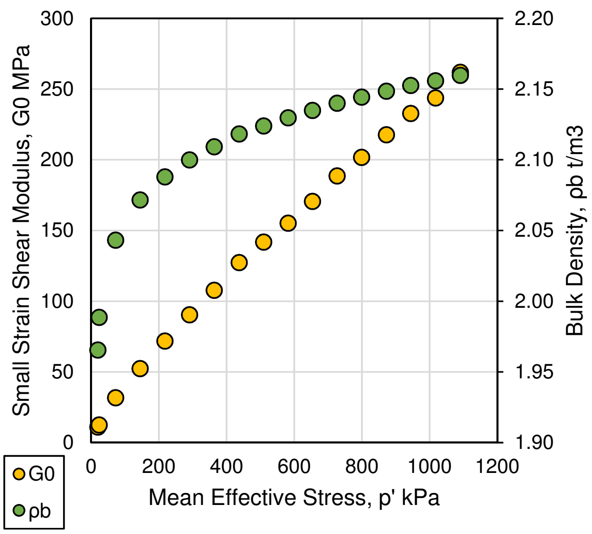
GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	24/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-1 BE loose

Initial Height (mm):	133.2	Final Height (mm):	114.9	B Response (%):	97
Initial Dry Density (t/m3):	1.52	Final Dry Density (t/m^3):	1.83	Input Signal Frequency (Hz):	2500
Initial Void Ratio (-):	0.80	Final Void Ratio (-):	0.50	Input Signal Amplitude (V):	14.0
Initial Water Content (%)	29.3	Final Water Content (%)	18.3		

Stage -	Mean Effective Stress, p' kPa	Deviatoric Stress, q kPa	Geostatic Stress Ratio, K_0 -	Bulk Density, ρ_b t/m^3	Void Ratio, e -	Shear Wave Velocity, Vs m/s	Small Strain Shear Modulus, G_0 MPa
BE01	20.0	1.8	0.91	1.97	0.802	75	11.0
BE02	23.7	12.6	0.61	1.99	0.760	79	12.4
BE03	72.3	38.3	0.61	2.04	0.668	125	31.7
BE04	144.9	76.6	0.61	2.07	0.624	159	52.3
BE05	217.9	114.5	0.61	2.09	0.600	185	71.7
BE06	290.8	152.9	0.61	2.10	0.582	207	90.3
BE07	363.8	191.7	0.61	2.11	0.569	226	107.6
BE08	437.5	230.3	0.61	2.12	0.556	245	127.3
BE09	509.7	267.4	0.61	2.12	0.548	258	141.8
BE10	582.0	305.5	0.61	2.13	0.540	270	155.1
BE11	654.2	343.6	0.61	2.13	0.533	283	170.5
BE12	727.0	381.6	0.61	2.14	0.526	297	188.5
BE13	799.2	419.8	0.61	2.14	0.521	307	201.7
BE14	872.7	458.4	0.61	2.15	0.515	318	217.6
BE15	944.5	496.1	0.61	2.15	0.510	329	232.7
BE16	1017.7	534.2	0.61	2.16	0.505	336	243.7
BE17	1091.4	572.4	0.61	2.16	0.500	348	261.8





Preparation Notes:	Moist tamped loose	Tested by:	Y. Guadalupe
		Reviewed by:	R. Fanni

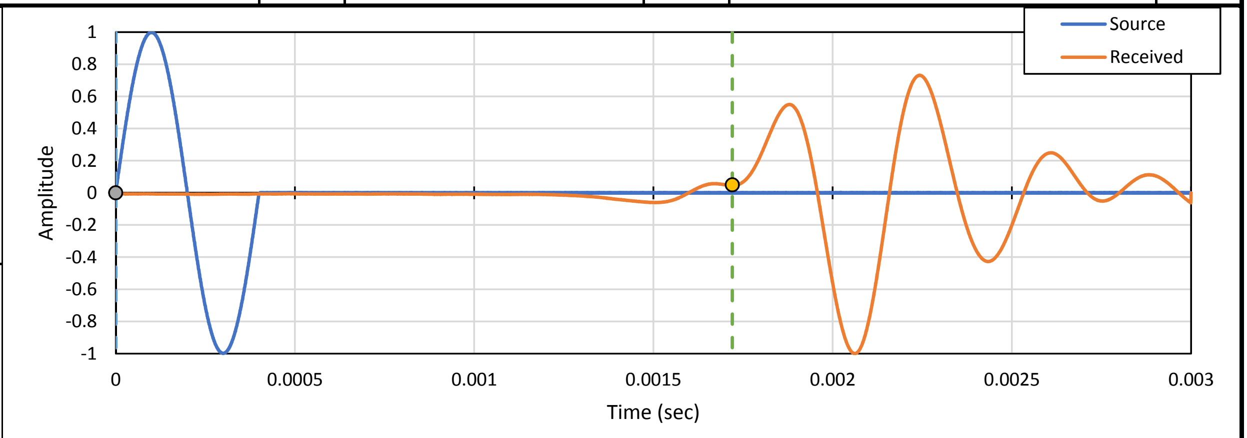
Shear Wave Velocity Measurement on Triaxial Specimen Test Report

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

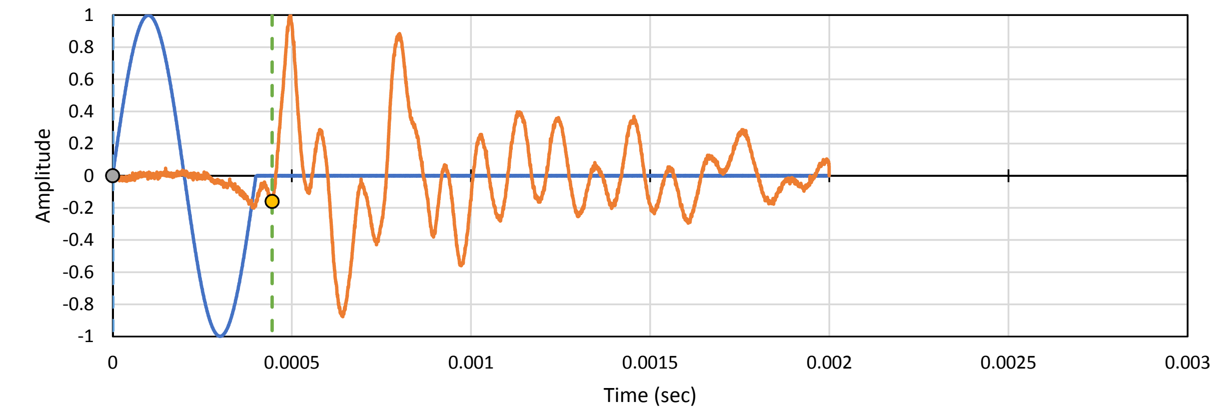
Client:	Hatch	**Date:**	24/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-1 BE loose

Initial Height (mm):	133.2	Final Height (mm):	114.9	B Response (%):	97
Initial Dry Density (t/m3):	1.52	Final Dry Density (t/m^3):	1.826	Input Signal Frequency (Hz):	2500
Initial Void Ratio (-):	0.80	Final Void Ratio (-):	0.50	Input Signal Amplitude (V):	14.0
Initial Water Content (%)	29.3	Final Water Content (%)	18.3		

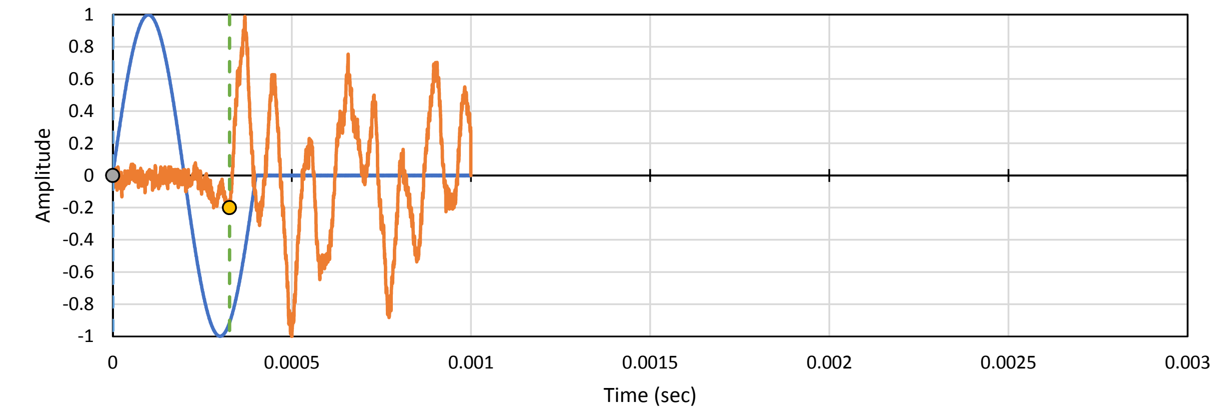
V_s Stage: BE01 p': 20.0 kPa



V_s Stage: BE09 p': 509.7 kPa



V_s Stage: BE17 p': 1091.4 kPa



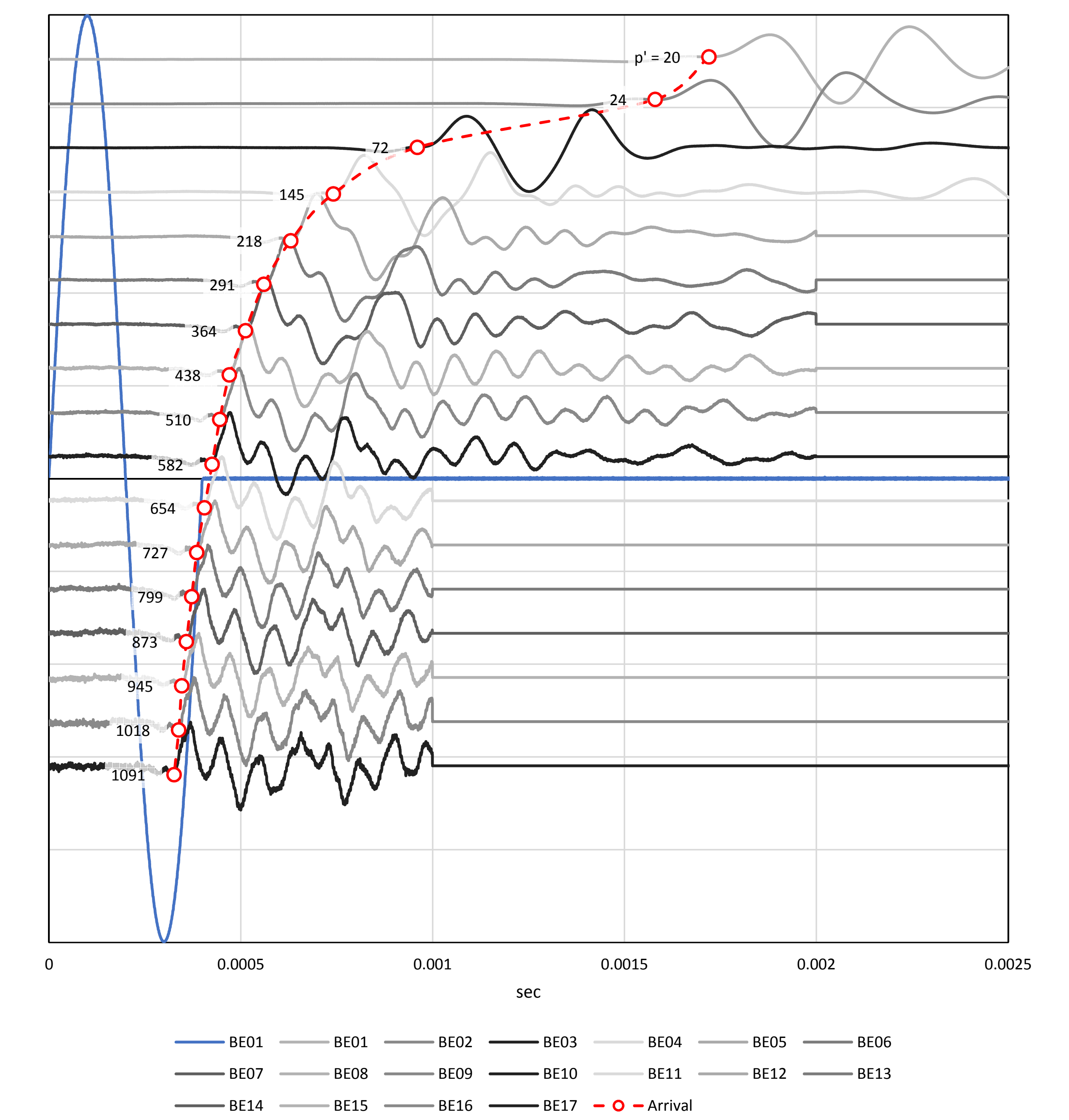
Preparation Notes:	Moist tamped loose	Tested by:	Y. Guadalupe
		Reviewed by:	R. Fanni

Shear Wave Velocity Measurement on Triaxial Specimen Test Report

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	24/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-1 BE loose

Initial Height (mm):	133.2	Final Height (mm):	114.9	B Response (%):	97
Initial Dry Density (t/m3):	1.52	Final Dry Density (t/m^3):	1.83	Input Signal Frequency (Hz):	2500
Initial Void Ratio (-):	0.80	Final Void Ratio (-):	0.50	Input Signal Amplitude (V):	14.0
Initial Water Content (%)	29.3	Final Water Content (%)	18.3		



Preparation Notes:	Moist tamped loose	Tested by:	Y. Guadalupe
		Reviewed by:	R. Fanni

Annexure EM
CSD Triaxial Test Cetificates

Triaxial Test Report

Constant Shear Drained (CSD) Servo Controlled

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-10 CSD loose 200kPa

Initial Height (mm):	144.7	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	64.5	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	198
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.71

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

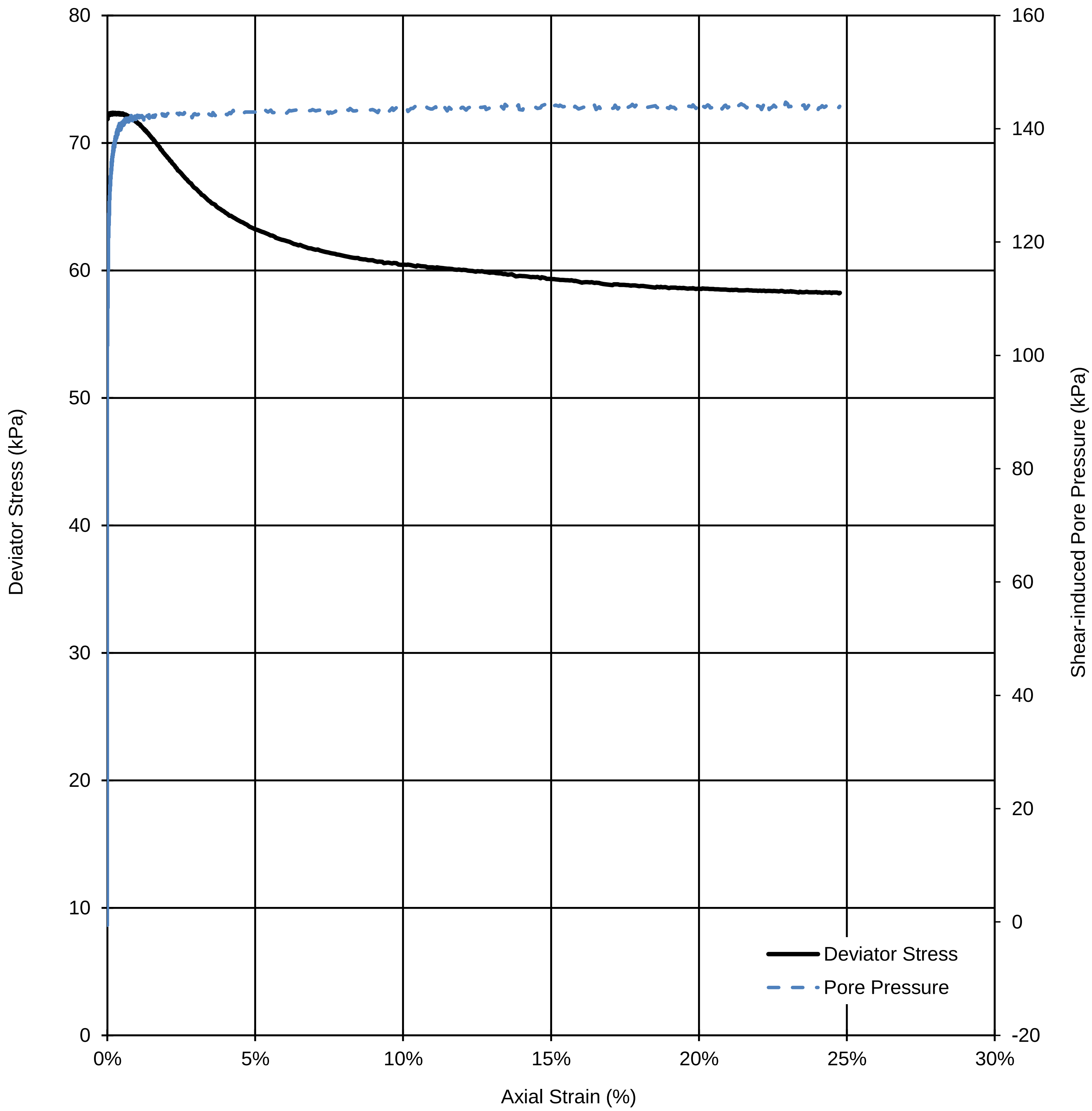
Triaxial Test Report

Constant Shear Drained (CSD) Servo Controlled

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-10 CSD loose 200kPa

Initial Height (mm):	144.7	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	64.5	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	198
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.71



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni

Triaxial Test Report

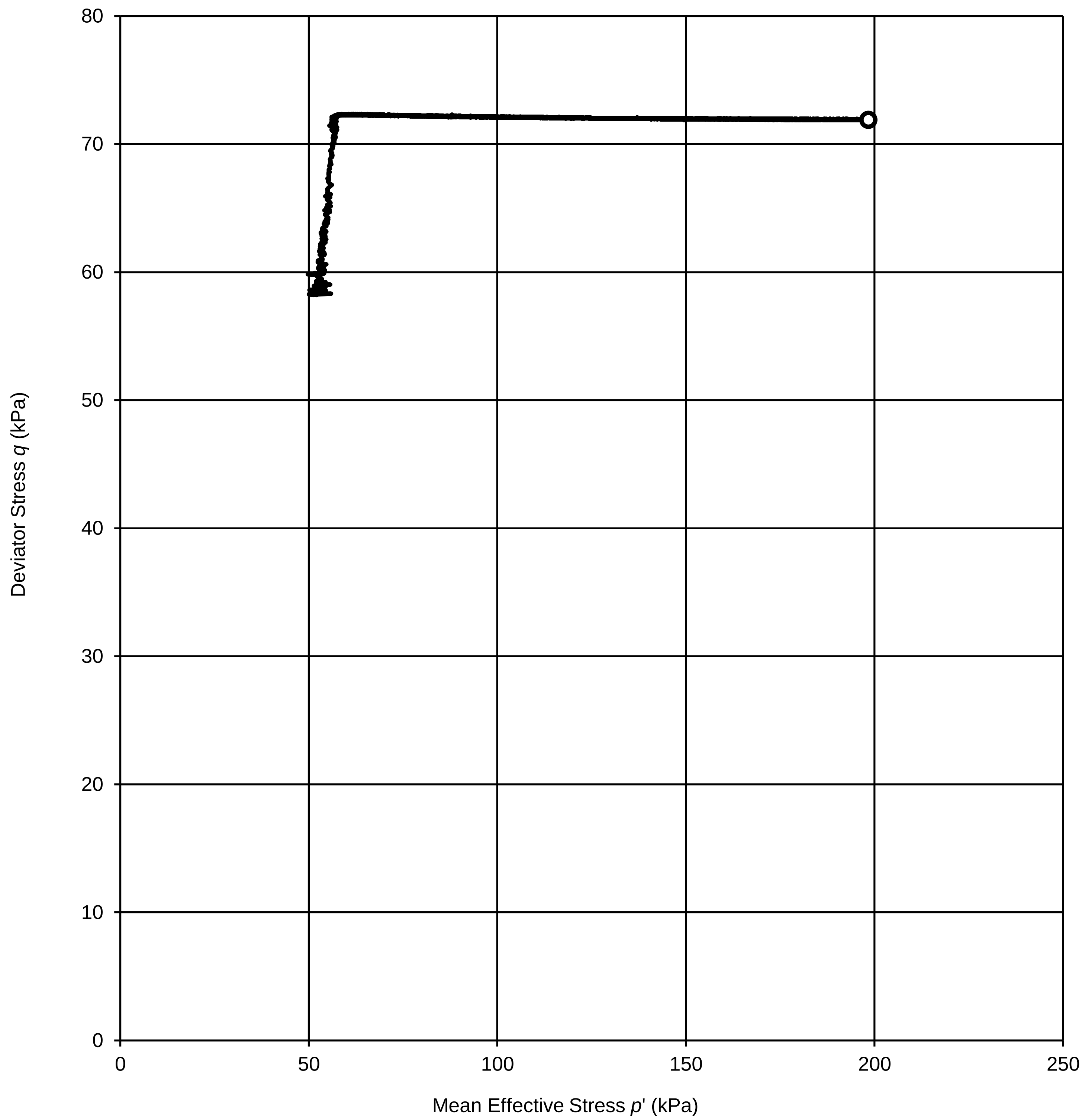
Constant Shear Drained (CSD) Servo Controlled

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-10 CSD loose 200kPa

Initial Height (mm):	144.7	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	64.5	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	198
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.71



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

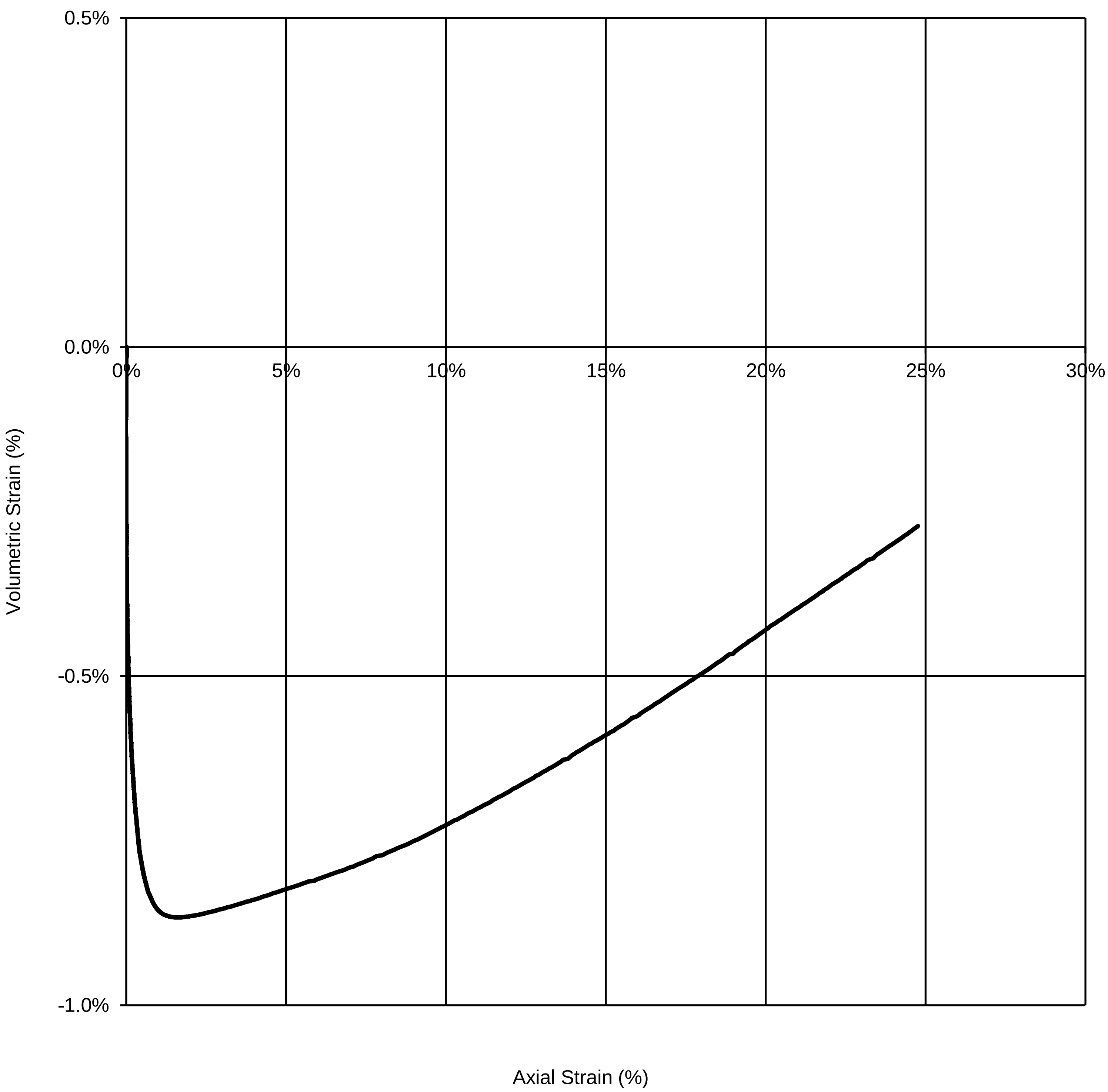
Triaxial Test Report

Constant Shear Drained (CSD) Servo Controlled

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-10 CSD loose 200kPa

Initial Height (mm):	144.7	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	64.5	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	198
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.71



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

Triaxial Test Report

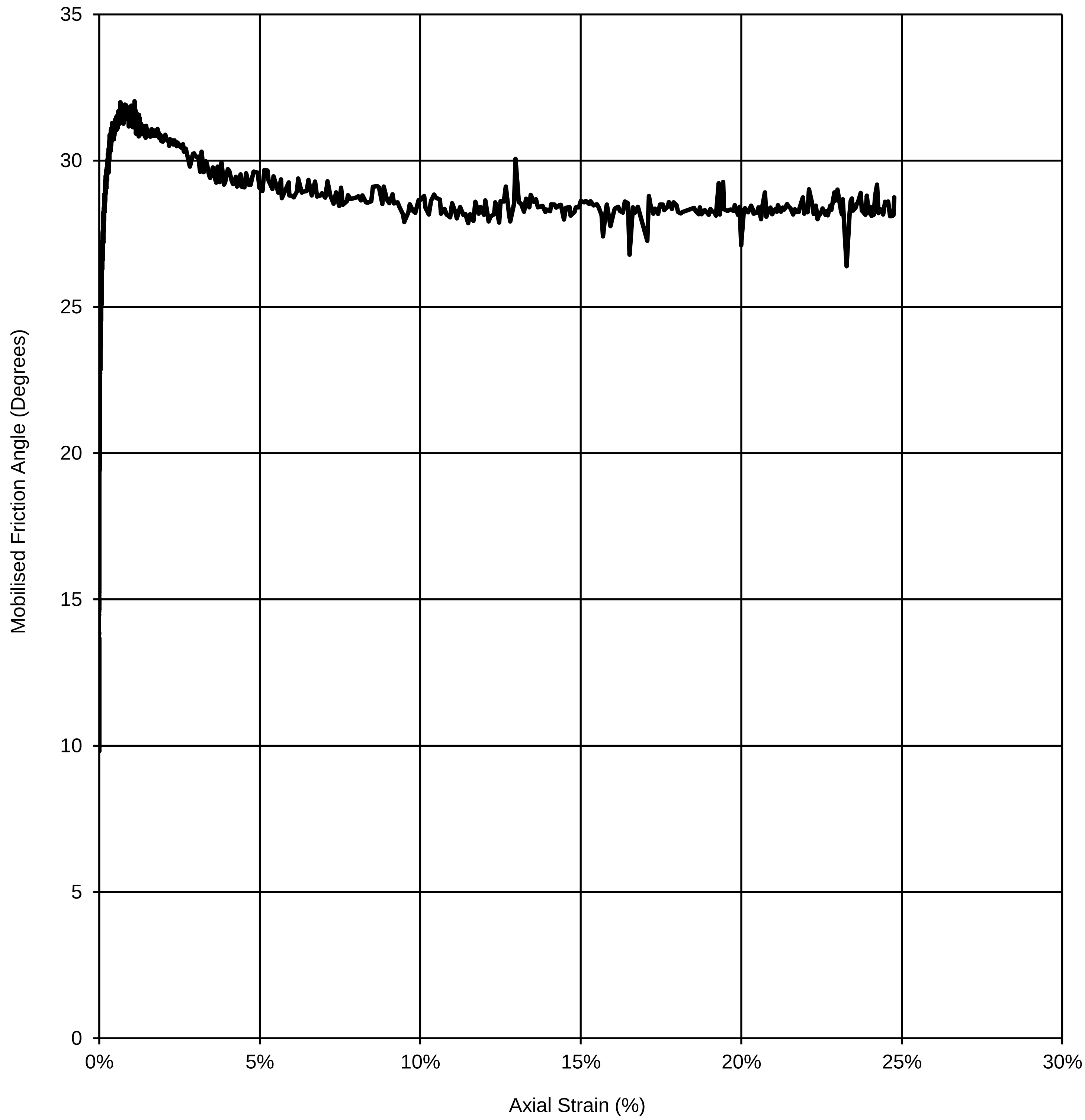
Constant Shear Drained (CSD) Servo Controlled

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	HA401 0-2m
Location:	Cadia Mine	**Test ID:**	18003 - sa-10 CSD loose 200kPa

Initial Height (mm):	144.7	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	64.5	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	11.3%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	198
Initial Dry Density (t/m^3):	1.21	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.71



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Triaxial Test Report

Constant Shear Drained (CSD) Servo Controlled

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-9 CSD loose

Initial Height (mm):	148.0	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.6	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	351
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.75

Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

Triaxial Test Report

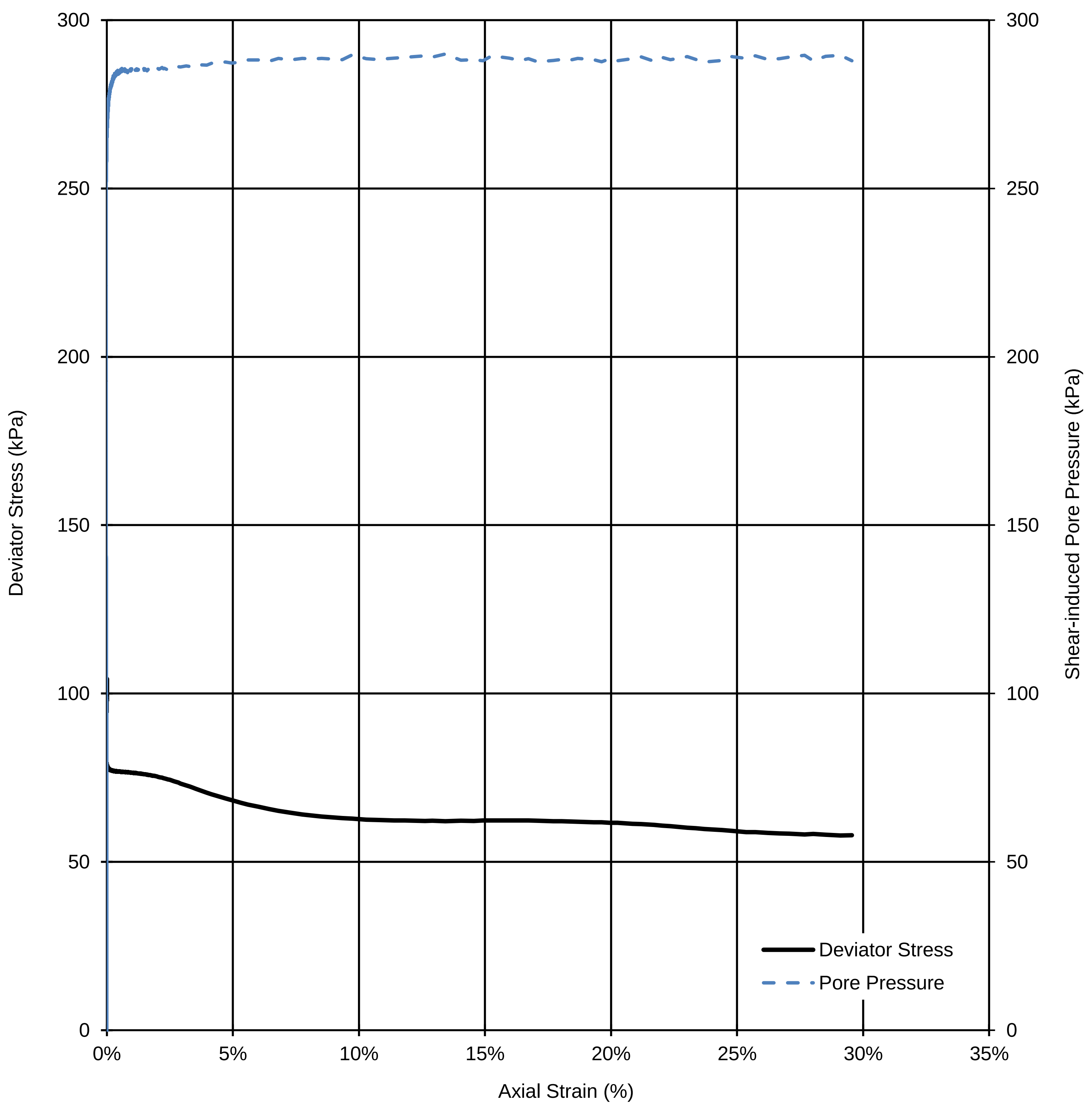
Constant Shear Drained (CSD) Servo Controlled

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-9 CSD loose

Initial Height (mm):	148.0	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.6	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	351
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.75



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

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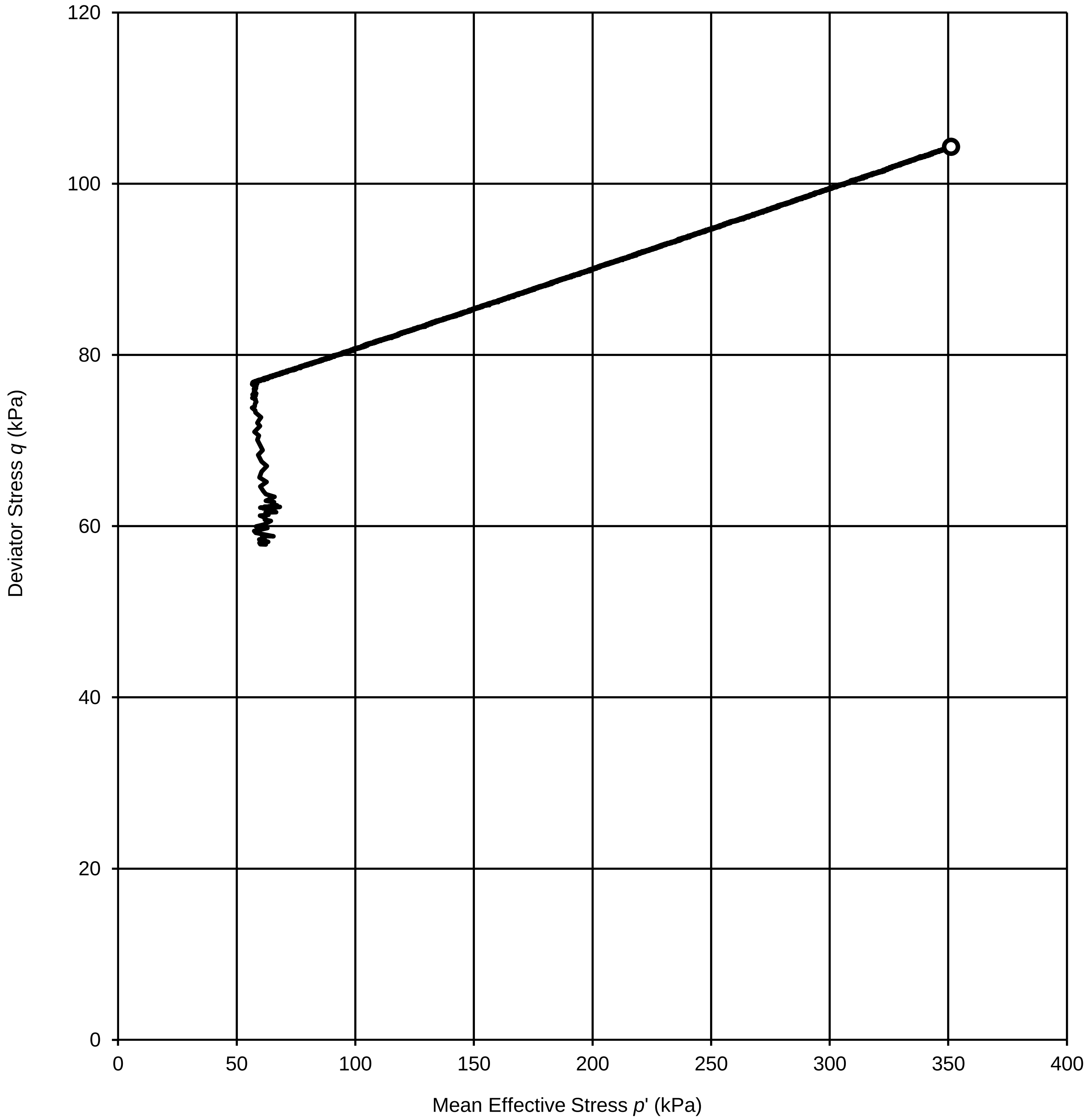
Triaxial Test Report

Constant Shear Drained (CSD) Servo Controlled

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-9 CSD loose

Initial Height (mm):	148.0	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.6	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	351
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.75



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Triaxial Test Report

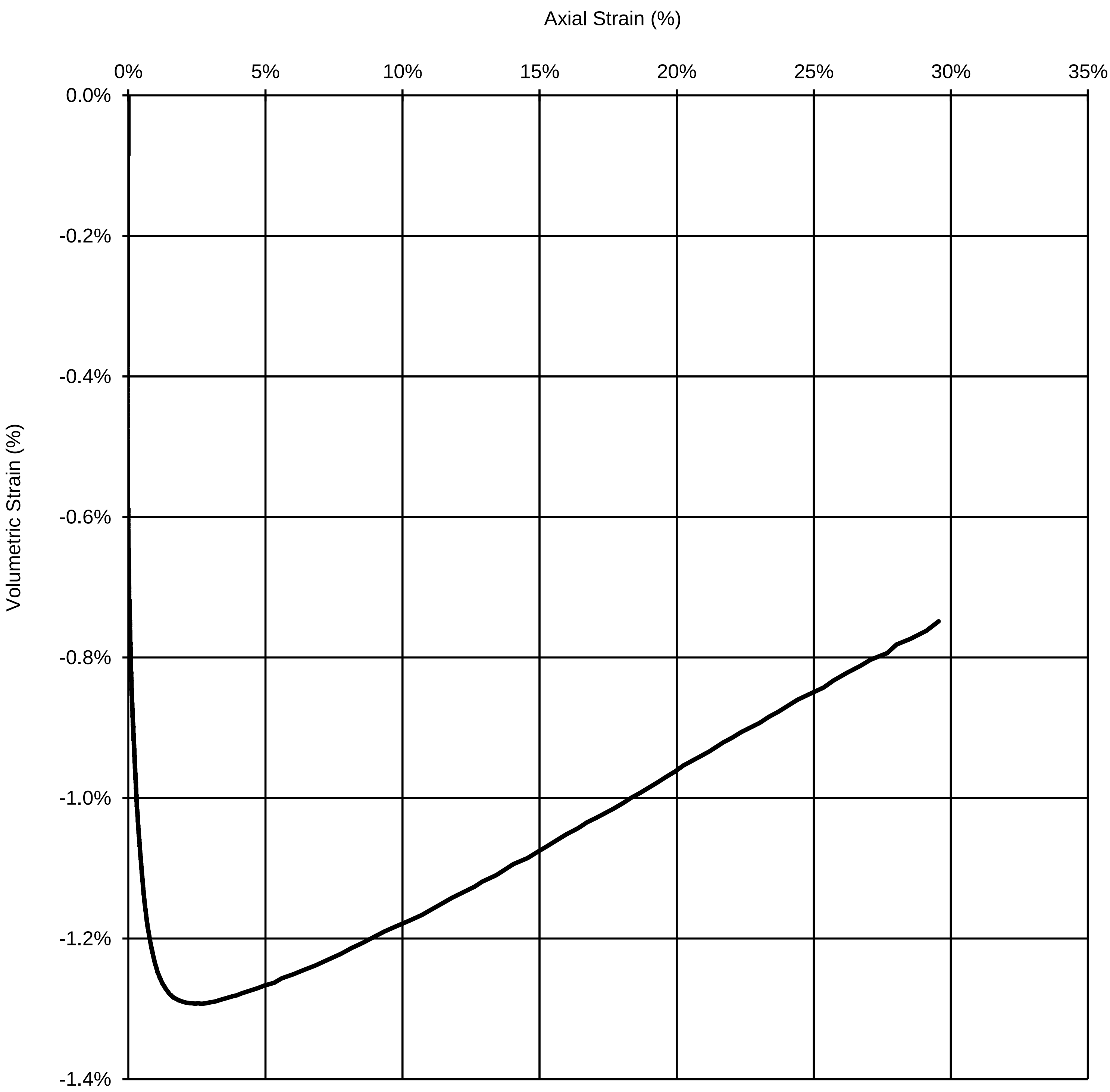
Constant Shear Drained (CSD) Servo Controlled

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-9 CSD loose

Initial Height (mm):	148.0	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.6	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	351
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.75



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

Triaxial Test Report

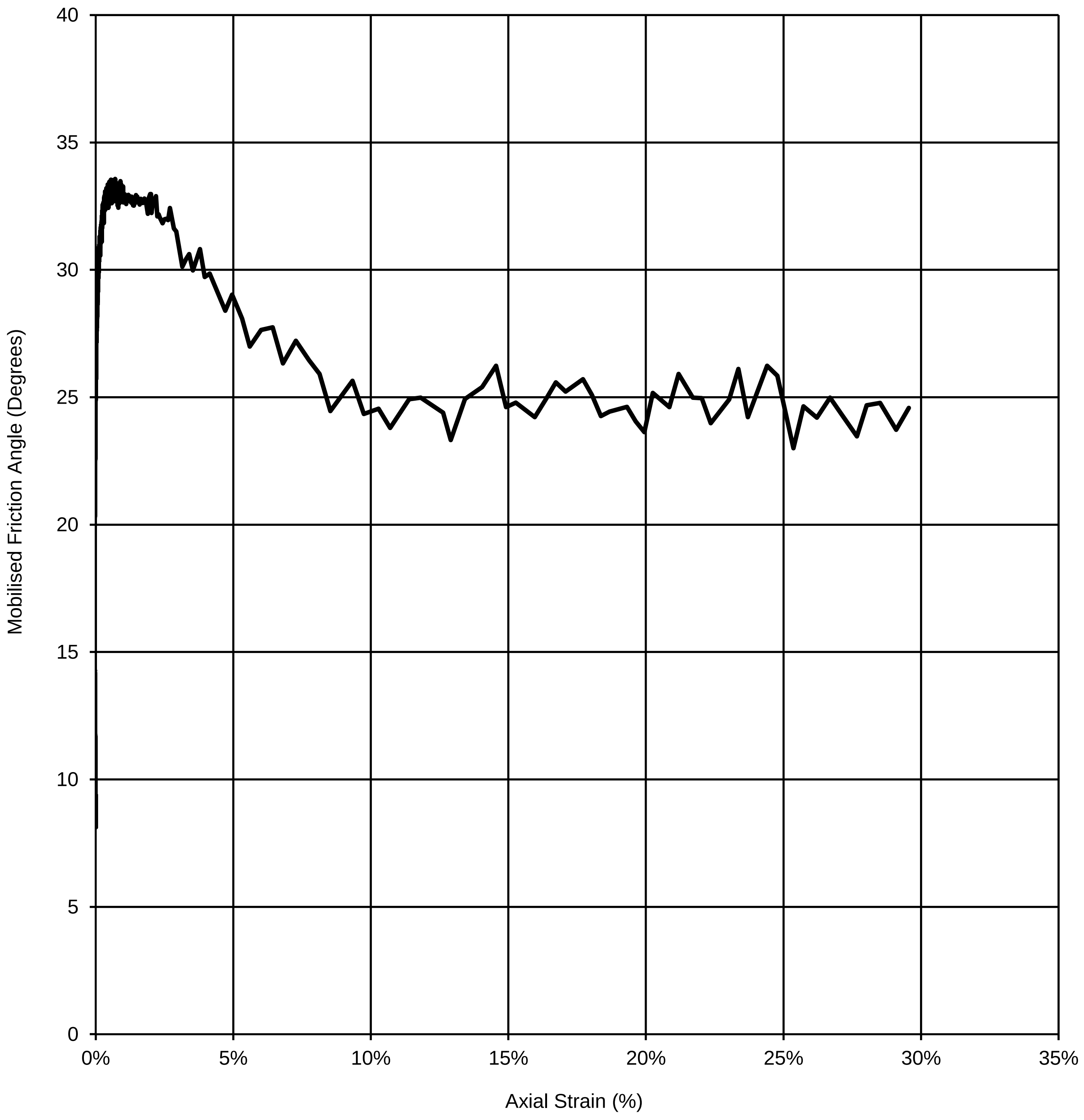
Constant Shear Drained (CSD) Servo Controlled

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	6/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-9 CSD loose

Initial Height (mm):	148.0	Final Liquor Content (%):	20.9%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	69.6	Final Dry Density (t/m^3):	1.74	B Response (%):	99%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.57	Mean Effective Consolidation Stress (kPa):	351
Initial Dry Density (t/m^3):	1.22	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.75



