Appendix D:
Foundation Laboratory Testing

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D1. Introduction

This appendix provides details on the engineering properties of the foundation and fill materials described in Appendix C. The engineering properties are largely based on the results of laboratory tests undertaken as part of the ITRB investigations, supplemented by other testing which includes:

- Previous laboratory investigations;
- Laboratory investigations undertaken in parallel to the ITRB investigations; and
- Limited field testing.

The scope of testing and a summary of the results of the testing are provided in the following sections while details of test procedures and test certificates are provided in the annexures to this appendix.

D2. ITRB Laboratory Testing

D2.1 Overview

ITRB investigations for the Cadia NTSF embankment failure are discussed in Appendix C. Samples collected as part of these investigations included:

- Disturbed samples;
- Undisturbed block samples;
- Thin walled undisturbed samples, 63mm diameter; and
- Lexan undisturbed samples, 100mm diameter.

Testing of selected samples of foundation and construction materials from these investigations was undertaken by:

- Trilab – Brisbane, Qld
- Golder – Perth, WA
- Fugro – Perth, WA
- Microanalysis – Perth, WA
- Hensel Geosciences – Mudgeeraba, Qld
- Consultant Palynological Services – Canberra, ACT

The type and number of tests completed by each organization is shown in Table D2-1.

Table D2-1: Type and number of tests completed by laboratory

Test	Trilab - Brisbane	Golder - Perth	Fugro - Perth	Microanalysis - Perth	Hensel Geoscience	Palynological Services
Atterberg Limits	25	8	4			
Linear Shrinkage	23	8	4			
Hydrometer / PSD	22	8	3			
Specific Gravity	13	9	3			
Bulk Density	4	2				
Standard Compaction		1				
Oedometer Consolidation	3		3			
Constant Rate of Strain Consolidation		6				
Direct Shear Test	7					
Ring Shear - Remoulded	1					
Direct Simple Shear (DSS) - Undisturbed		17	9			
DSS - Remoulded		3				
CIU Triaxial – Single Stage	9	3				
CIU Triaxial – Multi Stage	7					
X-Ray Diffraction – Semi Quantitative				6		
Petrographic Analysis					6	
Age Determination by Palynology						2

Table D2-2 provides a breakdown of tests according to material type.

Table D2-2: Type and number of tests completed according to material type

Test	Residual Basalt	Paleo Alluvium	Unit A – Forest Reef Volcanics	Unit B – Forest Reef Volcanics	Forest Reef Volcanics Bedrock
Atterberg Limits	4	8	13	12	
Linear Shrinkage	4	8	13	10	
Hydrometer / PSD	4	5	14	10	
Specific Gravity	3	4	13	5	
Bulk Density	1		3	2	
Organic Content (Loss on Ignition)		1			
Standard Compaction			1		
Oedometer Consolidation	1	3		2	
Constant Rate of Strain Consolidation	1	1	2	2	
Direct Shear Test			4	3	
Direct Simple Shear (DSS) - Undisturbed	6	5	9	6	
DSS - Remoulded			3		
CIU Triaxial – Single Stage					
CIU Triaxial – Multi Stage		2	3	2	
X-Ray Diffraction – Semi Quantitative	1		3	2	
Petrographic Analysis					6
Age Determination by Palynology		2			

D2.2 Test Details

D2.2.1 Test Methods

Where available, tests were completed to Australian Standards (AS) and these are listed below.

- Moisture Content AS1289.2.1.1
- Atterberg Limits AS1289.3.1.1, .3.2.1, .3.3.1
- Linear shrinkage AS1289.3.4.1
- Particle size distribution by wash sieving AS1289.3.6.1
- Particle size distribution by hydrometer AS1289.3.6.3
- Specific gravity AS1289.3.5.2
- Bulk density AS1289.6.4.1
- Standard Compaction AS1289.5.1.1
- Oedometer consolidation AS1289.6.6.1
- Direct Shear AS1289.6.2.2
- Isotropically Consolidated Undrained (CIU) TriaxialAS1289.6.4.2

Procedures adopted for advanced testing of foundation materials are included in Annexure DJ. The procedures adopted were often specific to the laboratory undertaking the testing but were generally in accordance with the American Society for Testing and Materials (ASTM). Applicable ASTM standards are:

- D4767 Consolidated undrained triaxial compression (CIU)
- D6528 Consolidated undrained direct simple shear (DSS)
- D4186 Controlled Strain Loading Oedometer (CRS)
- D6467 Torsional Ring Shear (RS)

Standards were not used for petrographic analysis or age determination by palynology.

D2.2.2 Test Certificates

Certificates for various tests undertaken by the ITRB are provided in annexures to this report.

D3. Other Laboratory Testing

D3.1 Pre- Construction Testing

Prior to the construction of the NTSF, laboratory testing of soil samples from the investigations was limited and included the following:

- Atterberg Limits;
- Particle Size Distributions;
- Emerson Class;
- Moisture density tests (Standard Compaction);
- Consolidated undrained (CIU) triaxial tests on 4 re-compacted samples; and
- Constant head permeability tests on 4 samples.

Three CIU triaxial tests, completed on re-compacted specimens from the 2000 investigations for the STSF, were subsequently incorporated into the NTSF data base.

Results of the pre-construction testing are included in references 1995-001, 1997-001 and 1997-002. (Appendix J)

D3.2 Construction Testing

During construction, soil index tests and compaction tests were undertaken on low permeability materials as part of the Quality Assurance (QA) for the various stages of the NTSF. Particle size distribution tests were also completed on Stage 1 filter materials. No QA testing was completed on rockfill materials.

In general, only summaries of these data are provided in construction reports. Results for Stages 1 and 2 of the NTSF are included in references 1998-001, 2000-002, 2002-001 and 2003-001 (Appendix K).

D3.3 Supplementary Testing

D3.3.1 ATC Williams

ATC Williams (ATCW) recovered undisturbed samples of foundation materials at five (5) locations around the perimeter of the NTSF and STSF (reference 2018-005, Appendix K). Although the samples were taken in mid-February 2018, results of laboratory testing was not available until July 2018.

The testing included:

- Atterberg Limits;
- Particle size distribution (by hydrometer);
- Oedometer consolidation tests on 3 samples; and
- Anisotropically consolidated triaxial compression tests (CAU) on 4 samples.

D3.3.2 GHD

Following the NTSF embankment failure, GHD were engaged by Newcrest to assist CVO in minimizing the impacts of the failure (containment) and resuming production through a resumption in tailings emplacement in the STSF. As part of these activities GHD drilled nineteen (19) investigation holes and undertook laboratory testing that included:

- Atterberg Limits;
- Particle Size Distributions;
- Emerson Class;
- Consolidated undrained (CIU) triaxial tests;
- Unconsolidated undrained (UU) triaxial tests;
- Direct shear tests, and
- Oedometer consolidation tests.

D3.4 Test Certificates

Test certificates for the previous and supplementary testing are included in the relevant references and are not reproduced in this appendix. Results are incorporated in the following sections where they are deemed to be both relevant and of an appropriate quality.

D4. Foundation Properties

D4.1 Foundation Materials

The geological units intersected in the immediate vicinity of the NTSF slump are highlighted on Figure D4-1. The field characteristics of these units are discussed in Appendix C, while the engineering properties will be presented in the following sections.

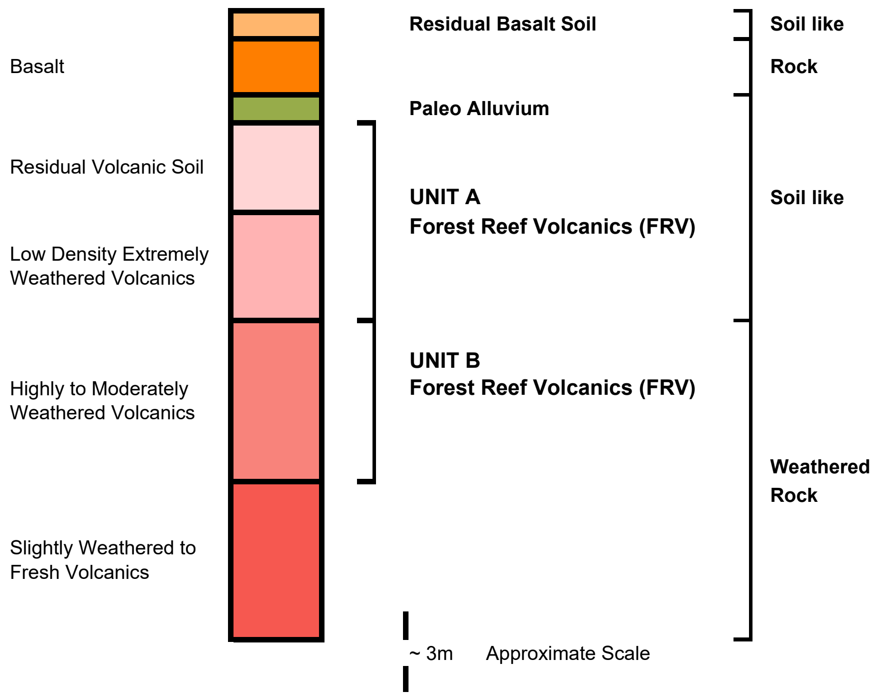


Figure D4-1: Geological units intersected at NTSF slump

D4.2 Residual Basalt

D4.2.1 Index Tests

Atterberg Limit and index tests completed on four samples of residual basaltic soil are summarised in Table D4-1. Atterberg Limits are plotted on Figure D4-2.

Table D4-1: Residual Basalt - Atterberg Limits and Index Tests

Hole No.	Depth Range (m)		Atterberg Limits			Linear Shrinkage (%)	Field Moisture (%)	Dry Density (t/m3)	Specific Gravity
	From	To	LL	PL	PI				
CE411	3.00	3.45	59	21	38	15.0	30.3	1.52	2.79
CE412	39.50	39.72	81	37	44	1.5	48.5		2.55
CE413	53.50	53.80	39	15	24	12.5	20.1		
TP401	0.70	1.00	53	20	33	14.5	21.7	1.76	2.80

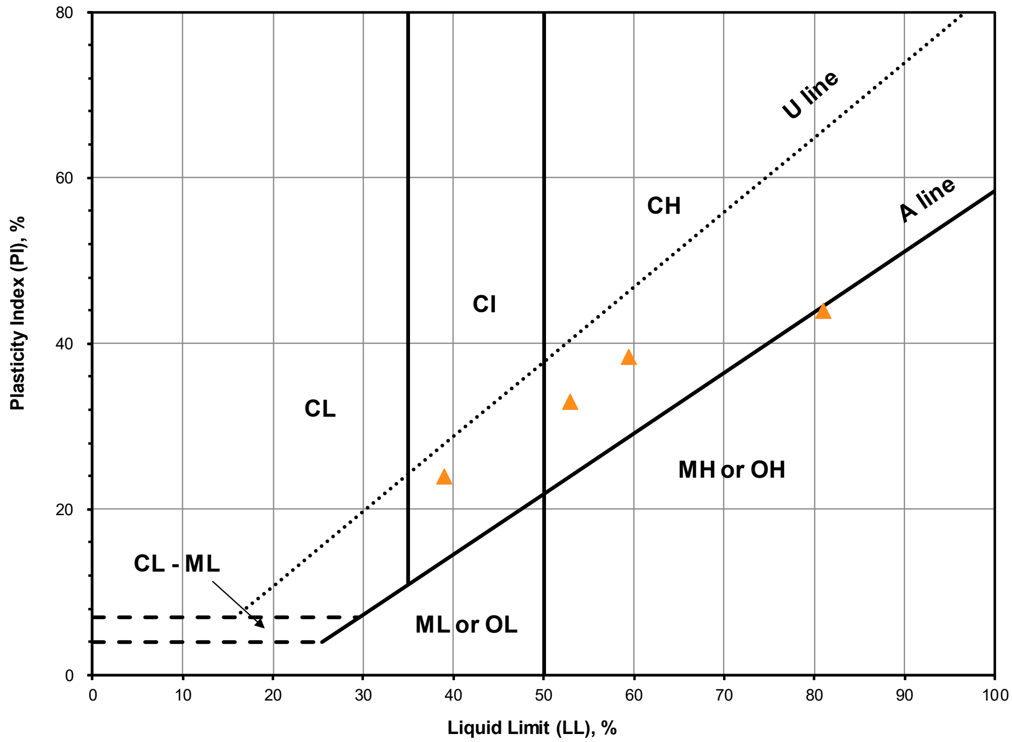


Figure D4-2: Residual Basalt – Plasticity chart

D4.2.2 Direct Simple Shear Tests

Direct simple shear tests were completed on two samples of residual basaltic soil. These test results are summarized in Table D4-2.

Table D4-2: Residual Basalt – Undrained shear strength data

Sample No	Depth (m)	Consol. Stress (kPa)	Dry Density (kN/m3)	Shear Strength		SS Ratio		Test Type
				Peak (kPa)	Post Peak (kPa)	Peak	Post Peak	
TP401	0.70 – 1.00	400	1.76	270	270	0.68	0.68	G/DSS
		800	1.76	277	219	0.35	0.27	G/DSS
		1200	1.77	408	372	0.34	0.31	G/DSS
CE411	3.00 – 3.45	400	1.52	114	110	0.29	0.28	F/DSS
		800	1.50	209	198	0.26	0.25	F/DSS
		1200	1.54	332	306	0.28	0.26	F/DSS

The peak mobilized friction (ϕm') from the DSS tests was 15.2° and 16.5° for CE411A and TP401 respectively, while the post peak mobilized friction at 25% strain ranged between 14.4° and 15.9°.

Shear stress versus vertical effective stress determined from the two DSS tests is plotted on Figure D4-3.

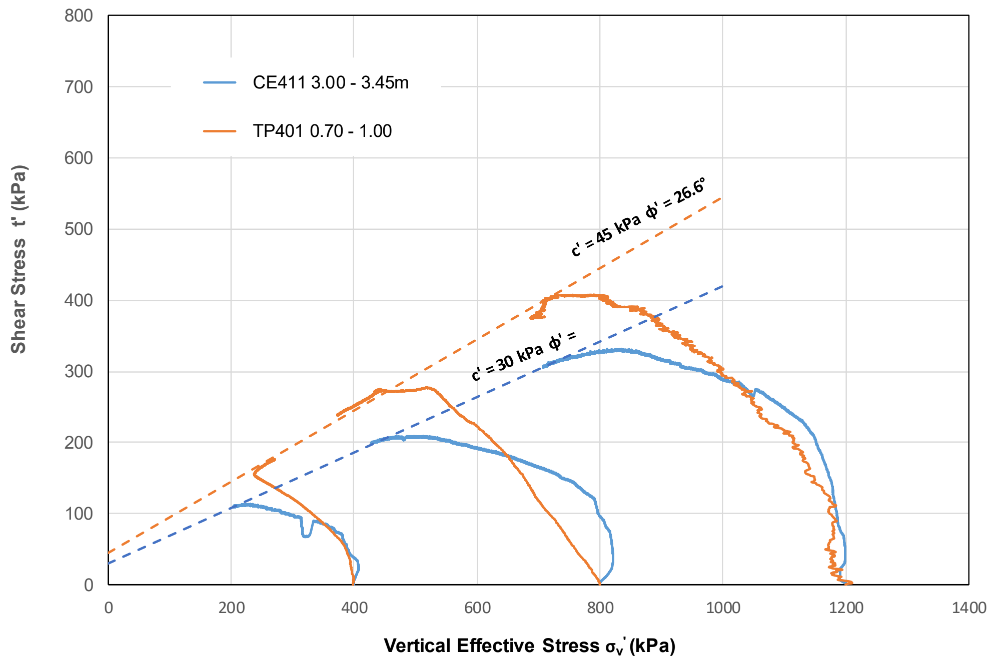


Figure D4-3: Residual Basalt – Shear stress versus vertical effective stress

D4.2.3 Consolidation Tests

One oedometer consolidation test was completed on residual basalt. The sample was loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then unloaded to 25kPa. The results are presented in Figure D4-4 as a void ratio / vertical effective stress plot and summarized in Table D4-3.

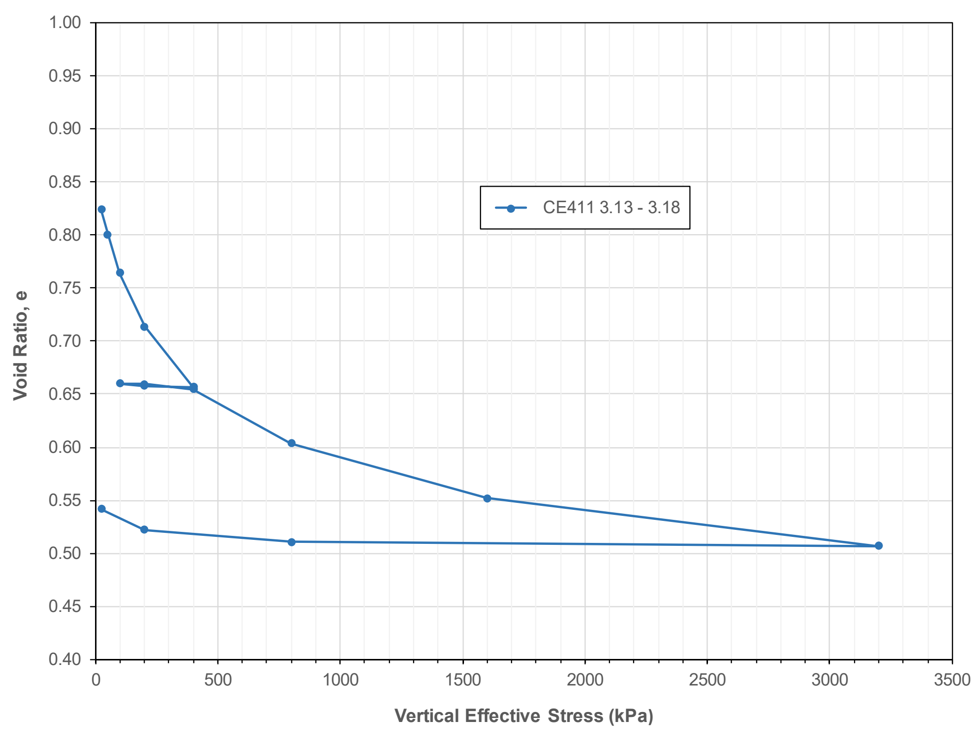


Figure D4-4: Residual Basalt – Oedometer consolidation plot

Table D4-3: Residual Basalt -Summary of consolidation test data

ID	Depth	RL	γd (t/m3)	w (%)	eo	Cr	Cc	σ'p
CE411	3.13 – 3.18	686.89	1.52	26.2	0.824	0.021	0.180	70

The apparent pre-consolidation pressure (σ_p) indicated in Table D4-3 was calculated using the Casagrande Method.

D4.3 Paleo Alluvium

D4.3.1 Index Tests

Atterberg Limit and index tests completed on nine samples of paleo alluvium are summarised in Table D4-4.

Samples CE417 18.50 to 19.00 and 19.50 to 20.00, were described as high plasticity, black CLAY with some organic matter. The organic content of CE417 18.50 to 19.00 was determined as 7.1% based on Loss on Ignition

Atterberg Limits are plotted on Figure D4-5.

Table D4-4: Paleo Alluvium - Atterberg Limits and Index Tests

Hole No.	Depth Range (m)		Atterberg Limits			Linear Shrinkage (%)	Field Moisture (%)	Dry Density (t/m3)	Specific Gravity
	From	To	LL	PL	PI				
CE406	18.40	18.50	71	24	47	19.0	27.5		2.70
CE411A	12.50	12.95	53	27	26	12.0	25.8	1.52	2.87
CE411A	14.50	15.00	53	25	28	12.0	25.7	1.64	2.70
CE411A	15.00	15.35	54	27	27	11.5	28.4	1.58	
CE416	21.85	21.90	87	27	60	22.0	34.1		
CE417	16.50	16.86	61	24	36	12.5	27.4	1.59	2.74
CE417	18.50	19.00	80	32	48	19.0	42.3	1.31	2.49
CE417	19.50	20.00	58	22	36	13.0	34.9	1.46	
CE417	20.80	20.85	48	19	29	13.0	26.3		

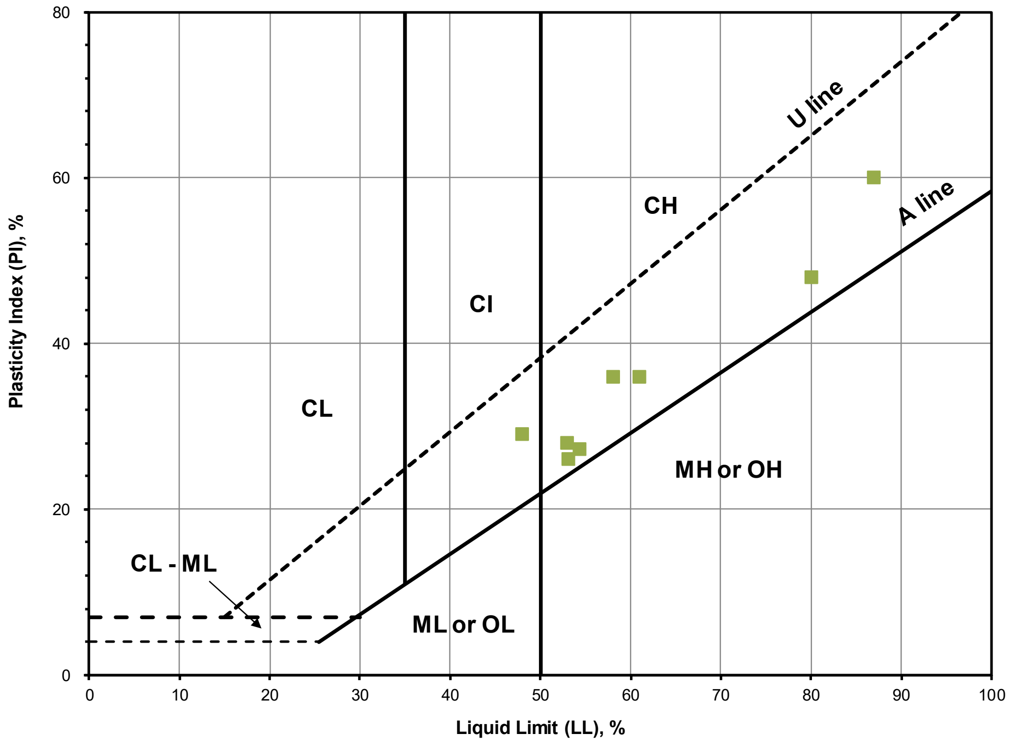


Figure D4-5: Paleo Alluvium – Plasticity Chart

D4.3.2 Strength Data

Direct simple shear tests and CIU triaxial tests were completed on five samples of paleo alluvium. Undrained shear strength data are summarized in Table D4-5.

Table D4-5: Paleo Alluvium – Undrained shear strength data

Sample No	Depth (m)	Consol. Stress (kPa)	Dry Density (kN/m3)	Shear Strength		SS Ratio		Test Type
				Peak (kPa)	Post Peak (kPa)	Peak	Post Peak	
CE411A	14.50 – 15.00	398	1.64	234		0.59		T/CIU M
		786		412		0.52		
		1194		595	387	0.50	0.32	
CE411A	15.00 – 15.35	400	1.58	162	161	0.41	0.40	F/DSS
		800	1.52	301	297	0.38	0.37	F/DSS
		1200	1.63	389	376	0.32	0.31	F/DSS
CE417	16.50 - 16.86	1000	1.49	438	425	0.44	0.43	G/DSS
CE417	18.50 – 19.00	194	1.22	135		0.70		T/CIU M
		394		198	105	0.59	0.27	
		799	1.31	260	119	0.33	0.15	T/CIU
CE417	19.50 – 20.00	1000	1.46	302	300	0.30	0.30	G/DSS

The data in Table D4-5 indicates a minimal reduction in post peak strength for DSS tests, while triaxial tests in both the inorganic and organic paleo alluvium exhibit a substantial reduction in post peak strength. A plot of undrained shear strength ratio vs consolidation stress provided as Figure D4-6 indicates the undrained shear strength ratio in DSS tests is approximately 70% of that measured in triaxial tests.

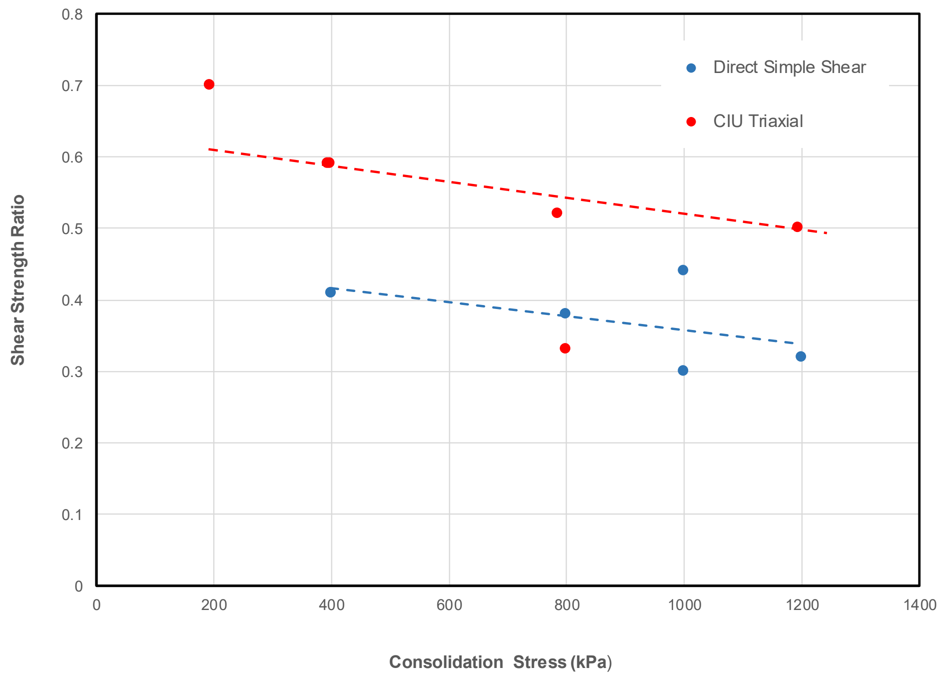


Figure D4-6: Paleo Alluvium – Undrained shear strength ratio vs consolidation stress

MIT stress paths for CIU triaxial tests are graphed on Figure D4-7, together with effective stress, strength parameters calculated for the triaxial tests.

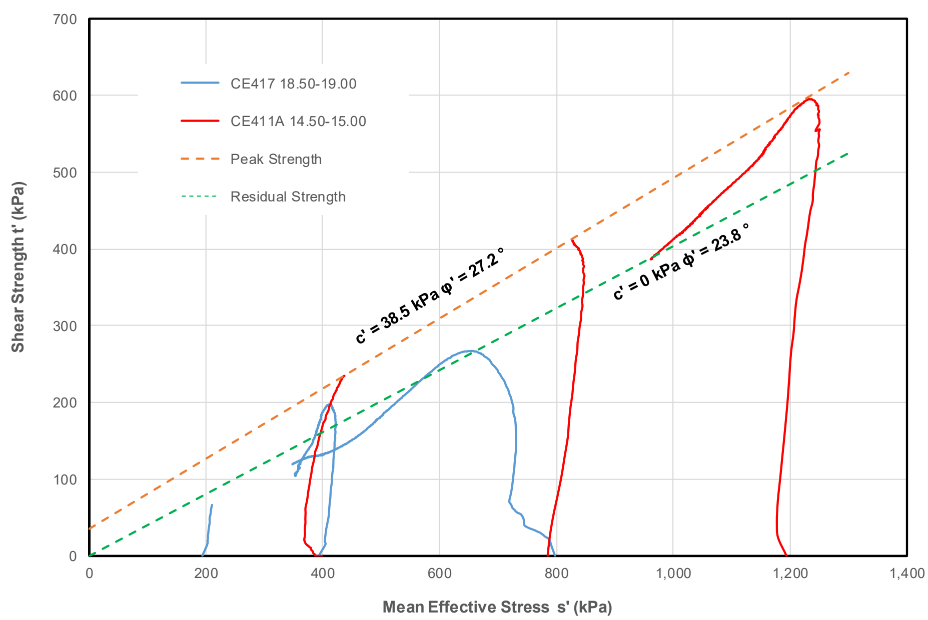


Figure D4-7: Paleo Alluvium – MIT stress paths & effective stress strength parameters

D4.3.3 Consolidation Tests

Three oedometer consolidation tests were completed on undisturbed samples of paleo- alluvium. The samples were loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then, in the case of one sample, unloaded to 25kPa. The results are presented in Figure D4-8 as a void ratio / p' plot and summarized in Table D4-6.

The void ratio and compression index of the organic clay (CE417 18.50 – 19.00) is substantially higher than that of the two 'remaining samples.

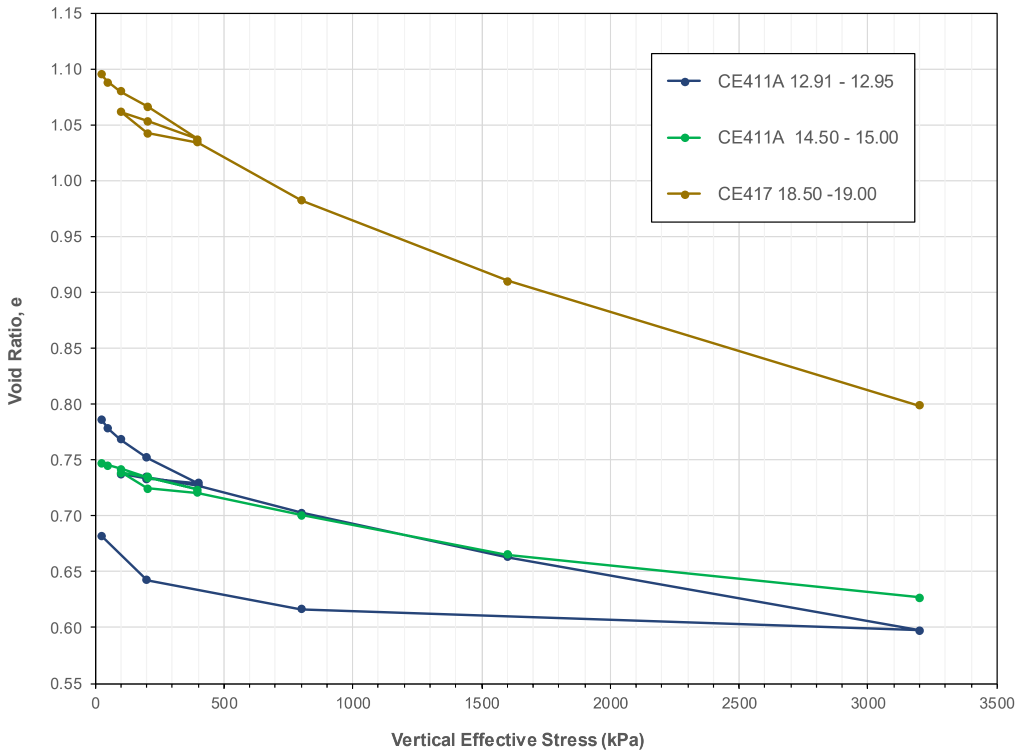


Figure D4-8: Paleo Alluvium – Oedometer consolidation plots

Table D4-6: Paleo Alluvium -Summary of consolidation test data

ID	Depth	RL	γd (t/m3)	w (%)	eo	Cr	Cc	σ'p
CE411A	12.91 – 12.95	677.09	1.52	25.8	0.786(1)	0.040	0.210	580
CE411A	14.50 – 15.00	675.00	1.56	26.0	0.732	0.030	0.125	425
CE417	18.50 – 19.00	681.58	1.20	45.5	1.077	0.045	0.380	675

The apparent pre-consolidation pressure (σ_p) indicated in Table D4-6 was calculated using the Casagrande Method.

D4.4 Unit A - Forest Reef Volcanics

D4.4.1 Index Tests

Atterberg Limit and index tests completed on eleven samples of Unit A of the Forest Reef Volcanics (FRV) are summarised in Table D4-7.

Table D4-7: Unit A FRV - Atterberg Limits and Index Tests

Hole No.	Depth Range (m)		Atterberg Limits			Linear Shrinkage (%)	Field Moisture (%)	Dry Density (t/m3)	Specific Gravity
	From	To	LL	PL	PI				
CE411A	16.00	16.50	61	31	30	12.5	37.7	1.28	2.58
CE415	4.12	4.30	52	33	19	8.5	38.4		
CE415	6.00	6.50	56	31	25	9.0	43.8	1.28	2.89
CE416	23.00	23.50	59	28	31	12.0	27.7	1.59	2.77
CE416	24.00	24.33	63	26	37	11.5	25.6	1.59	2.85
CE416	24.50	25.00	73	33	40	13.0	34	1.4	2.66
CE416	25.00	25.50	67	32	35	14.0	39.3	1.41	2.72
CE416	25.50	25.95	60	29	31	11.0	38.7	1.33	2.66
CE416	26.50	27.00	64	30	34	14.5	38.4	1.41	2.62
CE416	27.00	27.45	67	25	41	13.0	37.9	1.36	2.9
CE417	24.00	24.30	55	28	27	10.5	35.9	1.29	2.85
CE417	25.90	26.00	54	30	24	9.0	36		
PL01	0.00	0.50	51	25	26	13.5	33.5	1.38	2.78

The following graphs are provided for the various index tests.

Atterberg Limits are plotted on Figure D4-9.

Particle size distributions are plotted on Figure D4-10

Figure D4-11 is a graph of the initial dry density of Unit A samples with depth. The dry density of Unit A samples is typically below 1.40t/m^3 although there are some isolated samples with higher values.

Figure D4-12 is a graph of the initial void ratio of Unit A samples (open circles) and 'as tested' void ratio (closed circles) against confining stress.

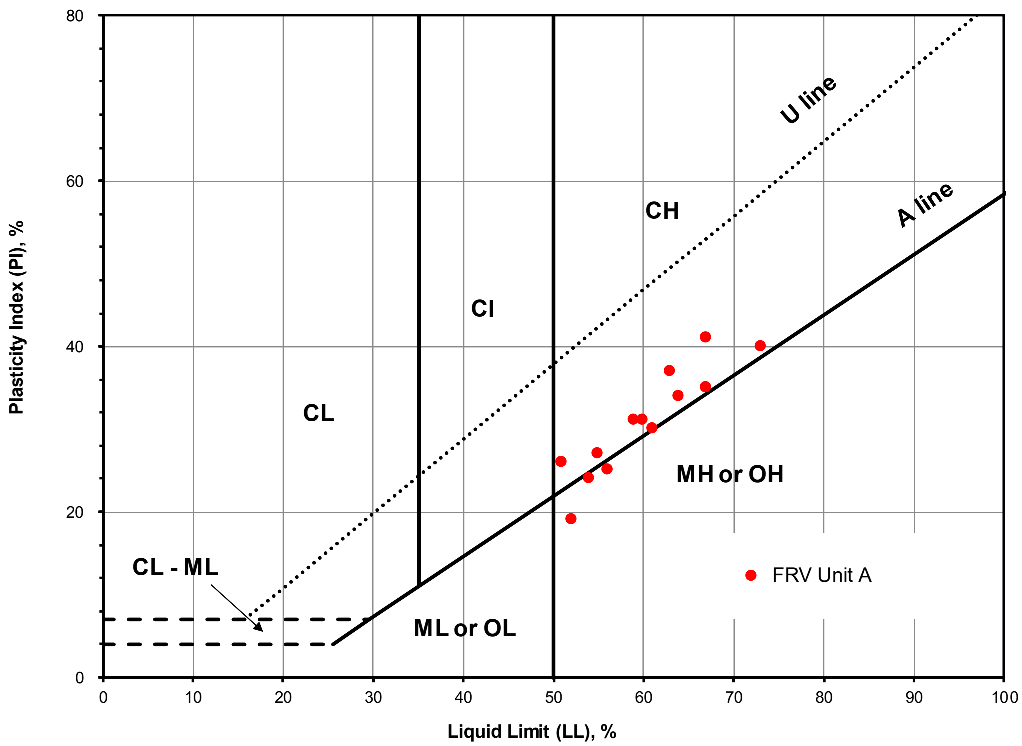


Figure D4-9: Unit A FRV – Plasticity Chart

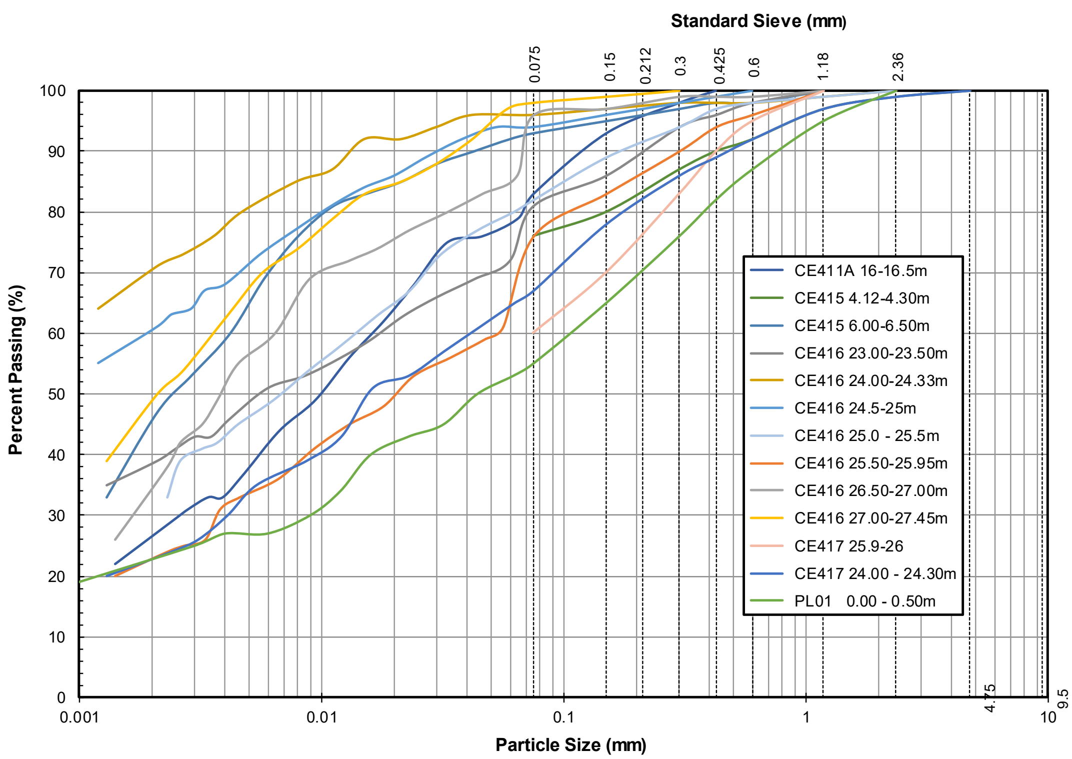


Figure D4-10: Unit A FRV – Particle Size Distributions

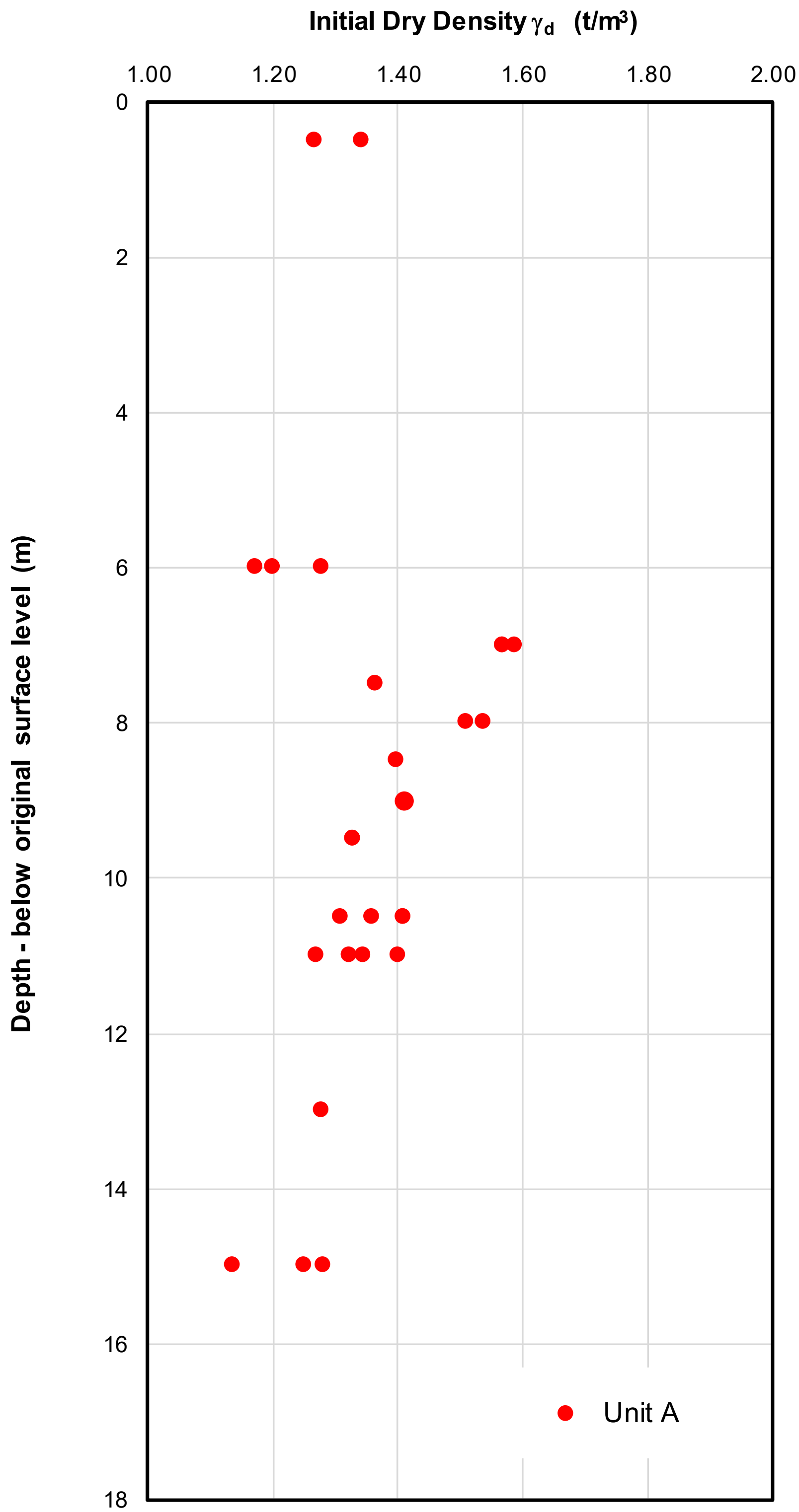


Figure D4-11: Unit A FRV – Initial dry density vs depth

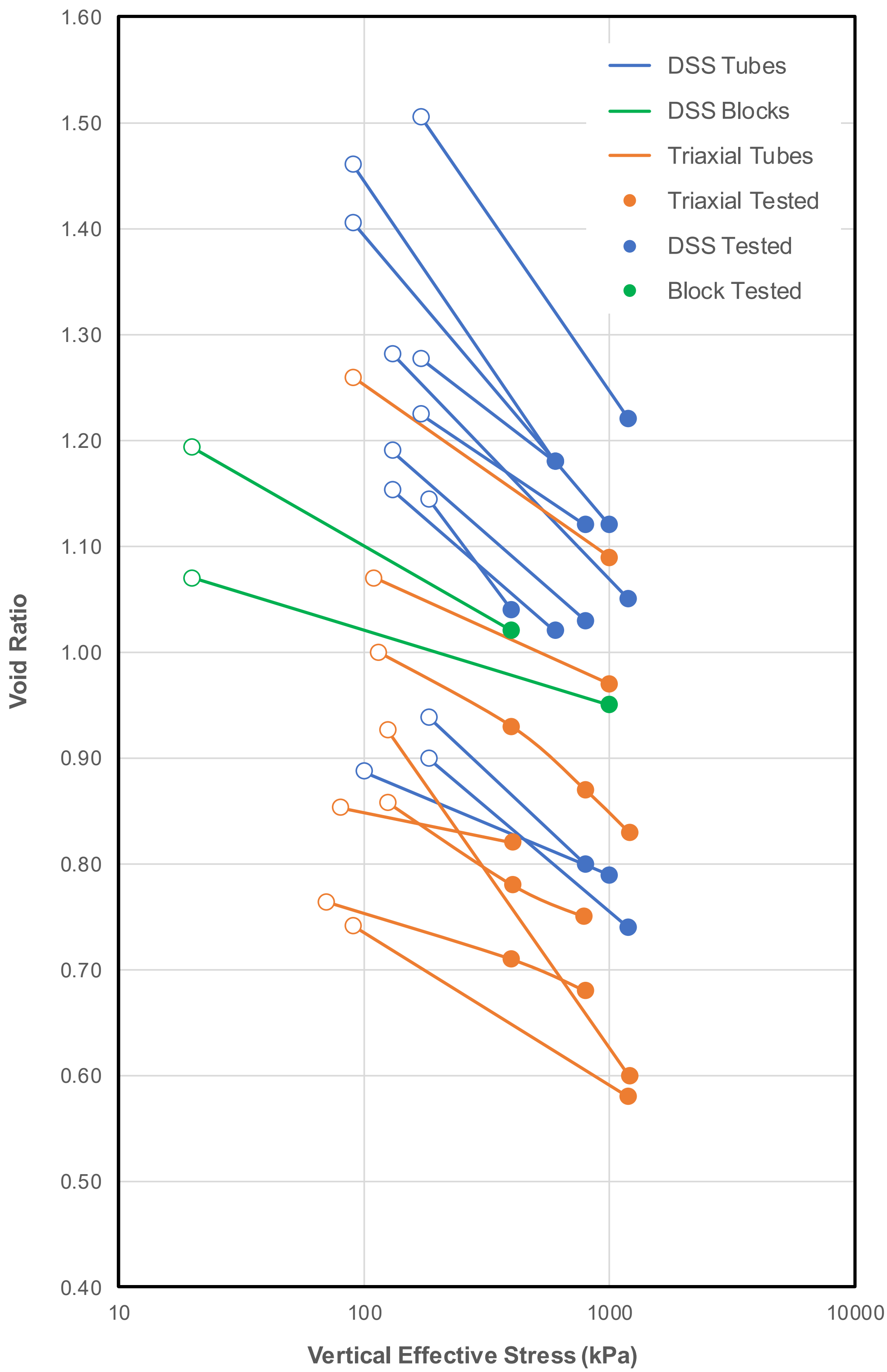


Figure D4-12: Unit A FRV – Initial & tested void ratio vs vertical stress

D4.4.2 Strength Data

Direct simple shear tests and CIU triaxial tests were completed on eight samples of FRV Unit A while direct shear tests and one ring shear test were completed on a remoulded sample of FRV Unit A.

Undrained shear strength data is summarized in Table D4-8.

Table D4-8: Unit A FRV– Undrained shear strength data

Sample No	Depth (m)	Consol. Stress (kPa)	Dry Density (kN/m3)	Shear Strength		SS Ratio		Test Type
				Peak (kPa)	Post Peak (kPa)	Peak	Post Peak	
CE415	6.00 - 6.50	600	1.33	225	200	0.38	0.33	G/DSS
		1000	1.36	275	195	0.28	0.20	G/DSS
		1000	1.28	395	223	0.40	0.22	G/CIU
CE416	23.00 – 23.50	400	1.57	222		0.56		T/CIU M
		801		347	164	0.43	0.20	
		1199	1.59	490	242	0.41	0.20	T/CIU
CE416	24.00 – 24.33	1000	1.59	340	320	0.34	0.32	G/DSS
CE416	25.50 – 25.95	400	1.33	260		0.65		T/CIU M
		799		379		0.47		
		1203		491	86	0.41	0.07	T/CIU
CE416	26.50 – 27.00	403	1.41	240		0.60		T/CIU M
		791		380		0.48		
		1204	1.36	342	77	0.28	0.06	T/CIU
CE416	27.00 - 27.45	1200	1.41	315	252	0.26	0.21	G/DSS
		1000	1.33	347	257	0.35	0.26	G/CIU
CE417	24.00 – 24.30	600	1.31	334	316	0.56	0.53	G/DSS
		800	1.35	385	385	0.48	0.48	G/DSS
		1200	1.29	362	287	0.30	0.24	G/DSS
PL1	0.00 – 0.50	400	1.36	204	204	0.51	0.51	G/DSS
		1000	1.43	390	235	0.39	0.24	G/DSS
PL1	0.00 – 0.50 Remoulded	250	1.46	244	244	0.98	0.98	G/DSS
		500	1.48	319	312	0.62	0.62	G/DSS
		1000	1.49	396	359	0.40	0.36	G/DSS

A plot of undrained shear strength ratio vs consolidation stress is provided as Figure D4-13. Equations defining the trend lines indicated on Figure D4-13 are:

- Peak triaxial strength $Su/p' = 0.72 - 0.000300\ \sigma v'$
- Peak DSS strength $Su/p' = 0.66 - 0.000300\ \sigma v'$
- Post Peak DSS strength $Su/p' = 0.45 - 0.000200\ \sigma v'$

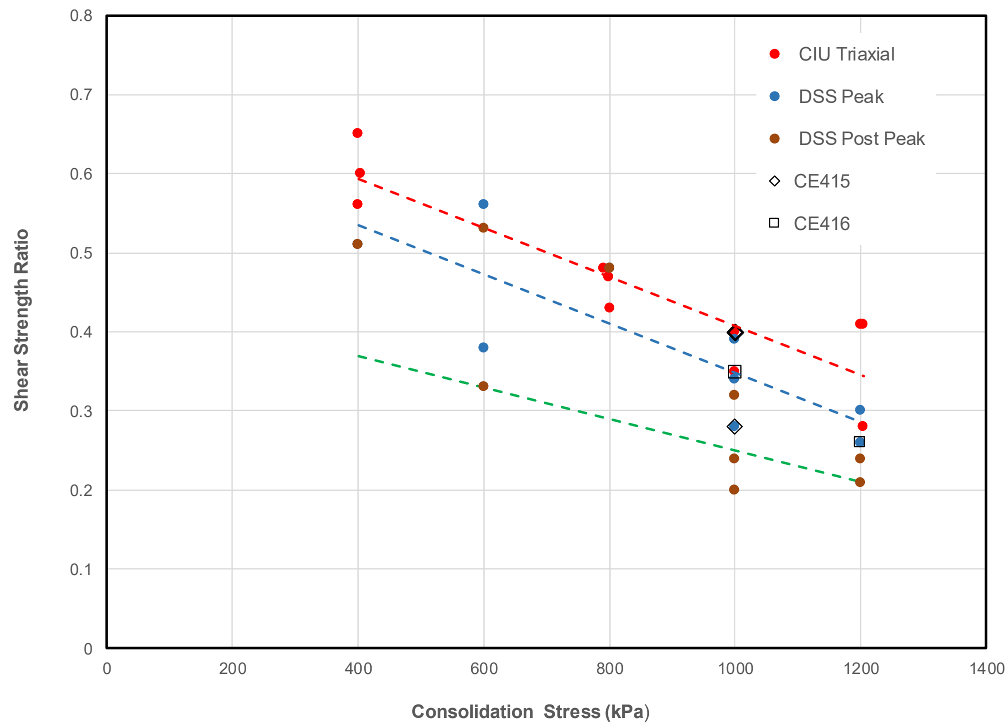


Figure D4-13: Unit A FRV - Shear stress ratio vs consolidation stress

MIT stress paths for representative CIU triaxial tests are graphed on Figure D4-14, together with effective stress, strength parameters calculated for these tests.

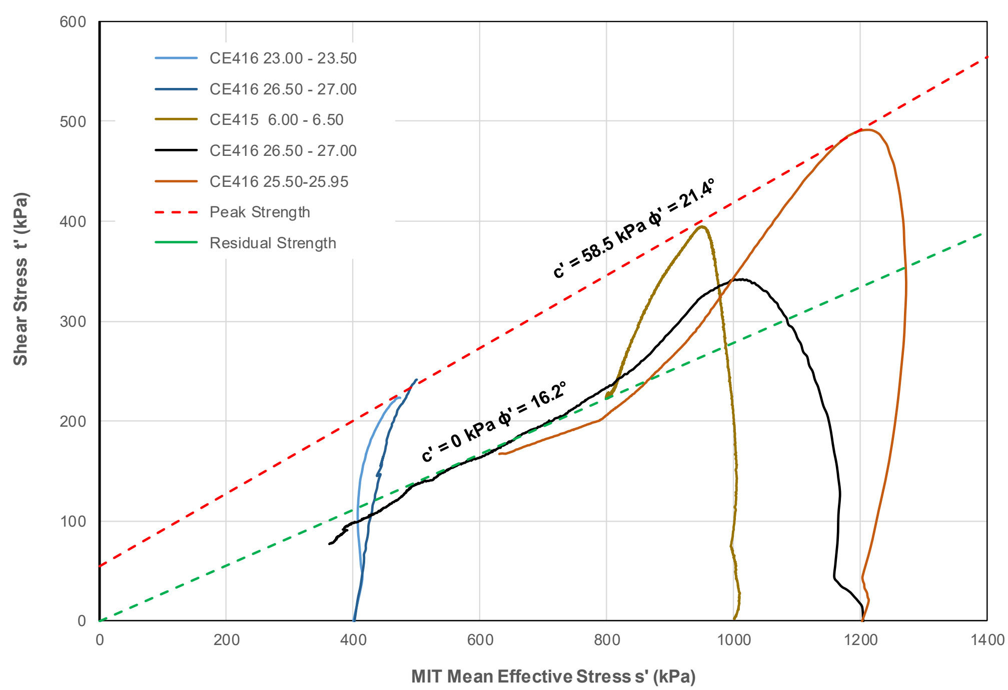


Figure D4-14: Unit A FRV – MIT stress paths & effective stress strength parameters

A ring shear test and direct shear tests were undertaken on a single sample of FRV Unit A (CE416 24.5 – 25.0) remoulded at its insitu moisture content and dry density (~34% & ~1.40t/m^3).

Due to equipment limitations the ring shear test was completed at one normal pressure (500kPa) on material passing 75 µm. The direct shear test was completed at three normal pressures on material as received (passing 2.36 mm). In order to provide a direct comparison with the ring shear test, an additional direct shear test was completed on < 75 µm material and a normal pressure of 500 KPa. Residual values (after 4 to 5 reversal cycles) are plotted on Figure D4-15 indicate an average mobilised friction ϕ'_m = 16° at normal stresses above 800kPa.

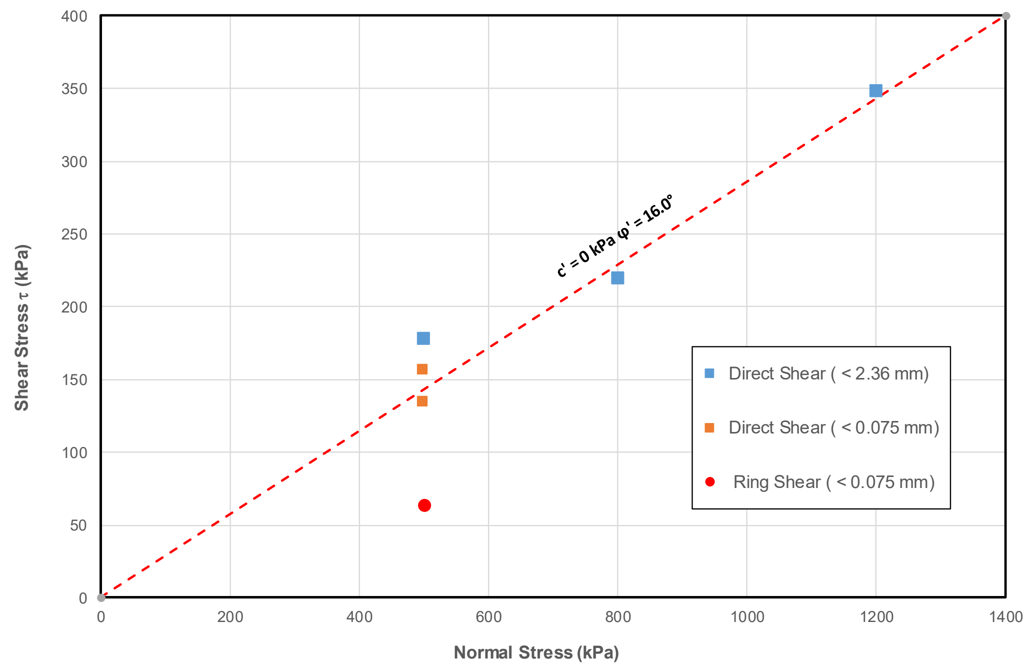


Figure D4-15: Unit A FRV – Residual values from direct shear and ring shear tests

D4.4.3 Consolidation Tests

Two constant rate of strain (CRS) consolidation tests were completed on undisturbed samples of Unit A. The samples were loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then, unloaded to 25kPa. The results are presented in Figure D4-16 as void ratio / vertical effective stress and in Figure D4-17 as Coefficient of Consolidation / log p'. Results are summarized in Table D4-9.

Table D4-9: Unit A FRV - Summary of CRS consolidation test data

ID	Depth	RL	γd (t/m3)	w (%)	eo	Cr	Cc	σ'p
CE415	6.00 – 6.50	680.20	1.28	41.5	1.25	0.025	0.095	170
CE417	24.00 -24.30	676.08	1.23	37.1	1.32	0.013	0.075	130

The apparent pre-consolidation pressure (σ_p) indicated in Table D4-9 was calculated using the Casagrande Method.

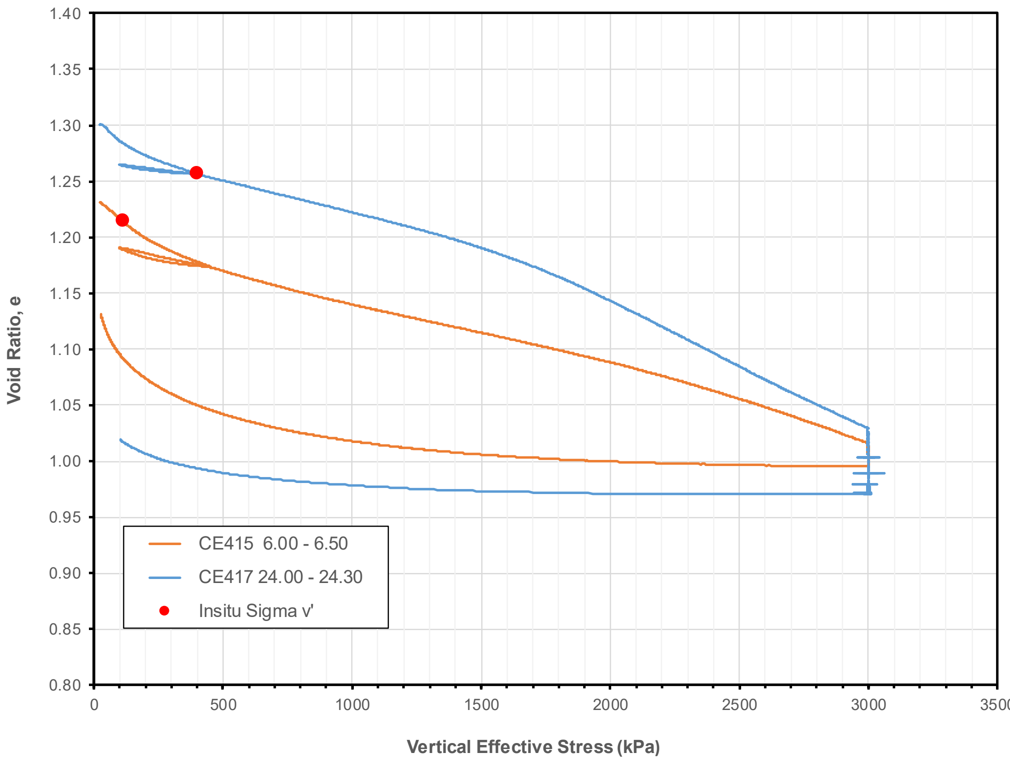


Figure D4-16: Unit A FRV – CRS Void Ratio

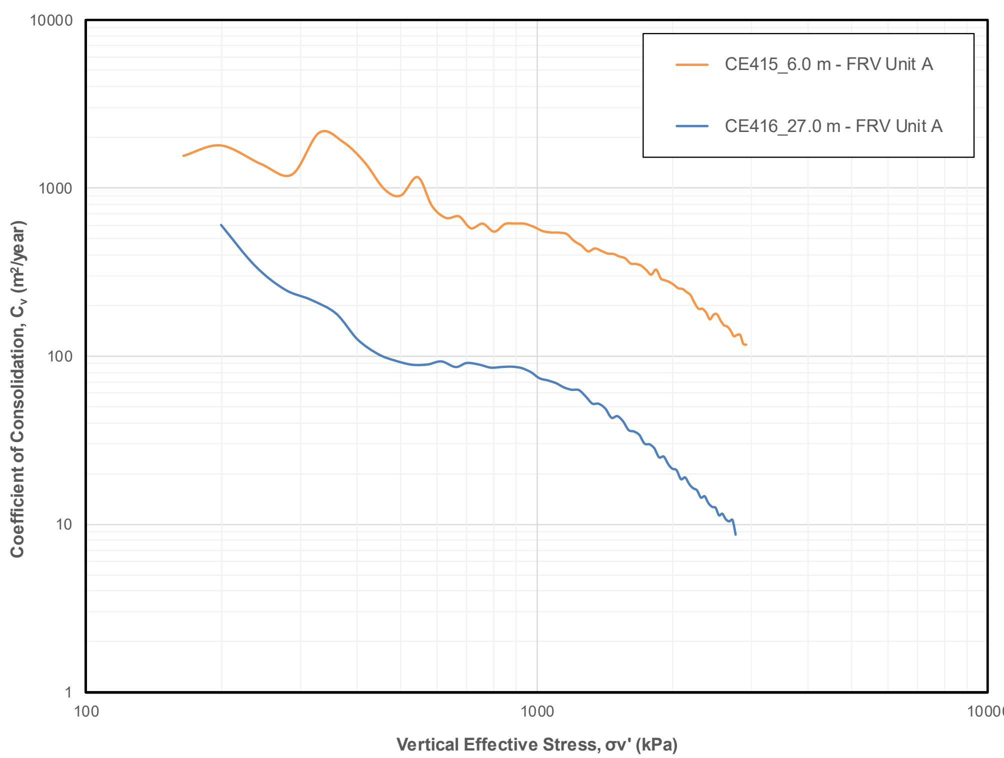


Figure D4-17: Unit A FRV – CRS Coefficient of Consolidation

D4.5 Unit B – Forest Reef Volcanics

D4.5.1 Index Tests

Table D4-10 provides a summary of Atterberg Limit and index tests completed on ITRB, GHD and ATCW samples taken from Unit B FRV. Atterberg Limits and particle size distributions are plotted on Figure D4-18 and Figure D4-19 respectively.

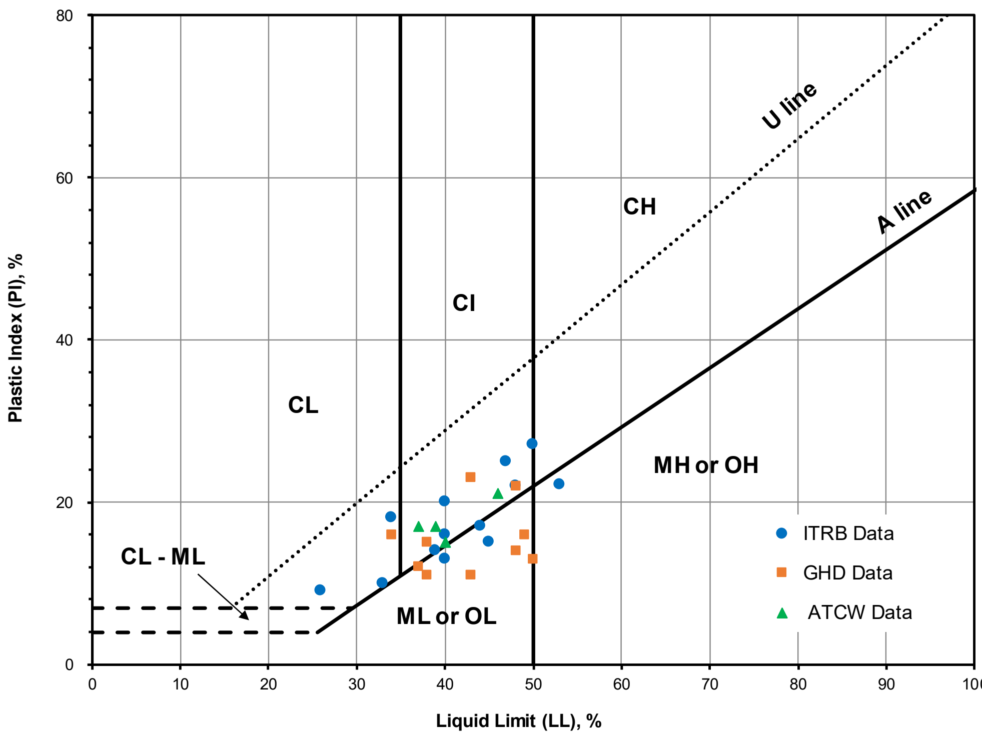


Figure D4-18: Unit B FRV – Plasticity chart

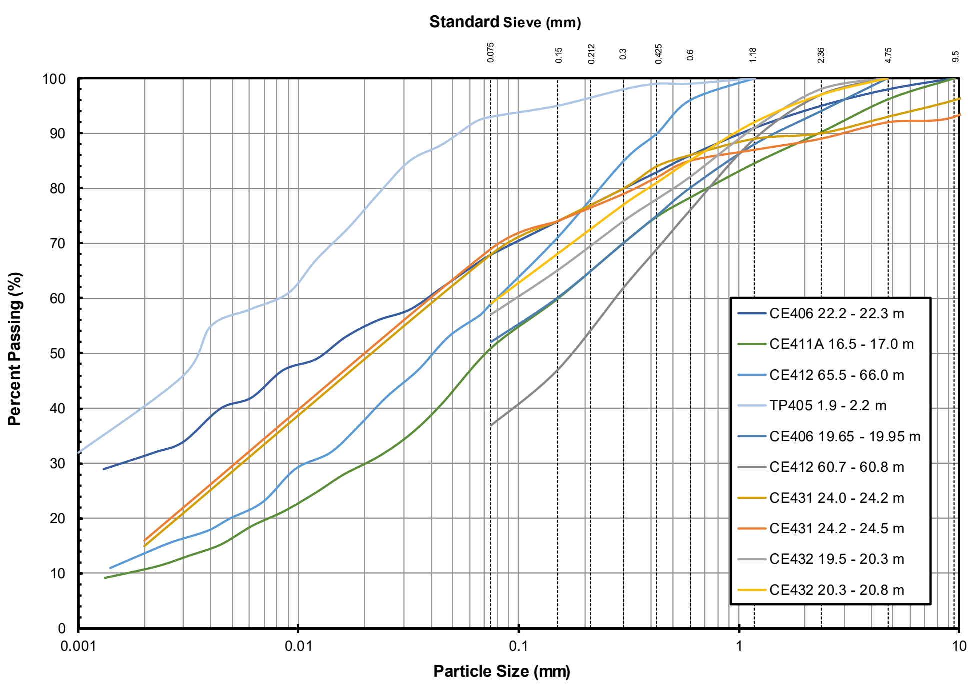


Figure D4-19: Unit B FRV – Particle size distributions

Table D4-10: Unit B FRV - Atterberg Limits and Index Tests

Hole No. (refer notes)	Depth Range (m)		Atterberg Limits			Linear Shrinkage (%)	Field Moisture (%)	Dry Density (t/m3)	Specific Gravity
	From	To	LL	PL	PI				
CE406	19.65	19.95	33	23	10	6.0	22.3	1.54	
CE406	22.20	22.30	40	20	20	8.0	19.8	1.75	2.82
CE411A	16.50	16.95	53	31	22	12.5	37.4	1.46	2.83
CE412	62.15	62.20	47	22	25	12.5	23.3		
CE412	65.50	66.00	50	23	27	11.5	25.5	1.50	2.64
CE432	19.80	20.30	40	27	13	8.0	24.2	1.61	
CE432	20.30	20.80	40	24	16	6.5	28.2	1.52	2.63
CE432	23.50	24.0					26.4	1.58	2.70
CE433	33.80	33.80	26	17	9	6.0	28.2		
TP405	1.90	2.20	48	26	22	12.0	28.6	1.58	2.75
CE382	0.45	0.90	37	25	12	9.00	17.7	1.80	
CE382	1.50	1.95	38	23	15	10.0	14.1	1.83	
CE383	1.00	1.45	48	34	14		31.8	1.85	
CE383	2.00	2.45	50	37	13		37.4	1.68	
CE383	3.00	3.45	43	32	11		34.8	1.78	
CE383	4.00	4.41	48	26	22		30.5	1.90	
CE383	5.00	5.35	49	33	16		28.1	1.91	
CE384	2.00	2.25	38	27	11	9.0	14.6	1.73	
CE392	2.00	2.45	43	20	23	12.0	17.2	1.83	
CE392	3.50	3.66	34	18	16	9.5	11.3	1.97	
BH2A	0.22	0.52	37	20	17		24.1	1.63	2.75
BH2B	1.30	1.50	46	25	21		19.0		
BH2B	1.50	1.90						1.64	
BH2B	2.00	2.0	40	25	15		15.0		
BH2B	3.00	3.40	39	22	17		11.5		
BH3	1.00	1.50	40	25	15		18.0		

Notes

Sample ITRB GHD ATCW

The initial dry density of Unit B samples is plotted against depth on Figure D4-20. The dry density of these samples is typically above 1.40t/m³.

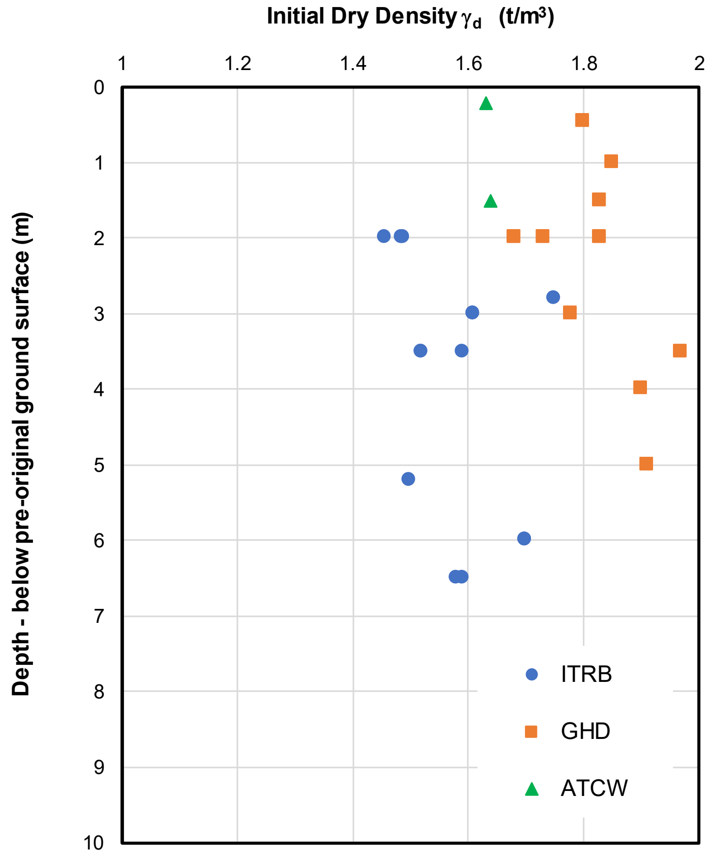


Figure D4-20: Unit B FRV – Initial dry density vs depth

The initial void ratio of Unit B ITRB samples (open circles) and 'as tested' void ratios (closed circles) are plotted against confining stress on Figure D4-21.

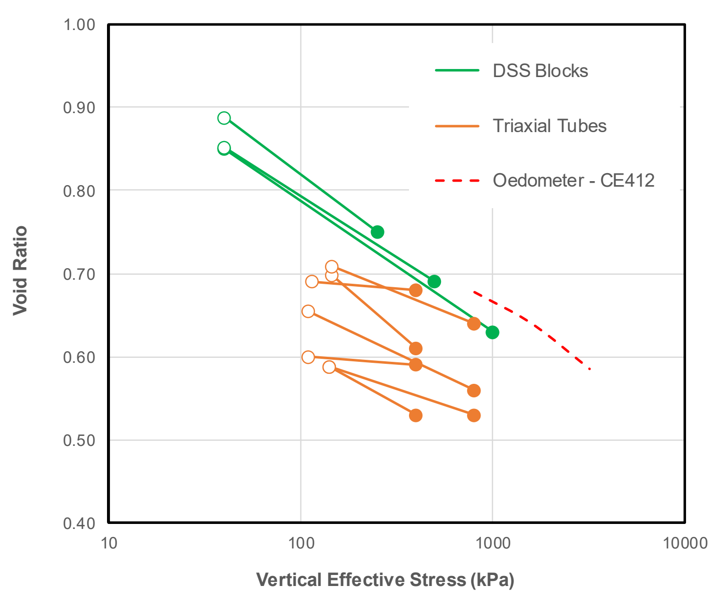


Figure D4-21: Unit B FRV – Initial & tested void ratio vs vertical stress

D4.5.2 Strength Data

Direct simple shear tests and CIU triaxial tests were completed on six samples of Unit B of the Forest Reef Volcanics. Undrained shear strength data is summarized in Table D4-11.

Table D4-11: Unit B FRV – Undrained shear strength data

Sample No	Depth (m)	Consol. Stress (kPa)	Dry Density (kN/m3)	Shear Strength		SS Ratio		Test Type
				Peak (kPa)	Post Peak (kPa)	Peak	Post Peak	
CE411A	16.50 – 16.95	400	1.32	263	260	0.66	0.65	F/DSS
		800	1.46	504	501	0.63	0.63	F/DSS
		1200	1.49	529	527	0.44	0.44	F/DSS
CE432	19.80 – 20.30	202	1.61	234		1.16		T/CIU M
		400		390	296	0.98	0.74	
		795	1.59	511	158	0.64	0.20	T/CIU
CE432	20.30 – 20.80	204	1.52	203	186	1.00	0.92	T/CIU
		398	1.52	361	255	0.91	0.64	T/CIU
CE432	22.80 – 23.20	400	1.70	468	410	1.17	1.03	T/CIU
		800	1.70	718	472	0.90	0.59	T/CIU
CE432	23.50 – 24.00	400	1.58	321	221	0.80	0.55	T/CIU
		796	1.59	624	253	0.78	0.32	T/CIU
TP405	1.90 – 2.20	250	1.58	90	90	0.36	0.36	G/DSS
		500	1.63	165	162	0.33	0.32	G/DSS
		1000	1.69	278	260	0.28	0.26	G/DSS

Results for tests on the above samples have been plotted on the following figures.

Figure D4-22 Undrained shear strength ratio vs consolidation stress for both DSS and CIU.

Figure D4-23. Shear stress versus vertical effective stress from DSS tests.

Figure D4-24. Stress paths for ITRB CIU triaxial tests.

Figure D4-25. MIT plot of shear strength at peak stress ratio for both ITRB and GHD data.

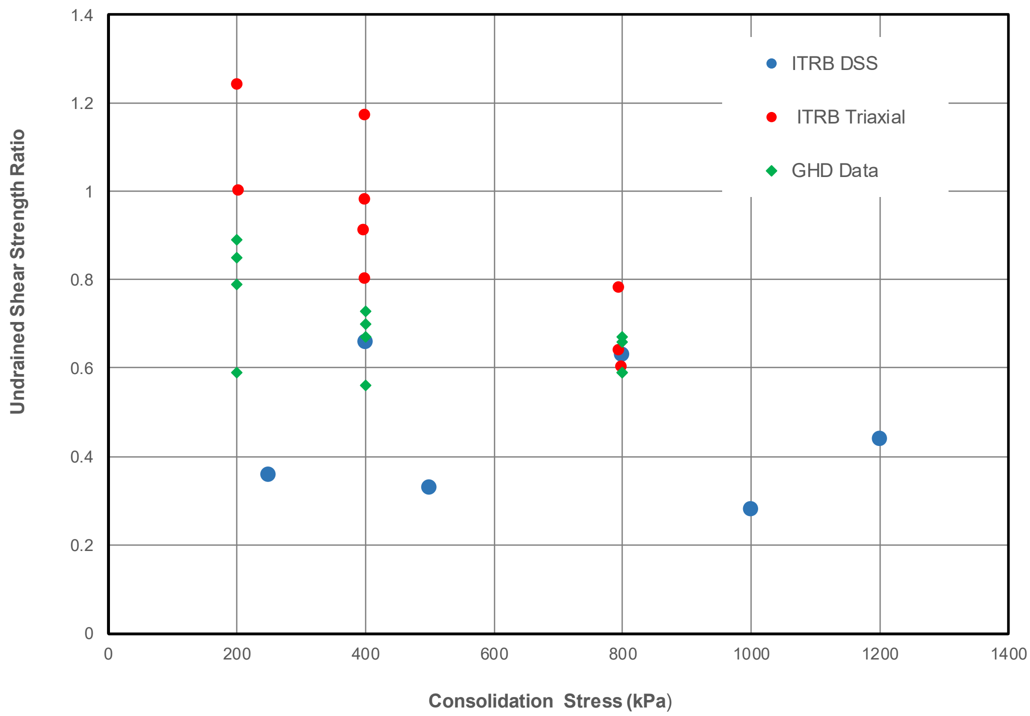


Figure D4-22: Unit B FRV: Undrained shear strength ratio vs consolidation stress

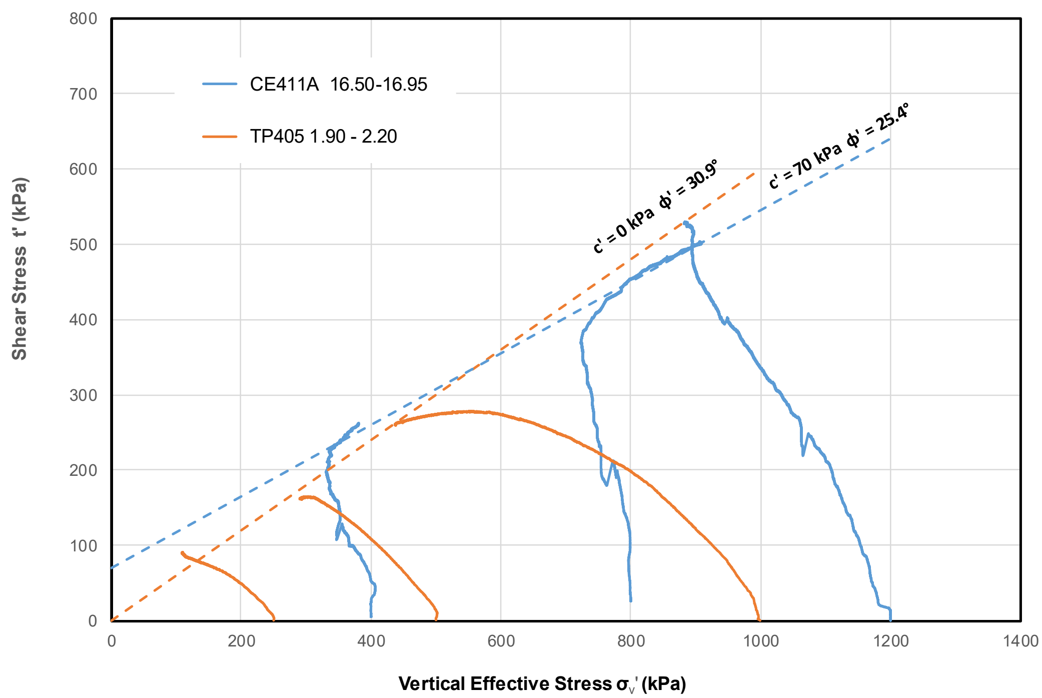


Figure D4-23: Unit B FRV – Shear stress versus vertical effective stress from DSS tests

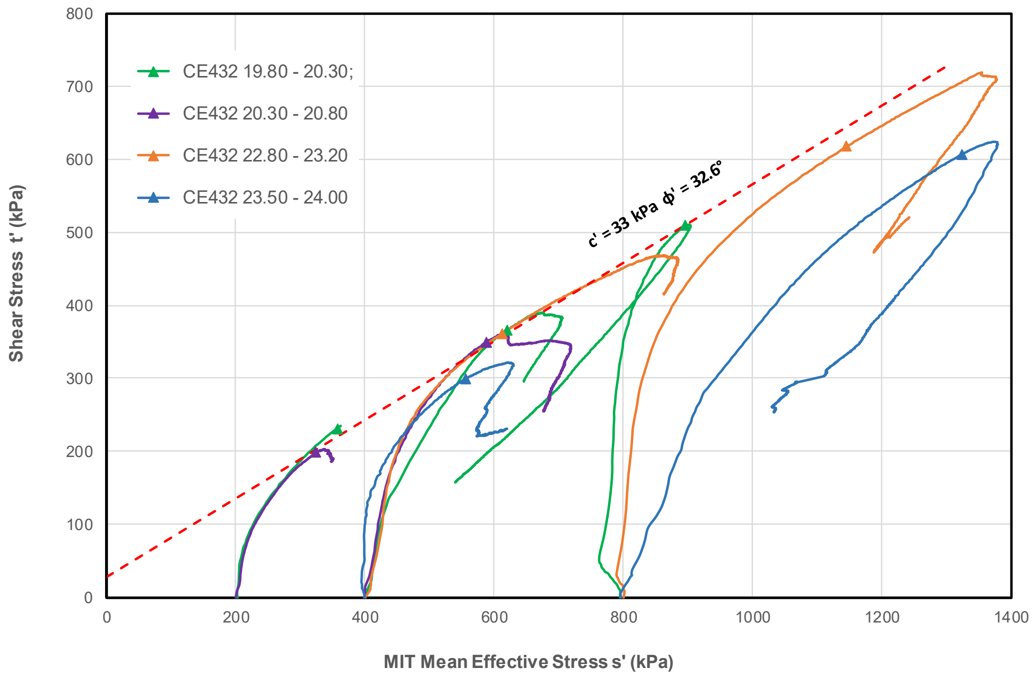


Figure D4-24: Unit B FRV - Stress paths for ITRB CIU triaxial tests

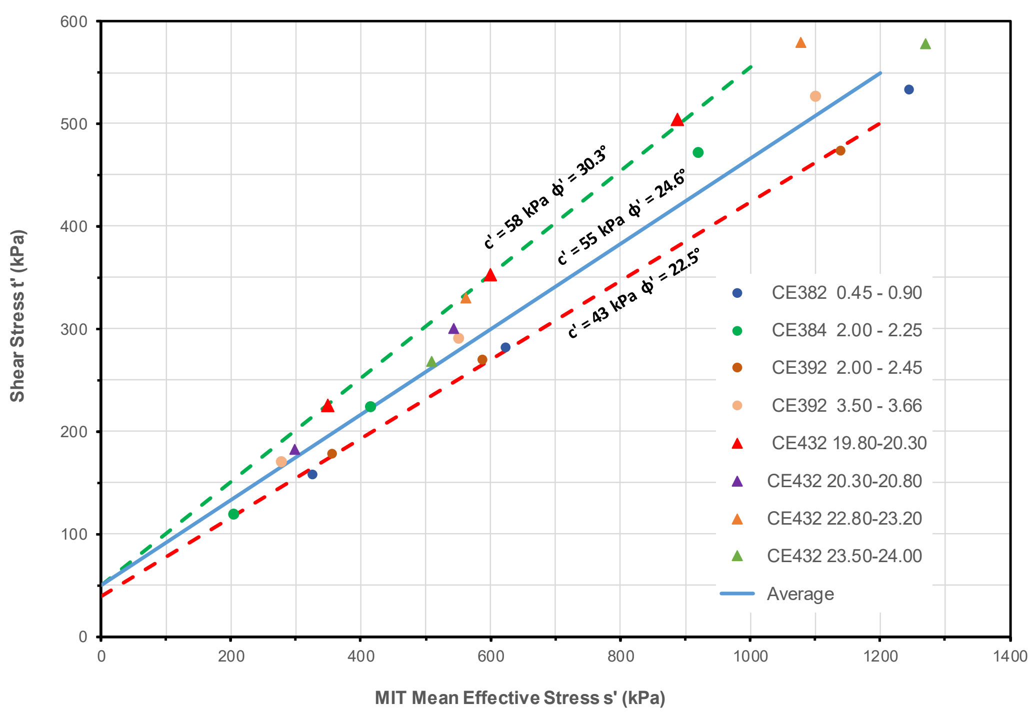


Figure D4-25: Unit FRV – MIT plot of shear strength at peak stress ratio

One direct shear test was completed on a section of FRV Unit B sonic core from CE406. Residual shear stress values are plotted on Figure D4-26.

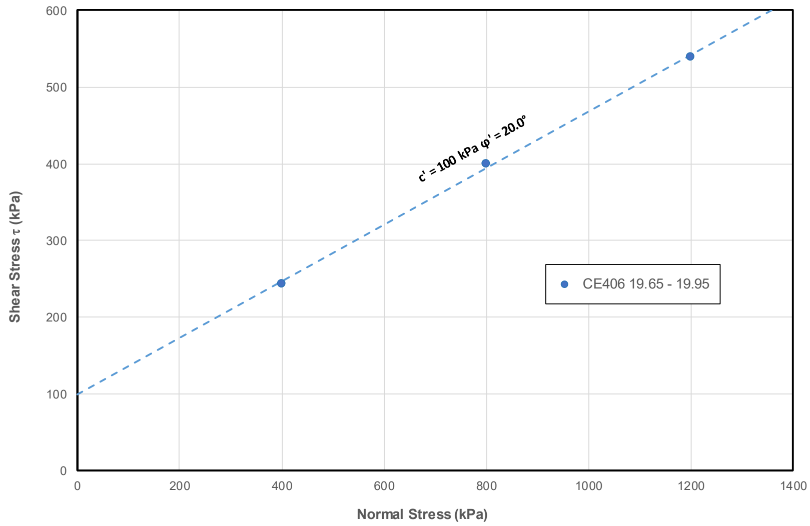


Figure D4-26: Unit B FRV – Residual shear stress values from direct shear

D4.5.3 Consolidation Tests

Two oedometer consolidation tests were completed on undisturbed samples of Unit B from Forest Reef Volcanics. The samples were loaded to 400kPa, unloaded to 100kPa, reloaded to 3200kPa, then, in the case of one sample, unloaded to 25kPa. The results are presented in Figure D4-27 as a plot of void ratio vs vertical effective stress and summarized in Table D4-12. The apparent pre-consolidation pressure (σ_p) indicated in Table D4-12 was calculated using the Casagrande Method.

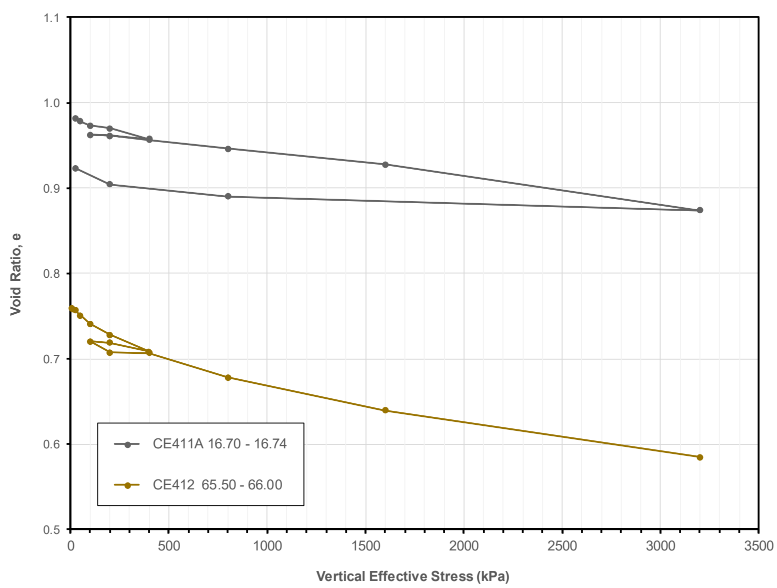


Figure D4-27: Unit B FRV – Oedometer consolidation plots

Table D4-12: Unit B FRV - Summary of consolidation test data

ID	Depth	RL	γd (t/m3)	w (%)	eo	Cr	Cc	σ'p
CE411A	16.70 – 16.74	673.3	1.44	30.9	0.982(1)	0.023	0.18	1000
CE412	65.50 – 66.00	666.6	1.50	26.1	0.758	0.022	0.18	400

Notes:

(1) Void ratio at initial loading stage

D5. Fill Materials and Nomenclature

D5.1 Embankment Zoning

The construction of the NTSF has been undertaken in ten (10) stages. The internal zoning and nomenclature has changed over the years and this is tracked in the following section.

The Stage 1 embankment had the following internal configuration;

- Zone A – A 5m wide sloping clay core, thickening to 12m at the base,
- Zone B – Upstream rockfill shoulder with a slope of 1.5H:1V,
- Zone D – Downstream rockfill shoulder with a slope of 1.5H:1V,
- Zone C1 – A 15m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone C3 – A secondary 5 m wide transition rockfill between Zone C1 and Zone A up to an elevation of 670 m,

The Stage 2A embankment, a 7m high zoned earth and rockfill downstream raise had the following internal configuration;

- Zone A – A 5m wide sloping clay core,
- Zone B – Rockfill shoulders with upstream and downstream slopes of 1.5H:1V,
- Zone B1 – Downstream Rockfill platform with a slope of 1.5H:1V
- Zone C4 – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone F – A secondary 1 m wide filter between Zone C4 and Zone A,

The Stage 2B embankment was also designed as a 7m downstream raise with zoning identical to Stage 2A, however Stage 2B was constructed in two separate lifts, each of 3.5m height. At this stage the nomenclature for the zones was changed from alphabetical to numerical. The Stage 2B dam had the following internal configuration;

- Zone 1 – A 5m wide sloping clay core,
- Zone 3B – Rockfill shoulders with upstream and downstream slopes of 1.5H:1V
- Zone 3A – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone 2A – A secondary 1 m wide filter between Zone C4 and Zone A,

The Stage 3 embankment was designed as a 4.5 m central raise with the upstream shell founded on the Stage 2 tailings beach. The embankment has upstream and downstream slopes of 2H:IV and 1.5H:IV respectively, and a 9 m crest width. The Stage 3 dam had the following internal configuration;

- Zone 1 – A 3m wide vertical clay core with a 3m wide cap
- Zone 3B or 3A – Rockfill shoulders with an upstream slope of 2H:1V and downstream slope of 1.5H:1V
- Zone 3A – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment, and
- Zone 3D – A working platform between the embankment and the tailings beach

Stages 4 through to 10 were designed as upstream raises of varying heights with upstream and downstream slopes of 2H:1V and 9m crests. These lifts had the following internal configurations;

- Zone 1 – A 4 m wide downstream sloping clay core with a 0.8 m horizontal clay blanket spanning the stage 3 Crest
- Zone 3B or 3A – Rockfill downstream shoulder with a slope of 2H:1V
- Zone 3A – A 3 m wide transition rockfill between the clay core and downstream rockfill shoulder of the embankment with a 0.6 m thick layer between the clay blanket and downstream rockfill, and
- Zone 3D – A working platform between the embankment and the tailings beach.

Table D5-1 provides a summary of the zone types for both Stage 1 / Stage 2A and Stage 2B.

Table D5-1: Summary of Stage 1 and 2 embankment zoning

Fill Type	Embankment Zones		Notes
	Stage 1/ Stage 2A	Stage 2B and Later	
Clay Fill	Zone A	Zone 1	Placed in 200 mm lifts
Rockfill	Zone B	Zone 3B	Monzonite Rockfill with a maximum Particle size of 600 mm, placed in 1.25 m lifts
	Zone D	Not Used	Silurian sedimentary Rockfill with a maximum particle size of 300 mm, placed in 650 mm lifts
	Zone B1	Not Used	Monzonite Rockfill with a maximum particle size of 1000 mm, end dumped in 5 m lifts.
	Not Used	Zone 3C	Monzonite Rockfill with a maximum Particle size of 1000 mm, placed in 5 m lifts
	Zone C4	Not Used	Monzonite Rockfill with a maximum Particle size of 300 mm, placed in 300 m lifts
	Not Used	Zone 3A	Monzonite Rockfill with a maximum Particle size of 300 mm, placed in 600 m lifts
	Not Used	Zone 3D	Well Graded Fresh Overburden from Mining Operations, Maximum Particle size of 300 mm
Filters	Zone C1	Not Used	Silurian Sedimentary Rockfill, Placed in 300 mm lifts
	Zone C3	Not Used	Silurian Sedimentary Rockfill, Placed in 300 mm lifts
	Zone F	Not Used	Placed in 300 mm lifts
	Not Used	Zone 2A	Placed in 300 mm lifts

D5.2 Clay Fill

D5.2.1 Previous Investigations

Prior to construction, two rounds of tests were conducted on the clayey soils within the reservoir area and within the foundation footprint for the purpose of clay borrow investigations. The first was by Woodward-Clyde as part of the Cadia Mine Feasibility Study (1995-001) and the second by Pells Sullivan Meynink (1997-001) as part of a supplementary site investigation for detailed design. The samples taken by Pells Sullivan Meynink (PSM) were combined to create bulk samples as follows;

- TP100 to TP104 - upper right abutment, above RL705 m
- TP105 to TP107 - plateau area on right abutment at RL 705 m
- TP108 to TP112 - central right abutment
- TP113 to TP115 - lower right abutment, below about RL686 m
- TP118 to TP121 - left abutment (all residual andesite)

Effective stress strength parameters were determined on three Woodward Clyde and one PSM sample compacted to 98% of Standard Maximum Dry Density. The results of these tests are summarized in Table D5-2, together with the results of three similar tests completed by Woodward Clyde in 2000 (2000-003) on samples from Lower Rodds Creek (LRC) TSF, now the STSF. An MIT plot of these tests, together with three tests completed for Upper Rodds Creek (URC) dam or presented as Figure D5-1.

Table D5-2: Results of preconstruction triaxial strength tests

Test Pit	Depth (m)	MC (%)	γd (kN/m3)	c' (kPa)	ϕ' (degrees)
Woodward-Clyde Investigation (1995)					
TS12	0.3 - 0.6	19.3	1.71	18	30
TS6	0.2 - 1.4	19.8	1.71	79	22
TD38	1.9 - 4.1	18.4	1.71	32	25
Pells Sullivan Meynink Investigation (1997)					
TP100 +TP107	Combined	27.2	1.48	6	24
Woodward-Clyde Investigation (2000)					
TP4	0.6 - 1.5	16.0	-	20	26.5
TP6	0.6	17.1	-	15	27
TP26	1.0	19.4	-	20	22.5

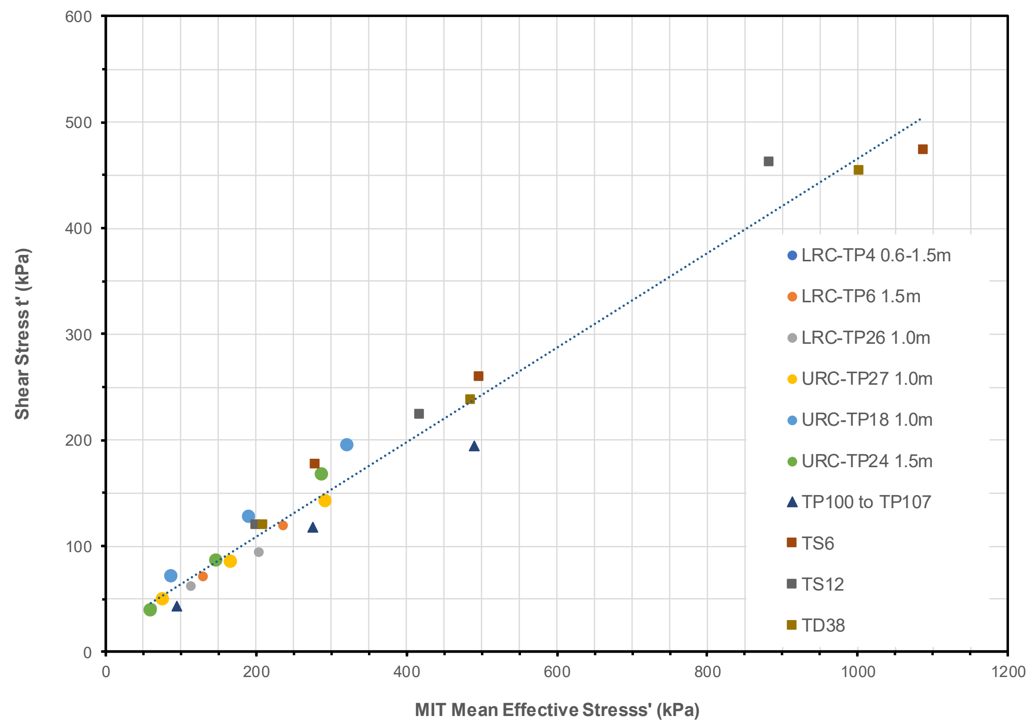


Figure D5-1: MIT plot of preconstruction and 2000 triaxial tests

D5.2.2 Construction

The specifications for Zone A/1 are provided in Table D5-3 and Table D5-4.

Table D5-3: Zone A/1 - Gradation specification

Grain size (mm)	Percent Passing (%)	
	Min	Max
37.5	100	100
19	95	100
4.75	85	100
1.18	65	100
0.425	50	100
0.25	35	95
0.075	20	90
0.002	8	80
0.001	0	0

Table D5-4: Zone A/1 - Atterberg Limit Specification

Atterberg Limits	
Liquid Limit (%)	25-80
Plasticity Index (%)	10-50
Linear Shrinkage (%)	<20

Atterberg limits from Quality Assurance (QA) testing of Stage 1 and Stage 2A clay core materials, presented on Figure D5-2 and Figure D5-3 respectively, show that tested materials generally conformed to the construction specification

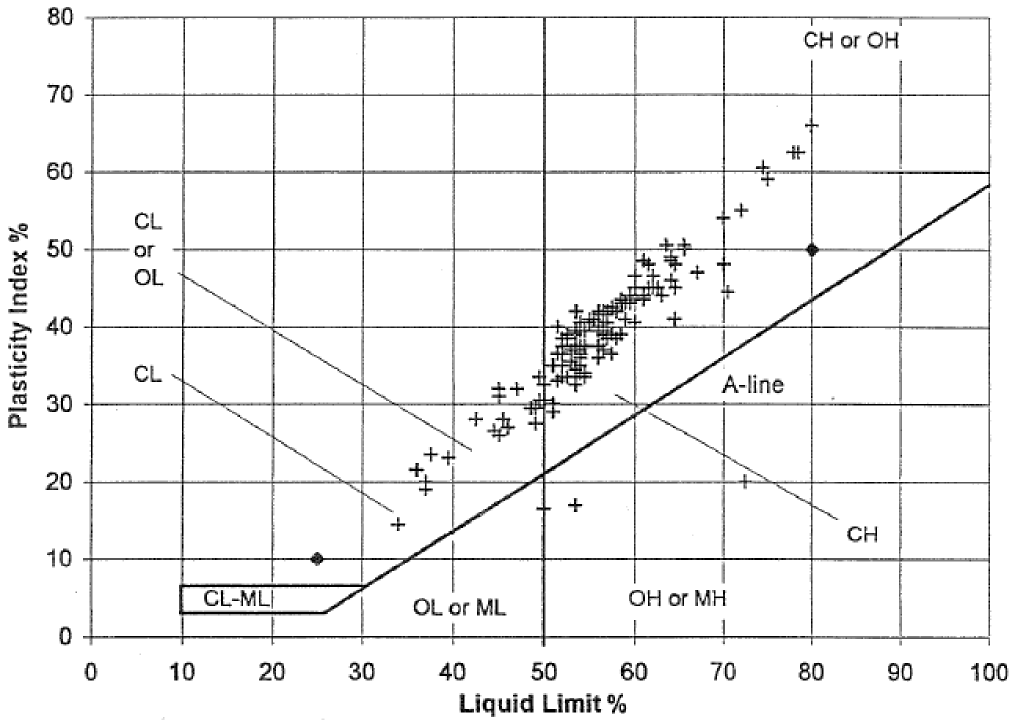


Figure D5-2: Stage 1 – Atterberg Limits from construction QA

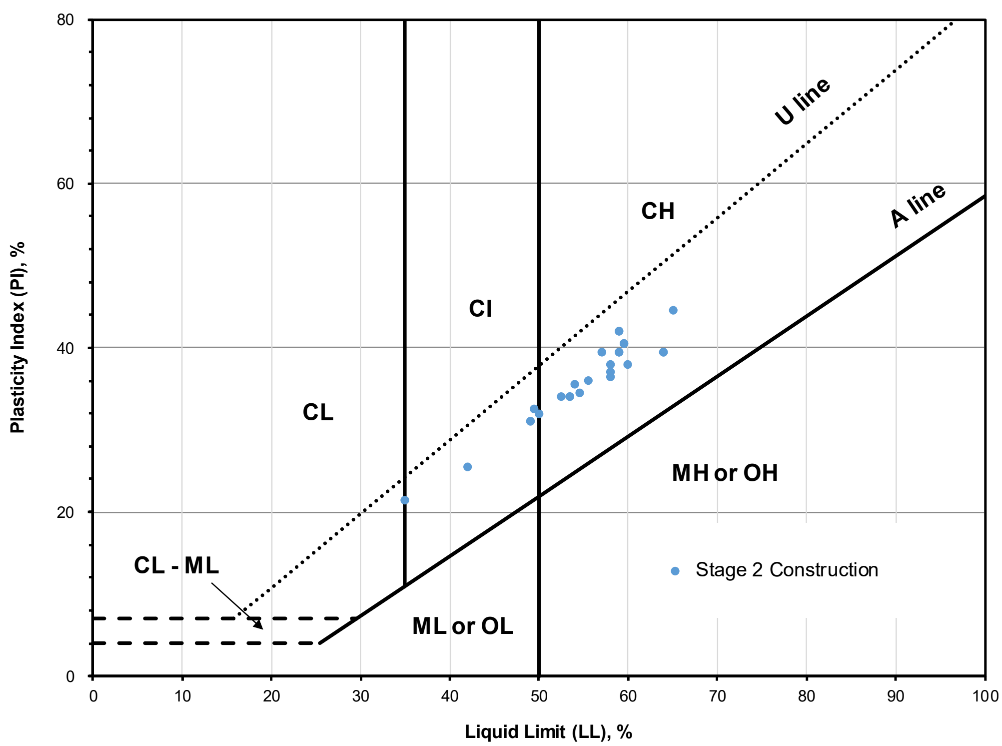


Figure D5-3: Stage 2A – Atterberg limits from construction QA.

D5.2.3 ITRB Investigation Data

As part of the ITRB investigation program, one drill hole (CE407) was completed specifically to intersect and sample the Stage 1 embankment clay core. The clay core intersected, over a depth of 3.5m, was high plasticity brown clay and three undisturbed samples were recovered. Two CIU tests and one oedometer consolidation test were completed on these samples.

Undrained shear strength data from the two CIU tests are summarized in Table D5-5, while the undrained shear strength ratio for these and the pre-construction tests (Table D5-2) are plotted in Figure D5-4. As could be expected the post peak mobilized friction shows only a minimal post peak reduction.

An MIT plot of effective stress strength results for the ITRB and previous tests is presented as Figure D5-5, while consolidation test results are presented in Figure D5-6 and Table D5-6.

Table D5-5: Clay Core – Undrained shear strength data

Sample No	Depth (m)	Consol. Stress (kPa)	Dry Density (kN/m^3)	Shear Strength		Stress Ratio		Test Type
				Peak (kPa)	Post Peak (kPa)	Peak	Post Peak	
CE407	50.00 – 50.50	613	1.73	207	-	0.34	-	CIU
CE407	50.00 – 50.50	812	1.73	294	-	0.36	-	CIU
CE407	50.00 – 50.50	1203	1.73	396	345	0.33	0.29	CIU
CE407	51.00 - 51.50	1202	1.77	456	445	0.38	0.37	CIU

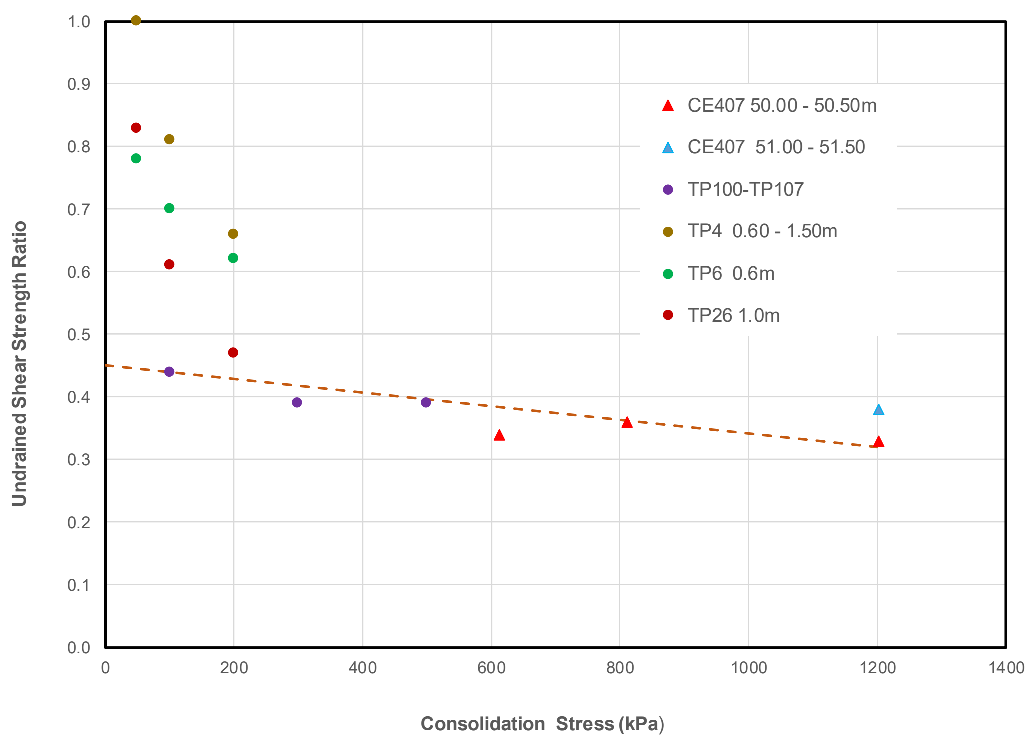


Figure D5-4: Clay Core – Undrained shear strength ratio results.

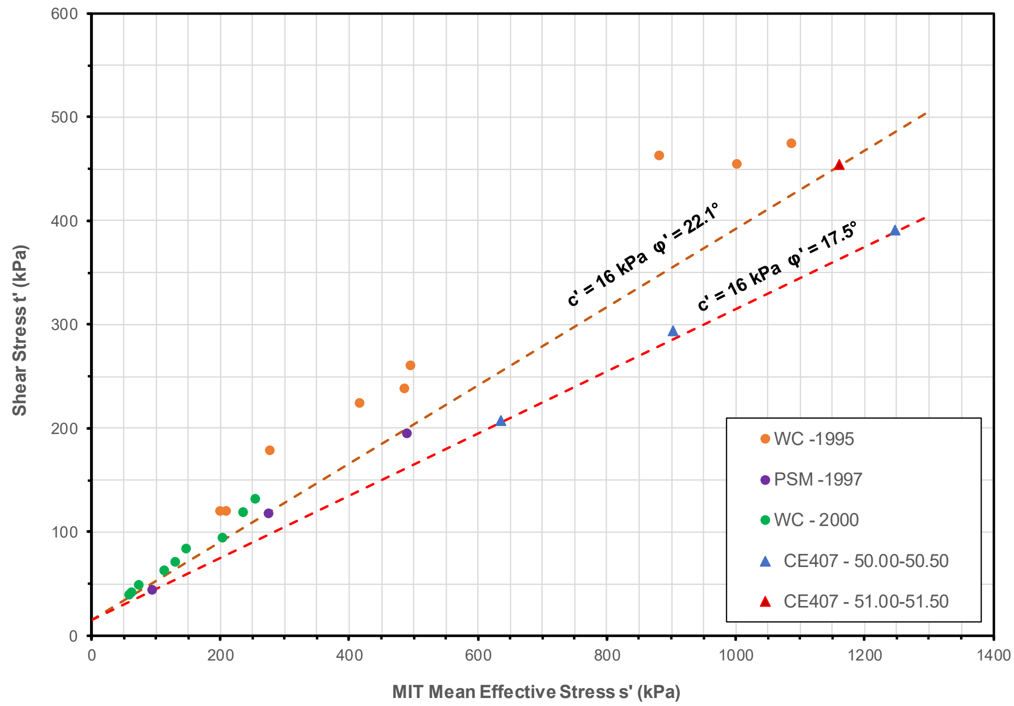


Figure D5-5: Clay Core – MIT plot of effective stress strength data

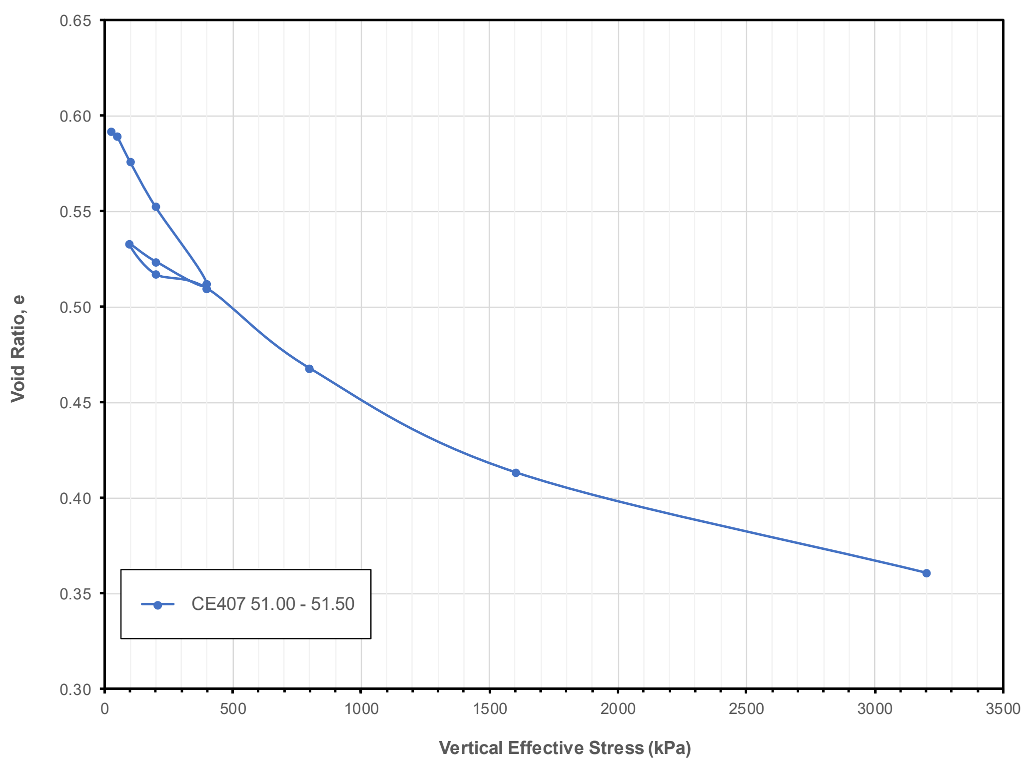


Figure D5-6: Clay Core – Oedometer consolidation test result

Table D5-6: Clay Core - Summary of consolidation test data

ID	Depth	RL	γd (t/m3)	w (%)	eo	Cr	Cc	σ'p
CE407	51.00 – 51.50	680.5	1.63	22.2	0.578	0.038	0.175	180

D5.3 Rockfill

D5.3.1 Construction

Rockfill (both Monzonite, and Silurian Sedimentary rock), was sourced from the initial stripping and mining operations for the open pit. The various specifications for these materials are summarised in Table D5-7.

Table D5-7: Rockfill – Type and construction specification.

Zone	Maximum Particle Size (mm)	Maximum Lift Thickness (m)	Compaction Requirements	Rock Type
B/3B	600	1.25	5 passes of a 10-tonne static weight vibrating roller	Fresh Monzonite Rock
B1	1000	10	End-dumped	Fresh Monzonite Rock
C4	300	0.3	2 passes of a 3-tonne static weight vibrating roller	Fresh Monzonite Rock
D	300	0.65	5 passes of a 10-tonne static weight vibrating roller	Silurian Sedimentary Rock
3A	300	0.6	5 passes of a 5-tonne static weight vibrating roller	Fresh Monzonite Rock
3C	1000	5	Trafficking of Haul Trucks with High Energy Impact Compaction.	Fresh Monzonite Rock

During construction of Stage 1, it became apparent that the volume of monzonite rock for Zone B was limited, and placement was constrained by double handling. As a consequence, the upstream shoulder was retained as Zone B (monzonite) while the downstream shoulder was changed to Silurian sedimentary rock (Zone D), compacted in the same manner as Zone B.

The Silurian sedimentary rockfill, designated as Zone D, was initially considered inferior to the igneous rock (Zone B) and as a consequence, the Stage 1 design was modified to incorporate a downstream waste rock berm (Zone B1), with a crest width of 32m at RL690m, and a downstream slope of 1.35H:1V. Zone B1 consisted of monzonite directly hauled from the open pit. Subsequently, direct shear tests on Zone D material indicated that it met the requirements of the original design, and placement of Zone B1 was postponed even though it formed part of the Stage 2 embankment. The direct shear tests on Zone D material are not reported in the construction documentation.

No quality control testing was completed on any of the rockfill zones.

D5.3.2 Design Shear Strength

Due to the difficulty (particle size and variability) and cost of performing large-scale tests on rockfill, no strength tests were completed for design nor insitu density tests during construction.

The bulk density used in design for the rockfill ranged between 19 kN/m^3 and 20 kN/m^3, while drained strength parameters of c' = 0kPa and ϕ' = 40° were adopted for rockfill and c' = 0kPa and ϕ' = 42° were adopted for the finer transition zone.

The rockfill strength parameters adopted for design were checked using Leps (1985) assembled published laboratory test data on rockfill strength and reported the friction angle as a function of normal pressures, as deduced from the Mohr diagram. A shortfall of the Leps data set is a lack of information at normal pressures below 70kPa. Lepps also acknowledges that this data only provides a rough estimate of the effects of relative density, gradation, and the effect of crushing, and that there is no evaluation of particle shape or degree of saturation influence

The Leps data set was subsequently been screened to include only fine grained igneous rocks similar to that which was used in the NTSF. This data is reproduced in Figure D5-7 and indicates that a friction angle of 40° to 42° is appropriate for a normal stress of 1000 to 2000 kPa.

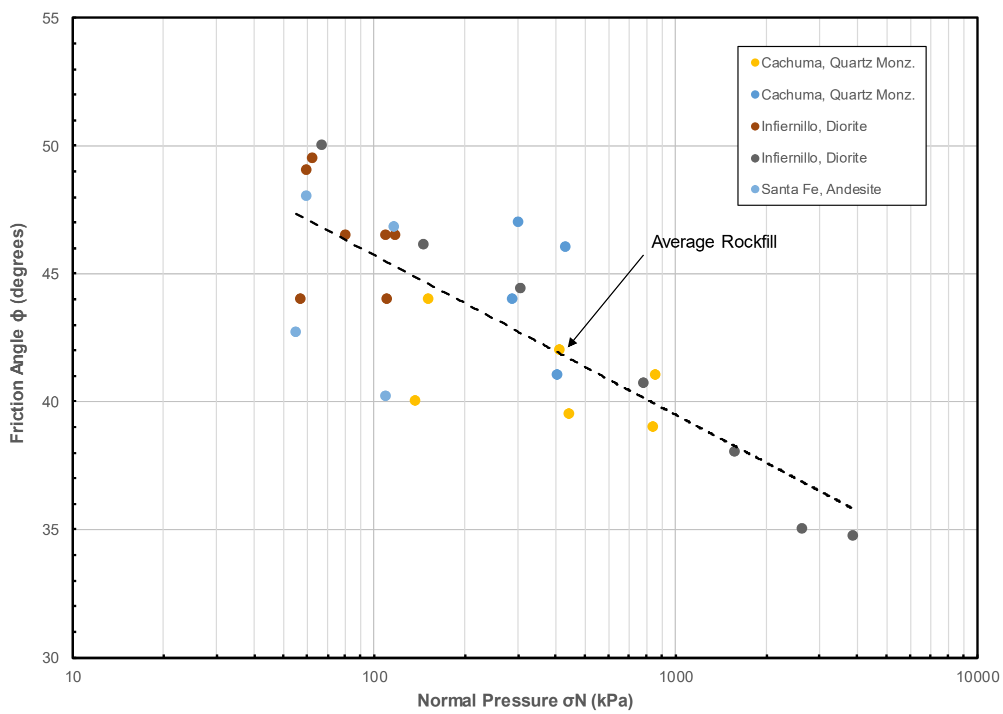


Figure D5-7: Leps (metric version) including fine grained igneous rocks

The reduction in shearing strength with confining pressure observed in triaxial tests on rockfill can also be described by the equation:

$$\tau = A\,(\sigma_n)^b$$

Where:

- τ = rockfill shear strength
- σ_n = normal stress
- A & b are constants.

Haselsteiner et. al. (2016) have looked at a more recent database of rockfill testing (2009) and have proposed four rock fill strength classes using the A b parameters as indicated in Figure D5-8.

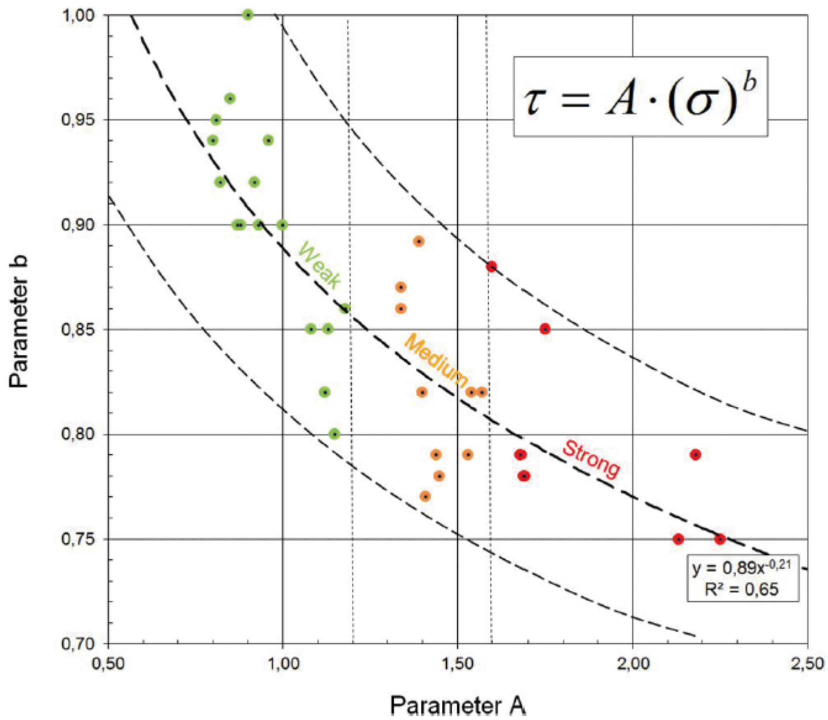


Figure D5-8: Rockfill strength parameters (Haselsteiner et al.)

Parameters A = 0.90, b = 0.97 provide a reasonable approximation to the lower bound strength in Lepps, while parameters of A = 1.9, b= 0.85 provide a reasonable approximation of the average rockfill strength for fine grained igneous rock shown in Figure D5-7.

D5.3.3 Deformation Modulus

The modulus of compressibility (E) of the rockfill is dependent on the rock type, strength, shape and gradation of rock sizes in the rockfill and layer thickness. It is also dependent on the roller size and type, number of passes, whether water is added during compaction, the confining stresses on the rockfill and also the duration of loading, i.e. there is a creep component.

Hunter and Fell (2002) developed a method for estimating the secant modulus of rockfill during construction (Erc) and pseudo modulus on first filling (Erf) based on analysis of monitoring data, mostly for concrete faced rockfill dams. Hunter and Fell recommend determining the representative secant modulus at the end of construction Erc using the D80 of the rockfill for rockfill of various strength as indicated in Figure D5-9.

In the case of the NTSF, with only the maximum particle size specified for the rockfill, a coefficient of uniformity (CU) of 7.5 (used to prevent gap-graded filters) can be used to determine the D80. For the three rockfills specified above, the secant modulus can be estimated as an average of 75 MPa.

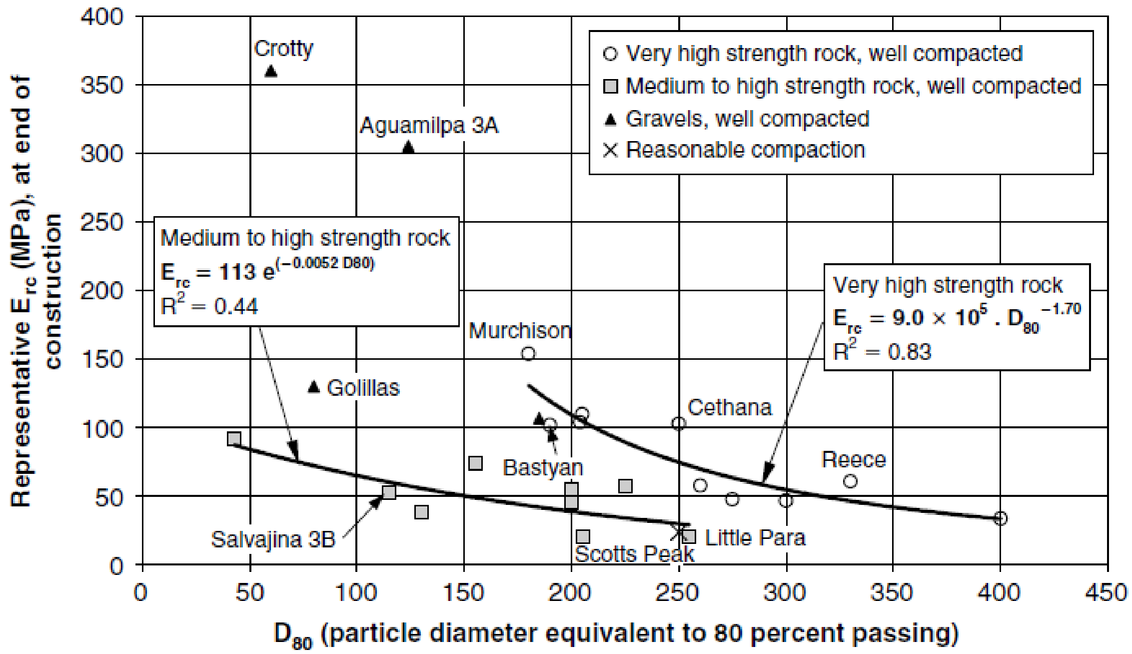


Figure D5-9: Representative secant modulus versus particle size and UCS

D5.3.4 Dynamic Shear Modulus

GHD were engaged by Newcrest to complete a geophysical investigation in the vicinity of the NTSF and STSF which comprised six ERI traverses and twelve Seismic Refraction Tomography (SRT) traverses.

Seismic refraction traverse Line 7 was located along the toe of the NTSF southern embankment. The traverse was approximately 1650m long and commenced on the eastern abutment of the NTSF and terminated on the partially constructed Stage 2 Buttress at approximately CH2500. As part of the seismic refraction traverse, Multi-channel Analysis of Surface Wave (MASW) soundings were completed at 18m intervals along the traverse. The output of the MASW soundings is a profile of shear wave velocity with depth which in turn can be interpreted as a profile of the dynamic shear modulus with depth.

A selection of MASW soundings completed along the Stage 2 Buttress were analysed to assess the dynamic shear modulus of the embankment rockfill. The results from nine MASW soundings are plotted on Figure D5-10 as the minimum, average and maximum shear wave velocity against the average thickness of the respective layers.

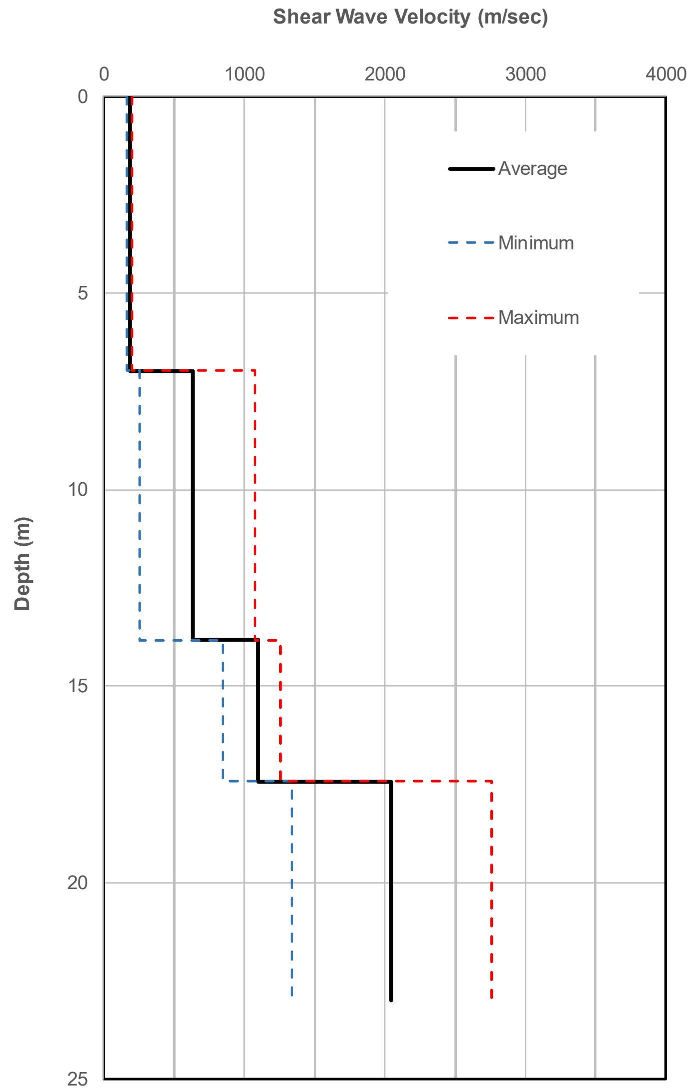


Figure D5-10: Stage 2 Buttress Rockfill – Shear wave velocity ranges

Due to the variable thickness of the rockfill at the toe of the southern embankment, the dynamic shear modulus calculated from specific soundings was compared with materials intersected in adjacent drillholes. In the case of drillholes CE403 and CE404, the midpoints of the soundings were located within 10m of the drillholes, while the nearest sounding to CE405 was located 100m to the east. The results for these three soundings are shown on Figure D5-11.

Taking into consideration possible errors in the layer thicknesses calculated from the MASW sounding, Table D5-8 provides a comparison of material type, shear wave velocity and dynamic shear modulus based on drillholes CE403, CE404 and CE405.

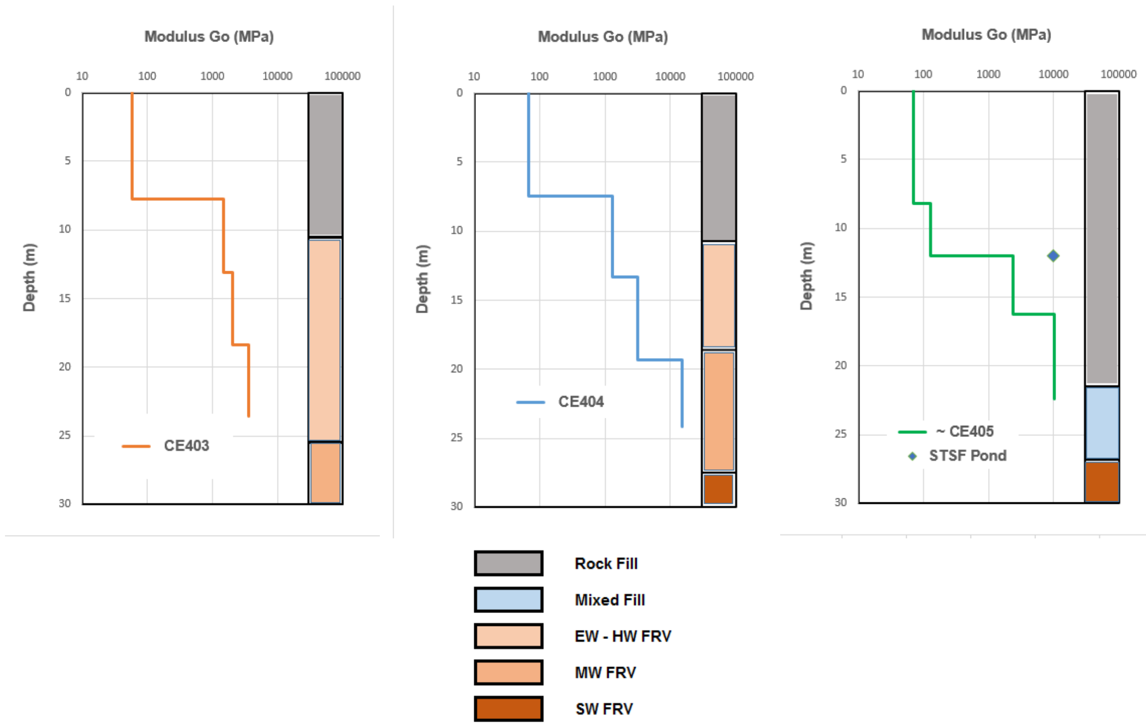


Figure D5-11: Stage 2 Buttress Rockfill – Comparison of MASW soundings and drillholes

Table D5-8: Comparison of shear wave velocity, dynamic shear modulus and material

Material Type	Shear Wave Velocity (m/sec)	Dynamic Shear Modulus (MPa)
Rockfill	170 - 260	60 - 130
EW – HW Volcanics	810 – 1,090	1,310 – 2,390
MW Volcanics	1,250 – 1,340	3,140 – 3,580
SW- Fresh Volcanics	2,260 – 3,080	10,190 – 20,870

D5.4 Filters

D5.4.1 Construction

As Stages 1 and 2 of the NTSF were design as water retaining structures, filters were provided between the clay core and the downstream rockfill. The specification for these materials are summarised in Table D5-9.