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

Annexure EN
Cyclic Direct Simple Shear (CDSS) Certificates

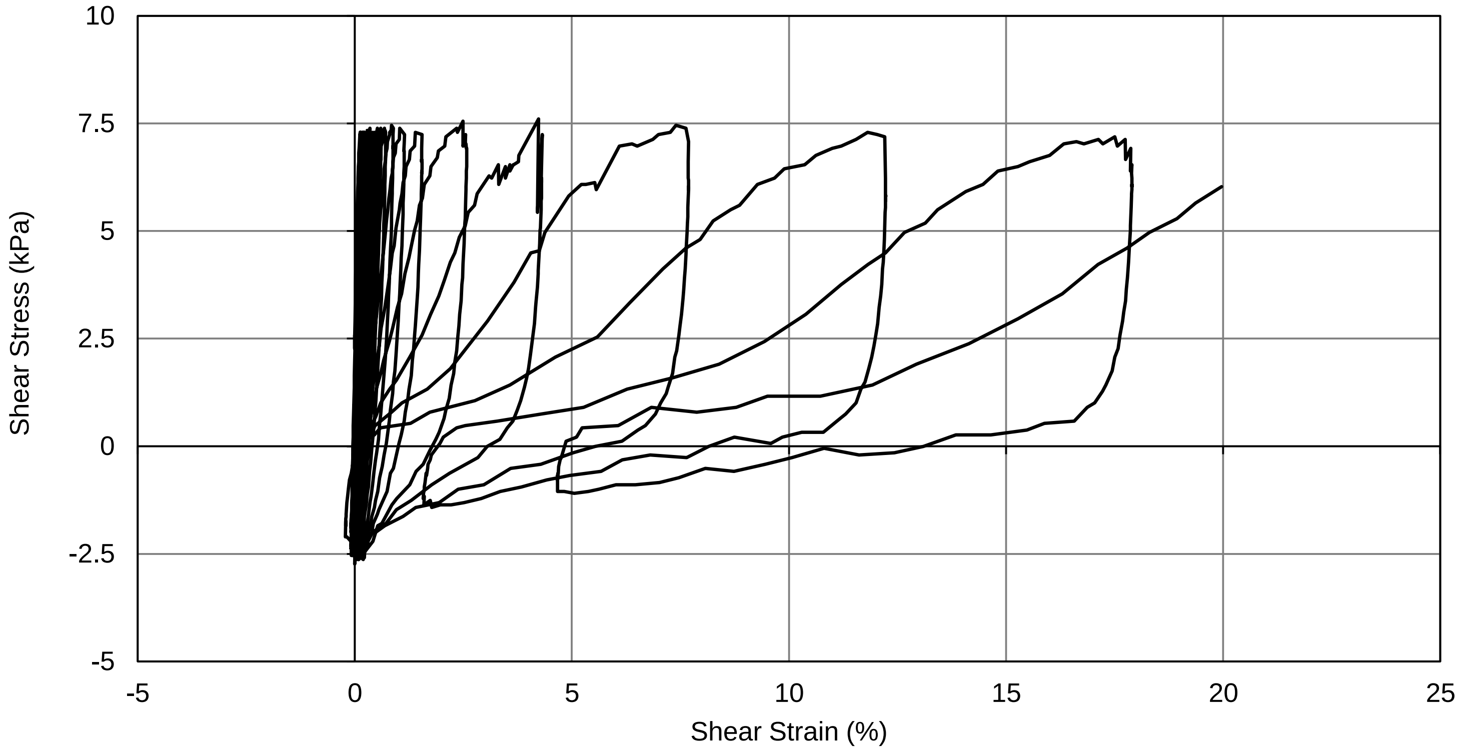
Cyclic Direct Simple Shear Test Report

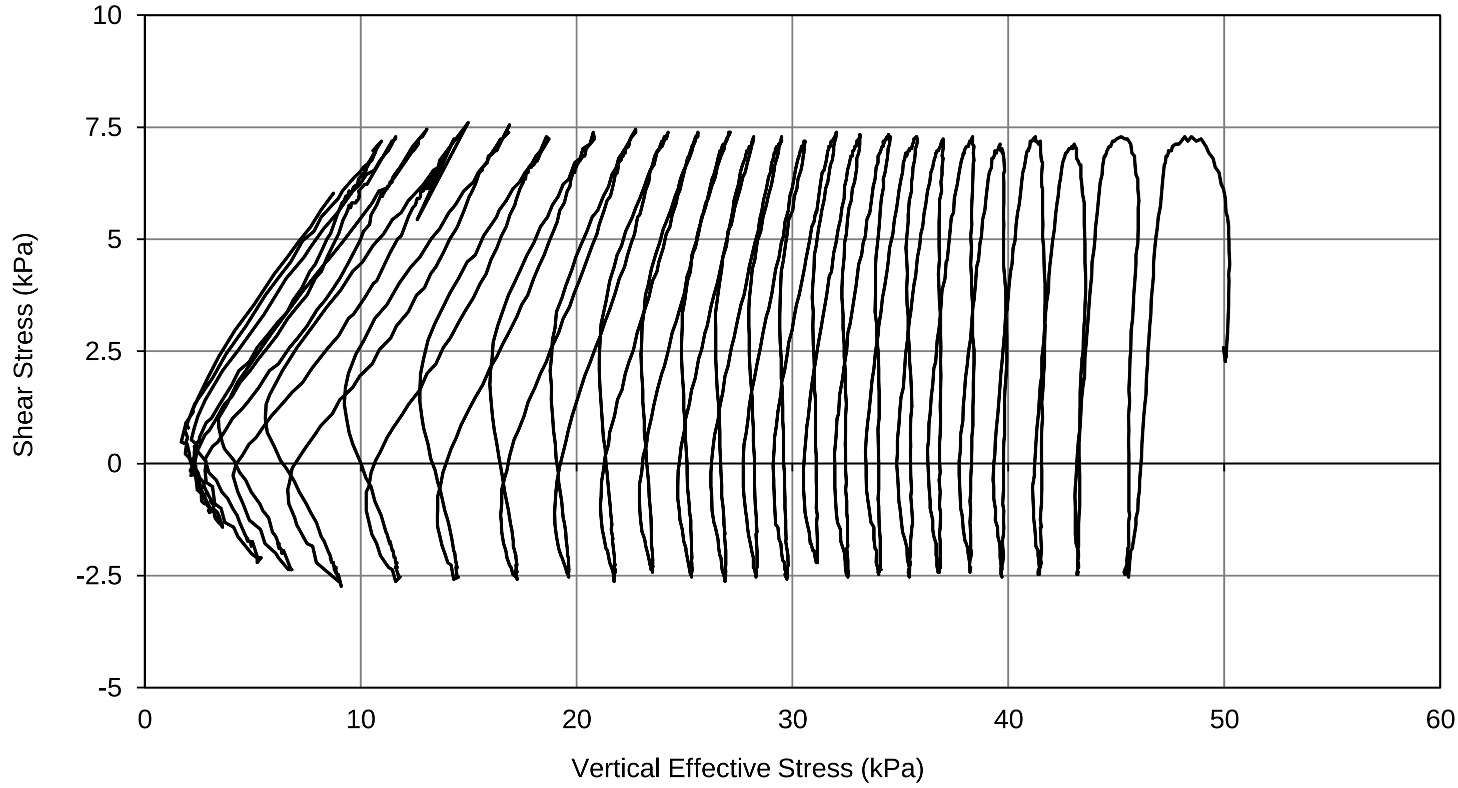
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css1 very loose

Vertical Effective Stress (kPa)	50	Final Bulk Density (t/m^3)	1.88
Diameter (mm)	100.5	Final Dry Density (t/m^3)	1.56
Shearing Height (mm)	23.3	Average Shear Stress Applied (kPa)	4.8
Applied Cyclic Stress Ratio	0.10	Cycle Period (seconds)	1





Preparation Notes:	Moist tamped in one layer	Tested by:	K. Koh
		Reviewed by:	R. Fanni

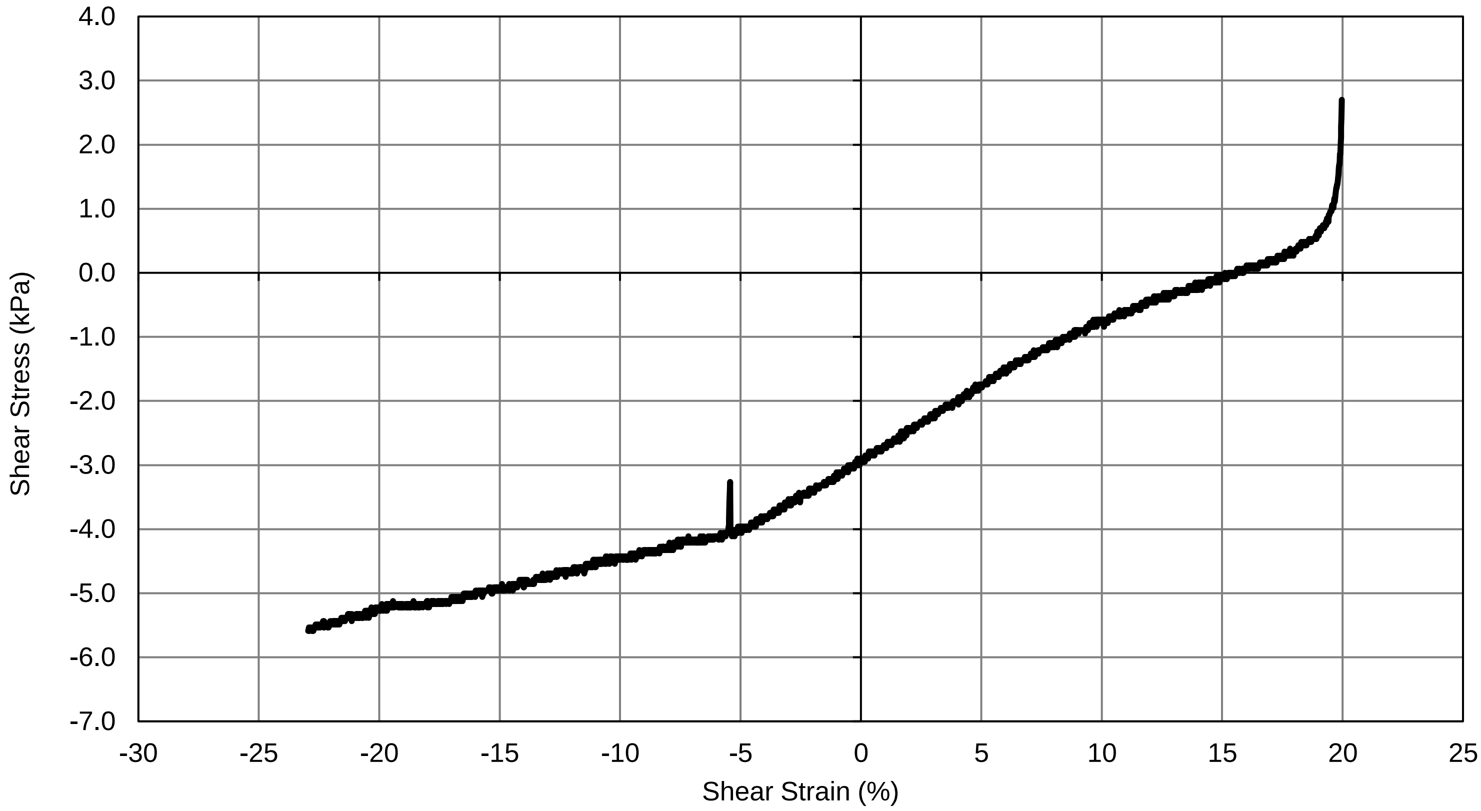
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

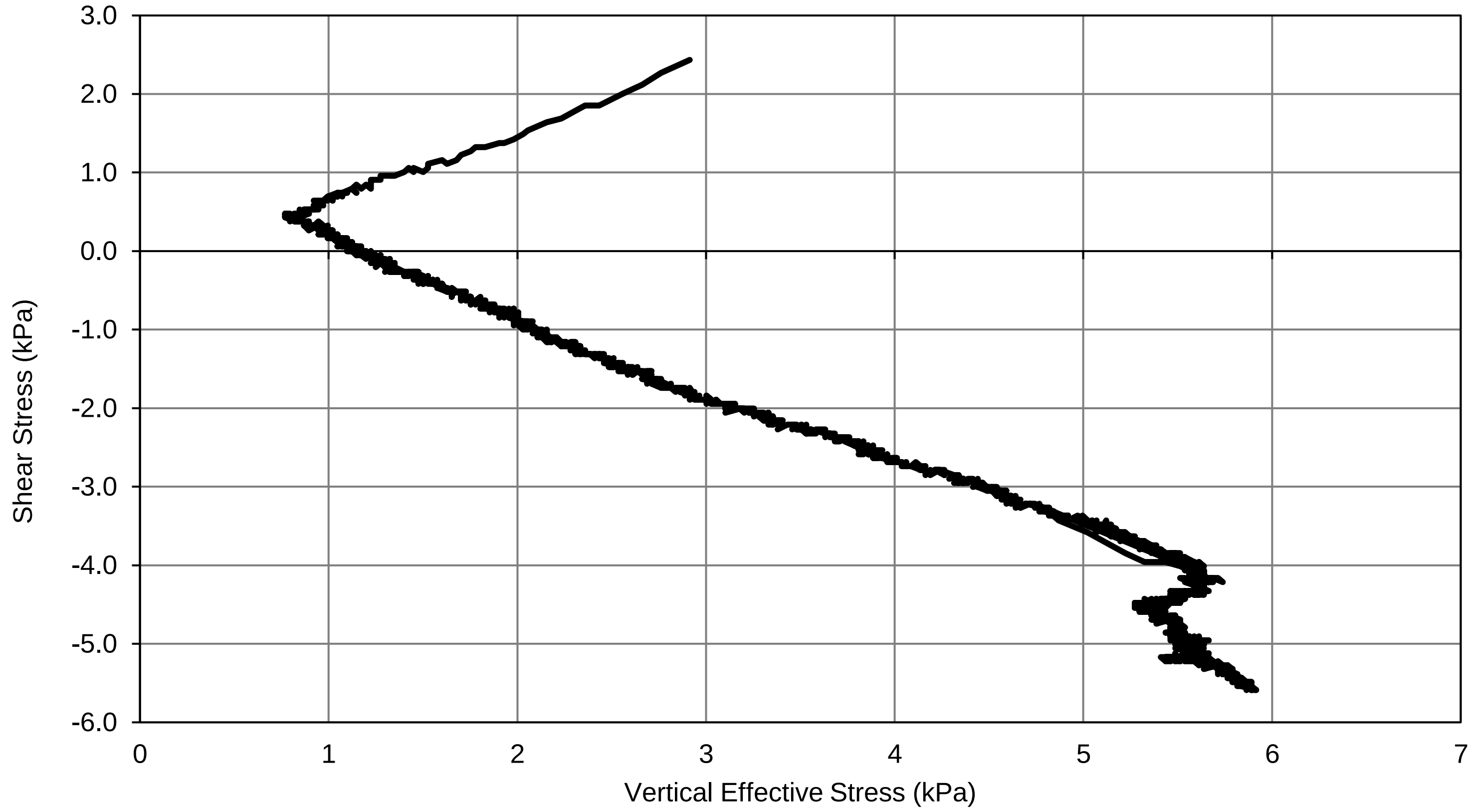
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css1 very loose

Vertical Effective Stress (kPa)	50	Final Bulk Density (t/m^3)	1.88
Diameter (mm)	100.5	Final Dry Density (t/m^3)	1.56
Shearing height (mm)	28.5	Shearing Strain Rate (mm/min)	0.020





Preparation Notes:	Moist tamped in one layer	Tested by:	K. Koh
		Reviewed by:	R. Fanni

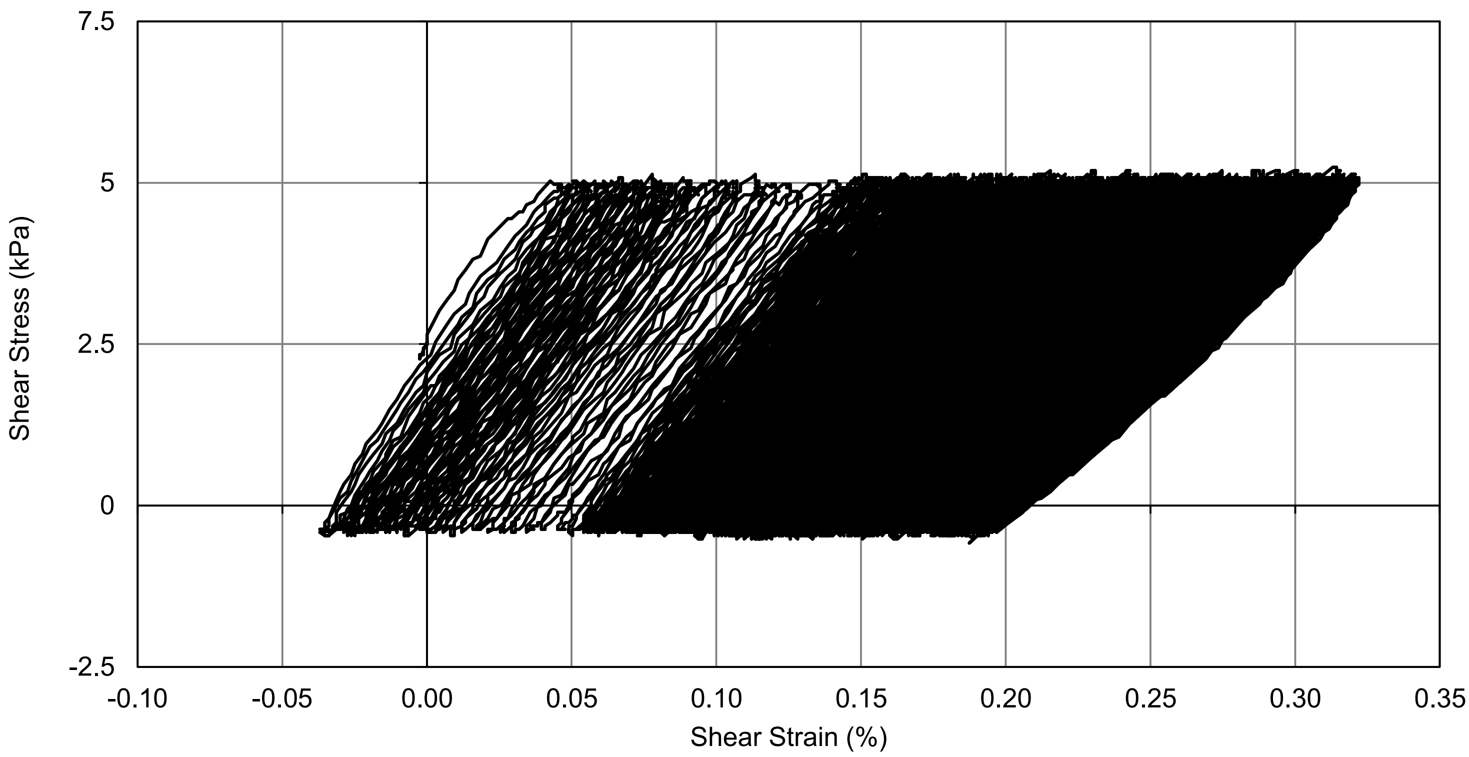
Cyclic Direct Simple Shear Test Report

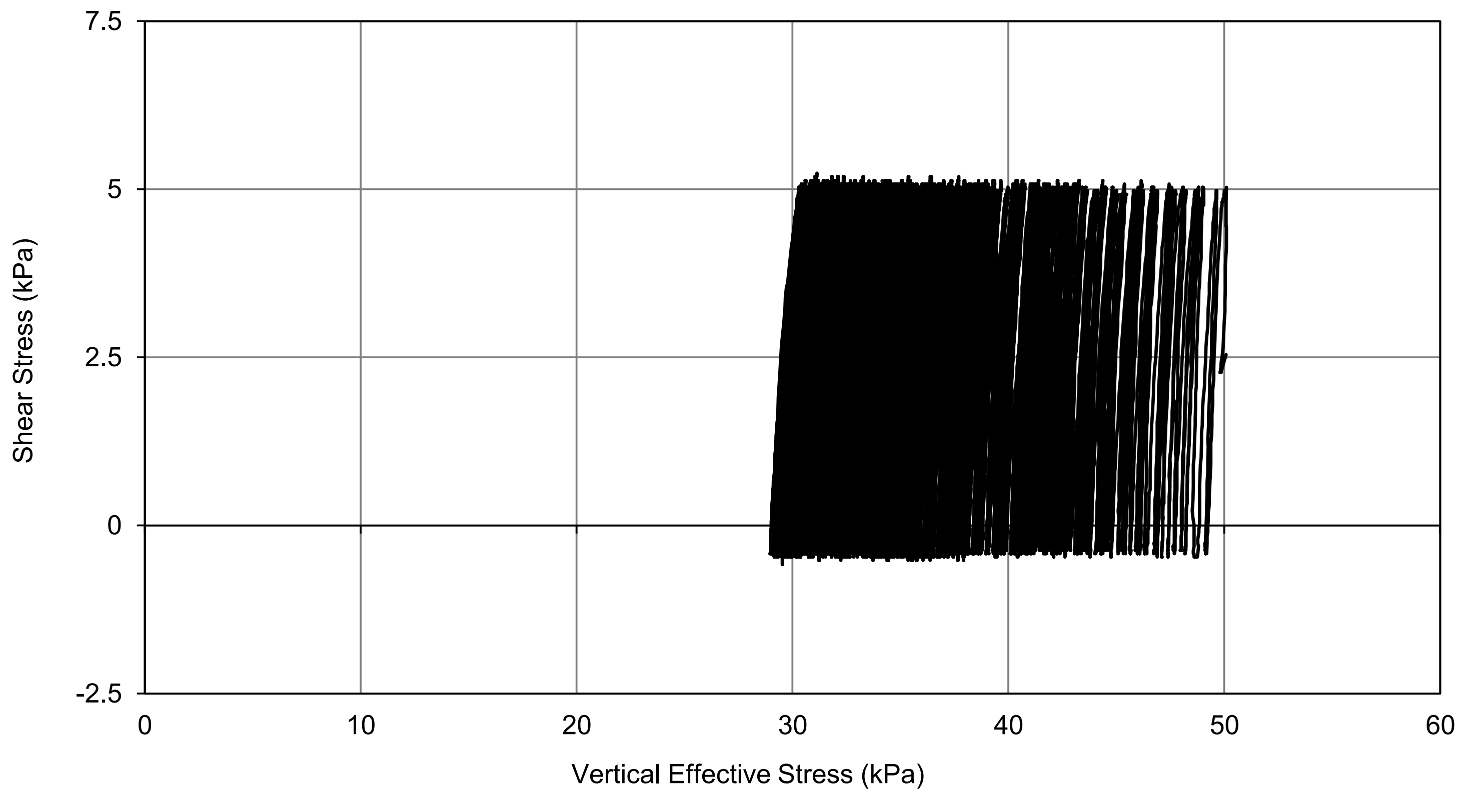
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css1 very loose

Vertical Effective Stress (kPa)	50	Final Bulk Density (t/m^3)	1.90
Diameter (mm)	100.4	Final Dry Density (t/m^3)	1.57
Shearing Height (mm)	23.3	Average Shear Stress Applied (kPa)	2.7
Applied Cyclic Stress Ratio	0.05	Cycle Period (seconds)	1





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

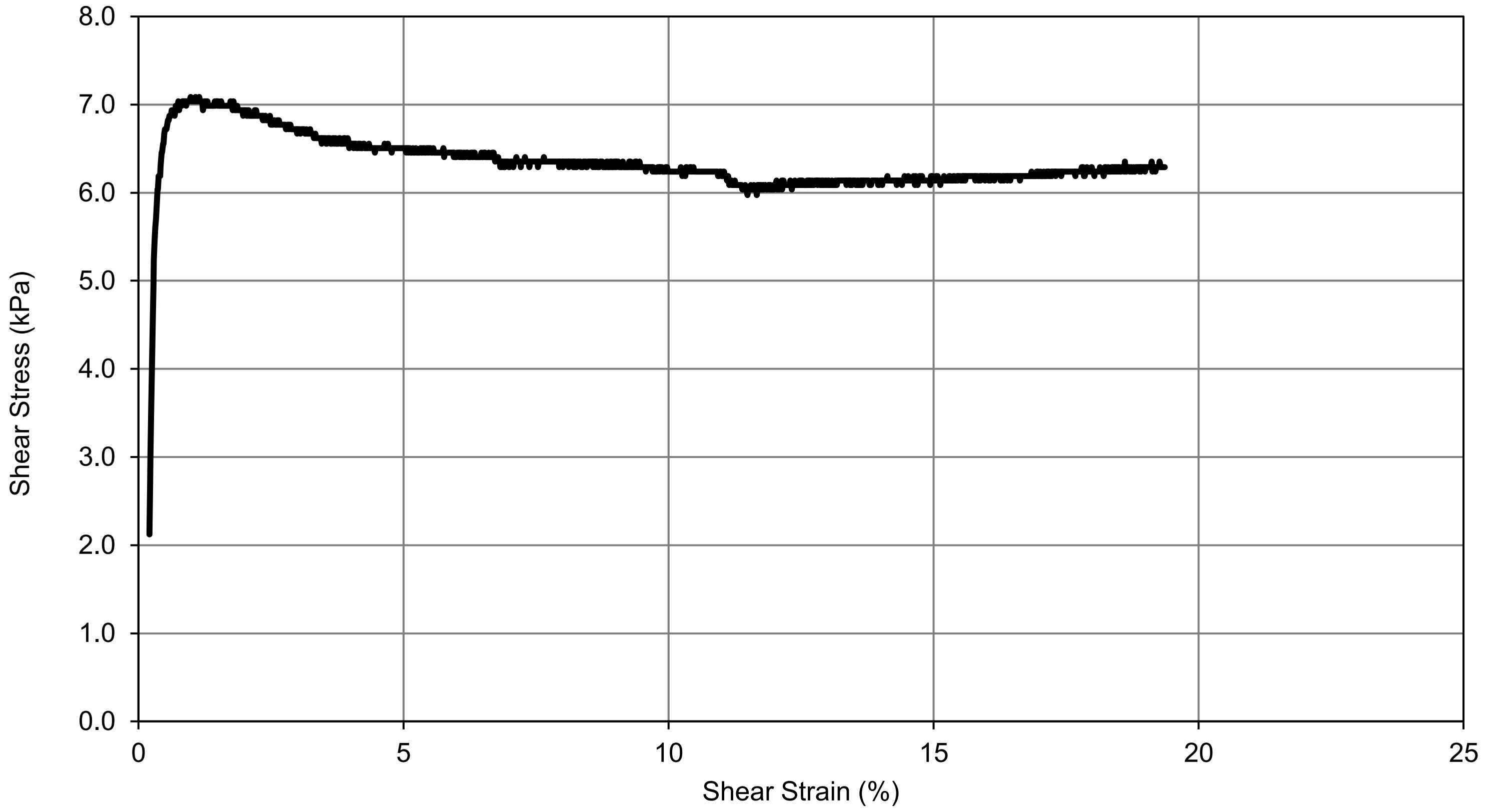
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

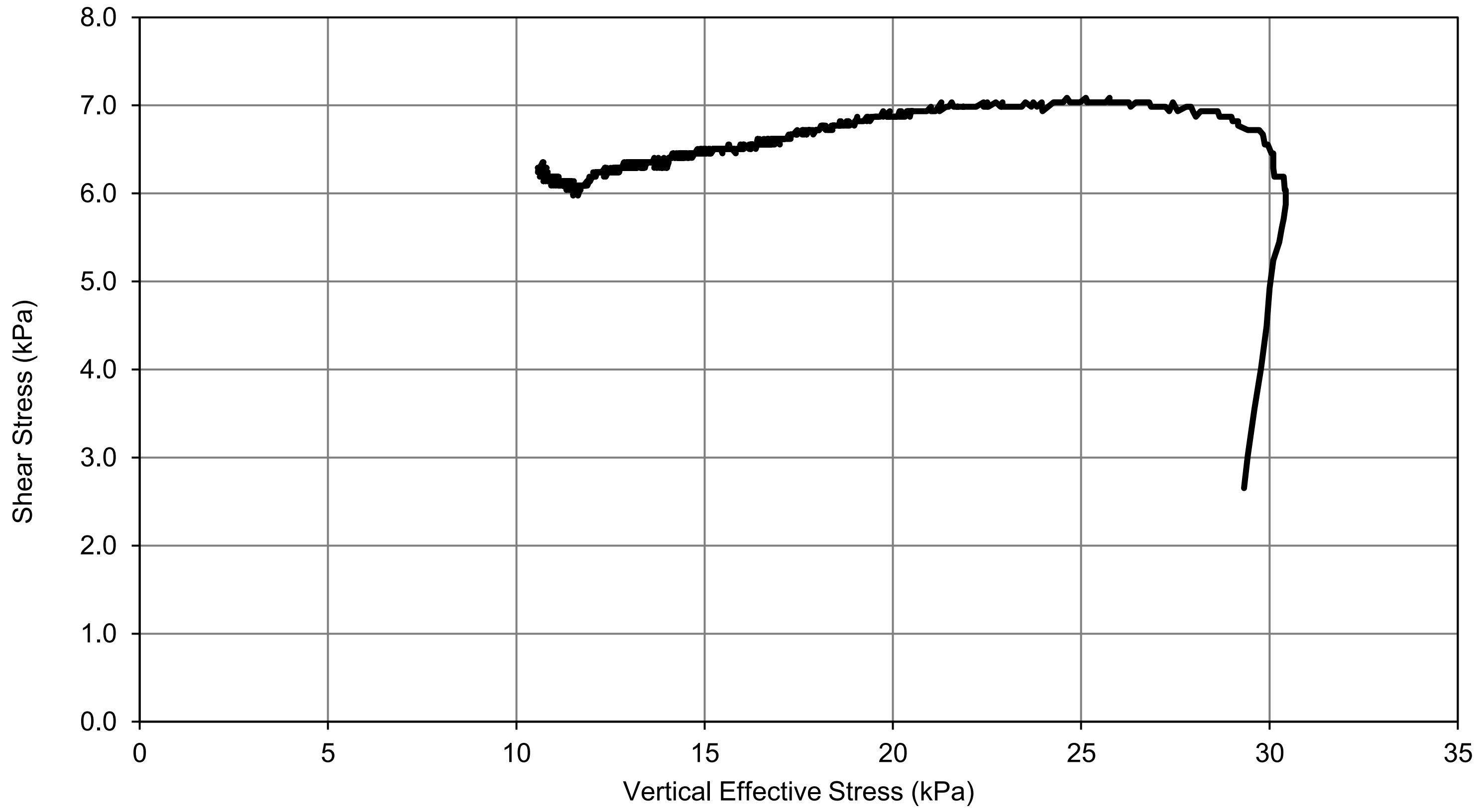
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css1 very loose

Vertical Effective Stress (kPa)	50	Final Bulk Density (t/m^3)	1.90
Diameter (mm)	100.4	Final Dry Density (t/m^3)	1.57
Shearing height (mm)	28.5	Shearing Strain Rate (mm/min)	0.019





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

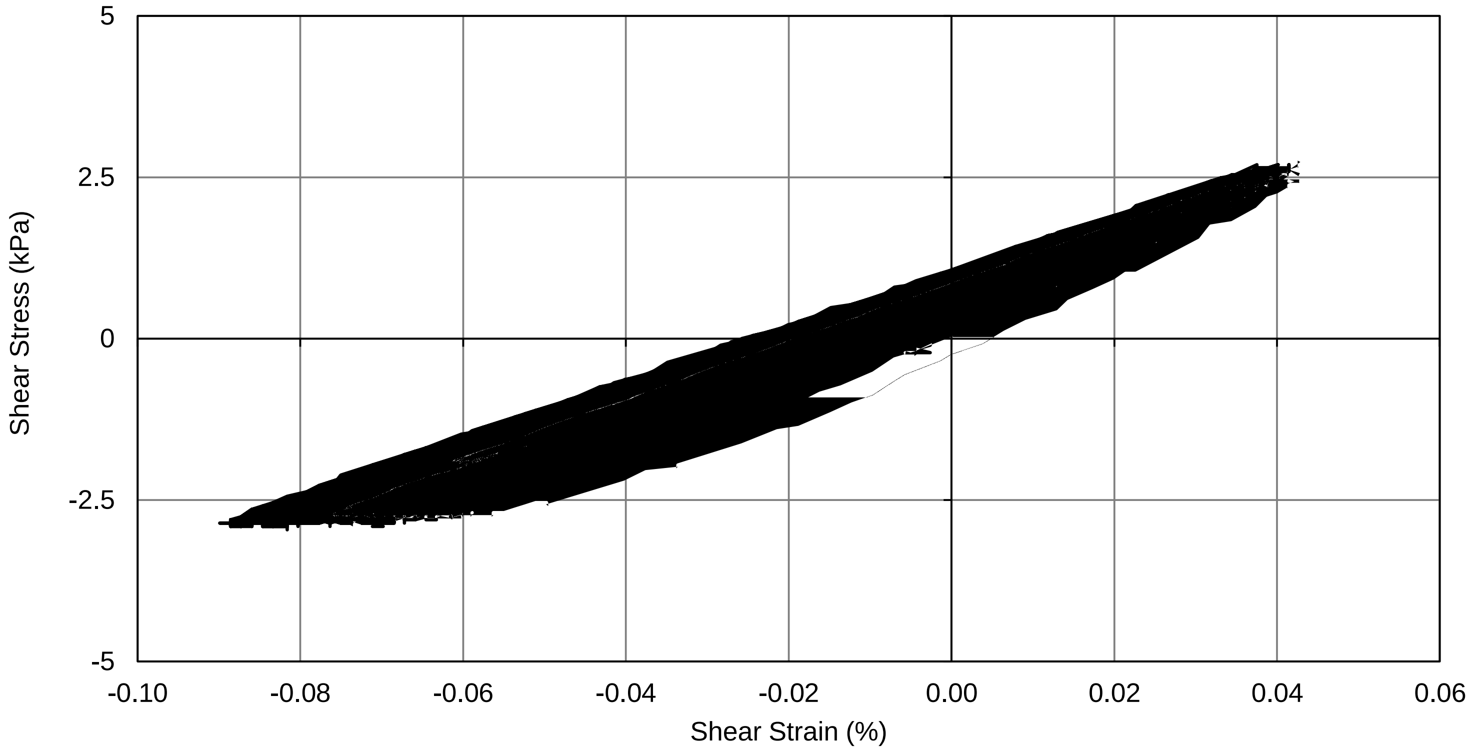
Cyclic Direct Simple Shear Test Report

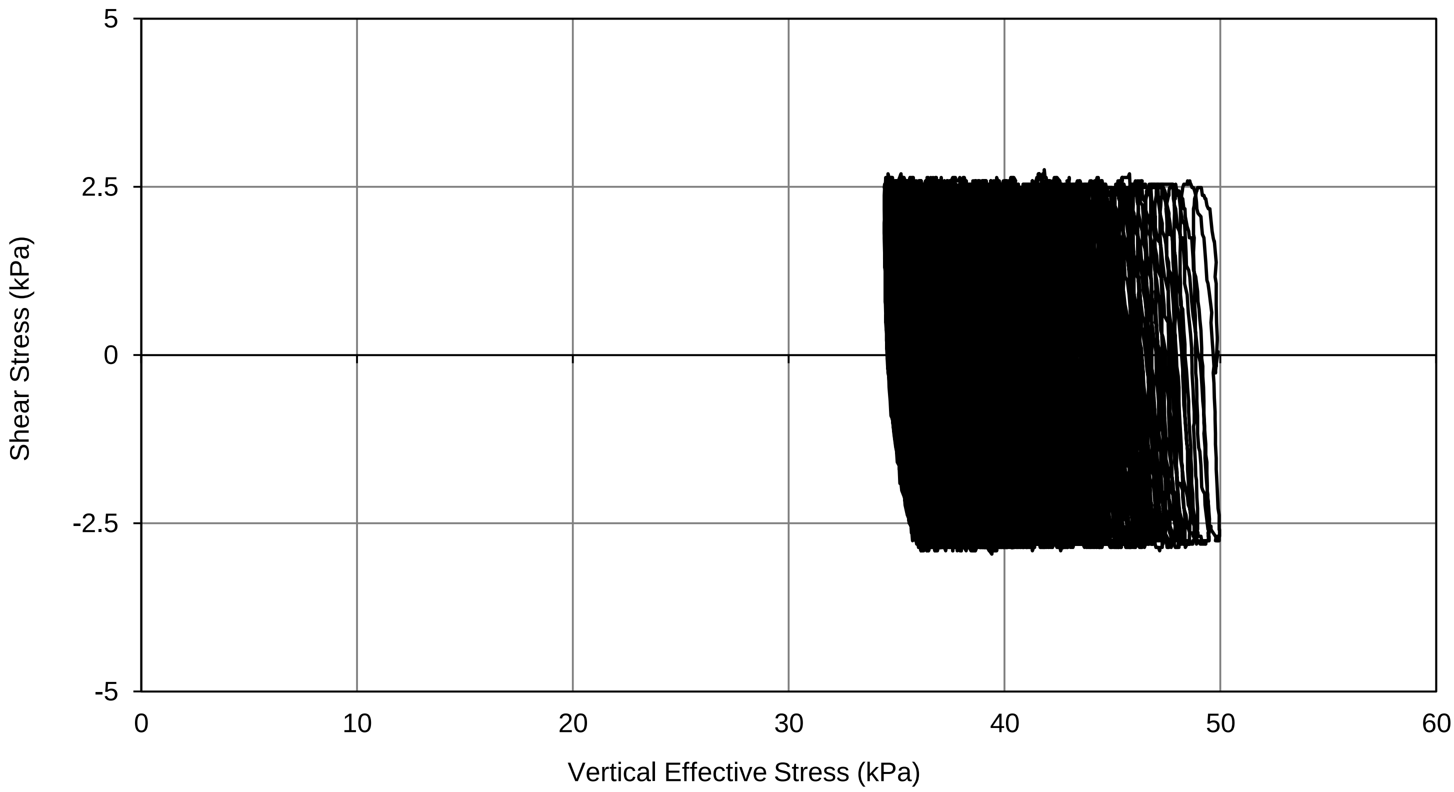
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css3 very loose

Vertical Effective Stress (kPa)	50	Final Bulk Density (t/m^3)	1.91
Diameter (mm)	100.4	Final Dry Density (t/m^3)	1.59
Shearing Height (mm)	22.9	Average Shear Stress Applied (kPa)	2.7
Applied Cyclic Stress Ratio	0.05	Cycle Period (seconds)	1





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

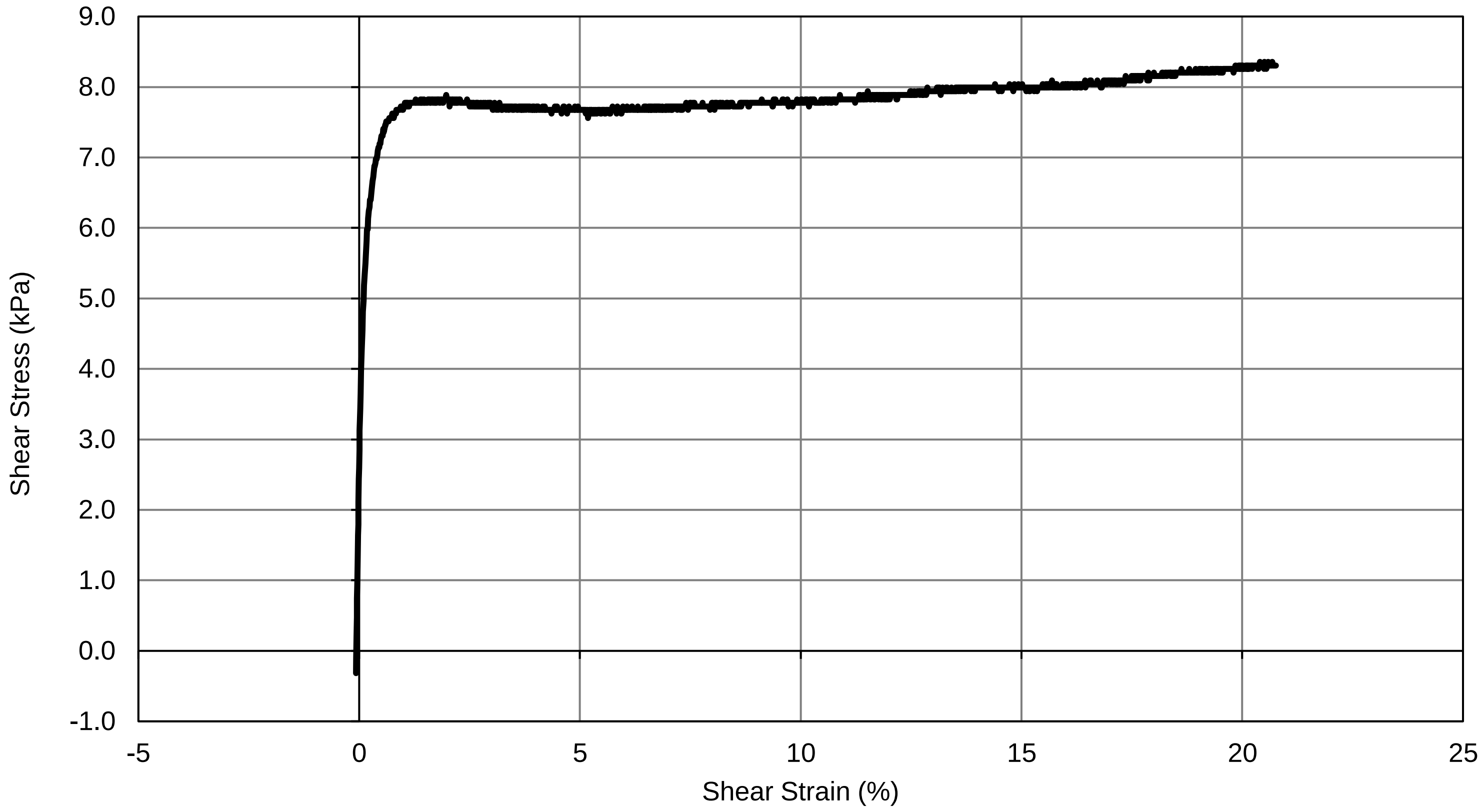
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

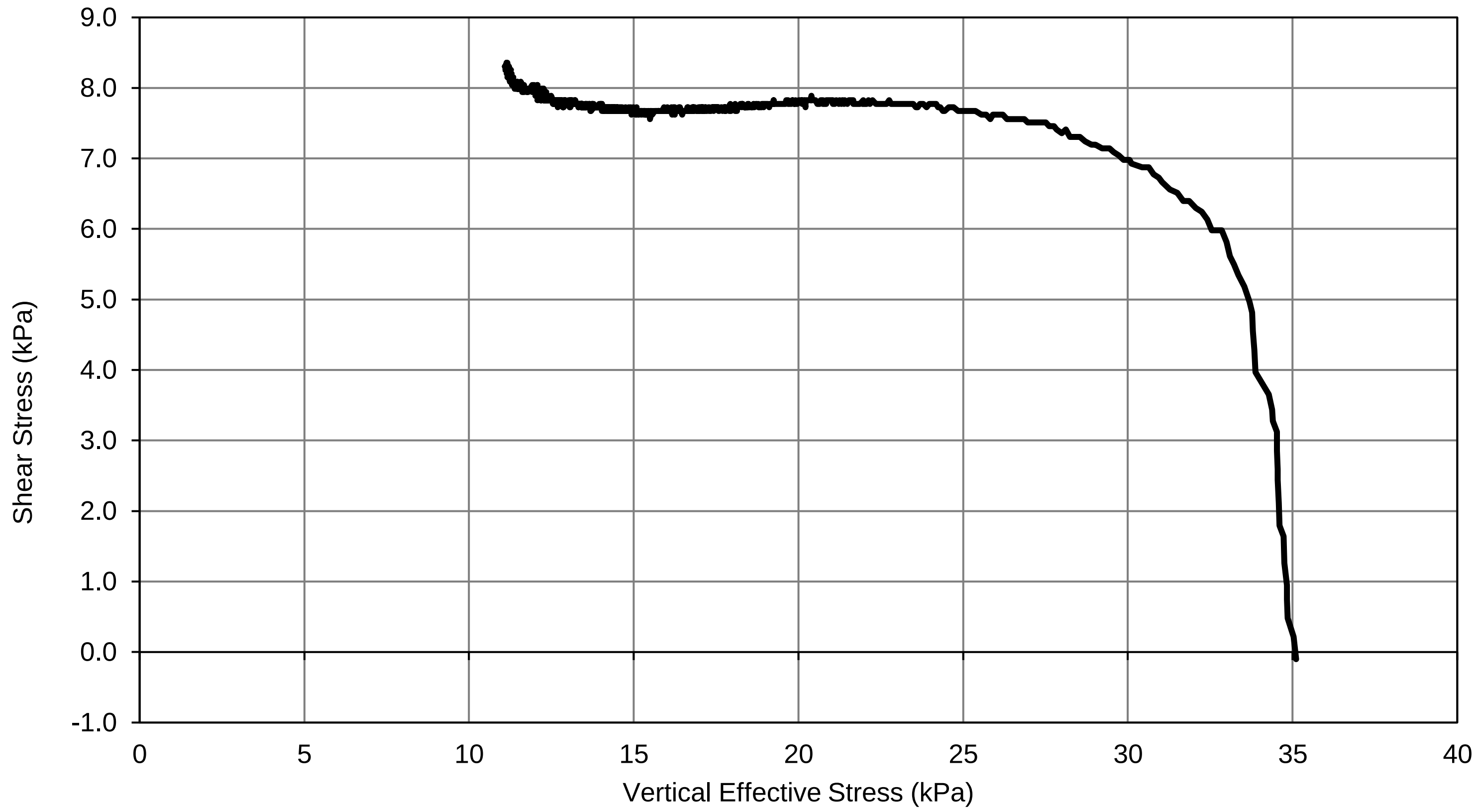
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css3 very loose

Vertical Effective Stress (kPa)	50	Final Bulk Density (t/m^3)	1.91
Diameter (mm)	100.4	Final Dry Density (t/m^3)	1.59
Shearing height (mm)	28.5	Shearing Strain Rate (mm/min)	0.019





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

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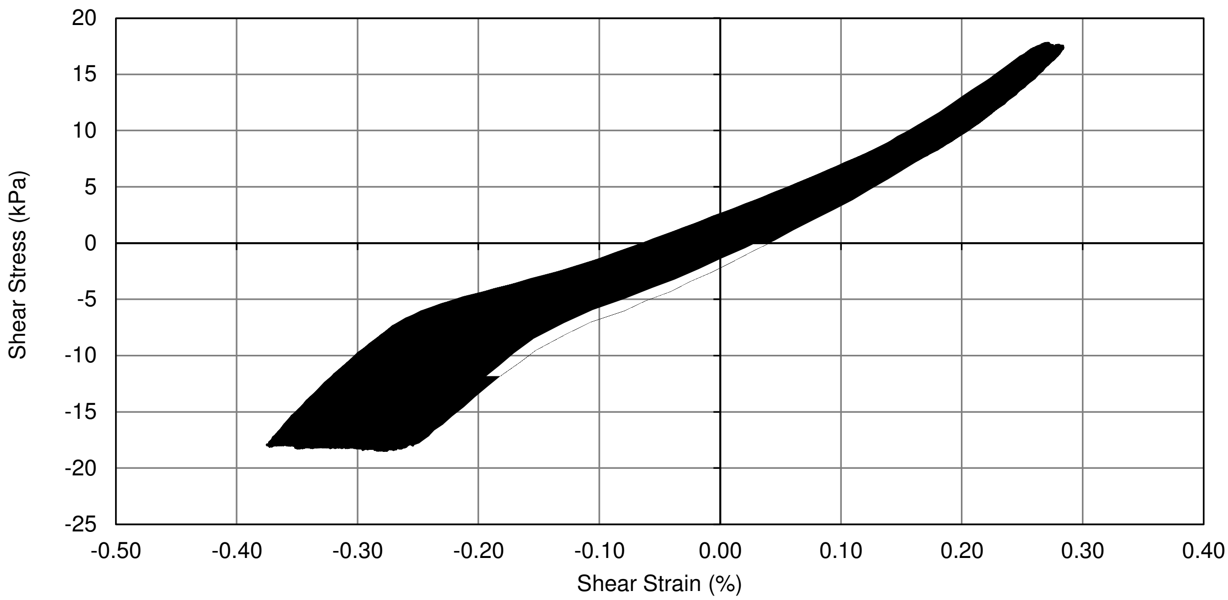
Cyclic Direct Simple Shear Test Report

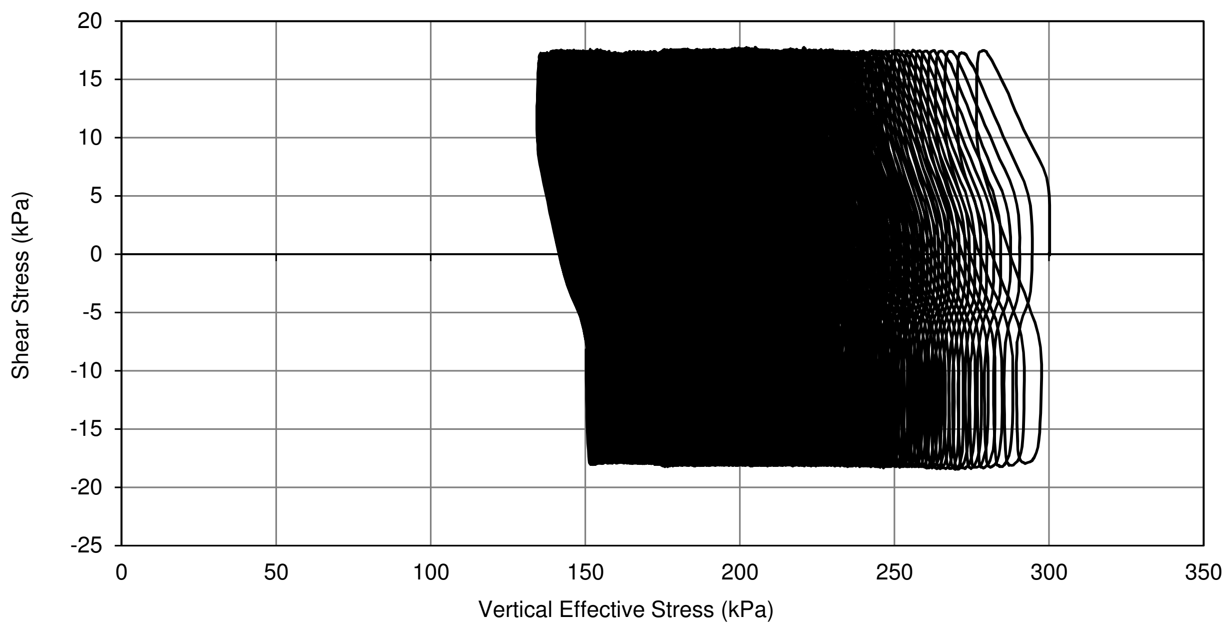
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/11/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css4 loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	1.99
Diameter (mm)	100.4	Final Dry Density (t/m^3)	1.70
Initial Shearing Height (mm)	22.6	Initial Static Shear Stress (kPa)	0.1
Post-consolidation Shearing Height (mm)	21.5	Average Shear Stress Applied (kPa)	17.8
Applied Cyclic Stress Ratio	0.06	Cycle Period (seconds)	1





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

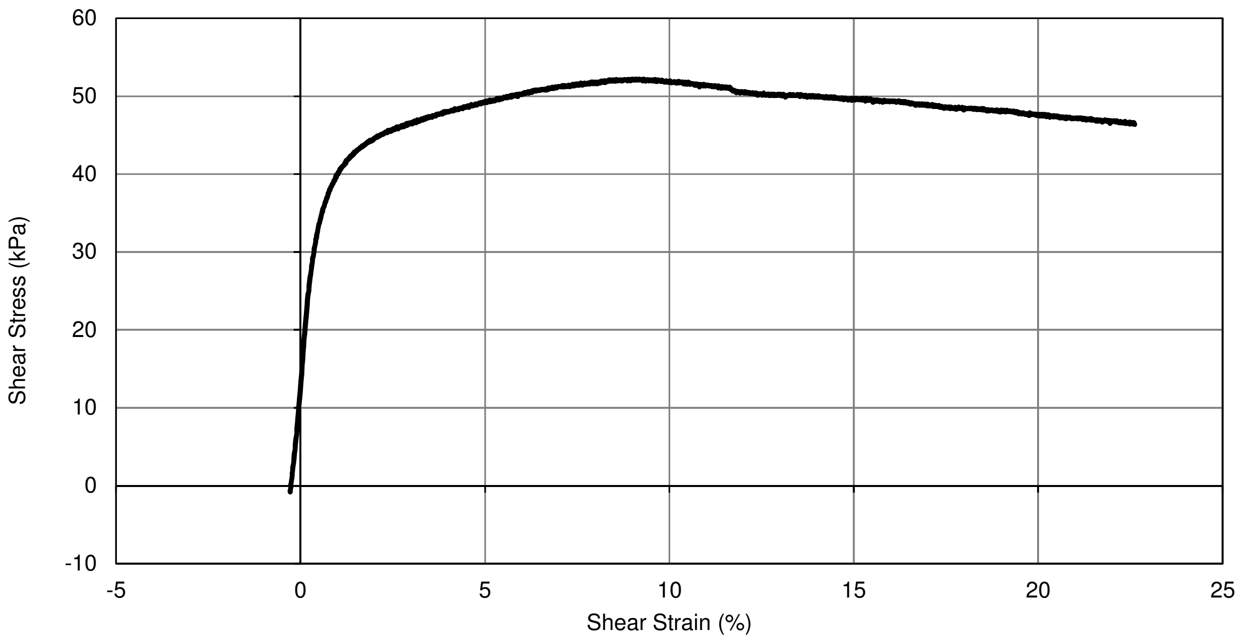
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

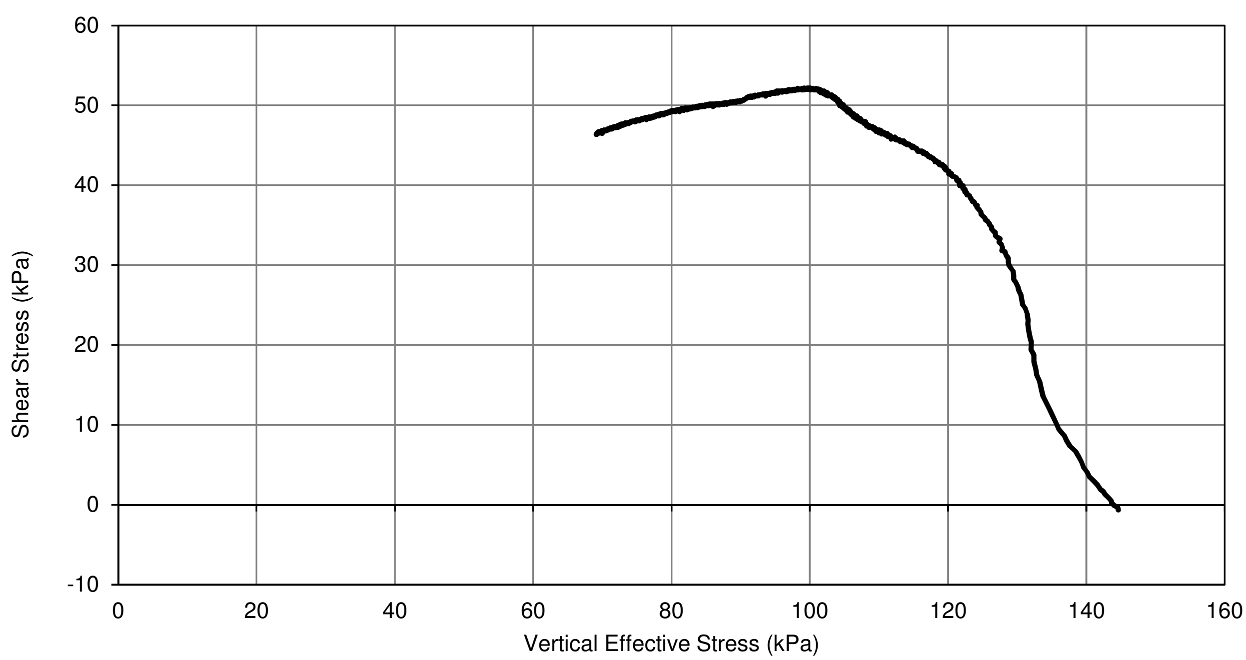
Post-cyclic Direct Simple Shear Test Report - Consolidated Undrained

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	8/11/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css4 loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	1.99
Diameter (mm)	100.4	Final Dry Density (t/m^3)	1.70
Initial Shearing Height (mm)	22.6	Initial Static Shear Stress (kPa)	0.1
Post-consolidation Shearing Height (mm)	21.5	Shearing Strain Rate (mm/min)	0.018





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

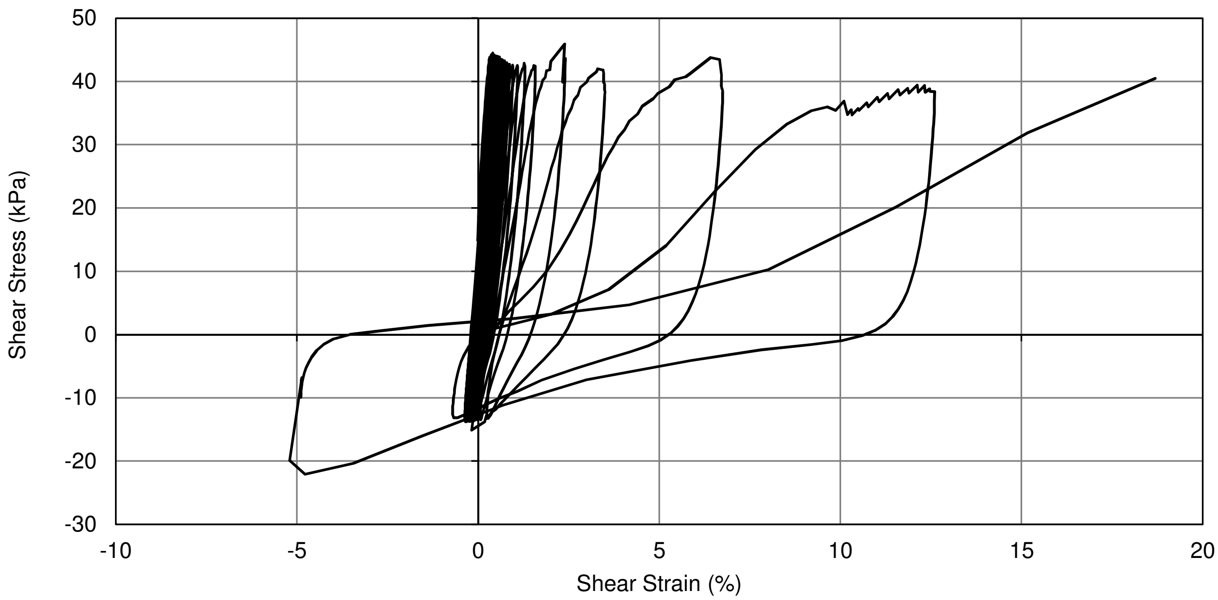
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

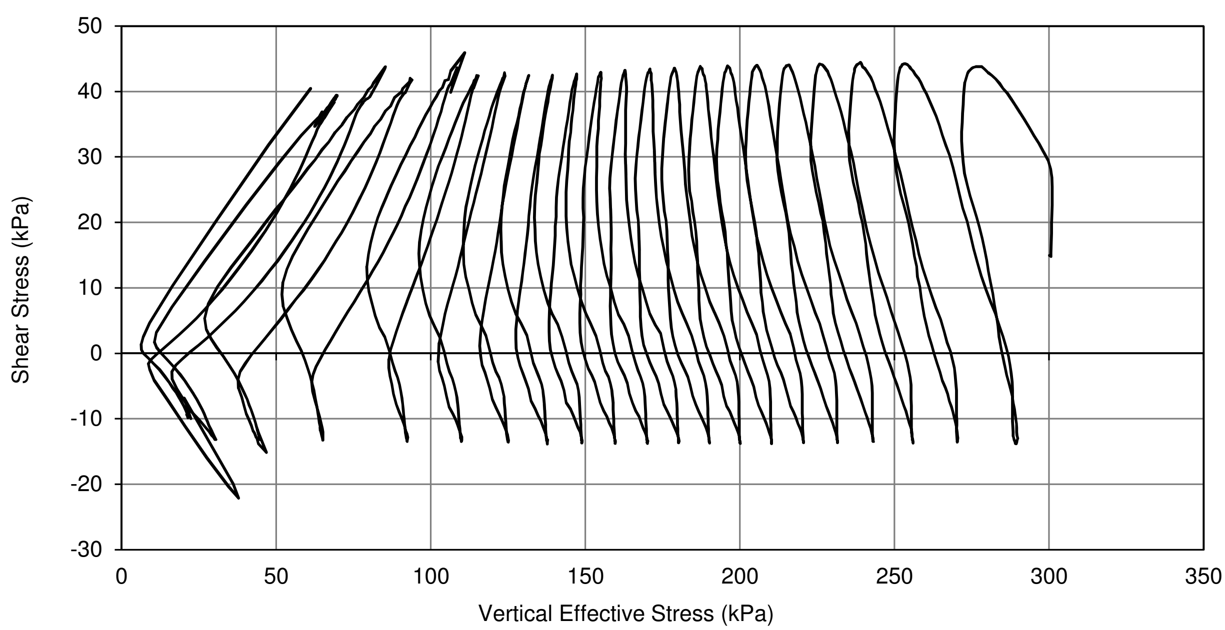
Cyclic Direct Simple Shear Test Report

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/11/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css5 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	1.99
Diameter (mm)	100.5	Final Dry Density (t/m^3)	1.69
Initial Shearing Height (mm)	28.2	Initial Static Shear Stress (kPa)	15.0
Post-consolidation Shearing Height (mm)	21.6	Average Shear Stress Applied (kPa)	28.3
Applied Cyclic Stress Ratio	0.09	Cycle Period (seconds)	1





Preparation Notes:	Moist tamped in one layer	Tested by:	K. Koh
		Reviewed by:	R. Fanni

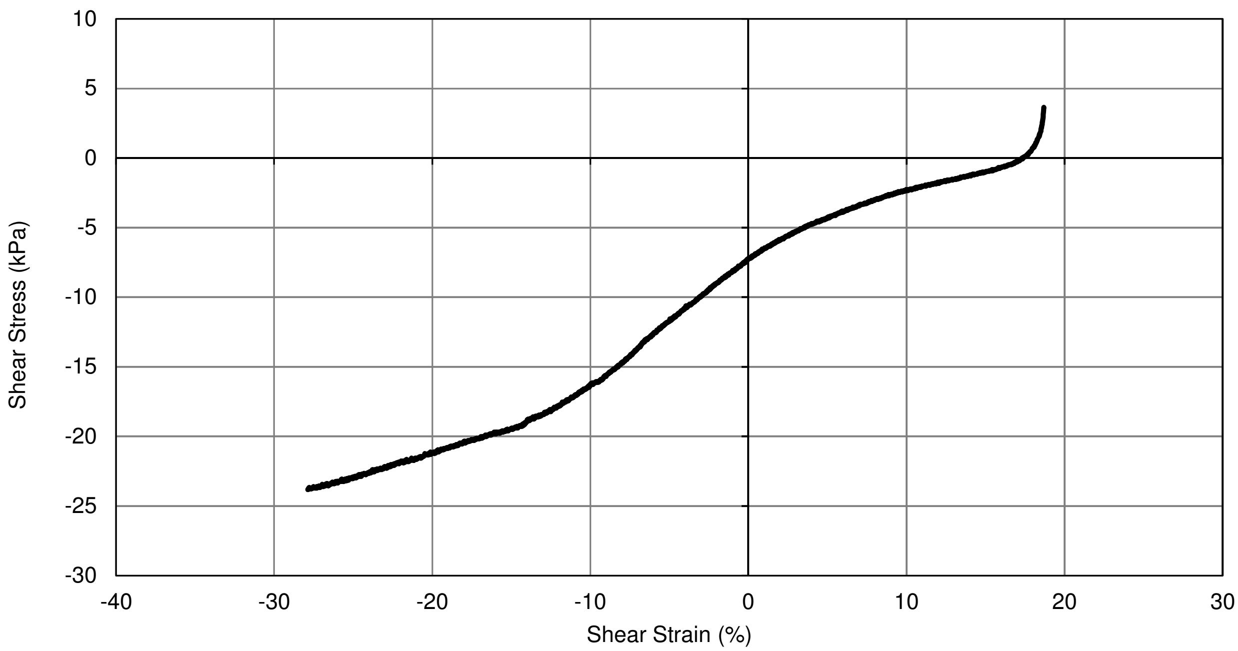
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

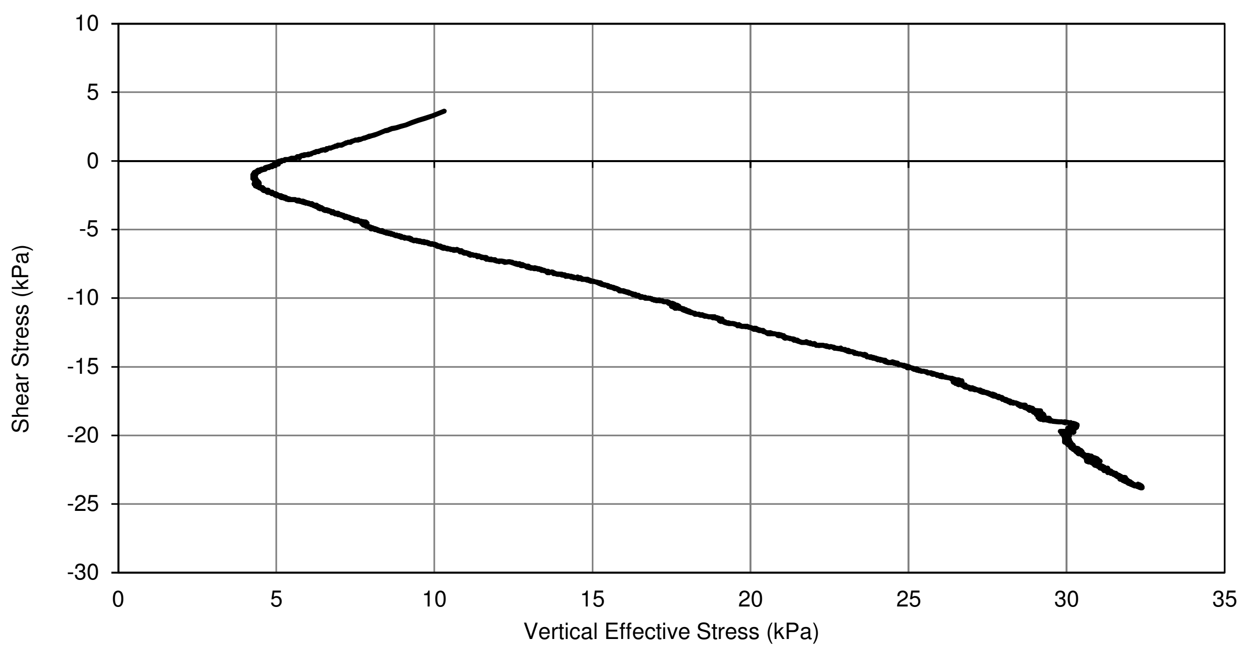
Post-cyclic Direct Simple Shear Test Report - Consolidated Undrained

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/11/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css5 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	1.99
Diameter (mm)	100.5	Final Dry Density (t/m^3)	1.69
Initial Shearing Height (mm)	28.2	Initial Static Shear Stress (kPa)	15.0
Post-consolidation Shearing Height (mm)	21.6	Shearing Strain Rate (mm/min)	0.018





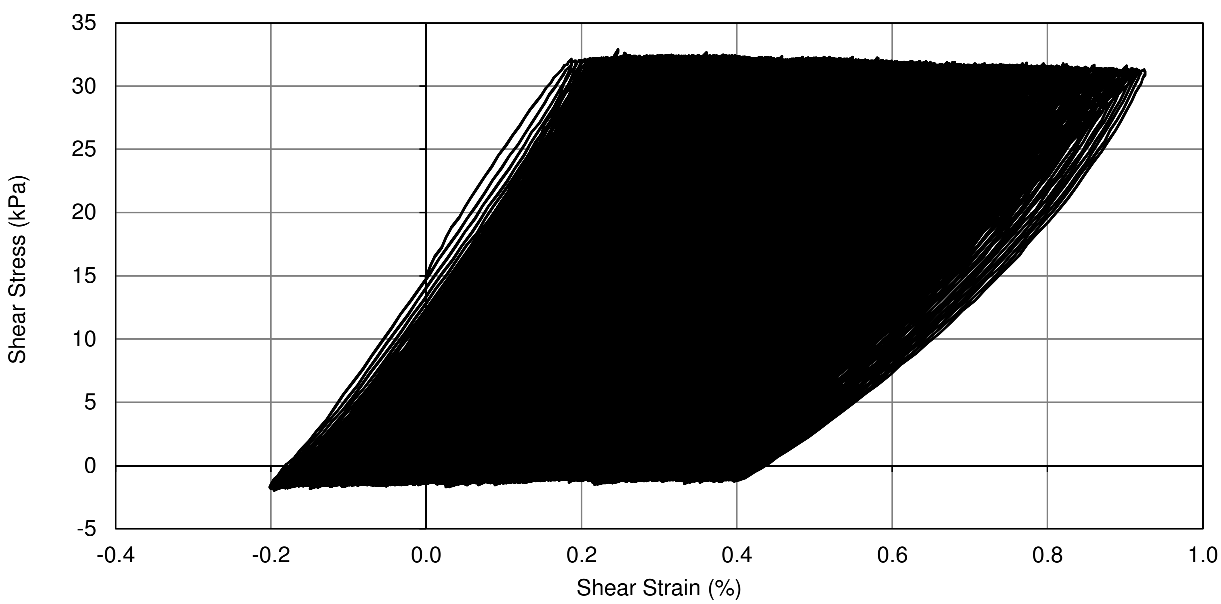
Preparation Notes:	Moist tamped in one layer	Tested by:	K. Koh
		Reviewed by:	R. Fanni

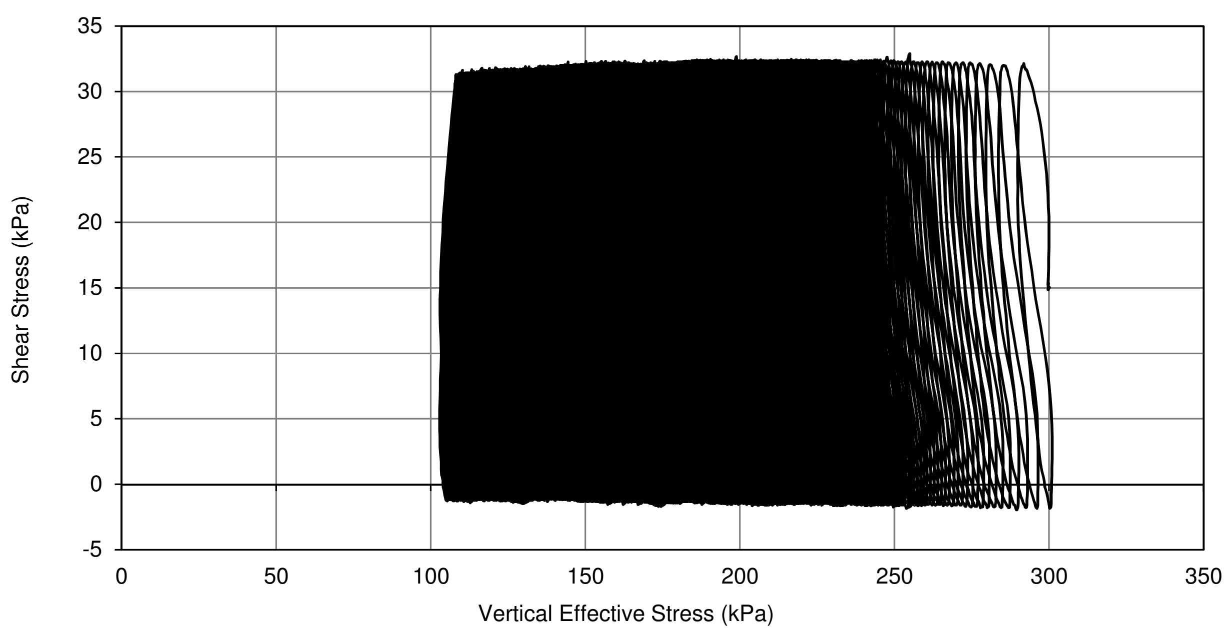
Cyclic Direct Simple Shear Test Report

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/11/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css6 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	1.99
Diameter (mm)	100.5	Final Dry Density (t/m^3)	1.69
Initial Shearing Height (mm)	28.8	Initial Static Shear Stress (kPa)	15.0
Post-consolidation Shearing Height (mm)	21.5	Average Shear Stress Applied (kPa)	16.7
Applied Cyclic Stress Ratio	0.06	Cycle Period (seconds)	1





Preparation Notes:	Moist tamped in one layer	Tested by:	K. Koh
		Reviewed by:	R. Fanni

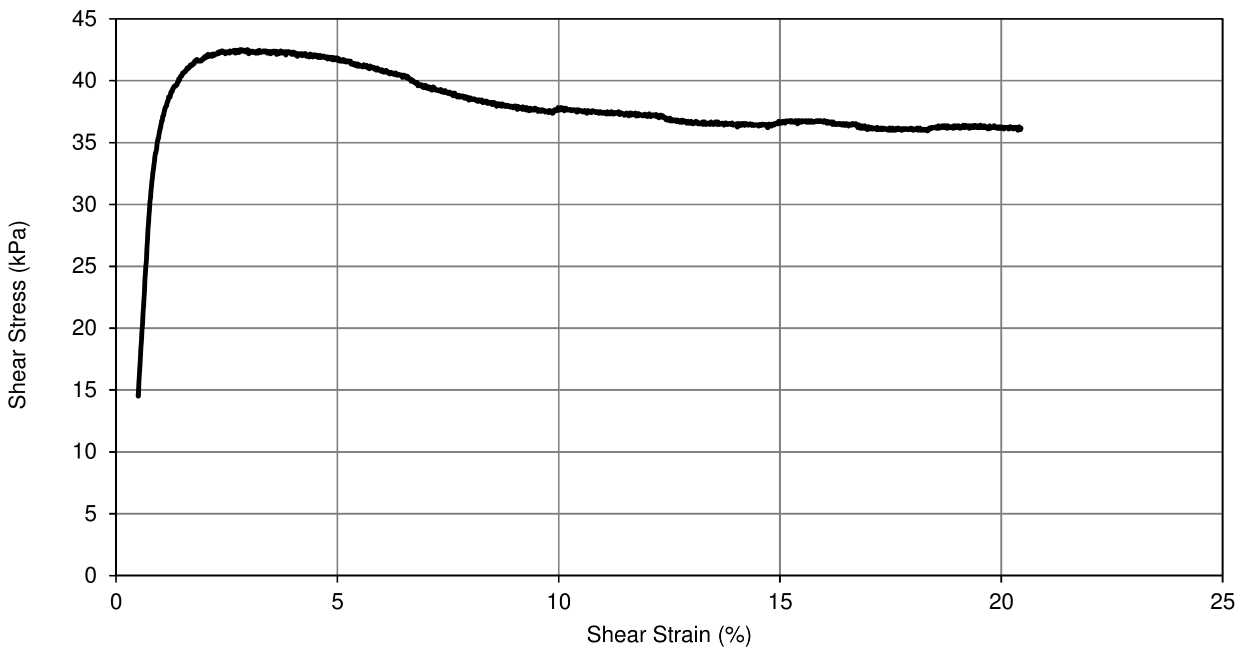
Post-cyclic Direct Simple Shear Test Report - Consolidated Undrained

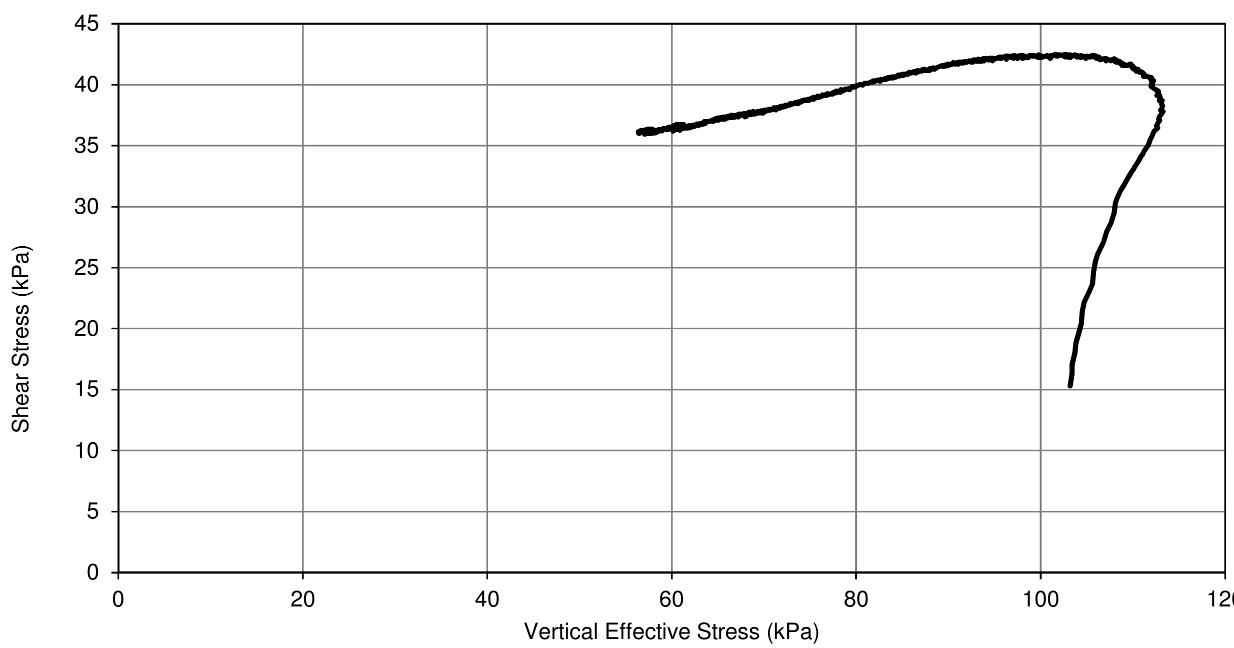
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	18/11/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css6 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	1.99
Diameter (mm)	100.5	Final Dry Density (t/m^3)	1.69
Initial Shearing Height (mm)	28.8	Initial Static Shear Stress (kPa)	15.0
Post-consolidation Shearing Height (mm)	21.5	Shearing Strain Rate (mm/min)	0.018





Preparation Notes:	Moist tamped in one layer	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni

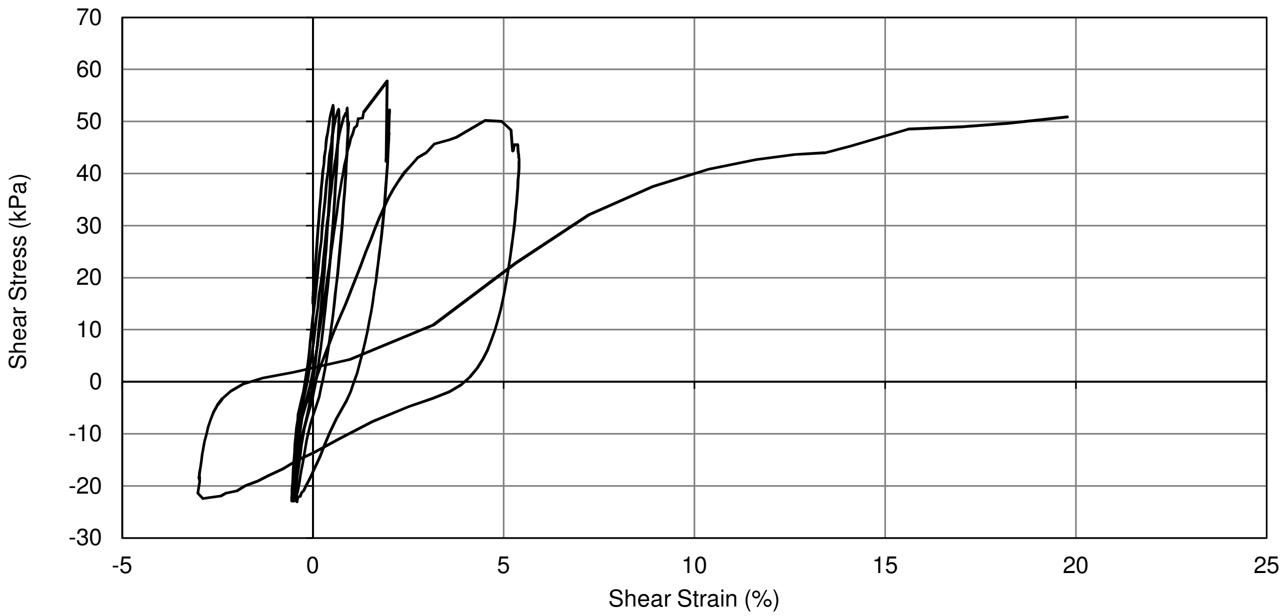
Cyclic Direct Simple Shear Test Report

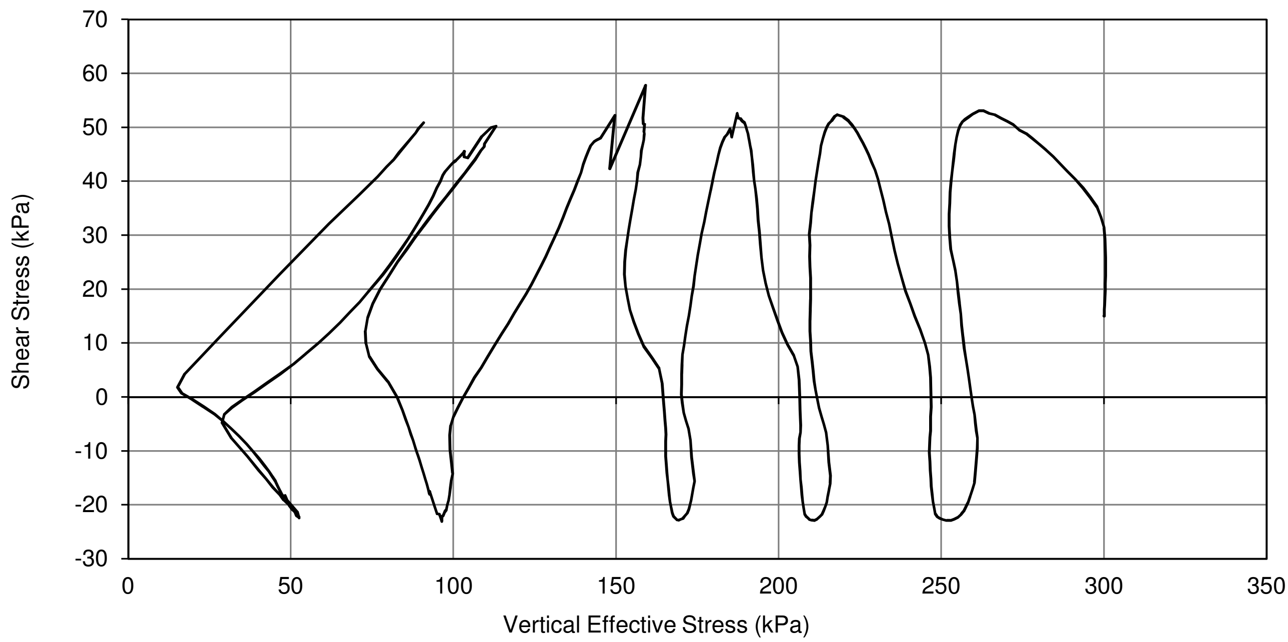
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	12/03/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css7 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.00
Diameter (mm)	100.2	Final Dry Density (t/m^3)	1.70
Initial Shearing Height (mm)	28.7	Initial Static Shear Stress (kPa)	15.0
Post-consolidation Shearing Height (mm)	21.6	Average Shear Stress Applied (kPa)	38.4
Applied Cyclic Stress Ratio	0.13	Cycle Period (seconds)	1





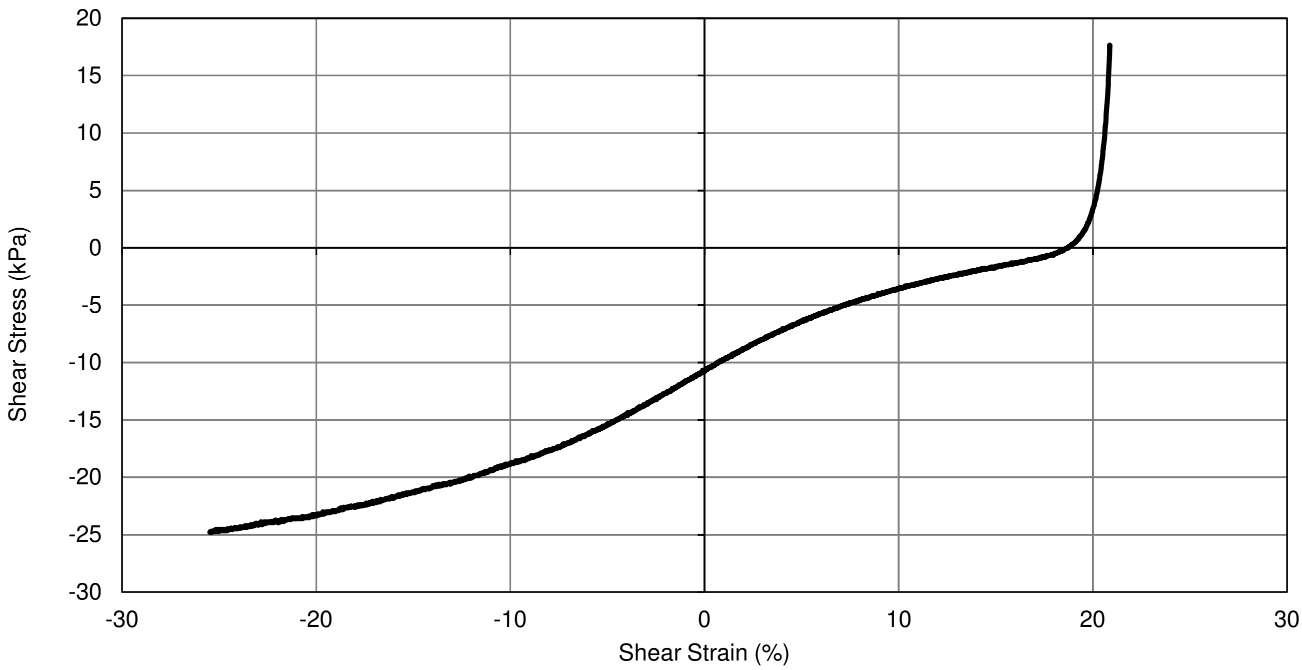
Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

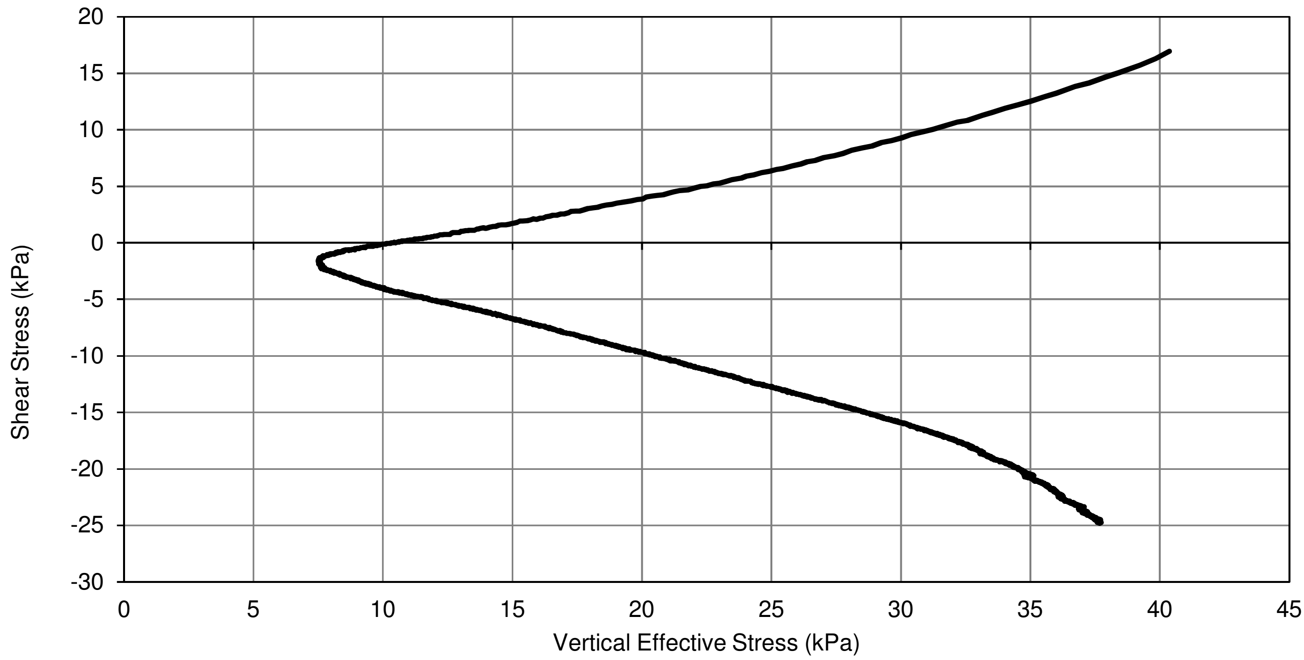
Post-cyclic Direct Simple Shear Test Report - Consolidated Undrained

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	12/03/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css7 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.00
Diameter (mm)	100.2	Final Dry Density (t/m^3)	1.70
Initial Shearing Height (mm)	28.7	Initial Static Shear Stress (kPa)	15.0
Post-consolidation Shearing Height (mm)	21.6	Shearing Strain Rate (mm/min)	0.018





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

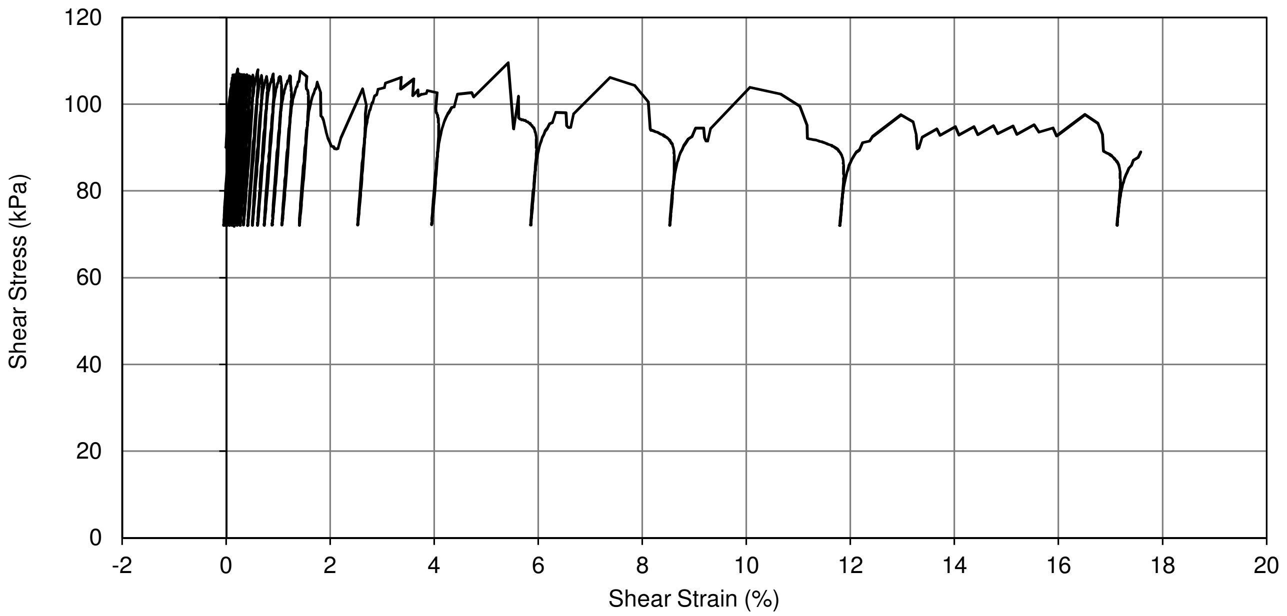
Cyclic Direct Simple Shear Test Report

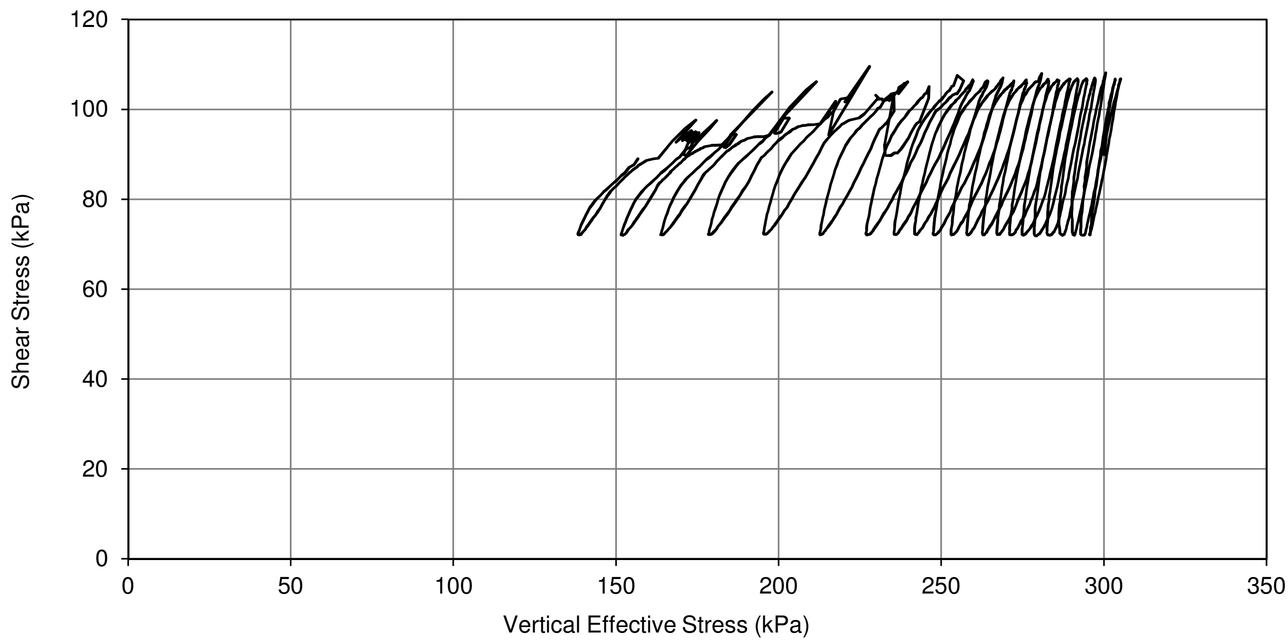
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css8 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.05
Diameter (mm)	100.2	Final Dry Density (t/m^3)	1.74
Initial Shearing Height (mm)	28.5	Initial Static Shear Stress (kPa)	90.0
Post-consolidation Shearing Height (mm)	20.9	Average Shear Stress Applied (kPa)	17.1
Applied Cyclic Stress Ratio	0.06	Cycle Period (seconds)	1





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

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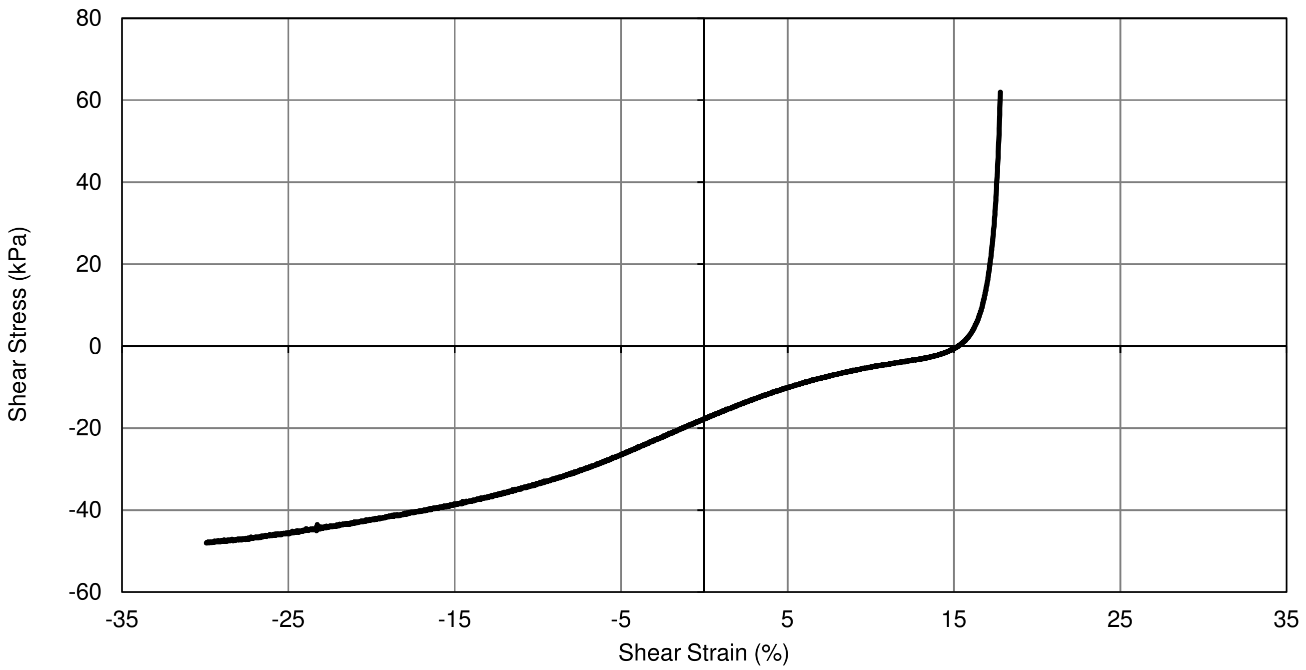
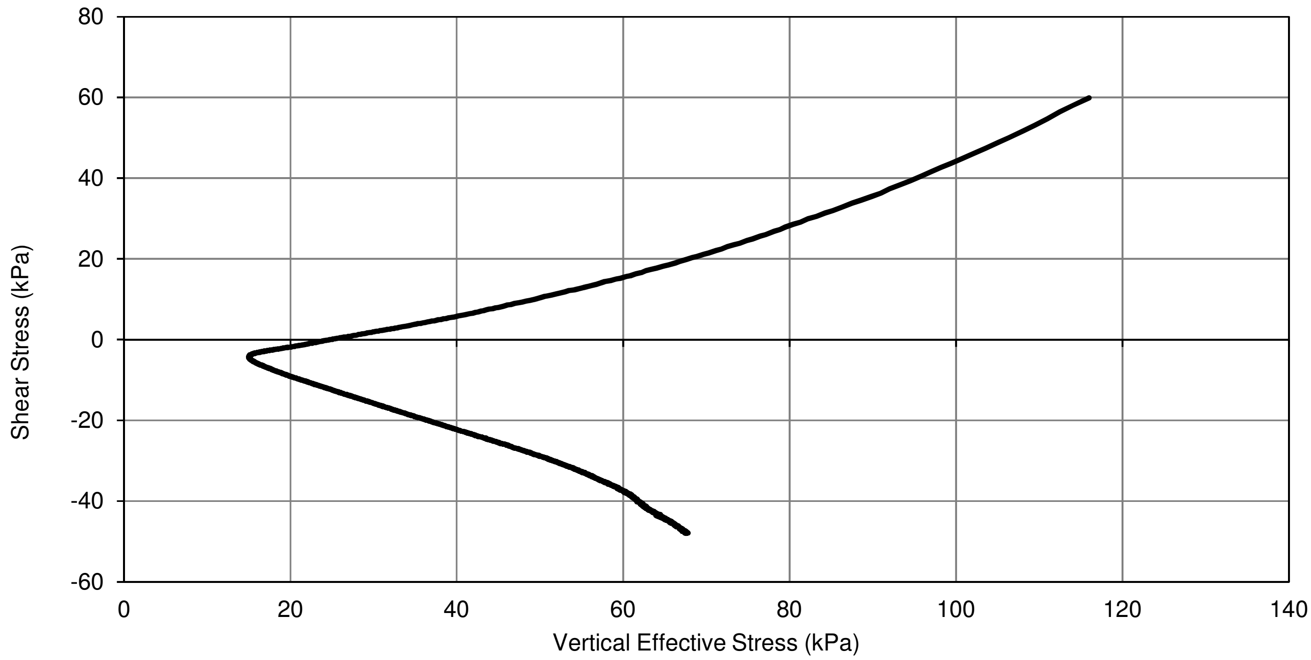
Post-cyclic Direct Simple Shear Test Report - Consolidated Undrained