Table D5-9: Filter Specification

Particle Size (mm)	Zone C1	Zone C3	Zone F
300	100-100		
200	96-100		
160	87-100		
80		100-100	
75	83-100	83-100	100-100
63	80-100	80-100	-
53	77-100	77-100	-
37.5	72-100	72-100	94-100
26.5	66-100	66-100	-
19.0	60-98	60-98	90-100
13.2	54-92	54-92	-
9.5	50-87	50-87	74-100
6.7	43-80	43-80	-
4.75	38-75	38-75	60-100
2.36	28-62	28-62	44-100
1.18	19-50	19-50	28-85
0.60	13-42	13-42	10-65
0.425	9-36	9-36	-
0.30	6-32	6-32	0-45
0.15	2-22	2-22	0-20
0.075	0-13	0-13	0-10
0.050	0-12	0-12	
0.001	0-0	0-0	

A major change to the design during the construction, was the inclusion of transition, Zone C3, as an L shaped zone at the base of Zone C1 and between Zone C1 and the core. Whereas Zone C1 was < 300mm Silurian sedimentary rock visually selected in the open pit, Zone C3 was crushed to < 80mm, placed in 300mm loose layers and compacted with 1 pass of a 10 tonne static weight vibrating roller. The base leg of Zone C3 was 10m wide and extended up the abutments to RL695 as a 1m thick layer, while the upstand leg was 5m wide and extended full height to RL670 and then 3m height between RL670 and RL680.

Excavation beneath the clay core and transition/ filter was undertaken to expose hard residual soil or extremely weathered rock. Where potentially permeable material was identified in the downstream side of the core trench, the core trench was widened (on the downstream side by 6m and blanketed with Zone A. Zone C3 filter was then extended over the widened section of core trench.

D5.4.2 Quality Control

Apart from the Clay Core, Zones C1 and C3 were the only materials that were tested regularly as part of the QA. The summarised results for Stage 1 QA on Zone C1 and C3 are shown in Figure D5-12, however the tests did not distinguish between Zone C1 and Zone C3, even though they had separate specifications.

During construction, concerns were raised regarding the particle size distribution of Zone C1, as the contractor consistently had difficulties in achieving the specified material grading. Test excavations in this material indicated that voids were filled. It was also decided to complete a large scale slot test to assess the potential for piping.

The test was completed in a 44-gallon drum and Zone C1 and Zone A materials were compacted in layers. An 8 mm cable, embedded into the Zone A material, was pulled out to create an artificial crack. The test confirmed, that under a significant head, the artificial crack in the did not propagate.

There exists no documentation for the QA/QC testing on Zone F, however the Stage 2A construction report states that “After some initial teething problems and plant modifications, a sand/gravel product meeting the specification requirements was consistently produced”.

The average QA/QC data for Zone 2A is reproduced in Figure D5-13.

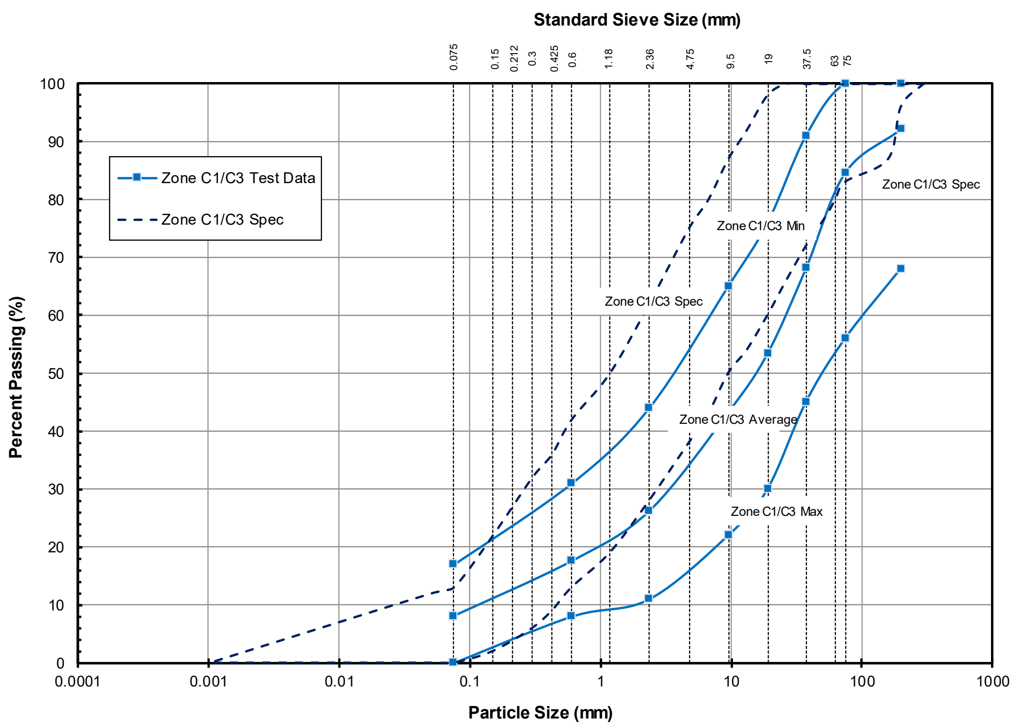


Figure D5-12: QA/QC Data for Zones C1/C3

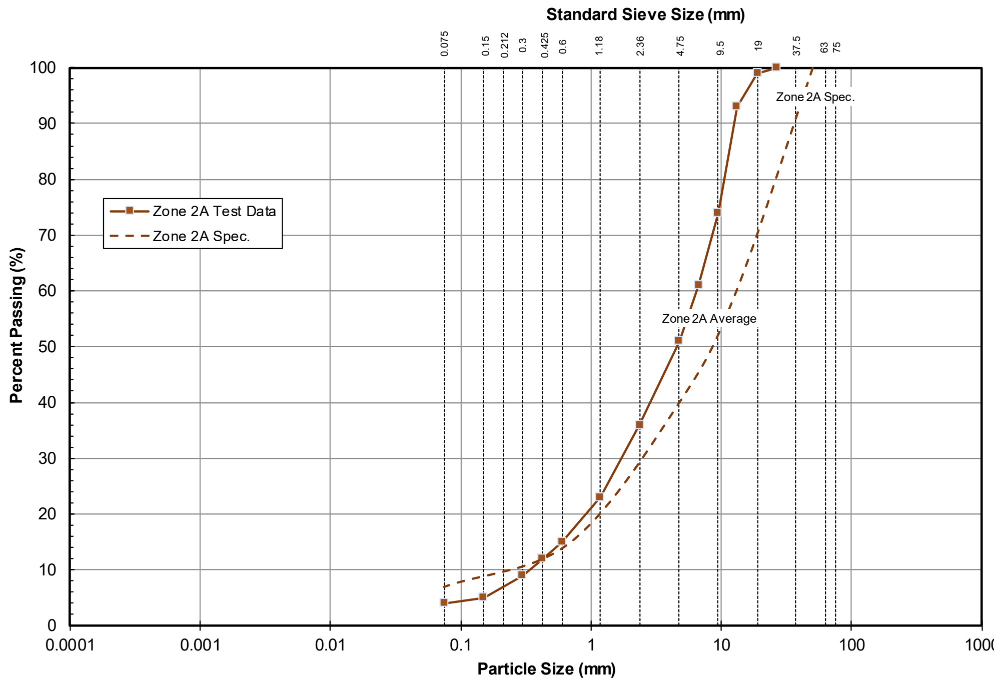


Figure D5-13: QA/QC Data for Zone 2A

D5.4.3 Filter Design Criteria

A filter criteria analysis was completed to assess the suitability of Zone C1/C3 to act as a critical filter for Zone 2A. This analysis, based on Chapter 26 of the National Engineering Handbook (1994), assesses filtering criteria, permeability criteria, prevention of gap-graded filters, and segregation criteria. As shown in Figure D5-14, Zone C1/C3 complies with the permeability and filter criteria at the D15 size. However, it becomes too coarse and well graded to comply with gap-graded prevention and segregation criteria. Zone 2A complies with all criteria except for gap-graded prevention at the D60 size.

A second analysis was completed to determine the internal stability of both filters using the Kenny and Lau (1985) method. The Zone C1/C3 filters fall well within the unstable zone while the Zone 2A filter falls just outside of the zone.

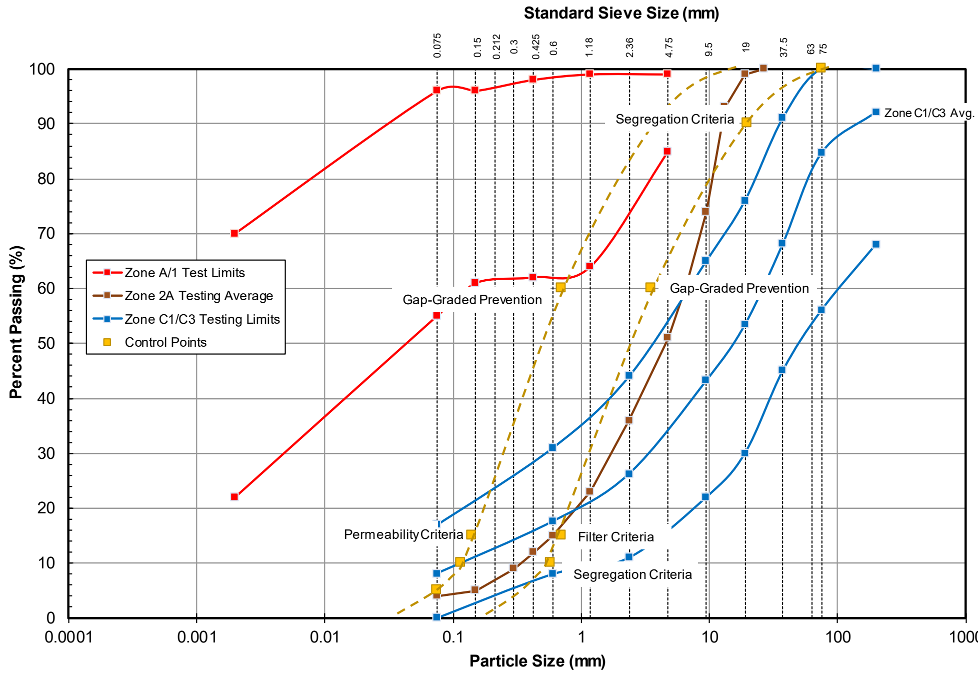


Figure D5-14: Filter Criteria for Zone A/1 with Zone C1/C3 and Zone 2A

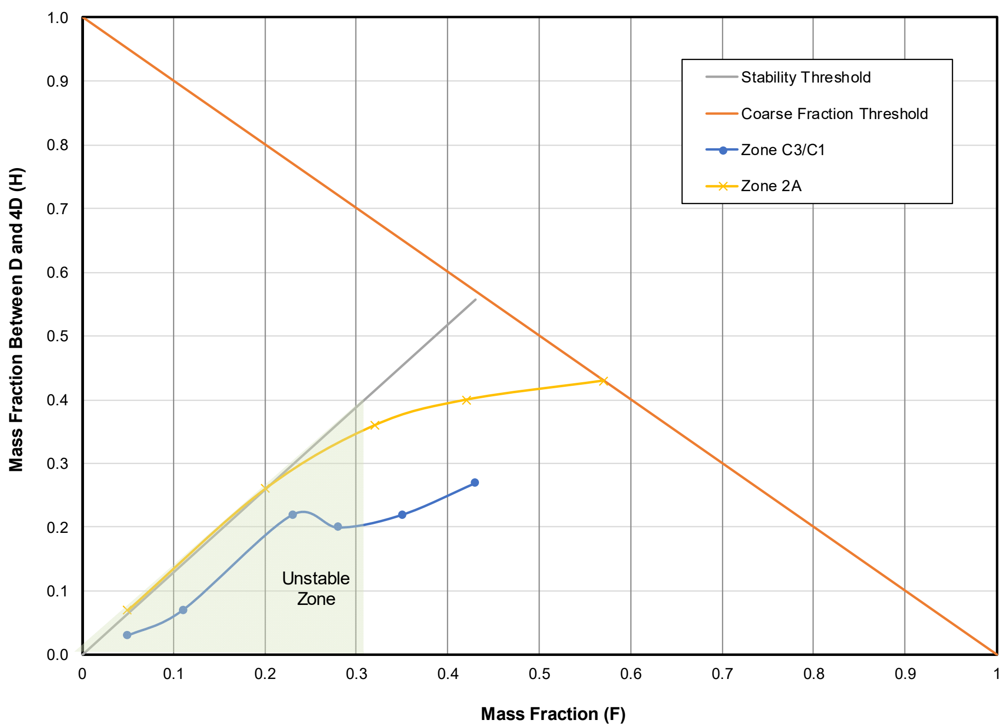


Figure D5-15: Internal stability analysis for Zone C1/C3 and Zone 2A

D6. References

Hunter, G., & Fell, R. (2002). *The Deformation Behaviour of Rockfill. UNICIV Report No. R405, School of Civil and Environmental Engineering, The University of New South Wales.*

Kenny, T., & Lau, D. (1985). *Internal stability of granular filters.* Candian Geotechnical Journal.

Leps, T. (1970). Review of Shearing Strength of Rockfill. *Journal of the Soil Mechanics and Foundations Division*, 1159-1171.

National Engineering Handbook. (1994). *Gradation Design of Sand and Gravel Filters.* United States Department of Agriculture - Natural Resources Conservation Service .

Annexure DA
Index Tests

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations

IPO Number: 2018-017
Sample ID: Refer to Table
Borehole ID: Refer to Table

Tested By:	KM	**Checked By:**	RC
Date:	Refer to Table	**Date:**	26/09/2018

ATTERBERG LIMITS
Test Method: AS1289.3.9.1, AS1289.3.2.1 and AS1289.3.3.2

Borehole ID	Sample No.	Sample ID	Date Tested	Depth (m)		W_L* (%)	W_P* (%)	I_P*	LS*	
				From	To				(%)	mode*
CE411	PT1	2018-017-005	25/09/2018	3.00	3.45	**59**	**21**	**38**	**15.0**	**Cracking**
CE411A	PT2	2018-017-007	18/09/2018	12.50	12.95	**53**	**27**	**26**	**12.0**	**Curling**
CE411A	PT4	2018-017-011	25/09/2018	15.00	15.35	**54**	**27**	**27**	**11.5**	**Curling**
CE411A	PT5	2018-017-016	25/09/2018	16.50	16.95	**53**	**31**	**22**	**12.5**	**Curling**

* W_L = Liquid Limit, W_P = Plastic Limit, I_P = Plasticity Index, NP = Non Plastic, LS = Linear Shrinkage
Method of preparation : Dry sieved, History of sample : Oven dried at 50^0c
mode = condition after drying

Cadia NTSF Failure - Laboratory Testing
Atterberg Limits

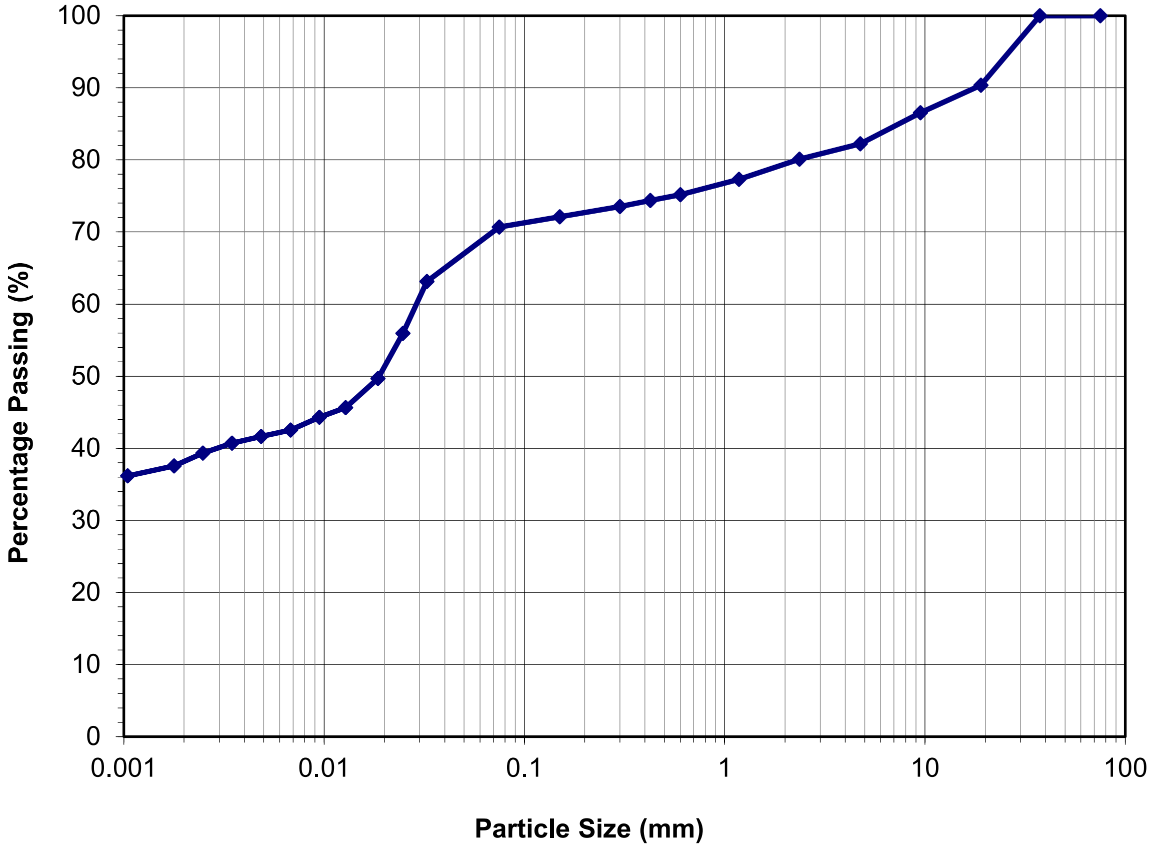
Job No.LAB127730

Figure A2-1

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-005
Location:	Cadia Valley Operations	**Borehole ID:**	CE411
Sample No.:	PT1	**Depth:**	3.00 m to 3.45 m

Tested By:	KM	**Checked By:**	RC
Date:	26/09/2018	**Date:**	28/09/2018

PARTICLE SIZE DISTRIBUTION
Test Method: AS1289.3.6.1 & AS1289.3.6.3



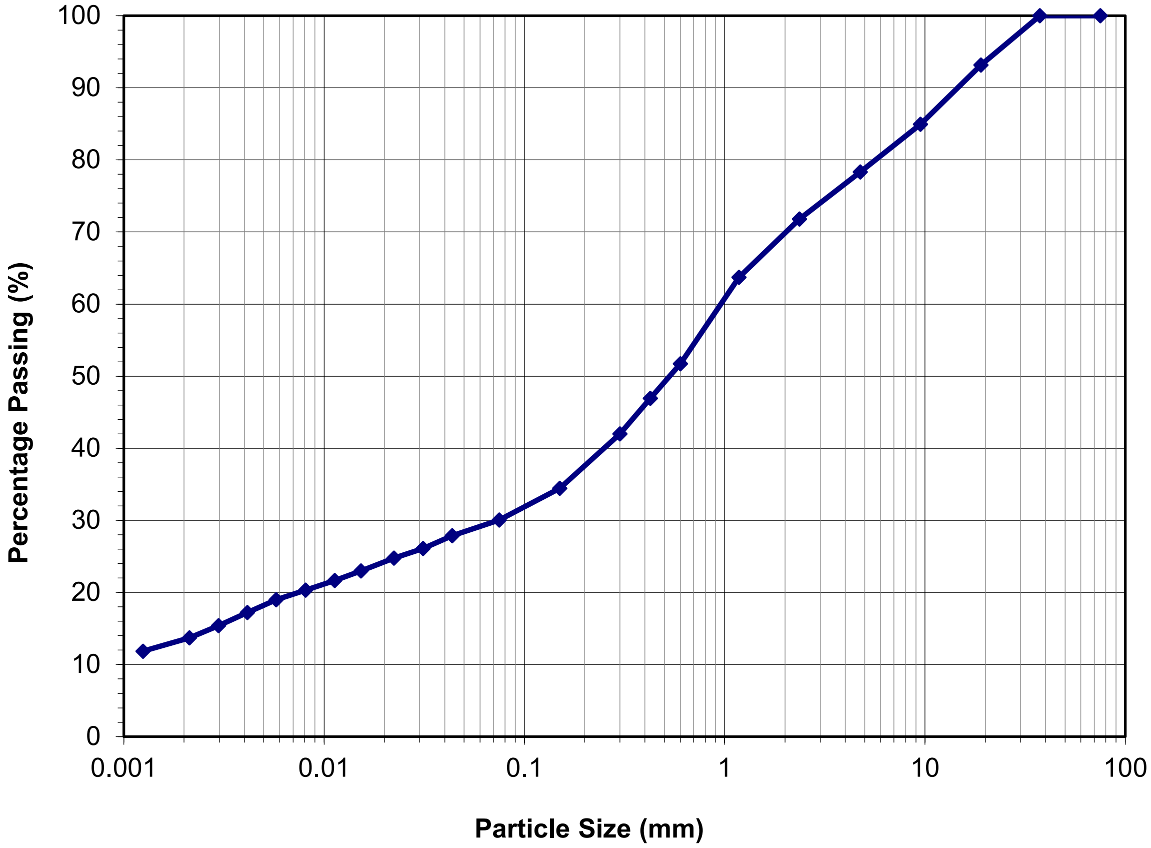
Sieve Analysis				Hydrometer Analysis			
Particle size (mm)	% passing	Particle size (mm)	% passing	Particle size (mm)	% passing	Particle size (mm)	% passing
75	100	1.18	77	0.0326	63	0.0049	42
37.5	100	0.600	75	0.0248	56	0.0035	41
19	90	0.425	74	0.0186	50	0.0025	39
9.5	87	0.300	74	0.0128	46	0.0018	38
4.75	82	0.150	72	0.0095	44	0.0010	36
2.36	80	0.075	71	0.0068	43		

Project
Particle Size Distribution

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-007
Location:	Cadia Valley Operations	**Borehole ID:**	CE411A
Sample No.:	PT2	**Depth:**	12.50 m to 12.95 m

Tested By:	SL/KM	**Checked By:**	RC
Date:	20/09/2018	**Date:**	28/09/2018

PARTICLE SIZE DISTRIBUTION
Test Method: AS1289.3.6.1 & AS1289.3.6.3



Sieve Analysis			
Particle size (mm)	**% passing**	**Particle size (mm)**	**% passing**
75	100	1.18	64
37.5	100	0.600	52
19	93	0.425	47
9.5	85	0.300	42
4.75	78	0.150	34
2.36	72	0.075	30

Hydrometer Analysis			
Particle size (mm)	**% passing**	**Particle size (mm)**	**% passing**
0.0436	28	0.0058	19
0.0312	26	0.0041	17
0.0223	25	0.0030	15
0.0153	23	0.0021	14
0.0113	22	0.0012	12
0.0081	20		

Project
Particle Size Distribution

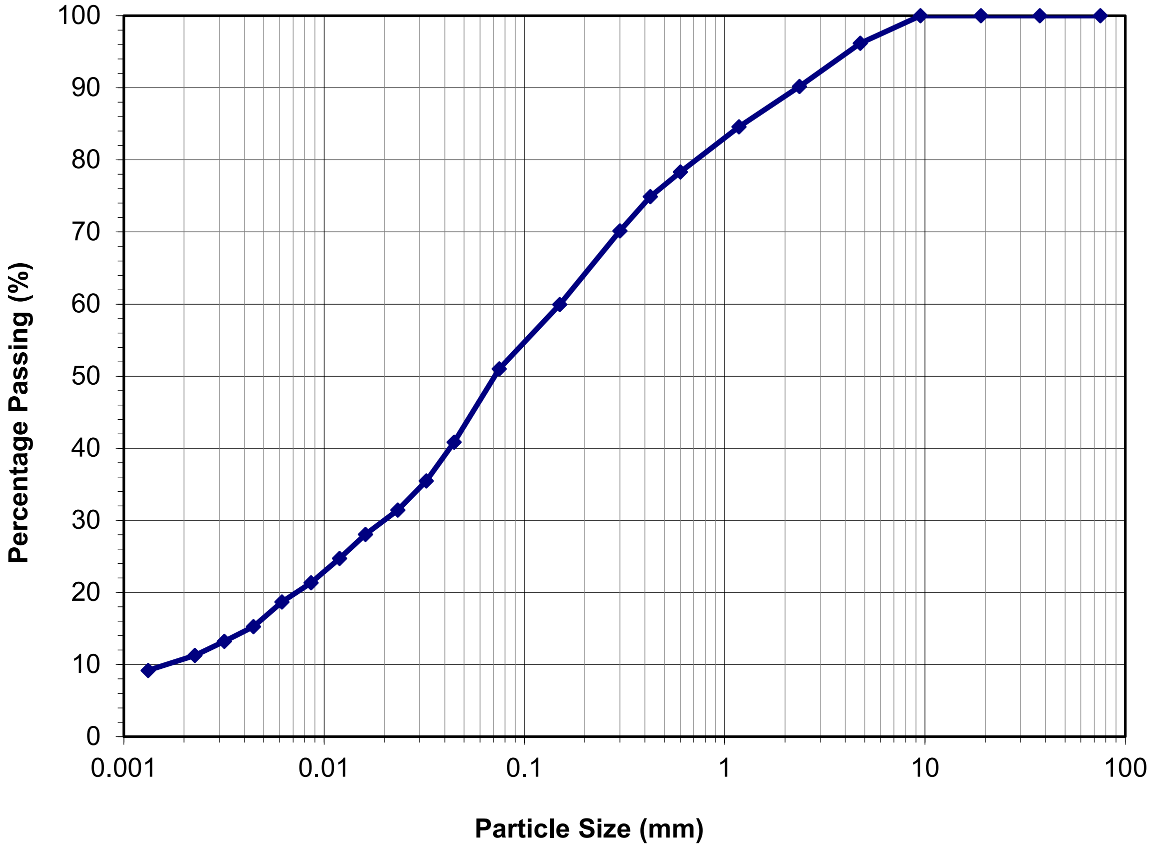
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

IPO Number: 2018-017
Sample ID: 2018-017-016
Borehole ID: CE411A
Depth: 16.50 m to 16.95 m

Tested By:	SL/KM
Date:	25/09/2018

Checked By:	RC
Date:	28/09/2018

PARTICLE SIZE DISTRIBUTION
Test Method: AS1289.3.6.1 & AS1289.3.6.3



Sieve Analysis			
Particle size (mm)	% passing	Particle size (mm)	% passing
75	100	1.18	85
37.5	100	0.600	78
19	100	0.425	75
9.5	100	0.300	70
4.75	96	0.150	60
2.36	90	0.075	51

Hydrometer Analysis			
Particle size (mm)	% passing	Particle size (mm)	% passing
0.0445	41	0.0062	19
0.0323	35	0.0044	15
0.0233	31	0.0032	13
0.0161	28	0.0023	11
0.0120	25	0.0013	9
0.0086	21		

Cadia NTSF Failure - Laboratory Testing
Particle Size Distribution

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations

IPO Number: 2018-017
Sample ID: Refer to Table
Borehole ID: Refer to Table

Tested By:	KM
Date:	Refer to Table

Checked By:	RC
Date:	28/09/2018

SOIL PARTICLE DENSITY OF FRACTION PASSING THE 2.36 mm SIEVE
Test Method: AS1289.3.5.1

Borehole ID	Sample No.	Sample ID	Date Tested	Depth (m)		Soil Particle Density
				From	To	(g/cm^3)
CE411	PT1	2018-017-005	26/09/2018	3.13	3.18	**2.79**
CE411A	PT2	2018-017-007	26/09/2018	12.91	12.95	**2.87**
CE411A	PT5	2018-017-016	26/09/2018	16.70	16.74	**2.83**

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Client:	Hatch Pty Ltd		
	61 Petrie Terrace Brisbane QLD 4000		
Project:	NTSF Embankment Failure ITRB	**Date:**	22/06/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	180721
Sample Identification	18005 TP401 0.7-1.0m Block sample
Sample Description	CLAY (with sand, trace of gravel)
Liquid Limit (%)	53
Plastic Limit (%)	20
Plasticity Index (%)	33
Linear Shrinkage (%)	14.5
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	Yes

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

Tested as received **PLF1-041 RL0 21/11/17**

Certificate Reference: **18101980_180721_TR-180090_PI_Rev0**

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Client:	Hatch 61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	29/06/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	180788
Sample Identification	18006 TP405 Block Sample 1.9-2.2m
Sample Description	CLAY (trace of sand)
Liquid Limit (%)	48
Plastic Limit (%)	26
Plasticity Index (%)	22
Linear Shrinkage (%)	12.0
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	No

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

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Client: Hatch
61 Petrie Terrace, Brisbane

Project: NTSF Embankment Failure ITRB — **Date:** 25/09/18

Location: Cadia Mine — **Project No.:** 18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	181314
Sample Identification	18027 CE416 PT2 24.0-24.33m
Sample Description	CLAY
Liquid Limit (%)	63
Plastic Limit (%)	26
Plasticity Index (%)	37
Linear Shrinkage (%)	11.5
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	No

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

Tested as received **PLF1-041 RL1 14/09/18**

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Client:	Hatch 61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	25/09/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	181313
Sample Identification	18026 CE417 PT4 24.0-24.3m
Sample Description	CLAY
Liquid Limit (%)	55
Plastic Limit (%)	28
Plasticity Index (%)	27
Linear Shrinkage (%)	10.5
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	No

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

Tested as received **PLF1-041 RL1 14/09/18**

Certificate Reference:	**18101980_181313_TR-180150_PI_Rev0**
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Client:	Hatch		
	61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	25/09/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	181312
Sample Identification	18025 CE417 PT2 19.5-20.0m
Sample Description	CLAY
Liquid Limit (%)	58
Plastic Limit (%)	22
Plasticity Index (%)	36
Linear Shrinkage (%)	13.0
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	Yes

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

Tested as received **PLF1-041 RL1 14/09/18**

Certificate Reference: **18101980_181312_TR-180150_PI_Rev0**

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Client:	Hatch		
	61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	2/10/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	181204
Sample Identification	18024 CE416 PT4 27.0-27.45m
Sample Description	CLAY
Liquid Limit (%)	67
Plastic Limit (%)	25
Plasticity Index (%)	41
Linear Shrinkage (%)	13.0
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	Yes

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

Tested as received **PLF1-041 RL1 14/09/18**

Certificate Reference: **18101980_181204_TR-180139_PI_Rev0**

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Sean Lenihan

Sean Lenihan - Senior Laboratory Technician

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Plasticity Index Test Report

Perth Laboratory
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www.golder.com
perthlab@golder.com.au

Client:	Hatch 61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	26/09/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	181203
Sample Identification	18023 CE417 PT1 16.5-16.86m
Sample Description	CLAY
Liquid Limit (%)	61
Plastic Limit (%)	24
Plasticity Index (%)	36
Linear Shrinkage (%)	12.5
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	Yes

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

Tested as received **PLF1-041 RL1 14/09/18**

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Plasticity Index Test Report

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perthlab@golder.com.au

Client:	Hatch 61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	26/09/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.2.1.1,AS 1289 3.9.1, AS 1289.3.2.1, AS 1289.3.3.2 & AS 1289.3.4.1

Laboratory Reference Number	181205
Sample Identification	18022 CE415 PT1 6.0-6.5m
Sample Description	SILT
Liquid Limit (%)	56
Plastic Limit (%)	31
Plasticity Index (%)	25
Linear Shrinkage (%)	9.0
Moisture Content (%)	ND
Sample History	Air Dried
Method of Preparation	Dry Sieved
Length of Shrinkage Mould (mm)	125
Cracking, Curling or Crumbling	No

N.D. = Not Determined **N.O. = Not Obtainable** **N.P. = Non Plastic**

Notes:

Tested as received **PLF1-041 RL1 14/09/18**

Certificate Reference: **18101980_181205_TR-180139_PI_Rev0**

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Sean Lenihan - Senior Laboratory Technician

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Particle Size Distribution, Hydrometer & Plasticity Index Test Report

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perthlab@golder.com.au

Client: Hatch Pty Ltd
61 Petrie Terrace

Project: Foundation Laboratory Testing | **Date:** 23/05/18

Location: Queensland | **Project No.:** 18101981

Lab Reference Number: 180609 | **Sample Identification:** Foundation Material

Laboratory Specimen Description: Sandy CLAY

AS1726 - Soil Classification: CH

Particle Size Distribution AS 1289 3.6.1		Hydrometer AS 1289 3.6.3	
Sieve Size	% Passing	Sieve Size	% Passing
150.0 mm	100	0.062 mm	53
75.0 mm	100	0.044 mm	50
53.0 mm	100	0.032 mm	45
37.5 mm	100	0.023 mm	43
26.5 mm	100	0.016 mm	40
19.0 mm	100	0.012 mm	34
9.5 mm	100	0.009 mm	30
4.75 mm	100	0.006 mm	27
2.36 mm	100	0.004 mm	27
1.18 mm	95	0.003 mm	25
0.600 mm	87	0.001 mm	19
0.425 mm	82		
0.300 mm	76		
0.150 mm	65		
0.075 mm	55		

Plasticity Index and Moisture Content

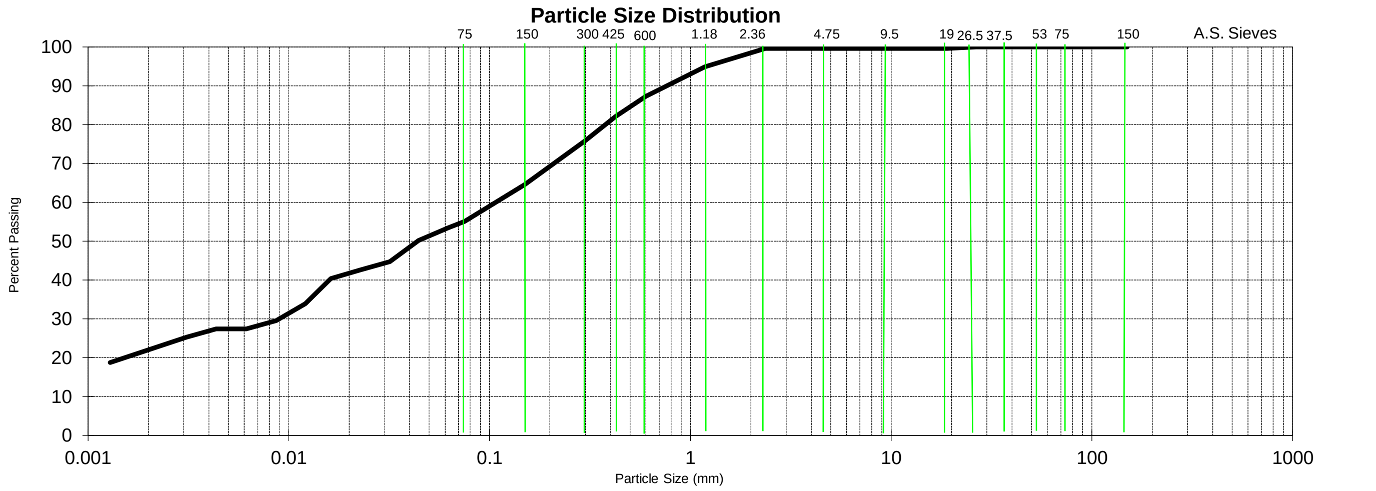
Test		Method	Result	Spec.
Liquid Limit	%	AS 1289.3.1.1	51	
Plastic Limit	%	AS 1289 3.2.1	25	
Plasticity Index	%	AS 1289 3.3.1	26	
Linear Shrinkage	%	AS 1289 3.4.1	13.5	
Moisture Content	%	AS 1289 2.1.1	33.5	

Sample History: Air Dried
Preparation Method: Dry Sieved
Cracking/Crumbling/Curling of linear shrinkage: No
Linear shrinkage mould length (mm): 125

ND = not determined NO = not obtainable NP = non plastic

Notes on Hydrometer test

Pretreatment	Omitted	Measured Particle Density -	2.78 g/cm³
Type of Hydrometer - ASTM		Type of dispersion -	Mechanical



Notes:

Tested as received | PLF1-020 RL0 12/12/12

Certificate Reference: 18101981_180609_TR-180078_HYD_Rev0

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Stephen Abbey - Laboratory Manager (VIC)

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Particle Size Distribution, Hydrometer & Plasticity Index Test Report

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Client:	Hatch Pty Ltd		
	61 Petrie Terrace Brisbane QLD 4000		
Project:	NTSF Embankment Failure ITRB	**Date:**	22/06/18
Location:	Cadia Mine	**Project No.:**	18101980
Lab Reference Number:	180721	**Sample Identification:**	18005 TP401 0.7-1.0m Block sample

Laboratory Specimen Description: CLAY (with sand, trace of gravel)
AS1726 - Soil Classification: CH

Particle Size Distribution AS 1289 3.6.1		Hydrometer AS 1289 3.6.3	
Sieve Size	% Passing	Sieve Size	% Passing
150.0 mm	100	0.056 mm	82
75.0 mm	100	0.040 mm	80
53.0 mm	100	0.029 mm	75
37.5 mm	100	0.021 mm	71
26.5 mm	100	0.015 mm	68
19.0 mm	100	0.011 mm	64
9.5 mm	100	0.008 mm	62
4.75 mm	98	0.006 mm	59
2.36 mm	96	0.004 mm	55
1.18 mm	94	0.003 mm	52
0.600 mm	92	0.001 mm	44
0.425 mm	91		
0.300 mm	91		
0.150 mm	89		
0.075 mm	87		

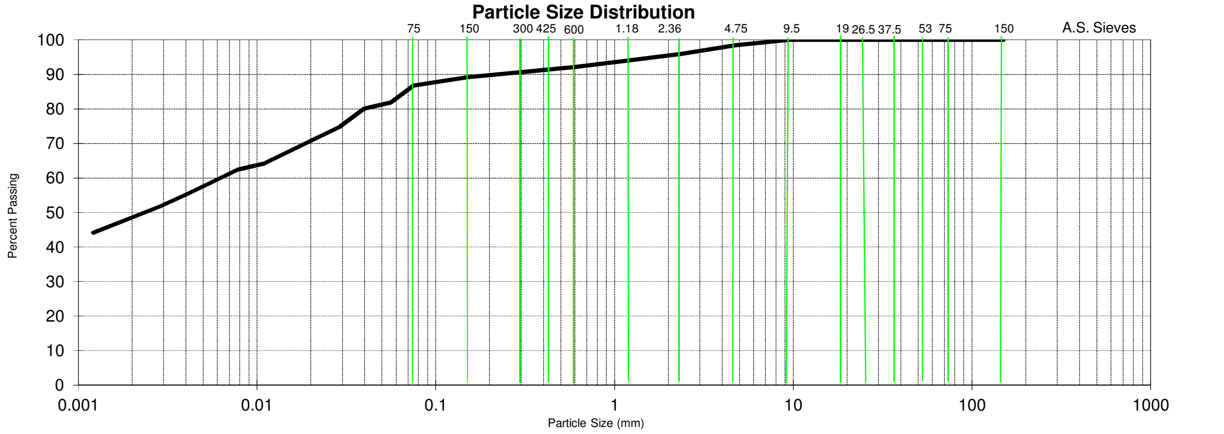
Plasticity Index and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS 1289.3.1.2	ND	
Plastic Limit	%	AS 1289 3.2.1	ND	
Plasticity Index	%	AS 1289 3.3.1	ND	
Linear Shrinkage	%	AS 1289 3.4.1	ND	
Moisture Content	%	AS 1289 2.1.1	21.2	

Sample History: Air Dried
Preparation Method: Dry Sieved
Cracking/Crumbling/Curling of linear shrinkage
Linear shrinkage mould length (mm):
ND = not determined NO = not obtainable NP = non plastic

Notes on Hydrometer test

Pretreatment	Omitted	Measured Particle Density -	2.80 g/cm³
Type of Hydrometer - ASTM		Type of dispersion -	Mechanical



Notes:

Tested as received **PLF1-020 RL1 22/05/18**

Certificate Reference: **18101980_180721_TR-180090_HYD_Rev0**

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Particle Size Distribution, Hydrometer & Plasticity Index Test Report

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Client: Hatch
61 Petrie Terrace, Brisbane

Project: NTSF Embankment Failure ITRB — **Date:** 29/06/18

Location: Cadia Mine — **Project No.:** 18101980

Lab Reference Number: 180788 — **Sample Identification:** 18006 TP405 Block Sample 1.9-2.2m

Laboratory Specimen Description: CLAY (trace of sand)

AS1726 - Soil Classification: CI

Particle Size Distribution AS 1289 3.6.1			Hydrometer AS 1289 3.6.3		
Sieve Size		% Passing	Sieve Size		% Passing
150.0	mm	100	0.063	mm	92
75.0	mm	100	0.045	mm	88
53.0	mm	100	0.032	mm	85
37.5	mm	100	0.023	mm	79
26.5	mm	100	0.017	mm	73
19.0	mm	100	0.012	mm	67
9.5	mm	100	0.009	mm	61
4.75	mm	100	0.006	mm	58
2.36	mm	100	0.004	mm	55
1.18	mm	100	0.003	mm	46
0.600	mm	99	0.001	mm	32
0.425	mm	99			
0.300	mm	98			
0.150	mm	95			
0.075	mm	93			

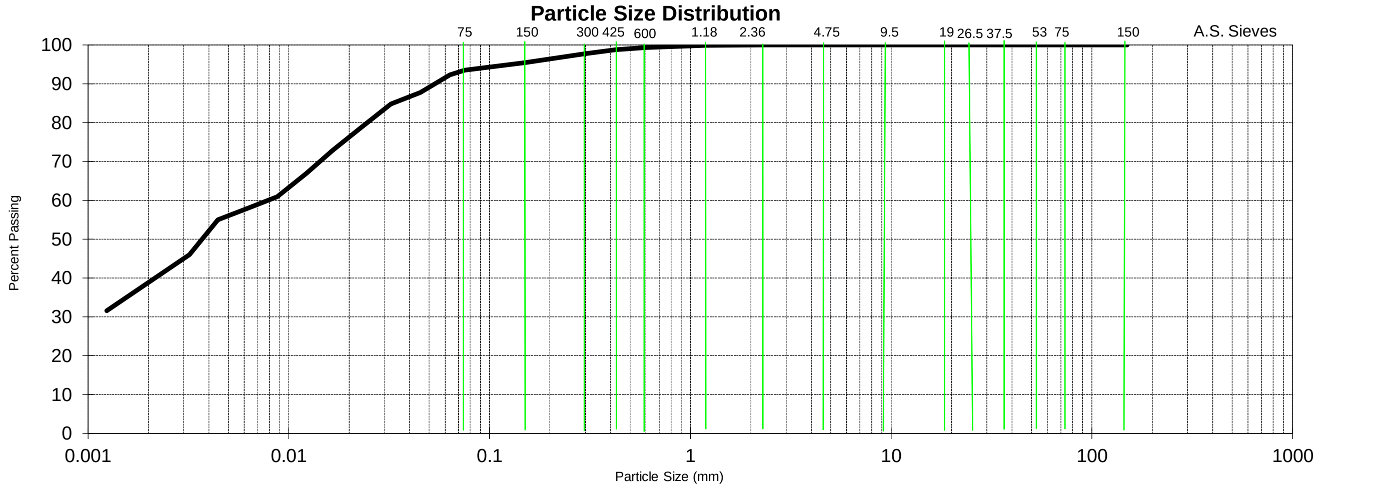
Plasticity Index and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS 1289.3.1.2	ND	
Plastic Limit	%	AS 1289 3.2.1	ND	
Plasticity Index	%	AS 1289 3.3.1	ND	
Linear Shrinkage	%	AS 1289 3.4.1	ND	
Moisture Content	%	AS 1289 2.1.1	28.6	

Sample History: Air Dried
Preparation Method: Dry Sieved
Cracking/Crumbling/Curling of linear shrinkage
Linear shrinkage mould length (mm):
ND = not determined NO = not obtainable NP = non plastic

Notes on Hydrometer test

Pretreatment: Omitted — Measured Particle Density - 2.75 g/cm³
Type of Hydrometer - ASTM — Type of dispersion - Mechanical



Notes:

Tested as received — PLF1-020 RL1 22/05/18

Certificate Reference: 18101980_180788_TR-180102_HYD_Rev0

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Soils testing - Particle size distribution & consistency limits test report STRICTLY CONFIDENTIAL

Standard method (by sieving) with hydrometer follow on

AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1 & 3.5.1

GOLDER

Test request #:	TRM18-0430	**Lab sample ID:**	LMEL201809261
Client:	Hatch		
Client address:	61,Petrie Terrace,Brisbane		
Project ID:	18101980	**Lab report ref.:**	LMEL_18019632

Golder Associates Pty Ltd

MELBOURNE GEOTECHNICAL LABORATORY

Building 7, Botanicca Corporate Park

570 - 588 Swan Street

Richmond, Victoria 3121

Project name:	NTSF Embankment Failure ITRB	**Exploratory Hole**	18027 CE416 PT2
Sample depth (m):	24.00 - 24.33	**Client sample ref:**	EW
Location:	Hatch	**Project Reference:**	-

Specimen description: (Based on visual and tactile assessment): (CH) CLAY, high plasticity, brown, trace, fine to coarse grained sand

Sampling co-ordinates		
Easting (m)	Northing (m)	Reduced Level

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	100%		
1.18 mm	99%		
600 µm	98%		
425 µm	98%		
300 µm	98%		
150 µm	97%		
75 µm	96%		

Standard:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1		AS 1289.3.5.1
Test:	Moisture content	1 point Liquid limit	Plastic limit	Plasticity index	Linear shrinkage	Curling/ Crumbling/ Cracking	Particle density (t/m^3)
Result:	25.6% As Rcvd.						2.85 Measured
LB S:						LSM length	
UB S:							

Specimen history/notes: Preparation of specimen and testing performed on sample supplied to the laboratory

PSD preparation method

Hydrometer: Loss on pre-treatment: n/a **Dispersant:** Sodium Hexametaphosphate

Definitions:
LB S = Lower bound specification; LSM = Linear shrinkage mould; UB S = Upper bound specification
n/a = Not applicable; ND = Not determined; NO = Not obtainable
NP = Non plastic; PSD = Particle size distribution

GRADING SUMMARY

Clay* (<2 µm)	Silt* (>2 µm - <75 µm)	Fines (<75 µm)	Sand* (>75 µm - <2 mm)	Gravel* (>2 mm - <60 mm)	Cobbles* (>60 mm - <200 mm)
70.1%	26.4%	96.4%	3.6%	0.0%	0.0%

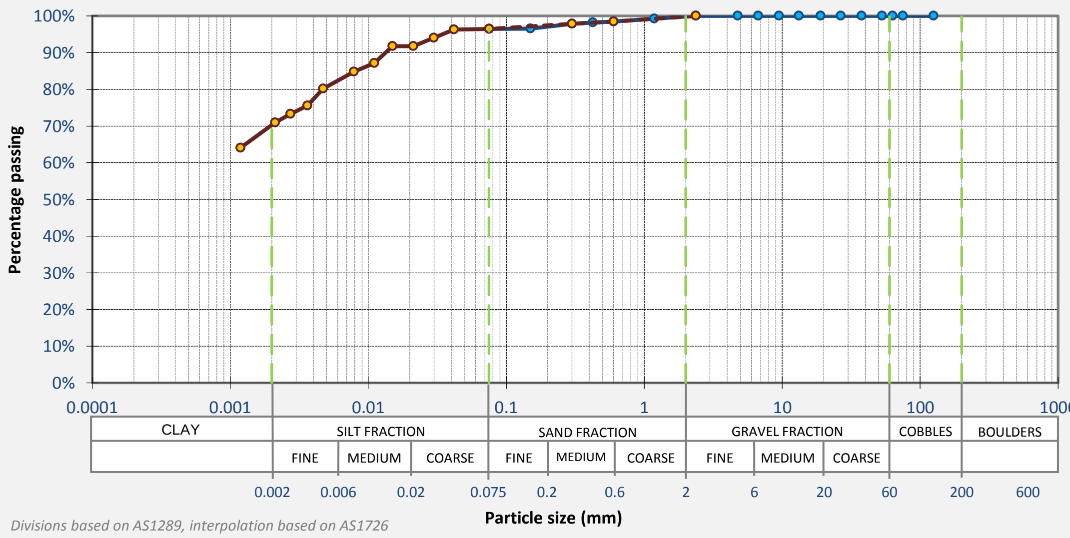
Hydrometer type = ASTM

**Proportions based on linear interpolation between sieve/particle of nearest size and smaller*

Hydrometer (AS1289.3.6.3)

Size	% Finer
75.0 µm	96%
-	-
41.8 µm	96%
29.8 µm	94%
21.2 µm	92%
15.0 µm	92%
11.1 µm	87%
7.9 µm	85%
4.7 µm	80%
3.6 µm	76%
2.7 µm	73%
2.1 µm	71%
1.2 µm	64%

PARTICLE SIZE DISTRIBUTION



Divisions based on AS1289, interpolation based on AS1726

Testing performed by:	NL	**Results reviewed by:**	NLobb	**Date reported:**	4/10/2018

Cert. ref.: 18101980_18027 CE416 PT2_TRM18-0430_CLSF_s1809261_Rep18019632

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1250 - Melbourne

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Nick Lobb - Senior Technician

Soils testing - Particle size distribution & consistency limits test report

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GOLDER

Standard method (by sieving) with hydrometer follow on

AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1 & 3.5.1

Test request #:	TRM18-0430	**Lab sample ID:**	LMEL201809260
Client:	Hatch		
Client address:	61,Petrie Terrace,Brisbane		
Project ID:	18101980	**Lab report ref.:**	LMEL_18019631

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Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121

Project name:	NTSF Embankment Failure ITRB	**Exploratory Hole**	18026 CE417 PT4
Sample depth (m):	24.00 - 24.30	**Client sample ref:**	Residual
Location:	Hatch	**Project Reference:**	-

Specimen description: (Based on visual and tactile assessment) (CH) Sandy CLAY, high plasticity, orange/brown, trace fine gravel, sand fine to coarse grained

Sampling co-ordinates: Easting (m)	Northing (m)	Reduced Level

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	99%		
1.18 mm	97%		
600 µm	92%		
425 µm	89%		
300 µm	86%		
150 µm	78%		
75 µm	67%		

Standard:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1		AS 1289.3.5.1
Test:	Moisture content	1 point Liquid limit	Plastic limit	Plasticity index	Linear shrinkage	Curling/ Crumbling/ Cracking	Particle density (t/m^3)
Result:	35.9% As Rcvd.						2.85 Measured
LB S:						LSM length	
UB S:							

Specimen history/notes: Preparation of specimen and testing performed on sample supplied to the laboratory

PSD preparation method

Hydrometer: Loss on pre-treatment: n/a **Dispersant:** Sodium Hexametaphosphate

Definitions:
LB S = Lower bound specification; LSM = Linear shrinkage mould; UB S = Upper bound specification
n/a = Not applicable; ND = Not determined; NO = Not obtainable
NP = Non plastic; PSD = Particle size distribution

GRADING SUMMARY

Clay* (<2 µm)	Silt* (>2 µm - <75 µm)	Fines (<75 µm)	Sand* (>75 µm - <2 mm)	Gravel* (>2 mm - <60 mm)	Cobbles* (>60 mm - <200 mm)
22.8%	44.3%	67.2%	32.0%	0.8%	0.0%

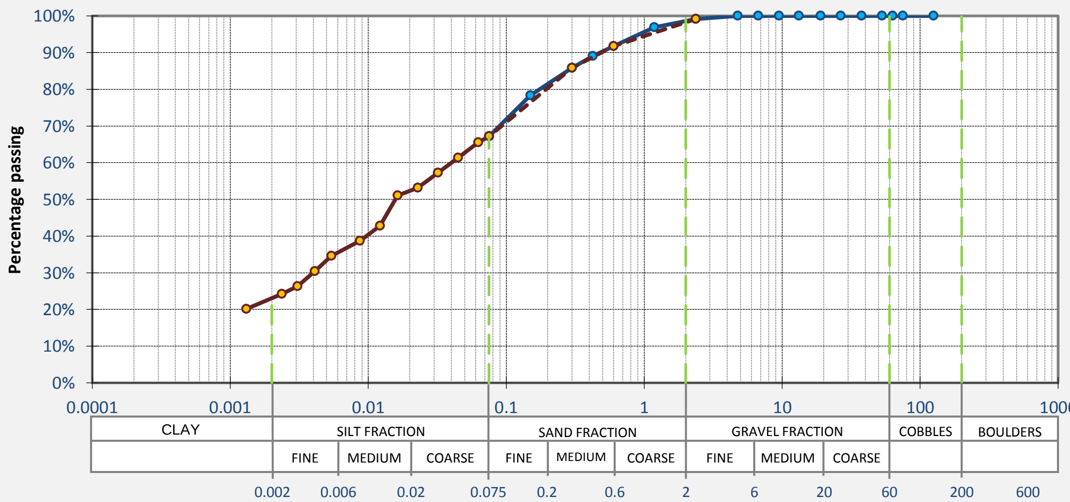
Hydrometer type = ASTM

**Proportions based on linear interpolation between sieve/particle of nearest size and smaller*

Hydrometer (AS1289.3.6.3)

Size	% Finer
75.0 µm	67%
62.7 µm	65%
44.8 µm	61%
32.0 µm	57%
22.9 µm	53%
16.3 µm	51%
12.1 µm	43%
8.7 µm	39%
5.4 µm	35%
4.1 µm	30%
3.1 µm	26%
2.4 µm	24%
1.3 µm	20%

PARTICLE SIZE DISTRIBUTION



Divisions based on AS1289, interpolation based on AS1726

Testing performed by:	NL	**Results reviewed by:**	NLobb	**Date reported:**	4/10/2018

Cert. ref.: 18101980_18026 CE417 PT4_TRM18-0430_CLSF_s1809260_Rep18019631

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1250 - Melbourne
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Soils testing - Particle size distribution & consistency limits test report
Standard method (by sieving) with hydrometer follow on
AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1 & 3.5.1

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GOLDER

Test request #:	TRM18-0407	**Lab sample ID:**	LMEL201809106
Client:	Hatch		
Client address:	61,Petrie Terrace,Brisbane		
Project ID:	18101980	**Lab report ref.:**	LMEL_18019421_7
Project name:	NTSF Embankment Failure ITRB	**Exploratory Hole**	18024 CE416
Location:	Cadia Mine	**Project Reference:**	-

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Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121

Sample depth (m): 27.00 - 27.45
Client sample ref: PT4

Specimen description: (Based on visual and tactile assessment) (CH)CLAY, high plasticity,red brown

Sampling co-ordinates		Reduced Level
Easting (m)	**Northing (m)**	

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	100%		
1.18 mm	100%		
600 µm	100%		
425 µm	100%		
300 µm	100%		
150 µm	99%		
75 µm	98%		

Standard:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1		AS 1289.3.5.1
Test:	Moisture content	1 point Liquid limit	Plastic limit	Plasticity index	Linear shrinkage	Curling/ Crumbling/ Cracking	Particle density (t/m^3)
Result:	37.7% As Rcvd.						2.90
LB S:						**LSM length**	Measured
UB S:							

Specimen history/notes: Preparation of specimen and testing performed on sample supplied to the laboratory

PSD preparation method

Hydrometer: **Loss on pre-treatment:** n/a **Dispersant:** Sodium Hexametaphosphate

Definitions:
LB S = Lower bound specification
LSM = Linear shrinkage mould
UB S = Upper bound specification
n/a = Not applicable
ND = Not determined
NO = Not obtainable
NP = Non plastic
PSD = Particle size distribution

GRADING SUMMARY

Clay* (<2 µm)	Silt* (>2 µm - <75 µm)	Fines (<75 µm)	Sand* (>75 µm - <2 mm)	Gravel* (>2 mm - <60 mm)	Cobbles* (>60 mm - <200 mm)
48.2%	49.5%	97.8%	2.2%	0.0%	0.0%

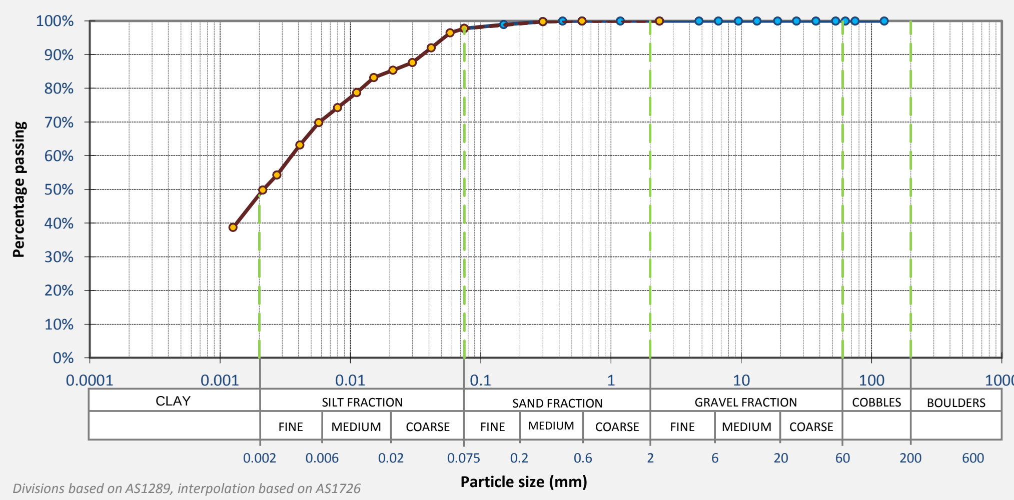
Hydrometer type = ASTM

**Proportions based on linear interpolation between sieve/particle of nearest size and smaller*

Hydrometer (AS1289.3.6.3)

Size	% Finer
75.0 µm	98%
58.4 µm	97%
41.8 µm	92%
29.9 µm	88%
21.3 µm	85%
15.1 µm	83%
11.2 µm	79%
8.0 µm	74%
5.7 µm	70%
4.1 µm	63%
2.7 µm	54%
2.1 µm	50%
1.3 µm	39%

PARTICLE SIZE DISTRIBUTION



Divisions based on AS1289, interpolation based on AS1726

Testing performed by: LM **Results reviewed by:** GSamaradiwakara **Date reported:** 2/10/2018

Cert. ref.: 18101980_18024 CE416_TRM18-0407_CLSF_s1809106_Rep019421_7

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1250 - Melbourne
Accredited for compliance with ISO/IEC 17025 - Testing

Gayani Samaradiwakara - Senior Laboratory Engineer

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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving) with hydrometer follow on

AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1 & 3.5.1

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Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121

Test request #:	TRM18-0407	**Lab sample ID:**	LMEL201809105
Client:	Hatch		
Client address:	61,Petrie Terrace,Brisbane		
Project ID:	18101980	**Lab report ref.:**	LMEL_18019420_6
Project name:	NTSF Embankment Failure ITRB	**Exploratory Hole**	18023 CE417
Sample depth (m):	16.50 - 16.86	**Client sample ref:**	PT1
Location:	Cadia Mine	**Project Reference:**	-

Specimen description: (Based on visual and tactile assessment) (CH) CLAY,high plasticity,grey,trace sand

Sampling co-ordinates: Easting (m)	Northing (m)	Reduced Level

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	98%		
1.18 mm	94%		
600 µm	94%		
425 µm	93%		
300 µm	93%		
150 µm	92%		
75 µm	90%		

Standard:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1		AS 1289.3.5.1
Test:	Moisture content	1 point Liquid limit	Plastic limit	Plasticity index	Linear shrinkage	Curling/ Crumbling/ Cracking	Particle density (t/m^3)
Result:	29.0% As Rcvd.						2.74 Measured
LB S:						LSM length	
UB S:							

Specimen history/notes: Preparation of specimen and testing performed on sample supplied to the laboratory

PSD preparation method

Hydrometer: **Loss on pre-treatment:** n/a **Dispersant:** Sodium Hexametaphosphate

Definitions:
LB S = Lower bound specification; LSM = Linear shrinkage mould; UB S = Upper bound specification
n/a = Not applicable; ND = Not determined; NO = Not obtainable
NP = Non plastic; PSD = Particle size distribution

GRADING SUMMARY

Clay* (<2 µm)	Silt* (>2 µm - <75 µm)	Fines (<75 µm)	Sand* (>75 µm - <2 mm)	Gravel* (>2 mm - <60 mm)	Cobbles* (>60 mm - <200 mm)
38.3%	51.5%	89.8%	7.9%	2.3%	0.0%

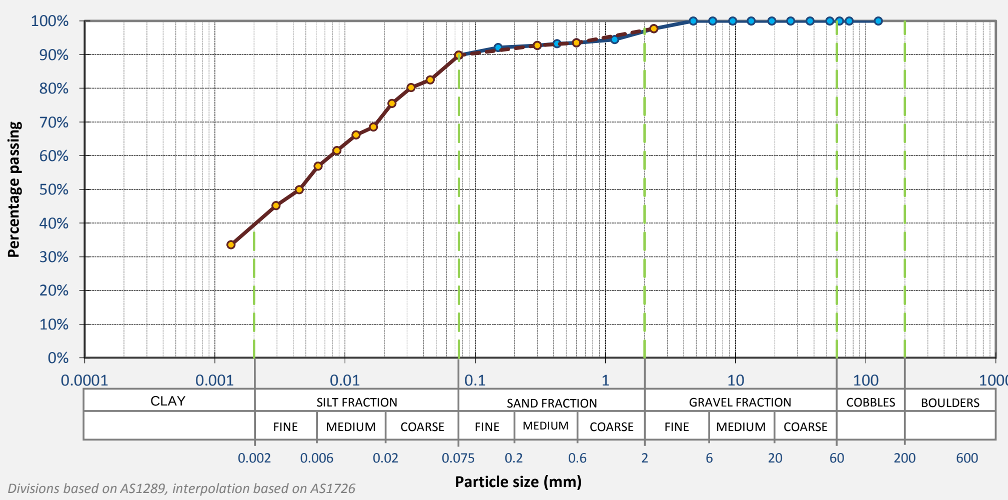
Hydrometer type = ASTM

**Proportions based on linear interpolation between sieve/particle of nearest size and smaller*

Hydrometer (AS1289.3.6.3)

Size	% Finer
75.0 µm	90%
-	-
45.2 µm	83%
32.2 µm	80%
23.0 µm	76%
16.5 µm	69%
12.1 µm	66%
8.7 µm	62%
6.2 µm	57%
4.5 µm	50%
3.0 µm	45%
1.3 µm	34%
-	-

PARTICLE SIZE DISTRIBUTION



Divisions based on AS1289, interpolation based on AS1726

Testing performed by:	LM	**Results reviewed by:**	GSamaradiwakara	**Date reported:**	2/10/2018

Cert. ref.: 18101980_18023 CE417 _TRM18-0407_CLSF_s1809105_Rep019420_6

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1250 - Melbourne
Accredited for compliance with ISO/IEC 17025 - Testing

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Gayani Samaradiwakara - Senior Laboratory Engineer

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Soils testing - Particle size distribution & consistency limits test report

Standard method (by sieving) with hydrometer follow on

AS1289.3.6.1, 3.6.3, 2.1.1, 3.1.2, 3.2.1, 3.3.1, 3.4.1 & 3.5.1

Golder Associates Pty Ltd

MELBOURNE GEOTECHNICAL LABORATORY
Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond, Victoria 3121

Test request #:	TRM18-0407	**Lab sample ID:**	LMEL201809107
Client:	Hatch		
Client address:	61,Petrie Terrace,Brisbane		
Project ID:	18101980	**Lab report ref.:**	LMEL_18019419_6
Project name:	NTSF Embankment Failure ITRB	**Exploratory Hole**	18022 CE415
Sample depth (m):	6.00 - 6.50	**Client sample ref:**	PT1
Location:	Cadia Mine	**Project Reference:**	-

Specimen description: (Based on visual and tactile assessment) (MH) Clayey SILT, high liquid limit,red brown,trace sand

Sampling co-ordinates: Easting (m)	Northing (m)	Reduced Level

PARTICLE SIZE DISTRIBUTION AS 1289.3.6.1

Sieve Size	Passing	LB S	UB S
125 mm	100%		
75 mm	100%		
63 mm	100%		
53 mm	100%		
37.5 mm	100%		
26.5 mm	100%		
19 mm	100%		
13.2 mm	100%		
9.5 mm	100%		
6.7 mm	100%		
4.75 mm	100%		
2.36 mm	100%		
1.18 mm	100%		
600 µm	98%		
425 µm	98%		
300 µm	97%		
150 µm	95%		
75 µm	93%		

Standard:	AS 1289.2.1.1	AS 1289.3.1.2	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1		AS 1289.3.5.1
Test:	Moisture content	1 point Liquid limit	Plastic limit	Plasticity index	Linear shrinkage	Curling/ Crumbling/ Cracking	Particle density (t/m^3)
Result:	38.0% As Rcvd.						2.89 Measured
LB S:						LSM length	
UB S:							

Specimen history/notes: Preparation of specimen and testing performed on sample supplied to the laboratory

PSD preparation method

Hydrometer: Loss on pre-treatment: n/a **Dispersant:** Sodium Hexametaphosphate

Definitions: LB S = Lower bound specification; LSM = Linear shrinkage mould; UB S = Upper bound specification; n/a = Not applicable; ND = Not determined; NO = Not obtainable; NP = Non plastic; PSD = Particle size distribution

GRADING SUMMARY

Clay* (<2 µm)	Silt* (>2 µm - <75 µm)	Fines (<75 µm)	Sand* (>75 µm - <2 mm)	Gravel* (>2 mm - <60 mm)	Cobbles* (>60 mm - <200 mm)
44.1%	48.7%	92.9%	7.1%	0.0%	0.0%

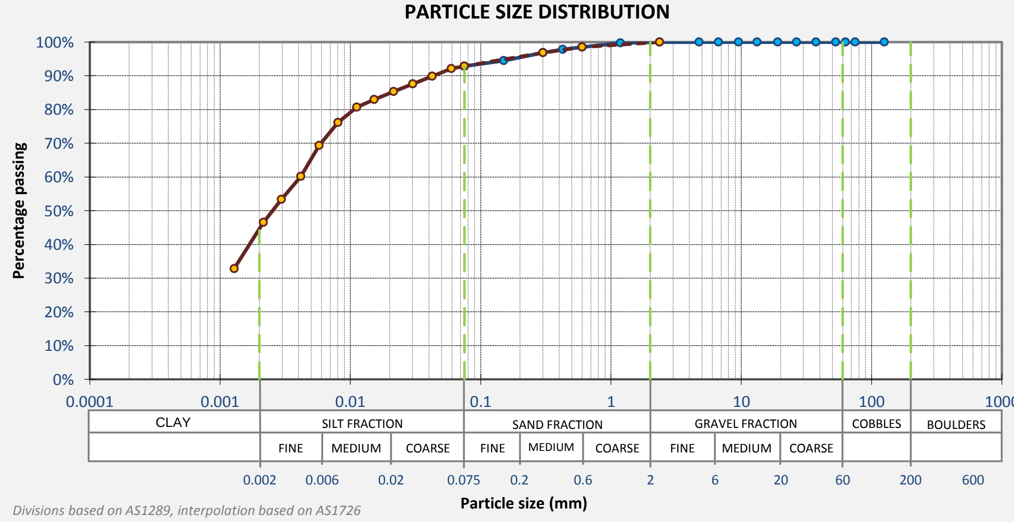
Hydrometer type = ASTM

**Proportions based on linear interpolation between sieve/particle of nearest size and smaller*

Hydrometer (AS1289.3.6.3)

Size	% Finer
75.0 µm	93%
59.6 µm	92%
42.4 µm	90%
30.2 µm	88%
21.4 µm	85%
15.3 µm	83%
11.2 µm	81%
8.0 µm	76%
5.8 µm	69%
4.2 µm	60%
2.9 µm	53%
2.1 µm	47%
1.3 µm	33%

PARTICLE SIZE DISTRIBUTION



Testing performed by:	LM	**Results reviewed by:**	GSamaradiwakara	**Date reported:**	2/10/2018

Cert. ref.: 18101980_18022 CE415_TRM18-0407_CLSF_s1809107_Rep019419_6

Approved signatory:

NATA

NATA accreditation number: 1961 - Site:1250 - Melbourne
Accredited for compliance with ISO/IEC 17025 - Testing

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Gayani Samaradiwakara - Senior Laboratory Engineer

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Soil Particle Density Report

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Client:	Hatch 61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	29/06/18
Location:	Cadia Mine	**Project No.:**	18101981

Test procedure: AS 1289.3.5.1

Laboratory Reference Number	180609
Sample Identification	PL-BS1
	0-0.5m
Material Description	Sandy CLAY
Temperature of Test (°C)	21
The average apparent Particle Density of the fraction passing 2.36mm (g/cm^3)	2.78

Notes: This test certificate replaces test certificate reference 18101981_180609_TR-180078_SG_Rev0

Tested as received **PLF1-011 RL0 7/12/12**

Certificate Reference: **18101981_180609_TR-180078_SG_REV1**

NATA

NATA Accreditation No: 1961 Perth

Accredited for compliance with ISO/IEC 17025

Stephen Abbey - Laboratory Manager (VIC)

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Soil Particle Density Report

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Client:	Hatch 61 Petrie Terrace, Brisbane		
Project:	NTSF Embankment Failure ITRB	**Date:**	29/06/18
Location:	Cadia Mine	**Project No.:**	18101980

Test procedure: AS 1289.3.5.1

Laboratory Reference Number	180788
Sample Identification	18006 TP405 Block Sample 1.9-2.2m
Material Description	CLAY (trace of sand)
Temperature of Test (°C)	20
The average apparent Particle Density of the fraction passing 2.36mm (g/cm^3)	2.75

Notes:

Tested as received **PLF1-011 RL0 7/12/12**

Certificate Reference:	**18101980_180788_TR-180102_SG_REV0**
NATA	**NATA Accreditation No: 1961 Perth**
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Stephen Abbey – Laboratory Manager (VIC)

Bulk Density Test Report

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE406 SA4 23.8-23.9m
Location:	Cadia Mine	**Laboratory ID:**	18020 - BD1

Sample preparation

A subsample was cored into a stainless steel ring. The subsample bulk density was measured directly from the internal volume of the ring and its wet mass. The subsample was removed from the ring and placed in a 110º oven for gravimetric moisture content measurement.