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css8 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.05
Diameter (mm)	100.2	Final Dry Density (t/m^3)	1.74
Initial Shearing Height (mm)	28.5	Initial Static Shear Stress (kPa)	90.0
Post-consolidation Shearing Height (mm)	20.9	Shearing Strain Rate (mm/min)	0.017





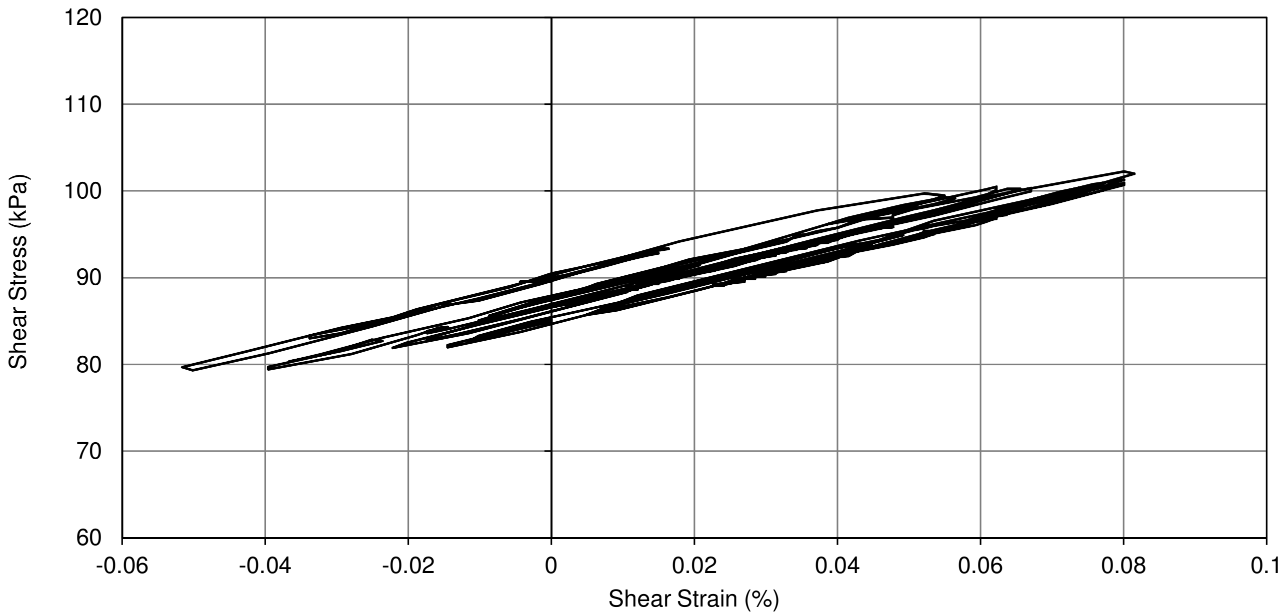
Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

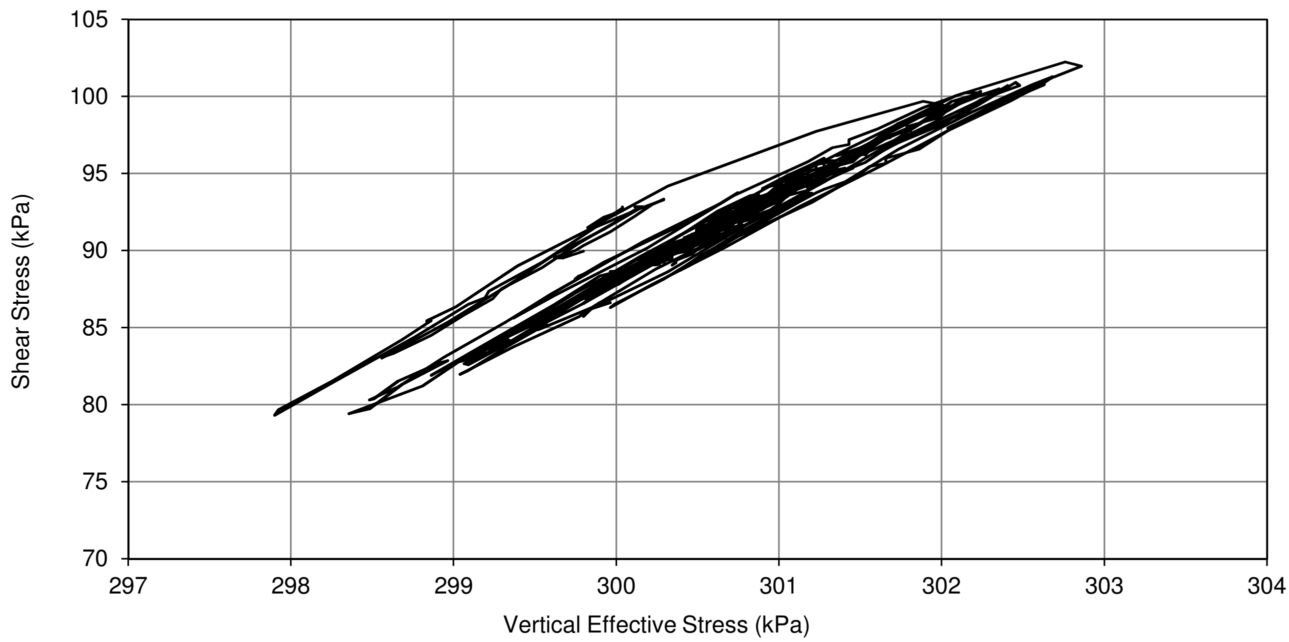
Cyclic Direct Simple Shear Test Report - Custom Waveform

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	12/03/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css11 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.06
Diameter (mm)	100.3	Final Dry Density (t/m^3)	1.76
Initial Shearing Height (mm)	28.7	Initial Static Shear Stress (kPa)	89.9
Post-consolidation Shearing Height (mm)	20.7	Average Shear Stress Applied (kPa)	N/A
Applied Cyclic Stress Ratio	N/A	Cycle Period (seconds)	N/A





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

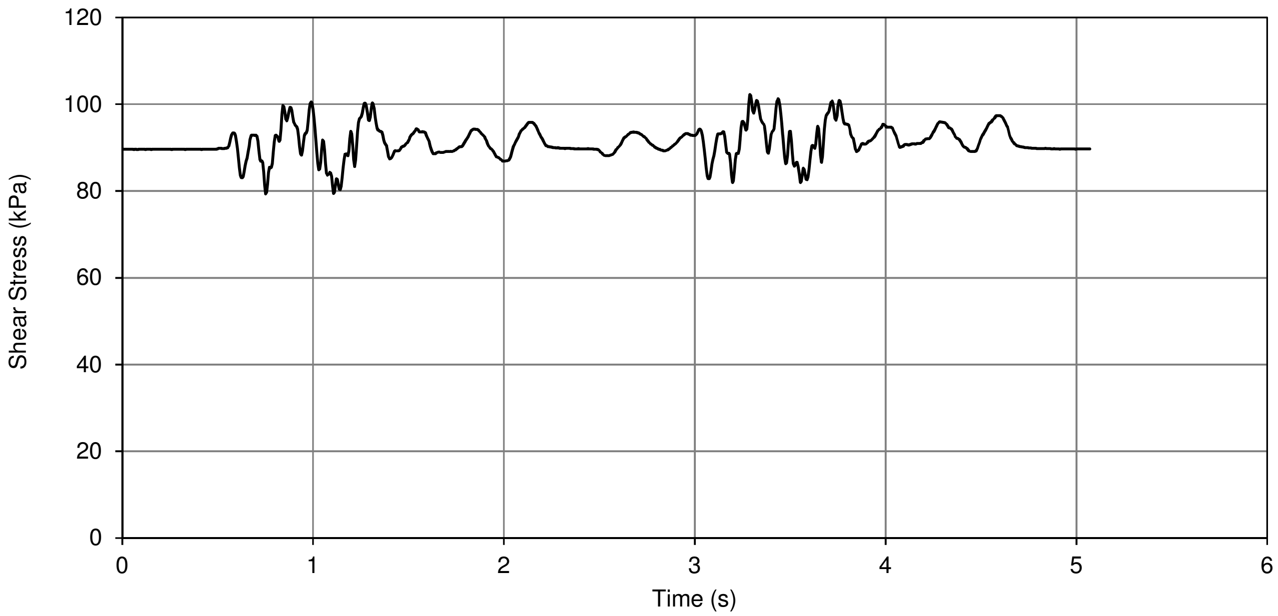
Cyclic Direct Simple Shear Test Report - Custom Waveform

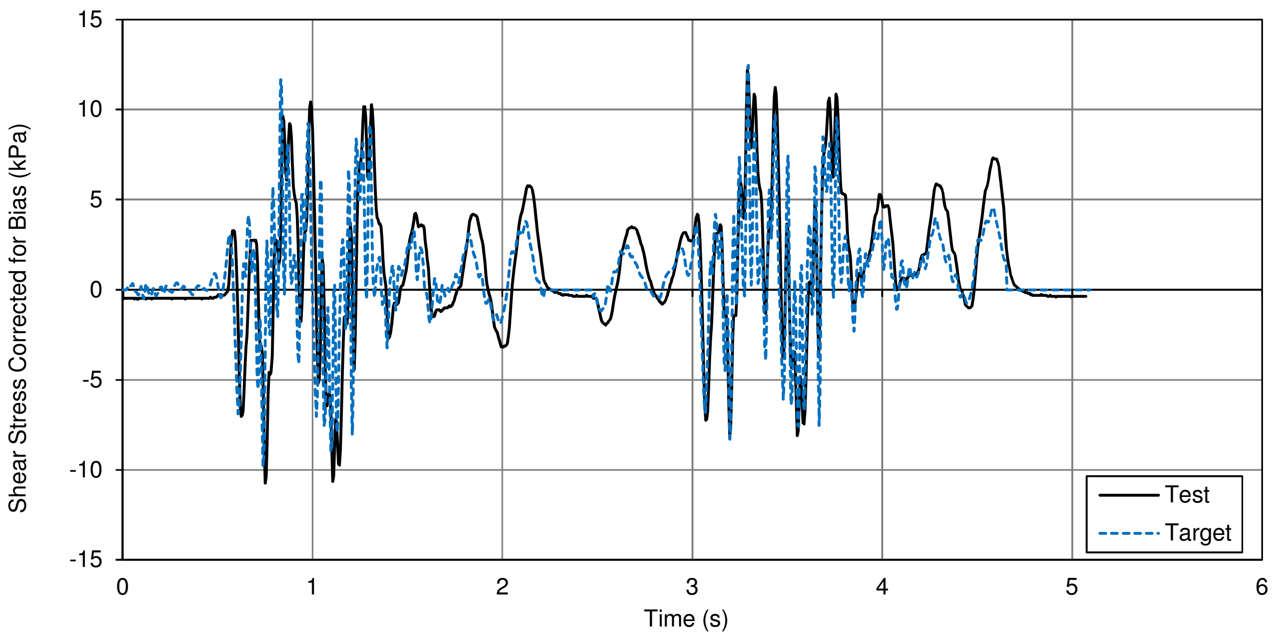
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	12/03/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css11 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.06
Diameter (mm)	100.3	Final Dry Density (t/m^3)	1.76
Initial Shearing Height (mm)	28.7	Initial Static Shear Stress (kPa)	89.9
Post-consolidation Shearing Height (mm)	20.7	Average Shear Stress Applied (kPa)	N/A
Applied Cyclic Stress Ratio	N/A	Cycle Period (seconds)	N/A





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

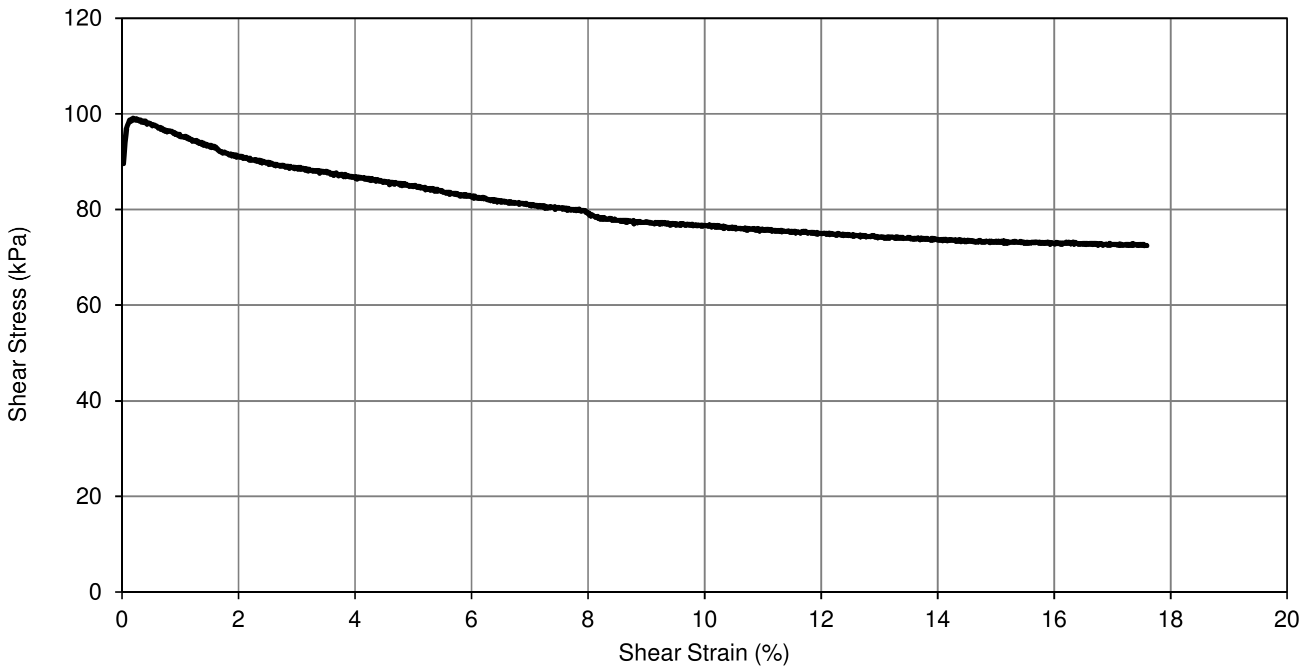
Post-cyclic Direct Simple Shear Test Report - Consolidated Undrained

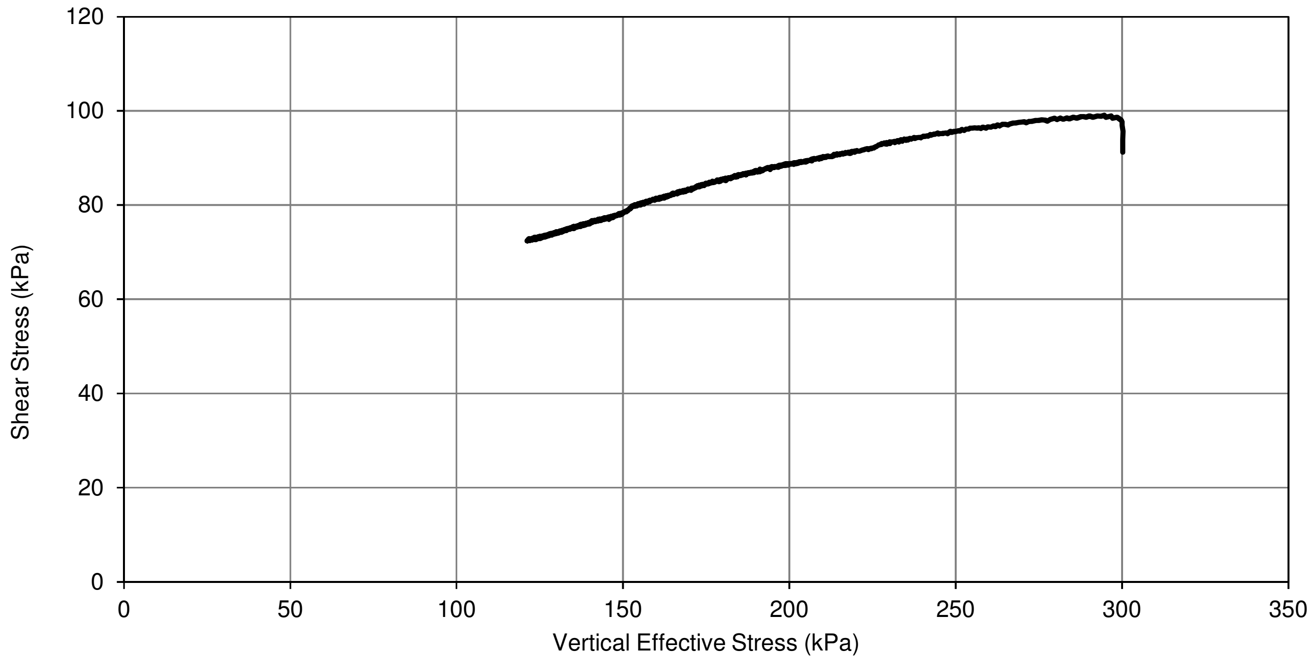
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	12/03/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-css11 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.06
Diameter (mm)	100.3	Final Dry Density (t/m^3)	1.76
Initial Shearing Height (mm)	28.7	Initial Static Shear Stress (kPa)	89.9
Post-consolidation Shearing Height (mm)	20.7	Shearing Strain Rate (mm/min)	0.017





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

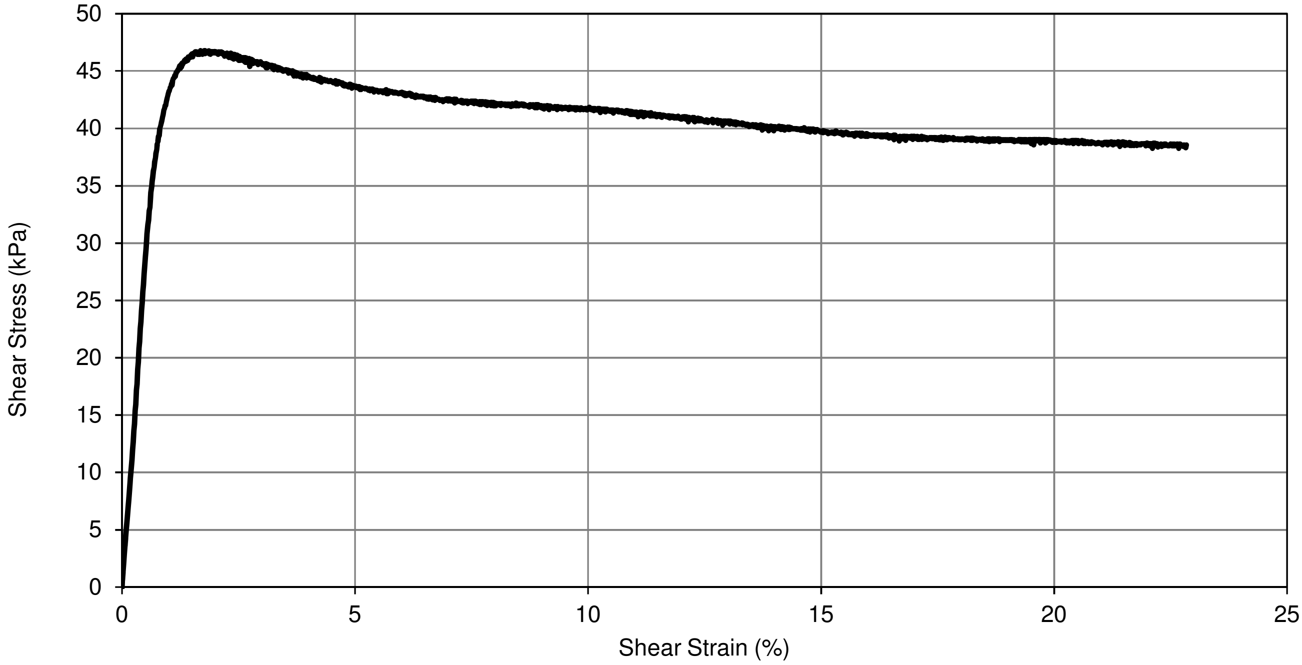
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

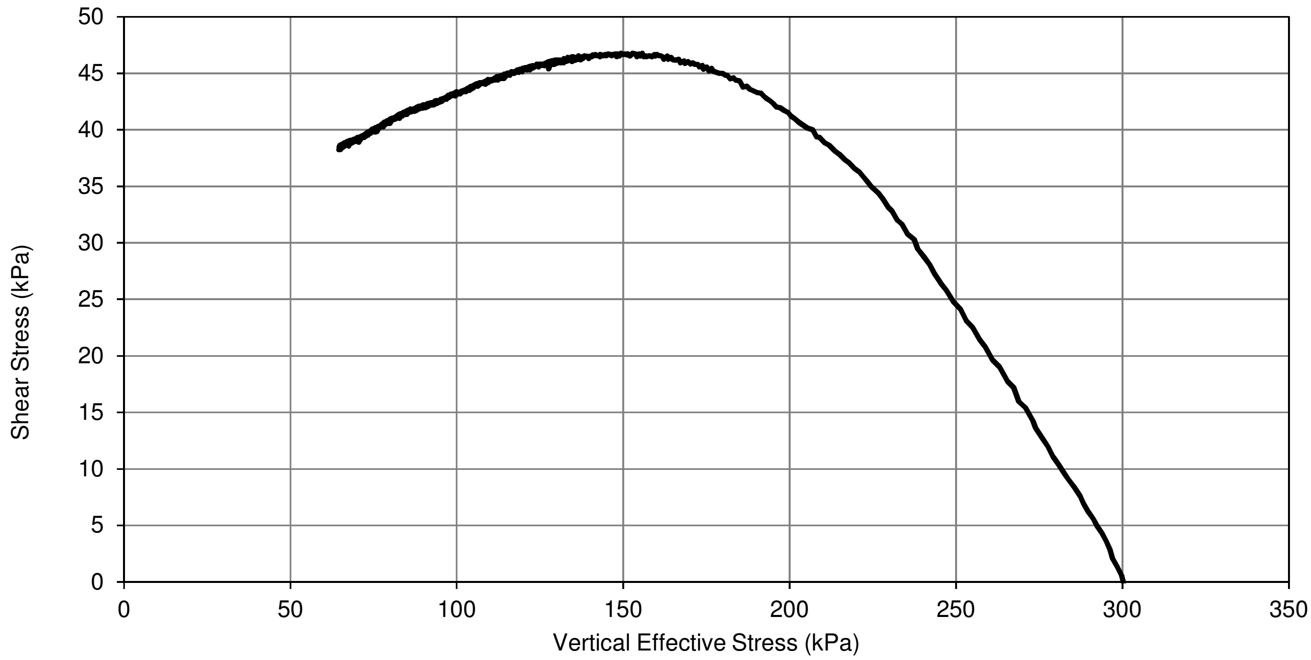
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	12/03/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-mss9 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.02
Diameter (mm)	100.4	Final Dry Density (t/m^3)	1.70
Initial Shearing Height (mm)	28.7	Initial Static Shear Stress (kPa)	-0.05
Post-consolidation Shearing Height (mm)	21.5	Shearing Strain Rate (mm/min)	0.017





Preparation Notes:	Moist tamped in one layer	Tested by:	R. Fanni
		Reviewed by:	R. Fanni

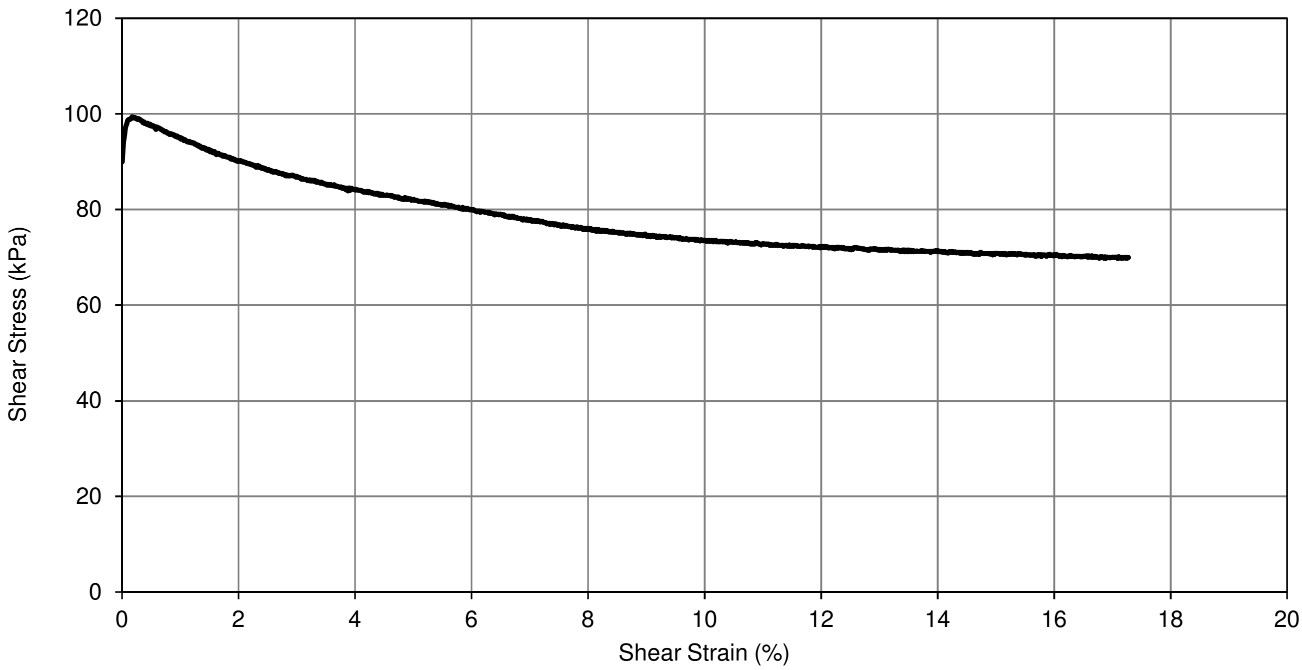
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

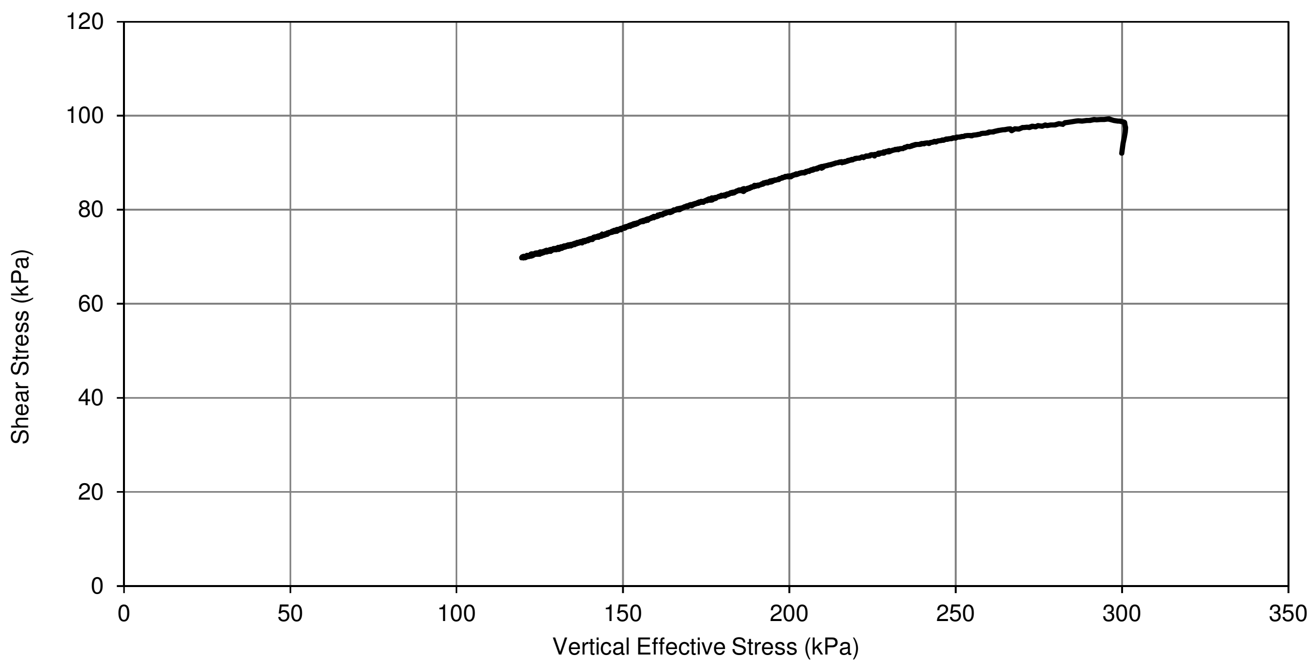
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	12/03/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1 - Tailings
Location:	Cadia Mine	**Test ID:**	18018 si-mss10 very loose

Vertical Effective Stress (kPa)	300	Final Bulk Density (t/m^3)	2.04
Diameter (mm)	100.2	Final Dry Density (t/m^3)	1.74
Initial Shearing Height (mm)	28.7	Initial Static Shear Stress (kPa)	90.1
Post-consolidation Shearing Height (mm)	21.0	Shearing Strain Rate (mm/min)	0.017





Preparation Notes:	Moist tamped in one layer	Tested by:	K. Koh
		Reviewed by:	R. Fanni

Annexure EO
Golder Stress Path Test Results

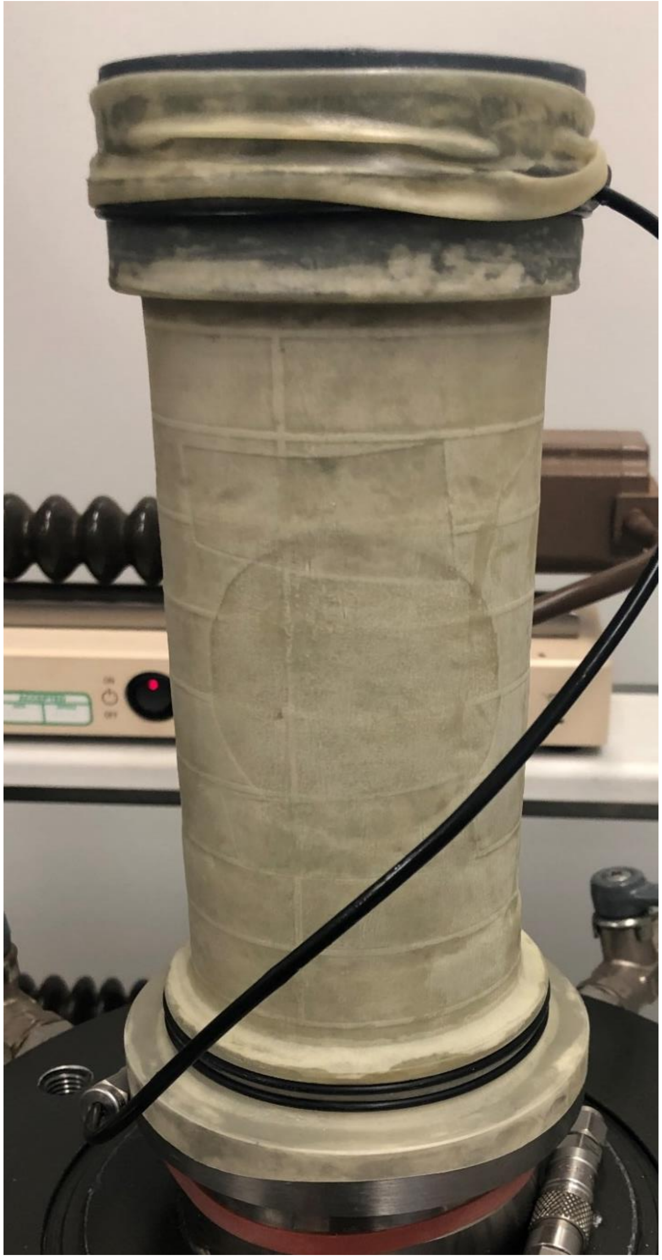
Triaxial Test Report

Stress Path Dead-Weights

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-10 Stress Path Test C

Initial Height (mm):	148.3	Final Liquor Content (%):	19.1%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.80	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.62



Sample Before Test	Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

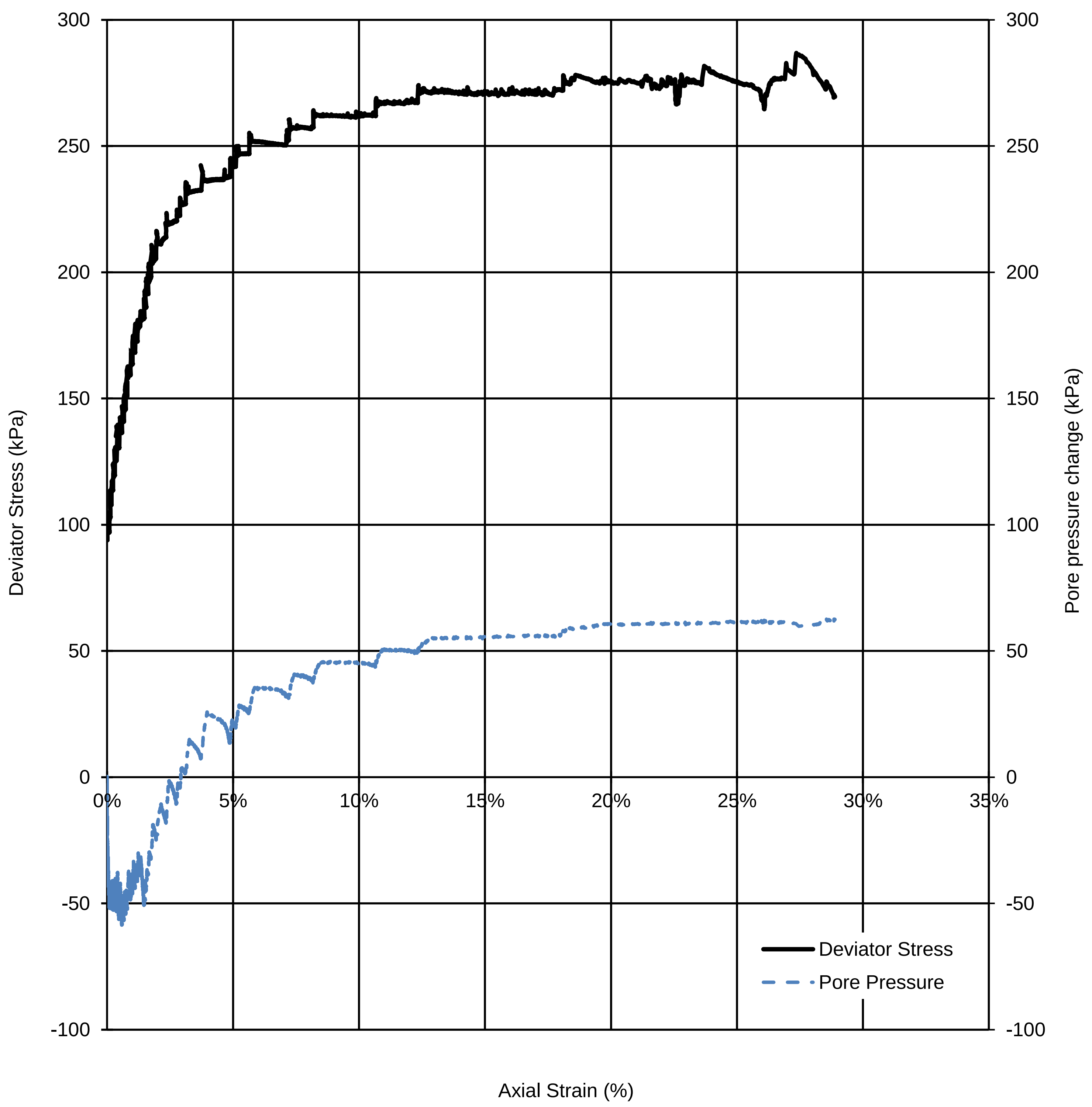
Triaxial Test Report

Stress Path Dead-Weights

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-10 Stress Path Test C

Initial Height (mm):	148.3	Final Liquor Content (%):	19.1%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.80	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.62



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

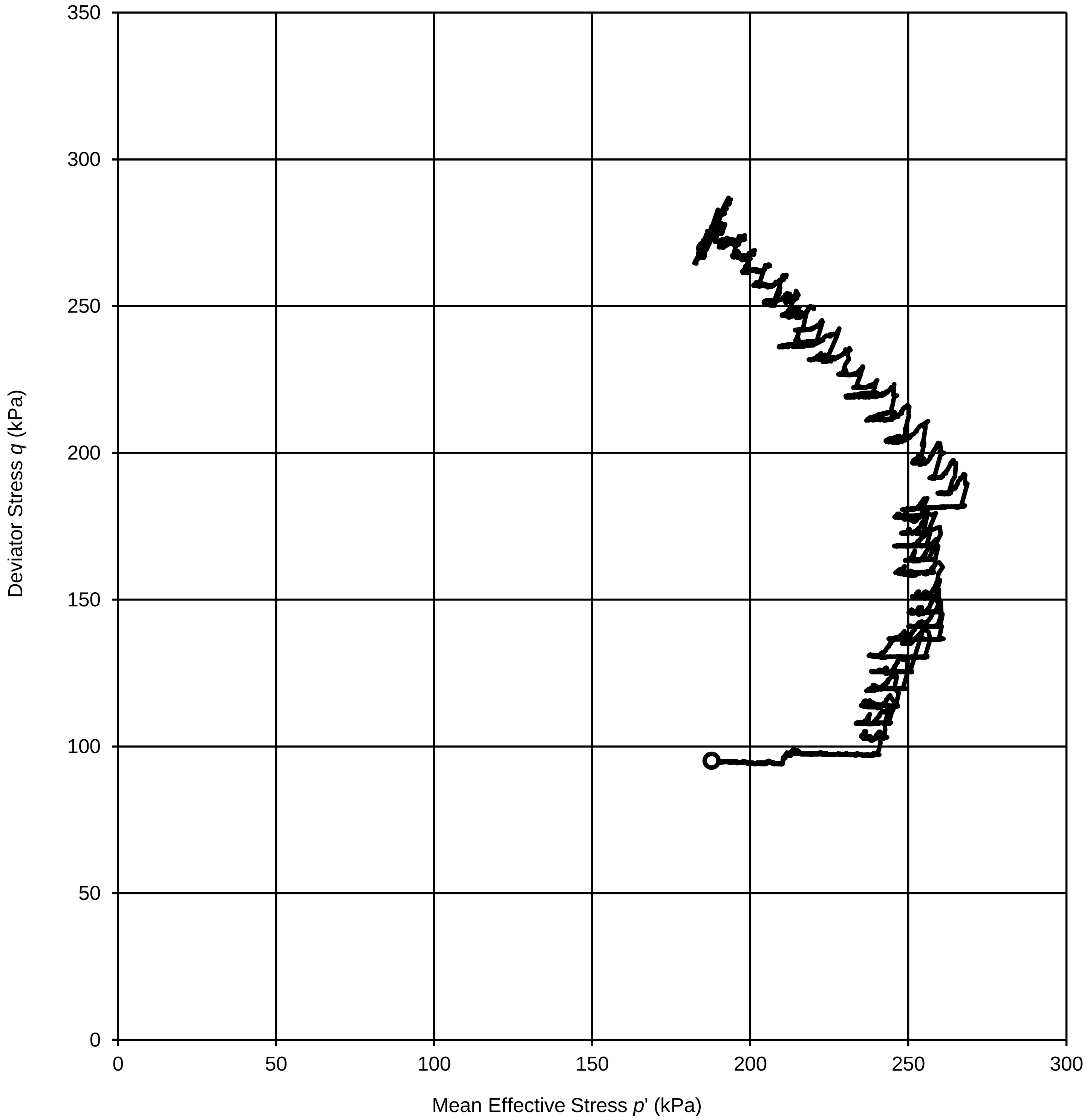
Stress Path Dead-Weights

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-10 Stress Path Test C

Initial Height (mm):	148.3	Final Liquor Content (%):	19.1%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.80	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.62



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

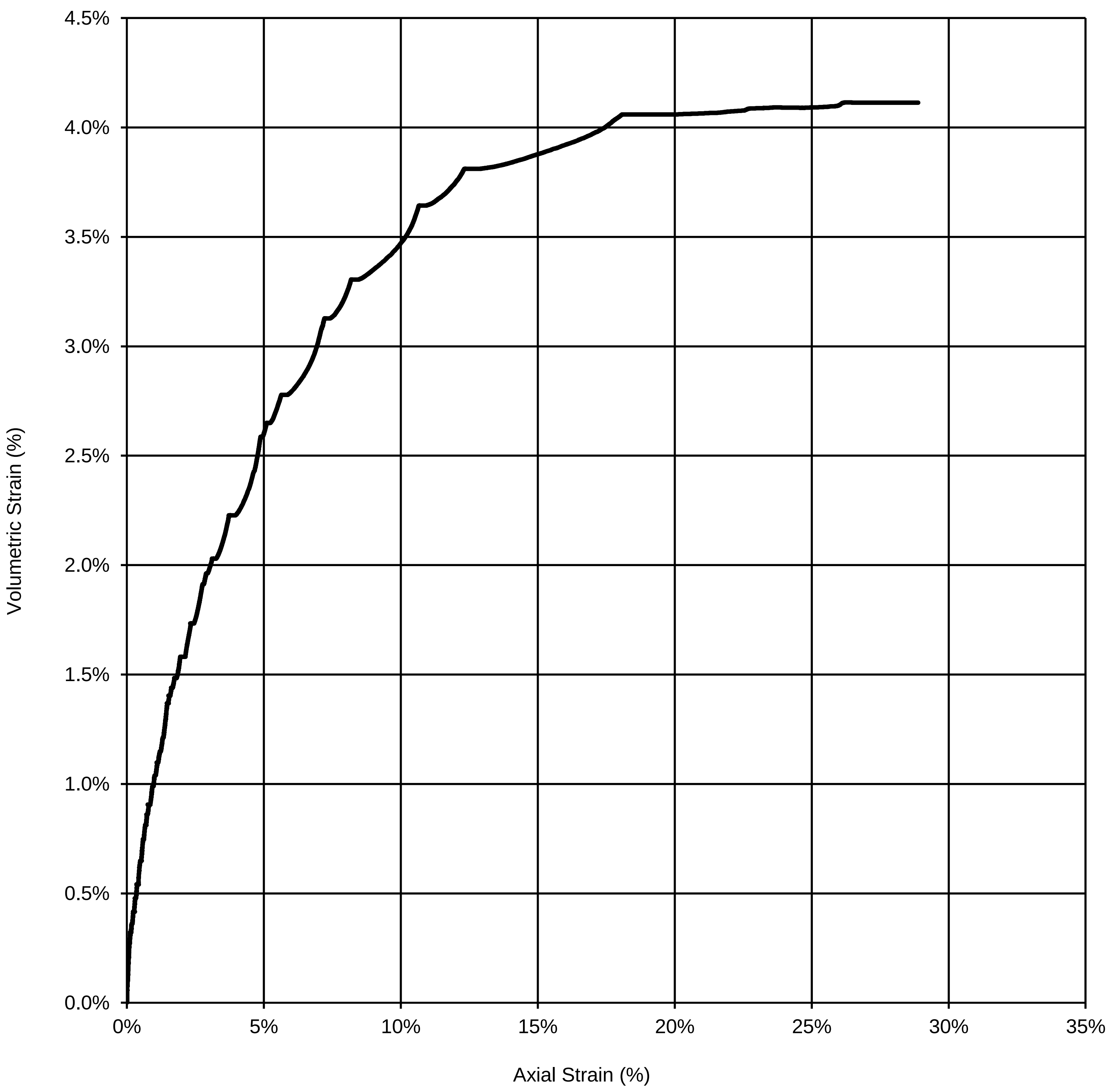
Triaxial Test Report

Stress Path Dead-Weights

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-10 Stress Path Test C

Initial Height (mm):	148.3	Final Liquor Content (%):	19.1%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.80	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.62



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

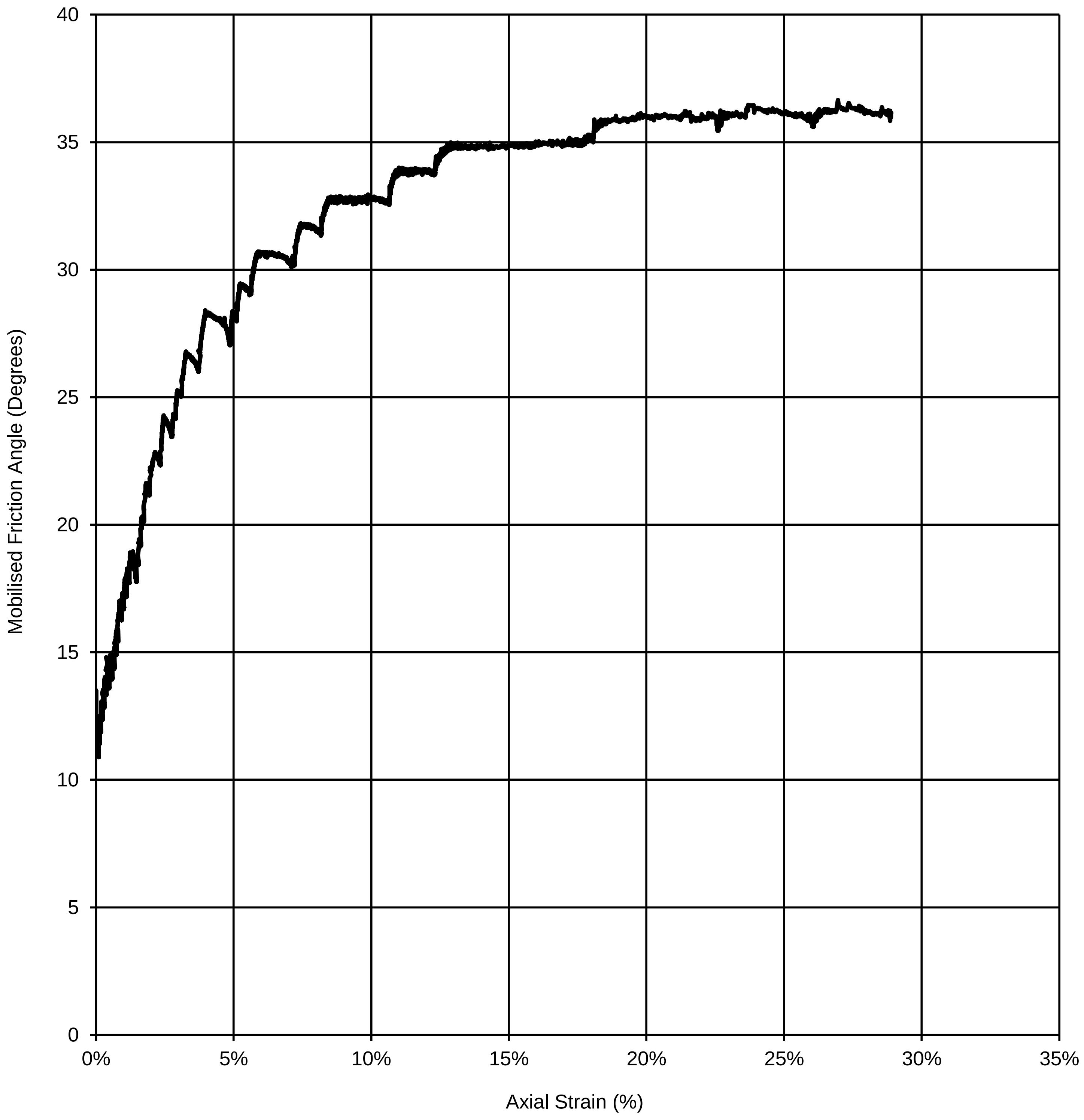
Triaxial Test Report

Stress Path Dead-Weights

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-10 Stress Path Test C

Initial Height (mm):	148.3	Final Liquor Content (%):	19.1%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	69.1	Final Dry Density (t/m^3):	1.80	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.52	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.62



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

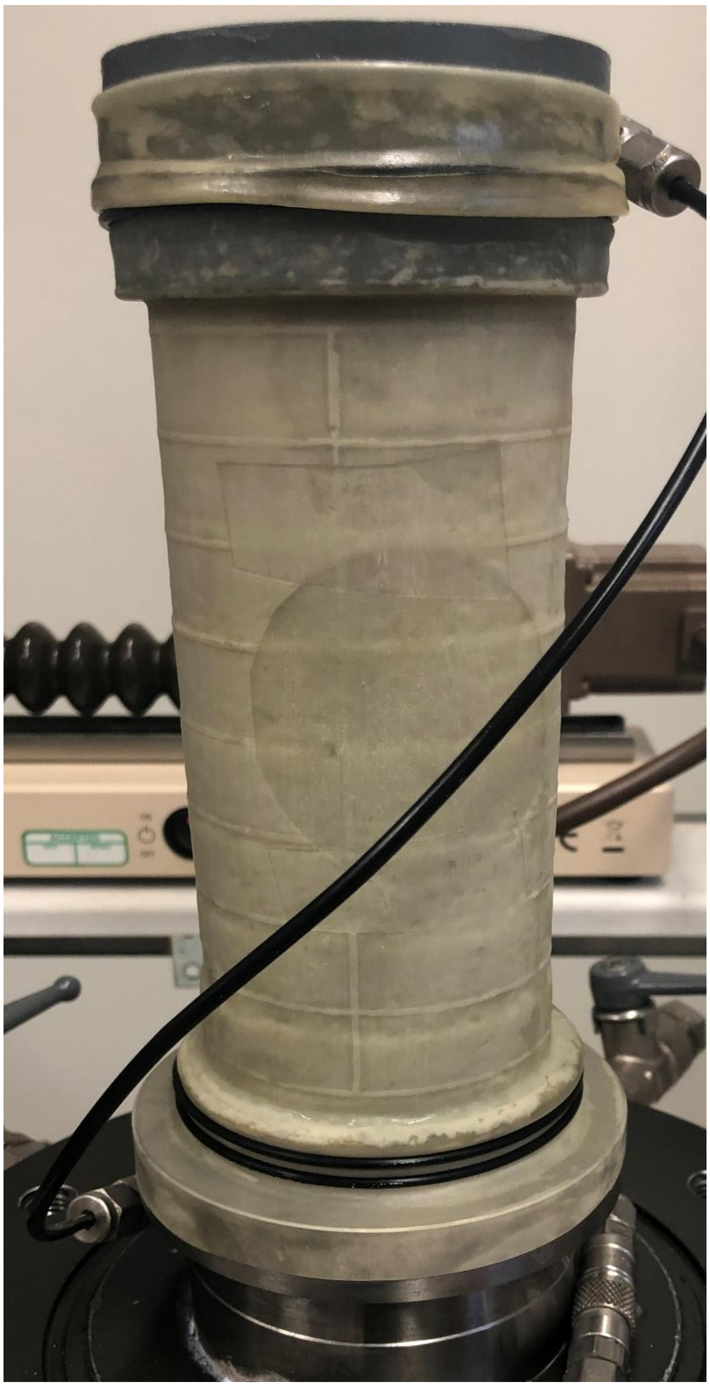
Stress Path Dead-Weights

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-11 Stress Path Test C

Initial Height (mm):	148.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.76	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.56	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.61



Sample Before Test

Sample After Test

Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

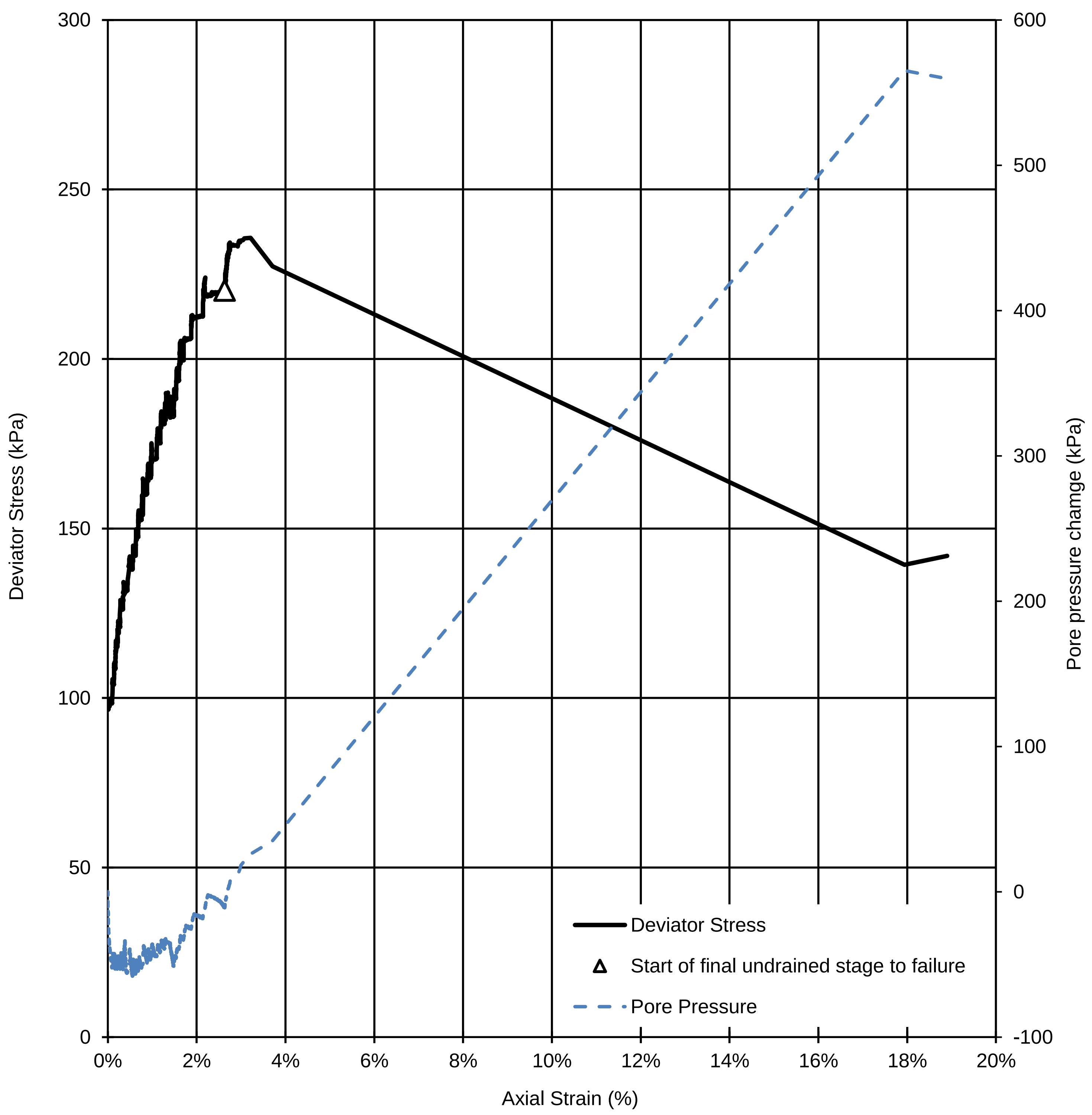
Stress Path Dead-Weights

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-11 Stress Path Test C

Initial Height (mm):	148.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.76	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.56	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.61



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

Triaxial Test Report

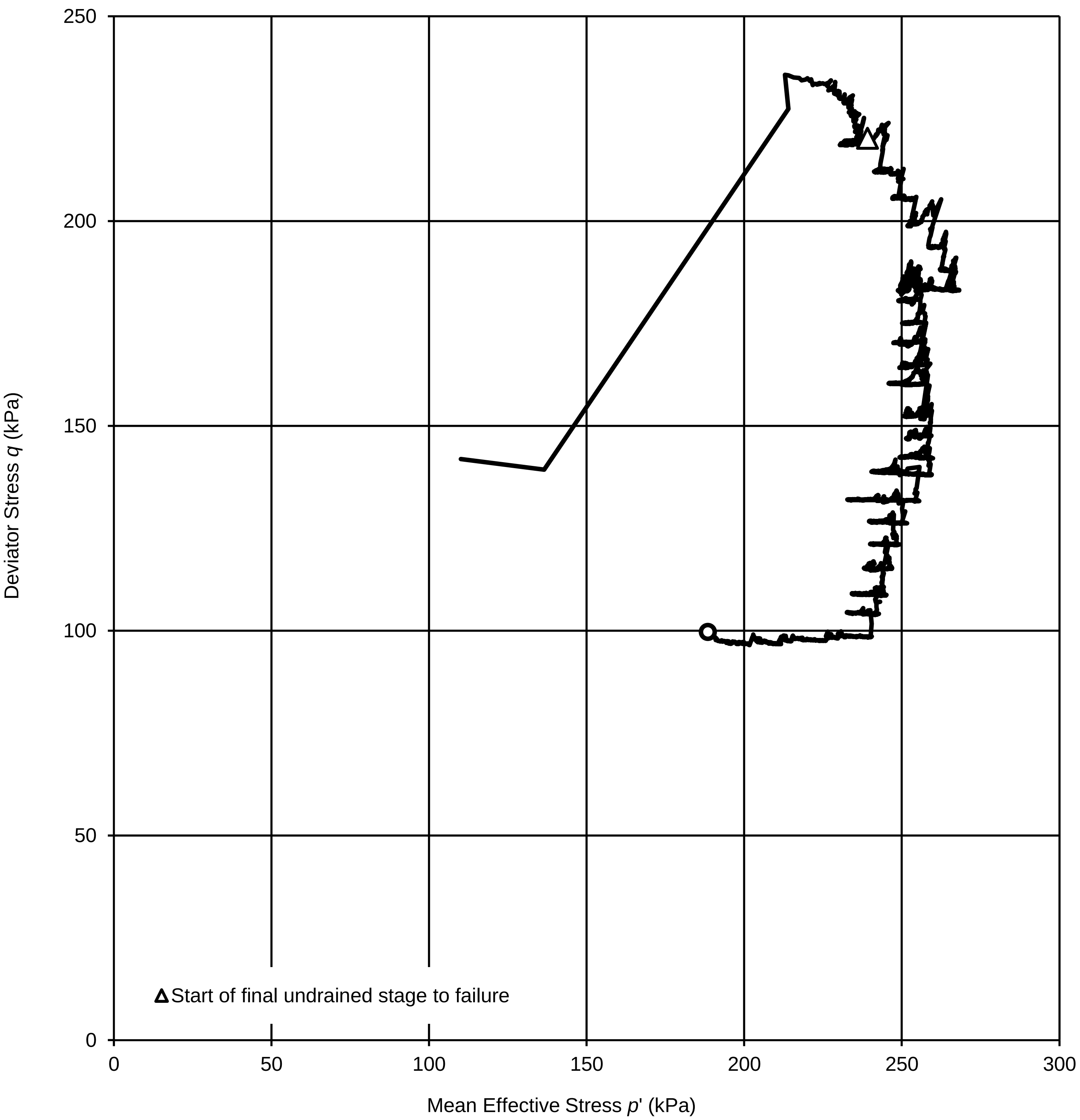
Stress Path Dead-Weights

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-11 Stress Path Test C

Initial Height (mm):	148.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.76	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.56	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.61



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

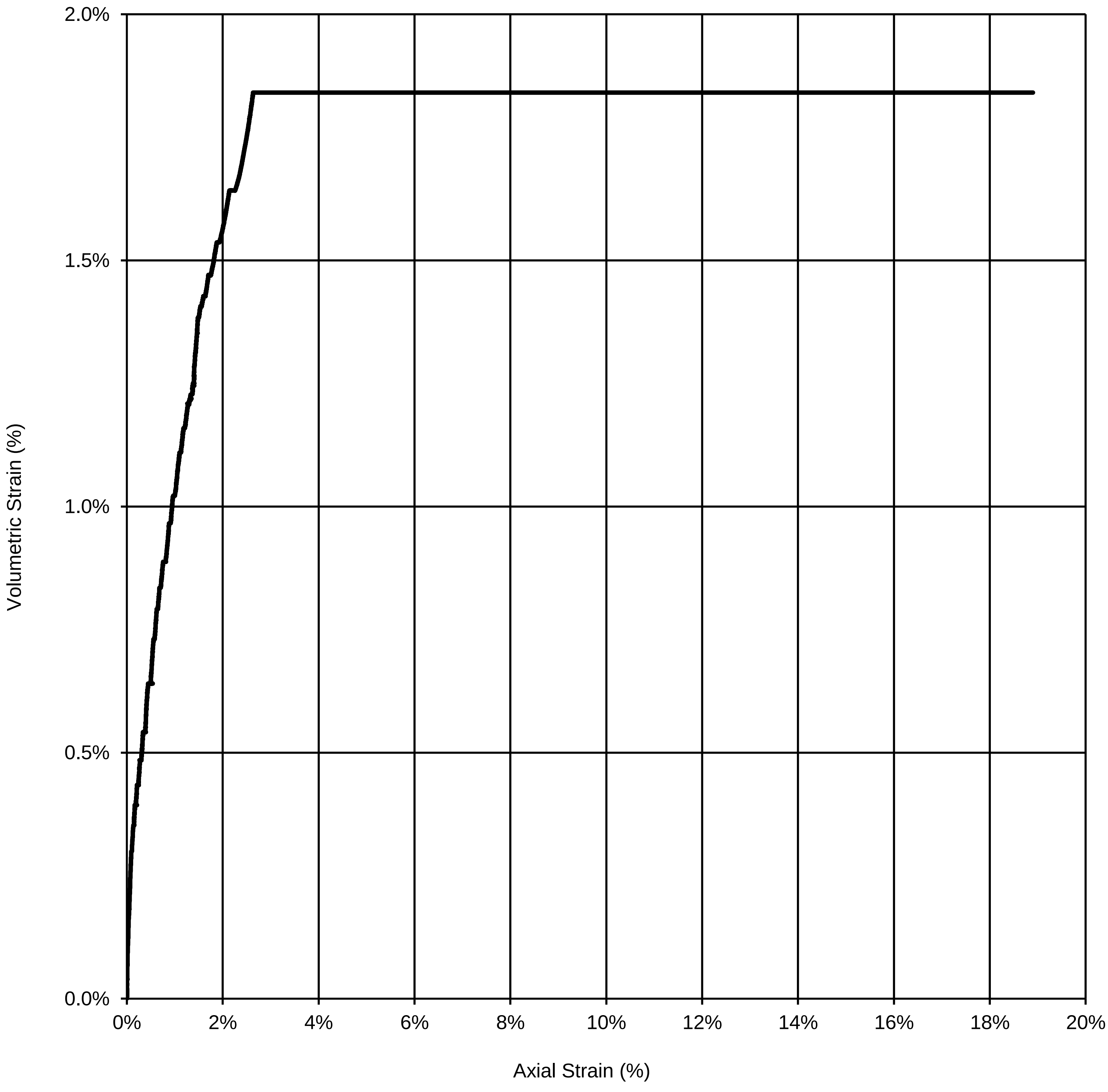
Triaxial Test Report

Stress Path Dead-Weights

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-11 Stress Path Test C

Initial Height (mm):	148.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.76	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.56	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.61



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
		Reviewed by:	R. Fanni /D. Reid

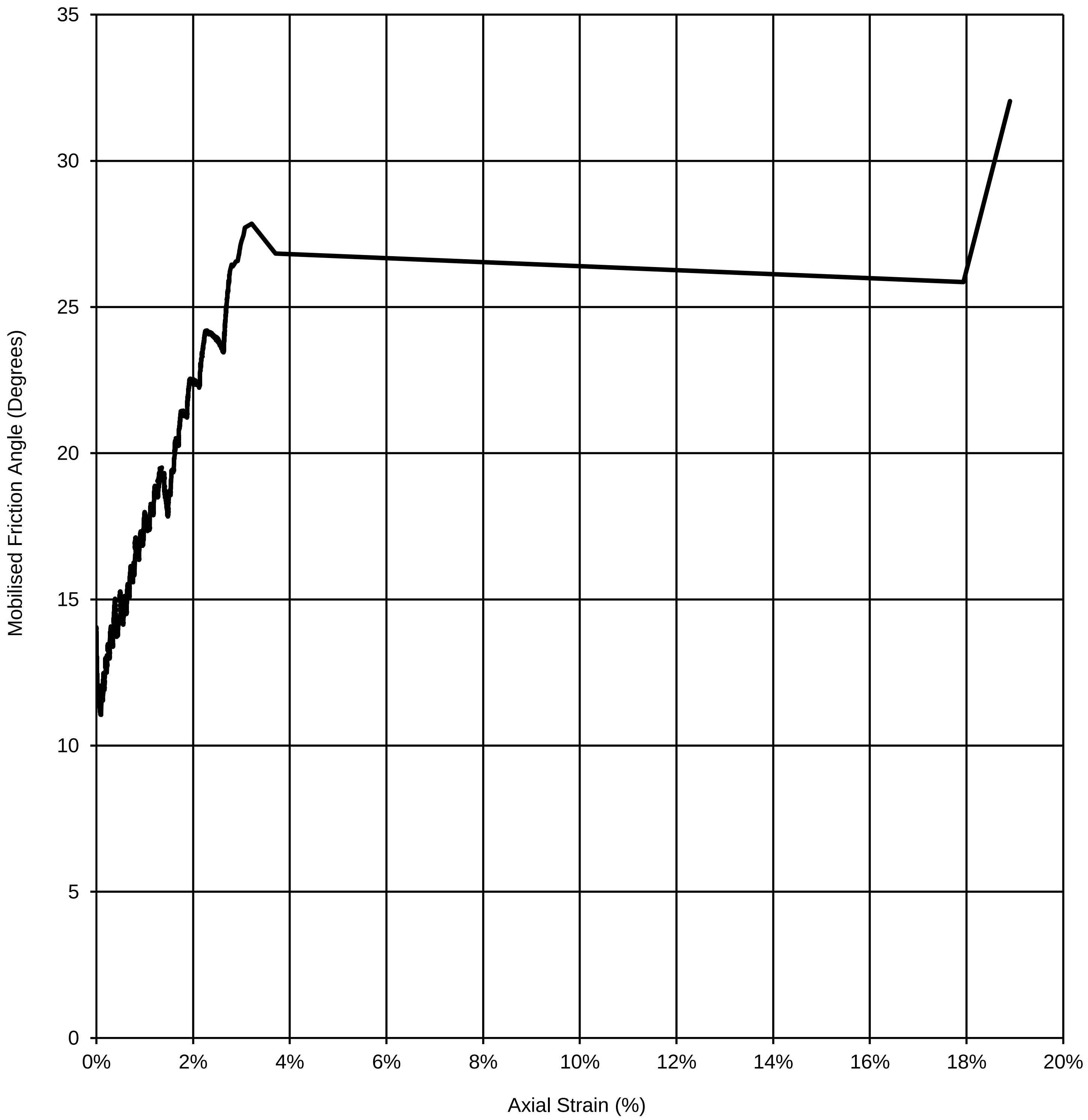
Triaxial Test Report

Stress Path Dead-Weights

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	23/01/2019
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TC1
Location:	Cadia Mine	**Test ID:**	18018 - si-11 Stress Path Test C

Initial Height (mm):	148.7	Final Liquor Content (%):	20.4%	Strain Rate (mm/min):	N/A
Initial Diameter (mm):	68.9	Final Dry Density (t/m^3):	1.76	B Response (%):	98%
Trimmings GWC (%):	10.9%	Final Void Ratio (-):	0.56	Mean Effective Consolidation Stress (kPa):	188
Initial Dry Density (t/m^3):	1.24	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.61



Preparation Notes:	Sample was moist tamped to a loose condition	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

Annexure EP
KCB Stress Path Test Results

Triaxial CD Test - Summary
(ASTM D7181)

PROJECT NO. :	A03353A01	DATE :	2019-03-01
PROJECT :	Cadia Dam	TESTED BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
TEST NO. :	TX04 - Stress Path / Dead Weight #2		

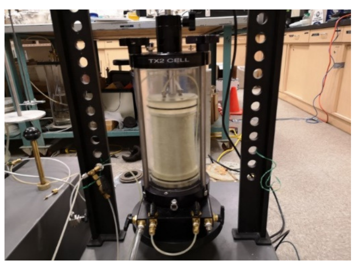
SPECIMEN INFORMATION	UNITS	Initial	Vacuum	Saturation	B value	End 1st Cons	End 2nd Cons	End 3rd Cons	End 4th Cons	Stress Path
Specimen Height	mm	139.91	138.20	131.68	131.51	129.49	128.52	127.55	126.65	122.37
Specimen Diameter	mm	69.80	69.17	67.46	67.51	66.43	65.77	65.17	64.66	65.15
Area	cm^2	38.26	37.58	35.74	35.79	34.66	33.98	33.36	32.84	33.33
Volume	cm^3	535.364	519.318	470.669	470.669	448.852	436.644	425.478	415.863	407.895
Wet Weight	g	840.39	840.39	923.39	925.80	903.99	891.78	880.61	871.00	863.03
Water Content	%	17.03	17.03	28.59	28.92	25.89	24.19	22.63	21.29	20.18
Dry Weight	g	718.10	718.10	718.10	718.10	718.10	718.10	718.10	718.10	718.10
Wet Density	g/cm^3	1.570	1.618	1.962	1.967	2.014	2.042	2.070	2.094	2.116
Dry Density	g/cm^3	1.341	1.383	1.526	1.526	1.600	1.645	1.688	1.727	1.760
Specific Gravity of Solids	-	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73
Solids Volume	cm^3	263.040	263.040	263.040	263.040	263.040	263.040	263.040	263.040	263.040
Void Volume	cm^3	272.325	256.279	207.630	207.630	185.813	173.604	162.438	152.823	144.855
Water Volume	cm^3	122.292	122.292	205.292	207.704	185.887	173.678	162.512	152.898	144.929
Void Ratio (e)	-	1.035	0.974	0.789	0.789	0.706	0.660	0.618	0.581	0.551
Saturation Ratio (Sr)	%	44.91	47.72	98.87	100.04	100.04	100.04	100.05	100.05	100.05
Effective Confining Stress	kPa					25	50	100	188.8	

Stress Path*		
Skempton's B Parameter		0.98
Back Pressure before shearing	kPa	251.0
Confining Stress (σ_3') before shearing	kPa	188.8
Stress Rate	kPa / min	<0.5

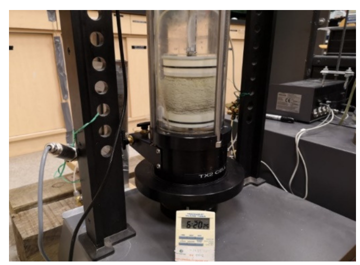
* one way drainage

Photos:

Before Test



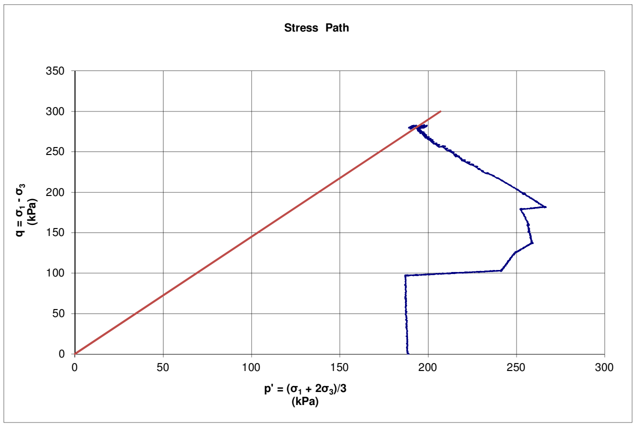
After Test

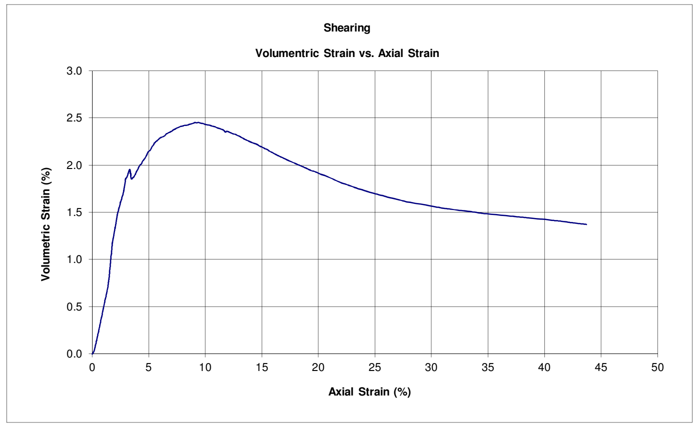


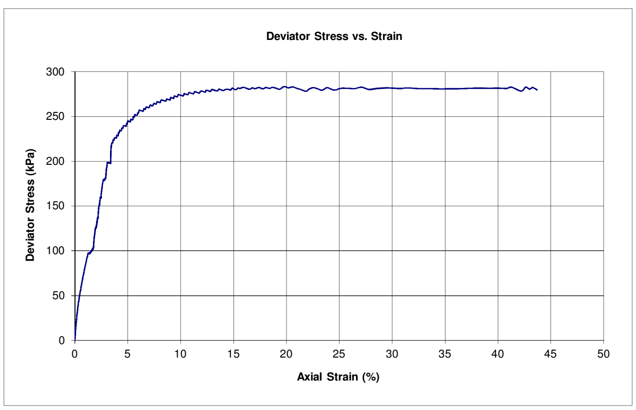
Triaxial CD Test - Charts

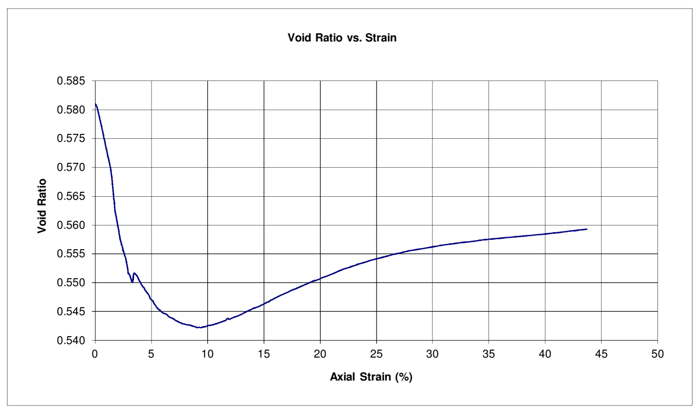
(ASTM D7181)

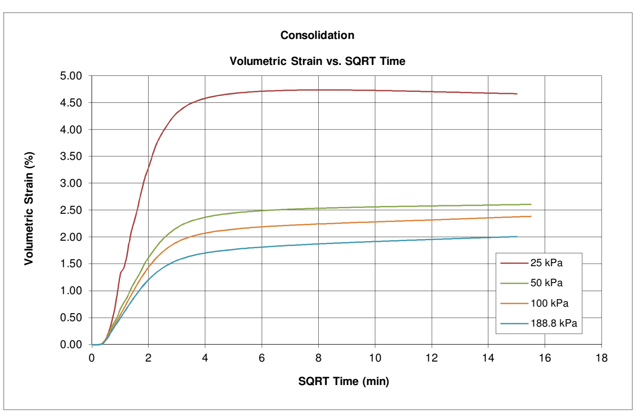
PROJECT NO. :	A03353A01	DATE :	2019-03-01
PROJECT :	Cadia Dam	TEST BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
TEST NO. :	TX04 - Stress Path / Dead Weight #2		

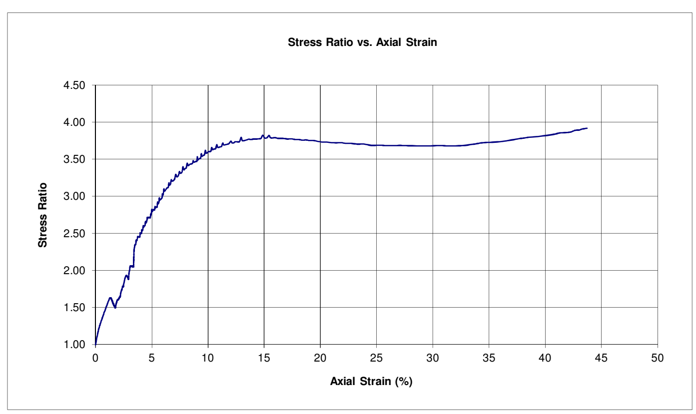












Klohn Crippen Berger

Triaxial CD Test - Summary
(ASTM D7181)

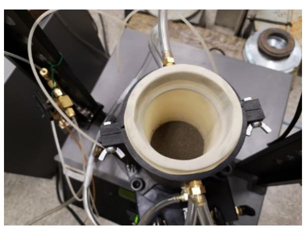
PROJECT NO. :	A03353A01	DATE :	2019-01-28
PROJECT :	Cadia Dam	TESTED BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
TEST NO. :	TX03 - Stress Path / Dead Weight		

SPECIMEN INFORMATION	UNITS	Initial	Vacuum	Saturation	B value	End 1st Cons	End 2nd Cons	End 3rd Cons	Stress Path	End Test
Specimen Height	mm	140.08	138.82	135.42	135.37	132.47	132.48	130.14	126.02	73.45
Specimen Diameter	mm	69.80	69.35	67.71	67.73	65.80	64.96	64.81	65.14	85.06
Area	cm^2	38.26	37.77	36.01	36.02	34.01	33.14	32.98	33.33	56.83
Volume	cm^3	536.015	524.366	487.678	487.678	450.456	439.091	429.249	419.980	417.394
Wet Weight	g	841.41	841.41	948.41	949.99	912.77	901.40	891.56	883.29	879.71
Water Content	%	15.21	15.21	29.86	30.08	24.98	23.42	22.08	20.72	20.45
Dry Weight	g	730.33	730.33	730.33	730.33	730.33	730.33	730.33	731.66	730.33
Wet Density	g/cm^3	1.570	1.605	1.945	1.948	2.026	2.053	2.077	2.103	2.108
Dry Density	g/cm^3	1.363	1.393	1.498	1.498	1.621	1.663	1.701	1.742	1.750
Specific Gravity of Solids	-	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73
Solids Volume	cm^3	267.519	267.519	267.519	267.519	267.519	267.519	267.519	268.008	267.519
Void Volume	cm^3	268.496	256.847	220.159	220.159	182.937	171.572	161.730	151.972	149.875
Water Volume	cm^3	111.083	111.083	218.083	219.663	182.440	171.076	161.233	151.630	149.378
Void Ratio (e)	-	1.004	0.960	0.823	0.823	0.684	0.641	0.605	0.567	0.560
Saturation Ratio (Sr)	%	41.37	43.25	99.06	99.77	99.73	99.71	99.69	99.78	99.67
Effective Confining Stress	kPa					50	100	188.8		

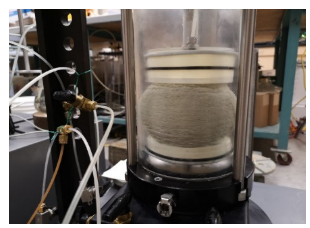
Stress Path (CD)		
Skempton's B Parameter		0.98
Back Pressure before shearing	kPa	151.7
Confining Stress (σ_3') before shearing	kPa	188.8
Stress Rate	kPa / min	<0.5

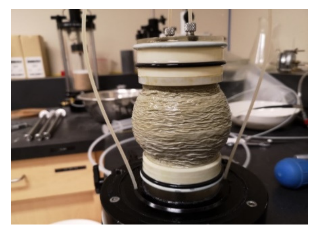
Photos:

Before Test



After Test

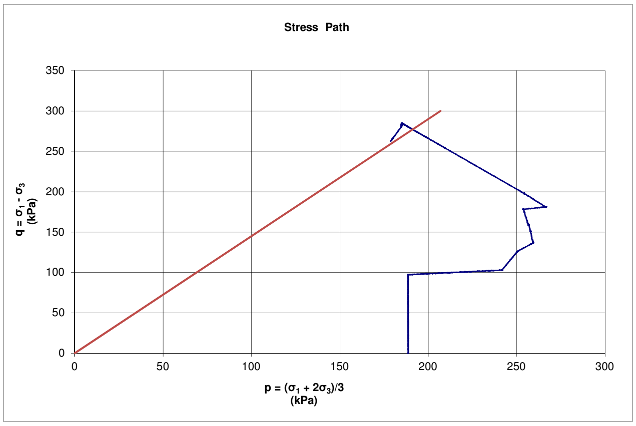


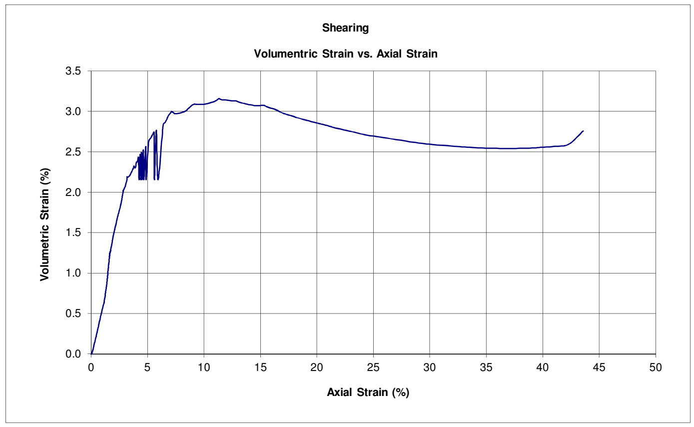


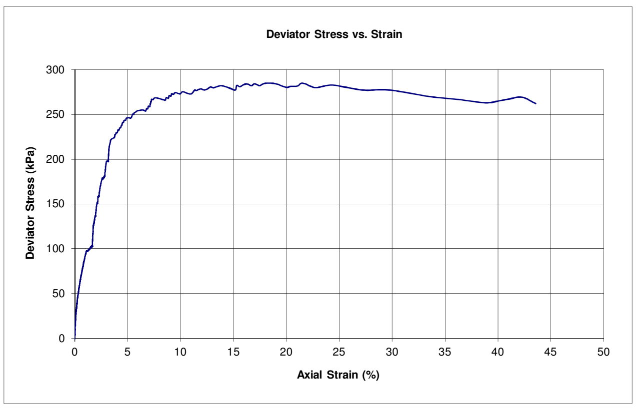
Triaxial CD Test - Charts

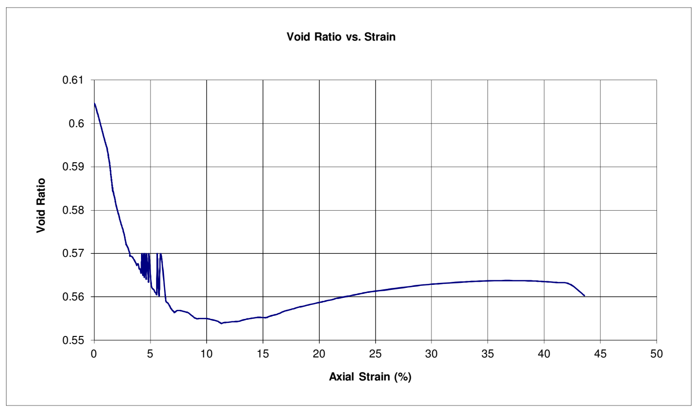
(ASTM D7181)

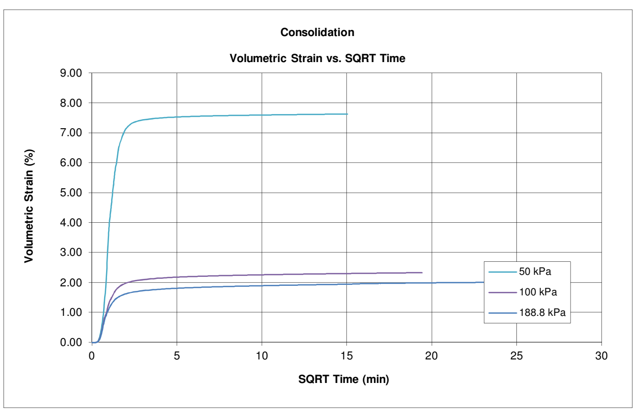
PROJECT NO. :	A03353A01	DATE :	2019-01-28
PROJECT :	Cadia Dam	TEST BY:	BY
SAMPLE :	Tailings	CHECKED BY:	
TEST NO. :	TX03 - Stress Path / Dead Weight		

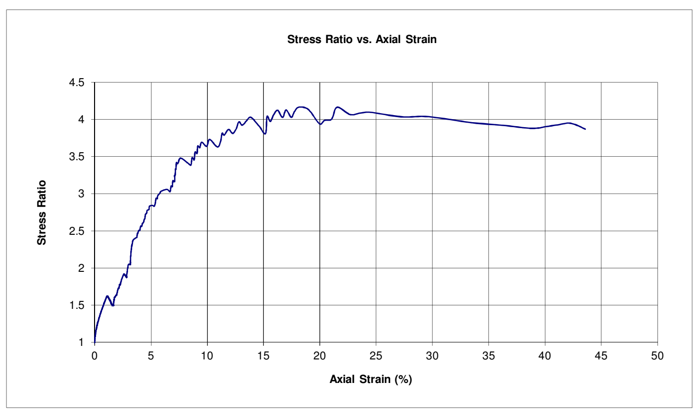












Klohn Crippen Berger

Cyclic Triaxial Test

(ASTM D5311)

PROJECT NO. :	A03353A01	DATE :	2019-01-11
PROJECT :	Cadia Tailings Dam	TESTED BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
Details:	ei = 1.0		

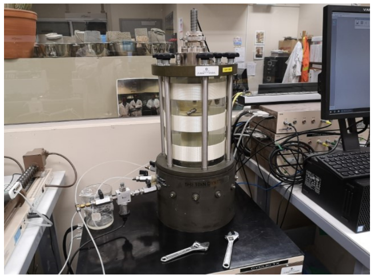
SPECIMEN INFORMATION	UNITS	Initial	Vacuum	Saturation	B-value	End of 1st Consolidation	End of 2nd Consolidation	End of 3rd Consolidation	End of 4th Consolidation	End of Stress Path	End of Cyclic Shearing	
Specimen Height	mm	140.02	140.03	139.09	138.91	136.93	135.65	134.46	133.38	128.34	103.07	
Specimen Diameter	mm	69.80	69.55	66.25	66.29	65.49	64.87	64.32	63.87	64.25	71.70	
Area	cm^2	38.26	37.99	34.47	34.51	33.69	33.05	32.50	32.04	32.42	40.38	
Volume	cm^3	535.79	531.99	479.42	479.42	461.27	448.35	436.96	427.34	416.13	416.19	
Wet Weight	g	841.05	841.05	936.05	940.90	922.74	909.83	898.44	888.81	877.60	877.67	
Water Content	%	15.16	15.16	28.17	28.83	26.35	24.58	23.02	21.70	20.16	20.17	
Dry Weight	g	730.33	730.33	730.33	730.33	730.33	730.33	730.33	730.33	730.33	730.33	
Wet Density	g/cm^3	1.570	1.581	1.952	1.963	2.000	2.029	2.056	2.080	2.109	2.109	
Dry Density	g/cm^3	1.363	1.373	1.523	1.523	1.583	1.629	1.671	1.709	1.755	1.755	
Specific Gravity of Solids	-	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73	
Solids Volume	cm^3	267.521	267.521	267.521	267.521	267.521	267.521	267.521	267.521	267.521	267.521	
Void Volume	cm^3	268.265	264.471	211.897	211.897	193.745	180.831	169.438	159.815	148.604	148.667	
Water Volume	cm^3	110.718	110.718	205.718	210.563	192.411	179.497	168.104	158.481	147.270	147.333	
Void Ratio (e)	-	1.003	0.989	0.792	0.792	0.724	0.676	0.633	0.597	0.555	0.556	
Saturation Ratio (Sr)	%	41.27	41.86	97.08	99.37	99.31	99.26	99.21	99.17	99.10	99.10	
Effective Confining Stress	kPa					25	50	100	188.8			

Stress Path (CD)		
Skempton's B Parameter		0.98
Back Pressure before shearing	kPa	400.0
Confining Stress (σ_3') before shearing	kPa	188.8
Stress Rate	kPa / min	<0.5

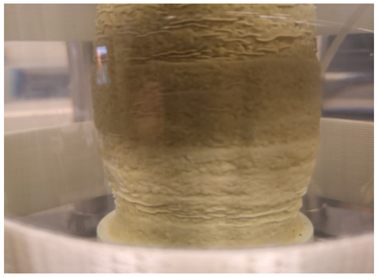
Note: *using cambridge method*

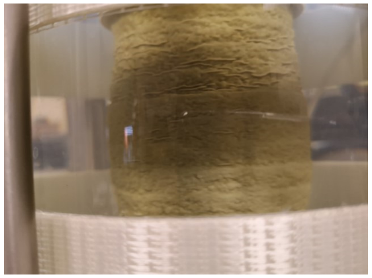
Test Photos:

Before Test



After Test

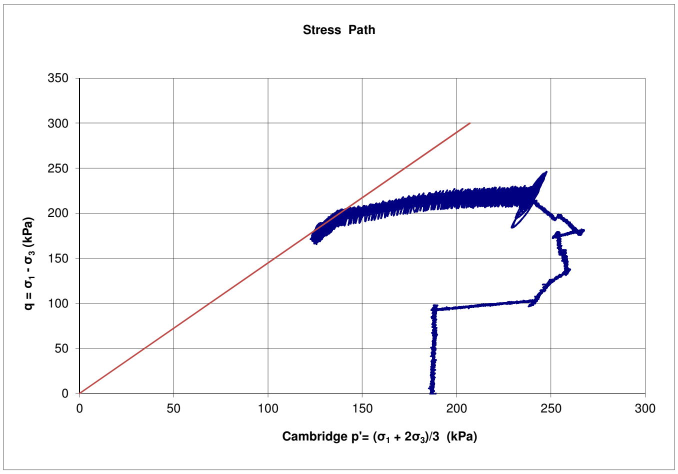


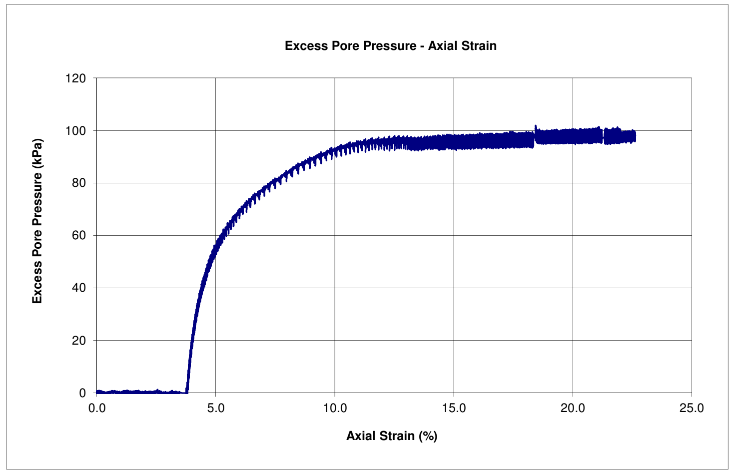


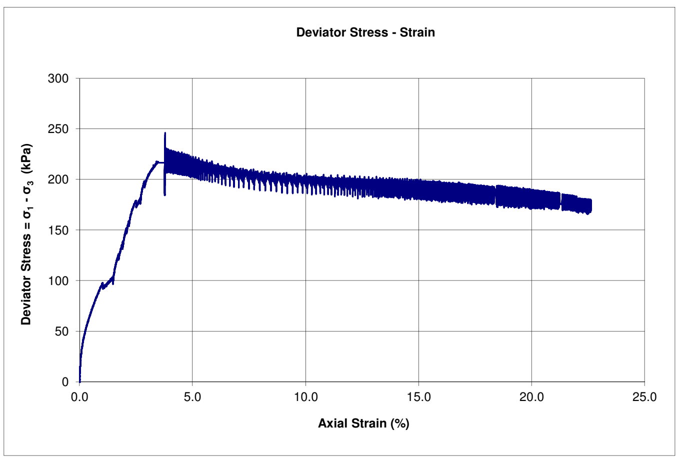
Cyclic Triaxial Test - Chart 1

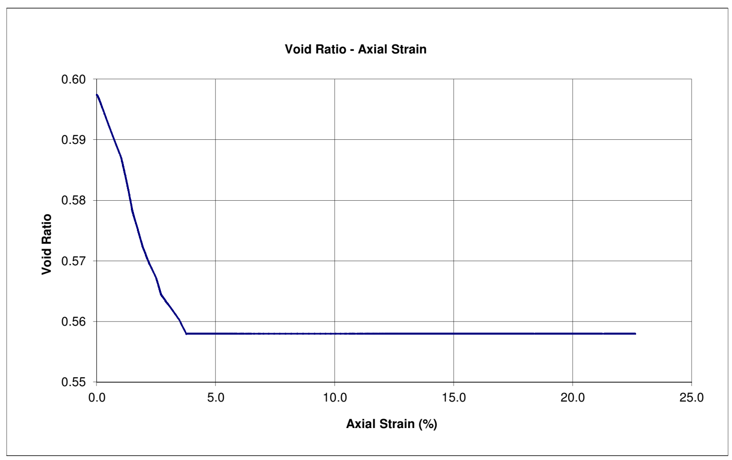
(ASTM D5311)

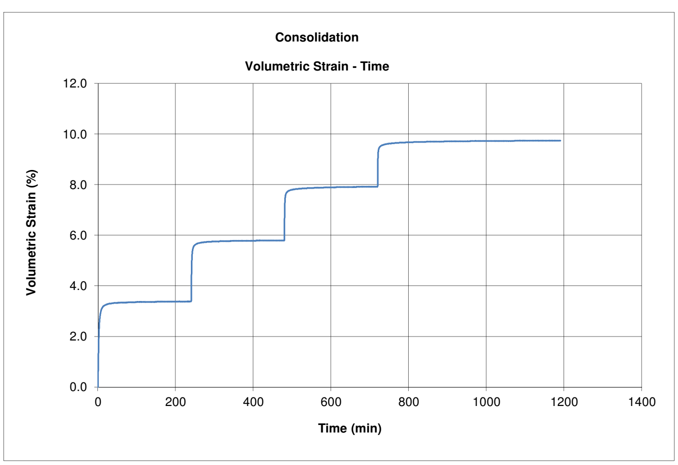
PROJECT NO. :	A03353A01	DATE :	2019-01-11
PROJECT :	Cadia Tailings Dam	TEST BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
Details:	ei = 1.0		

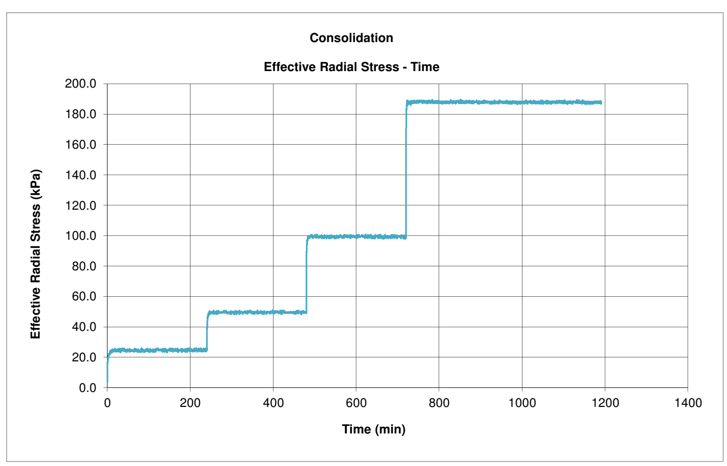










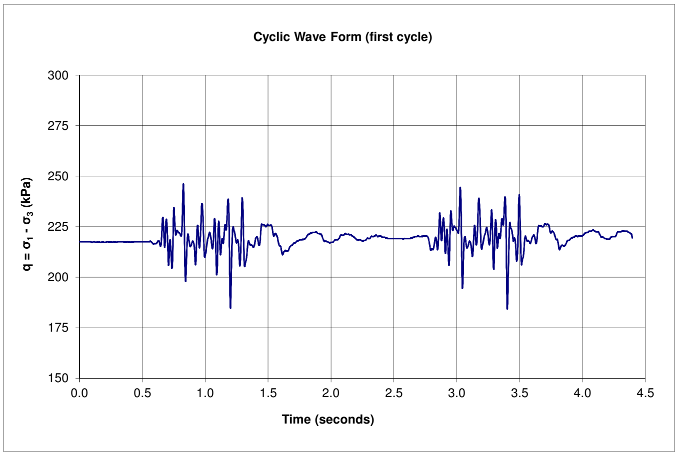


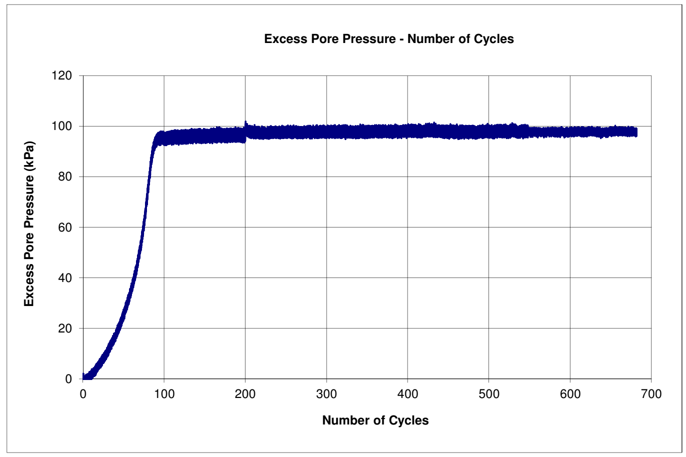
Klohn Crippen Berger

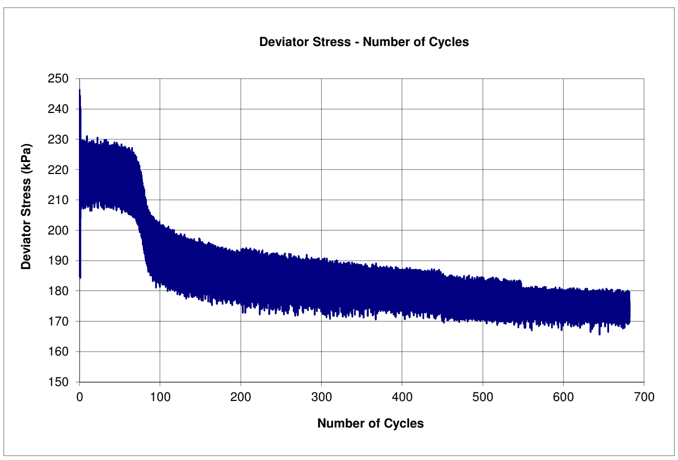
Cyclic Triaxial Test - Chart 1

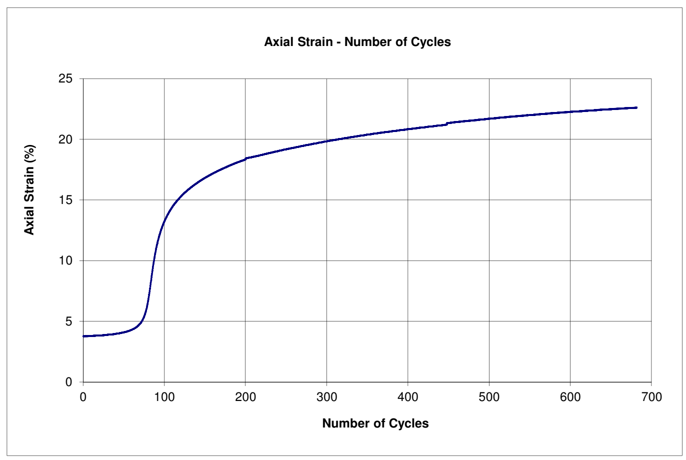
(ASTM D5311)

PROJECT NO. :	A03353A01	DATE :	2019-01-11
PROJECT :	Cadia Tailings Dam	TEST BY:	BY
SAMPLE :	Tailings	CHECKED BY:	JG
Details:	ei = 1.0		









Annexure EQ
Test Procedures

LABORATORY TESTING PROCEDURES

Laboratory testing of the tailings and foundation soils is undertaken according to the procedures provided in Table 1 and Table 2, respectively.