Mass - As Received Sample	g	1478.7
Water Content	%	19.8
Bulk Density	t/m^3	2.09

Notes:	Tested as received	Tested by:	K. Koh
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Bulk Density Test Report

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	14/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE406 SA3 22.2-22.3m
Location:	Cadia Mine	**Laboratory ID:**	18019 - BD1

Sample preparation

A subsample was cored into a stainless steel ring. The subsample bulk density was measured directly from the internal volume of the ring and its wet mass. The subsample was removed from the ring and placed in a 110º oven for gravimetric moisture content measurement.

Mass - As Received Sample	g	1052.5
Water Content	%	13.6
Bulk Density	t/m^3	2.05

Notes:	Tested as received	Tested by:	K. Koh
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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.**	18050383-AL
		Workorder No.	0004181
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	11/06/2018
Project	H356804 - Cadia NTSF Failure - Containment Bund - Left Abutment		

Sample No.	18050383					
Test Date	5/06/2018					
Client ID	BM1 - BS1					
Depth (m)	1.00-1.20					
Liquid Limit (%)	46					
Plastic Limit (%)	25					
Plasticity Index (%)	21					
Linear Shrinkage (%)	11.5 *					
Moisture Content (%)	40.7					

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

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

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

Authorised Signatory

C. Park

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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.**	18060849-AL
		Workorder No.	0004435
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	13/07/2018
Project	H356804 - Cadia		

Sample No.	18060849					
Test Date	12/07/2018					
Client ID	DH-410					
Depth (m)	19.65-19.95					
Liquid Limit (%)	33					
Plastic Limit (%)	23					
Plasticity Index (%)	10					
Linear Shrinkage (%)	6.0 +					
Moisture Content (%)	22.3					

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

NOTES/REMARKS: The samples were tested in a natural state, wet sieved and in a 125-250mm mould.

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

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Park

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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 (%)						

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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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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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.**	18080415-AL
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	12/09/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080415	18080416	18080417	18080420	18080423	18080425
Test Date	6/09/2018	6/09/2018	6/09/2018	6/09/2018	6/09/2018	6/09/2018
Client ID	CE412 - DH405 SA3	CE412 - DH405 SA5	CE412 - DH405 SA8	CE417 - DH406 L2B	CE417 - DH406 L3C	CE417 - DH406 SA6
Depth (m)	60.70-60.80	62.15-62.20	65.50-66.00	18.50-19.00	20.80-20.85	25.90-26.00
Liquid Limit (%)	34	47	50	80	48	54
Plastic Limit (%)	16	22	23	32	19	30
Plasticity Index (%)	18	25	27	48	29	24
Linear Shrinkage (%)	7.0 +	12.5 +	11.5	19.0 +	13.0	9.0 *
Moisture Content (%)	11.7	23.3	25.5	42.3	26.3	36.0

Sample No.	18080426	18080429	18080432	18080435	18080436	18080439
Test Date	6/09/2018	6/09/2018	6/09/2018	6/09/2018	6/09/2018	6/09/2018
Client ID	CE415 - DH408 SA1	CE415 - DH408 SA4	CE411A - DH409A L1	CE416 - DH407 SA1	CE416 - DH407 L1B	CE416 - DH407 PT3
Depth (m)	4.12-4.30	20.20-20.40	14.50-15.00	21.85-21.90	23.00-23.50	25.50-26.95
Liquid Limit (%)	52	39	53	87	59	60
Plastic Limit (%)	33	25	25	27	28	29
Plasticity Index (%)	19	14	28	60	31	31
Linear Shrinkage (%)	8.5 *	6.5 *	12.0 +	22.0 *	12.0 *	11.0 +
Moisture Content (%)	38.4	17.3	25.7	34.1	27.7	38.7

NOTES/REMARKS: The samples were tested oven 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. Park

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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.**	18080441-AL
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	12/09/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080441					
Test Date	6/09/2018					
Client ID	CE416 - DH407 L3C					
Depth (m)	26.50-27.00					
Liquid Limit (%)	64					
Plastic Limit (%)	30					
Plasticity Index (%)	34					
Linear Shrinkage (%)	14.5 +					
Moisture Content (%)	38.4					

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

NOTES/REMARKS: The samples were tested oven 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.
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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.**	18090290-AL
		Workorder No.	0004846
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	04/10/2018
Project	H356804 - Cadia NTSF Failure - Request 8		

Sample No.	18090290					
Test Date	28/09/2018					
Client ID	CE432 - L1B					
Depth (m)	19.80-20.30					
Liquid Limit (%)	40					
Plastic Limit (%)	27					
Plasticity Index (%)	13					
Linear Shrinkage (%)	8.0 *					
Moisture Content (%)	24.2					

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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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

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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.**	18110003-AL
		Workorder No.	0005081
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	15/11/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18110003	18110005				
Test Date	1/11/2018	1/11/2018				
Client ID	CE432 - L1C - Lexan	CE433 - L1 - Lexan				
Depth (m)	20.30-20.80	33.20-33.80				
Liquid Limit (%)	40	26				
Plastic Limit (%)	24	17				
Plasticity Index (%)	16	9				
Linear Shrinkage (%)	6.5 *	6.0 +				
Moisture Content (%)	28.2	28.2				

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

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

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

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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.**	19010573-AL
		Workorder No.	0005444
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	25/01/2019
Project	H356804 - Caida NTSF Failure		

Sample No.	19010573	19010574				
Test Date	24/01/2019	24/01/2019				
Client ID	CE431 - SA-1	CE431 - SA-2				
Depth (m)	23.50-24.00	24.00-24.50				
Liquid Limit (%)	44	45				
Plastic Limit (%)	27	30				
Plasticity Index (%)	17	15				
Linear Shrinkage (%)	N/A	N/A				
Moisture Content (%)	26.3	31.8				

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.

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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.**	19010703-AL
		Workorder No.	0005472
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	01/02/2019
Project	H356804 - Cadia NTSF Failure		

Sample No.	19010703	19010704	19010705			
Test Date	30/01/2019	30/01/2019	30/01/2019			
Client ID	CE411A	CE416 - L2B	CE416 - L2C			
Depth (m)	16.00-16.50	24.50-25.00	25.00-25.50			
Liquid Limit (%)	61	73	67			
Plastic Limit (%)	31	33	32			
Plasticity Index (%)	30	40	35			
Linear Shrinkage (%)	12.5 +	13.0 +	14.0 +			
Moisture Content (%)	37.7	34.0	39.3			

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 3.6.1, 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18060849-G
		Workorder No.	4435
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	13/07/2018
Project	H356804 - Cadia		

Sample No.	18060849						
Test Date	13/07/2018						
Client ID	DH-410						
Depth (m)	19.65-19.95						
Moisture (%)	22.3						
AS SIEVE SIZE (mm)	**PERCENT PASSING**						
150							
75							
63							
53							
37.5							
26.5							
19							
13.2							
9.5							
6.7							
4.75	100						
2.36	94						
1.18	88						
0.600	80						
0.425	75						
0.300	70						
0.150	60						
0.075	52						

NOTES/REMARKS:

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080182-G
		Workorder No.	4644
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	21/08/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080182	18080183					
Test Date	13/08/2018	13/08/2018					
Client ID	CE413 - DH404	CE406 - DH410					
Depth (m)	53.50-53.80	18.40-18.50					
Moisture (%)	20.1	27.5					
AS SIEVE SIZE (mm)	**PERCENT PASSING**						
150							
75							
63							
53							
37.5							
26.5							
19							
13.2							
9.5							
6.7							
4.75							
2.36	100	100					
1.18	99	98					
0.600	96	95					
0.425	95	94					
0.300	93	92					
0.150	90	89					
0.075	87	86					

NOTES/REMARKS:

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080415-G
		Workorder No.	4681
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	31/08/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18080415	18080423	18080425	18080426	18080429	18080435	
Test Date	20/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	29/08/2018	
Client ID	CE412 - DH405 SA3	CE417 - DH406 L3C	CE417 - DH406 SA6	CE415 - DH408 SA1	CE415 - DH408 SA4	CE416 - DH407 SA1	
Depth (m)	60.70-60.80	20.80-20.85	25.90-26.00	4.12-4.30	20.20-20.40	21.85-21.90	
Moisture (%)	11.7	26.3	36.0	38.4	17.3	34.1	
AS SIEVE SIZE (mm)	**PERCENT PASSING**						
150							
75							
63							
53							
37.5							
26.5							
19							
13.2							
9.5							
6.7							
4.75	100			100	100		
2.36	99			99	97	100	
1.18	95	100	100	97	89	99	
0.600	87	99	95	92	76	99	
0.425	82	99	90	90	69	99	
0.300	77	98	83	87	62	98	
0.150	69	94	70	80	47	97	
0.075	62	90	60	76	37	96	

NOTES/REMARKS:

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18090290-G
		Workorder No.	4846
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	27/09/2018
Project	H356804 - Cadia NTSF Failure - Request 8		

Sample No.	18090290						
Test Date	24/09/2018						
Client ID	CE432 - L1B						
Depth (m)	19.80-20.30						
Moisture (%)	24.2						
AS SIEVE SIZE (mm)	**PERCENT PASSING**						
150							
75							
63							
53							
37.5							
26.5							
19							
13.2							
9.5							
6.7	100						
4.75	99						
2.36	98						
1.18	91						
0.600	82						
0.425	78						
0.300	74						
0.150	65						
0.075	57						

NOTES/REMARKS:

Sample/s supplied by the client

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PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.1, 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18110003-G
		Workorder No.	5081
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	08/11/2018
Project	H356804 - Cadia NTSF Failure		

Sample No.	18110003						
Test Date	1/11/2018						
Client ID	CE432 - L1C - Lexan						
Depth (m)	20.30-20.80						
Moisture (%)	28.2						
AS SIEVE SIZE (mm)	**PERCENT PASSING**						
150							
75							
63							
53							
37.5							
26.5							
19							
13.2							
9.5							
6.7							
4.75	100						
2.36	97						
1.18	92						
0.600	85						
0.425	81						
0.300	77						
0.150	68						
0.075	59						

NOTES/REMARKS:

Sample/s supplied by the client

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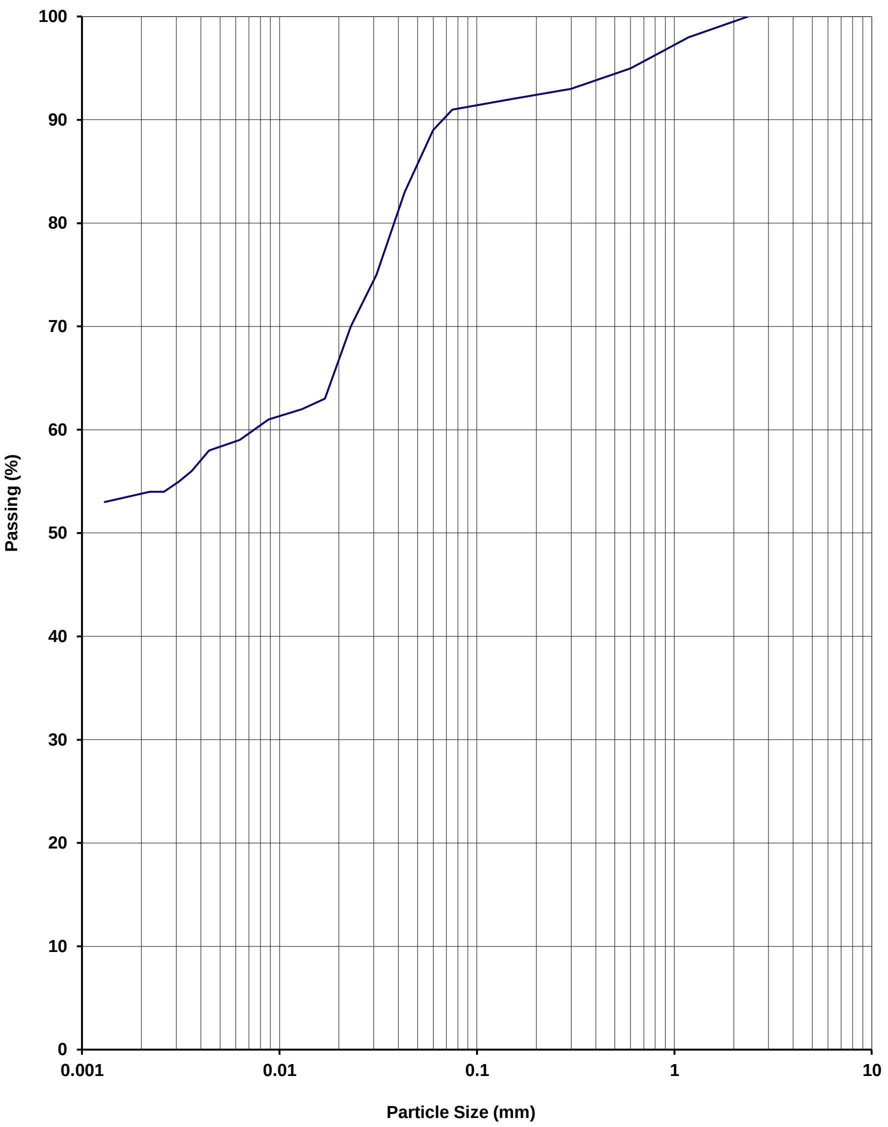
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18050383-G
		Workorder No.	0004181
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	9/5/18-21/5/18
		Report Date	22/5/2018
Project	H356804 - Cadia NTSF Failure - Containment Bund - Left Abutment		
Client ID	BM1 - BS1	**Depth (m)**	1.00-1.20

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	100
1.18	98
0.600	95
0.425	94
0.300	93
0.150	92
0.075	91
0.06	89
0.043	83
0.031	75
0.023	70
0.017	63
0.013	62
0.0088	61
0.0063	59
0.0044	58
0.0036	56
0.0031	55
0.0026	54
0.0022	54
0.0013	53



NOTES/REMARKS: -

Moisture Content 12.9% -2.36mm Soil Particle Density(t/m^3) 2.66

Sample/s supplied by the client

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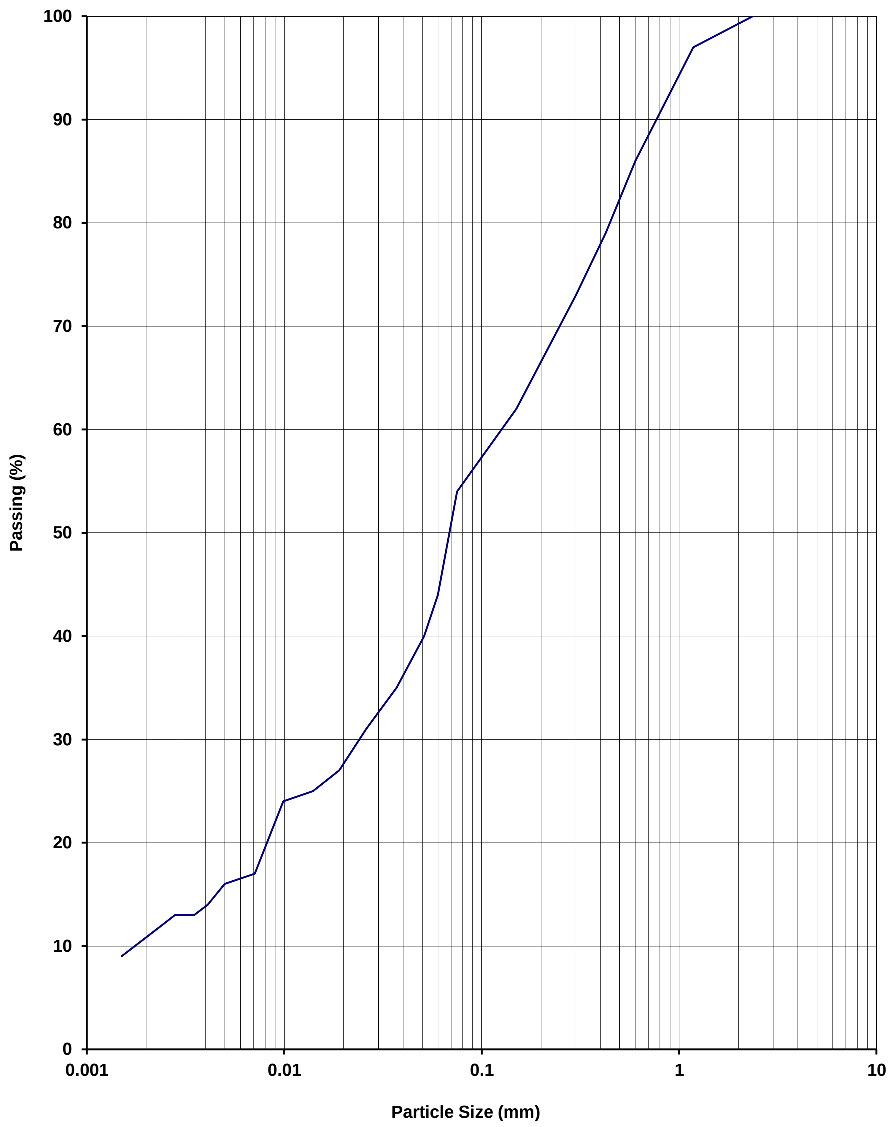
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080197-G
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	13/8/18-21/8/18
		Report Date	22/8/2018
Project	H356804 - Cadia NTSF Failure		
Client ID	CE412 - DH405 - PT2	**Depth (m)**	39.50-39.72

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	100
1.18	97
0.600	86
0.425	79
0.300	73
0.150	62
0.075	54
0.06	44
0.051	40
0.037	35
0.026	31
0.019	27
0.014	25
0.0099	24
0.0071	17
0.005	16
0.0041	14
0.0035	13
0.0028	13
0.0024	12
0.0015	9



NOTES/REMARKS: -

Moisture Content 48.5% -2.36mm Soil Particle Density(t/m^3) 2.55

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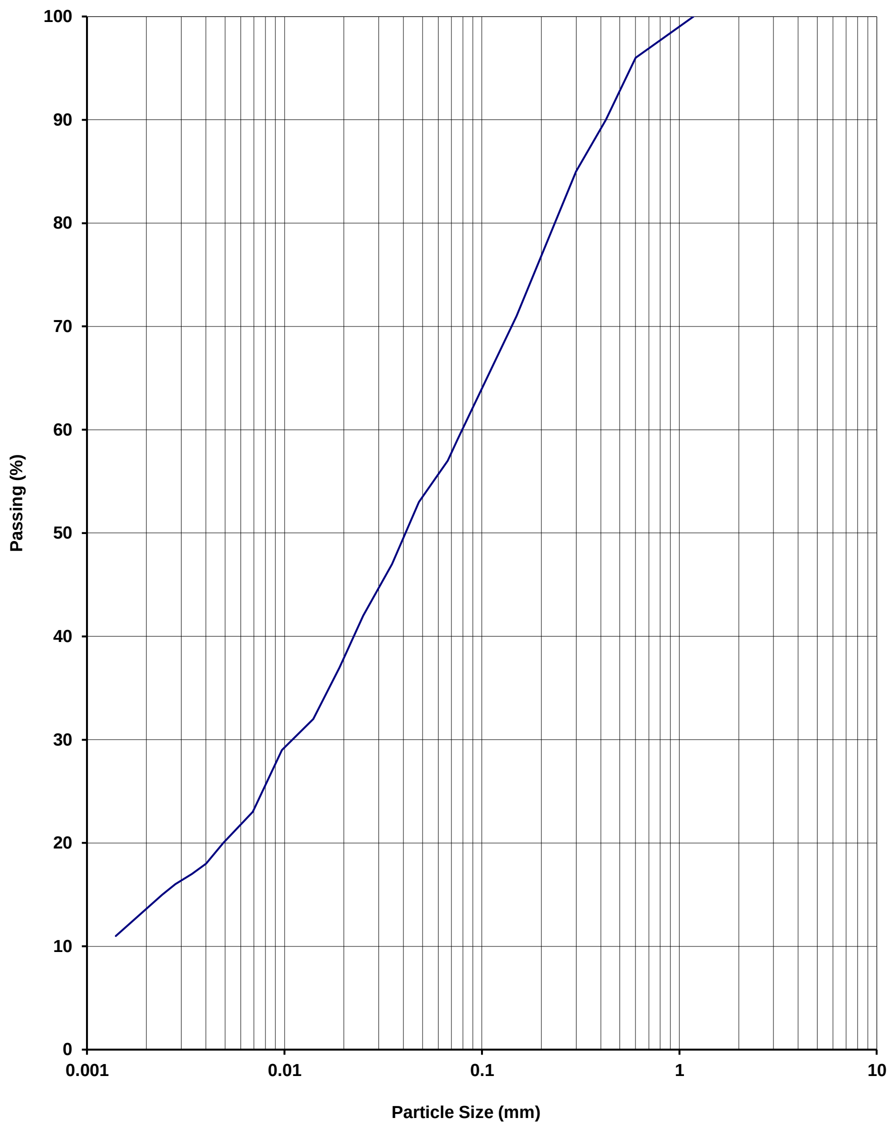
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080417-G
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	22/8/18-31/8/18
		Report Date	31/8/2018
Project	H356804 - Cadia NTSF Failure		
Client ID	CE412 - DH405 SA8	**Depth (m)**	65.50-66.00

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	100
0.600	96
0.425	90
0.300	85
0.150	71
0.075	59
0.067	57
0.048	53
0.035	47
0.025	42
0.019	37
0.014	32
0.0097	29
0.0069	23
0.0049	20
0.004	18
0.0034	17
0.0028	16
0.0024	15
0.0014	11



NOTES/REMARKS: -

Moisture Content 25.5% -2.36mm Soil Particle Density(t/m^3) 2.64

Sample/s supplied by the client

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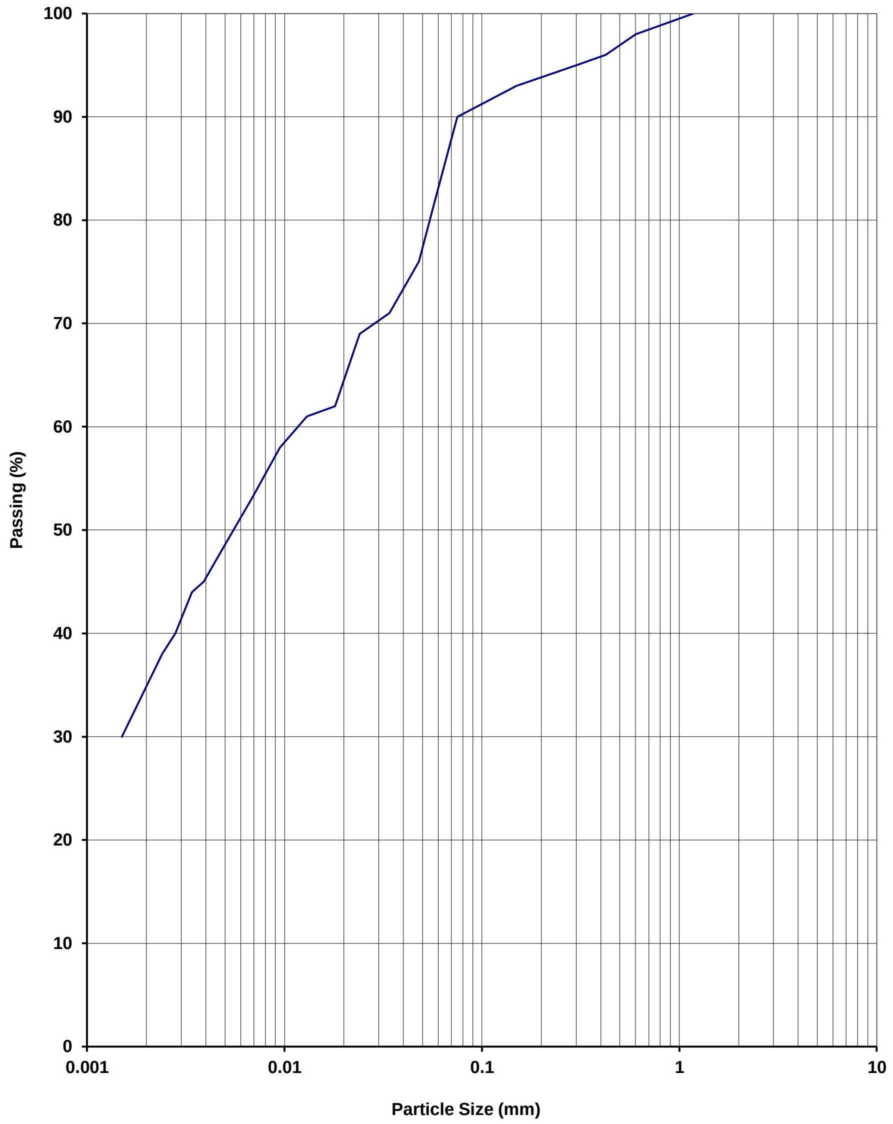
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080420-G
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	22/8/18-31/8/18
		Report Date	31/8/2018
Project	H356804 - Cadia NTSF Failure		
Client ID	CE417 - DH406 L2B	**Depth (m)**	18.50-19.00

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	100
0.600	98
0.425	96
0.300	95
0.150	93
0.075	90
0.058	82
0.048	76
0.034	71
0.024	69
0.018	62
0.013	61
0.0095	58
0.0068	53
0.0048	48
0.0039	45
0.0034	44
0.0028	40
0.0024	38
0.0015	30



NOTES/REMARKS: -

Moisture Content 42.3% -2.36mm Soil Particle Density(t/m^3) 2.49

Sample/s supplied by the client

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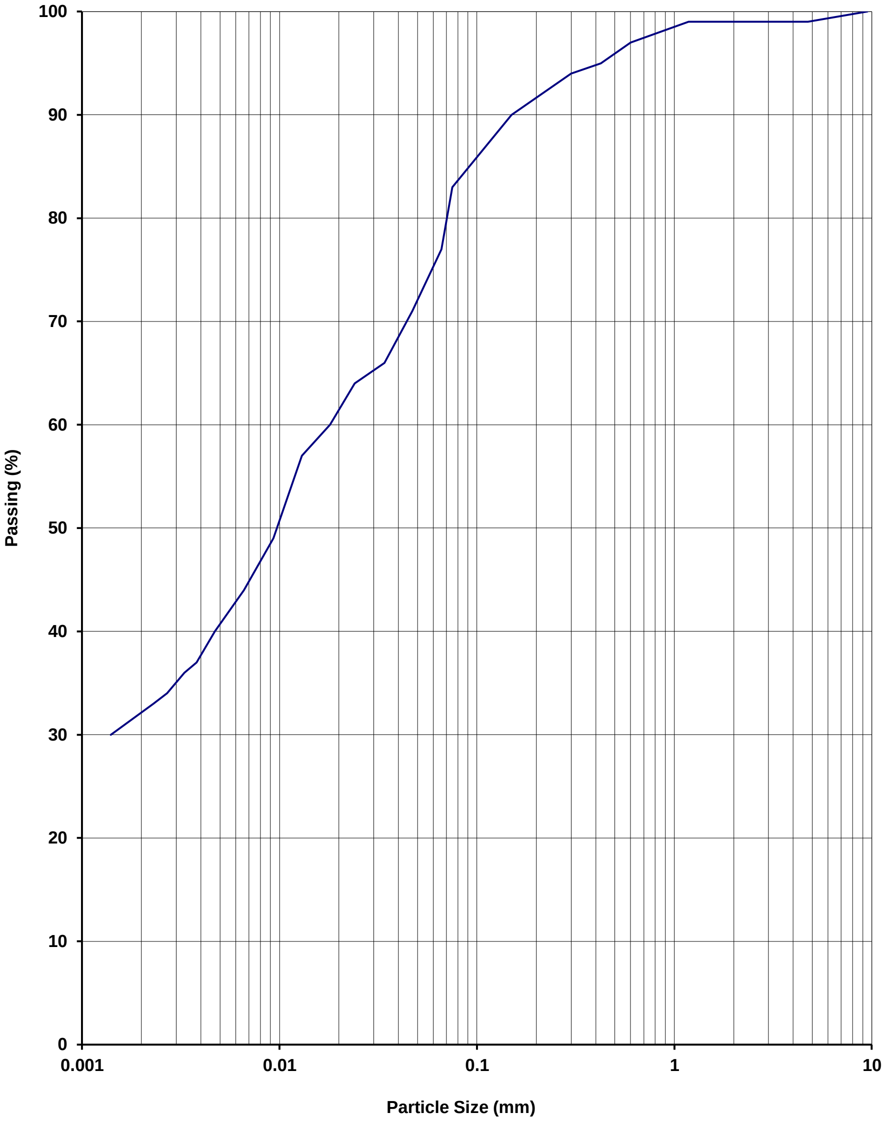
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080432-G
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	23/8/18-31/8/18
		Report Date	31/8/2018
Project	H356804 - Cadia NTSF Failure		
Client ID	CE411A - DH409A L1	**Depth (m)**	14.50-15.00

Sieve Size (mm)	Passing %
150.0	
75.0	
63.0	
53.0	
37.5	
26.5	
19.0	
13.2	
9.5	100
6.7	99
4.75	99
2.36	99
1.18	99
0.600	97
0.425	95
0.300	94
0.150	90
0.075	83
0.066	77
0.047	71
0.034	66
0.024	64
0.018	60
0.013	57
0.0093	49
0.0066	44
0.0047	40
0.0038	37
0.0033	36
0.0027	34
0.0023	33
0.0014	30



NOTES/REMARKS: -

Moisture Content 25.7% -2.36mm Soil Particle Density(t/m^3) 2.70

Sample/s supplied by the client

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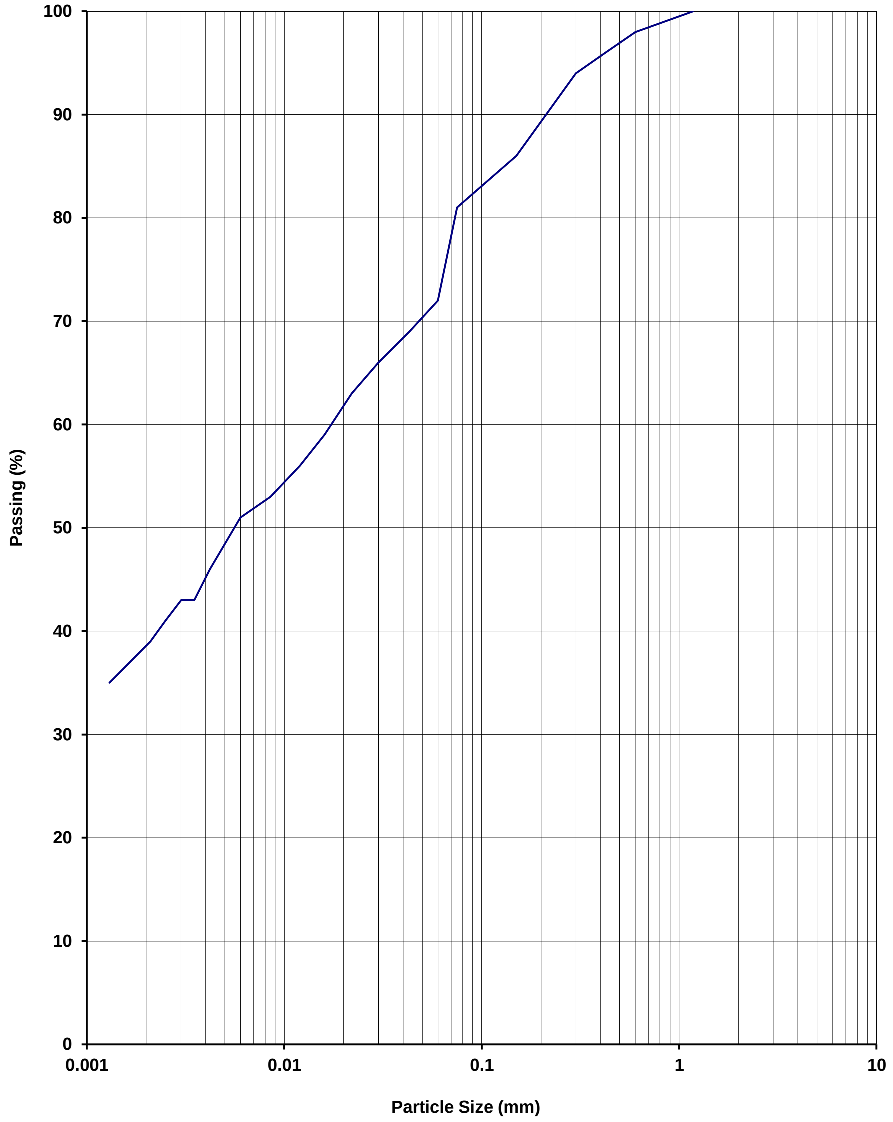
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080436-G
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	27/8/18-3/9/18
		Report Date	3/9/2018
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - DH407 L1B	**Depth (m)**	23.00-23.50

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	100
0.600	98
0.425	96
0.300	94
0.150	86
0.075	81
0.06	72
0.043	69
0.03	66
0.022	63
0.016	59
0.012	56
0.0085	53
0.006	51
0.0042	46
0.0035	43
0.003	43
0.0025	41
0.0021	39
0.0013	35



NOTES/REMARKS: -

Moisture Content 27.7% -2.36mm Soil Particle Density(t/m^3) 2.77

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
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WA 6107
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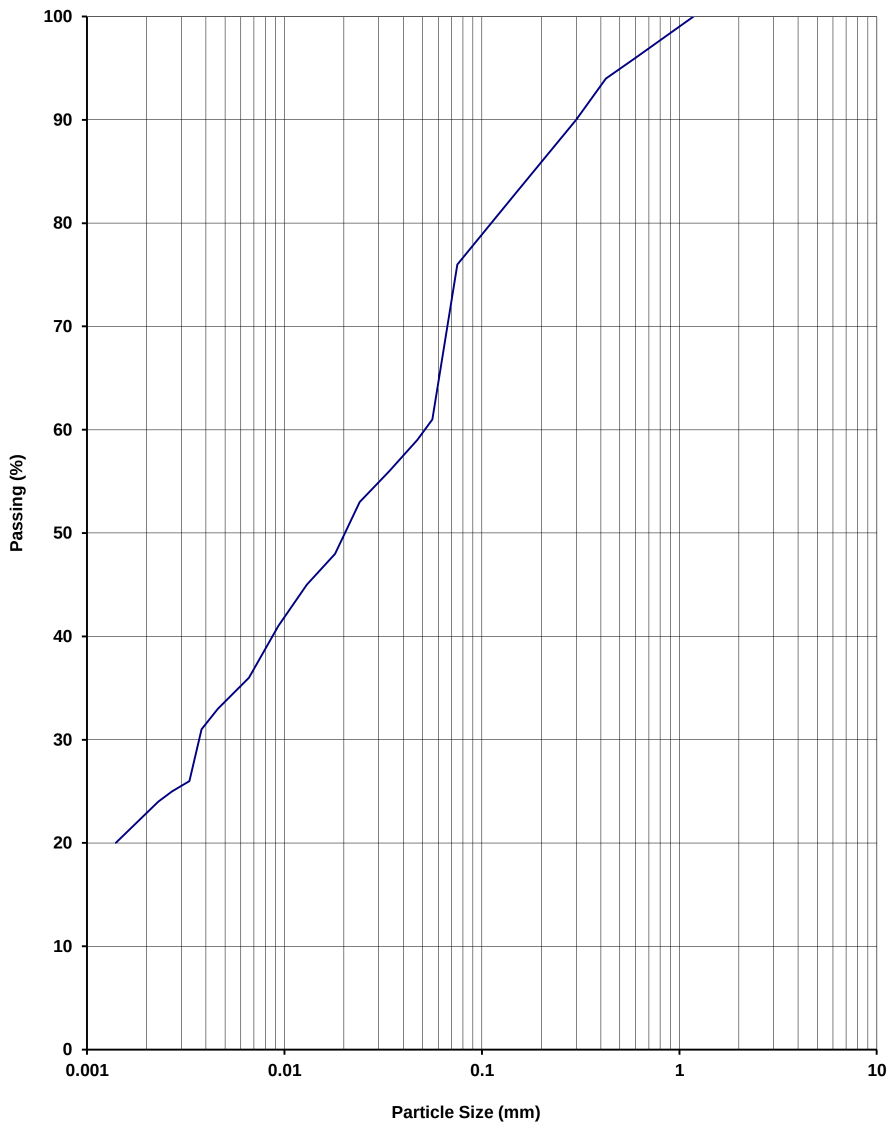
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080439-G
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	27/8/18-7/9/18
		Report Date	7/9/2018
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - DH407 PT3	**Depth (m)**	25.50-26.95

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	100
0.600	96
0.425	94
0.300	90
0.150	83
0.075	76
0.056	61
0.047	59
0.034	56
0.024	53
0.018	48
0.013	45
0.0093	41
0.0066	36
0.0046	33
0.0038	31
0.0033	26
0.0027	25
0.0023	24
0.0014	20



NOTES/REMARKS: -

Moisture Content 38.7% -2.36mm Soil Particle Density(t/m^3) 2.66

Sample/s supplied by the client

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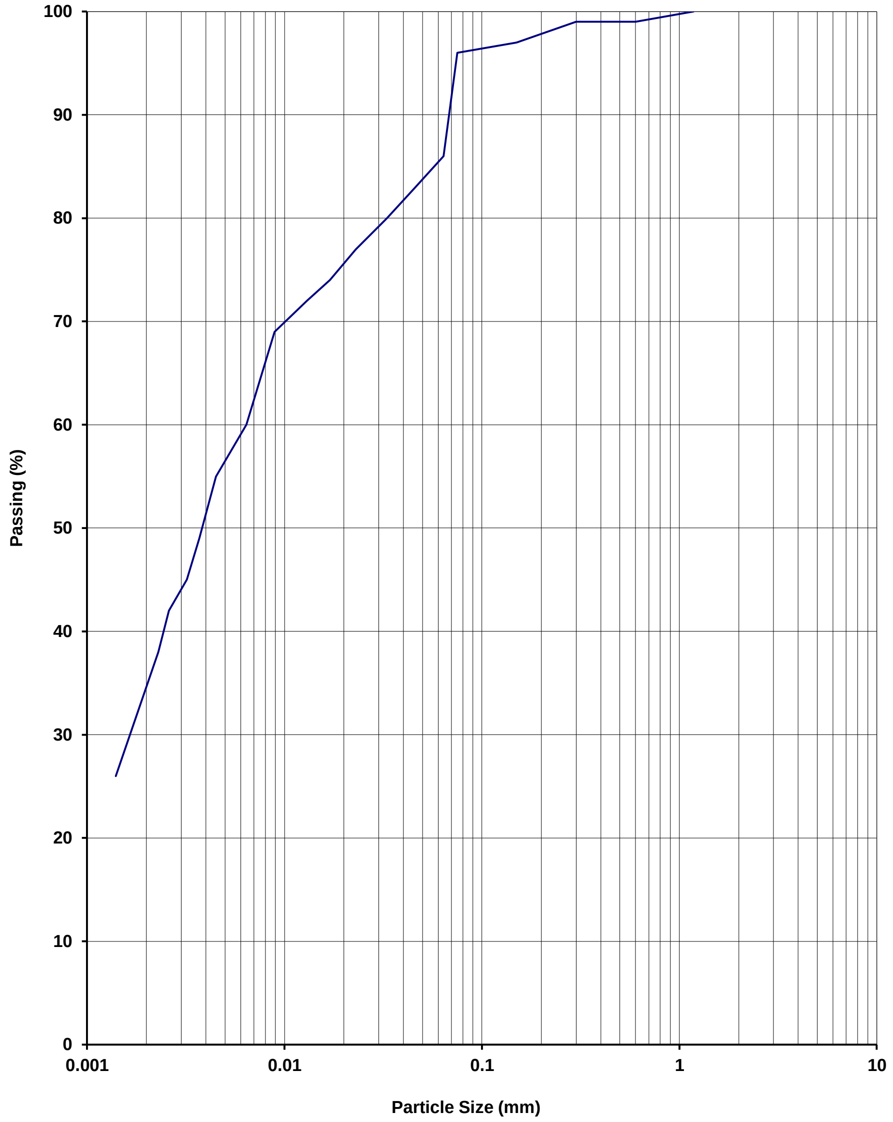
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	18080441-G
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	23/8/18-3/9/18
		Report Date	3/9/2018
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - DH407 L3C	**Depth (m)**	26.50-27.00

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	100
0.600	99
0.425	99
0.300	99
0.150	97
0.075	96
0.064	86
0.046	83
0.033	80
0.023	77
0.017	74
0.013	72
0.0089	69
0.0064	60
0.0045	55
0.0037	49
0.0032	45
0.0026	42
0.0023	38
0.0014	26



NOTES/REMARKS: -

Moisture Content 38.4% -2.36mm Soil Particle Density(t/m^3) 2.62

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory.

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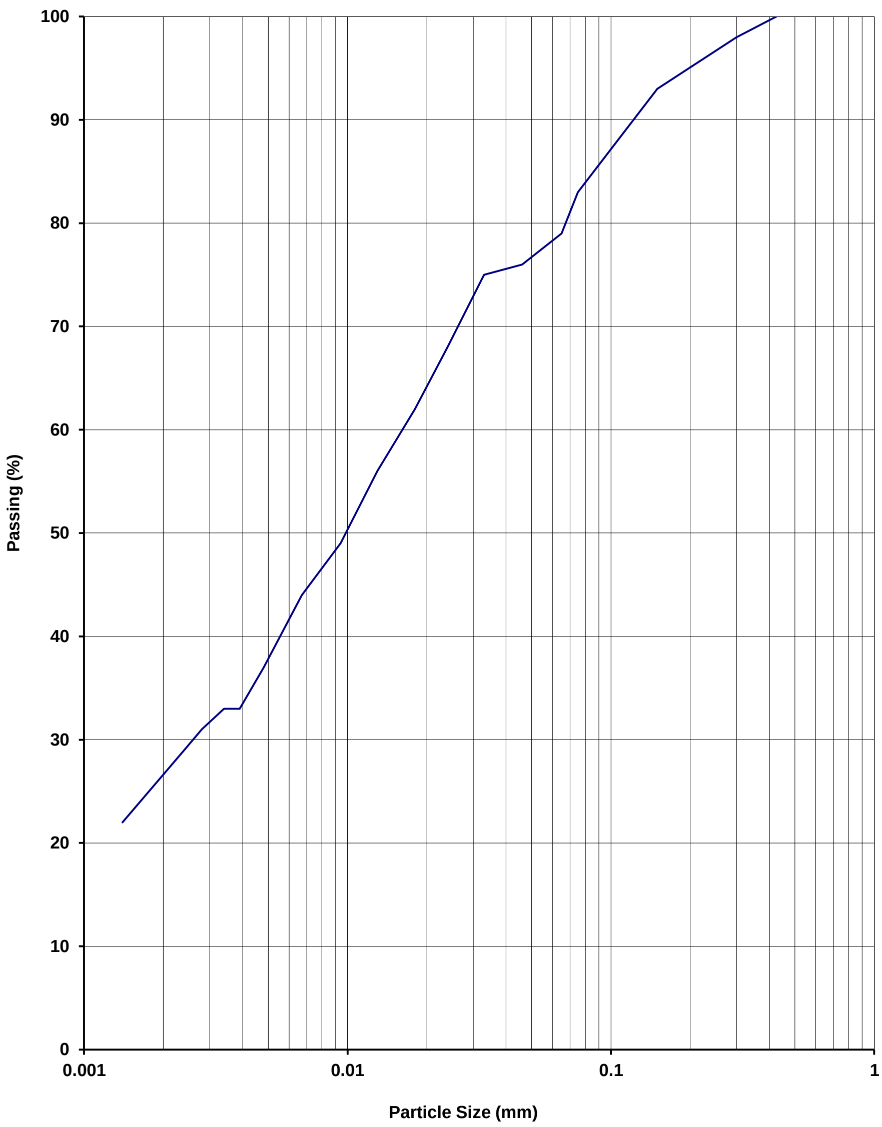
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	19010703-G
		Workorder No.	0005472
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	26/1/19-30/1/19
		Report Date	30/1/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE411A	**Depth (m)**	16.00-16.50

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	
0.425	100
0.300	98
0.150	93
0.075	83
0.065	79
0.046	76
0.033	75
0.024	68
0.018	62
0.013	56
0.0094	49
0.0067	44
0.0048	37
0.0039	33
0.0034	33
0.0028	31
0.0024	29
0.0014	22



NOTES/REMARKS: -

Moisture Content 37.7% -2.36mm Soil Particle Density(t/m^3) 2.58

Sample/s supplied by the client

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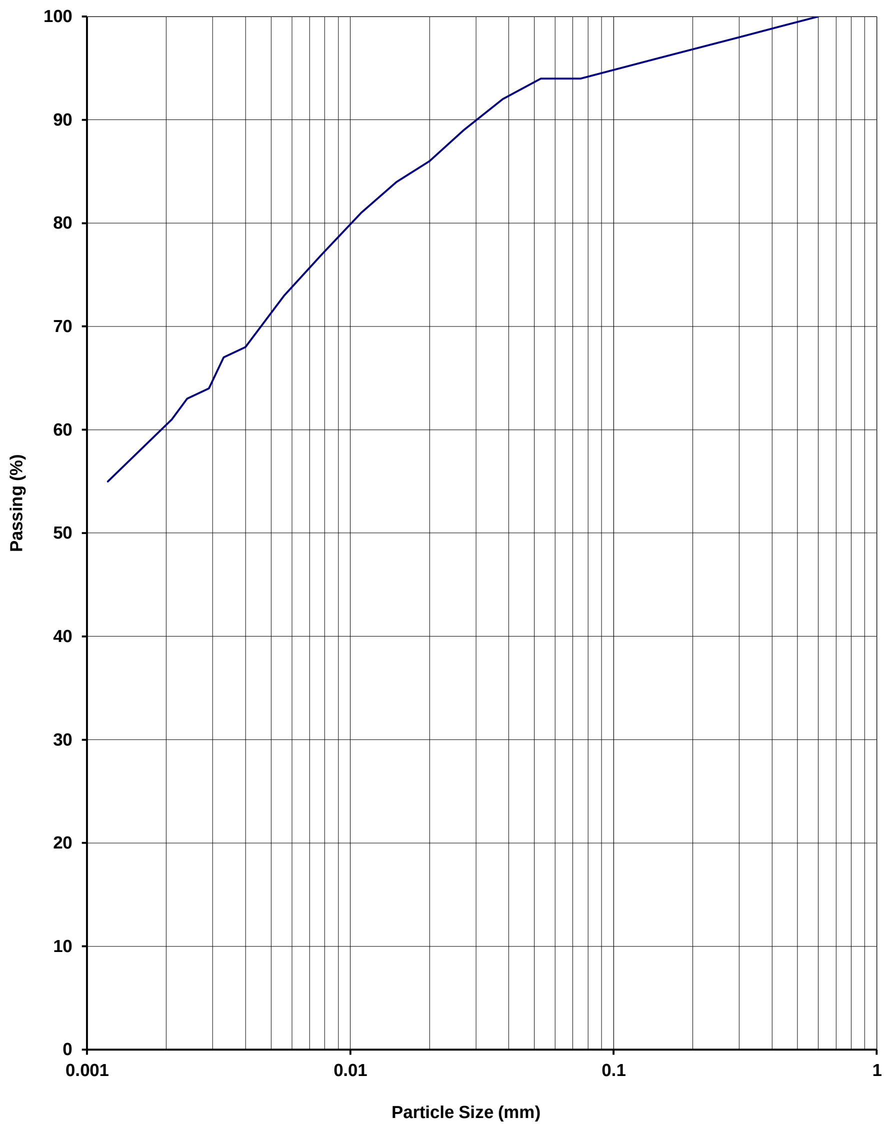
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	19010704-G
		Workorder No.	0005472
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	26/1/19-30/1/19
		Report Date	30/1/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - L2B	**Depth (m)**	24.50-25.00

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	98
0.150	96
0.075	94
0.053	94
0.038	92
0.027	89
0.02	86
0.015	84
0.011	81
0.0078	77
0.0056	73
0.004	68
0.0033	67
0.0029	64
0.0024	63
0.0021	61
0.0012	55



NOTES/REMARKS: -

Moisture Content 34% -2.36mm Soil Particle Density(t/m^3) 2.66

Sample/s supplied by the client

Authorised Signatory

C. Park

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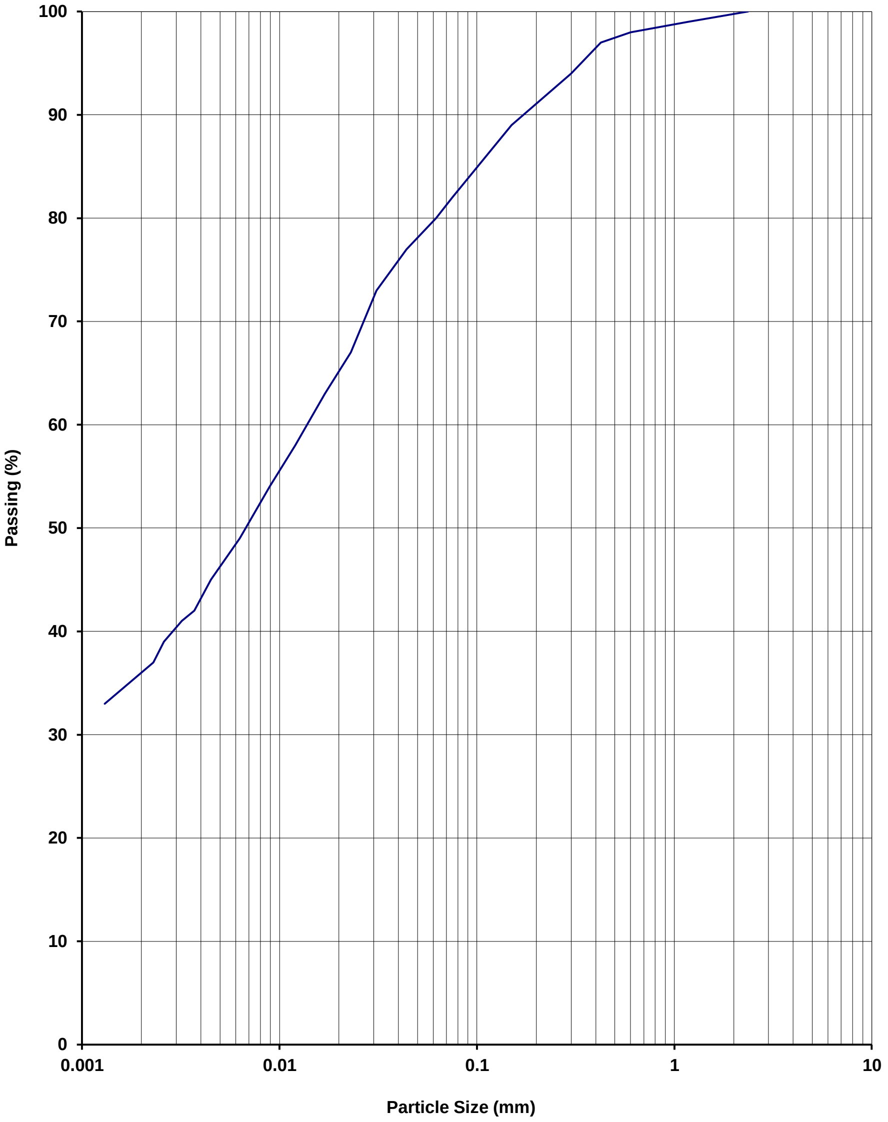
PARTICLE SIZE DISTRIBUTION TEST REPORT

Test Method: AS 1289 3.6.3, 3.5.1 & 2.1.1

Client	Hatch Pty Ltd	**Report No.**	19010705-G
		Workorder No.	0005472
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	26/1/19-30/1/19
		Report Date	30/1/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - L2C	**Depth (m)**	25.00-25.50

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	100
1.18	99
0.600	98
0.425	97
0.300	94
0.150	89
0.075	82
0.062	80
0.044	77
0.031	73
0.023	67
0.017	63
0.012	58
0.0089	54
0.0063	49
0.0045	45
0.0037	42
0.0032	41
0.0026	39
0.0023	37
0.0013	33



NOTES/REMARKS: -

Moisture Content 39.3% -2.36mm Soil Particle Density(t/m^3) 2.72

Sample/s supplied by the client

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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/m^3)	2.11	1.95	1.95	1.70	-	-	-
Dry Density (t/m^3)	1.79	1.61	1.59	1.14	-	-	-

Sample No.	-	-	-	-	-	-	-
Test Date	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Moisture (%)	-	-	-	-	-	-	-
Wet Density (t/m^3)	-	-	-	-	-	-	-
Dry Density (t/m^3)	-	-	-	-	-	-	-

NOTES/REMARKS:

Sample/s supplied by the client

Authorised Signatory

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UNIT WEIGHT TEST REPORT

Test Method: AS 1289 6.4.1

Client	Hatch Pty Ltd	**Report No.**	19010703-UW
		Workorder No.	0005472
Address	PO Box 425 SPRING HILL QLD 4004	**Report Date**	31/01/2019
Project	H356804 - Cadia NTSF Failure		

Sample No.	19010703	19010704	19010705	-	-	-	-
Test Date	25/01/2019	25/01/2019	13/02/1900	-	-	-	-
Client ID	CE411A	CE416 - L2B	CE416 - L2C	-	-	-	-
Depth (m)	16.00-16.50	24.50-25.00	25.00-25.50	-	-	-	-
Moisture (%)	37.7	34.0	39.3	-	-	-	-
Wet Density (t/m^3)	1.76	1.87	1.96	-	-	-	-
Dry Density (t/m^3)	1.28	1.40	1.41	-	-	-	-

Sample No.	-	-	-	-	-	-	-
Test Date	-	-	-	-	-	-	-
Client ID	-	-	-	-	-	-	-
Depth (m)	-	-	-	-	-	-	-
Moisture (%)	-	-	-	-	-	-	-
Wet Density (t/m^3)	-	-	-	-	-	-	-
Dry Density (t/m^3)	-	-	-	-	-	-	-

NOTES/REMARKS:

Sample/s supplied by the client

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Laboratory No. 9926

Annexure DB
Direct Simple Shear Tests - Golders

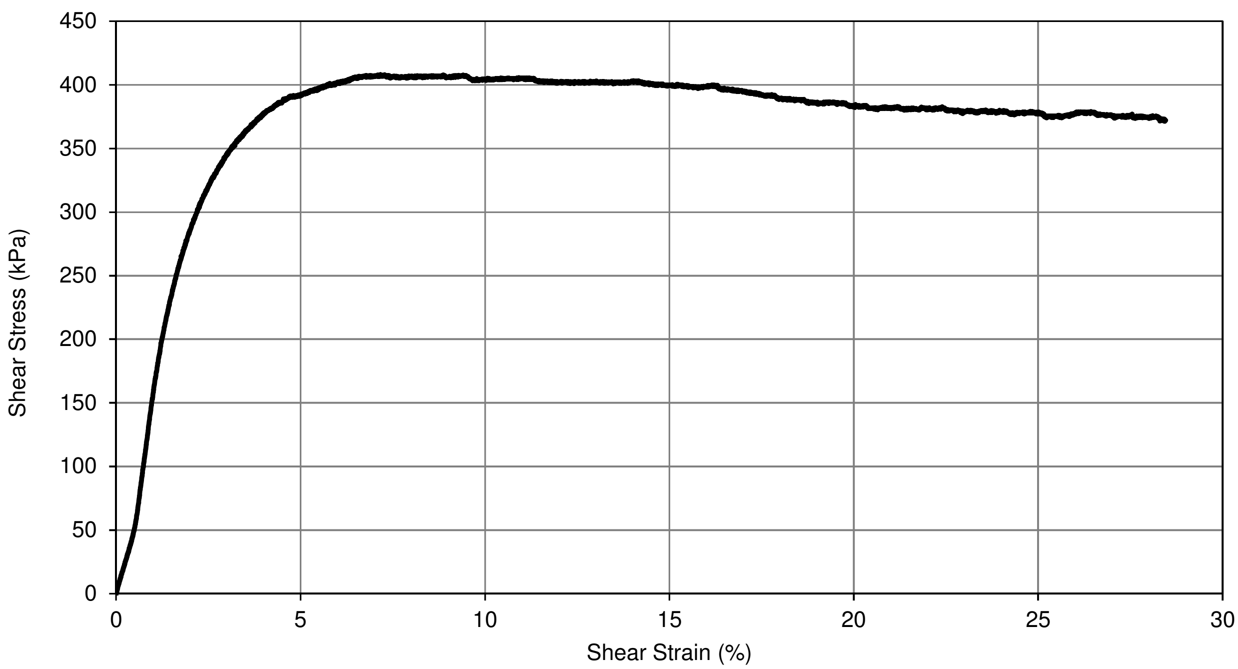
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

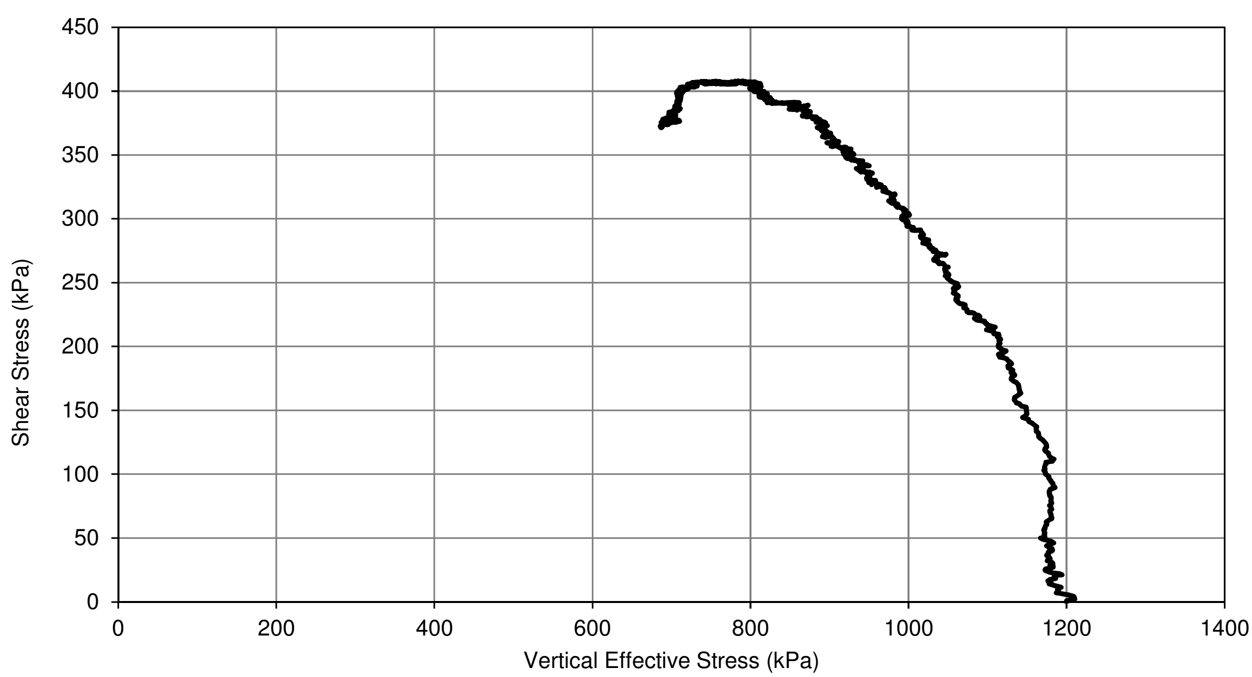
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	10/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP401 0.7-1.0m
Location:	Cadia Mine	**Test ID:**	18005 - DSS1 1200kPa

Vertical Effective Stress (kPa)	1200	Final Bulk Density (t/m^3)	2.17
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.77
Shearing Height (mm)	20.6	Shearing Strain Rate (mm/min)	0.006





Preparation Notes:	Trimmed from block sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Monotonic Direct Simple Shear Test Report - Consolidated Undrained

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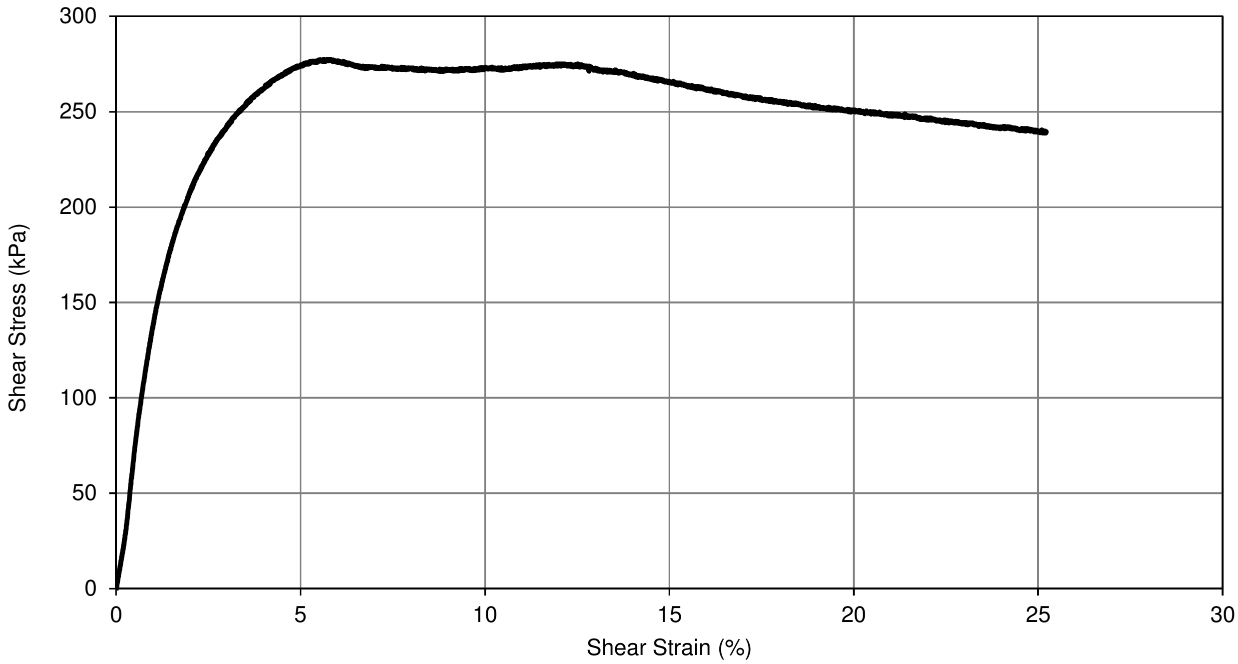
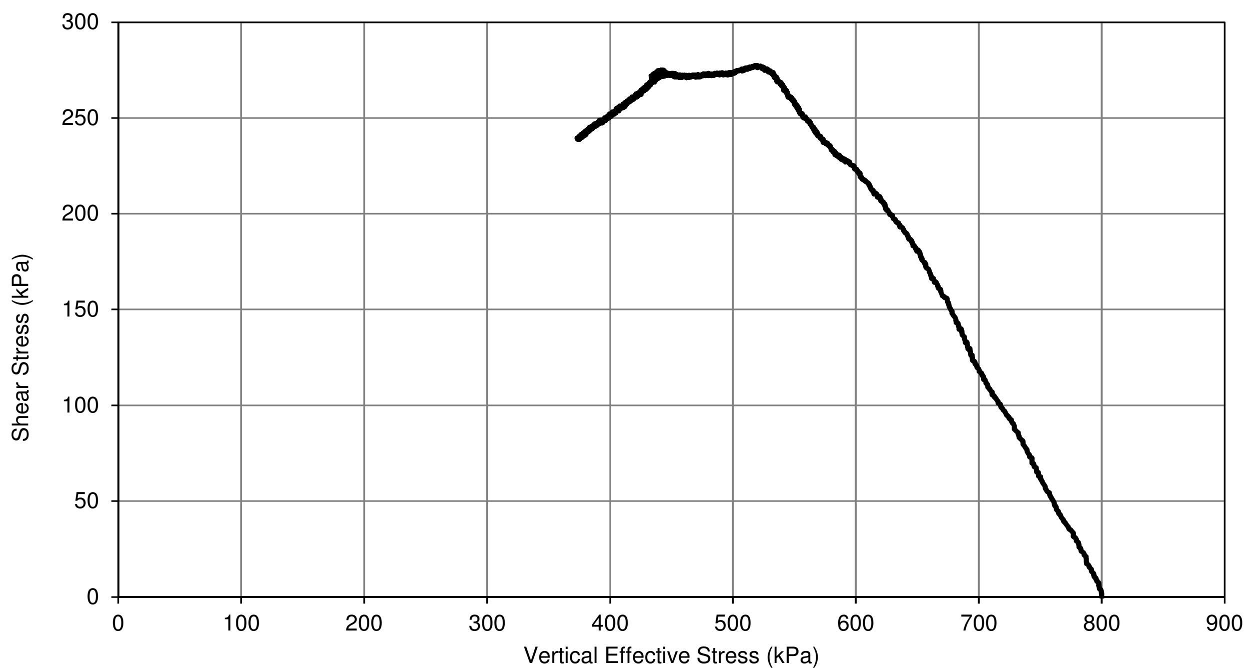
GOLDER

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:**	TP401 0.7-1.0m
Location:	Cadia Mine	**Test ID:**	18005 - DSS2 800kPa

Vertical Effective Stress (kPa)	800	Final Bulk Density (t/m^3)	2.16
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.76
Shearing height (mm)	17.7	Shearing Strain Rate (mm/min)	0.005





Preparation Notes:	Trimmed from block sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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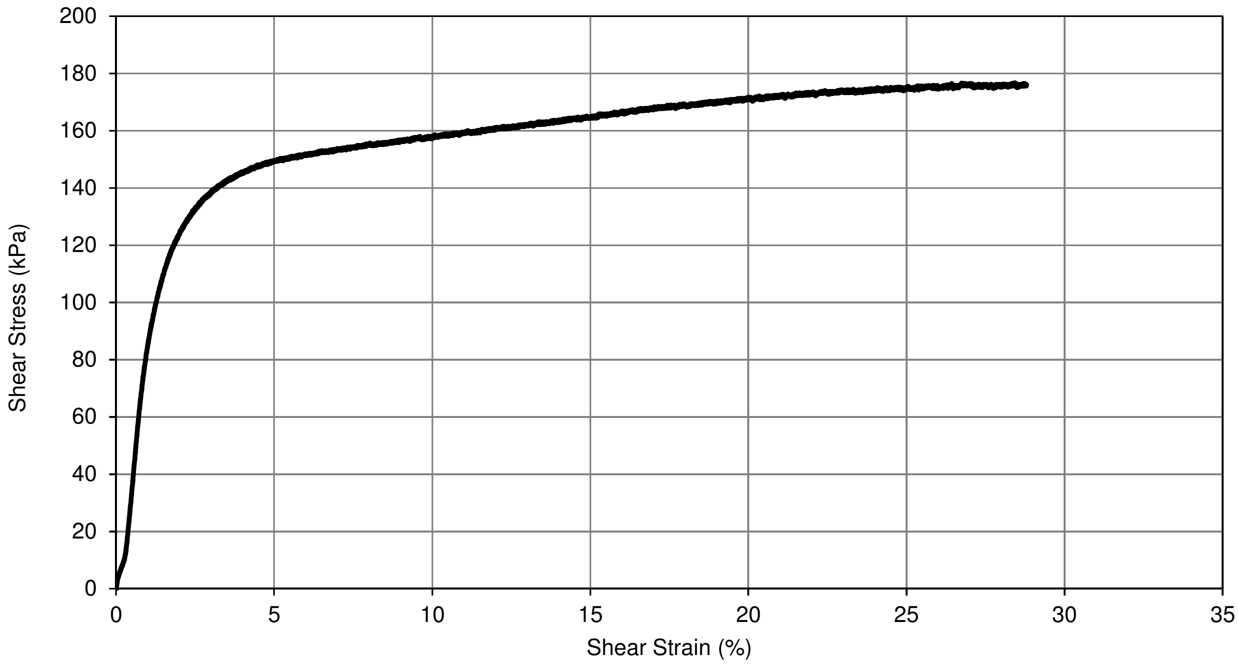
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

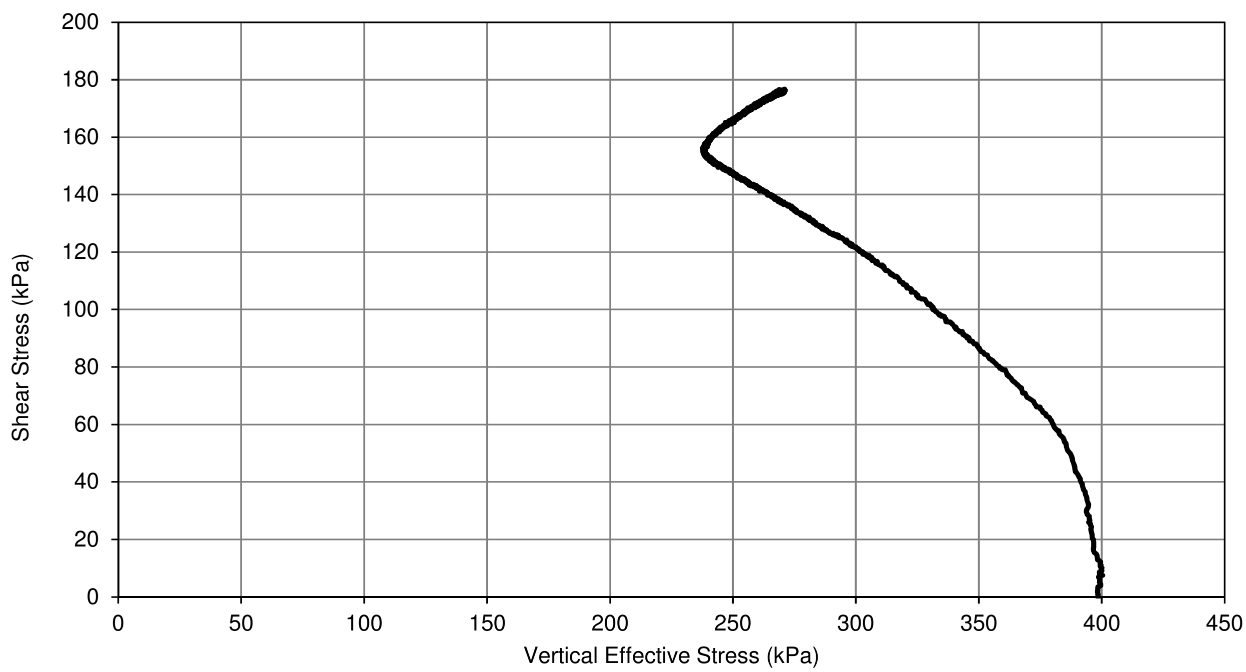
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP401 0.7-1.0m
Location:	Cadia Mine	**Test ID:**	18005 - DSS3 400kPa

Vertical Effective Stress (kPa)	400	Final Bulk Density (t/m^3)	2.16
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.76
Shearing height (mm)	19.0	Shearing Strain Rate (mm/min)	0.006





Preparation Notes:	Trimmed from block sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

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GOLDER

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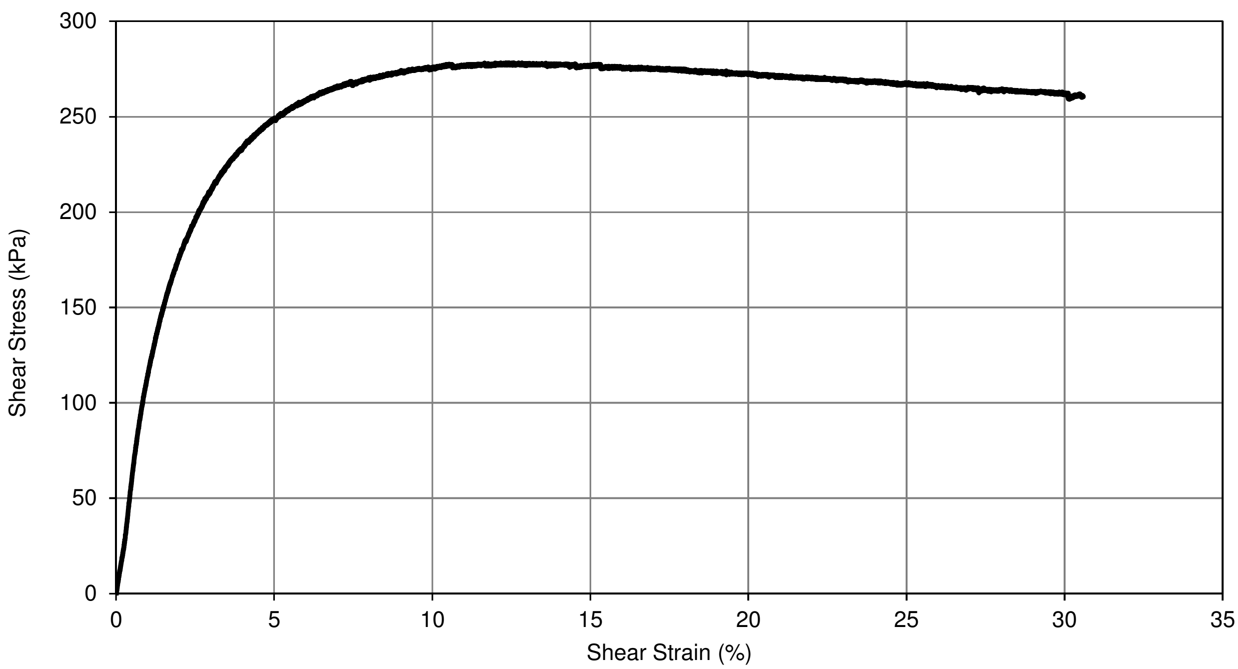
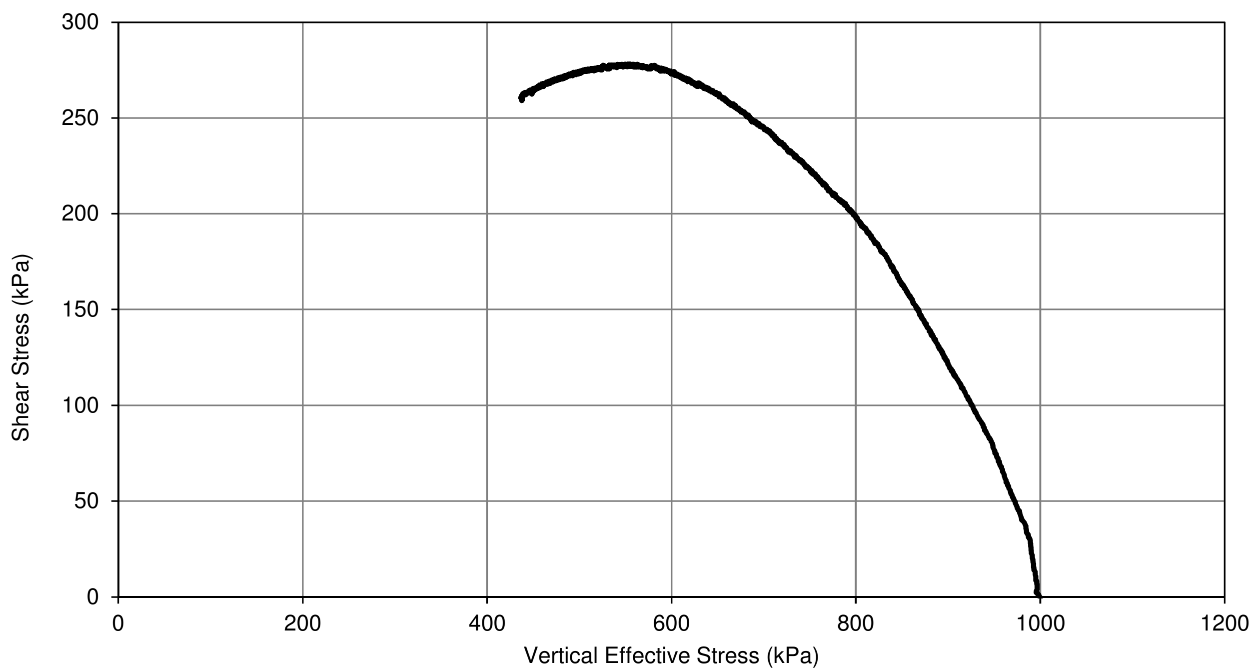
Client:	Hatch	**Date:**	20/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2m
Location:	Cadia Mine	**Test ID:**	18006 - DSS1 1000kPa

Vertical Effective Stress (kPa)	1000	Final Bulk Density (t/m^3)	2.16
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.69
Shearing Height (mm)	19.2	Shearing Strain Rate (mm/min)	0.005





Preparation Notes:	Trimmed from block sample "Dead zone"-type end platens	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni / D. Reid

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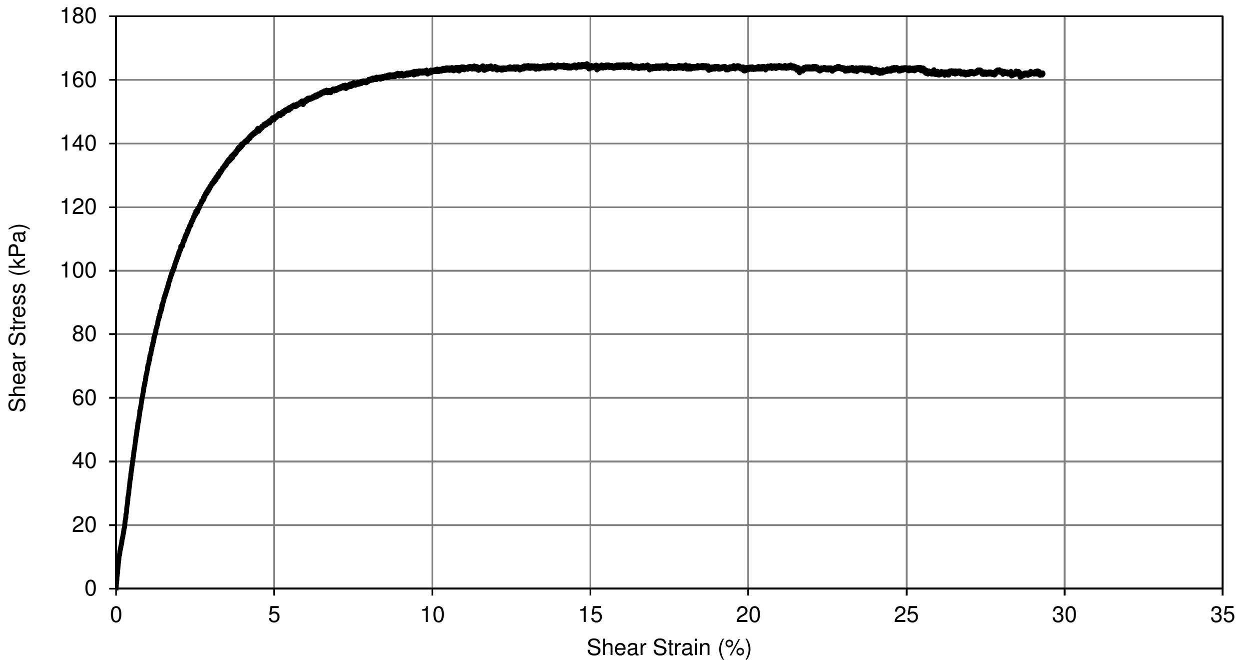
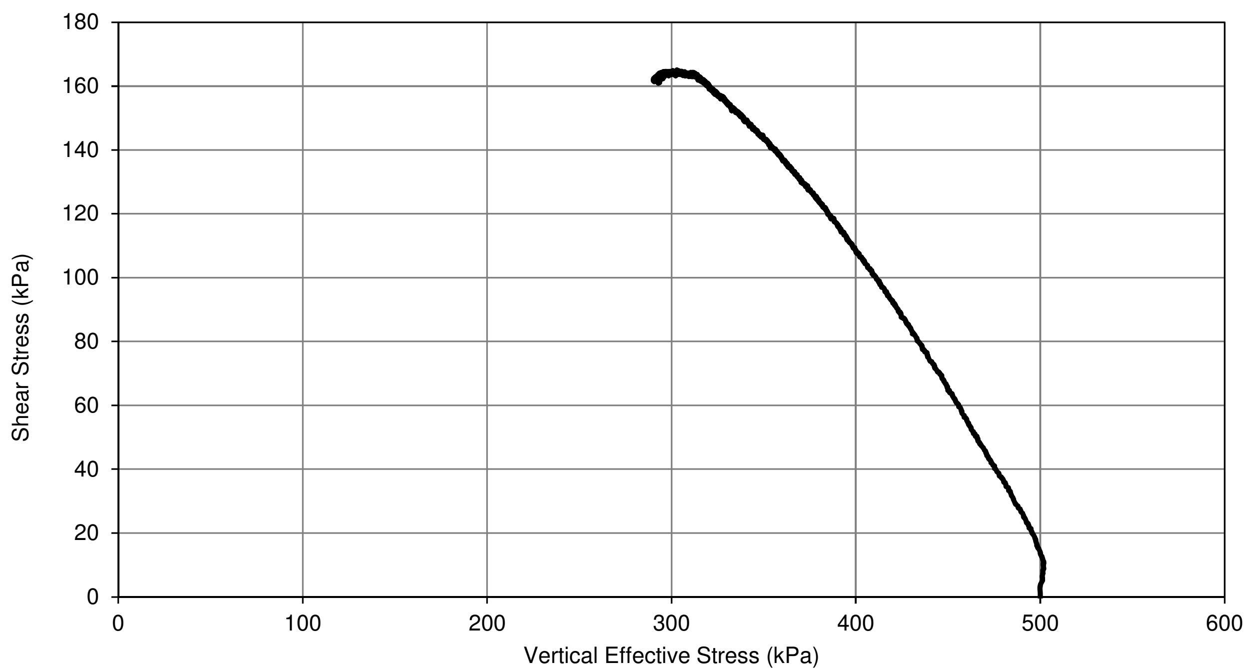
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	22/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2m
Location:	Cadia Mine	**Test ID:**	18006 - DSS2 500kPa

Vertical Effective Stress (kPa)	500	Final Bulk Density (t/m^3)	2.09
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.63
Shearing Height (mm)	19.4	Shearing Strain Rate (mm/min)	0.006





Preparation Notes:	Trimmed from block sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni / D. Reid

Monotonic Direct Simple Shear Test Report - Consolidated Undrained

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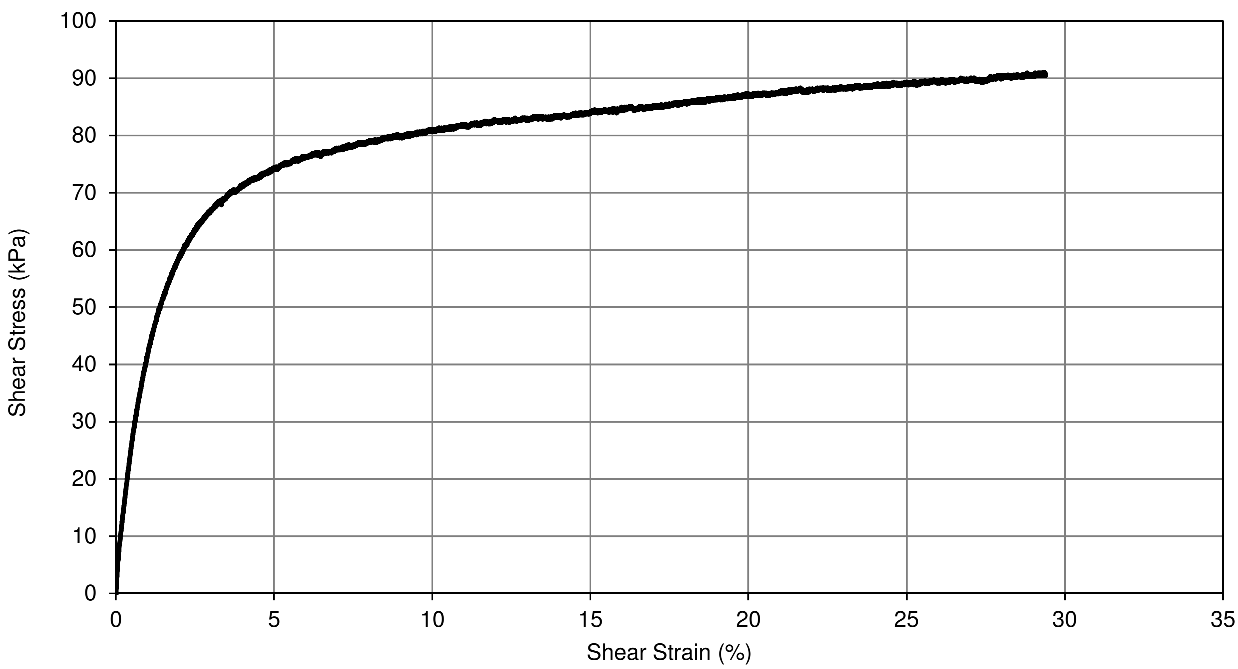
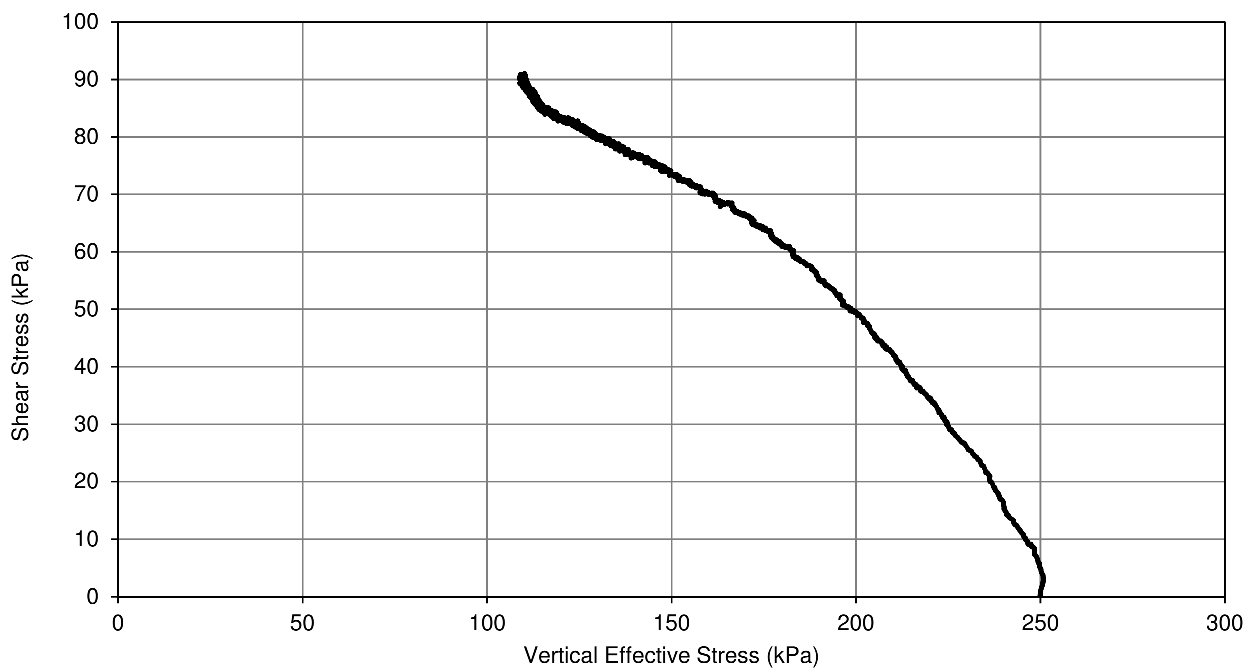
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	25/06/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2m
Location:	Cadia Mine	**Test ID:**	18006 - DSS3 250kPa

Vertical Effective Stress (kPa)	250	Final Bulk Density (t/m^3)	2.01
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.58
Shearing Height (mm)	19.3	Shearing Strain Rate (mm/min)	0.006





Preparation Notes:	Trimmed from block sample "Dead zone"-type end platens	Tested by:	I. Orea
		Reviewed by:	R. Fanni / D. Reid

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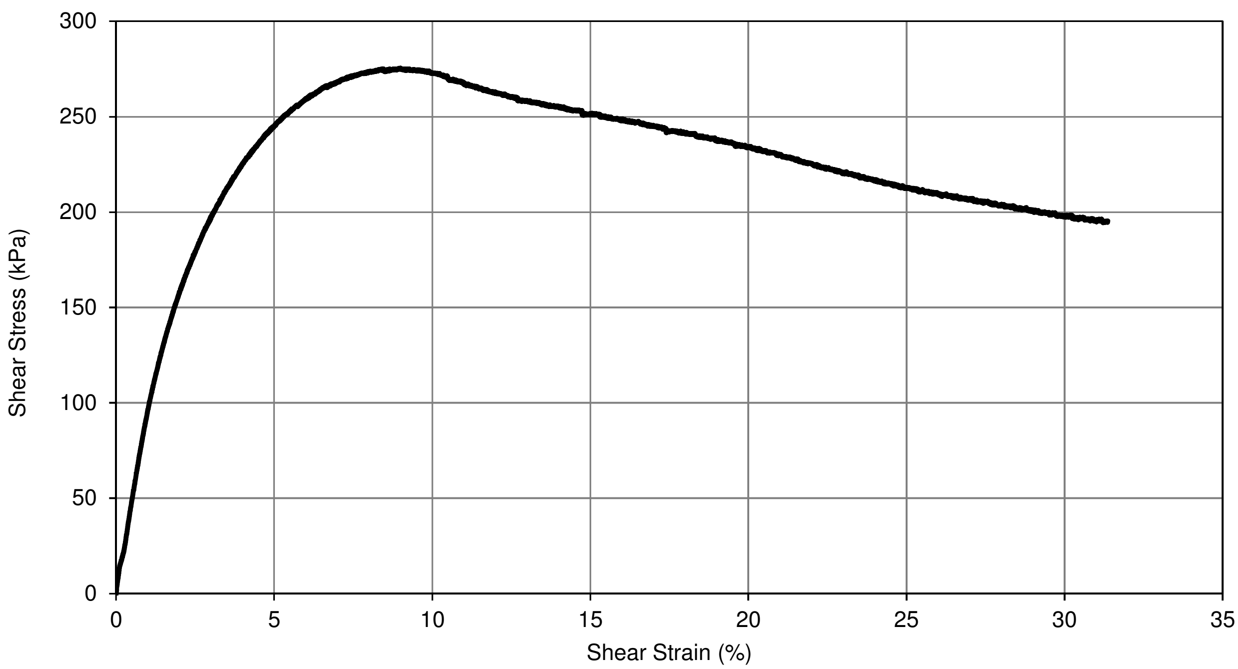
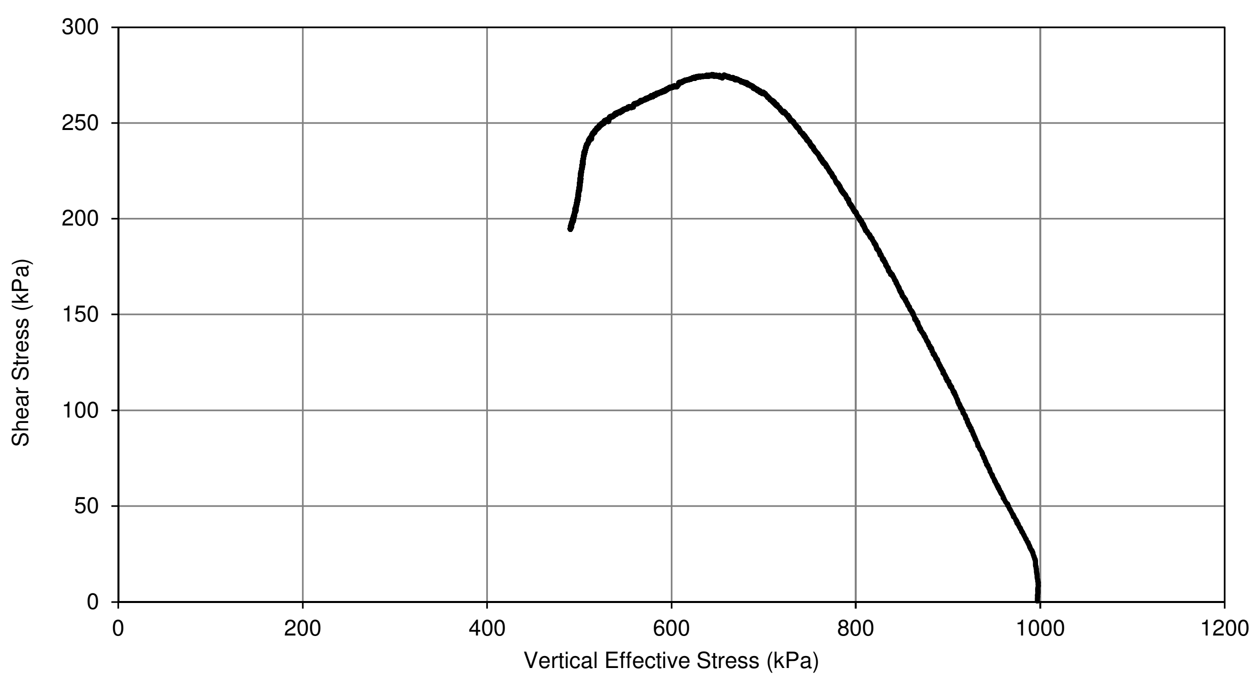
GOLDER

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:**	CE415-PT1 6.0-6.5m
Location:	Cadia Mine	**Test ID:**	18022 - DSS1 1000kPa

Vertical Effective Stress (kPa)	1000	Final Bulk Density (t/m^3)	1.95
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.36
Shearing height (mm)	19.4	Shearing Strain Rate (mm/min)	0.006





Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	D. Reid / R. Fanni

Monotonic Direct Simple Shear Test Report - Consolidated Undrained

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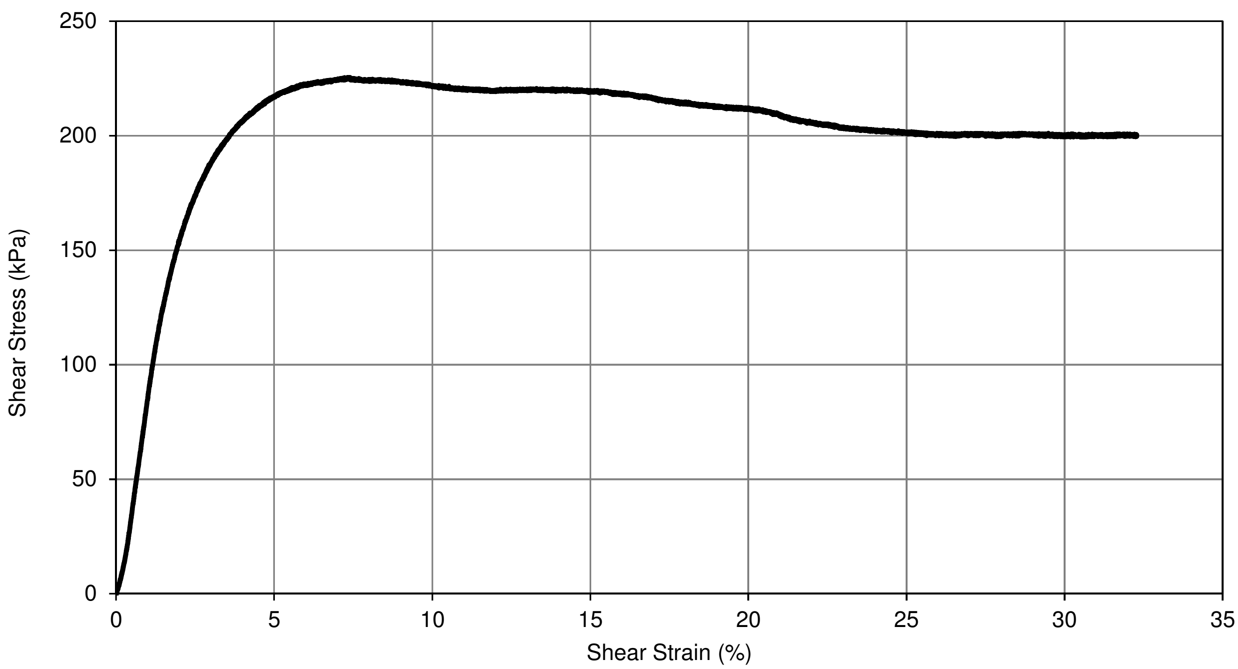
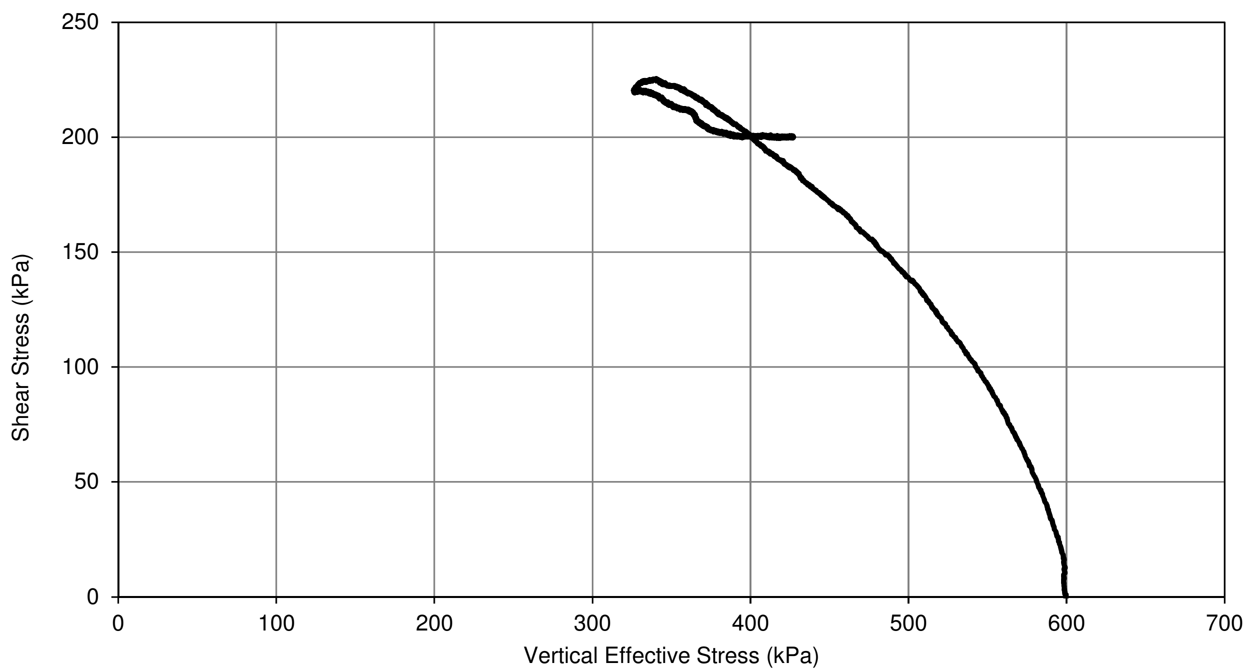
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	28/08/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5m
Location:	Cadia Mine	**Test ID:**	18022 - DSS2 600kPa

Vertical Effective Stress (kPa)	600	Final Bulk Density (t/m^3)	1.91
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.33
Shearing height (mm)	19.1	Shearing Strain Rate (mm/min)	0.005





Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	I. Orea
		Reviewed by:	D. Reid / R. Fanni

Monotonic Direct Simple Shear Test Report - Consolidated Undrained

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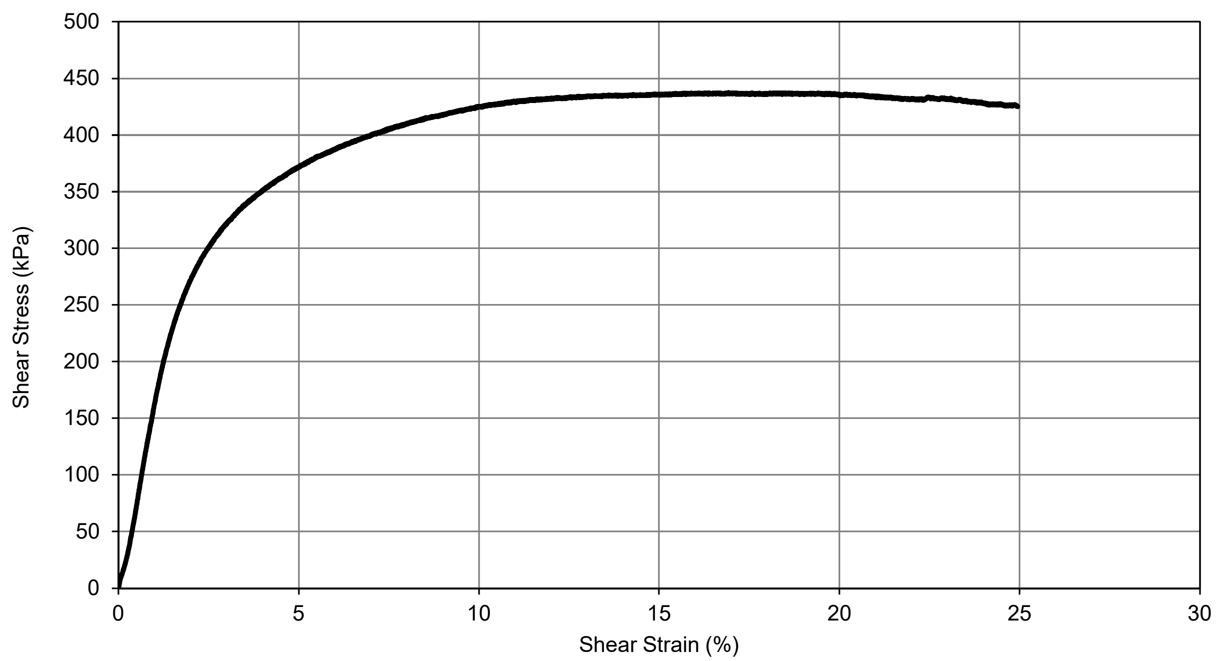
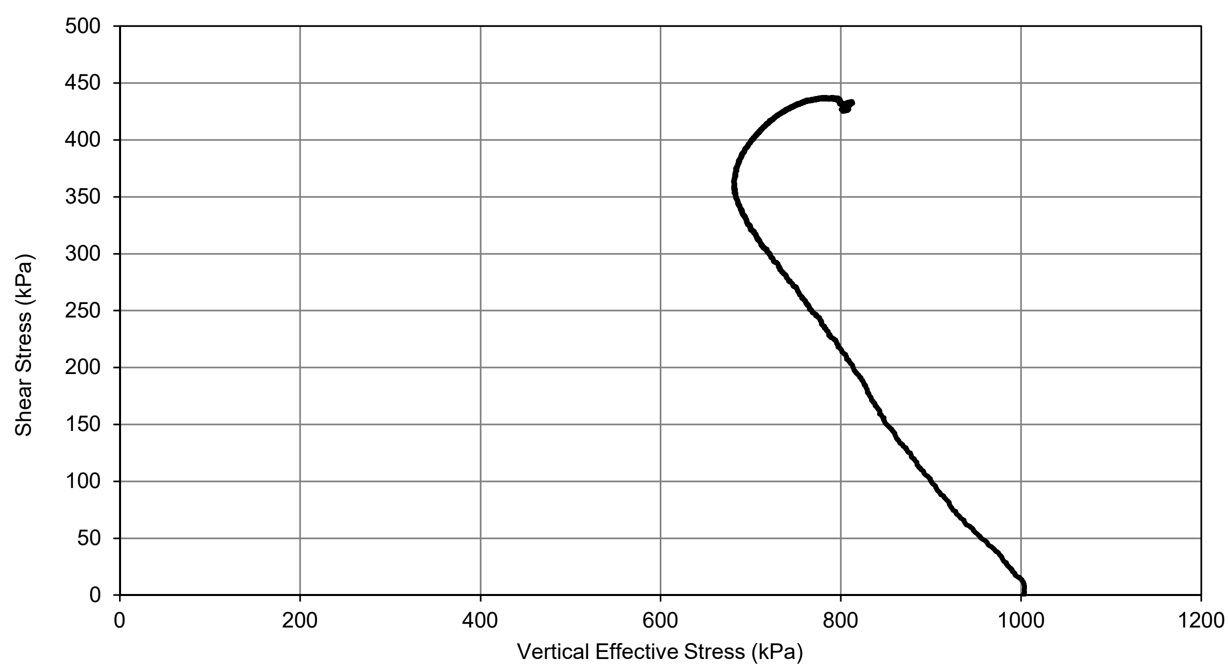
GOLDER

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:**	CE417-PT1 16.5-16.86m
Location:	Cadia Mine	**Test ID:**	18023 - DSS1 1000kPa

Vertical Effective Stress (kPa)	1000	Final Bulk Density (t/m^3)	1.99
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.49
Shearing height (mm)	22.8	Shearing Strain Rate (mm/min)	0.007





Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	D. Reid / R. Fanni

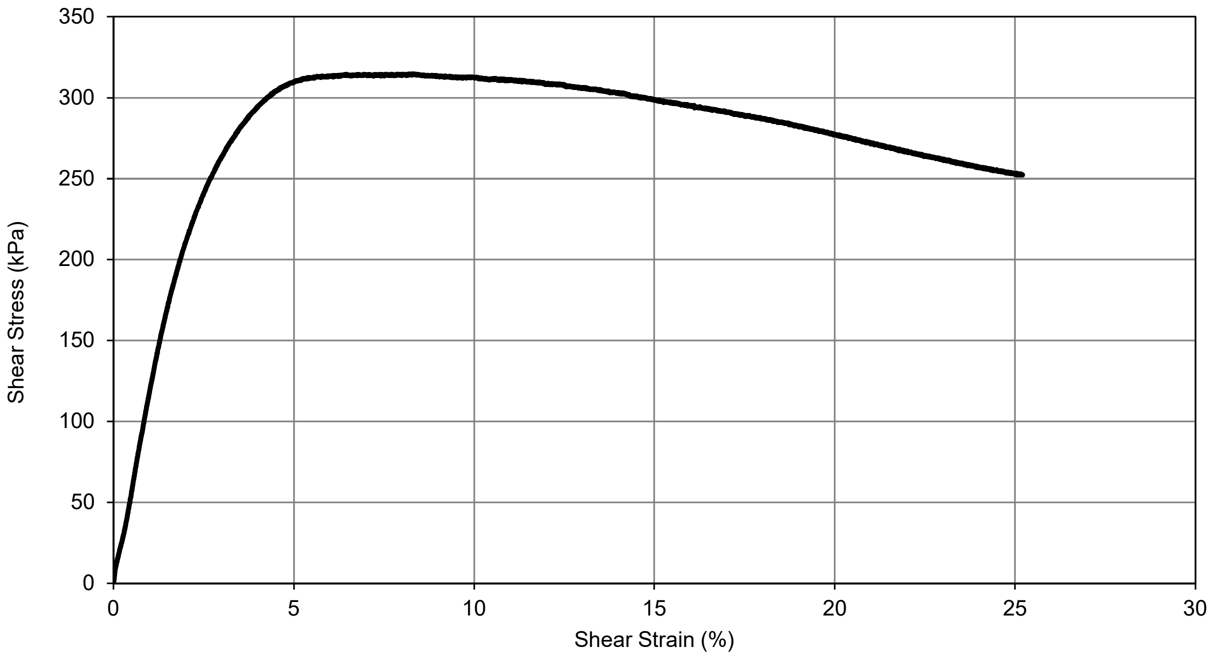
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

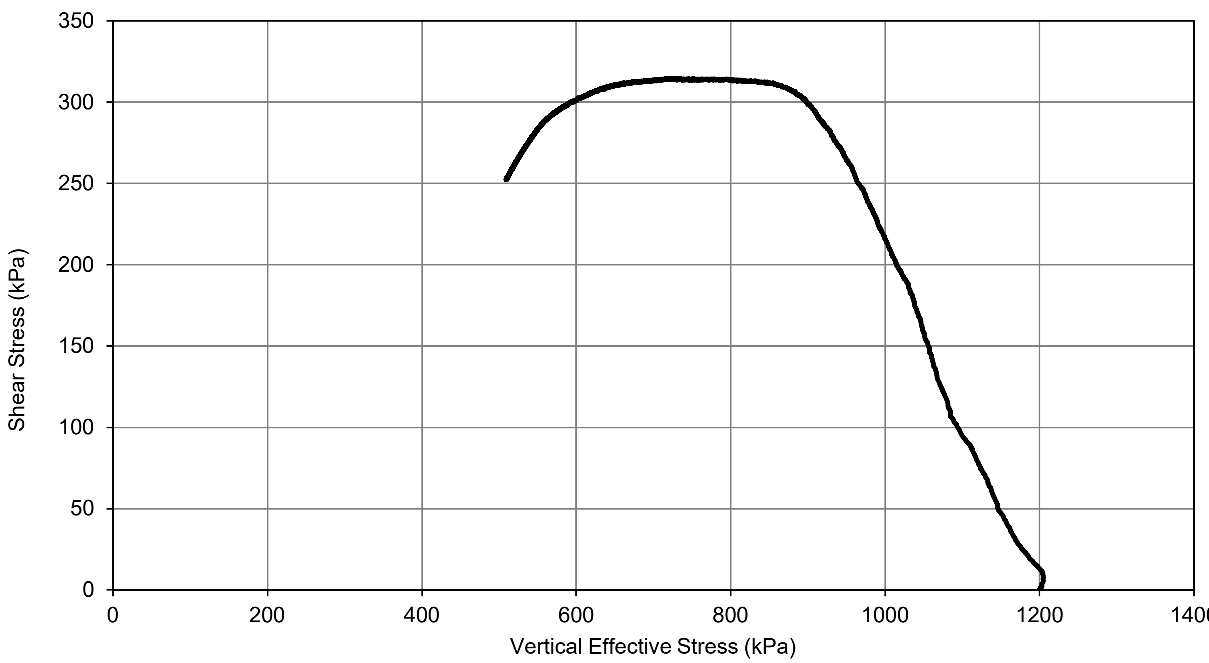
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	3/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416-PT4 27.0-27.45m
Location:	Cadia Mine	**Test ID:**	18024 - DSS1 1200kPa

Vertical Effective Stress (kPa)	1200	Final Bulk Density (t/m^3)	1.96
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.41
Shearing height (mm)	22.6	Shearing Strain Rate (mm/min)	0.007





Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni

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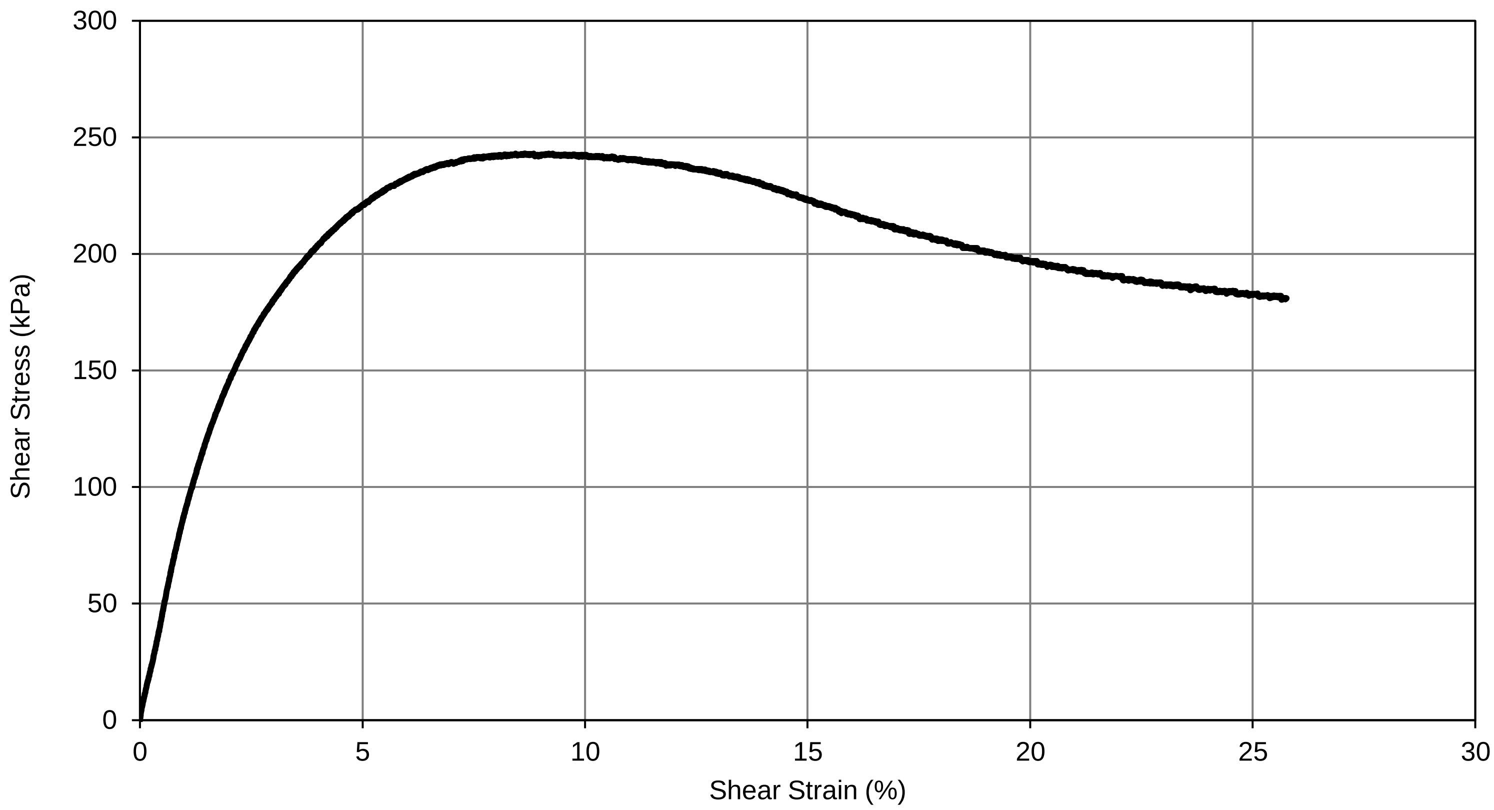
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

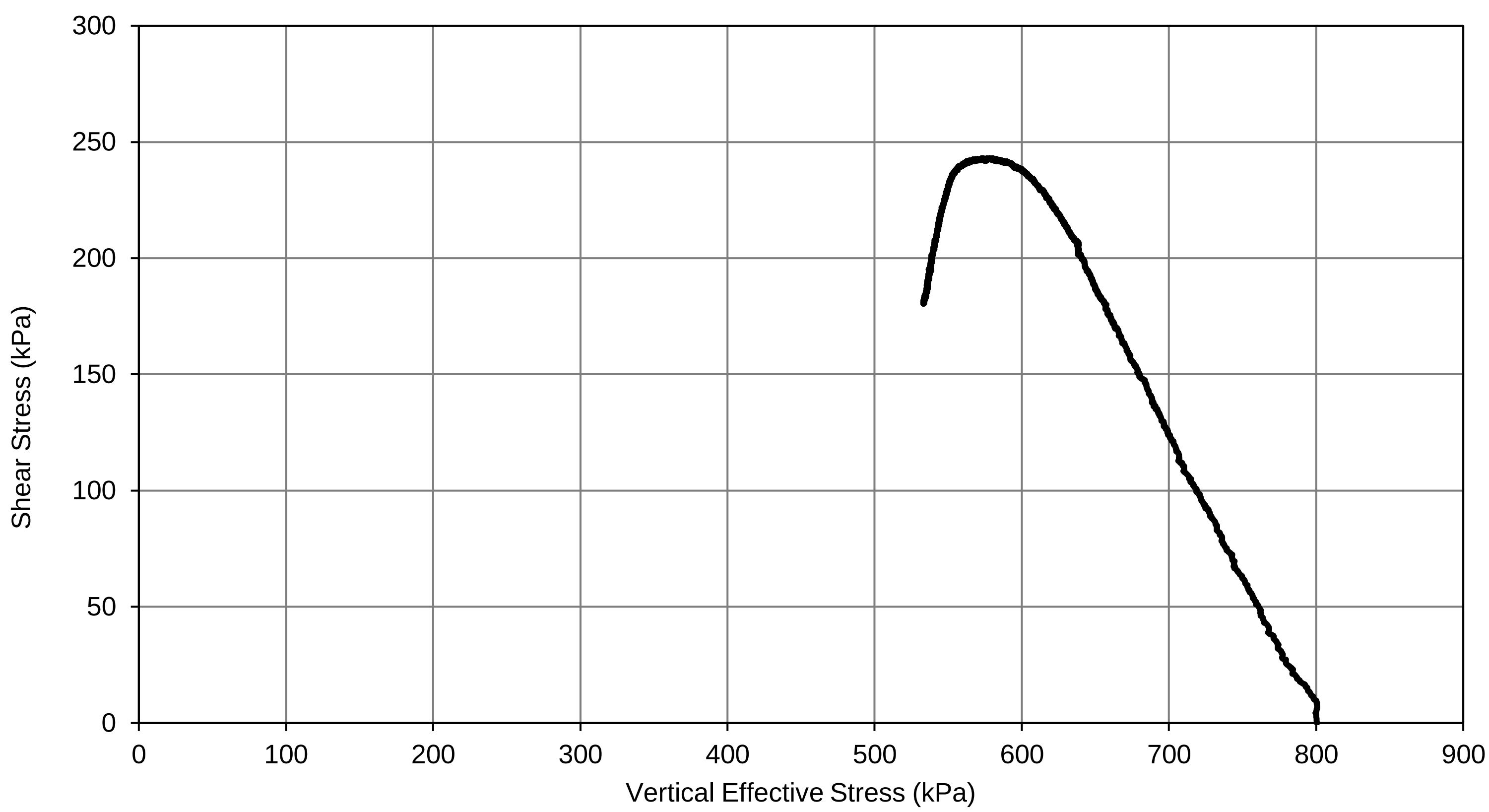
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	15/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416-PT4 27.0-27.45m
Location:	Cadia Mine	**Test ID:**	18024 - DSS2 800kPa

Vertical Effective Stress (kPa)	800	Final Bulk Density (t/m^3)	1.97
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.43
Shearing height (mm)	22.4	Shearing Strain Rate (mm/min)	0.007





Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni

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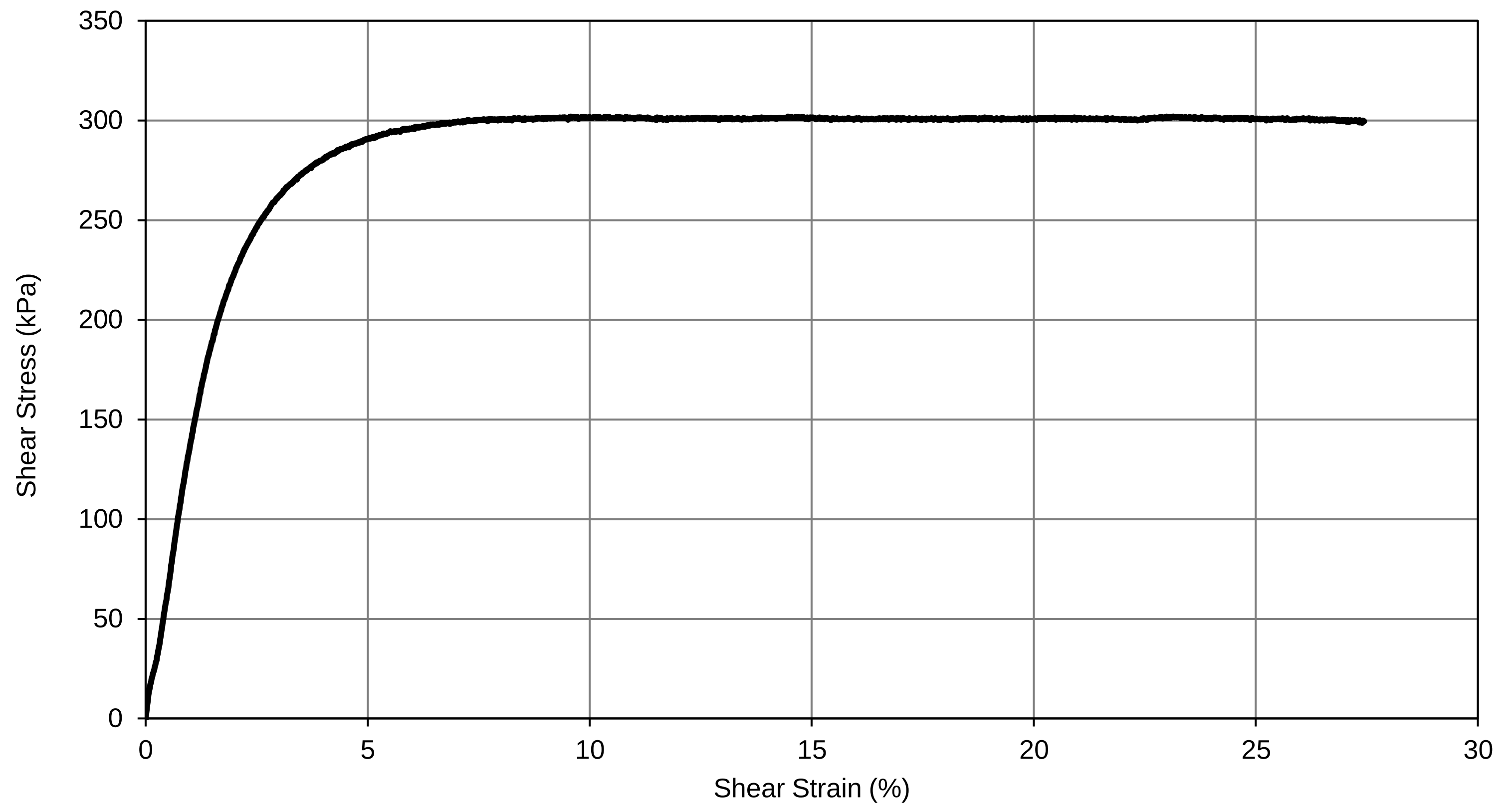
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

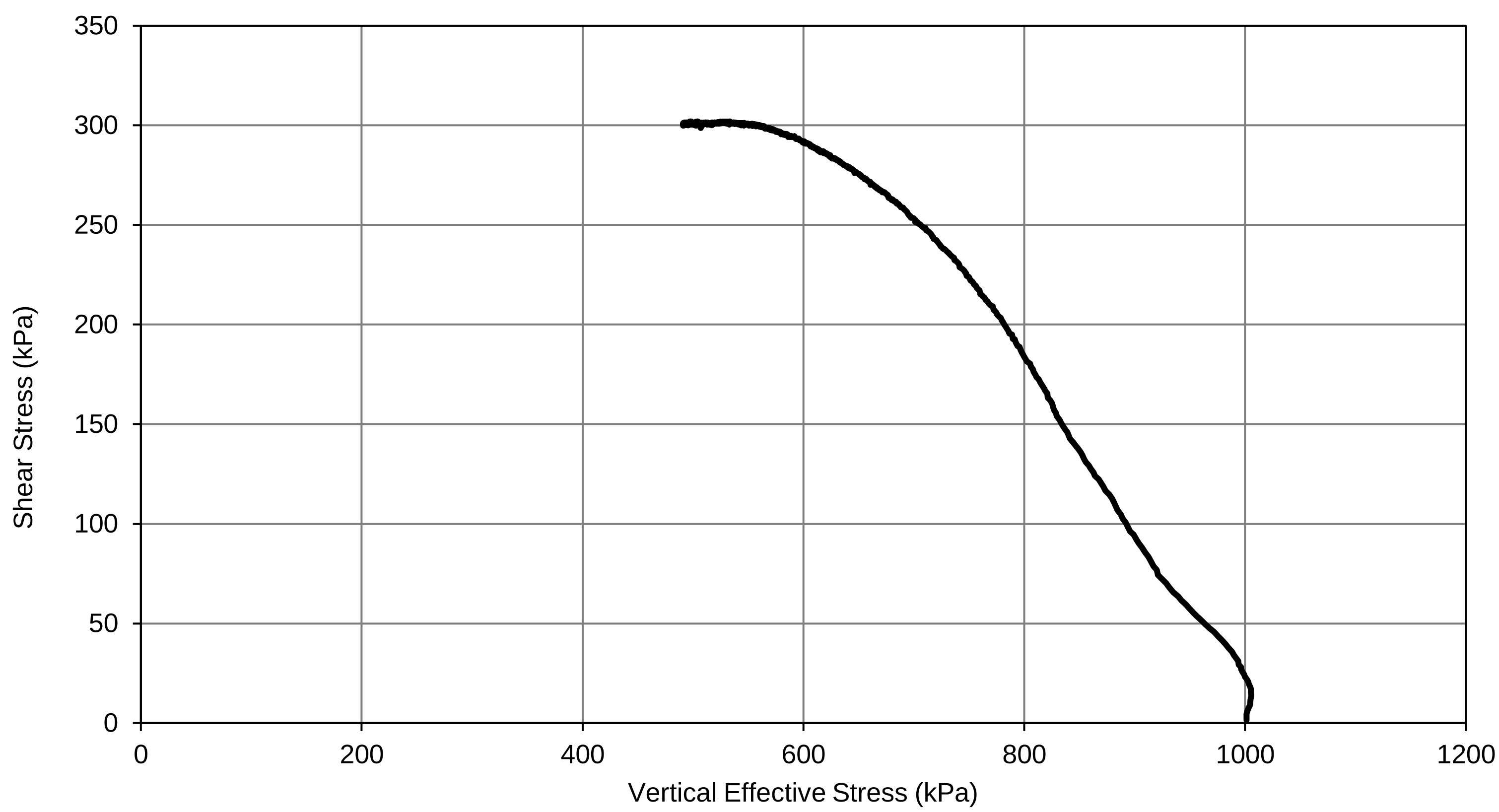
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	11/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE417-PT2 19.5-20.0m
Location:	Cadia Mine	**Test ID:**	18025 - DSS1 1000kPa