Table 1: Laboratory testing procedures for tailings characterisation

Test Name	Procedure
Sample Preparation	
Bulk Sample Preparation	GAPMW 1.1.2
Total Dissolved Solids Measurement of Bulk Sample	GAPMW 1.1.5
Triaxial Testing	
Specimen Preparation	
Moist Tamped Loose Specimen Preparation for Triaxial Testing	GAPMW 3.1.1
Moist Tamped Dense Specimen Preparation for Triaxial Testing	GAPMW 3.1.2
Testing	
Strain Controlled Triaxial Test of Moist Tamped Reconstituted Specimen Isotropically Consolidated	GAPMW 3.2.1
Constant Shear Drained Test with Servo Stress Controlled	GAPMW 3.2.4
Constant Shear Drained Test with Dead-Weight Stress Controlled	GAPMW 3.2.5
Cyclic Direct Simple Shear Testing	
Specimen Preparation	
Moist Tamped Loose Specimen Preparation for Direct Simple Shear Testing	GAPMW 4.1.1
Testing	
Cyclic Direct Simple Shear Test	GAPMW 4.2.2
Bender Elements Testing	
Shear Wave Velocity Measurement Using Bender Elements for Triaxial Test of Specimen Consolidated Anisotropically	GAPMW 3.4.2

Table 2: Laboratory testing procedures for foundation soil characterisation

Test Name	Procedure
Sample Preparation	
Bulk Sample Preparation	GAPMW 1.1.4
Tube Sample Preparation	GAPMW 1.2.1
Block Sample Preparation	GAPMW 1.2.2
Consolidation Testing	
Constant Rate of Strain Consolidation Test	GAPMW 2.1
Triaxial Testing	
Specimen Preparation	
Intact Specimen Preparation for Triaxial Testing	GAPMW 3.1.5
Testing	
Strain Controlled Triaxial Test of Intact Specimen Isotropically Consolidated	GAPMW 3.3.1
Direct Simple Shear Testing	
Specimen Preparation	
Compacted Specimen Preparation for Direct Simple Shear Testing	GAPMW 4.1.2
Intact Specimen Preparation for Direct Simple Shear Testing	GAPMW 4.1.3
Testing	
Monotonic Direct Simple Shear Test	GAPMW 4.2.1

Foundation Soils

GAPMW 1.1.4 – BULK SAMPLE PREPARATION

Scope

The purpose of this procedure is to provide the steps for preparation of a bulk sample to a target moisture content.

Equipment

The sample preparation was undertaken using a mixing tray.

Procedure

The sample preparation is undertaken using the following steps:

1) The received sample is emptied from the bucket and placed on a mixing tray (Figure 1).

2) The sample is mixed thoroughly and sealed in a sample bag. A subsample is taken to determine the initial moisture content of the sample.

3) Demineralised water is added to bring the sample to a target moisture content.

4) The sample is mixed thoroughly in the bag and left to cure. A subsample is taken to check the moisture content of the cured sample before testing.

Figure 1: Received sample placed on a mixing tray

GAPMW 1.2.1 – TUBE SAMPLE PREPARATION

Scope

The purpose of this procedure is to provide the steps for preparation of a tube sample for testing.

Equipment

The tube samples were extruded using a Geo-Con Universal Vertical Extruder (Figure 1).

Figure 1: Geo-Con tube sample extruder

Procedure

The sample preparation is undertaken using the following steps:

1) The end caps of the tube sample are removed, and the length of voids measured from both ends of the tube to estimate available sample length for testing.

2) The tube is inverted and positioned with the top facing downwards in the extruder.

3) The sample is slowly extruded from the bottom of the tube for triaxial and index testings. For direct simple shear and constant rate of strain consolidation testings, the sample is slowly extruded into a stainless-steel ring of the same diameter as the tube.

4) The extruded specimen is cut and trimmed to the required size for testing.

5) The trimmings are used for gravimetric water content measurements and the remaining trimmings sealed in a sample bag for index testing.

6) The tube is wrapped with cling film, covered with end caps and stored for further testing.

Pictures of this procedure are provided in Figure 2 to Figure 7.

Figure 2: As received tube sample

Figure 3: Top end of tube

Figure 4: Bottom end of tube

Figure 5: Sample extruded for triaxial testing

Figure 6: Sample extruded into a stainless-steel ring for DSS and CRS testings

Figure 7: Trimming of specimen to required size for testing

GAPMW 1.2.2 – BLOCK SAMPLE PREPARATION

Scope

The purpose of this procedure is to provide the steps for preparation of a block sample for testing.

Equipment

The block samples were prepared using stainless-steel coring rings and scalpel (Figure 1).

Figure 1: Stainless-steel coring ring and scalpel

Procedure

The sample preparation is undertaken using the following steps:

1) The box is opened from the top to access the block sample.

2) Specimens are carefully cored from the surface of the block sample using stainless-steel coring rings and a scalpel.

3) The cored specimens are cut and trimmed to the required size for testing. The trimmed specimens are wrapped with cling film and stored in a sealed bag.

4) The trimmings are used for gravimetric water content measurements and the remaining trimmings sealed in a sample bag for index testing.

5) The block sample is wrapped with cling film and aluminium foil. The top of the box is sealed, and the block sample stored for further testing.

Pictures of this procedure are provided in Figure 2 to Figure 6.

Figure 2: As received block sample

Figure 3: Accessing block sample from the top of box

Figure 4: Coring specimen from block sample

Figure 5: Cored specimens: before coring (left) and after coring (right)

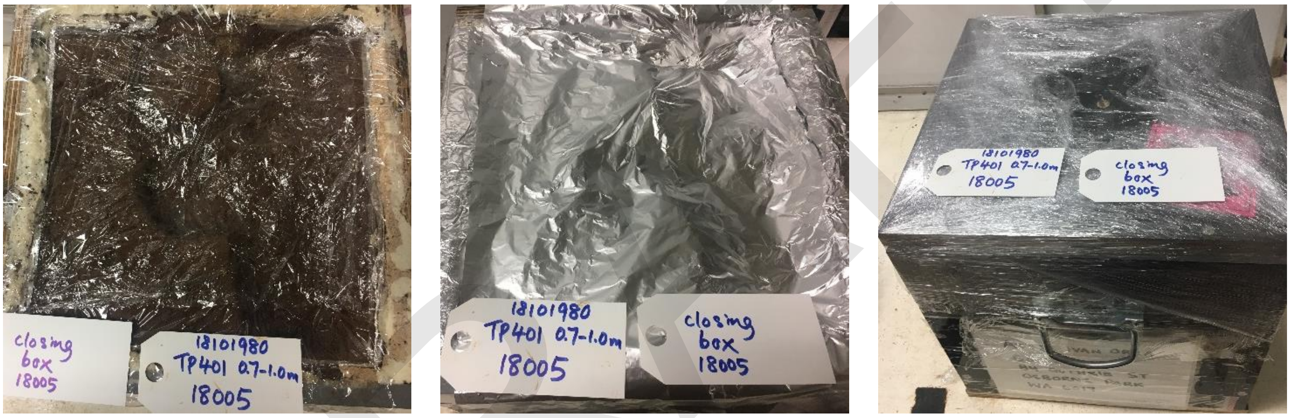


Figure 6: Wrapping and sealing block sample after coring

GAPMW 2.1 – CONSTANT RATE OF STRAIN CONSOLIDATION TEST

Scope

The purpose of this procedure is to provide the steps for undertaking constant rate of strain (CRS) consolidation testing. CRS testing can be undertaken significantly faster than a conventional oedometer as the typical rule of loading stages of 24 hours duration is not required. During the test the specimen is loaded continuously maintaining an approximate constant axial strain rate. During axial loading, excess pore pressure is allowed to develop at the base of the specimen to allow inference of hydraulic conductivity and coefficient of consolidation. The hydraulic conductivity can be also directly measured by undertaking constant head permeability testing at different loading stages, from the base pump to the top surface of the specimen.

Equipment

The CRS test is undertaken in a GDS automatic oedometer device, with the software capable to undertake CRS testing. Testing is undertaken in accordance with ASTM D4186[1]. The device is provided of a 50kN load frame, fully enclosed stainless-steel cell, cell and base pumps, pore pressure differential transducer (PPT) mounted at the base of the cell, 5 mm spring-loaded LVDT displacement sensor and 32 kN capacity submersible load cell. The GDS automatic oedometer is illustrated in a picture and schematically in Figure 1. The GDS automatic oedometer device is equipped of a stepper motor driven unit controlled either manually or from a PC. A CRS cell is fitted on the loading pedestal. The CRS cell is similar to a conventional triaxial cell as both cells are closed to the external environment allowing the cell to be entirely filled with water. However, in a CRS cell the specimen is exposed to the cell pressure, while in a triaxial cell, the specimen is separated from the cell environment by a membrane.

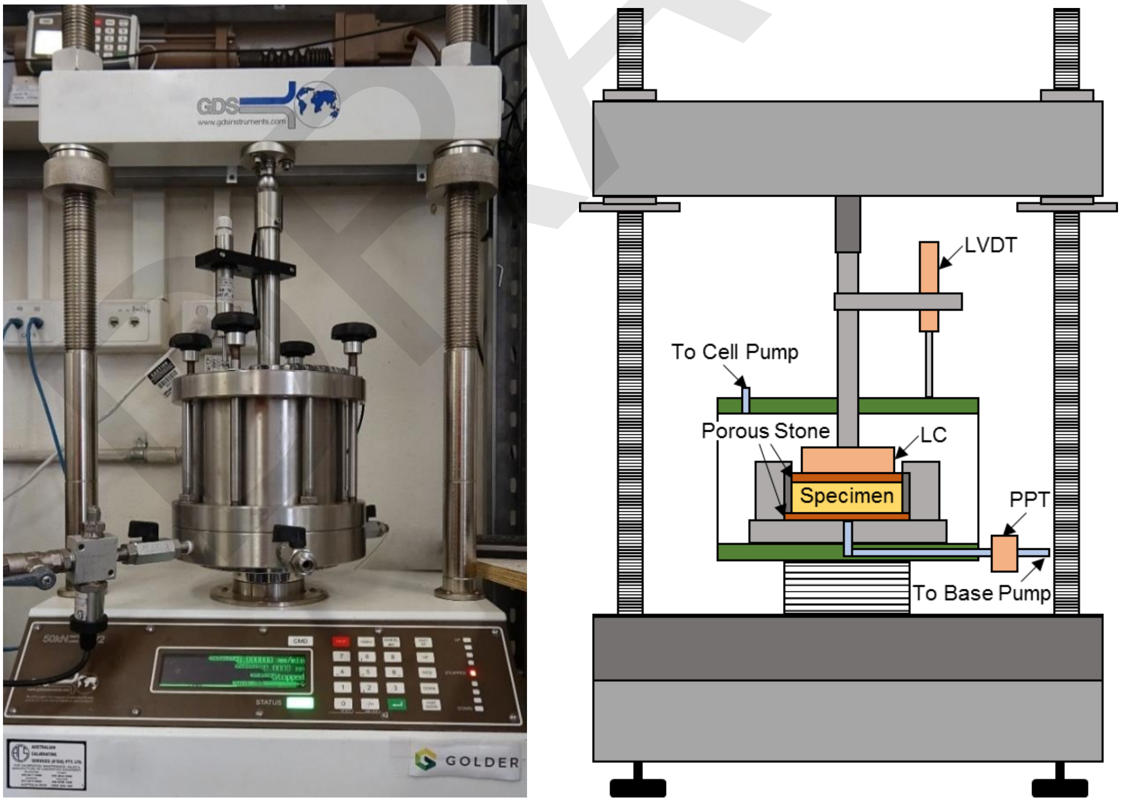


Figure 1: GDS load frame with stainless-steel CRS cell (left) and schematic of CRS testing device (right)

[1] ASTM D4186 / D4186M-12e1, Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading, ASTM International, West Conshohocken, PA, 2012, www.astm.org

Procedure

The CRS test is undertaken in a 60 mm diameter specimen. The specimen is restrained by a stainless-steel ring provided of top and bottom porous stones and filter papers. The base is separated from the cell environment via a system of sealing O-rings, allowing to measure excess pore pressure at the base of the specimen during axial loading. The specimen is confined in a stainless-steel chamber with axial stresses measured by a submersible load cell. Vertical strain is measured with a LVDT, pressures are provided by 3 MPa capacity pumps, while the specimen base pressure is measured using a pore pressure transducer.

The test is undertaken using the following steps:

1) The base porous stone and filter paper are placed dry on the CRS base to prevent swelling of the specimen.
2) The specimen is extruded from the tube[2] or cored from the block[3] sample and placed within a stainless-steel CRS ring. The top end of the specimen is trimmed to form a flat surface.
3) The top porous stone and filter paper are placed dry on the top end of the specimen inside the CRS ring and the bottom end of the specimen is trimmed to the size required for the testing.
4) Trimmings are taken during specimen preparation from both ends of the specimen to enable measurement of the initial gravimetric water content.
5) The specimen mass is taken, and initial height measured using a digital calliper.
6) The specimen is placed on the base porous stone and filter paper.
7) The remaining CRS components including the sealing O-rings are assembled (**Error! Reference source not found.**).
8) The CRS cell is closed and a seating load of 10 kPa applied.
9) The test commenced, and the stress is increased to 25 kPa and left to consolidate under this load.
10) The cell is flushed with CO_2 for approximately 1 hour and then flooded with deaired demineralised water under constant height conditions.
11) Back pressure is ramped up to 500 kPa over a period of time depending on material type under double drainage and constant height conditions. If the stress dropped below 25 kPa, the back pressure saturation is interrupted to bring the stress back to 25 kPa before continuing saturation.
12) Once back pressure saturation is completed, constant head permeability test is undertaken under 25 kPa constant stress.
13) The constant rate of strain test is undertaken by targeting an axial strain rate until a target stress is achieved. The strain rate is guessed based on material type with the intent to provide excess pore pressure ratio (Ru = excess pore pressure / total stress) within 3% – 15%.
14) Unloading and reloading loop from 400 kPa to 100 kPa is undertaken.
15) The constant rate of strain test is continued to a target vertical stress of 3000 kPa.

[2] GAPMW 1.2.1 Tube Sample Preparation
[3] GAPMW 1.2.2 Block Sample Preparation

16) Once the target vertical stress is achieved, the total vertical stress is maintained, and constant head permeability test is undertaken.

17) The specimen and cell pressures are finally unloaded, and the CRS disassembled.

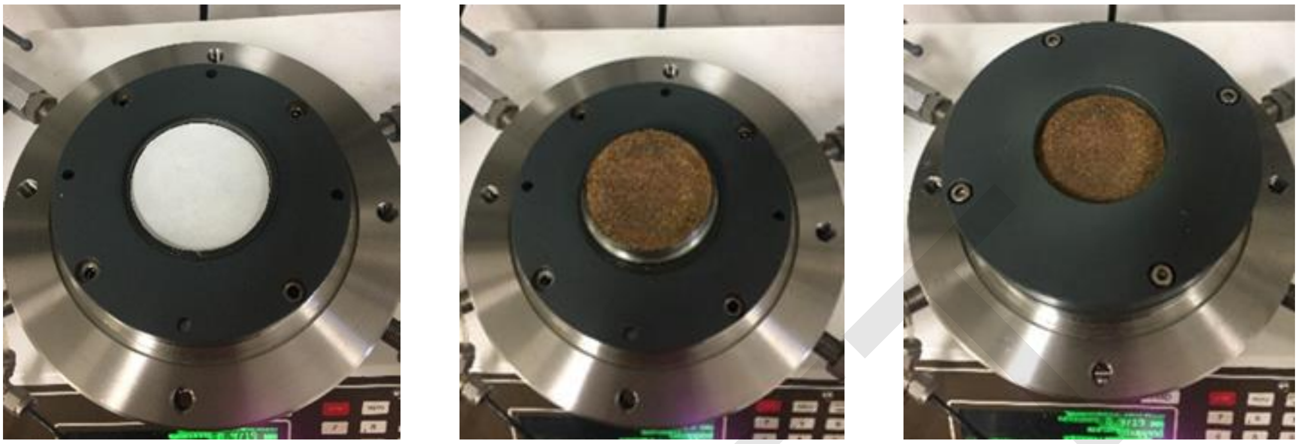


Figure 2: CRS test device setup: base porous stone and filter paper (left), specimen in stainless-steel ring with top porous stone and filter paper (middle), sealing components assembled (right)

GAPMW 3.1.5 – INTACT SPECIMEN PREPARATION FOR TRIAXIAL TESTING

Scope

The purpose of this procedure is to prepare an intact (undisturbed) specimen for triaxial testing. The specimen is generally extruded from a tube or cored from a block sample.

Equipment

The preparation is undertaken using a scalpel, split mould and membrane stretcher (Figure 1). Standard triaxial end caps (Figure 2) are used in this procedure.

Figure 1: Scalpel and split mould to trim specimen (left) and membrane stretcher (right)

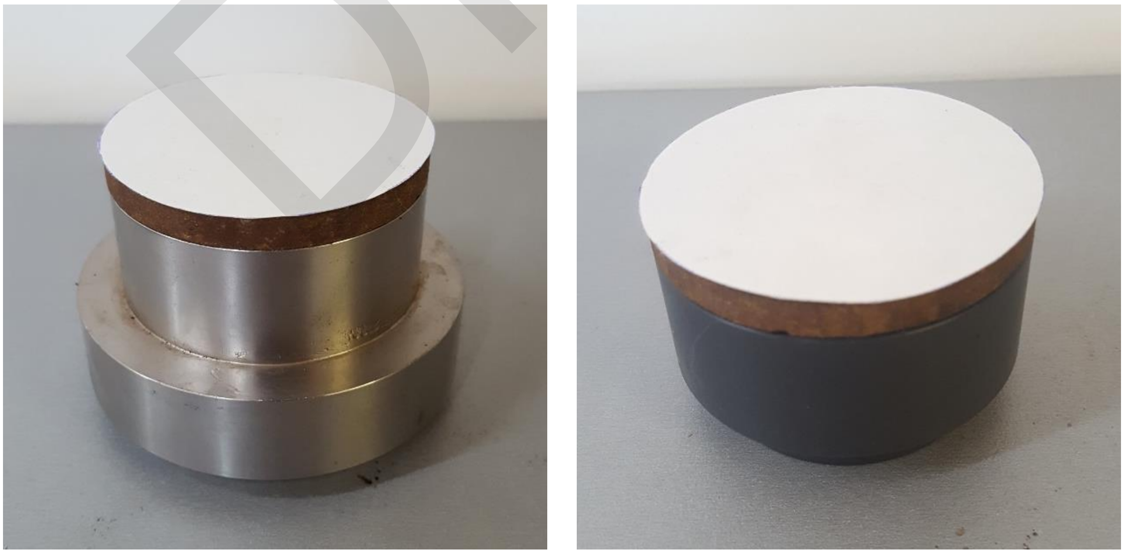


Figure 2: Standard triaxial end caps with porous stones and filter papers

Procedure

The following steps are undertaken to prepare the intact specimen:

1) The specimen extruded from the tube sample[1] is trimmed to a height of approximately 2 times the specimen diameter using a scalpel and a split mould to hold the specimen.

2) Initial specimen mass is measured and the dimensions taken using a digital calliper measuring both diameter and height at different locations.

3) Porous stone and filter paper are placed dry (to reduce initial swelling) on the bottom end cap and the specimen is placed on top.

4) A membrane is placed around the specimen using a membrane stretcher and sealed to the bottom end cap with sealing grease and O-rings.

5) Top filter paper and porous stone are placed dry on the specimen. The top end cap is added and the membrane is sealed.

6) The triaxial device is assembled and the cell filled with water.

The typical specimen during and after preparation is shown in Figure 3.

Figure 3: Specimen placed on bottom end cap (left) and specimen sealed with membrane and O-rings (right)

[1] GAPMW 1.2.1 Tube Sample Preparation

GAPMW 3.3.1 – STRAIN CONTROLLED TRIAXIAL TEST OF INTACT SPECIMEN ISOTROPICALLY CONSOLIDATED

Scope

Triaxial testing involves the preparation of a cylindrical specimen of material, wrapped in an impervious membrane. A confining stress is then applied to the specimen, and the material allowed to come to equilibrium under the applied stress. The initial stress can either be isotropic (the same all around the specimen), or K_0, which typically involves a higher vertical stress than horizontal stress on the specimen.

The purpose of this procedure is to undertake a strain controlled triaxial test of intact specimen extruded from a tube sample. Tests are undertaken consolidating a specimen isotropically and sheared under undrained strain control conditions.

Equipment

The tests were undertaken using a standard GDS triaxial device (Figure 1) with 50 kN digital load frame, 3 MPa 200 cc pressure volume controllers, submersible load cell, pore pressure transducer and linear variable displacement transducer.

Figure 1: Standard GDS triaxial device

Procedure

The test is undertaken using the following steps:

1) The specimen is prepared using the intact specimen preparation procedure[1].

2) The cell and back pressure are increased to promote back pressure saturation of the specimen. Ramping of the cell and back pressure is undertaken typically within a period of 24 hours. A back pressure of 500 kPa was generally used. During this process, an approximate difference between cell and back pressure of 20 kPa is maintained, to prevent the specimen being subjected to significant effective stresses.

3) Once the target saturation back pressure is reached and volume change is negligible, degree of saturation is assessed performing a B-value check. For this, the specimen drainage valves are closed, and an all-around pressure is applied to the specimen while monitoring and recording the pore pressure response at the base of the specimen. All tests undertaken in this study obtained a B-value of 0.95 or greater.

4) The specimen is consolidated to the target stress in one step, via two stages, one undrained loading stage and a final drained dissipation stage. In the undrained loading stage, the specimen drainage valves are closed, and an isotropic confining pressure is applied to the specimen until the pore pressure response is steady. In the drained dissipation stage, the specimen drainage valves are opened to allow consolidation.

5) Once consolidation is complete, the specimen is sheared either drained or undrained depending on the desired test conditions. The specimen is generally sheared to a minimum of 20% axial strain or terminated before if significant deformation occurs.

6) After the test is completed, the specimen drainage valves are closed and the water in the cell is emptied.

7) The specimen is removed and end of test moisture content is taken. Area correction is applied based on the visually-observed shape of the deformed specimen at the end of shearing (i.e. right cylinder, parabola or slip plane).

The typical end of test specimen is provided in Figure 2.

[1] GAPMW 3.1.5 Intact Specimen Preparation for Triaxial Testing

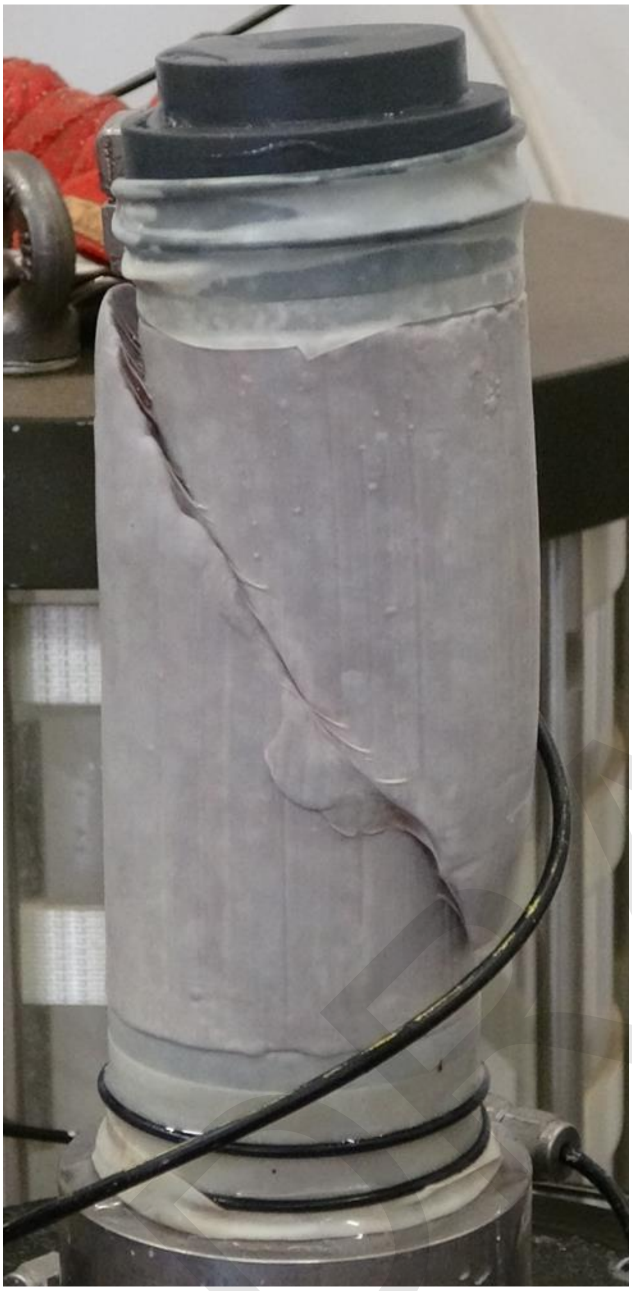


Figure 2: End of test typical deformed specimen with a slip plane

GAPMW 4.1.2 – COMPACTED SPECIMEN PREPARATION FOR DIRECT SIMPLE SHEAR TESTING

Scope

The purpose of this procedure is to prepare a compacted specimen for direct simple shear (DSS) testing.

Equipment

The preparation was undertaken using a special DSS mould designed to allow preparation of compacted specimen. This mould allows to undertake preparation of a specimen with accurate height control during compaction. The DSS mould is shown in Figure 1.

Figure 1: DSS mould for preparation of compacted specimen

Procedure

The specimen preparation is undertaken using the following steps:

1) The DSS is prepared with the rings and a latex membrane neatly fixed against the inner wall of the rings.

2) The top end platen is attached to the top cap of the mould and the DSS bolted to the base of the mould.

3) The sample is prepared to its optimum moisture content[1] and placed inside the DSS.

4) The sample is compacted to a known density (98% of standard maximum dry density) in one layer by lowering the top cap of the mould. The height and volume of the specimen is pre-determined by the inner dimensions of the DSS in the mould.

5) The DSS with compacted specimen is removed from the mould and finished to assemble to the device.

6) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of generally 25 kPa.

[1] GAPMW 1.1.4 Bulk Sample Preparation to Optimum Moisture Content

7) The DSS base is tightened via four screws located at each corner to the main device, the restraint arms to reduce specimen rotation during shear assembled and the test commenced.

The specimen preparation procedure is shown in Figure 2 to Figure 5.

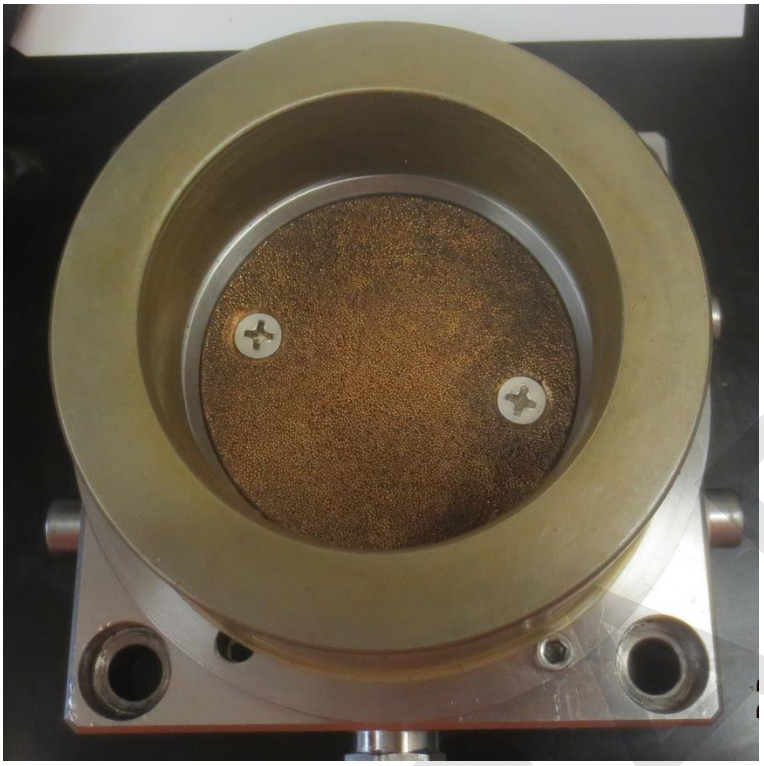


Figure 2: DSS prepared with rings and membrane

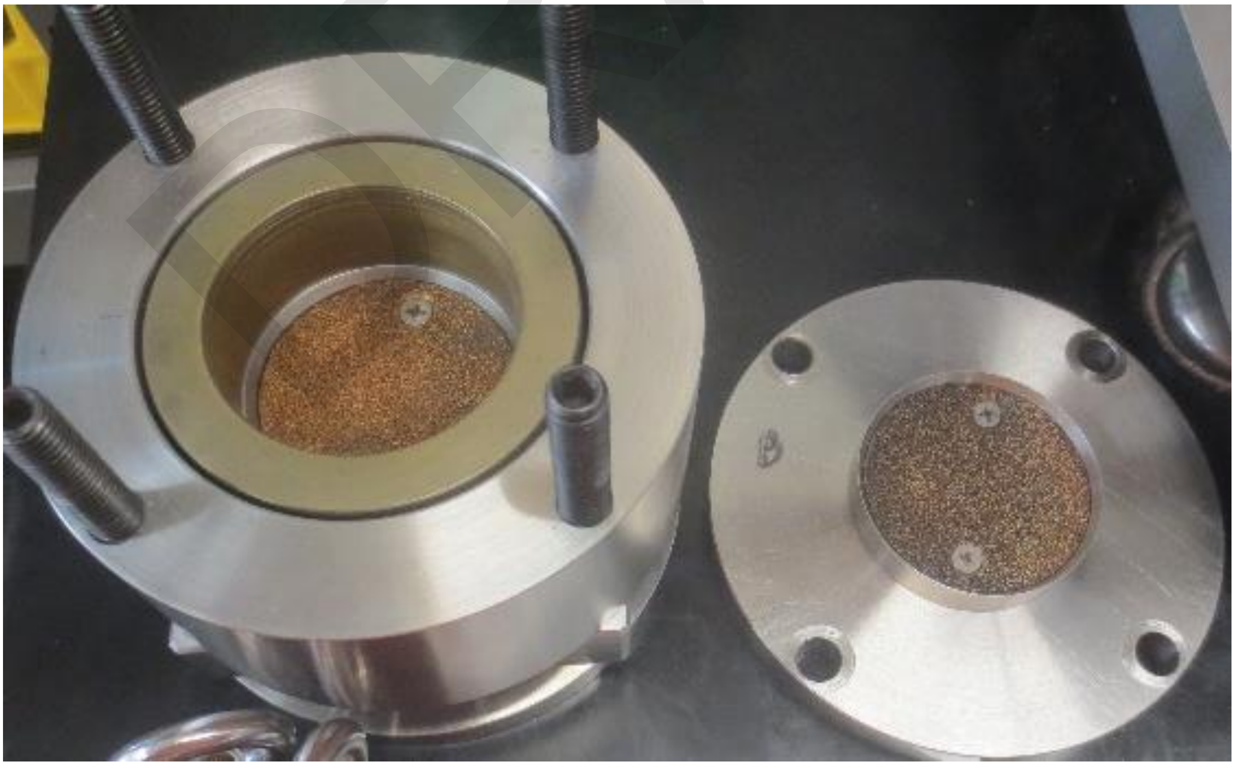


Figure 3: DSS bolted to the base of mould (left) and top end platen attached to top cap of mould (right)

Figure 4: DSS specimen inside compactor mould: before compaction (left) and after compaction (right)

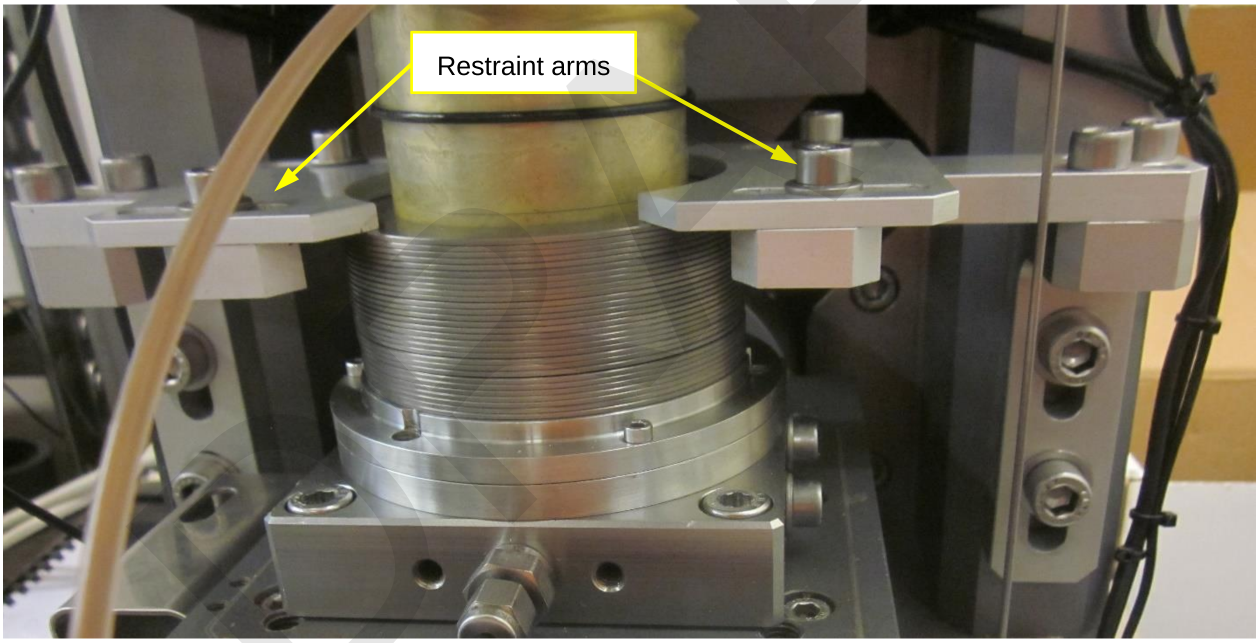


Figure 5: DSS device assembled with restraint arms mounted

GAPMW 4.1.3 – INTACT SPECIMEN PREPARATION FOR DIRECT SIMPLE SHEAR TESTING

Scope

The purpose of this procedure is to prepare an intact (undisturbed) specimen for direct simple shear (DSS) testing. The specimen is generally extruded from a tube or cored from a block sample.

Equipment

The preparation is undertaken using a scalpel and 60 mm diameter stainless-steel ring shown in Figure 1.

Figure 1: 60 mm diameter stainless-steel ring and scalpel

Procedure

The specimen preparation is undertaken using the following steps:

1) The specimen extruded from 63 mm diameter tube sample[1] is trimmed to a diameter of 60 mm using a scalpel and 60 mm diameter stainless-steel ring. The specimen from block sample[2] is cored directly into a 60 mm stainless-steel ring.
2) The top and bottom ends are trimmed to a specimen height of approximately 27 mm.
3) The specimen is placed on the bottom platen of the DSS and the latex membrane and rings are placed around the specimen.
4) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of generally 10 kPa.
5) The DSS base is tightened via four screws located at each corner to the main device, the restrain arms to reduce specimen rotation during shear assembled and the test commenced.

The specimen preparation procedure is shown in Figure 2 to Figure 5.

[1] GAPMW 1.2.1 Tube Sample Preparation

[2] GAPMW 1.2.2 Block Sample Preparation

Figure 2: Trimming specimen extruded from 63 mm diameter tube sample to 60 mm diameter

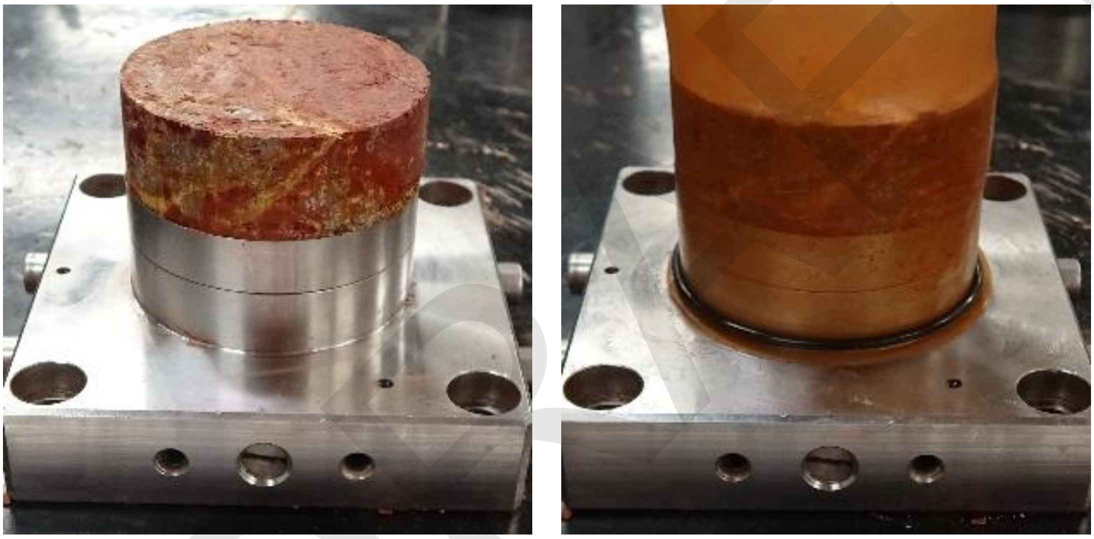


Figure 3: Trimmed specimen on DSS base platen (left) and covered with membrane (right)

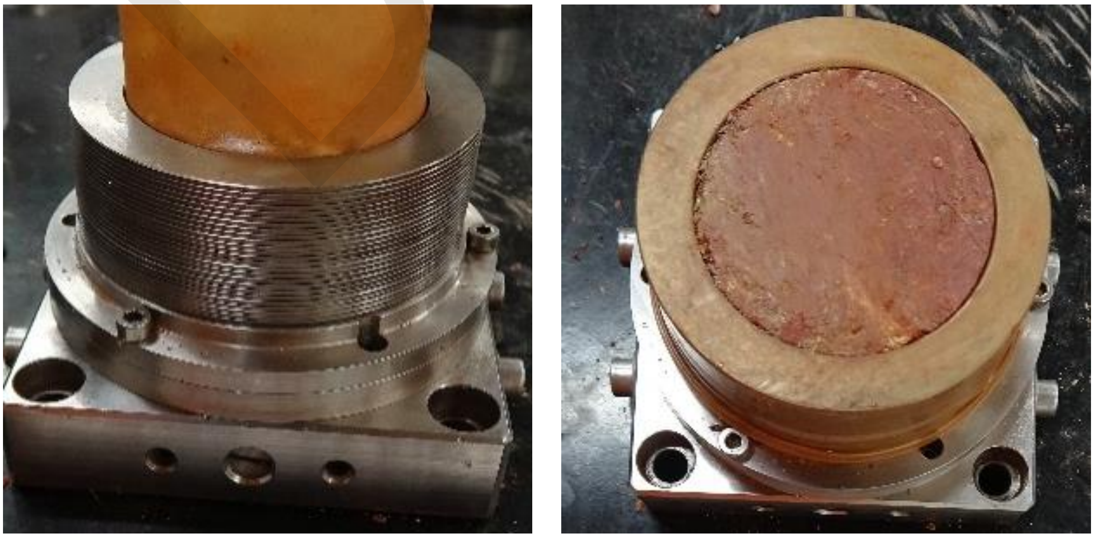


Figure 4: DSS rings in place (left) and membrane folded outwards for DSS device assembly (right)

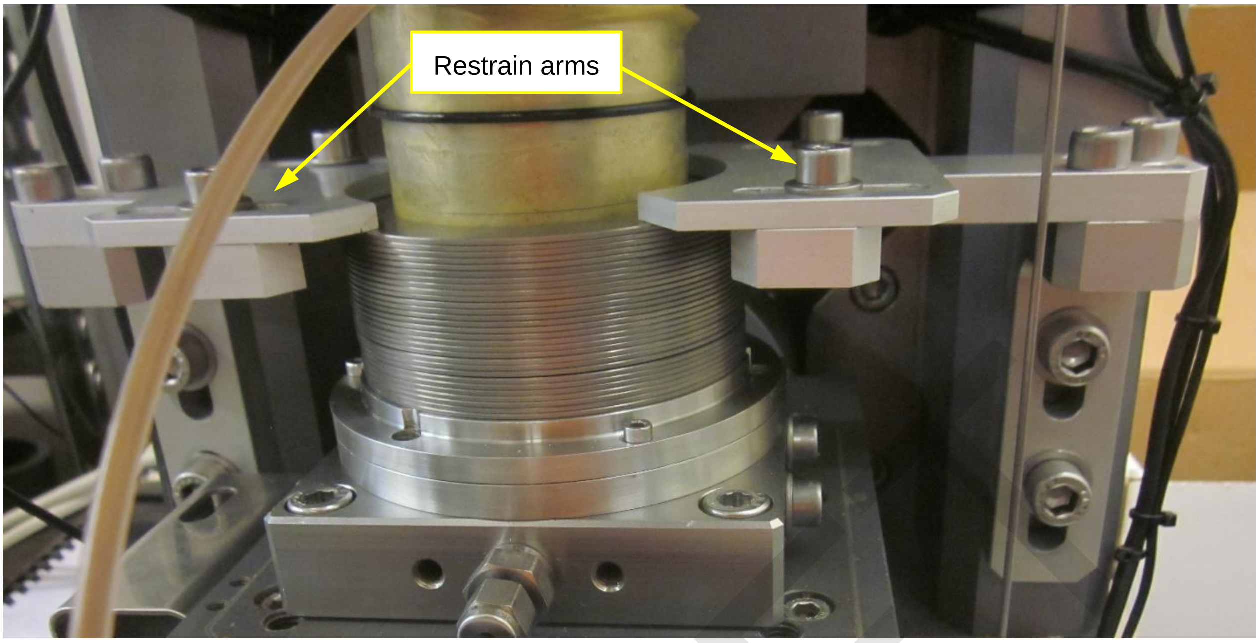


Figure 5: DSS device assembled with restrain arms mounted

GAPMW 4.2.1 – MONOTONIC DIRECT SIMPLE SHEAR TEST

Scope

Direct simple shear (DSS) testing involves preparation of a cylindrical specimen with a typical height to diameter ratio of about 0.4 within a membrane that is laterally constrained by a stack of low-friction metal rings. The material is vertically consolidated to the desired stress with or without an initial static shear stress (α, bias). Owing to the lateral restraint provided by the stack of rings, consolidation occurs under a K_0 condition (i.e. zero lateral strain). Once consolidation is completed, the specimen is sheared monotonically by moving the lower platen horizontally while the top platen remains still. Monotonic loading is analogous to static undrained loading, such as when undrained conditions initiate within contractive material.

It should be noted that while DSS testing provides undrained strength parameters, the test itself is not undrained. Rather than restrict drainage, constant volume conditions are enforced via computer control of the test. Should the specimen contract, the top platen would begin to move downwards, reducing the height of the specimen. However, the computer control system prevents this from occurring by reducing the vertical stress to maintain a constant height. The excess pore pressures that would have developed within the specimen can then be inferred from the changes in vertical stress required to maintain constant height. This testing method has been shown to provide the same results as tests with enforced drainage conditions (Finn 1985[1], Dyvik et al. 1987[2]).

Equipment

Specimens were tested using a GDS electro-mechanical dynamic cyclic simple shear (EMDCSS) system shown in Figure 1.