Vertical Effective Stress (kPa)	1000	Final Bulk Density (t/m^3)	1.97
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.46
Shearing height (mm)	21.2	Shearing Strain Rate (mm/min)	0.015





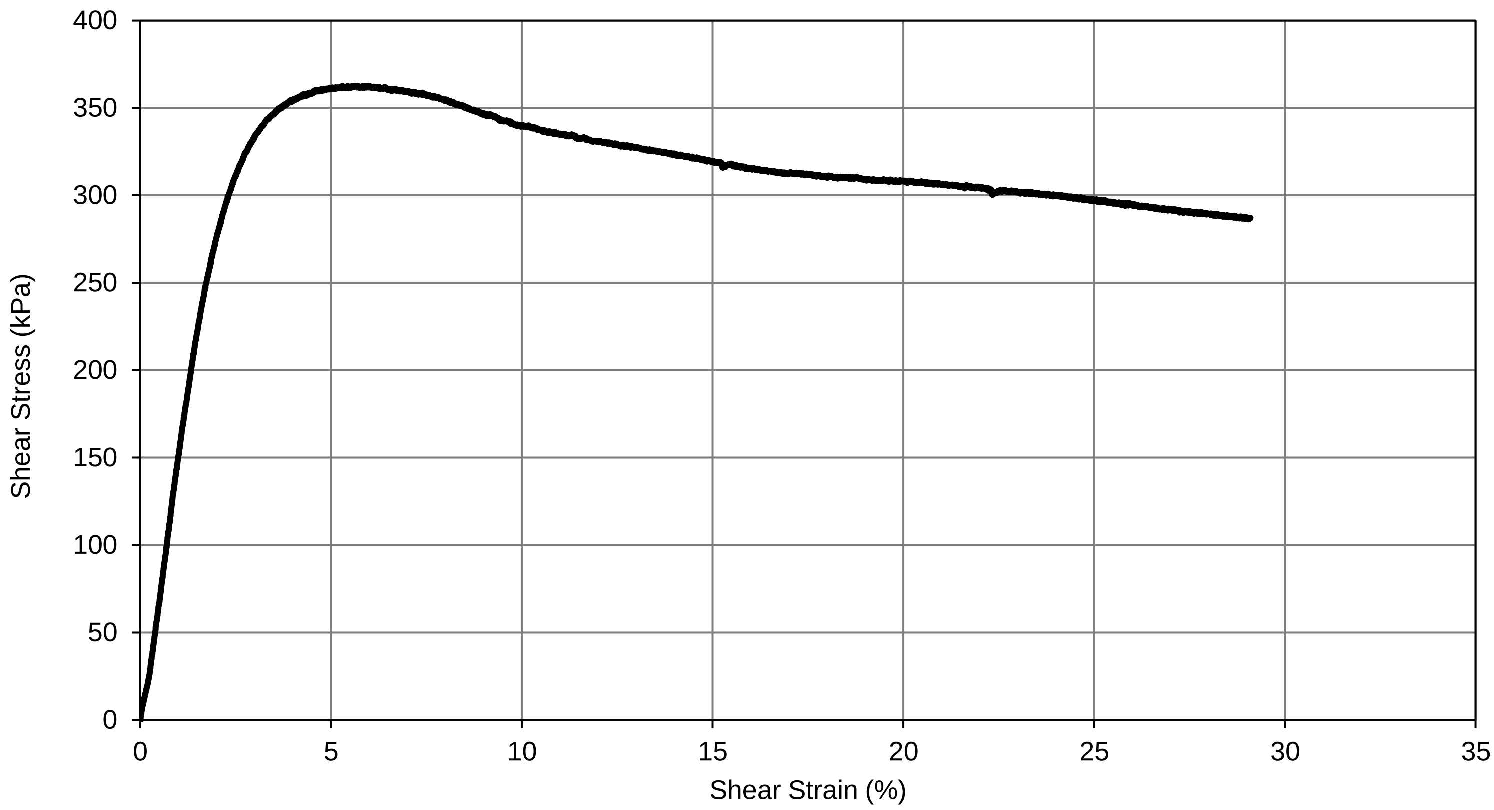
Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	I. Orea
		Reviewed by:	R. Fanni

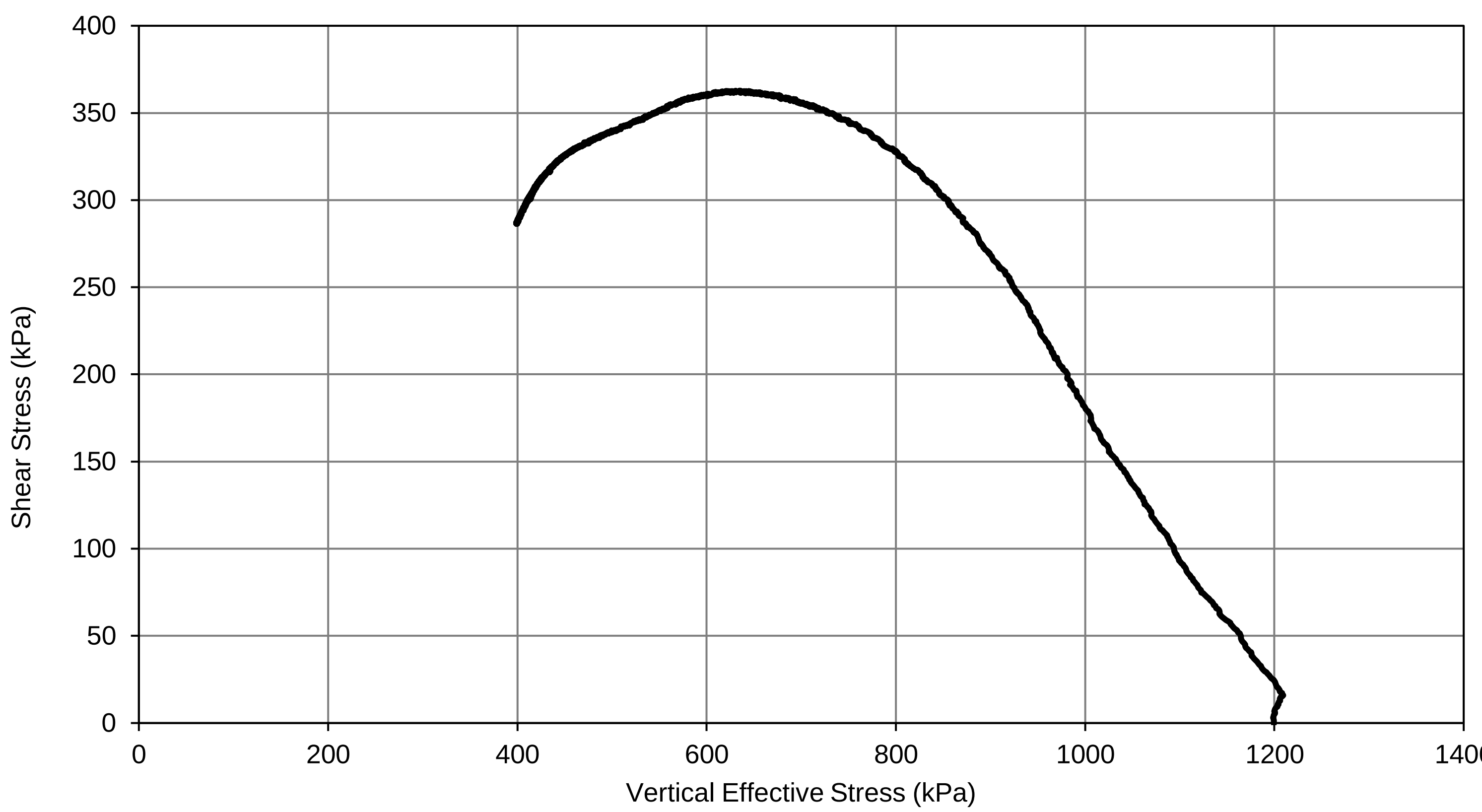
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

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:**	CE417-PT4 24.0-24.3m
Location:	Cadia Mine	**Test ID:**	18026 - DSS1 1200kPa

Vertical Effective Stress (kPa)	1200	Final Bulk Density (t/m^3)	1.84
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.29
Shearing height (mm)	19.8	Shearing Strain Rate (mm/min)	0.006





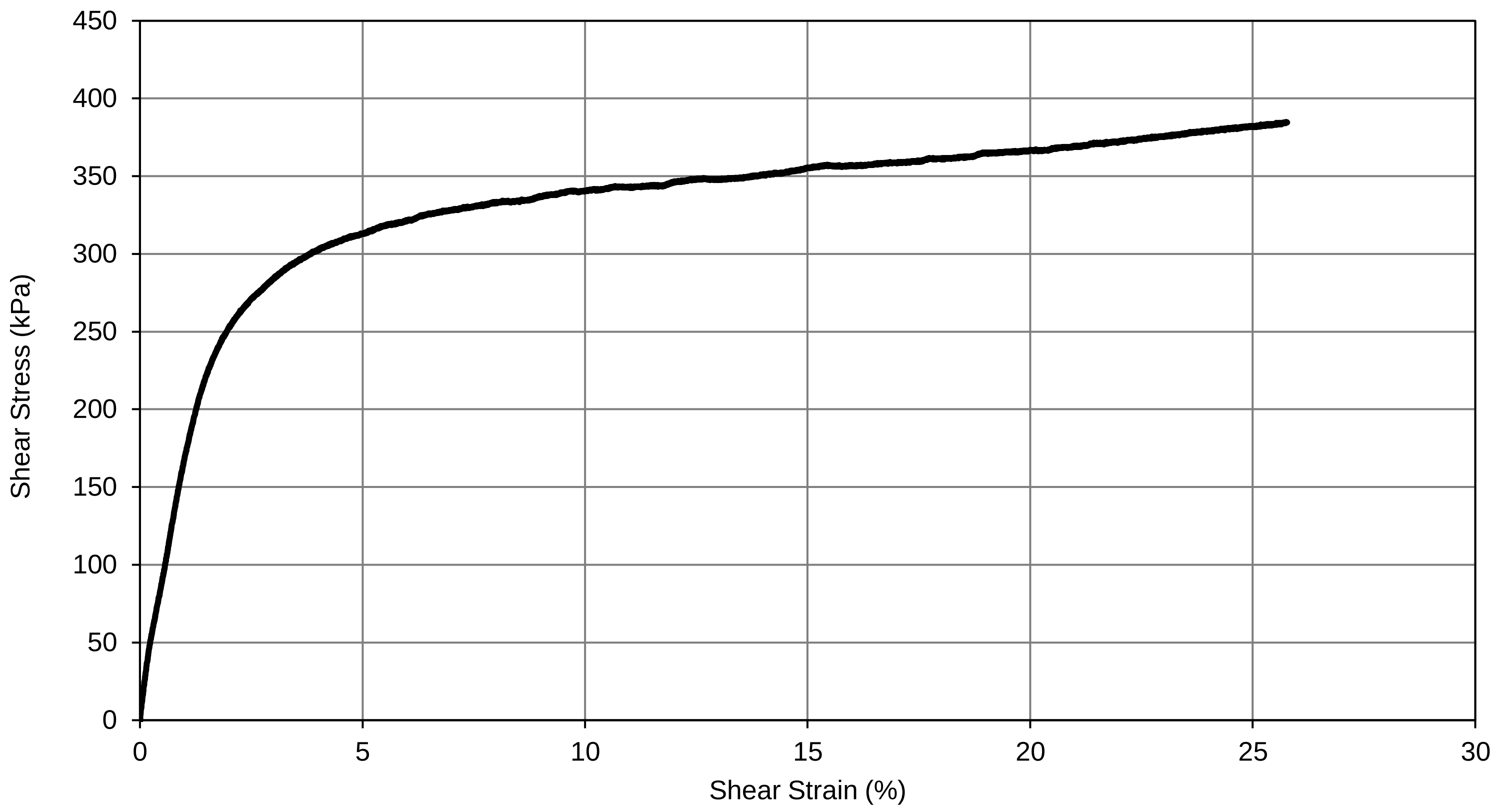
Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni

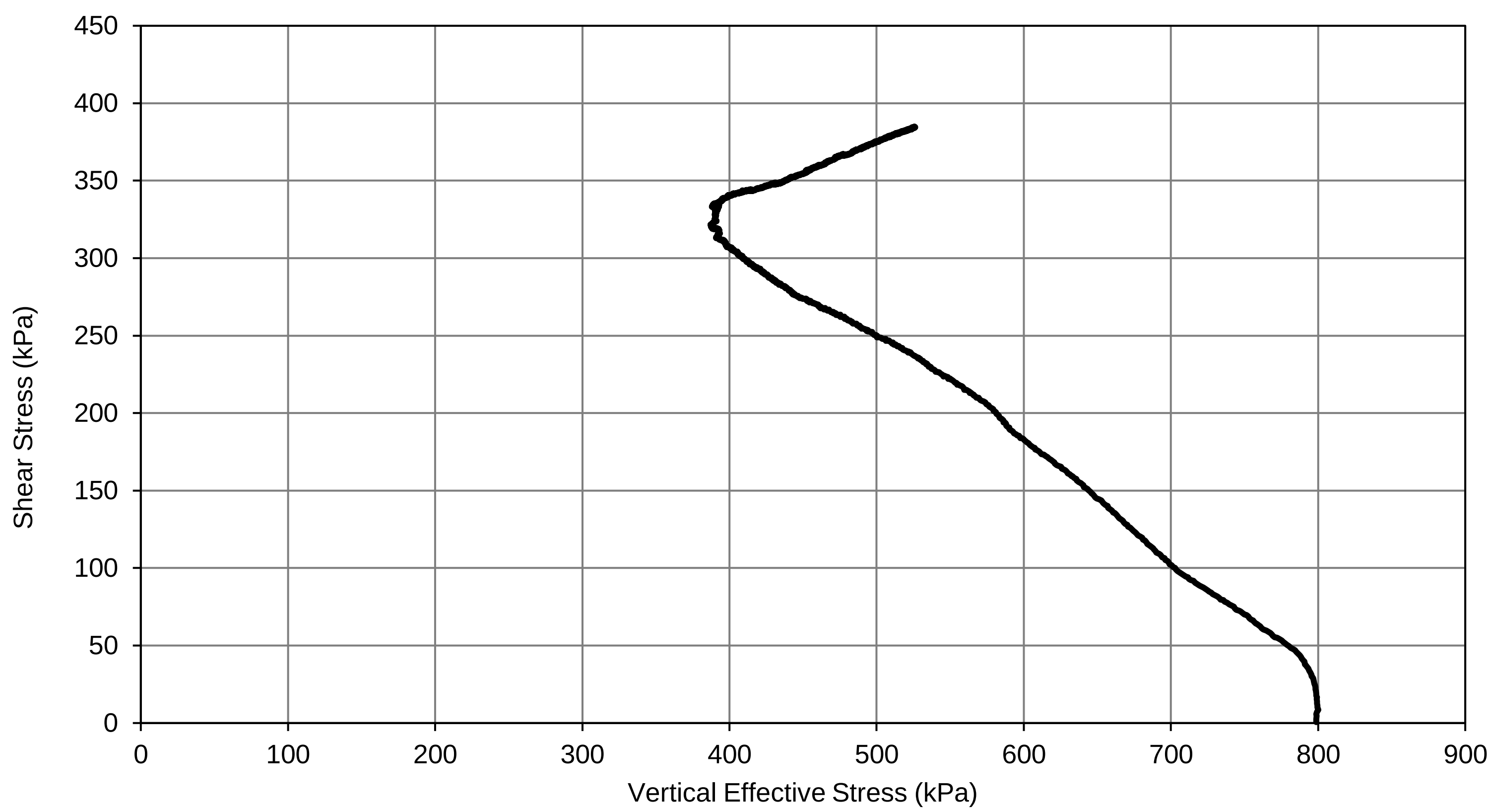
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE417-PT4 24.0-24.3m
Location:	Cadia Mine	**Test ID:**	18026 - DSS2 800kPa

Vertical Effective Stress (kPa)	800	Final Bulk Density (t/m^3)	1.85
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.35
Shearing height (mm)	21.6	Shearing Strain Rate (mm/min)	0.007





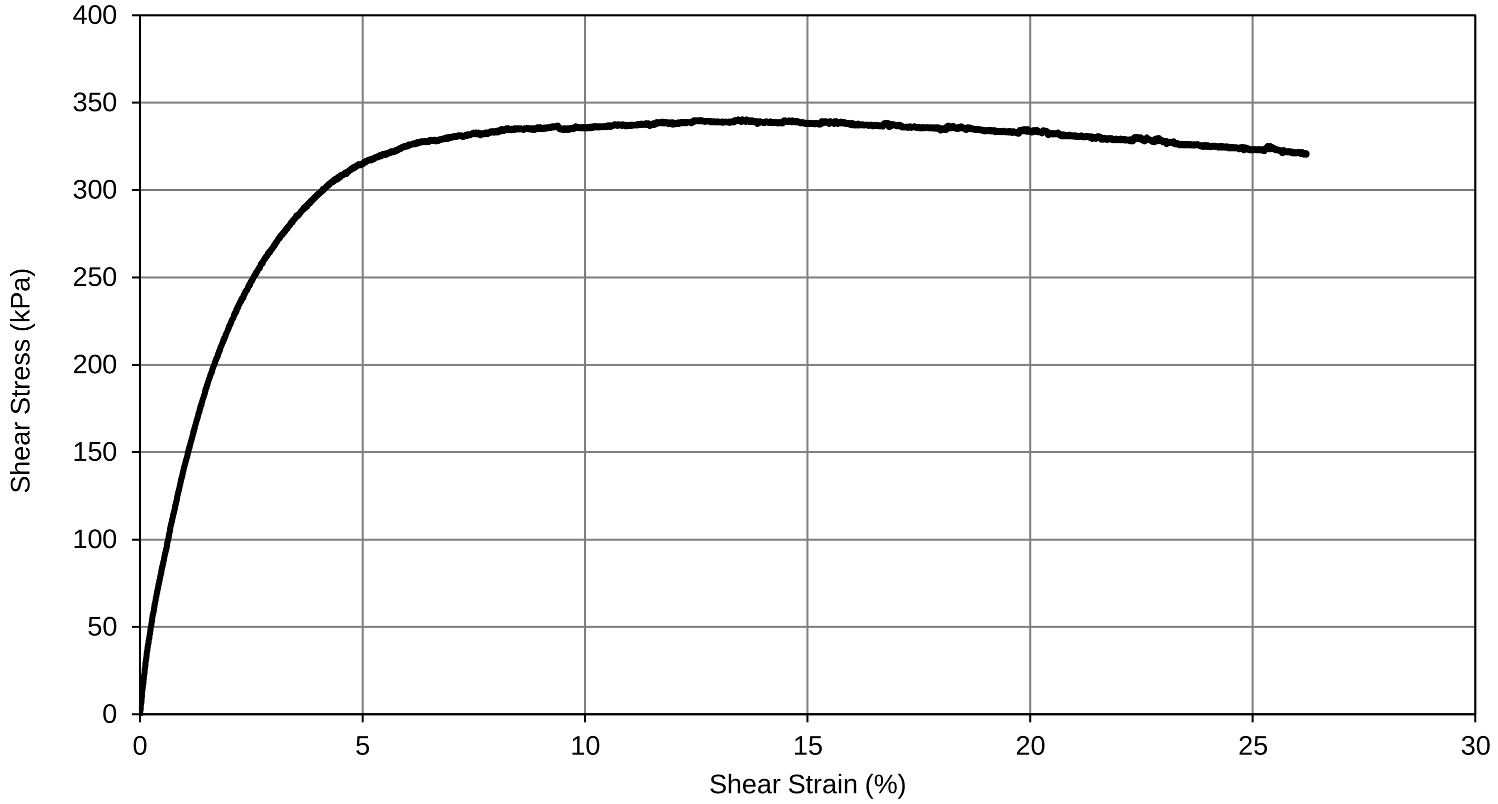
Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni

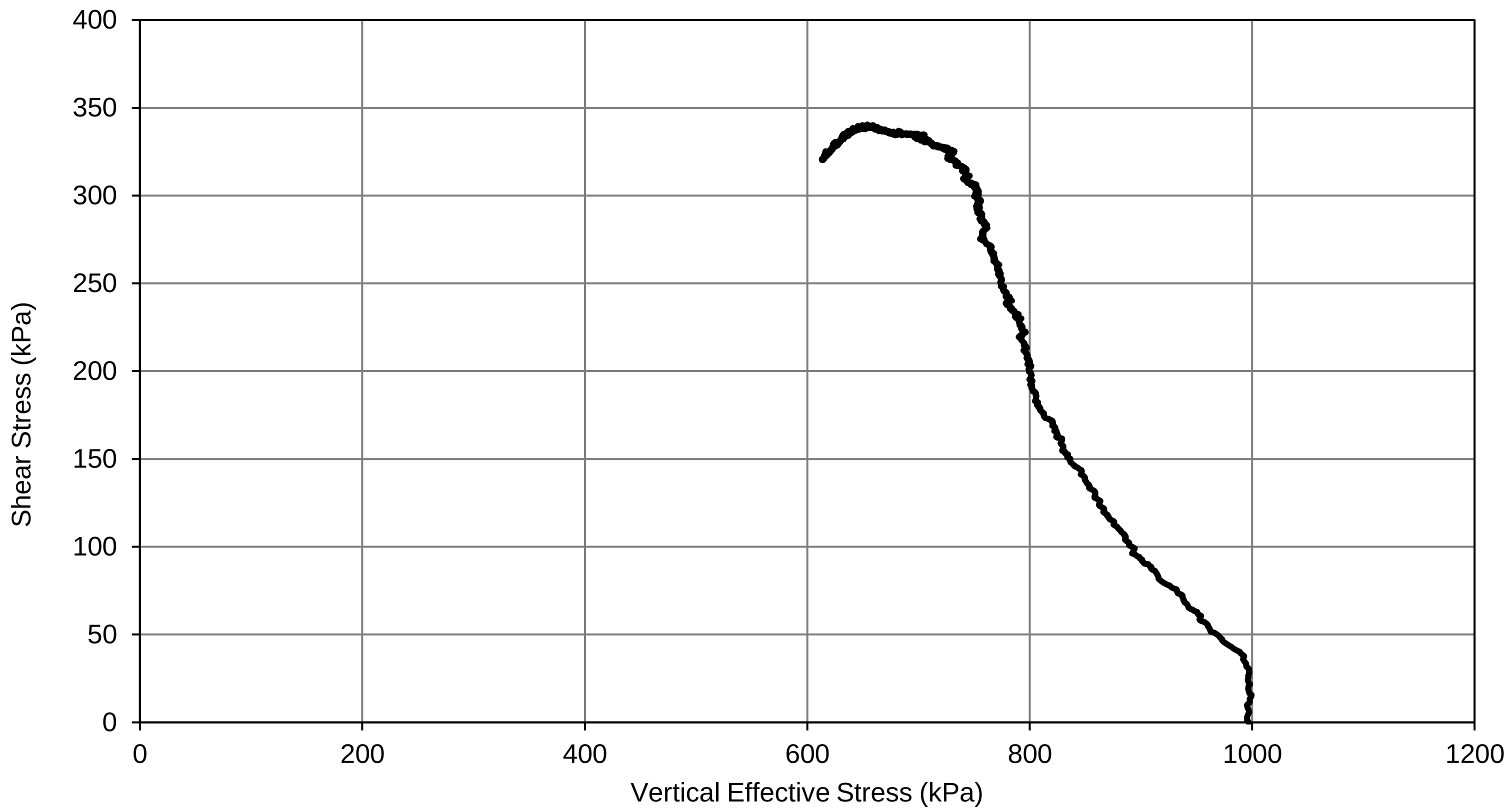
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416-PT2 24.0-24.33m
Location:	Cadia Mine	**Test ID:**	18027 - DSS1 1000kPa

Vertical Effective Stress (kPa)	1000	Final Bulk Density (t/m^3)	2.10
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.59
Shearing height (mm)	21.6	Shearing Strain Rate (mm/min)	0.007





Preparation Notes:	Extruded and trimmed from tube sample "Dead zone"-type end platens	Tested by:	K. Koh
		Reviewed by:	R. Fanni

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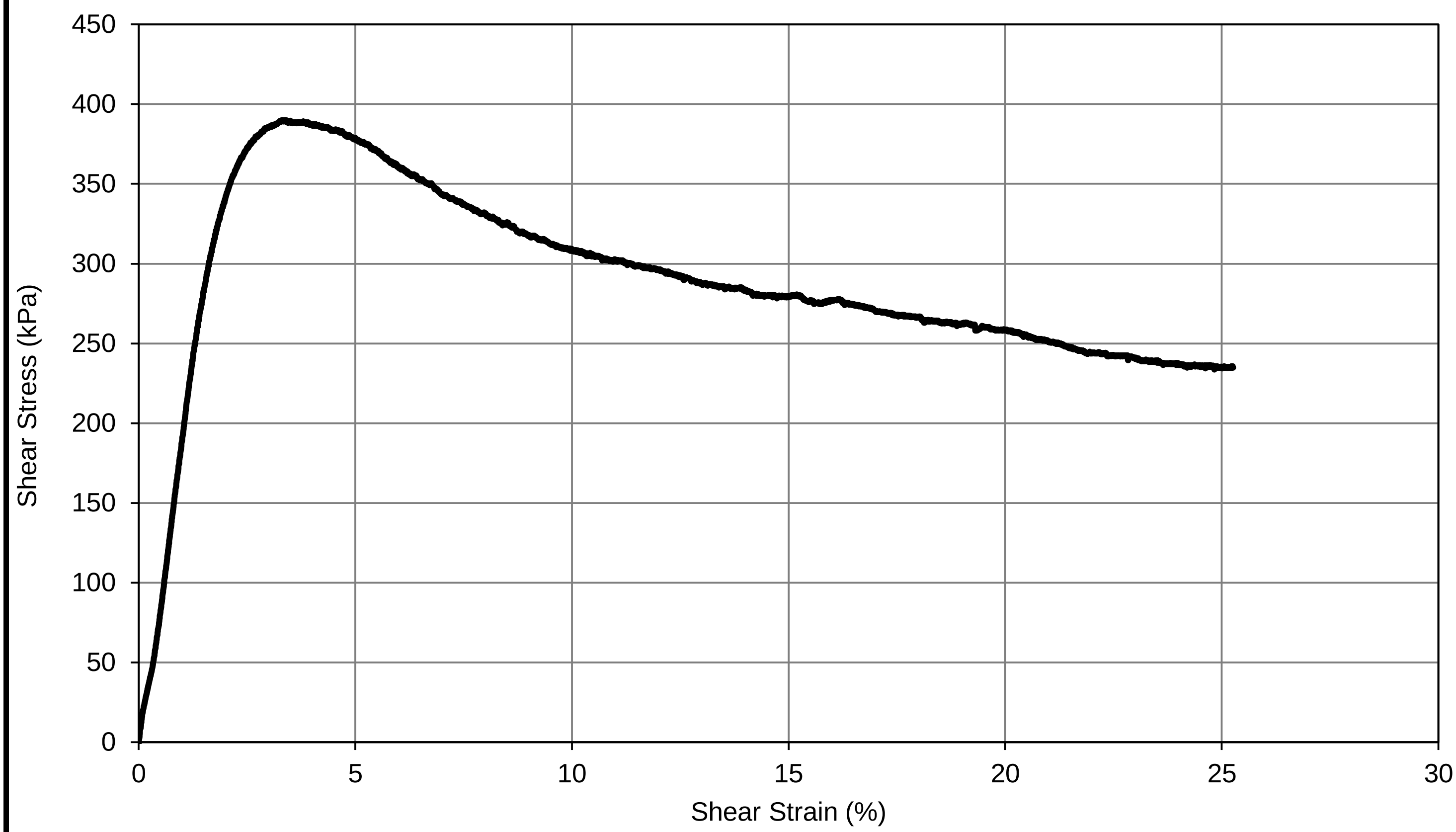
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

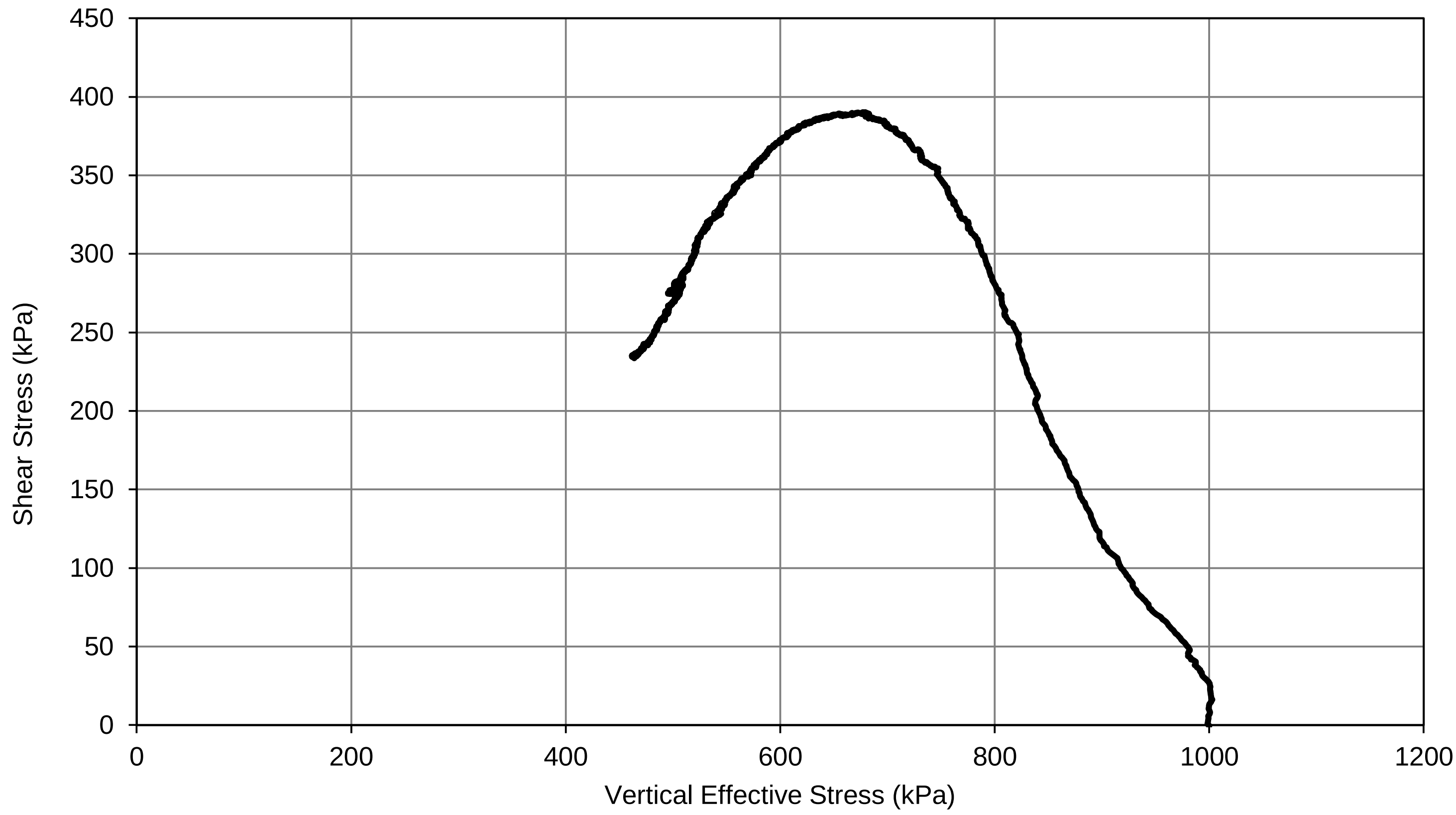
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch Pty Ltd	**Date:**	23/05/2018
Address:	61 Petrie Terrace	**Project No.:**	18101981
Project:	Foundation Laboratory Testing	**Sample ID:**	DSS1
Location:	Queensland		Foundation Material

Vertical Effective Stress (kPa)	1000	Final Bulk Density (t/m3)	1.88
Diameter (mm)	60.5	Final Dry Density (t/m3)	1.43
Final Height (mm)	19.0	Shearing Strain Rate (mm/min)	0.006





Preparation Notes:	Sample cored from block sample	Tested by:	K. Koh
		Reviewed by:	R. Fanni

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Monotonic Direct Simple Shear Test Report - Consolidated Undrained

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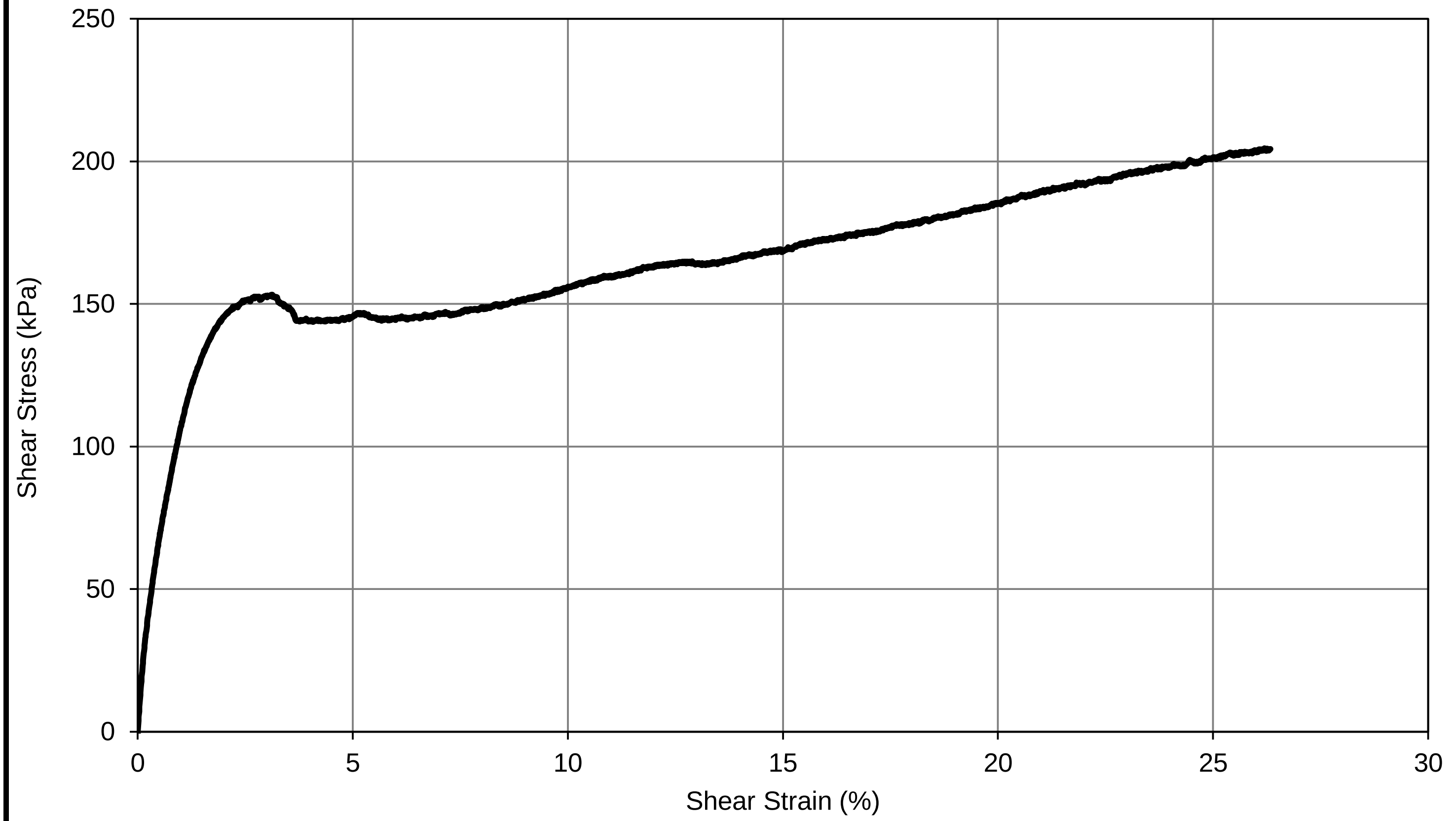
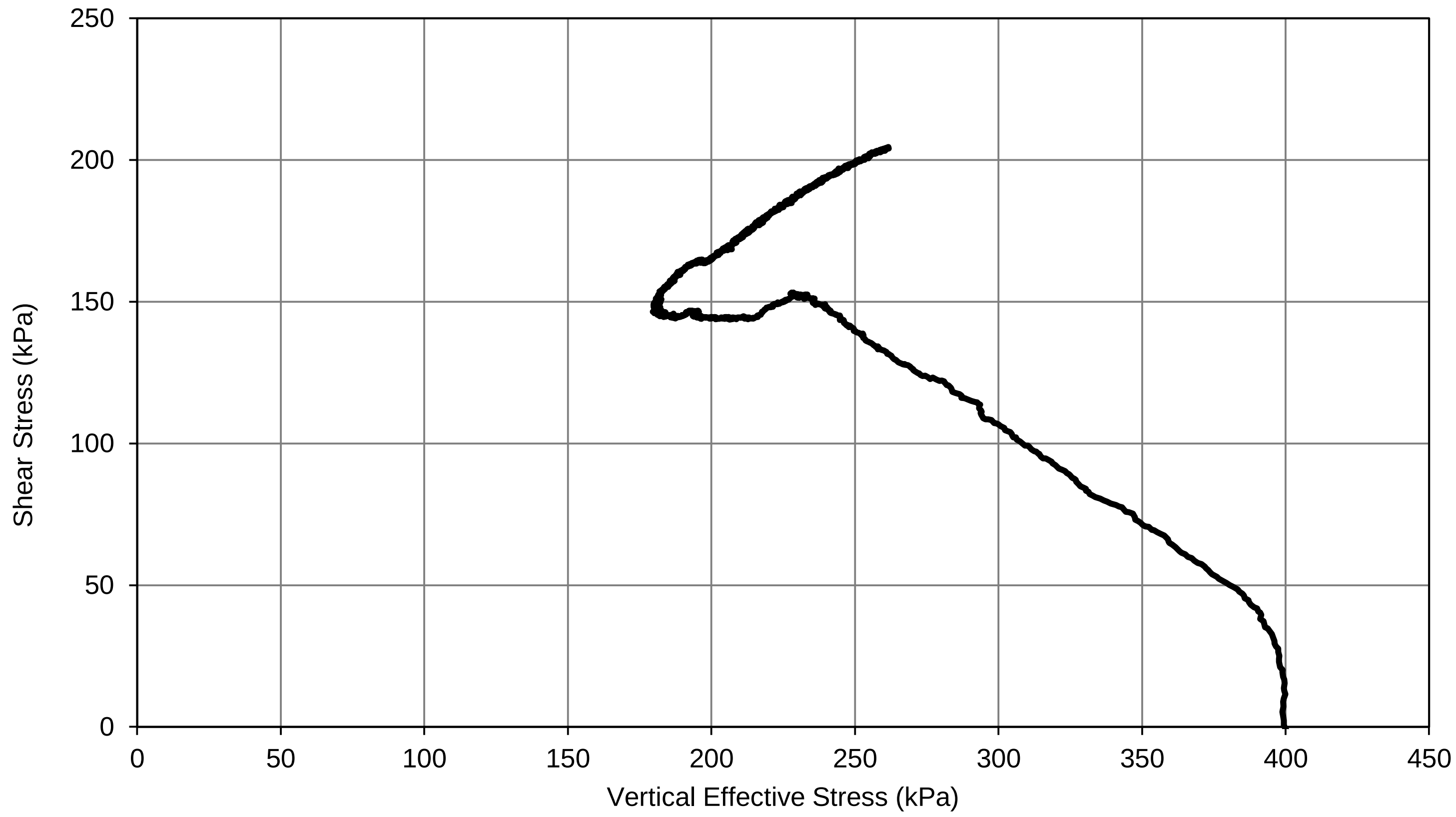
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch Pty Ltd	**Date:**	23/05/2018
Address:	61 Petrie Terrace	**Project No.:**	18101981
Project:	Foundation Laboratory Testing	**Sample ID:**	DSS2
Location:	Queensland		Foundation Material

Vertical Effective Stress (kPa)	400.6	Final Bulk Density (t/m3)	1.88
Diameter (mm)	60.5	Final Dry Density (t/m3)	1.38
Final Height (mm)	25.1	Shearing Strain Rate (mm/min)	0.008





Preparation Notes:	Sample cored from block sample	Tested by:	K. Koh
		Reviewed by:	R. Fanni

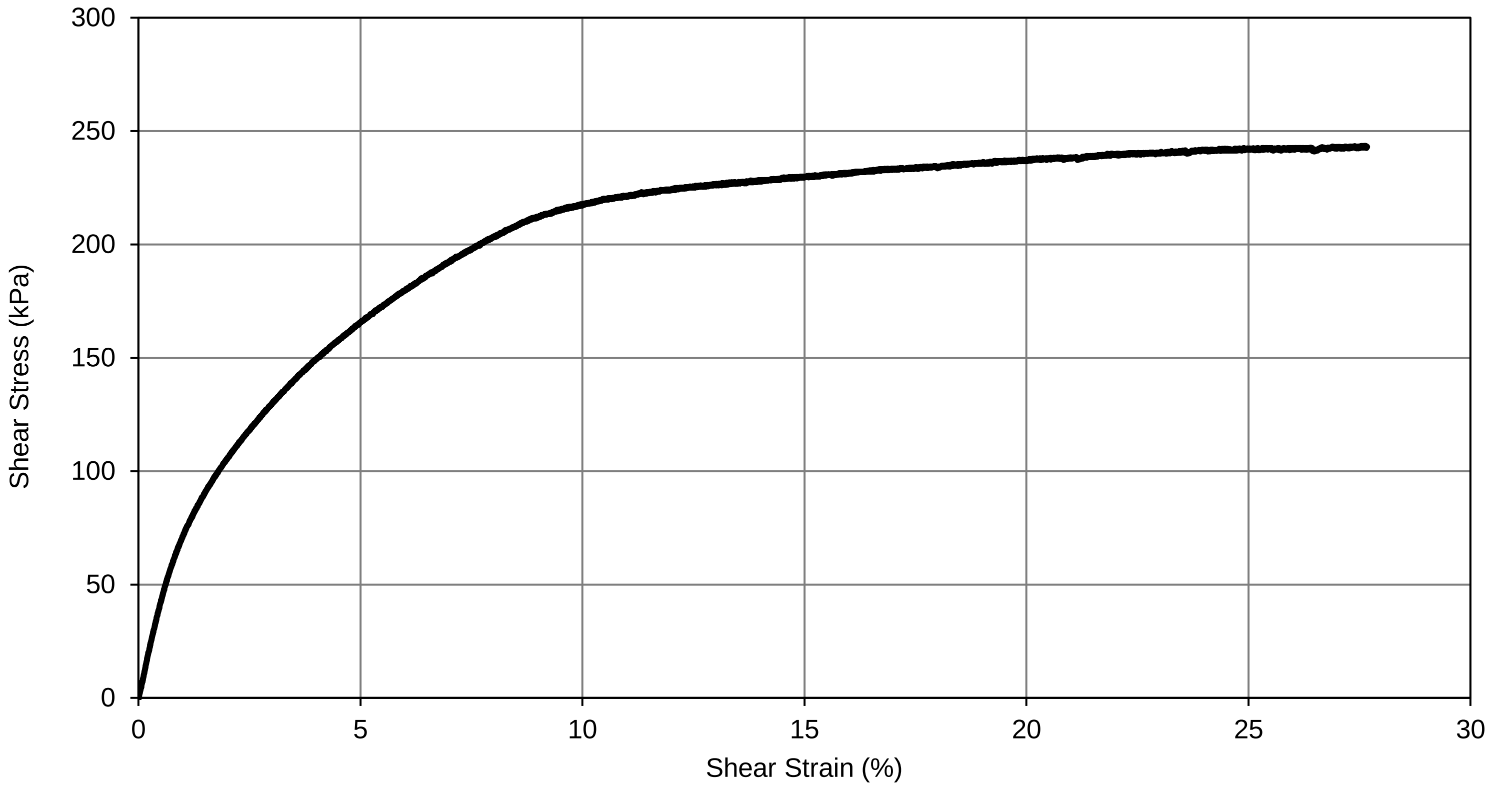
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

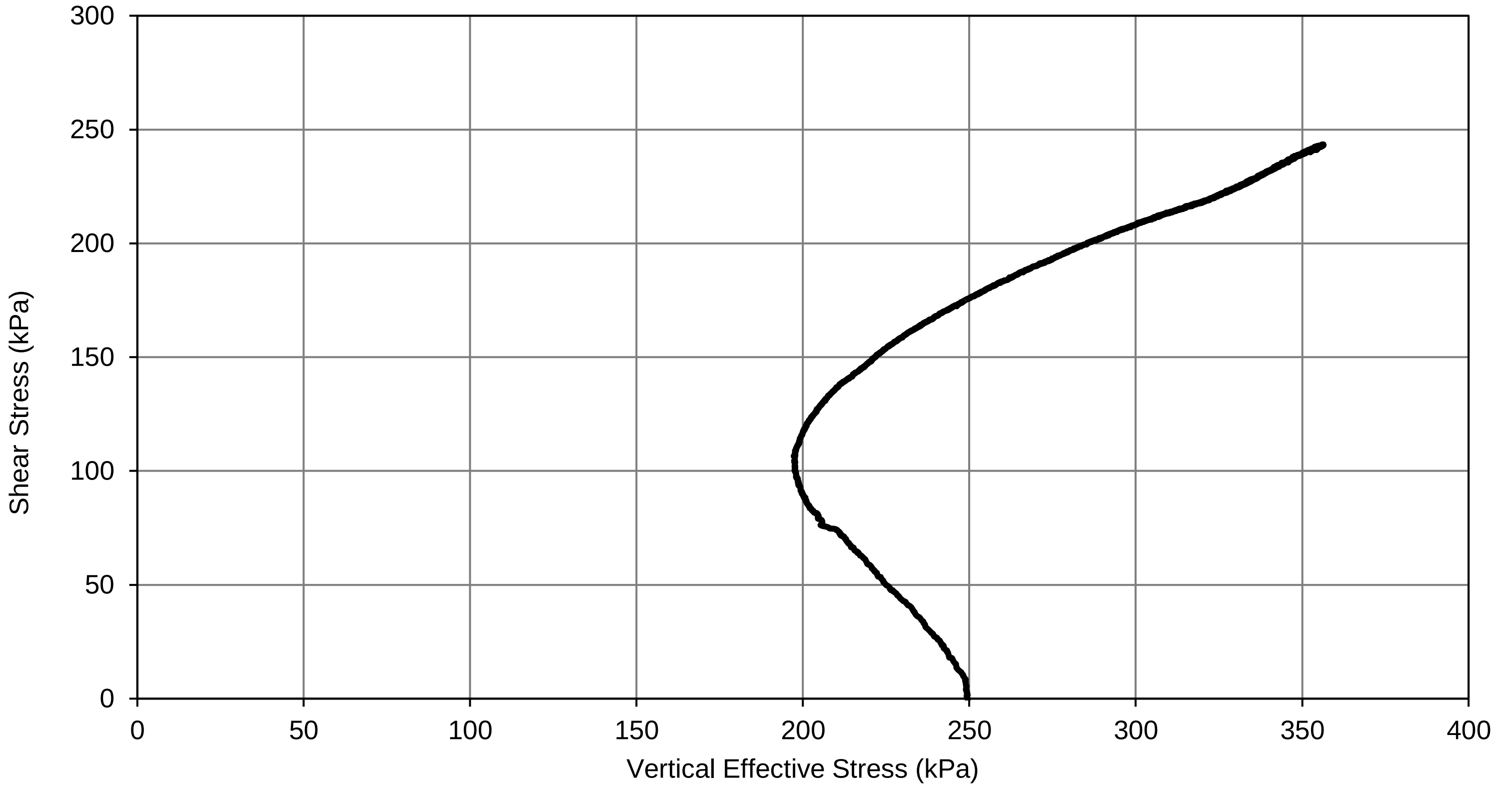
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch Pty Ltd	**Date:**	21/05/2018
Address:	61 Petrie Terrace	**Project No.:**	18101981
Project:	Foundation Laboratory Testing	**Sample ID:**	DSS-3 (Compacted)
Location:	Queensland		PL-BS1 0.0-0.5m

Vertical Effective Stress (kPa)	250.6	Final Bulk Density (t/m^3)	1.96
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.46
Final Height (mm)	21.1	Shearing Strain Rate (mm/min)	0.005





Preparation Notes:	Compacted to 98% SMDD (1.42 t/m3) at OMC (26% GWC)	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni

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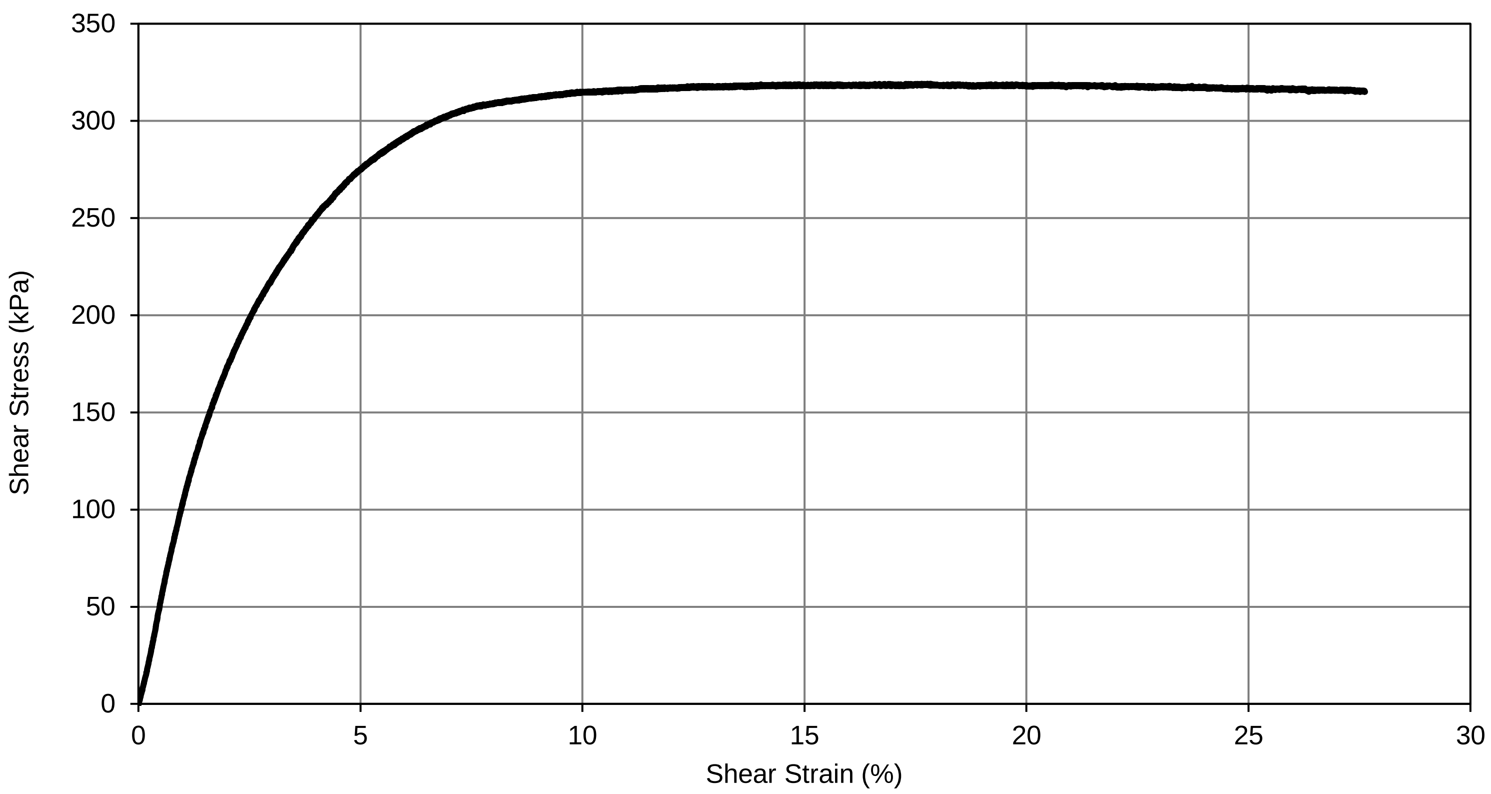
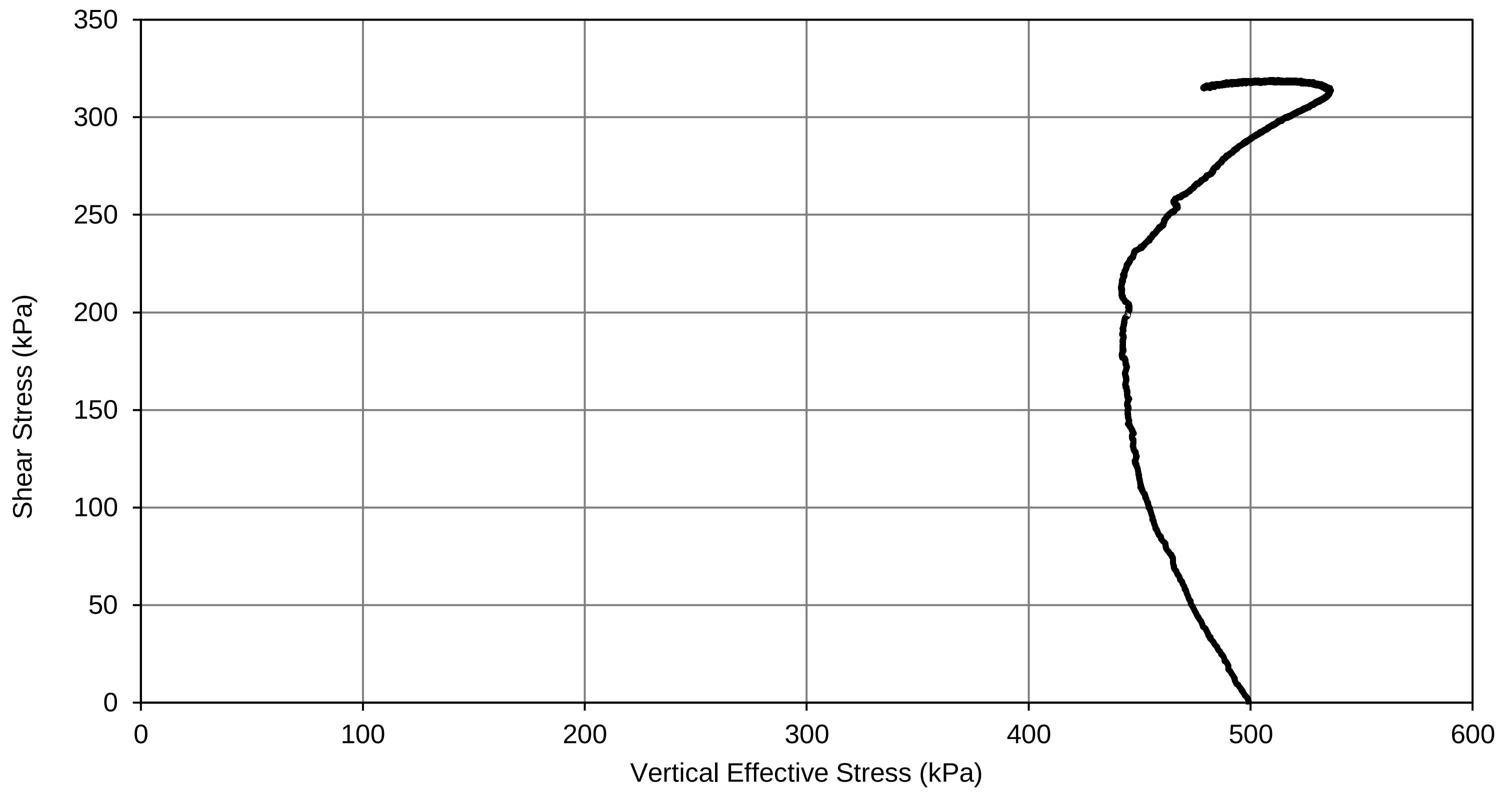
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

GOLDER
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch Pty Ltd	Date:	24/05/2018
Address:	61 Petrie Terrace	Project No.:	18101981
Project:	Foundation Laboratory Testing	Sample ID:	DSS-4 (Compacted)
Location:	Queensland		PL-BS1 0.0-0.5m

Vertical Effective Stress (kPa)	500.2	Final Bulk Density (t/m^3)	1.98
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.48
Final Height (mm)	20.8	Shearing Strain Rate (mm/min)	0.005





Preparation Notes:	Compacted to 98% SMDD (1.42 t/m3) at OMC (26% GWC)	Tested by:	K. Koh
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni

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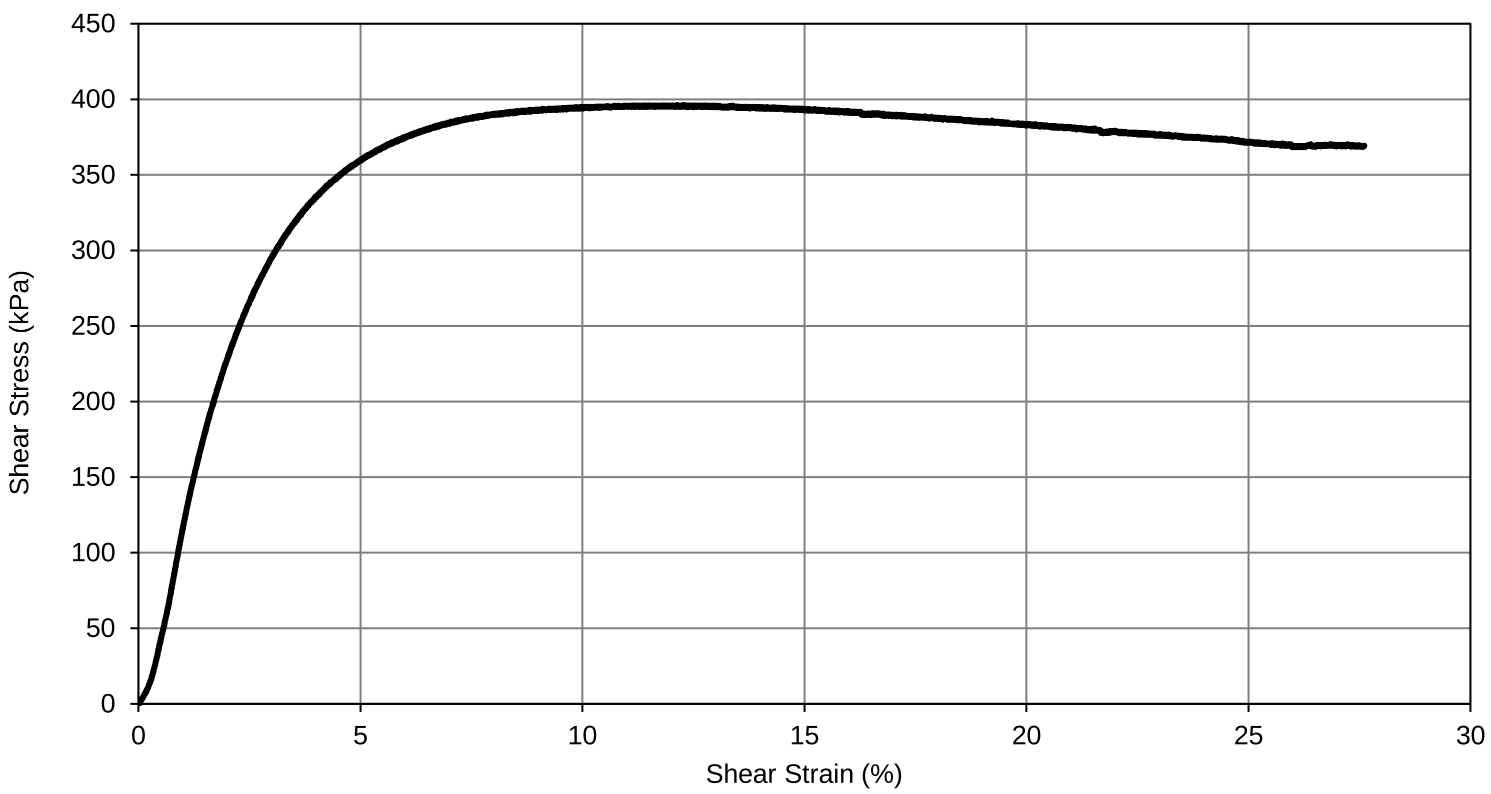
Monotonic Direct Simple Shear Test Report - Consolidated Undrained

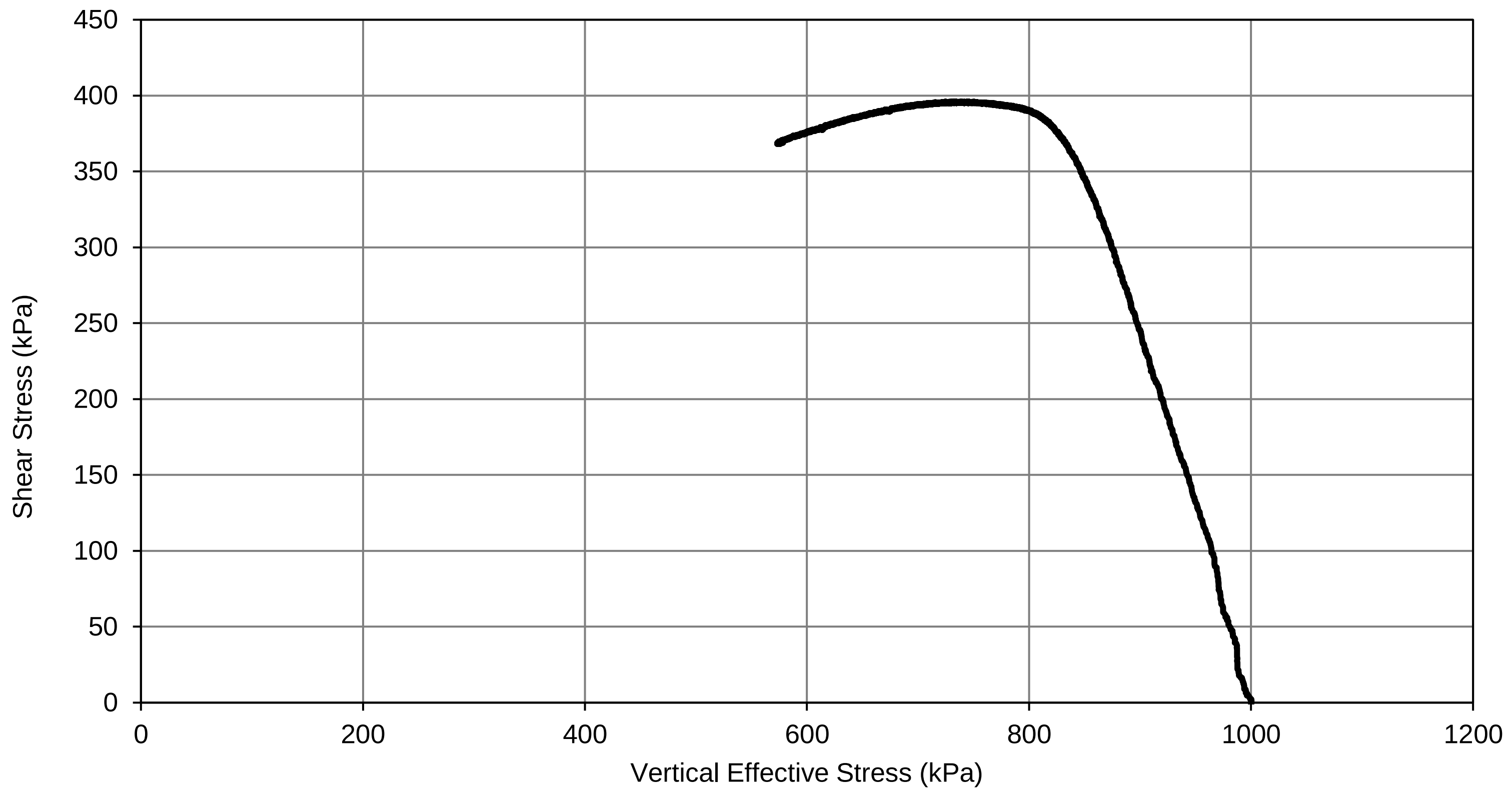
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch Pty Ltd	**Date:**	26/05/2018
Address:	61 Petrie Terrace	**Project No.:**	18101981
Project:	Foundation Laboratory Testing	**Sample ID:**	DSS-5
Location:	Queensland		PL-BS1 0.0-0.5m

Vertical Effective Stress (kPa)	1000	Final Bulk Density (t/m^3)	1.98
Diameter (mm)	60.5	Final Dry Density (t/m^3)	1.49
Final Height (mm)	20.6	Shearing Strain Rate (mm/min)	0.005