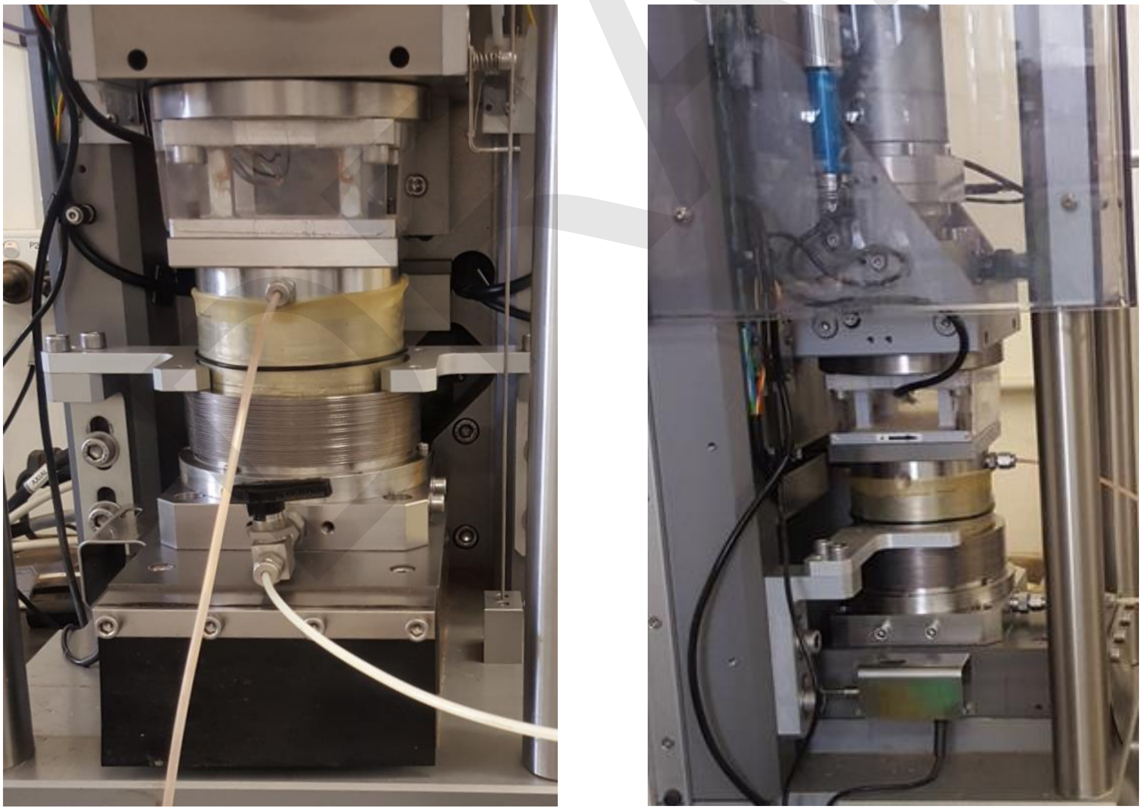


Figure 1: GDS electro-mechanical DSS device

[1] Finn, WDL 1985. Aspects of constant volume cyclic simple shear. Proceedings of Advances in the Art of Testing of Soils under Cyclic Conditions, pp 74-98 (ASCE, New York).

[2] Dyvik, R, Berre, T, Lacasse, S and Raadim, B 1987. Comparison of truly undrained and constant volume direct simple shear tests. Géotechnique, Vol 37, No 1, pp 3-10.

The device is capable of carrying out DSS testing under monotonic and cyclic conditions. The GDS DSS base and top platens are specially designed to allow saturation to occur by applying a flow, generally from the bottom of the specimen to its top via a pump or a water reservoir. Leaks are prevented introducing a series of O-rings at the base and top of the DSS platens and by placement of a sealing agent.

DSS testing is undertaken in 60 mm diameter compacted (bulk) and intact (tube or block) specimens using dead zone end platens (Figure 2 and Figure 3).

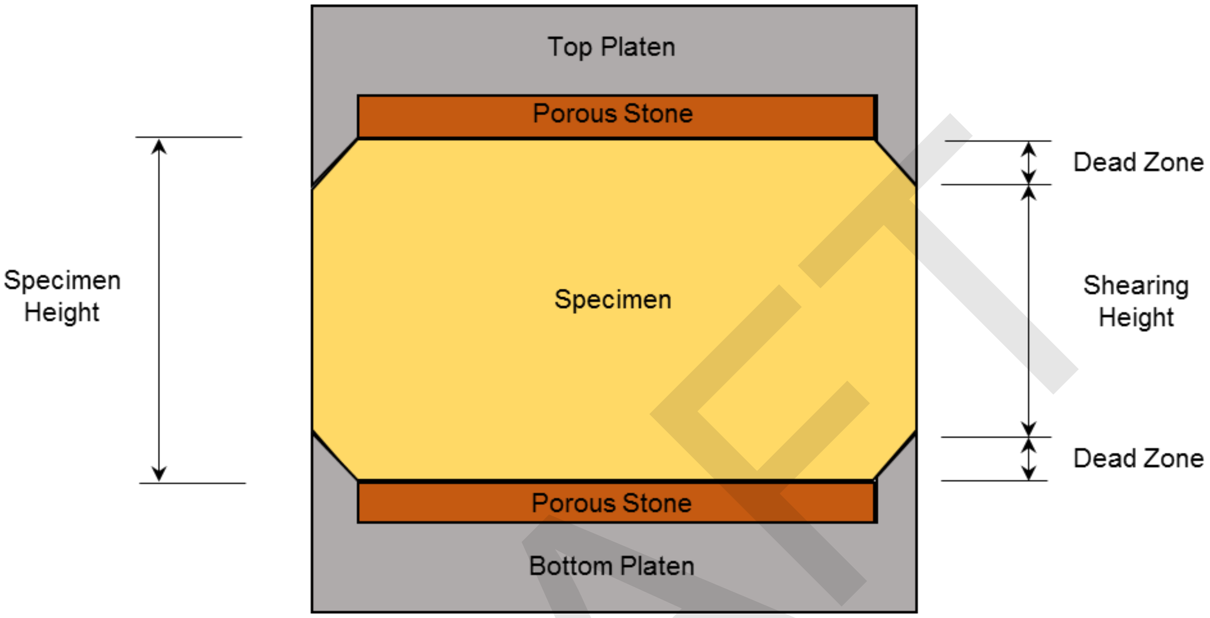


Figure 2: Schematic of DSS specimen between dead zone end platens

Figure 3: Dead zone end platen

Procedure

The test is undertaken using the following steps:

1) A specimen is prepared according to the compacted[3] or intact[4] specimen preparation procedures.
2) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of generally 10 kPa.
3) The initial specimen height is calculated based on height calibration undertaken using a block of known height, and the test is commenced.
4) The specimen is consolidated to the vertical effective stress for saturation and water is flushed through the specimen from the base to the top. If the sample appears saturated, the saturation step is not undertaken.
5) The specimen is consolidated to the target vertical effective stress in stages.
6) The specimen is sheared monotonically at a strain rate of around 2% per hour.
7) Once the test is completed, the DSS is dissembled, the specimen removed and dried in a 110°C oven to obtain the mass of dry solids and moisture content of the specimen.

The typical end of test specimen is provided in Figure 4.

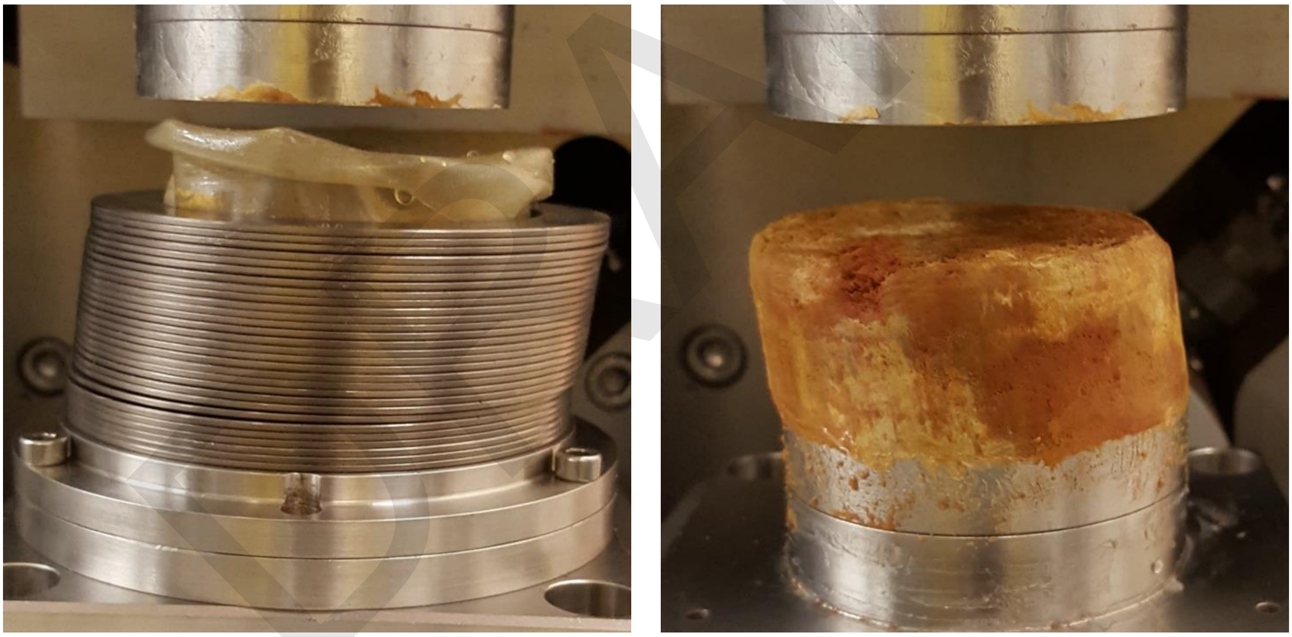


Figure 4: End of test specimen

[3] GAPMW 4.1.2 Compacted Specimen Preparation for Direct Simple Shear Testing
[4] GAPMW 4.1.3 Intact Specimen Preparation for Direct Simple Shear Testing

Tailings

GAPMW 1.1.2 – BULK SAMPLE PREPARATION

Scope

The purpose of this procedure is to provide the steps for preparation of a bulk sample to a homogeneous condition that is suitable for testing.

Equipment

The sample preparation was undertaken using a 40°C oven, drying trays and 2.36 mm opening size sieve.

Procedure

The sample preparation is undertaken using the following steps:

1) The received sample is emptied from the bucket, placed on drying trays and dried in a 40°C oven to a moisture content of around 7~12% or first prepared as a thick slurry by adding process water before drying.

2) The 40°C oven-dried moist sample is passed through a 2.36 mm opening size sieve, separating the agglomerates from the sieved material. The agglomerates are broken down by hand and re-sieved until all material passes through the sieve.

3) The sieved sample is mixed thoroughly and sealed in a sample bag for testing.

Pictures of this procedure are provided in Figure 1 to Figure 4.

Figure 1: Sample prepared as thick slurry

Figure 2: As received sample in drying trays

Figure 3: Sieving process

Figure 4: Sieved material

GAPMW 1.1.5 – TOTAL DISSOLVED SOLIDS MEASUREMENT OF BULK SAMPLE

Scope

The purpose of this procedure is to provide the steps to measure the total dissolved solids of a bulk sample.

Equipment

The test is undertaken using a funnel, filter paper, syringe and beakers.

Procedure

The test is undertaken using the following steps:

1) A subsample is taken from the sample prepared according to the bulk sample preparation procedure[1]

2) The specimen is placed in a beaker and dried in the 110°C oven

3) A known amount of demineralised water is added to the oven-dried specimen, mixed thoroughly, and left to settle

4) Clear solution is decanted using a syringe and filtered into another beaker through a funnel

5) The mass of the decanted solution is taken and the solution dried in the 110°C oven to determine the salt (dissolved solids) content

6) The total dissolved solids in the bulk sample is calculated from the salt content of decanted solution, amount of added demineralised water and the initial dry mass of the specimen.

Pictures of this procedure are provided in Figure 1 and Figure 2.

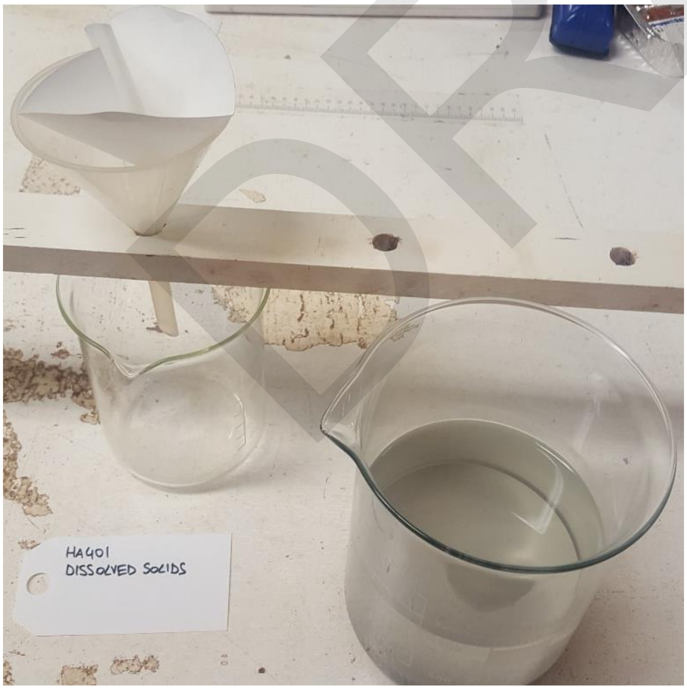


Figure 1: Filter-funnel setup and specimen before decanting

[1] GAPMW 1.1.2 Bulk Sample Preparation

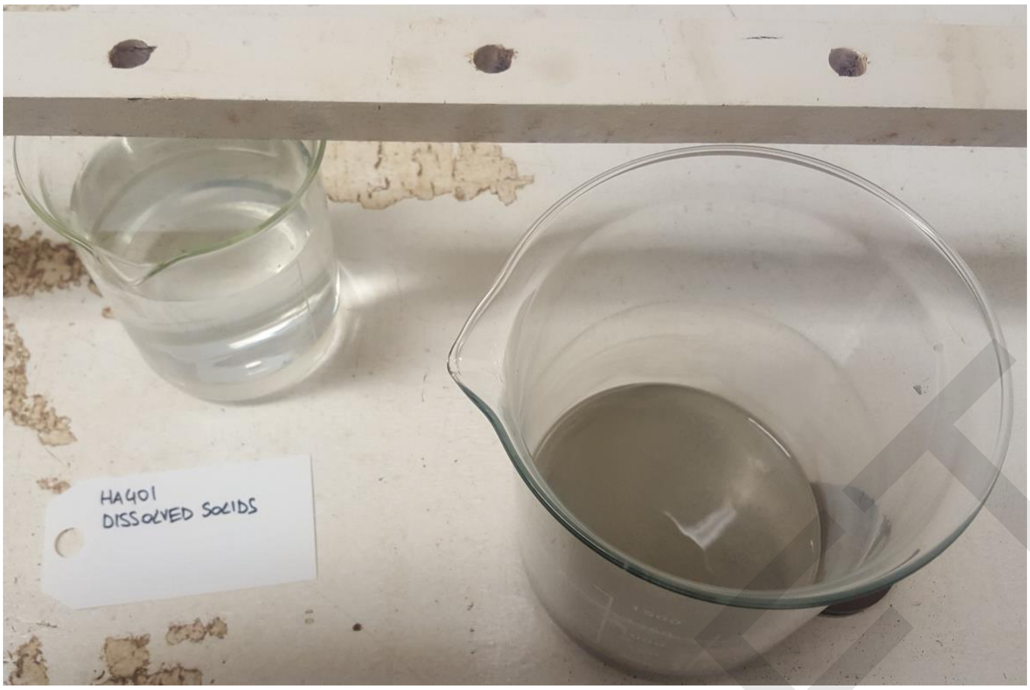


Figure 2: Decanted clear solution and specimen after decanting

GAPMW 3.1.1 – MOIST TAMPED LOOSE SPECIMEN PREPARATION FOR TRIAXIAL TESTING

Scope

The purpose of this procedure is to prepare a loose specimen using the moist tamping preparation technique for triaxial testing.

Equipment

The preparation is undertaken using a split mould to allow preparation of loose specimens of 72 mm diameter and 149 mm height.

To enable placement of a specimen into the freezer without transfer of the entire triaxial base, a specially designed modular base platen system is used. The modular base consists of:

1) A "cradle" that mounts to the triaxial base with a recess
2) A base platen that fits tightly within the cradle recess
3) A drainage line for the base of the specimen exiting from the side of the base platen
4) Additional valves connected to the top and bottom drainage lines, to allow sealing the specimen at locations closer than the outer drainage control valves of the triaxial cell and removal of the sample for freezing.

The split mould and modular base are shown in Figure 1 and Figure 2, respectively. The modular base and top cap are shown in Figure 3 to Figure 4.

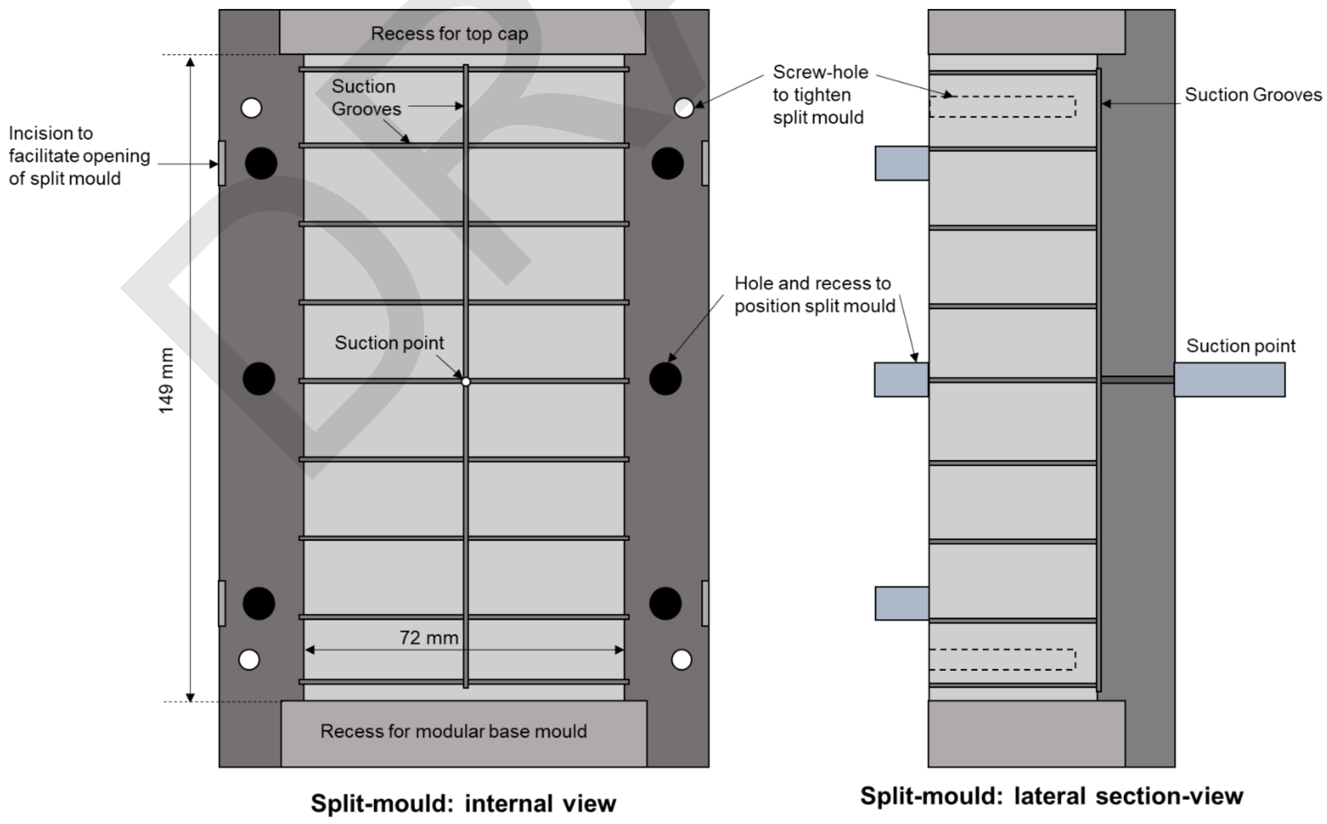


Figure 1: Split mould schematic view

Figure 2: Split mould internal (left) and external view (right)

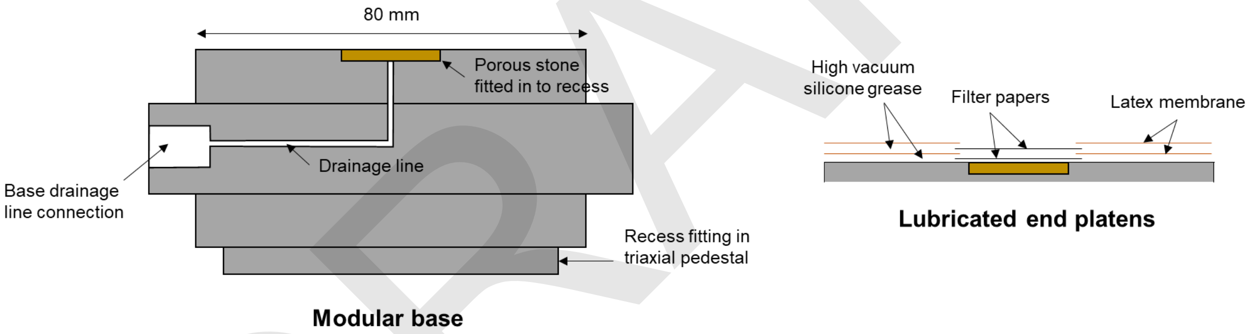


Figure 3: Modular base (left) and lubricated end platens (right)

Figure 4: Modular base with lubricated end platens (left) and top cap with lubricated end platens (right)

Procedure

The following steps are undertaken to prepare the loose moist tamped specimens:

1) Porous stones, filter papers and layers of trimmed latex membrane lubricated with high vacuum silicone grease are placed at the top and bottom end caps.

2) A cylindrical split mould is placed on the triaxial base pedestal with a membrane held against the walls of the mould by suction provided from a vacuum pump.

3) The sample is tamped using the undercompaction technique proposed by Ladd 1978[1] to promote a homogenous density along the specimen height. In this procedure, the sample is compacted in eight layers of equal thickness and varying masses.

4) Specimens are prepared tamping the material within the mould in eight layers using an under-compaction percentage of 10% for the first (bottom) layer and 0% for the final (top) layer (Figure 5).

5) Once the specimen is tamped, the top cap is placed and a suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during mould removal and test setup.

6) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different locations.

7) The triaxial device is assembled and the cell filled with water.

The under-compaction percentage adopted for the tamping of the loose specimens is provided in Figure 5. Pictures of this procedure are provided in Figure 6 to Figure 7.

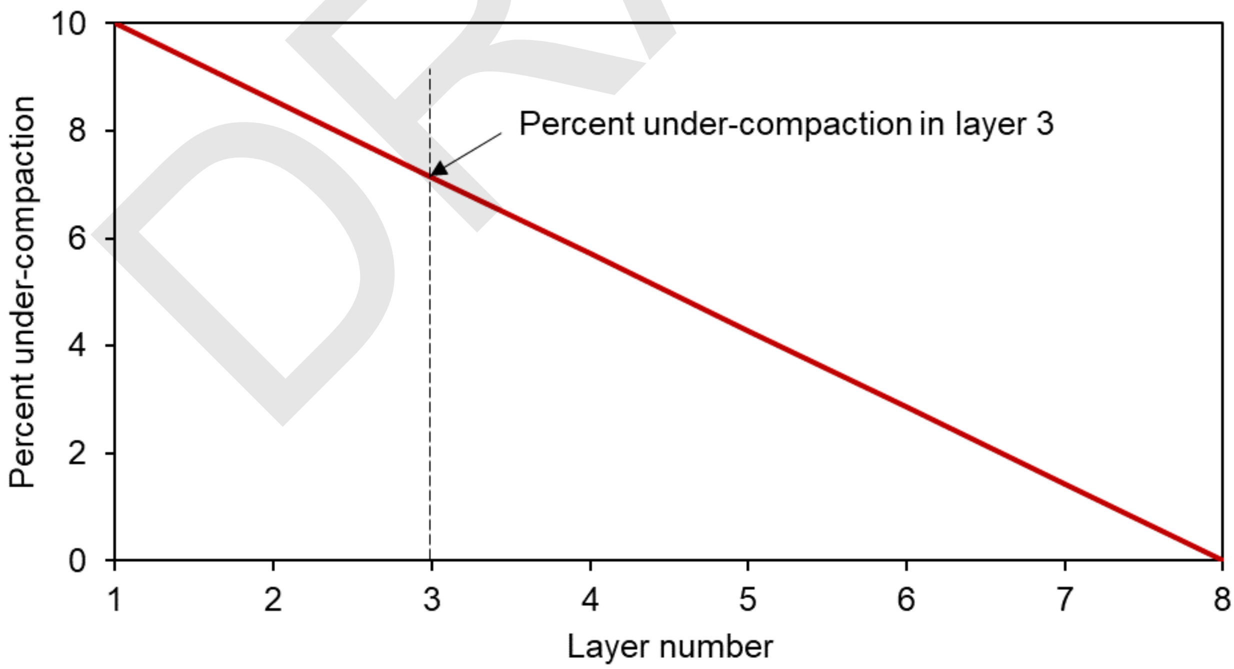


Figure 5: Under-compaction percent used for tamping of the loose specimens

[1] Ladd, R 1978. Preparing test specimens using undercompaction. Geotechnical Testing Journal, Vol 1, No 1, pp 16–23.

Figure 6: Split moulds with membrane under suction (left) and during specimen preparation with scarified layer prior tamping of next layer (right)

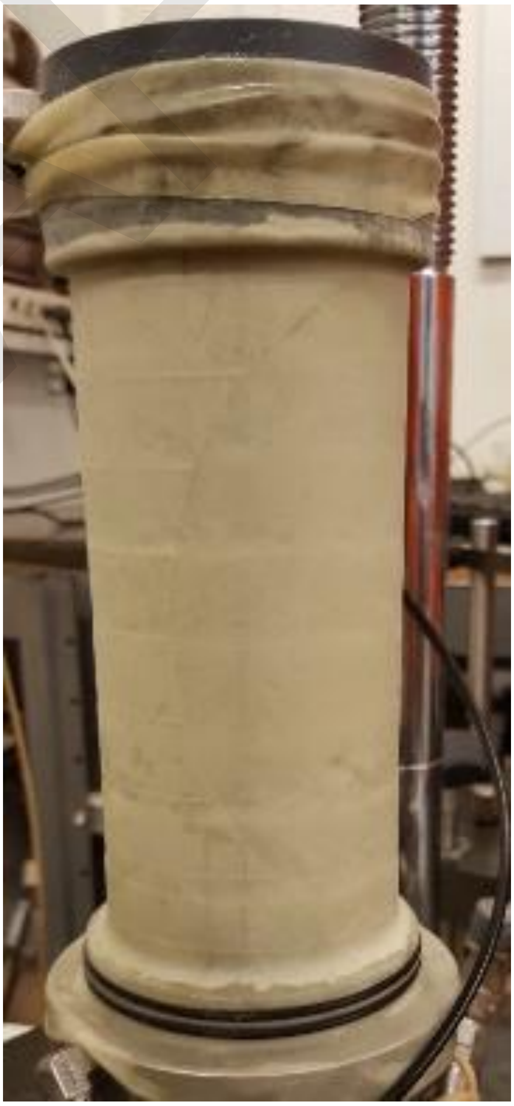


Figure 7: Tamped specimen prior placement of top cap (left) and with top cap after removal of split mould (right)

GAPMW 3.1.2 – MOIST TAMPED DENSE SPECIMEN PREPARATION FOR TRIAXIAL TESTING

Scope

The purpose of this procedure is to prepare a dense specimen, while avoiding the application of significant compaction stresses that may lead to an overconsolidated specimen after subsequent consolidation in a triaxial cell. The specimen is compacted by combining drop height compaction with gentle vibration of the mould.

Equipment

The compaction mould is designed to prepare the specimen in 8 layers, each with a height of 18 mm. Specimens are prepared to an approximate height of 144 and diameter of 63 mm.

A suction top cap typically used for undertaking extension triaxial testing is used in this procedure. The suction cap is used to limit the rotation of the top cap during shearing, thus forcing shearing to occur vertically. This allows shearing to continue to high strains even after shear bands develop in dense specimens.

The compaction mould developed for this process is schematically illustrated in Figure 1 and shown in Figure 2 to Figure 6.

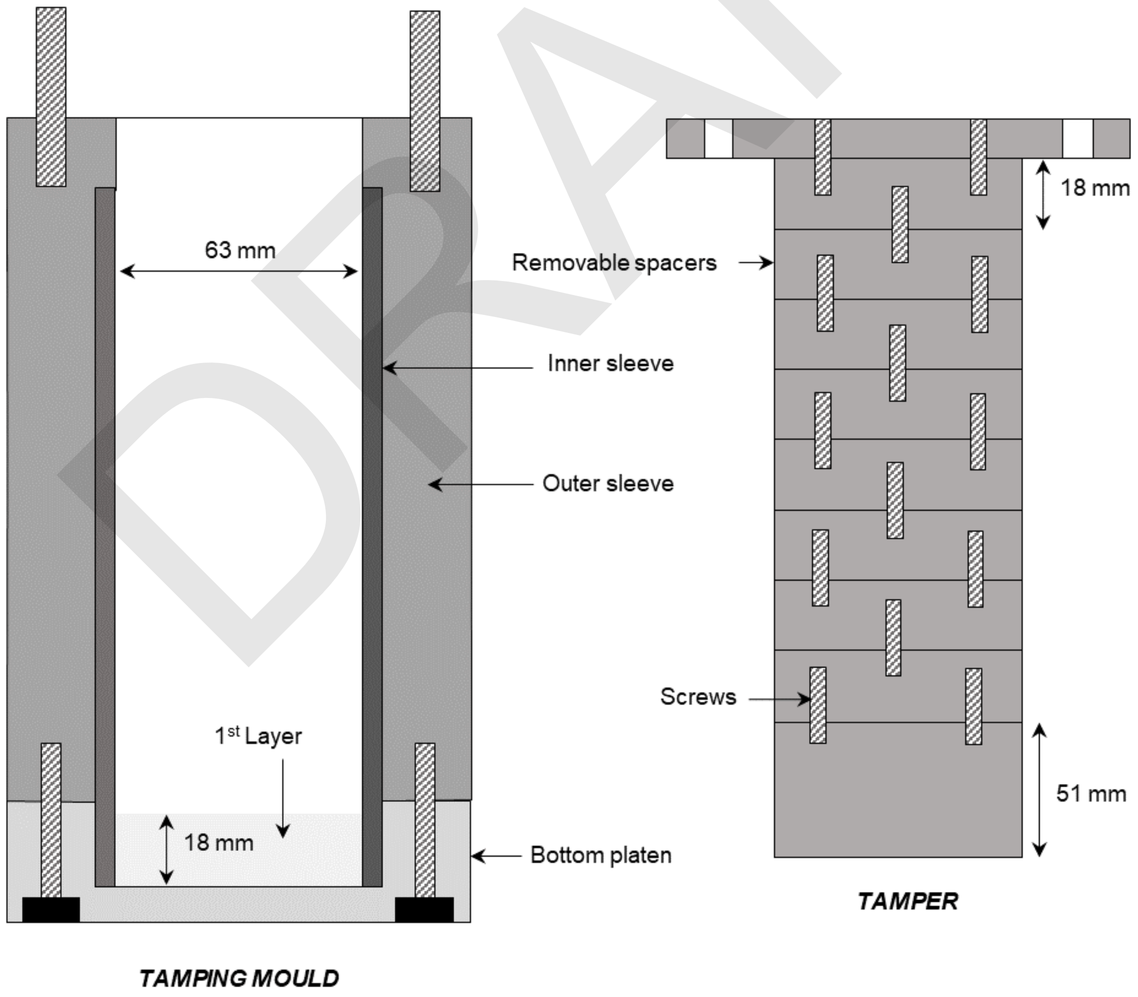


Figure 1: Tamper schematic view

Figure 2: View of different components of compactor: mould base platen with the inner sleave (left), outer sleave (middle) and adjustable height tamper with top platen to allow controlling the height (right)

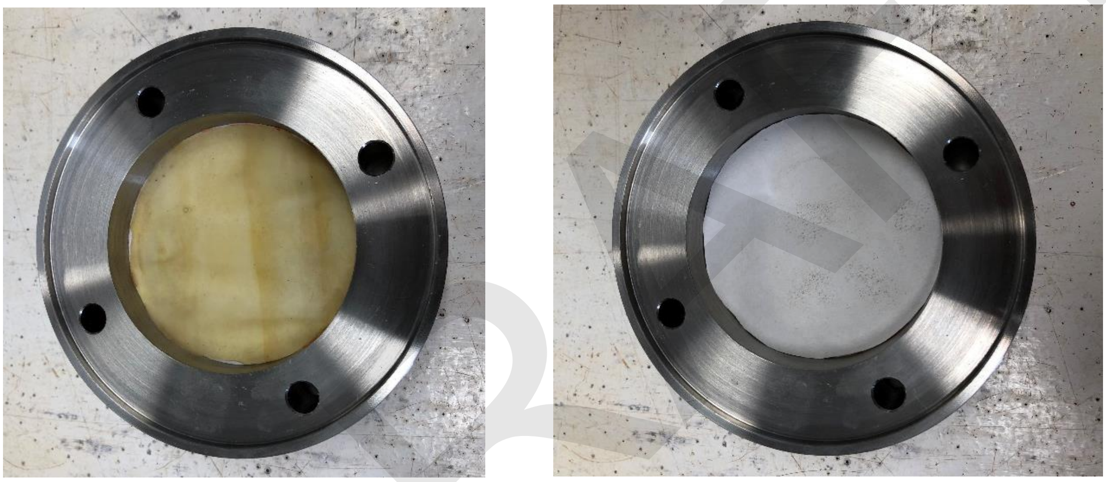


Figure 3: Mould base platen with sandwich of paper filter, latex membrane and paper filter at its bottom

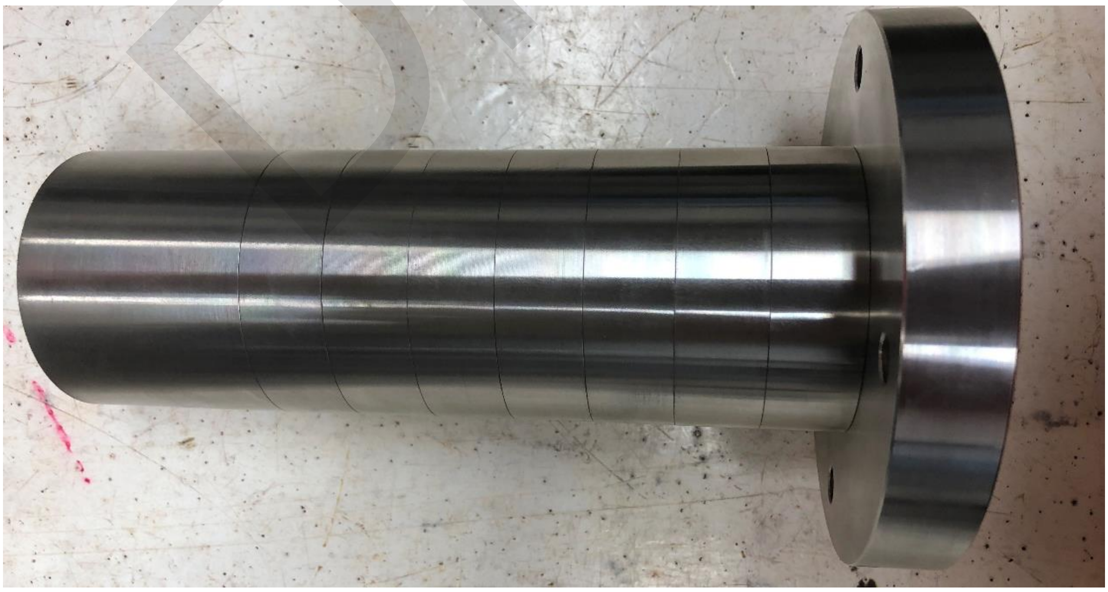


Figure 4: Tamper with top platen to allow controlling the tamping height

Figure 5: Tamper dismantled with various spacers

Figure 6: Tamper mounted with screws to allow dropping height control

Procedure

The following steps are undertaken to prepare the dense specimens:

1) The sample is prepared at a moisture content such that vibration will induce additional densification (i.e. wetter than typical moist tamping to produce loose samples)
2) Compaction is undertaken in eight layers using the Ladd undercompaction technique (Ladd 1978[1]) with an under-compaction percentage of 5% to 10% for the first (bottom) layer and 0% for the final (top) layer (Figure 7).
3) A sandwich of filter paper, latex membrane and filter paper is placed at the bottom of the mould to prevent the specimen from bonding to the mould, which could lead to damage of the specimen during subsequent extrusion
4) The inner sleeve is placed at the bottom of the mould
5) The outer sleeve encasing the inner sleeve is screwed to the bottom platen
6) The first layer is placed and gently levelled
7) The tamper is placed on top of the sample and tamping is provided by dropping the tamper from a height of approximately 2 cm or less, until compaction via drop height can no longer occur
8) The mould is then gently vibrated by providing horizontal manual rotations until the tamper is in contact with the edges of the outer mould, thus indicating that the target height has been achieved
9) If free standing water is present on the specimen surface, this is removed with a syringe
10) The first tamper spacer is unscrewed to allow the second layer to be tamped to its target height
11) Steps 6 to 10 are repeated until all layers have been compacted
12) The screws at the bottom of the compaction mould are removed and the inner sleeve housing the specimen taken out
13) The tamper's spacers are reassembled, the inner sleeve containing the specimen is placed within the tamper and left for a couple of hours to allow the draining of water from the specimen, thus allowing the specimen to become slightly unsaturated
14) The tamper is than used to extrude the specimen and the specimen trimmed as required to its target height for the testing
15) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different locations
16) Porous stones, filter papers and layers of lubricated trimmed latex membrane are placed at the top and bottom end caps
17) A latex membrane is placed around the sample sealed by O-rings
18) The triaxial device is assembled and the cell filled with water.

[1] Ladd, R 1978. Preparing test specimens using undercompaction. Geotechnical Testing Journal, Vol 1, No 1, pp 16–23.

The typical under-compaction percentage adopted for the tamping of the dense specimens is provided in Figure 7. Pictures of this procedure are provided in Figure 8 to Figure 10.

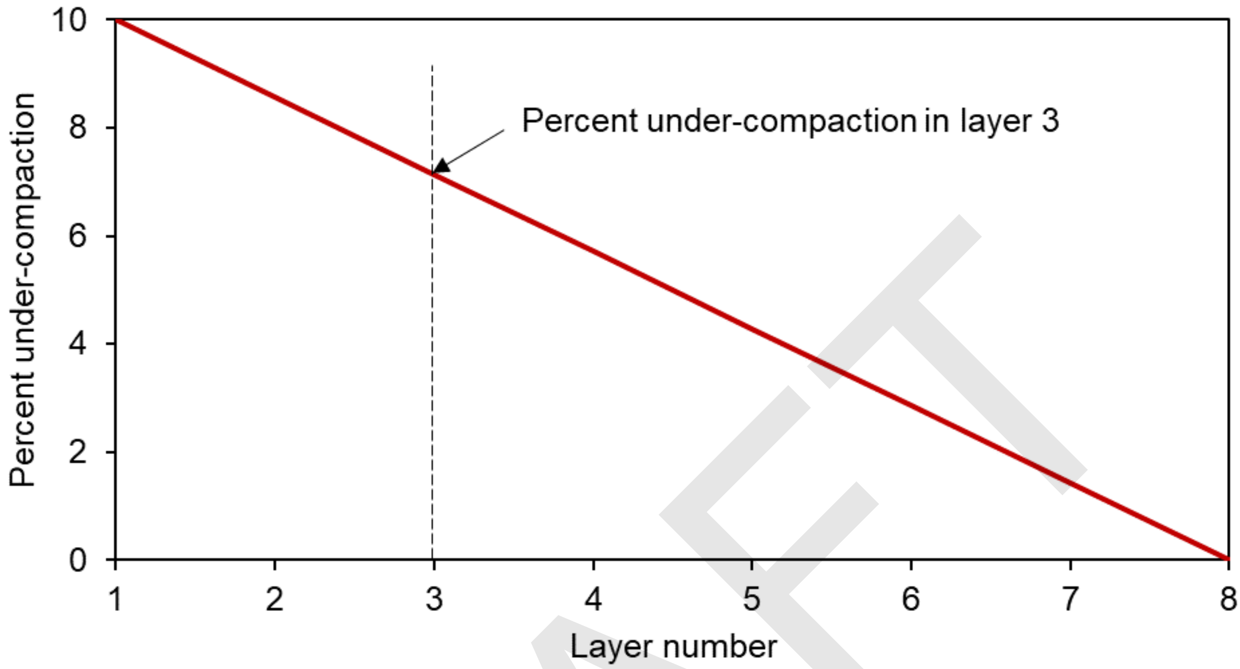


Figure 7: Typical under-compaction percent used for tamping of the dense specimens

Figure 8: Water at surface of sample at vibration of mould (left) and specimen after compaction inside inner sleeve

Figure 9: Specimen on top of tamper during water draining stage (left) and water draining from specimen (right)

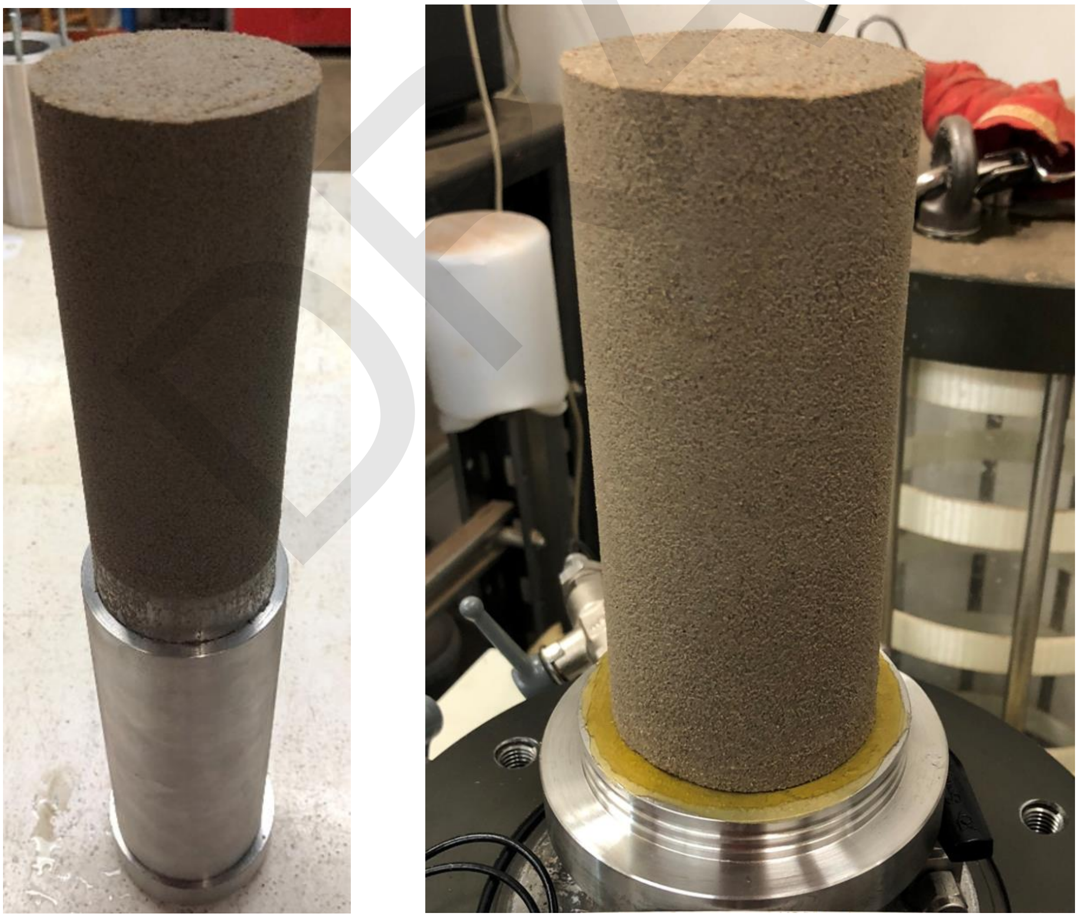


Figure 10: Specimen extruded using tamper (left) and sample on triaxial base platen (right)

Figure 11: Specimen with suction top cap assembled and inside cell

GAPMW 3.2.1 – STRAIN CONTROLLED TRIAXIAL TEST OF MOIST TAMPED RECONSTITUTED SPECIMENS ISOTROPICALLY CONSOLIDATED

Scope

Triaxial testing involves the preparation of a cylindrical specimen of material, wrapped in an impervious membrane. A confining stress is then applied to the specimen, and the material allowed to come to equilibrium under the applied stress. The initial stress can either be isotropic (the same all around the specimen), or K_0, which typically involves a higher vertical stress than horizontal stress on the specimen.

The purpose of this procedure is to undertake strain controlled triaxial test of specimen prepared using the moist tamping technique. The specimens are prepared using either the moist tamped loose or dense preparation procedures. Tests are undertaken consolidating a specimen isotropically and sheared under drained or undrained strain control conditions.

Equipment

The tests were undertaken using a standard GDS triaxial device (Figure 1) with 50 kN digital load frame, 3 MPa 200 cc pressure volume controllers, submersible load cell, pore pressure transducer and linear variable displacement transducer.

Figure 1: Standard GDS triaxial device

Procedure

The test is undertaken using the following steps:

1) The specimen is prepared using either the moist tamped loose[1] or dense[2] preparation procedures.

2) The moist tamped loose specimen is flushed with CO_2 for approximately 1 hour, followed by flushing with deaired deionised water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen. Flushing is carried out until bubbles are no longer observed leaving the top of the specimen. Flushing with CO_2 and deaired deionised water is not carried out for the dense specimens as these specimens are prepared in a near-saturated condition.

3) The cell and back pressure are increased to promote saturation of the material by forcing air into solution. Ramping of the cell and back pressure is undertaken typically within a period of six hours. During this process, an approximate difference between cell and back pressure of 20 kPa is maintained, to prevent the specimen being subjected to significant effective stresses.

4) Once the target saturation back pressure is reached, and volume change is negligible, degree of saturation is assessed performing a B-value check. For this, the specimen drainage valves are closed, and an all-around pressure is applied to the specimen while monitoring and recording the pore pressure response at the base of the specimen. All tests undertaken in this study obtained a B-value of 0.95 or greater, which indicated that the pore pressure response of the specimen was 95% or greater than of the applied load, indicating a material of sufficient saturation for testing.

5) The specimen is consolidated to the target stress in one step, via two stages, one undrained loading stage and a final drained dissipation stage. In the first stage, the specimen drainage valves are closed, and an isotropic confining pressure is applied to the specimen until the pore pressure response is steady. In the second stage, the specimen drainage valves are opened to allow consolidation.

6) Once consolidation is complete, the specimen is sheared either drained or undrained depending on the desired test conditions. The specimen is generally sheared to a minimum of 20% axial strain, to enable critical state conditions to be inferred where possible.

7) After the test is completed, the specimen drainage valves are closed and the water in the cell is emptied.

8) The specimen void ratio is determined by measuring moisture content at the end of test, adopting the freezing method (Sladen and Handford, 1987[3]) which involves carefully removing the specimen from the triaxial apparatus and freezing the specimen with the membrane, caps and drainage lines attached to prevent any water loss.

9) Area correction is applied based on the visually-observed shape of the deformed specimen at the end of shearing (i.e. right cylinder or parabola).

[1] GAPMW 3.1.1 Moist tamped loose sample preparation for triaxial testing

[2] GAPMW 3.1.2 Moist tamped dense specimen preparation for triaxial testing

[3] Sladen J.A. and Handford G. (1987). A potential systematic error in laboratory testing of very loose sands. Canadian Geotechnical Journal, 1987, (24)3: 462-466

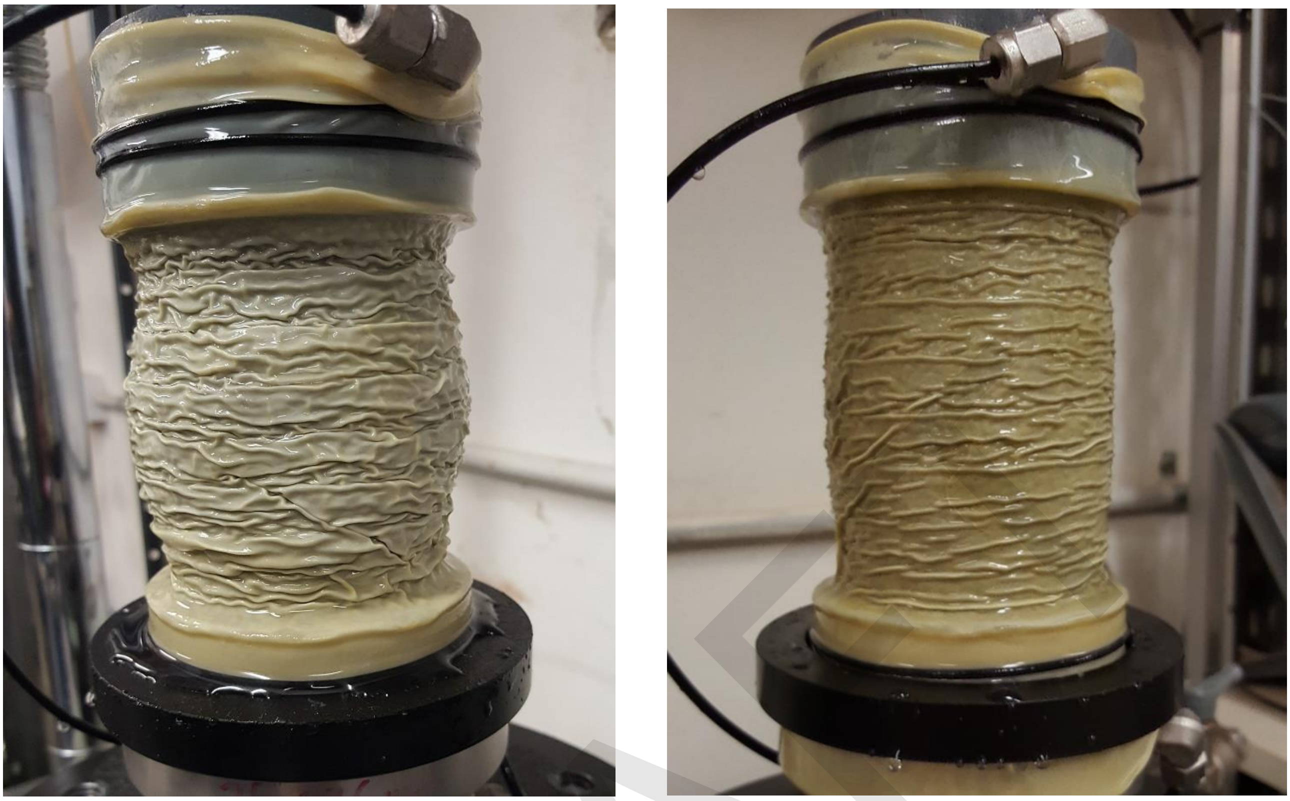


Figure 2: End of test typical deformed specimen to a parabola shape (left) and right cylinder shape (right)

Figure 3: Frozen specimen before removal of membrane and caps (left) and after (right)

GAPMW 3.2.4 – CONSTANT SHEAR DRAINED TEST WITH SERVO STRESS CONTROLLED

Scope

The purpose of this procedure is to provide the steps for undertaking constant shear drained (CSD) testing using a stress servo controller.

Equipment

A standard triaxial GDS device with an additional a servo controller is used to undertake the CSD collapse testing (Figure 1). The servo controller is a DigiRFM device manufactured by GDS which enables direct connection of the load cell and load frame (Figure 2). This direct linkage greatly increases the response time of the load frame. The DigiRFM allows via adjustment of the PID setting to achieve a maximum speed of the load frame of over 90 mm/min if the specified load suddenly reduces.

Figure 1: View of the GDS triaxial device

Figure 2: View of DigiRFM servo-controller mounted at the back of the load frame

Procedure

The test is undertaken using the following steps:

1) A specimen is prepared to its target density and consistency using the loose moist tamping preparation procedure.

2) A suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during test setup.

3) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different specimen locations

4) The triaxial device is assembled and the cell filled with water.

5) The specimen is flushed with CO_2 for approximately one hour.

6) The specimen is then flushed with water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen; flushing is carried out until bubbles are no longer observed to emerge from the pipe connected to the top of the specimen.

7) Back pressure saturation is undertaken over ~3 hours, maintaining a mean effective stress of 20 kPa.

8) Once the target saturation back pressure is reached, and volume change is negligible, a *B*-check is undertaken targeting a *B* value greater than 95%.

9) The specimen is then unloaded over ~3 hours to a cell pressure of 0 kPa and back pressure of -20 kPa.

10) The cell water is drained, the cell removed, and the specimen dimension taken using a digital calliper, to allow a more accurate measurement of specimen diameter for subsequent anisotropic consolidation.

11) The specimen is then reloaded following step 7.

12) The specimen is slowly consolidated anisotropically (i.e. confining and deviator stress increased) to its target K_0. The confining stress increase occurs at an approximate rate of 5 kPa per hour.

13) Once the target consolidation pressure is achieved, the specimen is left under the target anisotropic stress conditions for approximately 24 hours.

14) The CSD stage is then commenced by slowly increasing the back pressure at a rate of 15 kPa per hour. Test data are captured at intervals of one second, to provide stress conditions as close to failure as practicable.

15) Once failure occurs the specimen drainage valves are closed, and specimen void ratio determined by measuring its moisture content at the end of test, adopting the freezing method (Sladen and Handford, 1987[1]).

The CSD stage is video recorded with sound, to capture the rapid failure that initiates when the stress conditions reach the relevant instability stress ratio for the specimen's state.

The testing steps are provided in a diagram shown in Figure 3.

STEP 1. Specimen preparation

STEP 2. Suction applied to specimen to maintain its shape

STEP 3. Initial specimen dimensions taken

STEP 4. Assembling of triaxial device and specimen docking

STEP 5 and 6. CO_2 and water flushing

STEP 7. Back pressure saturation

STEP 8. B-Check

STEP 9. Unloading back pressure

STEP 10. Dissembling of triaxial cell and measure of new specimen dimensions for K_0 consolidation

STEP 11. Reloading back pressure

STEP 12. Anisotropic consolidation (15 kPa/hour)

STEP 13. Standby consolidation under K_0 for 24 hours

STEP 14. CSD stage increasing back pressure to 10-15 kPa/hour

STEP 15. Void ratio determination

Figure 3: CSD testing steps diagram

[1] Sladen J.A. and Handford G. (1987). A potential systematic error in laboratory testing of very loose sands. Canadian Geotechnical Journal, 1987, (24)3: 462-466

GAPMW 3.2.5 – CONSTANT SHEAR DRAINED TEST WITH DEAD-WEIGHT STRESS CONTROLLED

Scope

The purpose of this procedure is to provide the steps for undertaking constant shear drained (CSD) testing using a 'dead-weight' hanger system.

Equipment

A standard triaxial GDS device has been modified to undertake CSD collapse testing using dead-weights. The adjustments made to the standard triaxial device to allow CSD test to be undertaken are indicated in Figure 1. The system in use for a CSD test is shown in Figure 2.

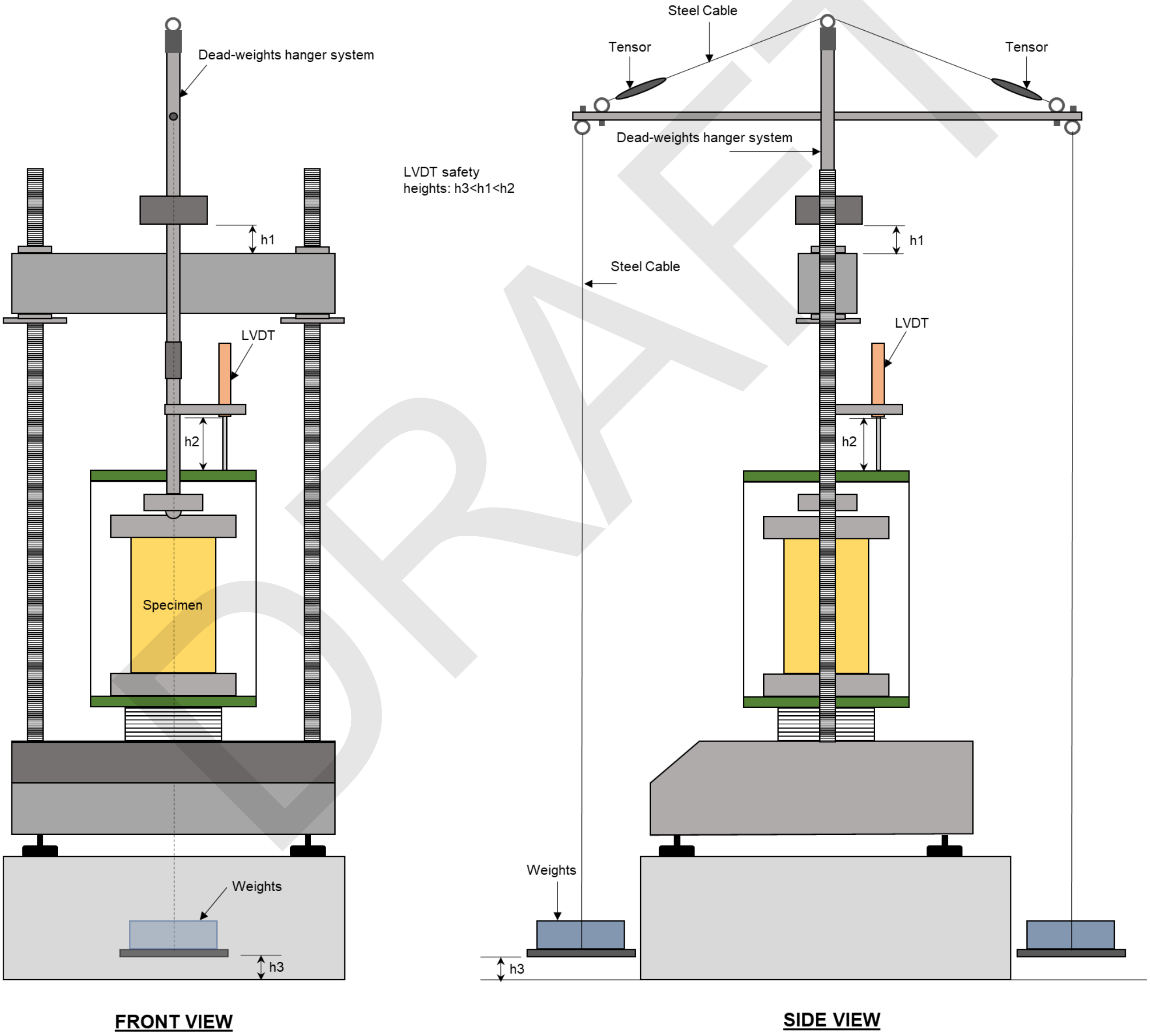


Figure 1: Front and side view of triaxial device modified for CSD testing using a dead-weights hanger system

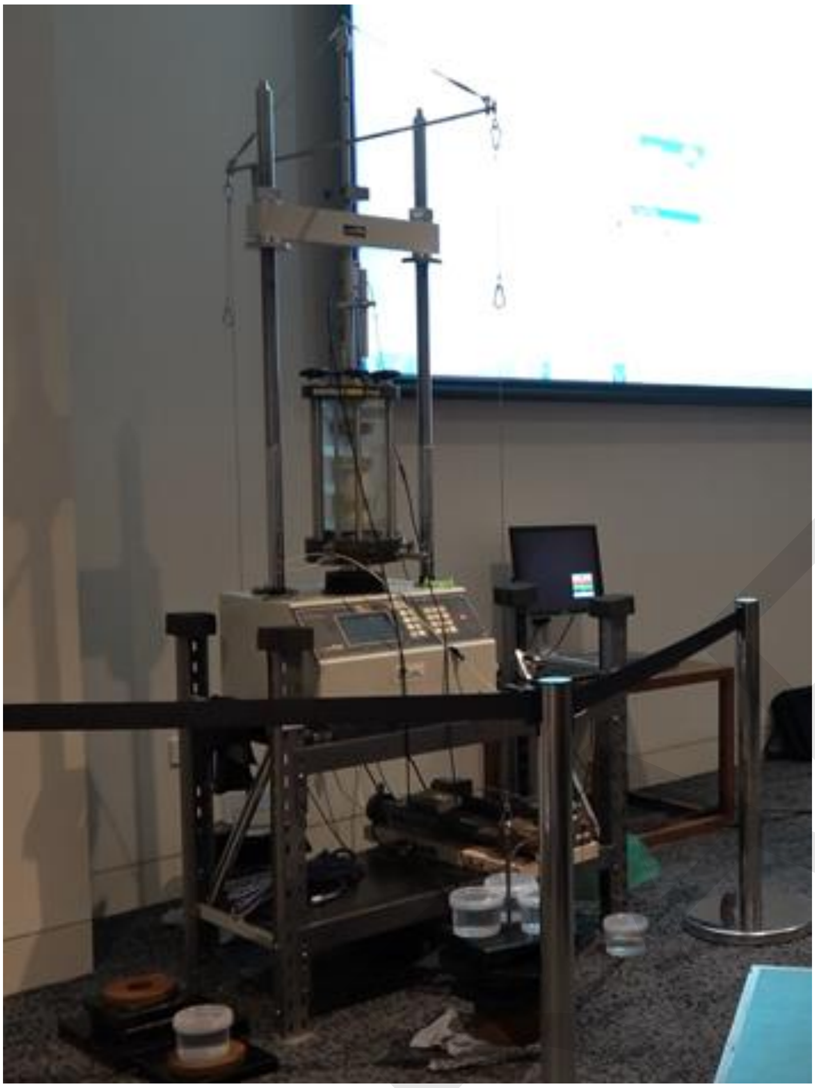


Figure 2: CSD triaxial during testing

Procedure

The test is undertaken using the following steps:

1) A specimen is prepared to its target density and consistency.
2) A suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during test setup.
3) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different specimen locations
4) The triaxial device is assembled and the cell filled with water.
5) The dead-weights hanger system is connected to the loading ram. Its vertical travel is initially controlled by using the triaxial cross-bar to gently lower the loading ram and hanger system down when necessary to “dock” to the specimen.
6) The specimen is flushed with CO_2 for approximately one hour.

7) The specimen is then flushed with water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen; flushing is carried out until bubbles are no longer observed to emerge from the pipe connected to the top of the specimen.

8) Back pressure saturation is undertaken over ~3 hours, maintaining an effective stress of 20 kPa. During this stage the clamp locking the dead-weights hanger system is unlocked and the weights are progressively added to prevent the cell pressure from lifting the hanger system. By keeping a dead-weight slightly higher than that required to balance the cell pressure, the hanger remains in a constant position resting on the cross bar.

9) Once the target saturation back pressure is reached and volume change is negligible, a *B*-check is undertaken targeting a *B* value greater than 95%.

10) The specimen is then unloaded over ~3 hours to a cell pressure of 0 kPa and back pressure of -20 kPa.

11) The cell water is drained, the cell removed, and the specimen dimension taken using a digital calliper, to allow a more accurate measurement of specimen diameter for subsequent anisotropic consolidation.

12) The specimen is then reloaded following step 8.

13) The specimen is slowly consolidated anisotropically (i.e. deviator stress increased) to its target anisotropic stress conditions by adding weights to the hanger system. The application of load to the specimen is regulated through use of the cross bar, to prevent any rapid loading occurring during this process. The deviator stress increase occurs at an approximate rate of 12 kPa per hour (i.e. approximately 4 kg of weight per hour assuming a specimen diameter of 65 mm). Owing to the manual loading requirement, the anisotropic consolidation is undertaken in stages, i.e. 10 hours of loading during daytime and 14 hours of standby, maintaining a constant stress overnight.

14) Once the target consolidation pressure is achieved, the specimen is left under K_0 consolidation for 24 hours.

15) The CSD stage is then commenced by slowly increasing the back pressure at a rate of 10 kPa per hour. Test data are captured at intervals of 1 second, to provide stress conditions as close to failure as practicable.

16) Once failure occurs the specimen drainage valves are closed, and specimen void ratio determined by measuring its moisture content at the end of test, adopting the freezing method.

The CSD stage is video recorded with sound, to capture the rapid failure that initiates when the stress conditions reach the relevant instability stress ratio for the specimen's state.

The testing steps are provided in a diagram shown in Figure 3.

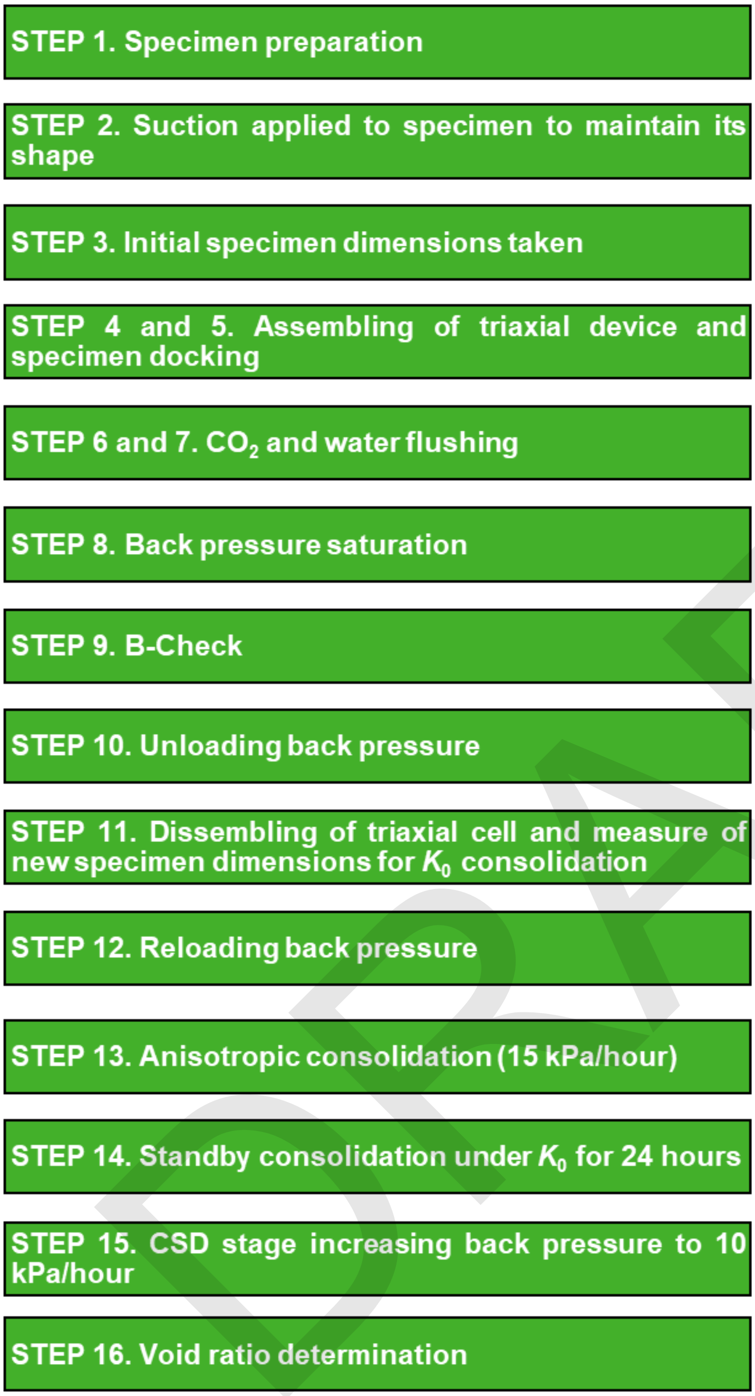


Figure 3: CSD testing steps diagram

GAPMW 3.4.2 – SHEAR WAVE VELOCITY MEASUREMENT USING BENDER ELEMENTS FOR TRIAXIAL TEST OF SPECIMEN CONSOLIDATED ANISOTROPICALLY

Scope

The purpose of this procedure is to provide the steps for measuring the shear wave velocity (V_s) of a triaxial specimen consolidated anisotropically using bender elements. When V_s and the bulk density (ρ_b) of the specimen at the time of measurement are known, the small strain shear modulus (G_0) can be determined by the following equation:

$$G_0 = \rho_b * V_s^2$$

The shear wave velocity is calculated by recording the time (t) required for the wave to travel through the specimen from the bottom through the top. Rather than the length of the specimen, the travel distance is defined as the length between the tip of the bender elements or tip-to-tip distance (L_{tt}). Therefore, the shear wave velocity is calculated by the following equation:

$$V_s = L_{tt} / t$$

Figure 1 shows an example of a transmitted and received signal using bender elements.

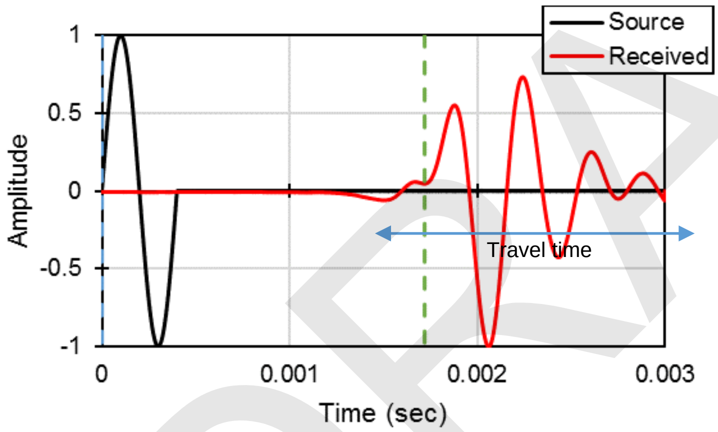


Figure 1: Transmitted and received signals using bender element system

Different criteria have been explored to select the point at which the arrival time (t) occurs in a bender element system such as (A) first deflection, (B) first bump maximum, (C) zero after first bump, and (D) major first peak as shown in Figure 2 (Lee and Santamarina, 2005[1]).

[1] Lee and Santamarina (2005) Bender Elements: Performance and Signal Interpretation Journal of Geotechnical and Geoenvironmental Engineering, Vol. 131, No. 9, September 1, 2005. ©ASCE, ISSN 1090-0241/2005/9-1063–1070

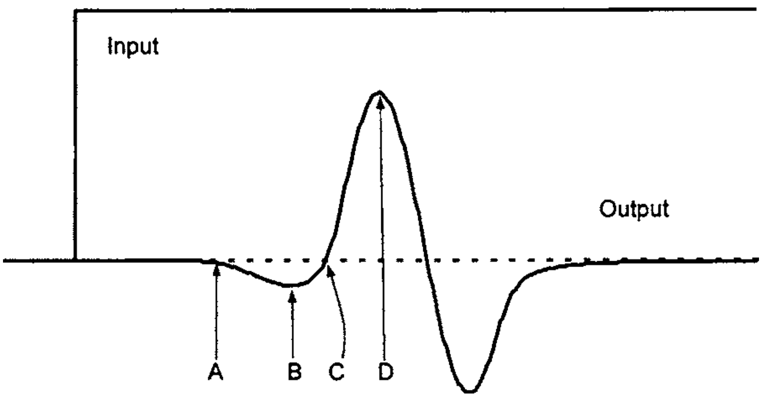


Figure 2: Different first arrival points as described by Lee and Santamarina, 2005

Equipment

A GDS wave function generator and data acquisition device is added to a standard triaxial GDS equipment. The triaxial cell is equipped with a pair of caps that have bender elements protruding from the centre of the caps as shown in Figure 3.

Figure 3: Set of caps with bender elements

When a voltage excitation is sent to one bender element, the element physically bends laterally (hence the name) creating a wave that propagates through the porous medium (triaxial specimen). When the other element receives the signal, it generates an electrical response. The transmitted signal deteriorates as it travels through the specimen requiring the received signal to be amplified. A computer program developed by GDS is used to control several features such as the period, amplitude and waveform of the input signal, the triggering mechanism (e.g. manual or configured), the amplification factor of the received signal, and data storage. The three main variables stored in a single file are; time, input signal, received signal.

Procedure

The test is undertaken using the following steps:

1) A specimen is prepared in accordance to the loose moist tamped triaxial preparation procedure, with the following exemptions:

   a) The standard caps are replaced with a pair of caps with bender elements

   b) A connection ring for the cell is required at the base to allow access of the connection ports for the bender element caps

   c) Installation of the bender elements caps requires proper alignment during the setup

2) A suction of maximum 20 kPa is applied to the specimen with a vacuum pump to enable the specimen shape to be maintained during test setup.

3) Initial specimen dimensions are taken using a digital calliper measuring both diameter and height at different specimen locations

4) The triaxial device is assembled and the cell filled with water.

5) The specimen is flushed with CO_2 for approximately one hour.

6) The specimen is then flushed with water imposing a differential head of approximately 5 kPa from the bottom to the top of the specimen; flushing is carried out until bubbles are no longer observed to emerge from the pipe connected to the top of the specimen.

7) Back pressure saturation is undertaken over ~3 hours, maintaining a mean effective stress of 20 kPa.

8) Once the target saturation back pressure is reached, and volume change is negligible, a B-check is undertaken targeting a *B* value greater than 95%.

9) The specimen is then unloaded over ~3 hours to a cell pressure of 0 kPa and back pressure of -20 kPa.

10) The cell water is drained, the cell removed, and the specimen dimension taken using a digital calliper, to allow a more accurate measurement of specimen diameter for subsequent anisotropic consolidation.

11) The specimen is then reloaded following step 7.

12) Using the BE program, the following parameters must be defined:

   a) Specimen height

   b) Data sampling frequency and time

   c) Amplification factor or gain (auto)

   d) Input signal waveform (sinusoidal), period (varies) and amplitude (14V)

   e) Wave type: compressional wave (P) or shear wave (S)

   f) Trigger type (manual)

13) The input signal is sent by pressing the trigger button.

14) Several periods are used to determine a range with a good quality signal.

15) At least three signals with different periods are recorded individually

16) The height of the specimen at the time of measurement is recorded.

17) The specimen is consolidation under anisotropic conditions targeting a K_0 of 0.6.

18) The process is repeated as many times as required, typically at the end of each consolidation stage generally every approximately 100 kPa mean effective stress. Arrival time and thus shear wave velocity can be obtained using the GDS program or during the data process analysis.

19) At the end of testing, the deviatoric stress is reduced to near zero stress to achieve near isotropic conditions allowing drainage of the specimen during the process.

20) After achieving steady conditions, confining stresses are further reduced to a confining effective stress of 20 kPa at the same time the back pressure is reduced to zero allowing the specimen to drain.

21) Following the reduction of stresses to 20 kPa, the cell pressure is reduced to zero and the back pressure to -20 kPa.

22) After the specimen achieves steady conditions the drainage valves are closed, and the cell is disassembled while the sample is under suction.

23) The end of test sample dimensions is taken using a digital calliper measuring both diameter and height at different locations to allow its comparison with the specimen void ratio inferred from the end of test freezing method (Sladen and Handford, 1987[2]).

24) The top cap with the bender element is carefully removed and replaced with a standard cap provided of drainage valves.

25) The specimen is flipped upside down and the bottom cap is also replaced with a standard cap of drainage valves.

26) The specimen void ratio is determined by measuring its moisture content at the end of test, adopting the freezing method which involves freezing the specimen with the membrane, replaced standard caps and drainage lines attached.

The specimen at step 10 (specimen measurement after saturation prior to K_0 consolidation) and step 23 (end of test specimen measurement) is shown in Figure 4.

[2] Sladen J.A. and Handford G. (1987). A potential systematic error in laboratory testing of very loose sands. Canadian Geotechnical Journal, 1987, (24)3: 462-466

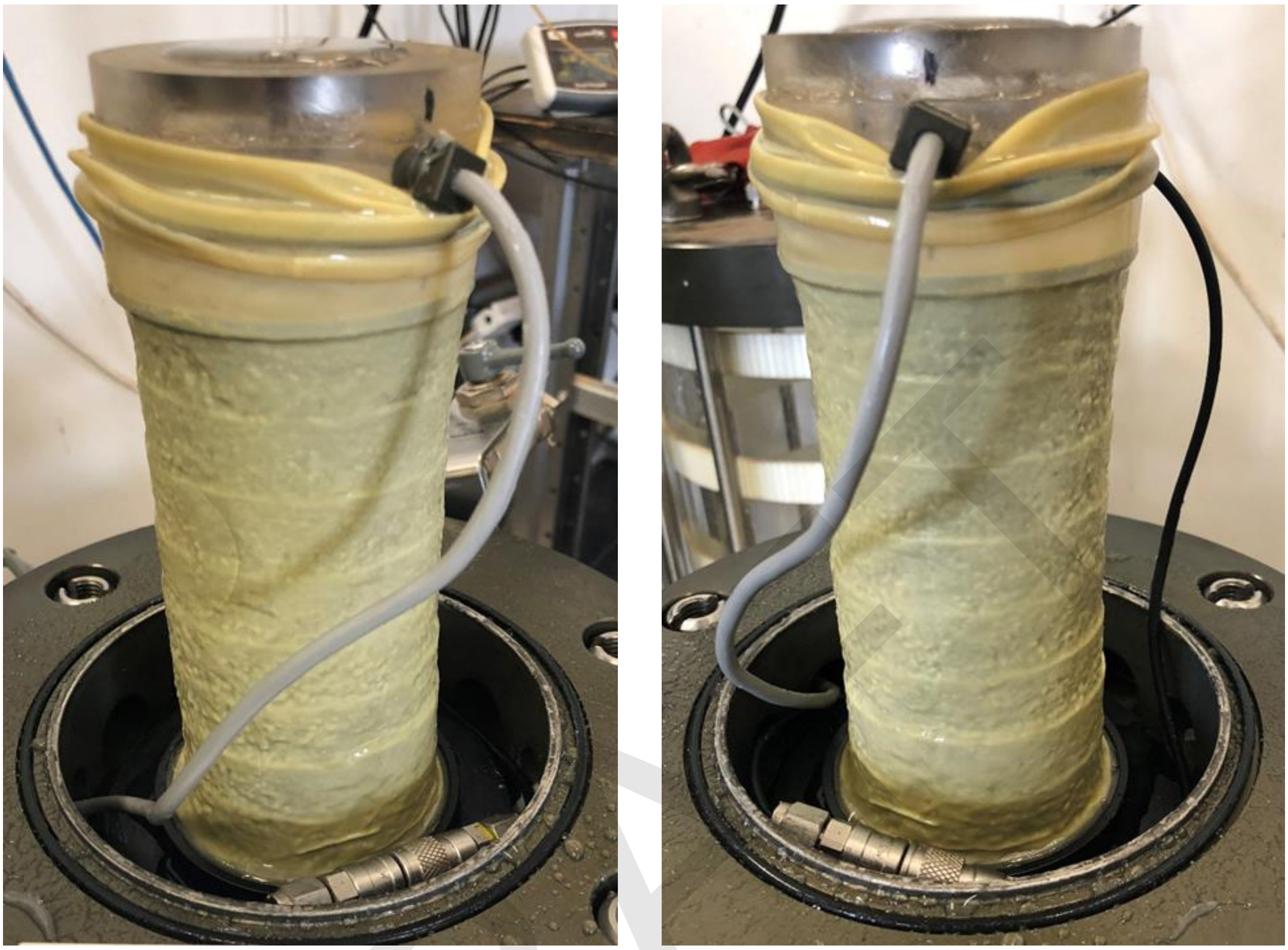


Figure 4: Specimen condition prior to K_0 consolidation (left) and at end of test (right)

GAPMW 4.1.1 – MOIST TAMPED LOOSE SPECIMEN PREPARATION FOR DIRECT SIMPLE SHEAR TESTING

Scope

The purpose of this procedure is to prepare a loose specimen using the moist tamping preparation technique for direct simple shear (DSS) testing.

Equipment

The preparation was undertaken using a special DSS mould designed to allow preparation of loose specimen and a suction pump. This mould allows to undertaking preparation of a specimen while allowing the membrane to be neatly fixed on the DSS rings by application of suction.

The GDS specimen preparation mould and the DSS mould while suction is applied are shown in Figure 1.

Figure 1: GDS specimen preparation mould (left) and DSS mould while suction is applied (right)

Procedure

The specimen preparation is undertaken using the following steps:

1) The DSS is prepared with the rings with a latex membrane neatly fixed against the walls of the mould by applying suction.
2) The sample is placed inside the DSS and tamped to a known density in one layer while applying suction. A stainless steel ring is used to facilitate placement of the material inside the DSS while tamping to the height of the last DSS ring.
3) The DSS device is assembled and the top platen is lowered down using the computer-controlled software to a given bedding load of approximately 10 kPa.
4) The suction is removed, and the specimen preparation mould dissembled.
5) The DSS base is tightened via four screws located at each corner to the main device, the restrain arms to reduce specimen rotation during shear assembled and the test commenced.

The specimen preparation procedure is shown in Figure 2 to Figure 5.

Figure 2: Placement of loose sample in DSS mould with stainless steel ring used to facilitate material placement

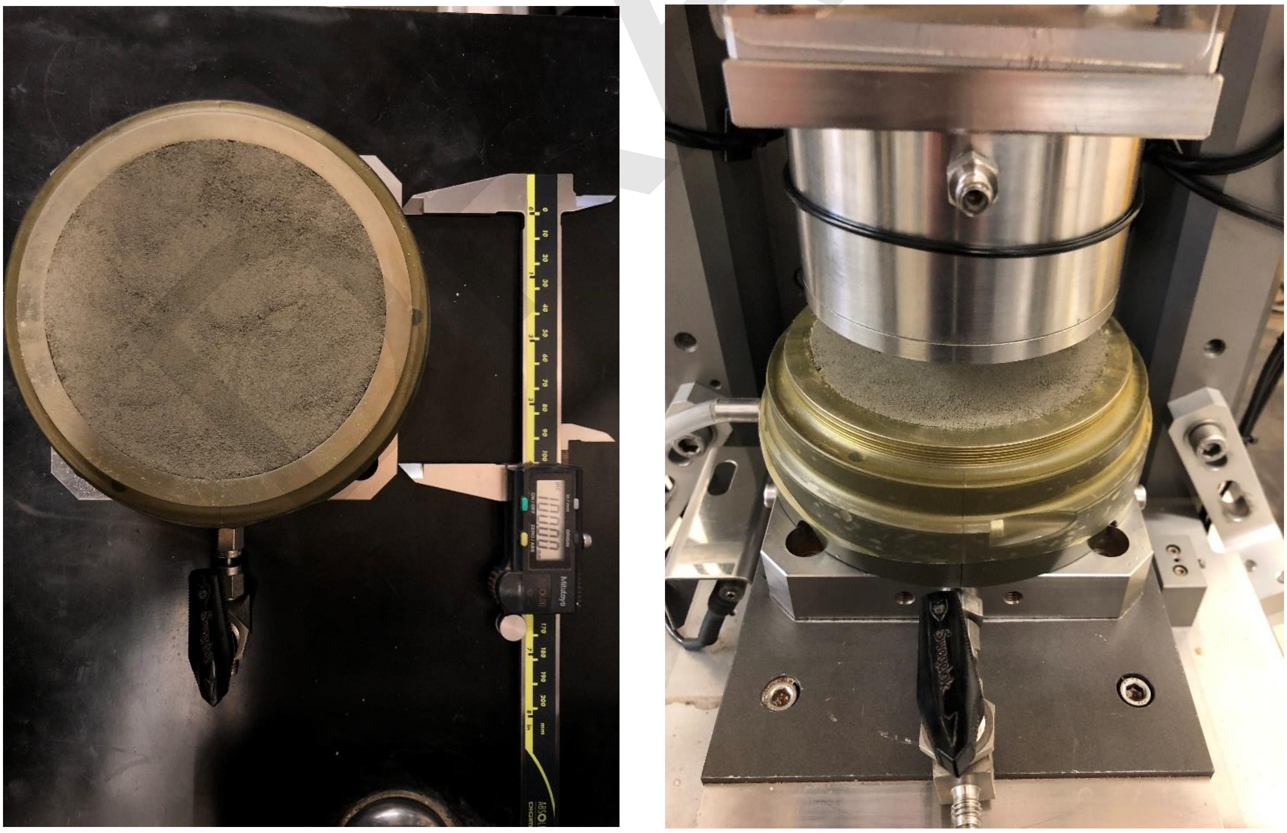


Figure 3: Tamped specimen outside DSS device (left) and fitted on the DSS base while still under suction (right)

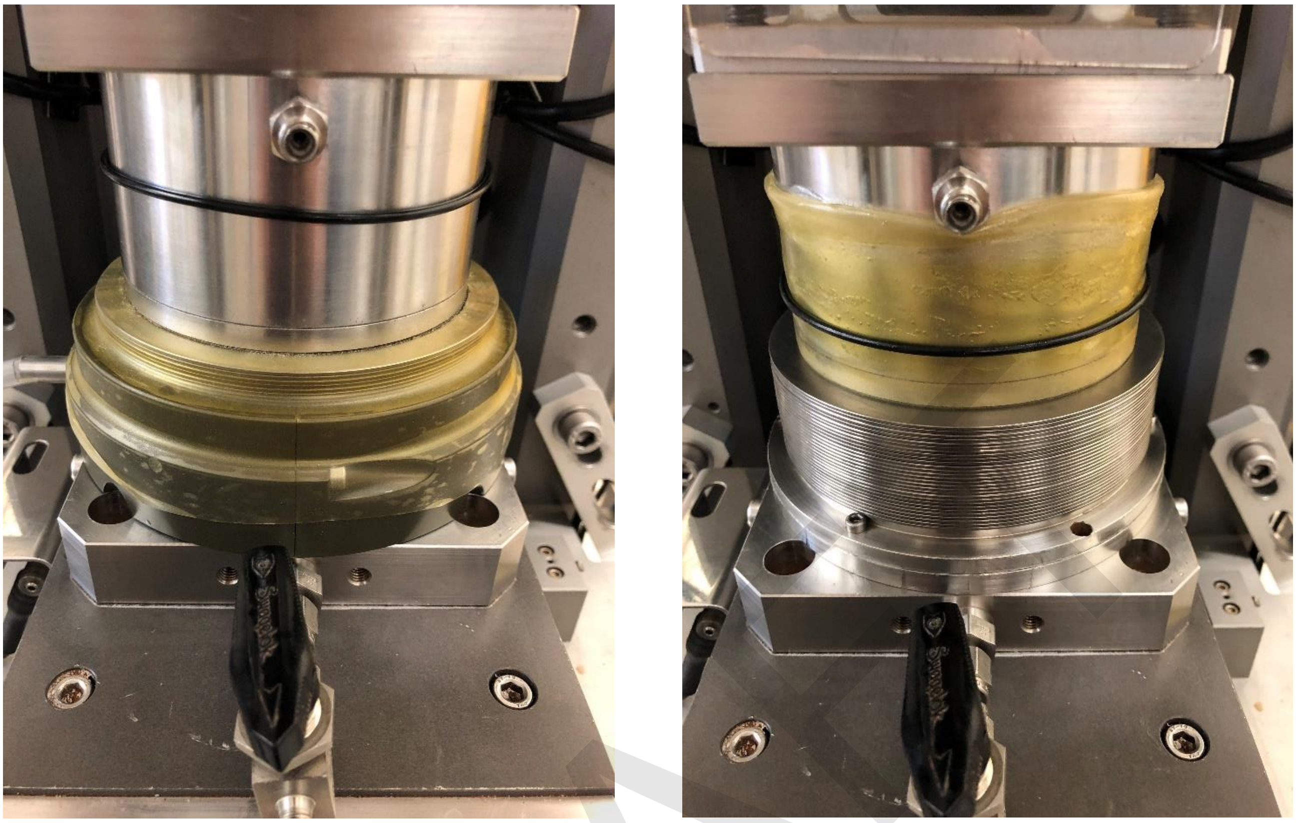


Figure 4: Top DSS platen lowered down to specimen surface (left) and with specimen preparation mould dissembled (right)

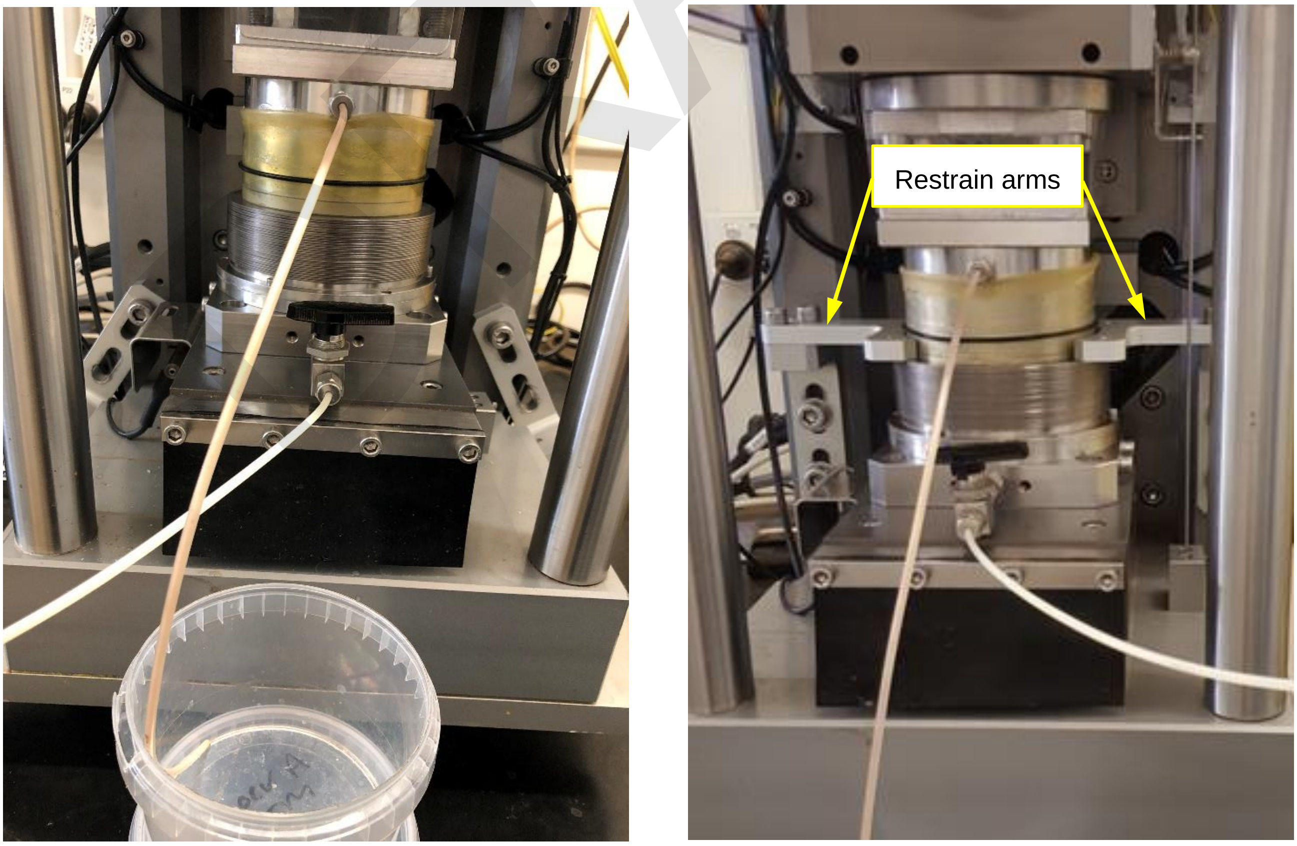


Figure 5: DSS device assembled without (left) and with (right) restrain arms mounted

GAPMW 4.2.2 – CYCLIC DIRECT SIMPLE SHEAR TEST

Scope

Direct simple shear (DSS) testing involves preparation of a cylindrical specimen with a typical height to diameter ratio of about 0.4 within a membrane which is laterally constrained by a stack of low-friction metal rings. The material is vertically consolidated to the desired stress with or without an initial static shear stress (α, bias). Owing to the lateral restraint provided by the stack of rings, consolidation occurs under a K_0 condition (i.e. zero lateral strain). Once consolidation is completed, the specimen is sheared cyclically by moving the lower platen horizontally while the top platen remains still. Following cyclic loading, the specimen is sheared monotonically provide an indication of post-cyclic strength. This may, in some instances, provide an assessment of post-liquefaction strength.

It should be noted that while DSS testing provides undrained strength parameters, the test itself is not undrained. Rather than restrict drainage, constant volume conditions are enforced via computer control of the test. Should the specimen contract, the top platen would begin to move downwards, reducing the height of the specimen. However, the computer control system prevents this from occurring by reducing the vertical stress to maintain a constant height. The excess pore pressures that would have developed within the specimen can then be inferred from the changes in vertical stress required to maintain constant height. This testing method has been shown to provide the same results as tests with enforced drainage conditions (Finn 1985[1], Dyvik et al. 1987[2]).

Equipment

Specimens were tested using a GDS electro-mechanical dynamic cyclic simple shear (EMDCSS) system shown in Figure 1.

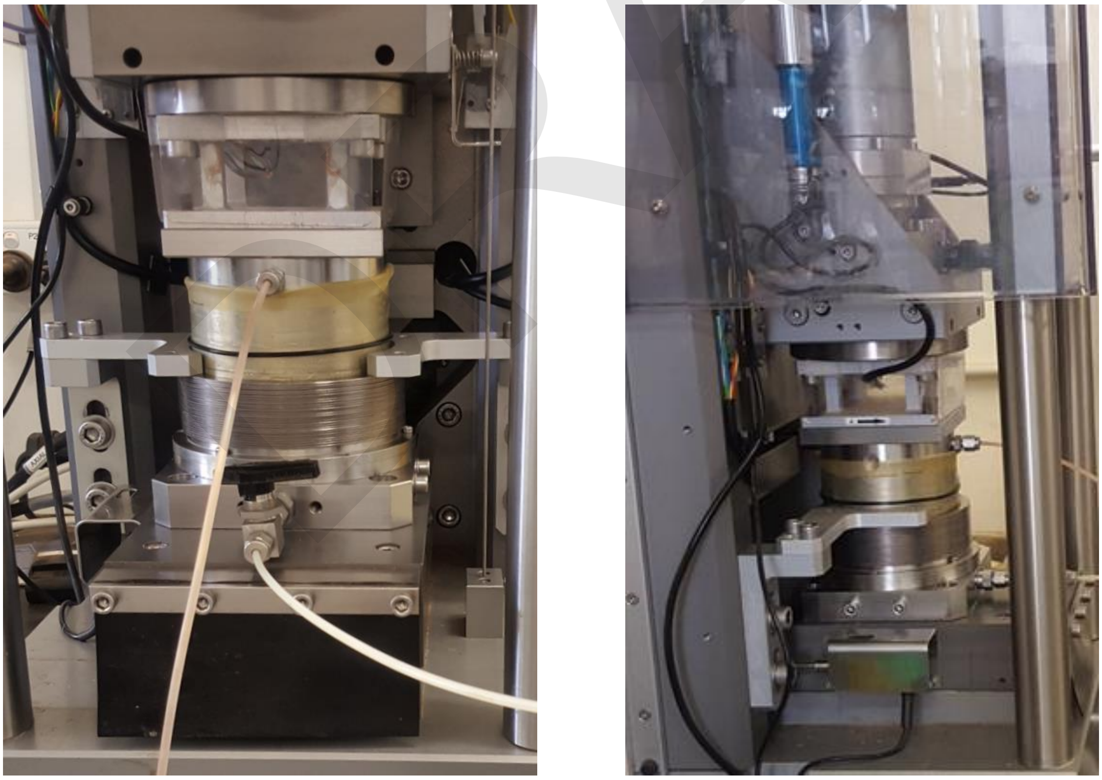


Figure 1: GDS electro-mechanical DSS device

[1] Finn, WDL 1985. Aspects of constant volume cyclic simple shear. Proceedings of Advances in the Art of Testing of Soils under Cyclic Conditions, pp 74-98 (ASCE, New York).

[2] Dyvik, R, Berre, T, Lacasse, S and Raadim, B 1987. Comparison of truly undrained and constant volume direct simple shear tests. Géotechnique, Vol 37, No 1, pp 3-10.

The device is capable of carrying out DSS testing under monotonic and cyclic conditions. The GDS DSS base and top platens are specially designed to allow saturation to occur by applying a flow, generally from the bottom of the specimen to its top via a pump or a water reservoir.

Procedure

The test is undertaken using the following steps:

1) A specimen is prepared according to the loose tamping preparation procedure[3] in a 100 mm diameter specimen.

2) The specimen is consolidated to the vertical effective stress for saturation of generally 15 kPa and water is flushed through the specimen from the base to the top.

3) For tests without bias, the specimen is consolidated to the target vertical effective stress in stages. For tests with a bias, the specimen is consolidated to the target vertical and horizontal effective stresses by ramping at a vertical stress rate of 10 ~ 25 kPa/hour.

4) The specimen is sheared cyclically by applying a sinusoidal cyclic stress at a loading frequency of 1 Hz.

5) Once the cyclic shear stage is completed, a post-cyclic monotonic shearing stage is undertaken. For testing with bias that during cyclic loading reached the maximum positive shear strain of the device, a" reverse" post-cyclic monotonic shear stage is undertaken – i.e. where post-cyclic shearing is in the opposite direction the bias application.

6) Once the test is completed, the DSS is dissembled, the specimen removed and dried in a 110°C oven for moisture content measurement.

The typical end of test specimen is provided in Figure 2.

Figure 2: End of test specimen

[3] GAPMW 4.1.1 Moist Tamped Loose Specimen Preparation for Direct Simple Shear Testing

Annexure ER
Stress Path Triaxial Test Video Footage