Preparation Notes:	Compacted to 98% SMDD (1.42 t/m3) at OMC (26% GWC)	Tested by:	K. Koh
		Reviewed by:	R. Fanni

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Annexure DC
Direct Simple Shear Tests - Fugro

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-001
Location:	Cadia Valley Operations	**Borehole ID:**	CE411
Sample No.:	PT1	**Depth:**	3.22 m to 3.26 m

Test Details:	
Test ID:	CVO-SS01R
Consolidation Stress (kPa):	400
Shearing Rate (%/Hr)	5

Tested By:	SF
Date:	03/09/2018

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.40	22.04
Dry Density (t/m^3) :	1.52	1.75
Moisture Content (%) :	30.3 *	28.1

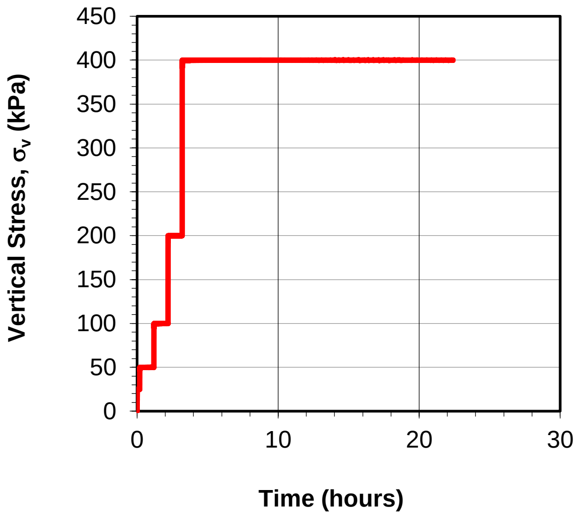
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

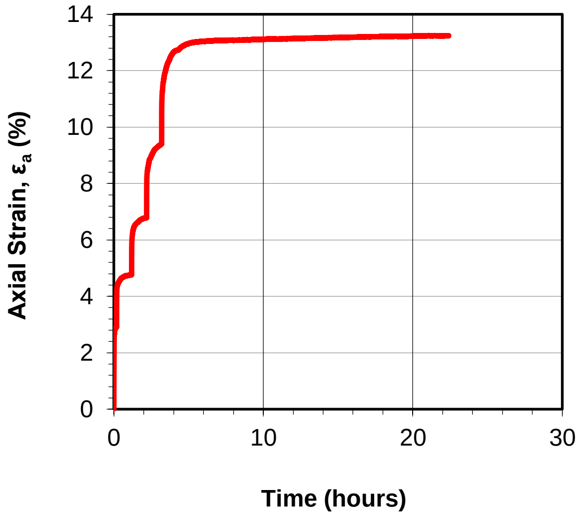
Checked By:	SRJ
Date:	27/9/2018

SIMPLE SHEAR TEST

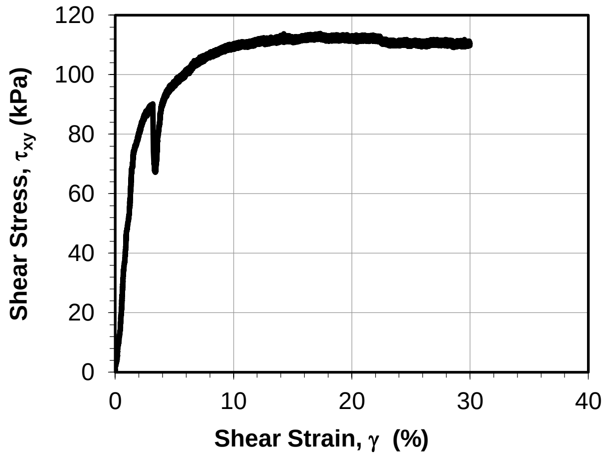
Test Method: AGLab Test Procedure FAM-18552

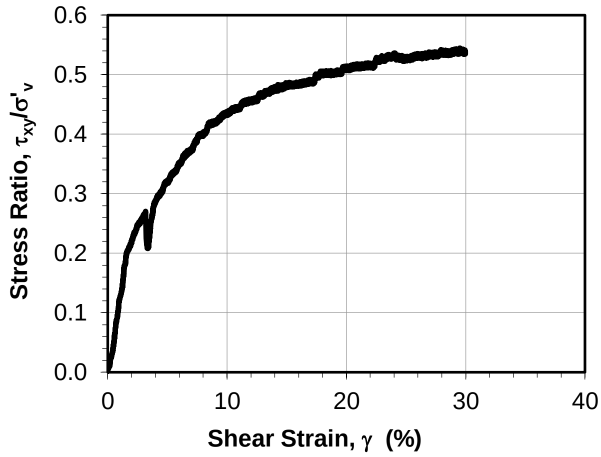
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





Cadia NTSF Failure - Laboratory Testing

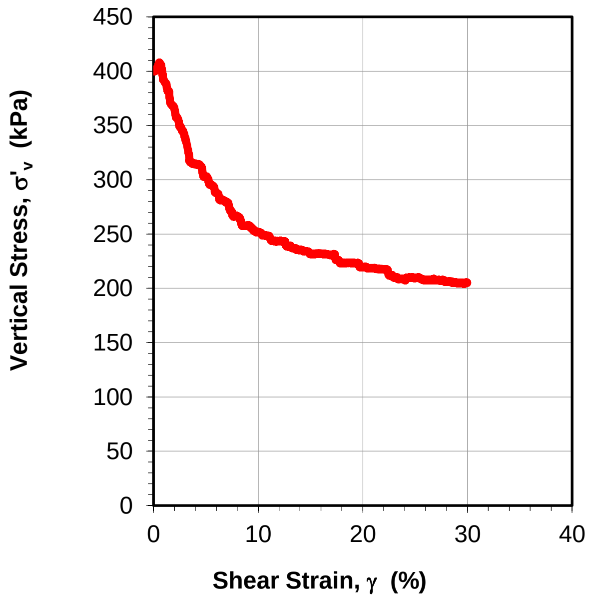
Monotonic Simple Shear

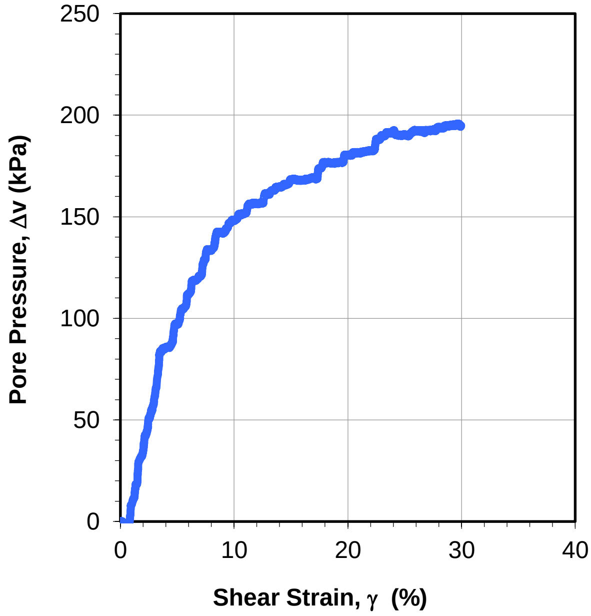
Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-001
Location:	Cadia Valley Operations	**Borehole ID:**	CE411
Sample No.:	PT1	**Depth:**	3.22 m to 3.26 m

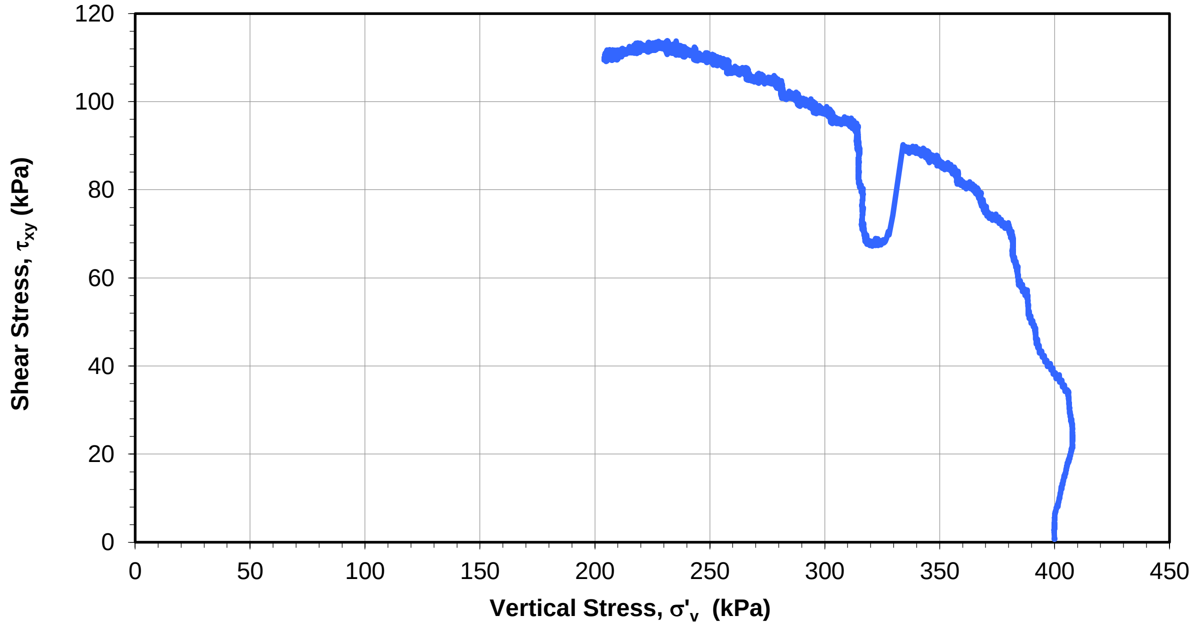
SIMPLE SHEAR TEST

Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-002
Location:	Cadia Valley Operations	**Borehole ID:**	CE411
Sample No.:	PT1	**Depth:**	3.18 m to 3.22 m

Test Details:	
Test ID:	CVO-SS02R
Consolidation Stress (kPa):	800
Shearing Rate (%/Hr)	5

Tested By:	SF
Date:	07/09/2018

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.40	20.53
Dry Density (t/m^3) :	1.50	1.85
Moisture Content (%) :	32.8 *	26.4

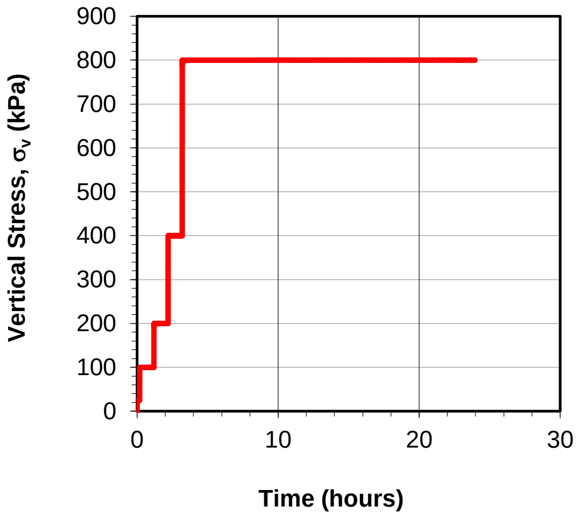
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

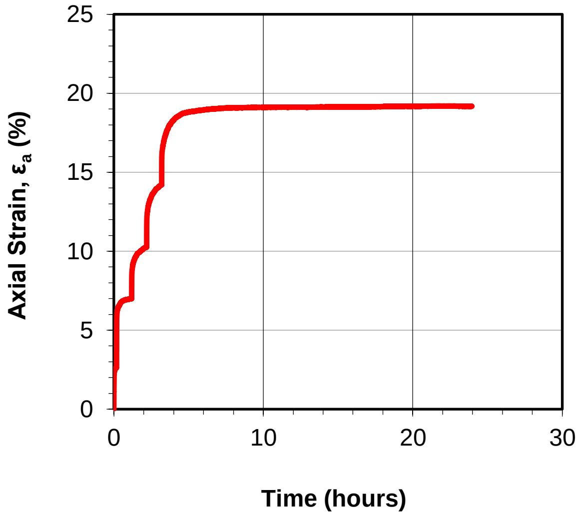
Checked By:	SRJ
Date:	27/9/2018

SIMPLE SHEAR TEST

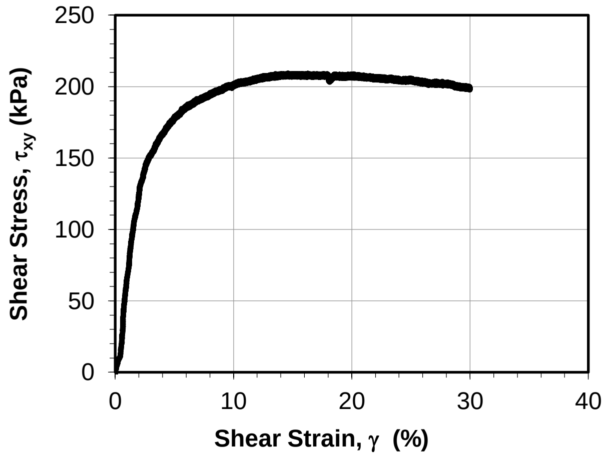
Test Method: AGLab Test Procedure FAM-18552

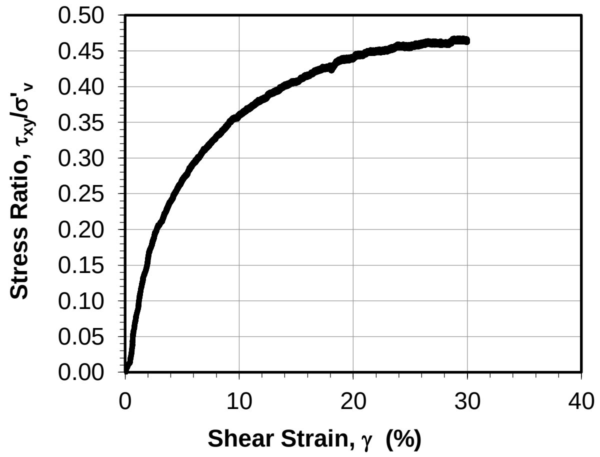
Stage 1: Consolidation





Stage 2 : Monotonic Shearing



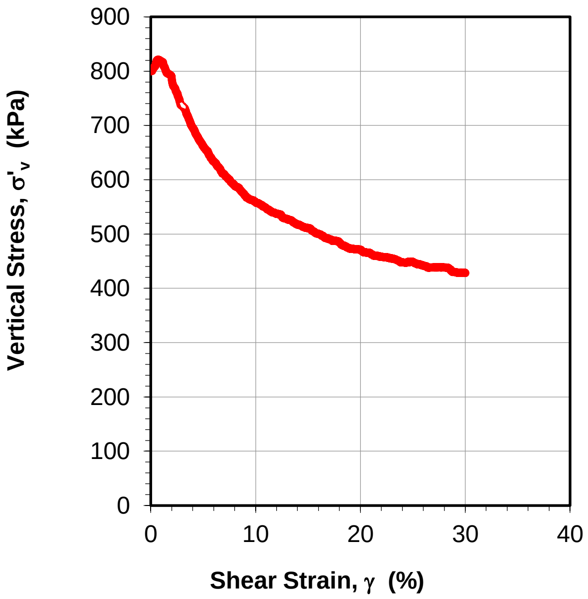


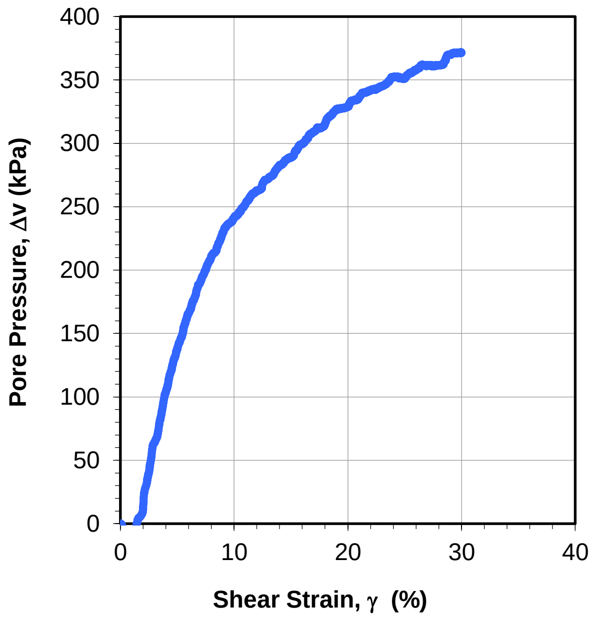
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT1

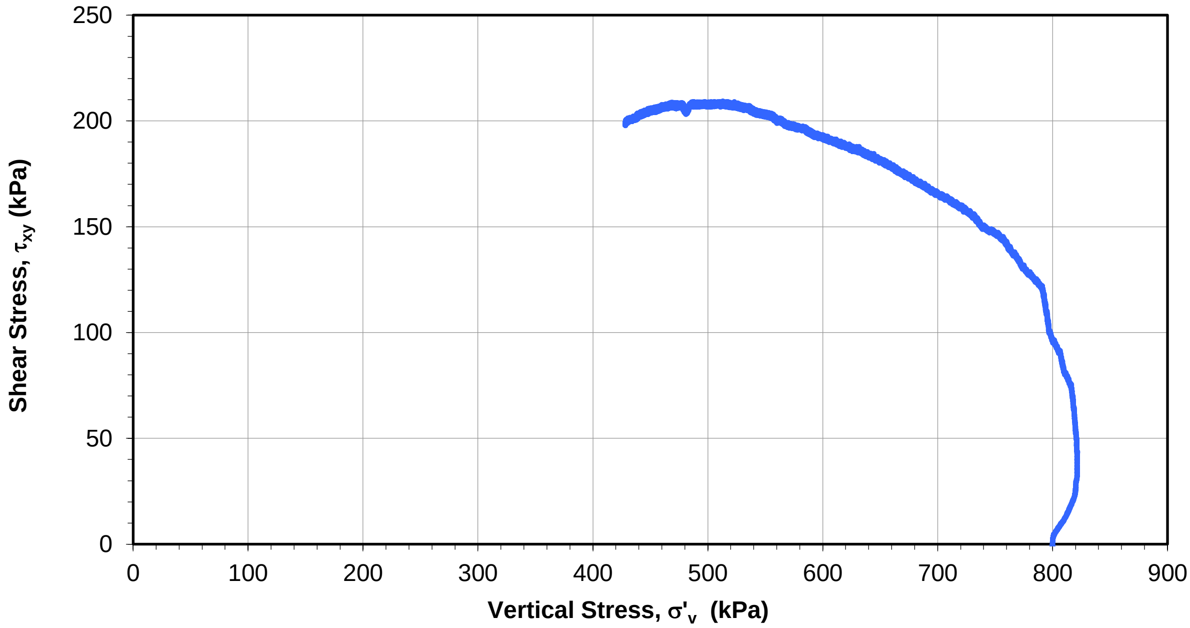
IPO Number: 2018-017
Sample ID: 2018-017-002
Borehole ID: CE411
Depth: 3.18 m to 3.22 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT1

IPO Number: 2018-017
Sample ID: 2018-017-003
Borehole ID: CE411
Depth: 3.26 m to 3.30 m

Test Details:	
Test ID:	CVO-SS03
Consolidation Stress (kPa):	1200
Shearing Rate (%/Hr)	5

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.50	20.64
Dry Density (t/m^3) :	1.54	1.91
Moisture Content (%) :	30.5 *	25.0

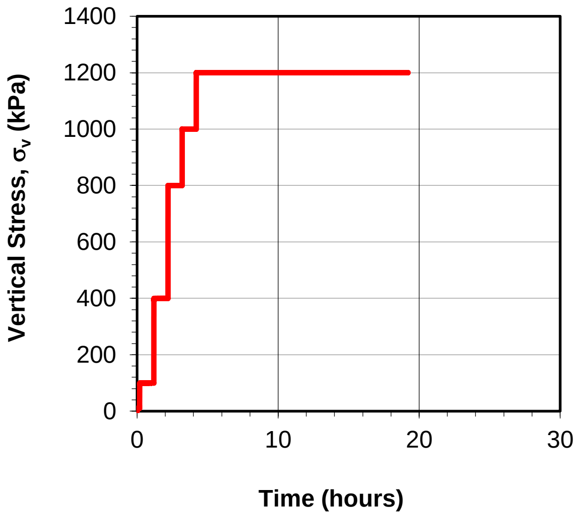
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

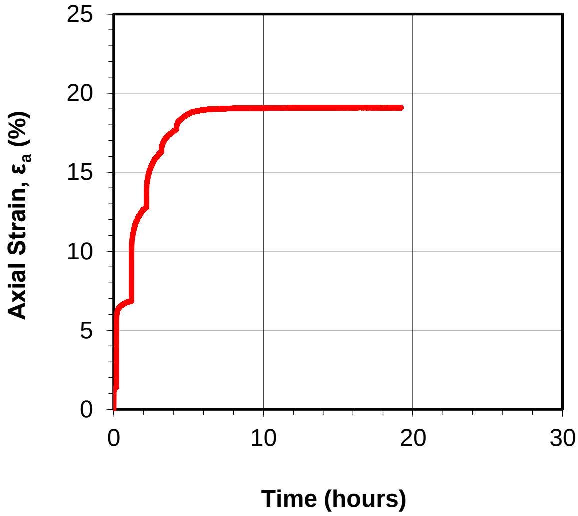
Tested By:	SF
Date:	29/08/2018

Checked By:	SRJ
Date:	27/9/2018

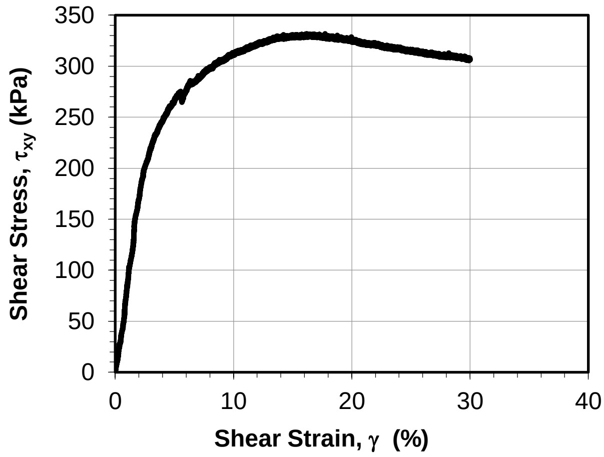
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

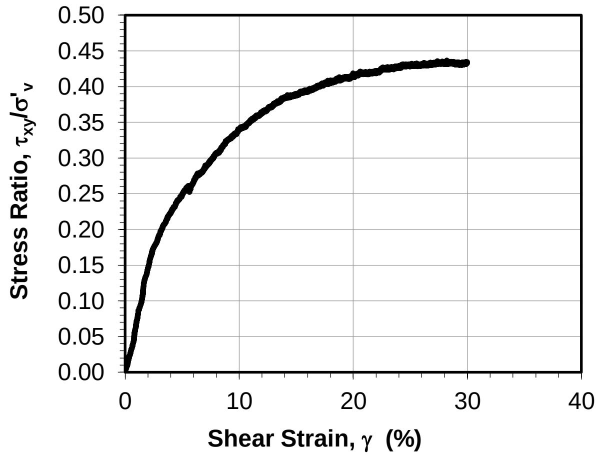
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





Cadia NTSF Failure - Laboratory Testing

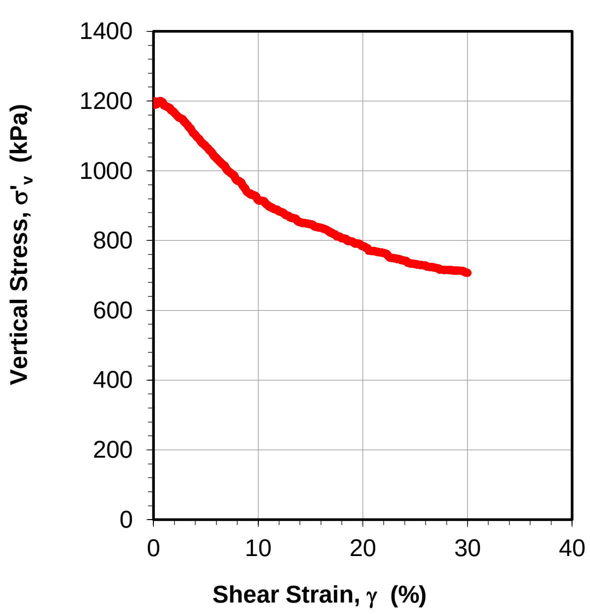
Monotonic Simple Shear

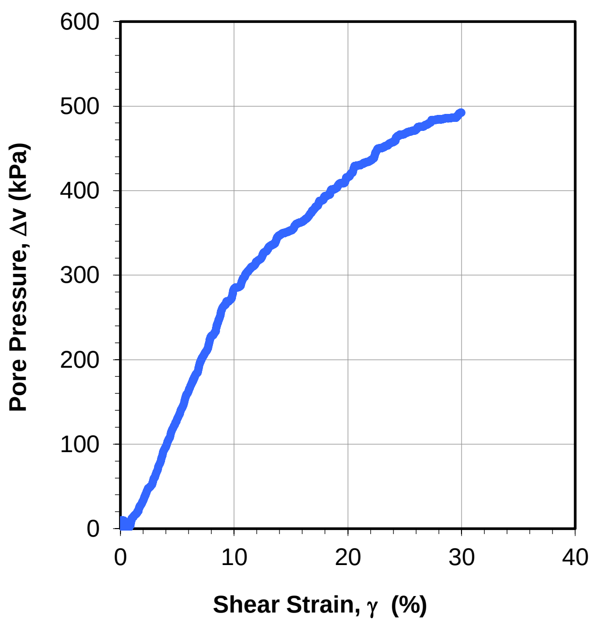
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT1

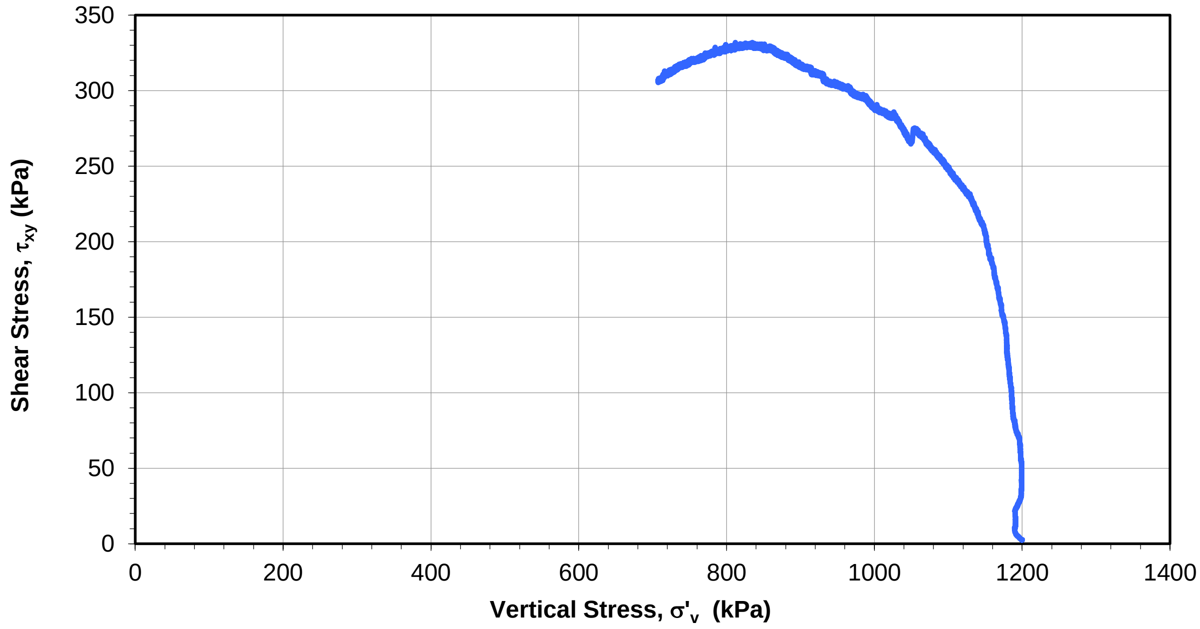
IPO Number: 2018-017
Sample ID: 2018-017-003
Borehole ID: CE411
Depth: 3.26 m to 3.30 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing

Monotonic Simple Shear

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-008
Location:	Cadia Valley Operations	**Borehole ID:**	CE411A
Sample No.:	PT4	**Depth:**	15.26 m to 15.30 m

Test Details:	
Test ID:	CVO-SS04
Consolidation Stress (kPa):	400
Shearing Rate (%/Hr)	5

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.40	21.84
Dry Density (t/m^3) :	1.58	1.84
Moisture Content (%) :	28.4 *	31.7

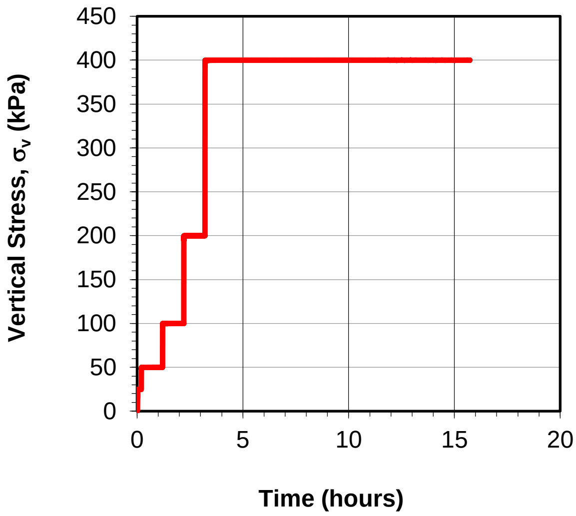
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

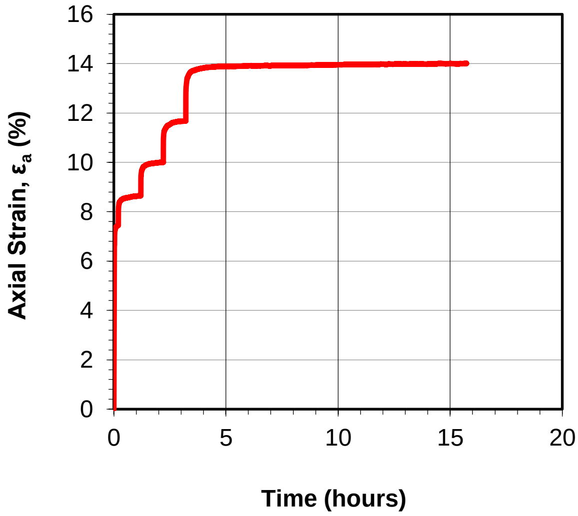
Tested By:	SF
Date:	12/09/2018

Checked By:	SRJ
Date:	27/9/2018

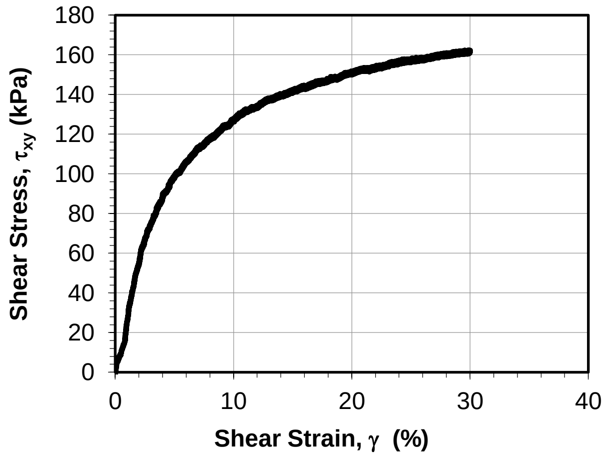
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

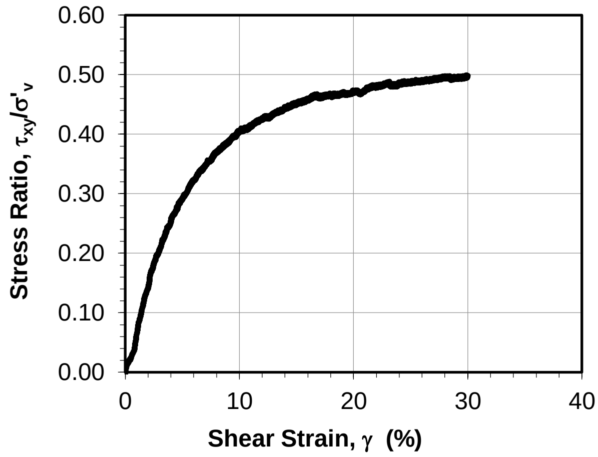
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





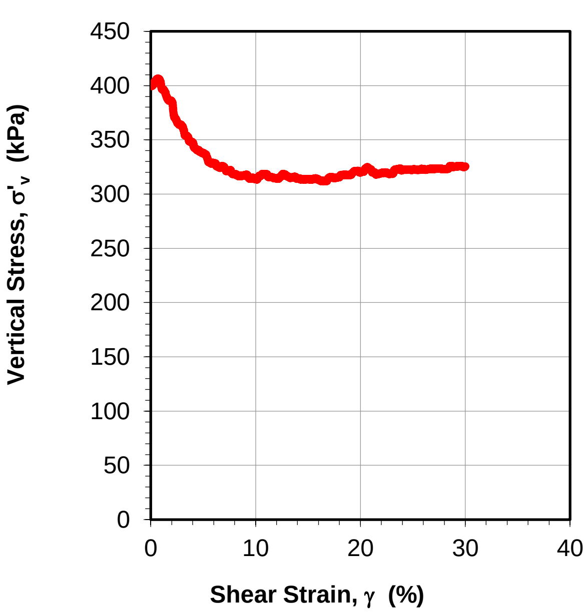
Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

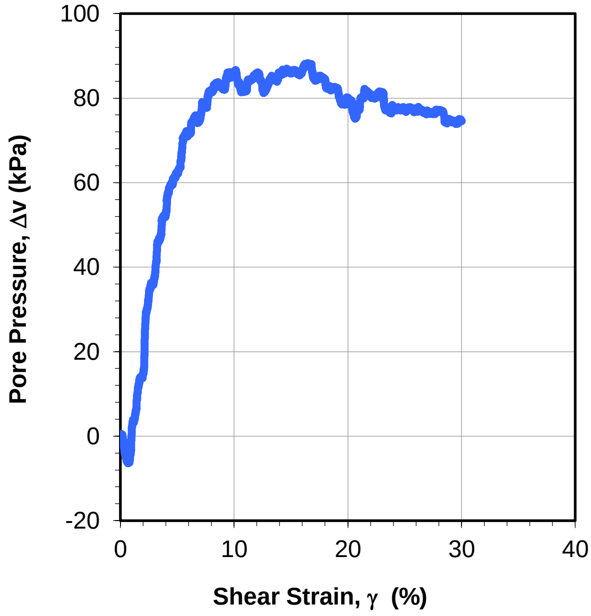
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT4

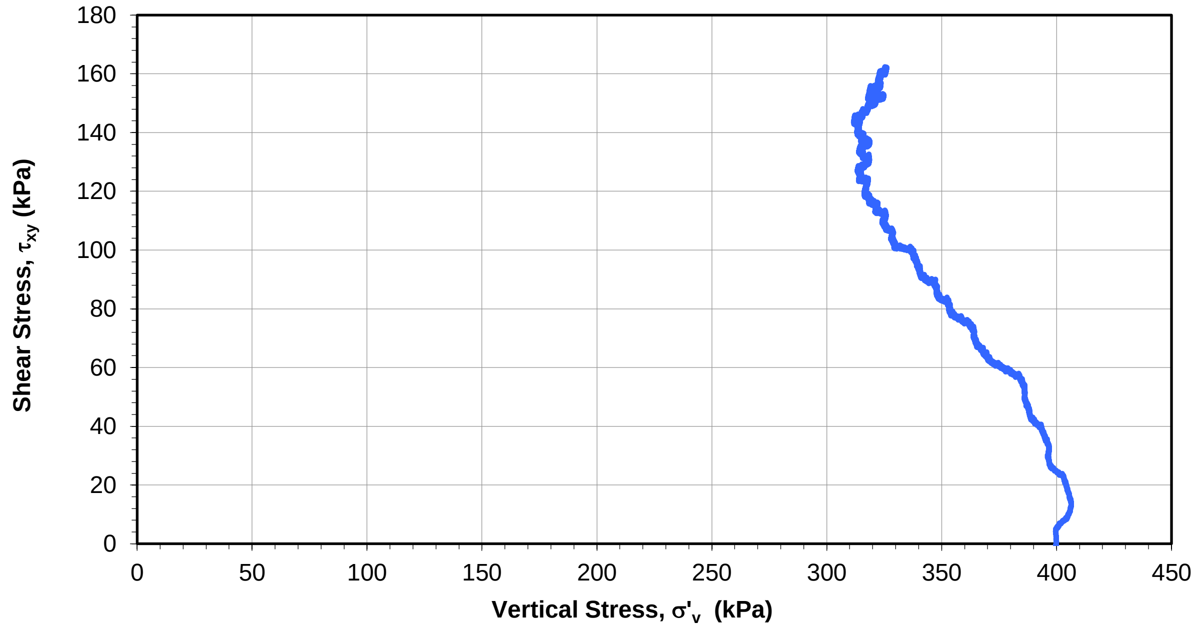
IPO Number: 2018-017
Sample ID: 2018-017-008
Borehole ID: CE411A
Depth: 15.26 m to 15.30 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

FUGRO

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT4

IPO Number: 2018-017
Sample ID: 2018-017-009
Borehole ID: CE411A
Depth: 15.22 m to 15.26 m

Test Details:	
Test ID:	CVO-SS05
Consolidation Stress (kPa):	800
Shearing Rate (%/Hr)	5

Tested By:	SF
Date:	14/09/2018

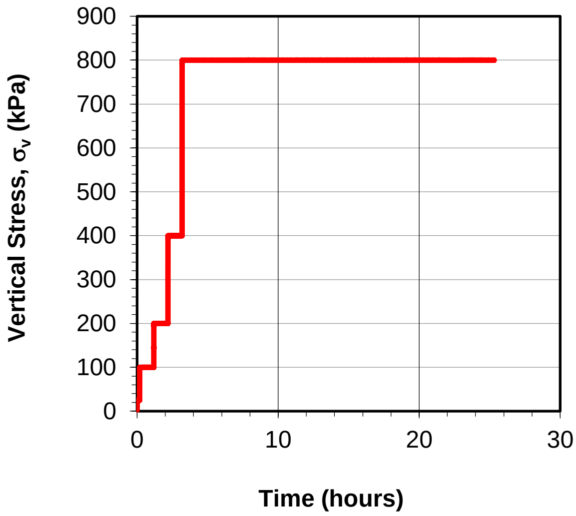
Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.40	22.99
Dry Density (t/m^3) :	1.52	1.68
Moisture Content (%) :	31.3 *	37.0

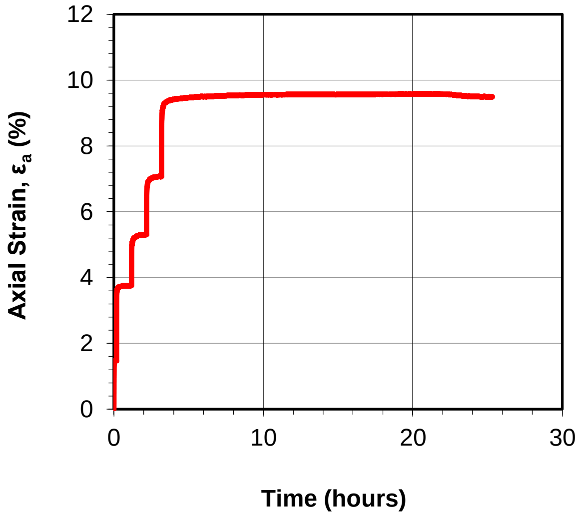
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

Checked By:	SRJ
Date:	27/9/2018

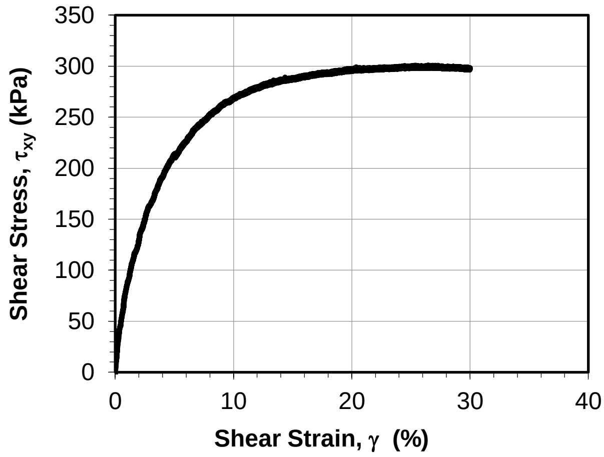
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

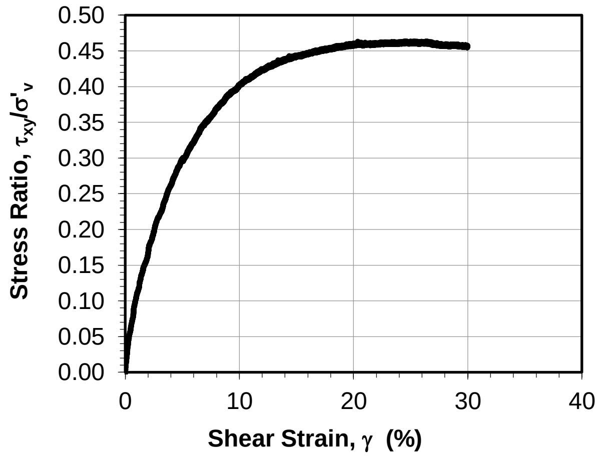
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





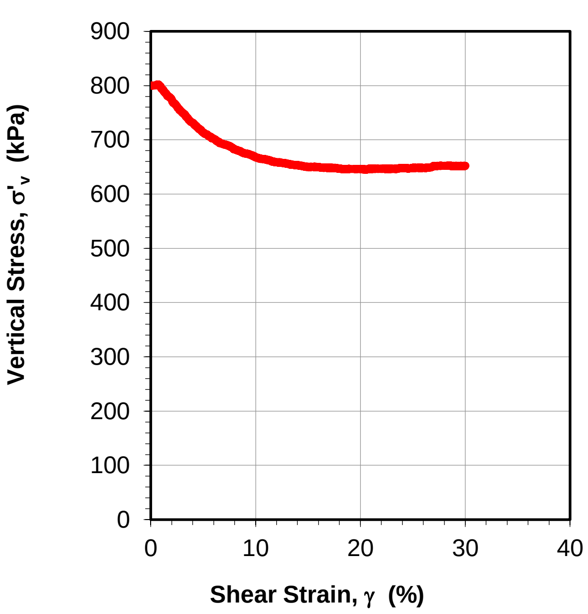
Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

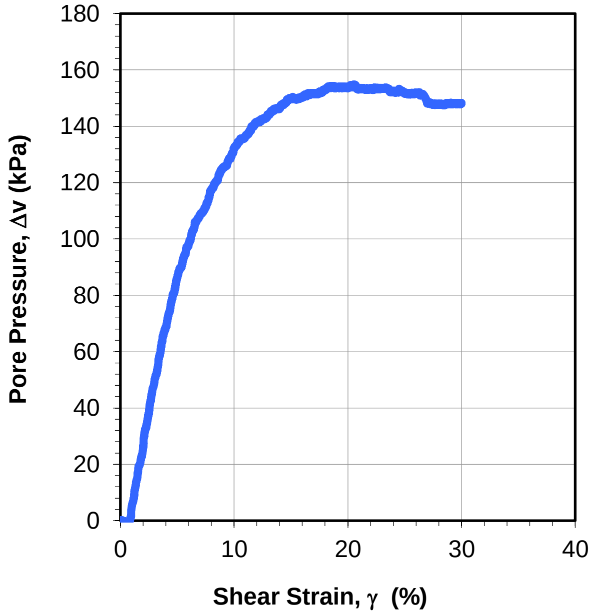
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT4

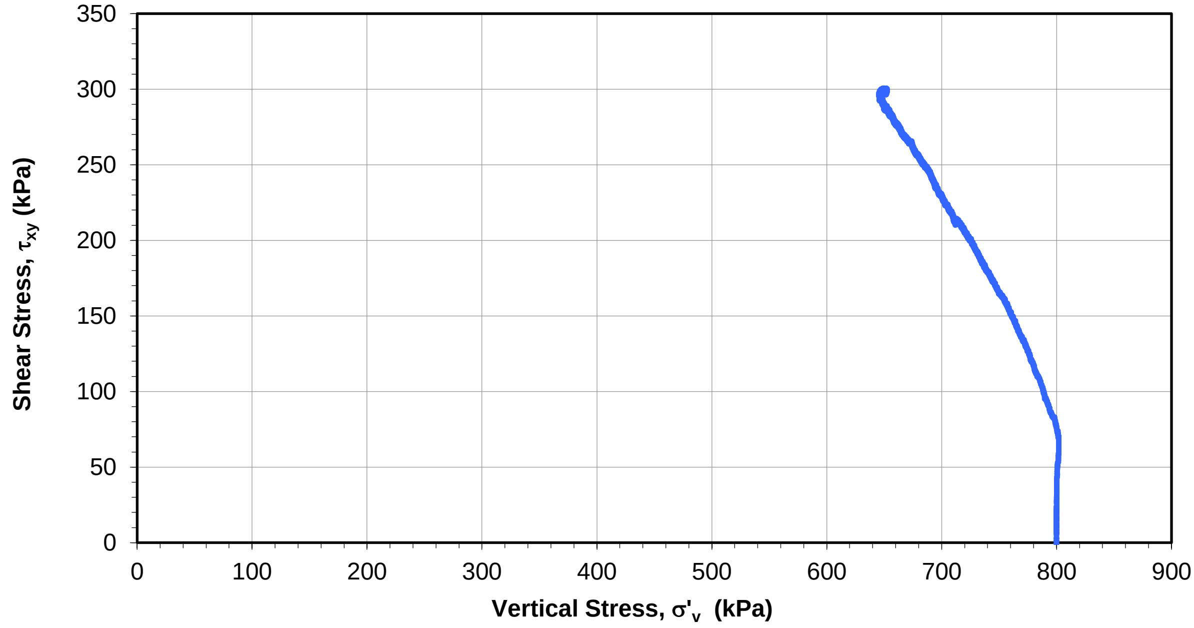
IPO Number: 2018-017
Sample ID: 2018-017-009
Borehole ID: CE411A
Depth: 15.22 m to 15.26 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

Client:	Newcrest Mining		**IPO Number:**	2018-017	
Project:	Cadia NTSF Failure - Laboratory Testing		**Sample ID:**	2018-017-010	
Location:	Cadia Valley Operations		**Borehole ID:**	CE411A	
Sample No.:	PT4		**Depth:**	15.18 m to 15.22 m	

Test Details:	
Test ID:	CVO-SS06
Consolidation Stress (kPa):	1200
Shearing Rate (%/Hr)	5

Tested By:	SF
Date:	17/09/2018

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.40	22.38
Dry Density (t/m^3) :	1.63	1.85
Moisture Content (%) :	24.3 *	31.9

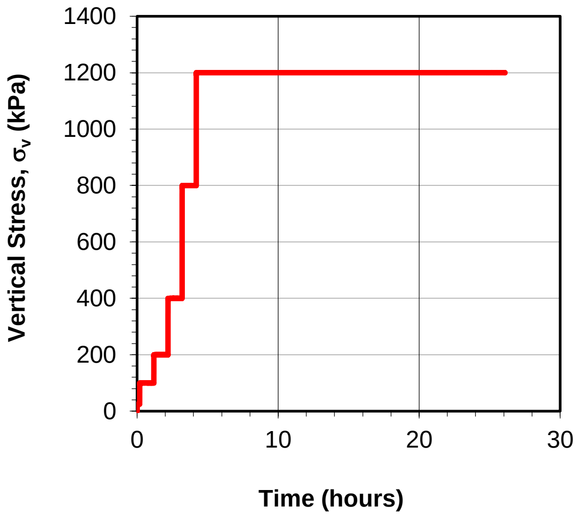
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

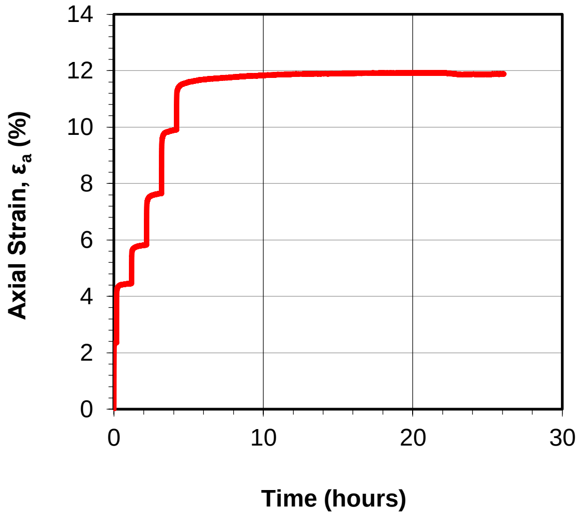
Checked By:	SRJ
Date:	27/9/2018

SIMPLE SHEAR TEST

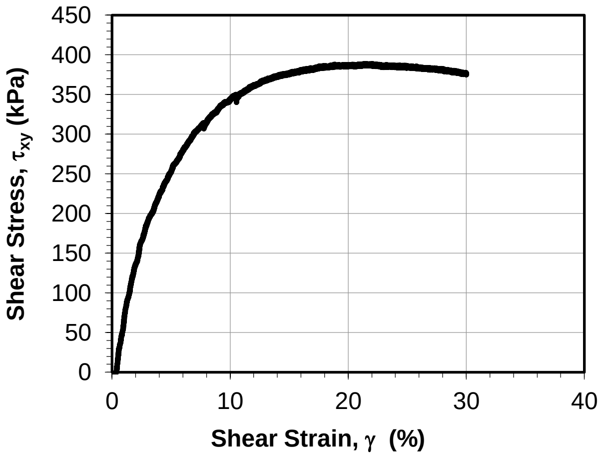
Test Method: AGLab Test Procedure FAM-18552

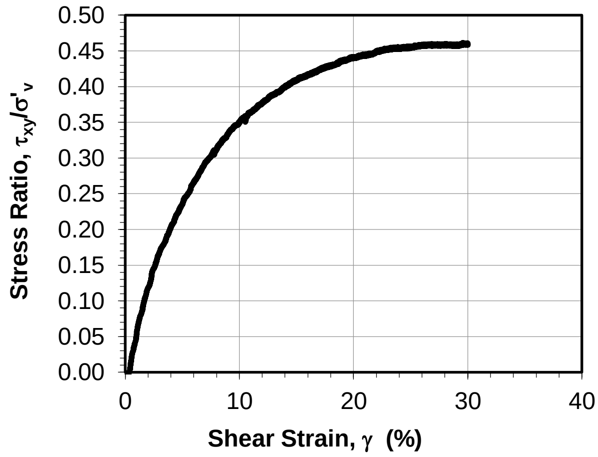
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





Cadia NTSF Failure - Laboratory Testing

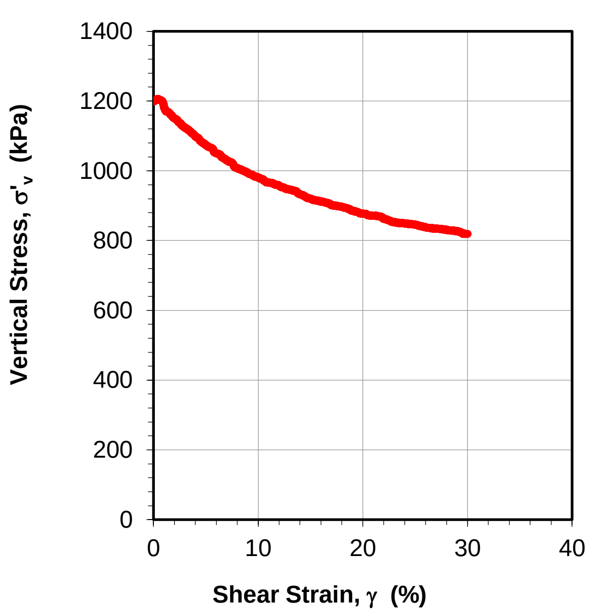
Monotonic Simple Shear

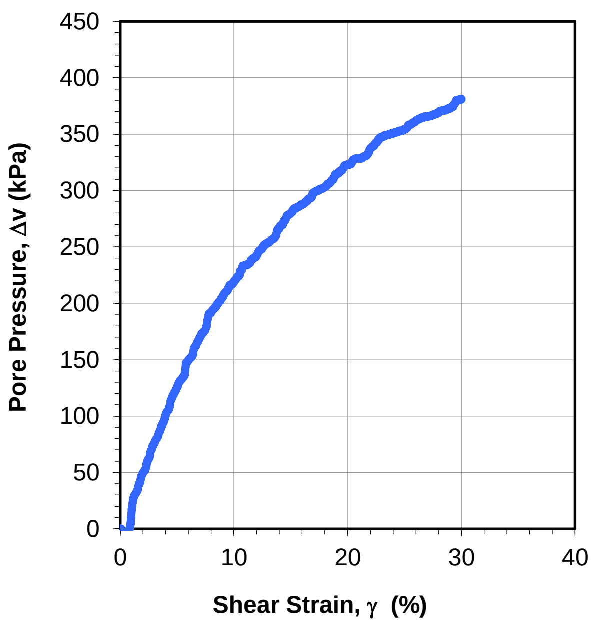
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT4

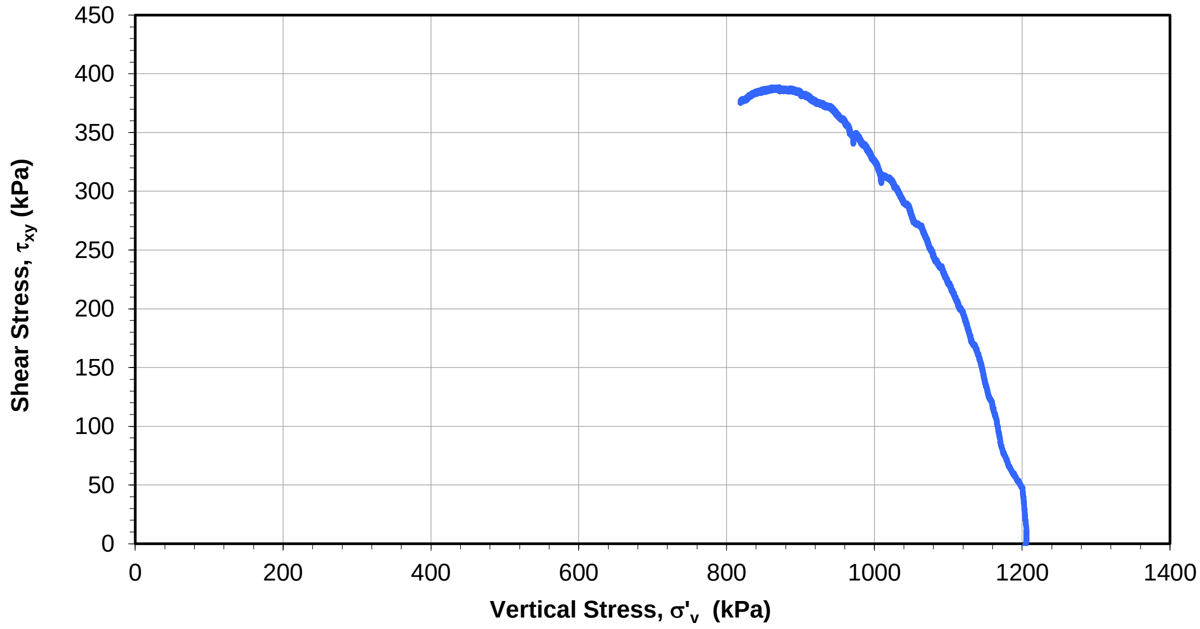
IPO Number: 2018-017
Sample ID: 2018-017-010
Borehole ID: CE411A
Depth: 15.18 m to 15.22 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-012
Location:	Cadia Valley Operations	**Borehole ID:**	CE411A
Sample No.:	PT5	**Depth:**	16.86 m to 16.90 m

Test Details:	
Test ID:	CVO-SS07
Consolidation Stress (kPa):	400
Shearing Rate (%/Hr)	5

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.50	24.24
Dry Density (t/m^3) :	1.32	1.39
Moisture Content (%) :	40.8 *	46.1

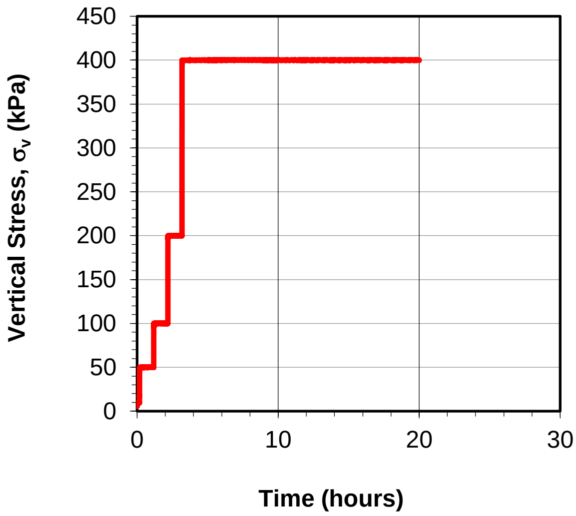
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

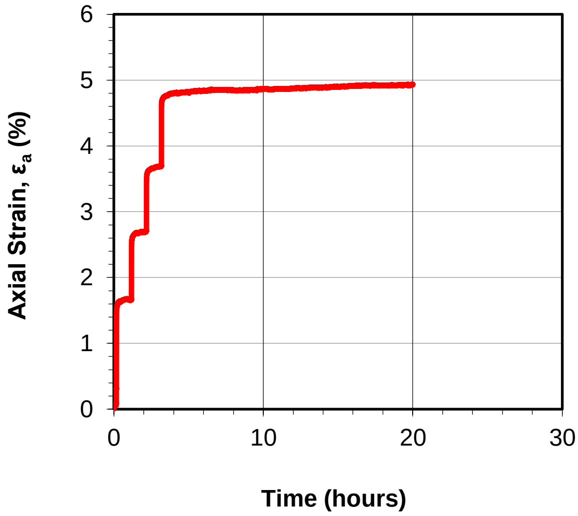
Tested By:	SF
Date:	31/08/2018

Checked By:	SRJ
Date:	27/9/2018

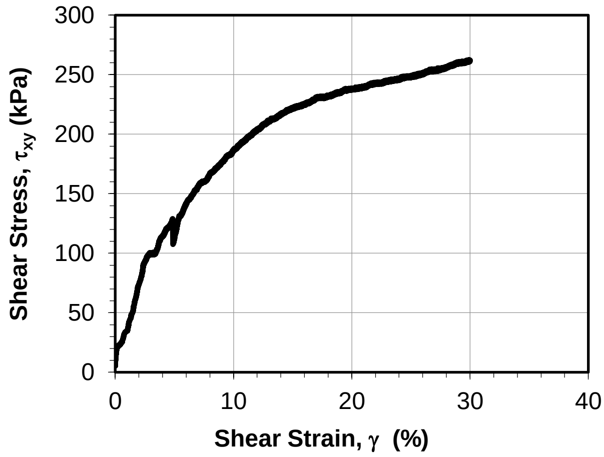
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

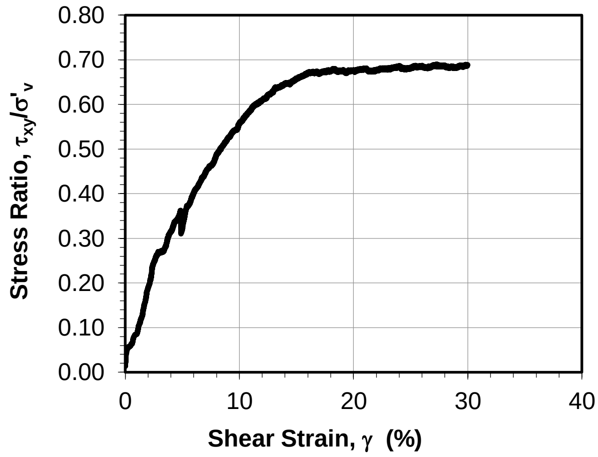
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





Cadia NTSF Failure - Laboratory Testing

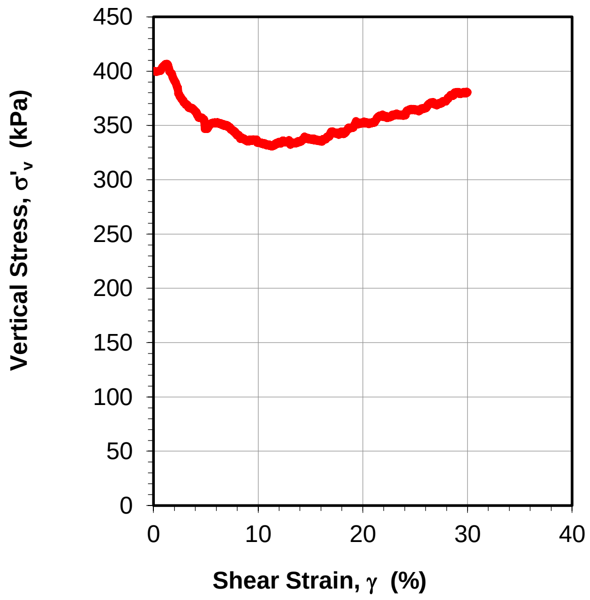
Monotonic Simple Shear

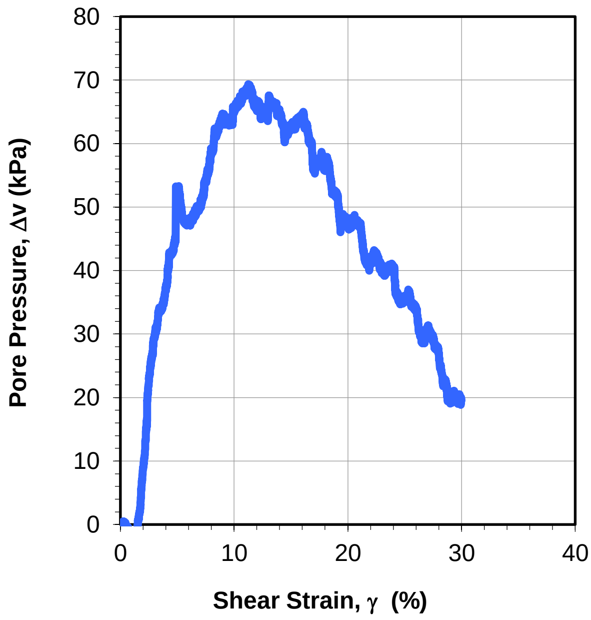
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

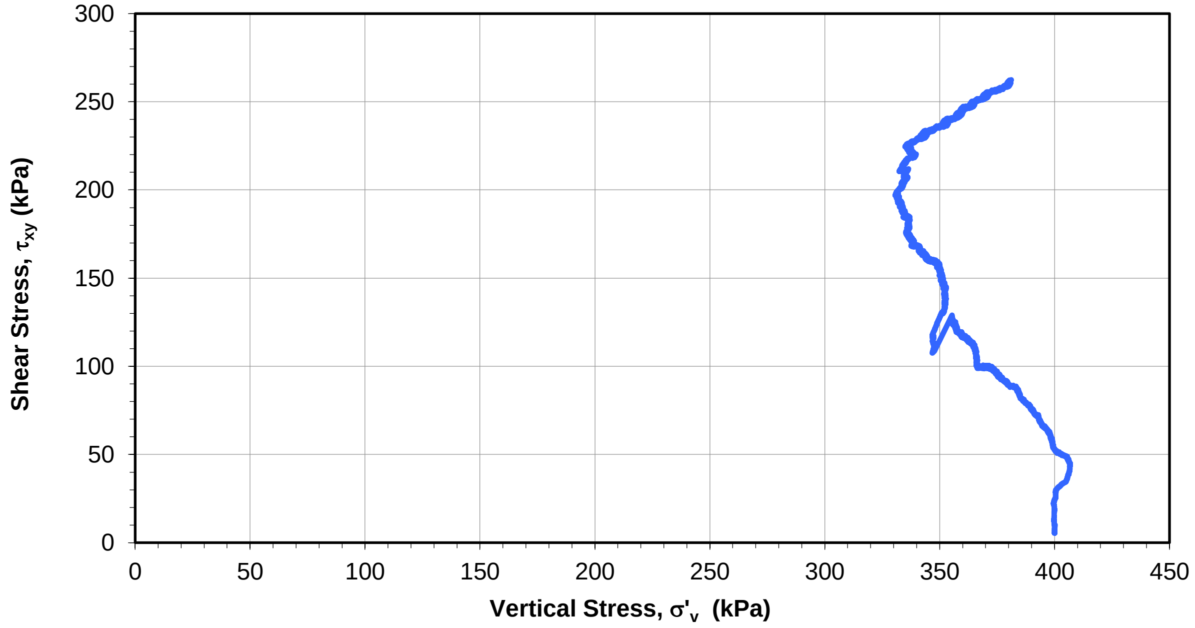
IPO Number: 2018-017
Sample ID: 2018-017-012
Borehole ID: CE411A
Depth: 16.86 m to 16.90 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing

Monotonic Simple Shear

Client:	Newcrest Mining		**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing		**Sample ID:**	2018-017-008
Location:	Cadia Valley Operations		**Borehole ID:**	CE411A
Sample No.:	PT5		**Depth:**	16.78 m to 16.82 m

Test Details:	
Test ID:	CVO-SS08
Consolidation Stress (kPa):	800
Shearing Rate (%/Hr)	5

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.40	23.60
Dry Density (t/m^3) :	1.46	1.57
Moisture Content (%) :	37.4 *	41.3

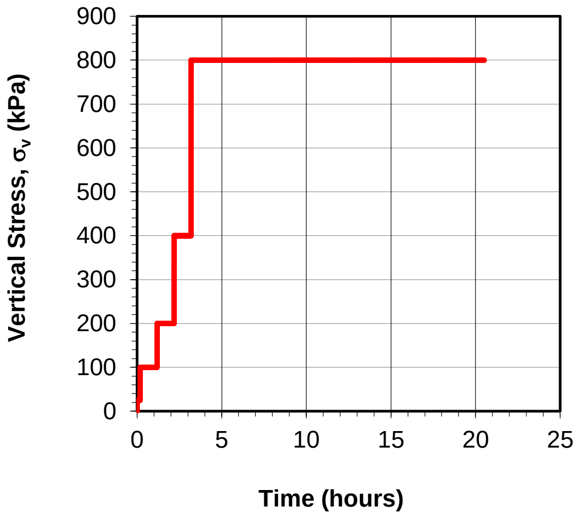
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

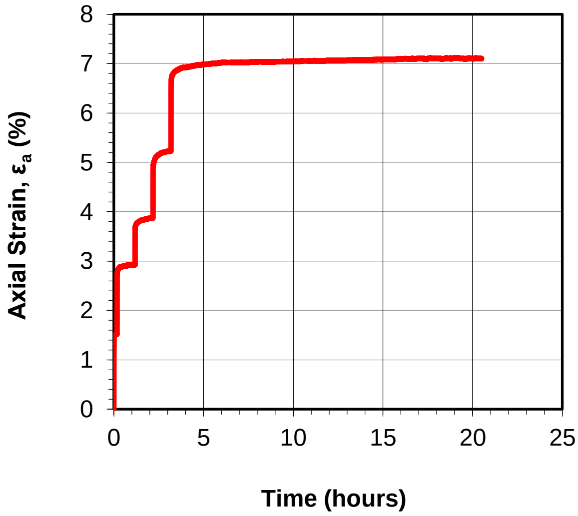
Tested By:	SF
Date:	08/09/2018

Checked By:	SRJ
Date:	27/9/2018

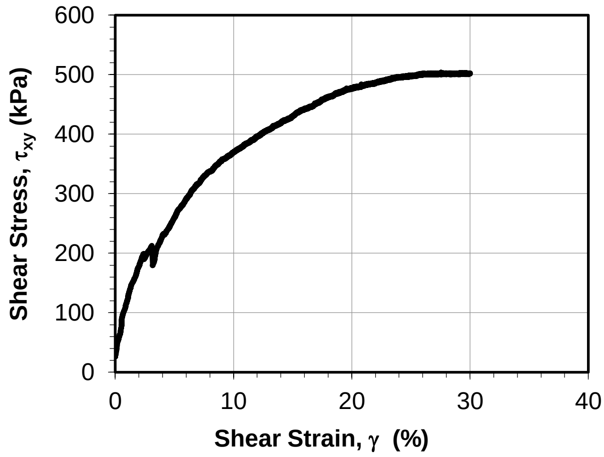
SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

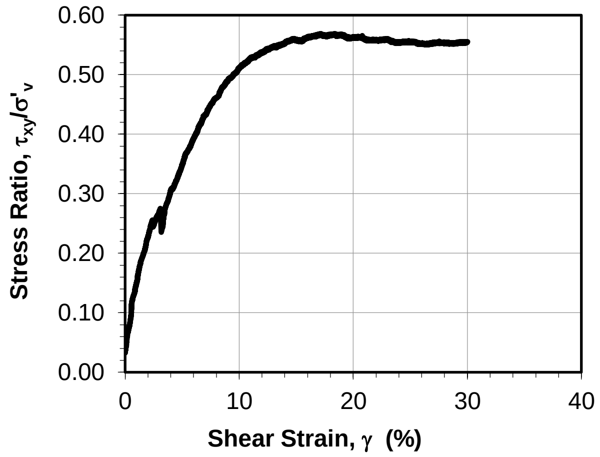
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

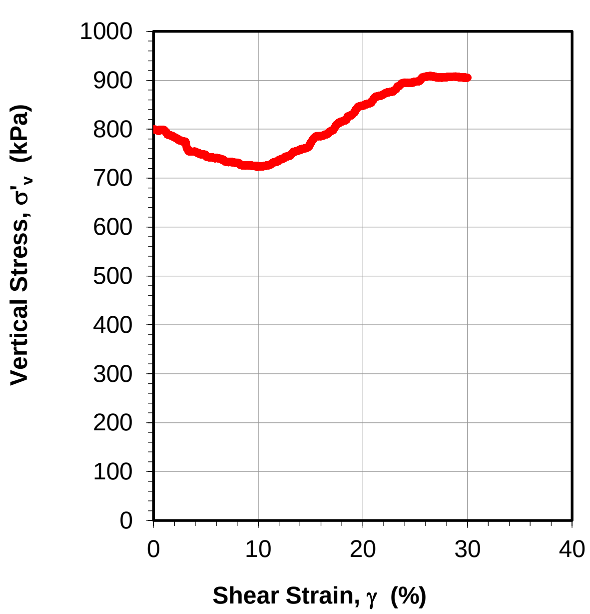
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

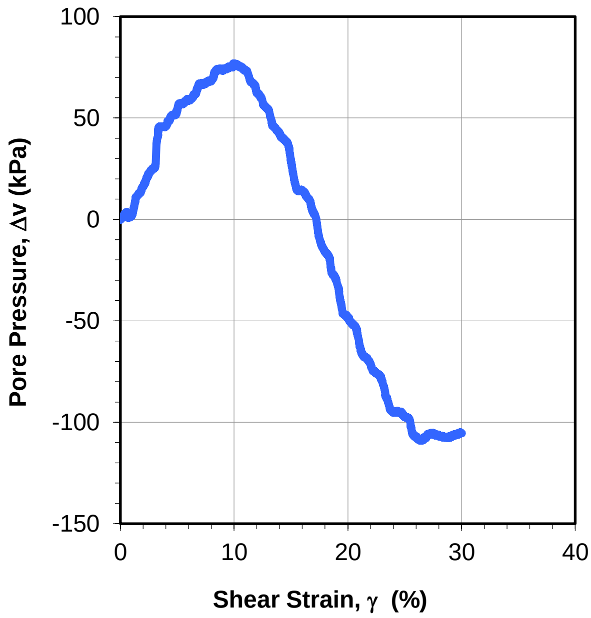
IPO Number: 2018-017
Sample ID: 2018-017-008
Borehole ID: CE411A
Depth: 16.78 m to 16.82 m

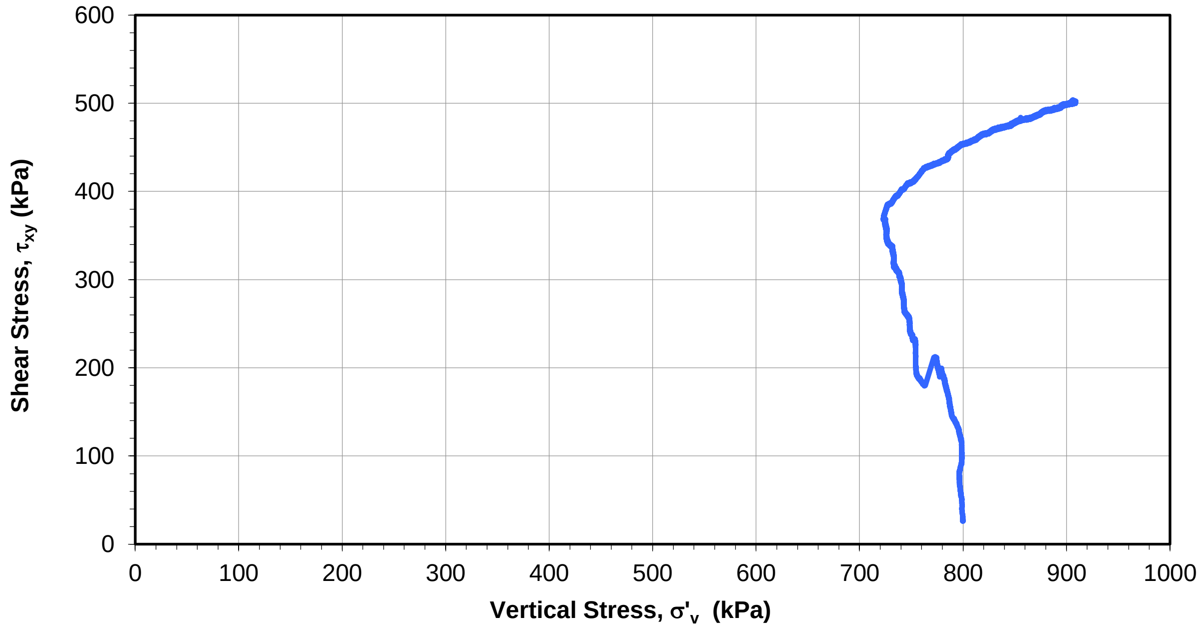
SIMPLE SHEAR TEST

Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing

Monotonic Simple Shear

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-014
Location:	Cadia Valley Operations	**Borehole ID:**	CE411A
Sample No.:	PT5	**Depth:**	16.74 m to 16.78 m

Test Details:	
Test ID:	CVO-SS09R
Consolidation Stress (kPa):	1200
Shearing Rate (%/Hr)	5

Tested By:	SF
Date:	10/09/2018

Sample Details:	Initial	Final
Sample Diameter (mm):	62.7	-
Sample Height (mm) :	25.40	23.27
Dry Density (t/m^3) :	1.49	1.63
Moisture Content (%) :	33.1 *	39.8

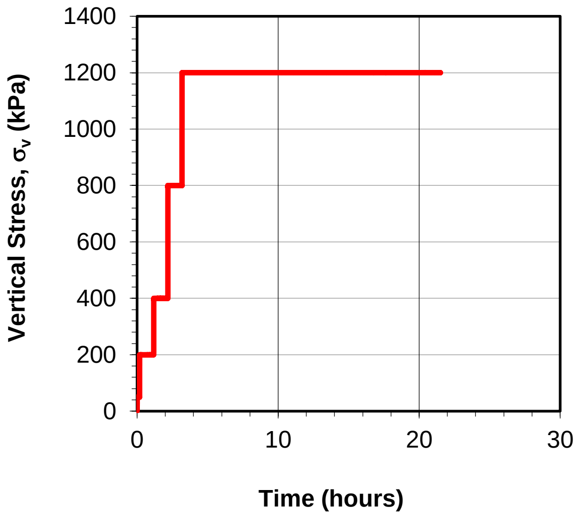
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample.

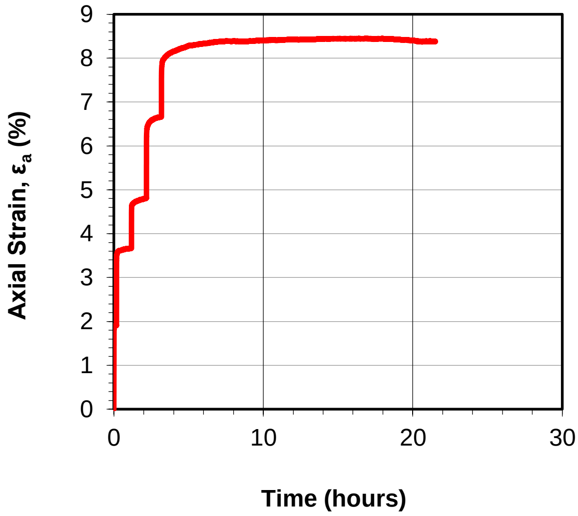
Checked By:	SRJ
Date:	27/9/2018

SIMPLE SHEAR TEST

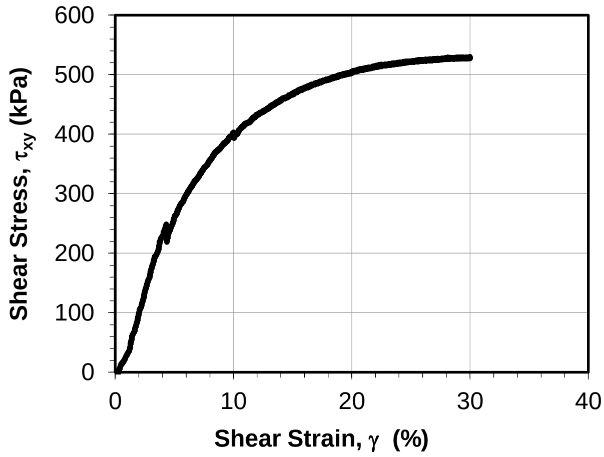
Test Method: AGLab Test Procedure FAM-18552

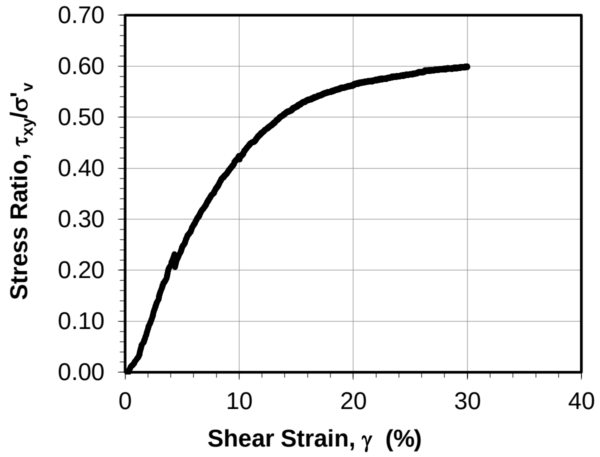
Stage 1: Consolidation





Stage 2 : Monotonic Shearing





Cadia NTSF Failure - Laboratory Testing

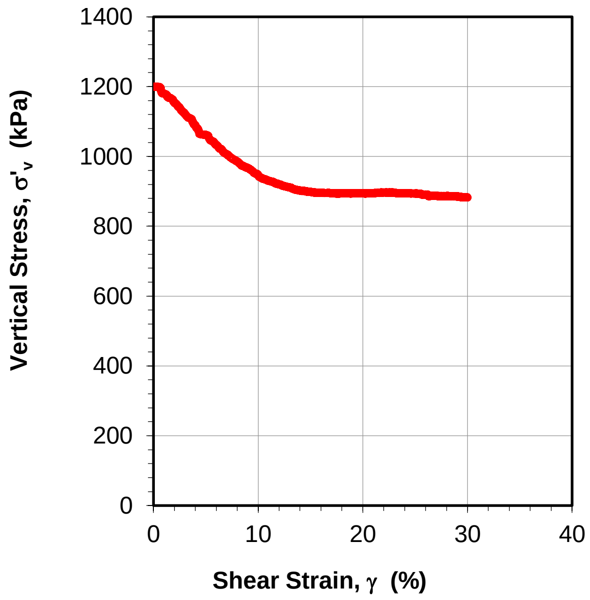
Monotonic Simple Shear

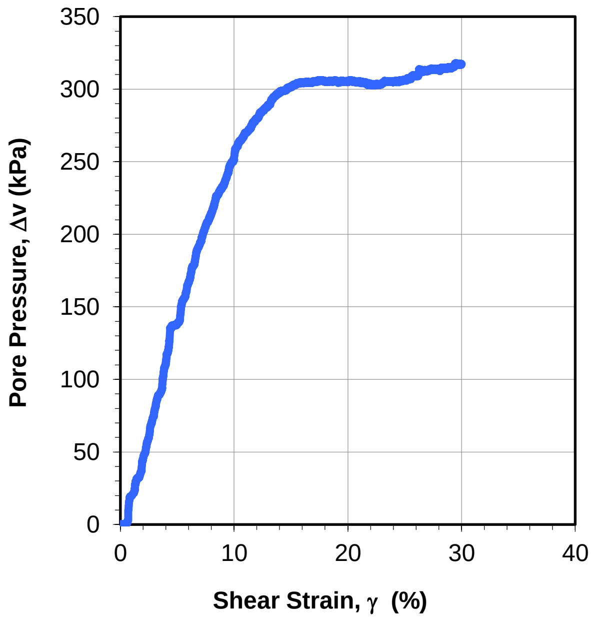
Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

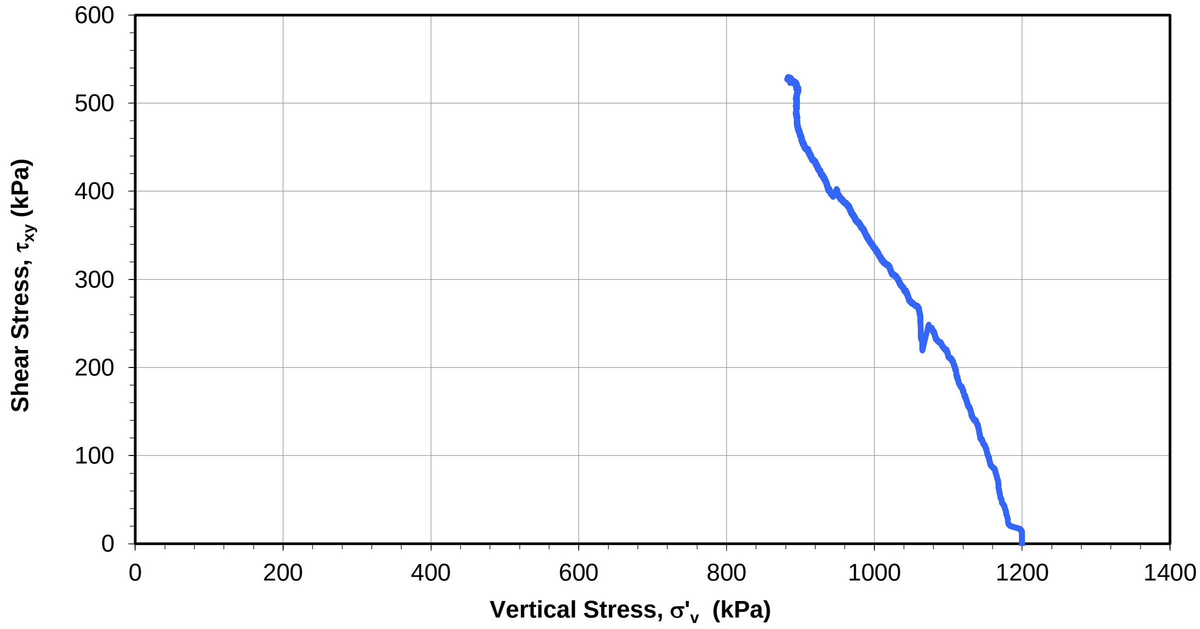
IPO Number: 2018-017
Sample ID: 2018-017-014
Borehole ID: CE411A
Depth: 16.74 m to 16.78 m

SIMPLE SHEAR TEST
Test Method: AGLab Test Procedure FAM-18552

Stage 2 : Monotonic Shearing







Cadia NTSF Failure - Laboratory Testing
Monotonic Simple Shear

Annexure DD
Direct Shear Tests - TriLabs

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS
		Workorder No	0004435
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	13/07/2018
		Report Date	23/07/2018
Project	H356804 - Cadia		
Client ID	DH-410	**Depth (m)**	19.65-19.95
Description	GRAVELLY CLAY - red/brown	**Sample Type**	Single individual soil specimen - Undisturbed.

SAMPLE DETAILS

Specimen Condition	Inundated
Specimen Dimensions (mm)	69.5
Rate of Strain (mm/min)	0.010
Initial Moisture Content (%)	22.3
Initial Wet Density(t/m^3)	1.94

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	7.00	400.5	256.6	400.5	256.7
Stage 2 - Residual 2	7.00	400.5	255.6	400.5	255.8
Stage 3 - Residual 3	7.00	400.5	252.7	400.5	252.7
Stage 4 - Residual 4	7.00	400.5	237.9	400.5	237.9
Stage 5 - Residual 5	7.00	400.5	243.6	400.5	243.8
Stage 6 - Residual 6	-	-	-	-	-

Notes/Remarks:

Note: Area correction based on circular sample equation.

Graph not to scale

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. Purvis

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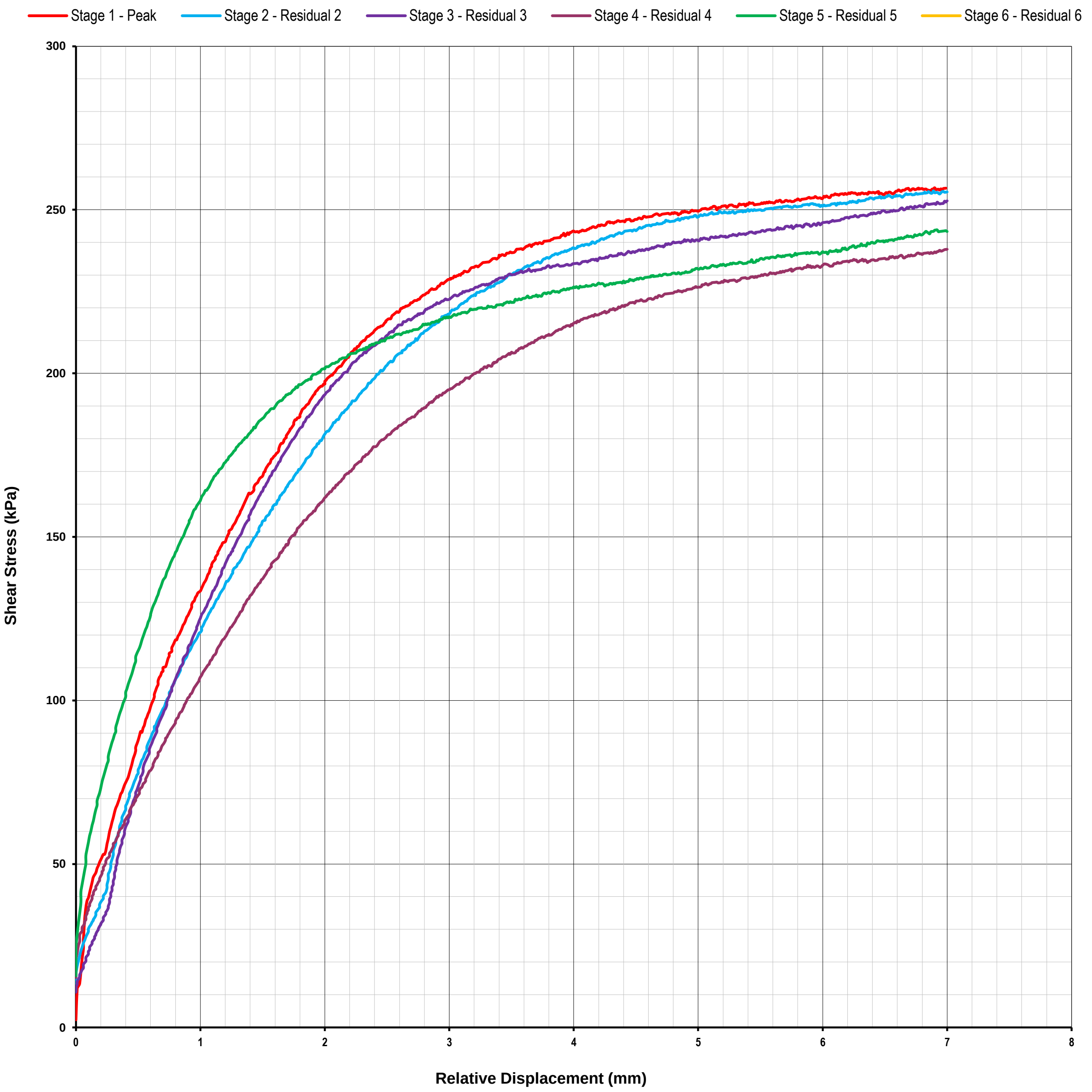
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Shear Stress/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on circular sample equation.

Graph not to scale

Sample/s supplied by the client

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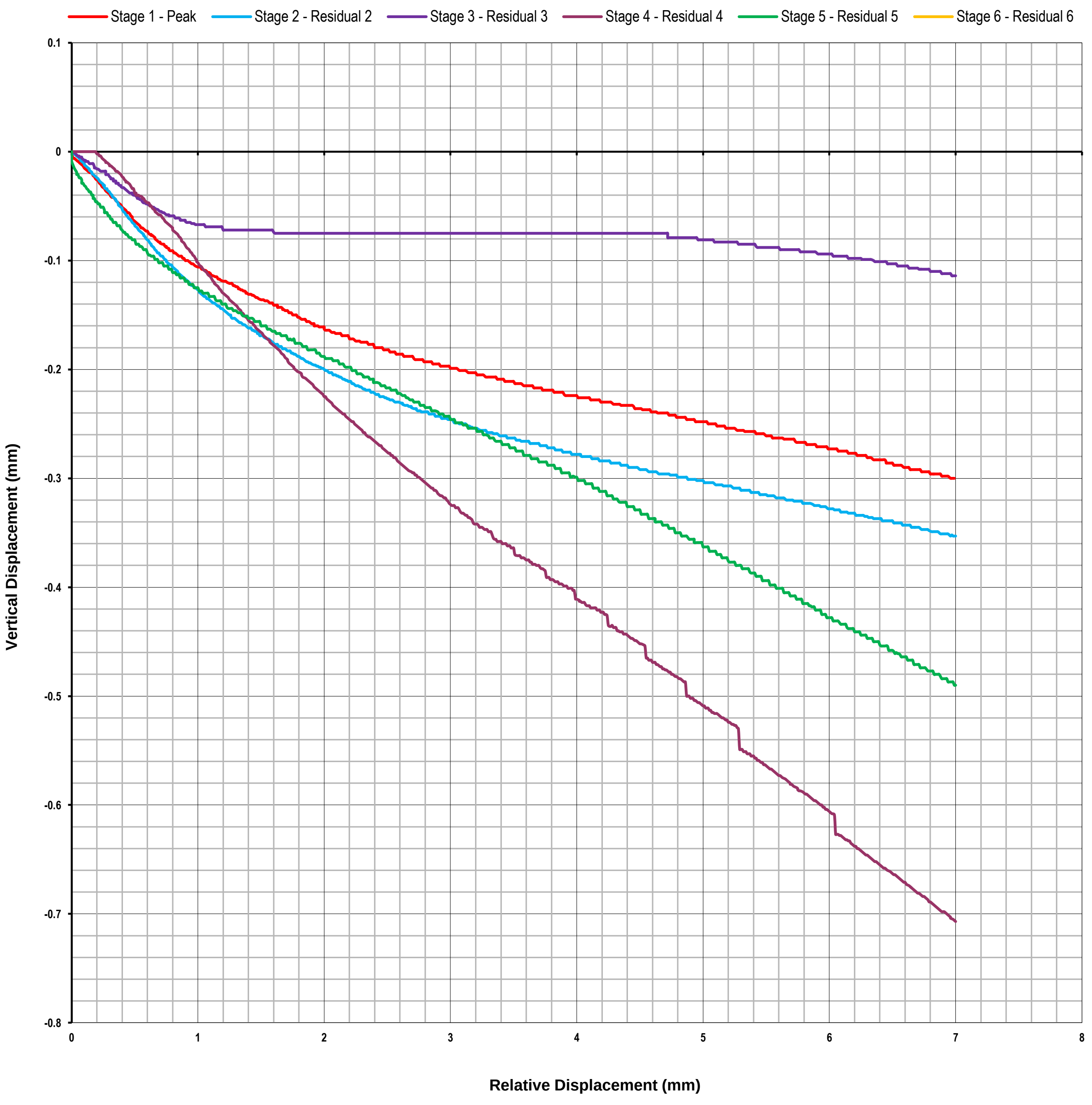
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client Hatch Pty Ltd	**Report No.** 18060849- DS

Vertical Displacement/Relative Displacement Plot



Notes/Remarks:

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Graph not to scale

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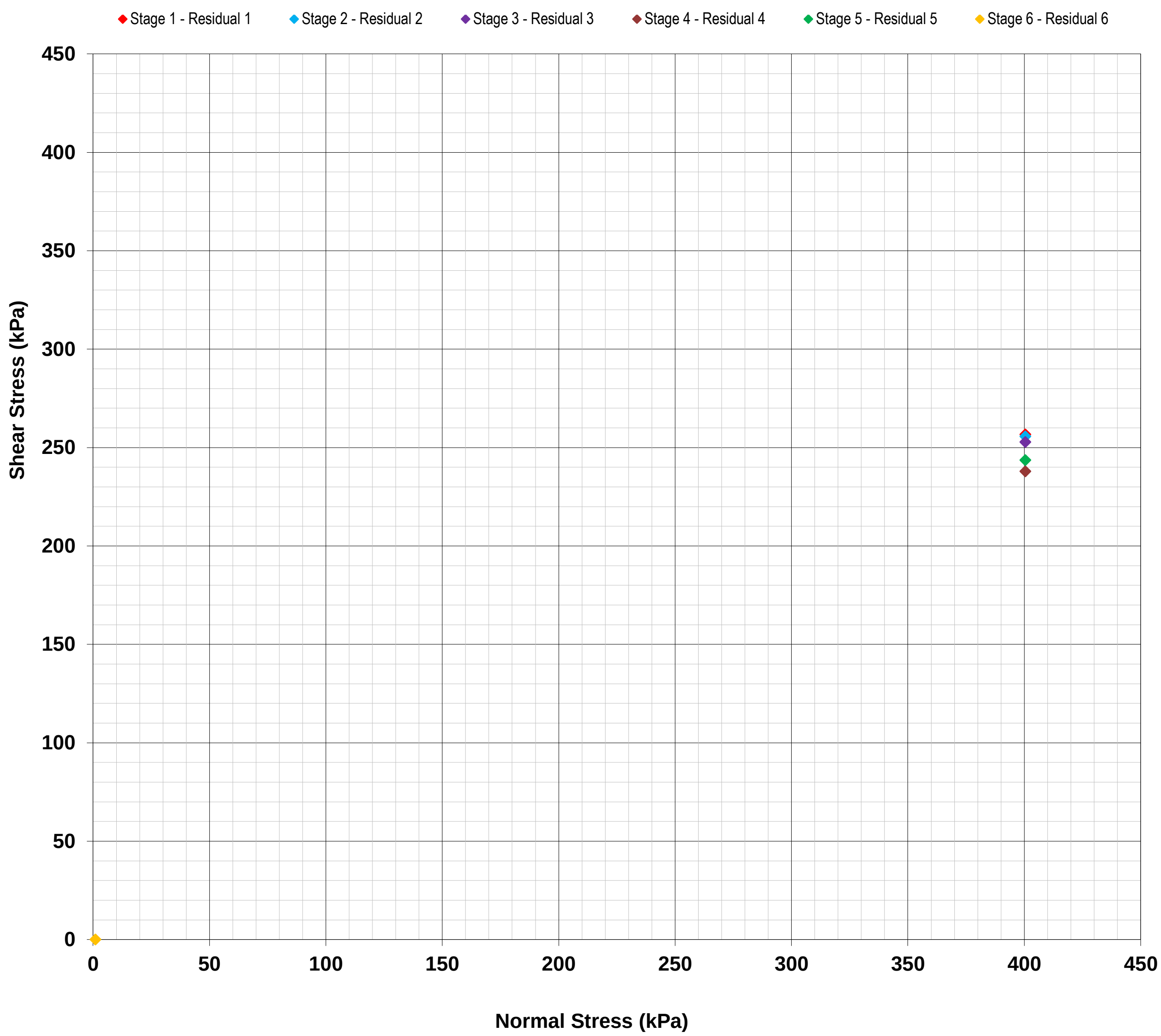
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Failure Criteria **Residual @ 7 , 7 , 7 , 7 mm Displacement**

Residual - Normal Stress vs Shear Stress



Notes/Remarks:

Photo not to scale

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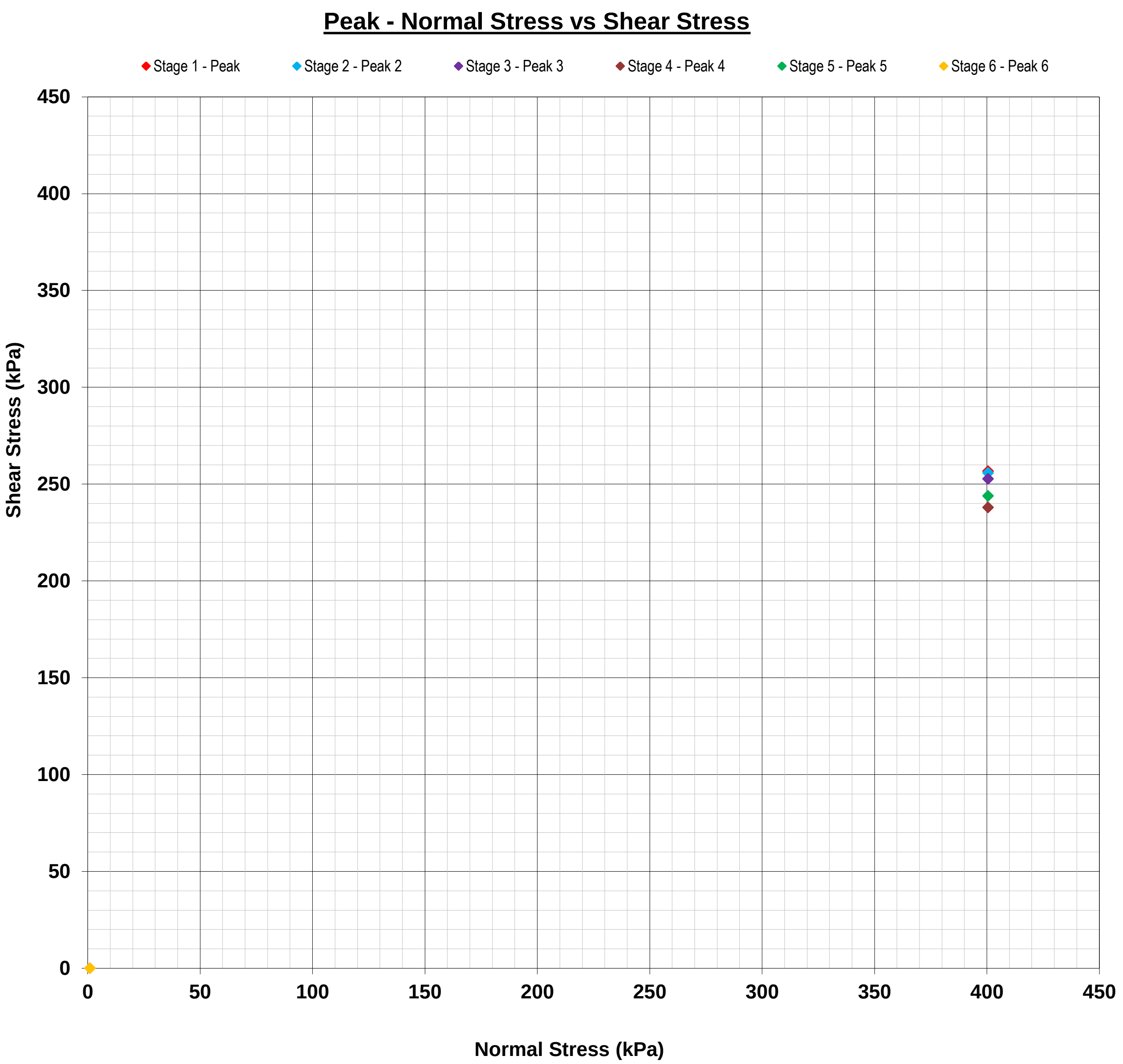
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS
Failure Criteria		**Peak**	



Notes/Remarks:

Graph not to scale

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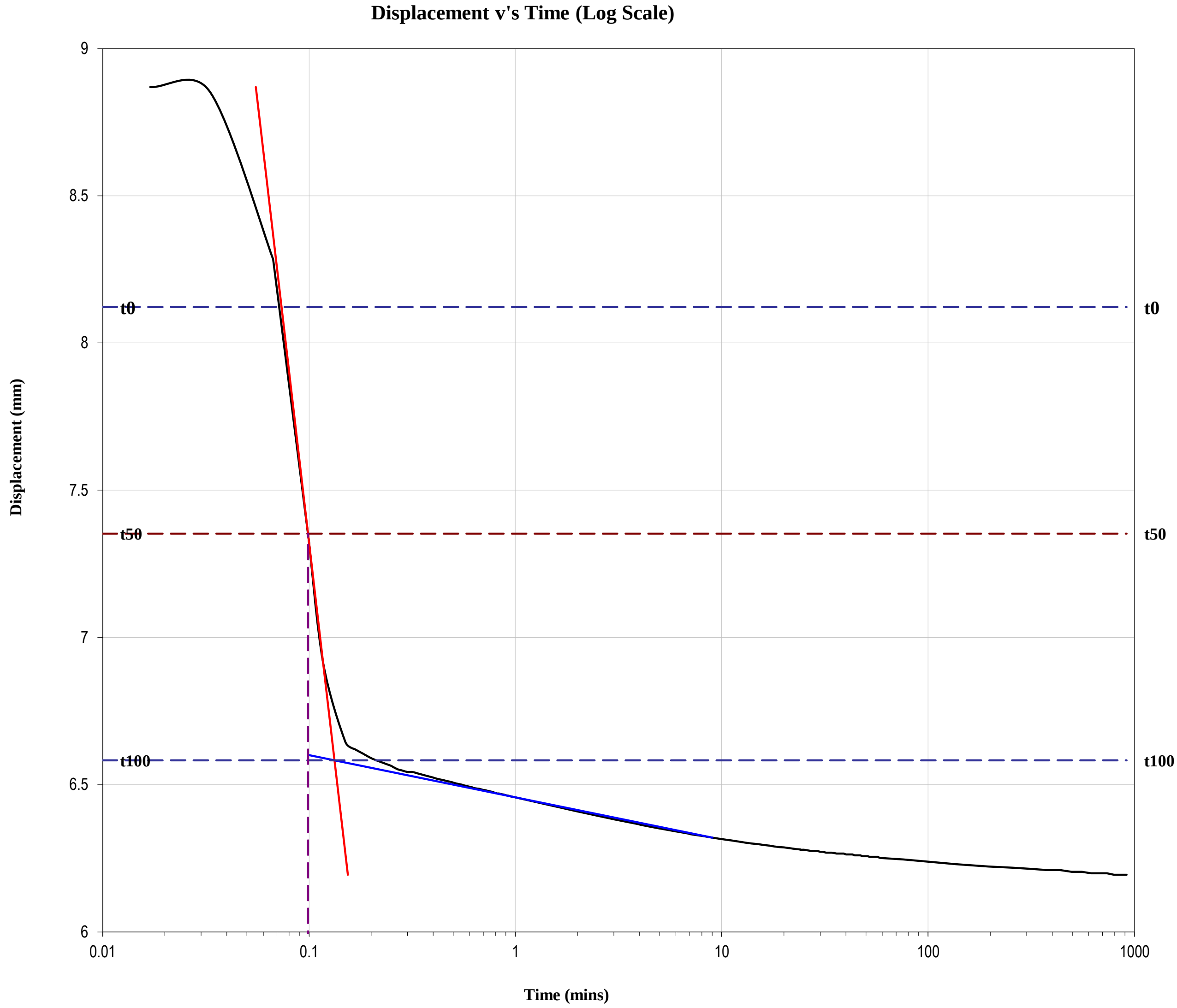
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Stage 1 Consolidation



t_{50}	0.10	mins
t_{100}	0.13	mins
Time to Failure =	367.62	mins
Estimated Displacement to Failure =	5	mm
Displacement Rate =	0.0136	mm/min

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Before and After Photos

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS
		Workorder No	0004435
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	13/07/2018
		Report Date	23/07/2018
Project	H356804 - Cadia		
Client ID	DH-410	**Depth (m)**	19.65-19.95
Description	GRAVELLY CLAY - red/brown	**Sample Type**	Single individual soil specimen - Undisturbed.

SAMPLE DETAILS

Specimen Condition	Inundated
Specimen Dimensions (mm)	69.5
Rate of Strain (mm/min)	0.010
Initial Moisture Content (%)	22.3
Initial Wet Density(t/m^3)	1.88

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	7.00	800.1	380.5	800.1	380.5
Stage 2 - Residual 2	7.00	800.1	369.1	800.1	369.1
Stage 3 - Residual 3	7.00	800.1	393.3	800.1	393.3
Stage 4 - Residual 4	7.00	800.1	378.1	800.1	378.1
Stage 5 - Residual 5	7.00	800.1	399.0	800.1	399.0
Stage 6 - Residual 6	-	-	-	-	-

Notes/Remarks:

Note: Area correction based on circular sample equation.

Graph not to scale

Sample/s supplied by the client

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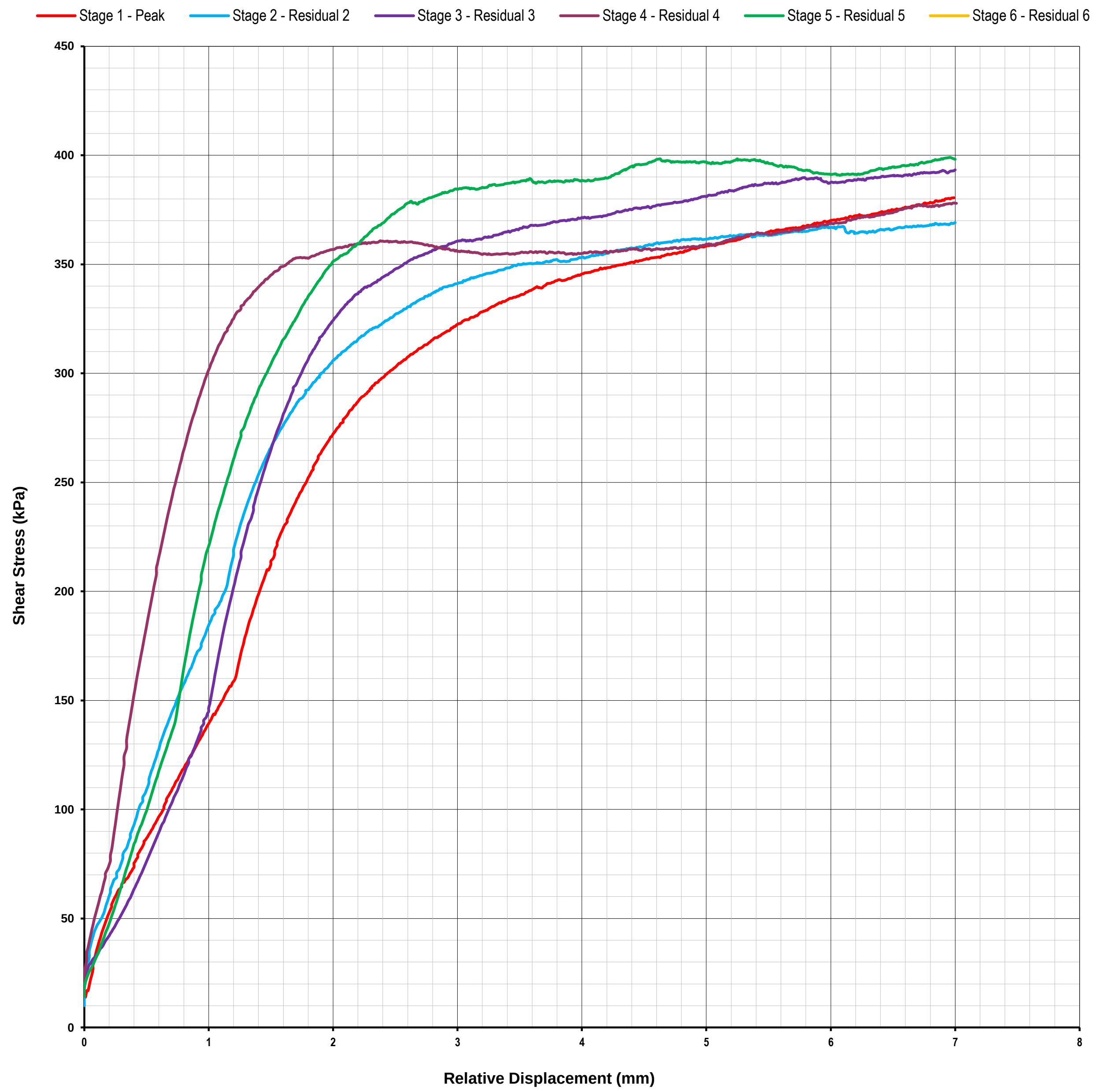
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Shear Stress/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on circular sample equation.

Graph not to scale

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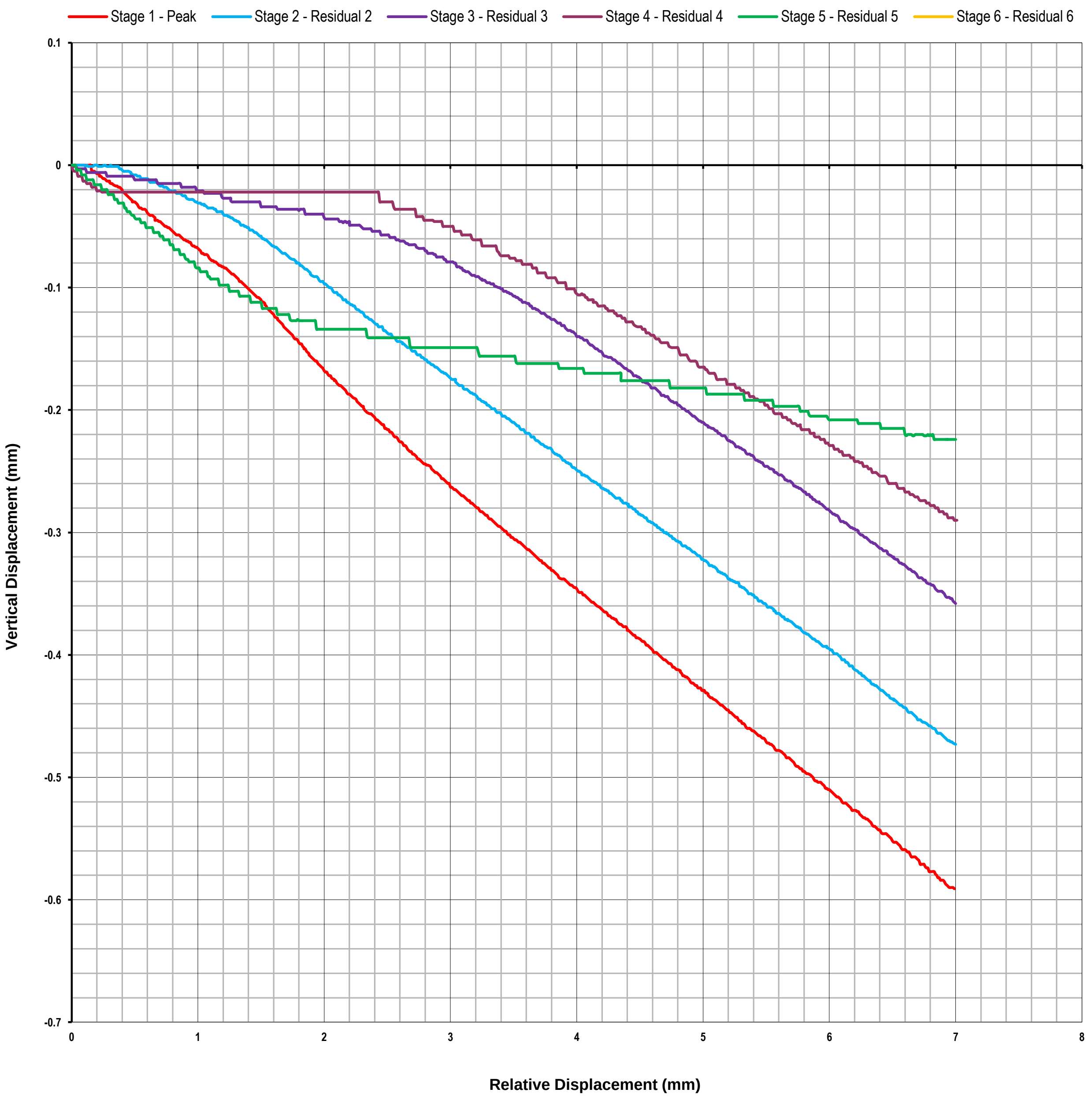
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Vertical Displacement/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on circular sample equation.

Graph not to scale

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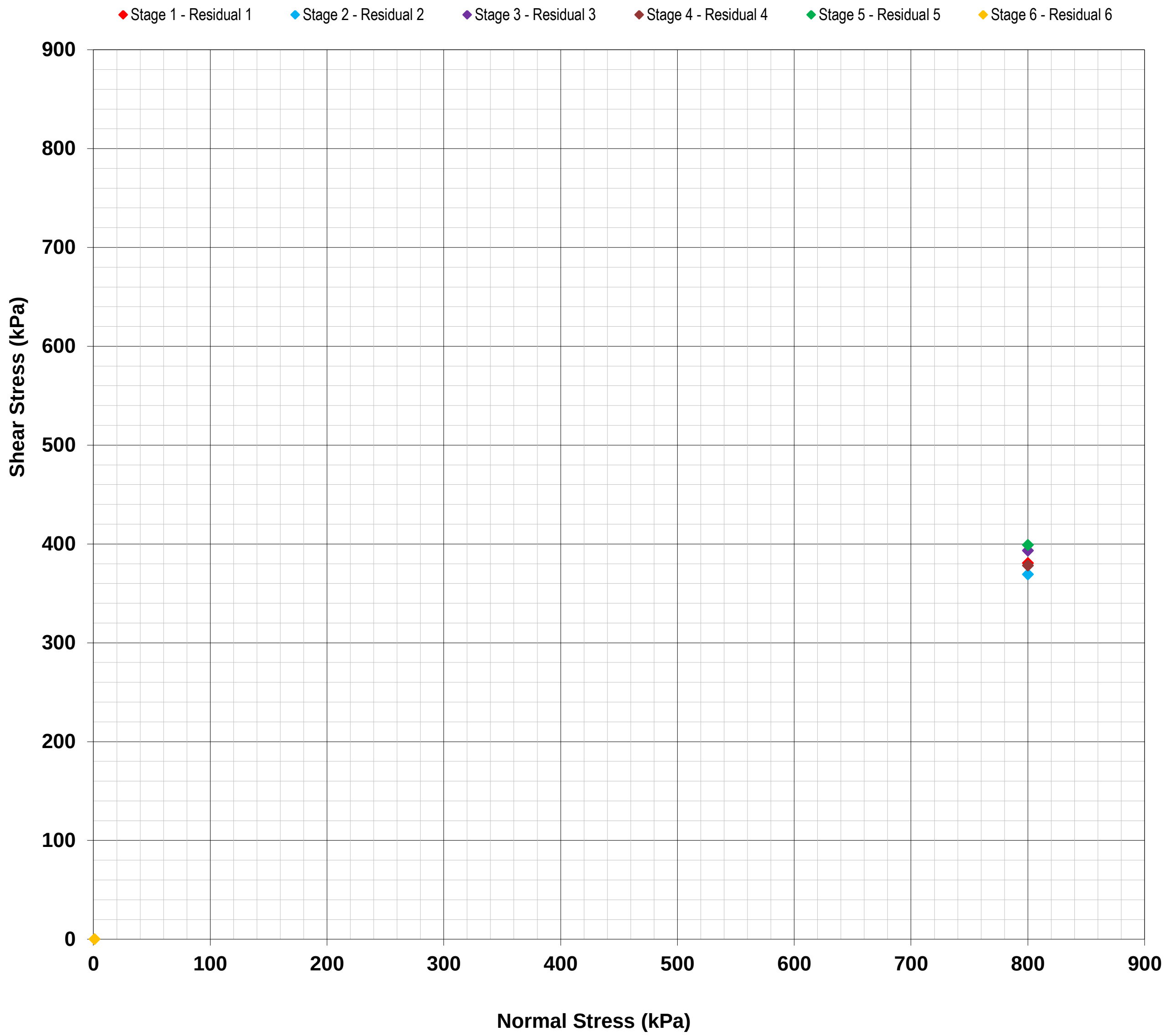
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Failure Criteria **Residual @ 7 , 7 , 7 , 7 mm Displacement**

Residual - Normal Stress vs Shear Stress



Notes/Remarks:

Photo not to scale

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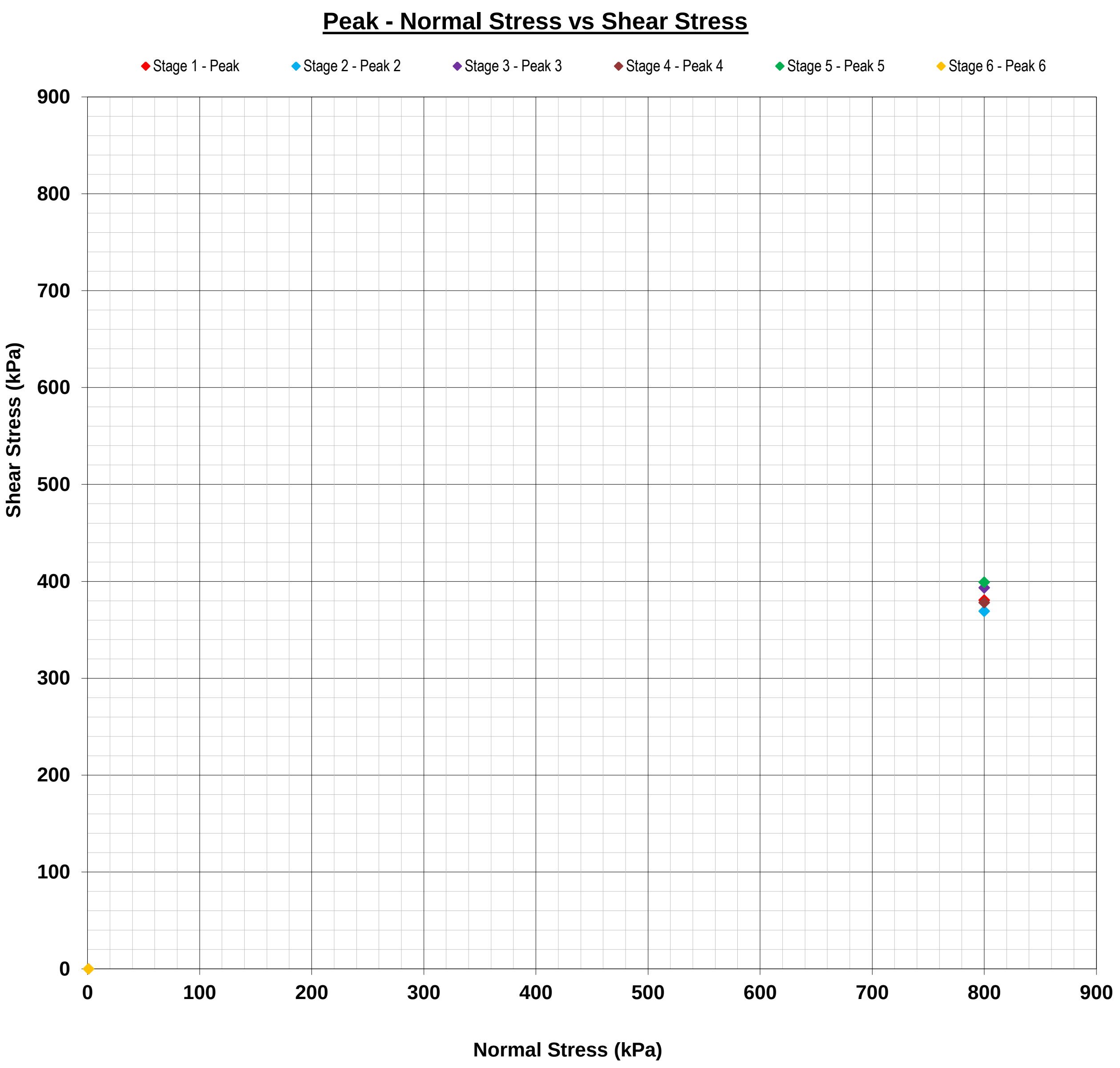
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS
Failure Criteria		**Peak**	



Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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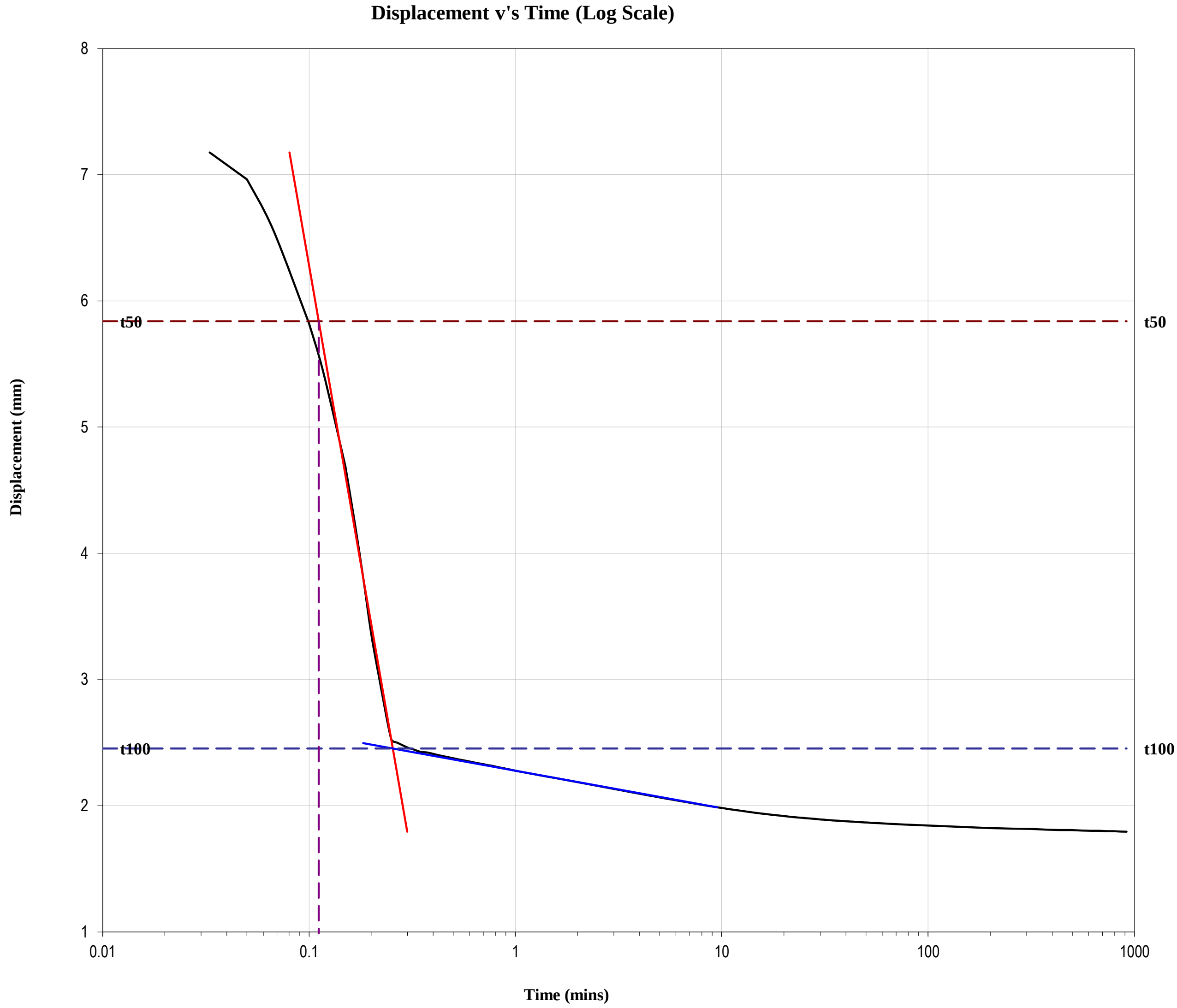
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Stage 1 Consolidation



t_{50}	0.11	mins
t_{100}	0.25	mins
Time to Failure =	291.93	mins
Estimated Displacement to Failure =	5	mm
Displacement Rate =	0.01713	mm/min

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Before and After Photos

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS
		Workorder No	0004435
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	13/07/2018
		Report Date	23/07/2018
Project	H356804 - Cadia		
Client ID	DH-410	**Depth (m)**	19.65-19.95
Description	GRAVELLY CLAY - red/brown	**Sample Type**	Single individual soil specimen - Undisturbed.

SAMPLE DETAILS

Specimen Condition	Inundated
Specimen Dimensions (mm)	69.5
Rate of Strain (mm/min)	0.010
Initial Moisture Content (%)	22.3
Initial Wet Density(t/m^3)	1.86

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	7.00	1200.1	682.7	1200.1	694.9
Stage 2 - Residual 2	7.00	1200.1	623.0	1200.1	634.7
Stage 3 - Residual 3	7.00	1200.1	539.0	1200.1	539.0
Stage 4 - Residual 4	7.00	1200.1	579.9	1200.1	581.3
Stage 5 - Residual 5	7.00	1200.1	626.6	1200.1	630.5
Stage 6 - Residual 6	-	-	-	-	-

Notes/Remarks:

Note: Area correction based on circular sample equation.

Graph not to scale

Sample/s supplied by the client

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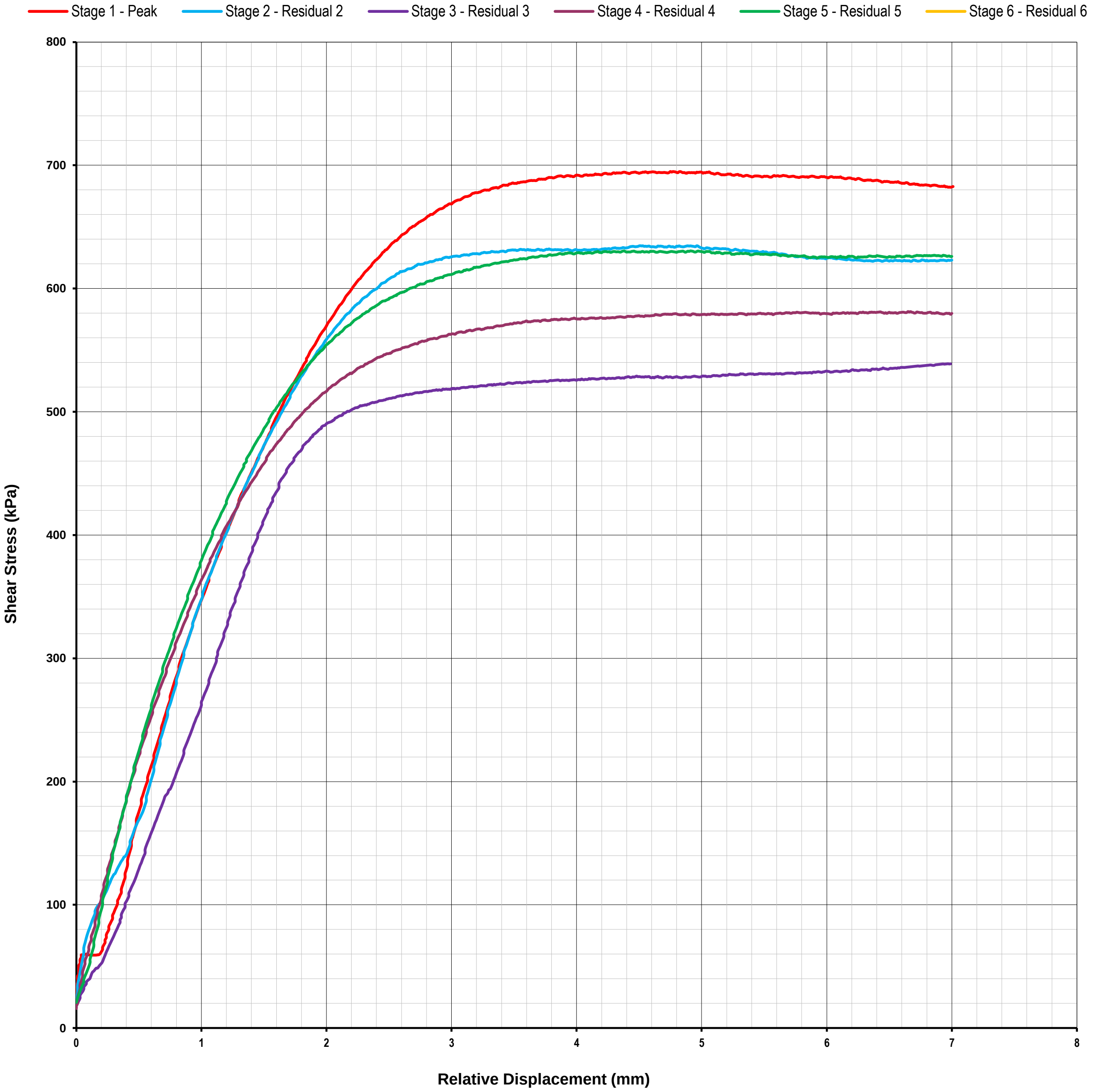
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Shear Stress/Relative Displacement Plot



Notes/Remarks:

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Graph not to scale

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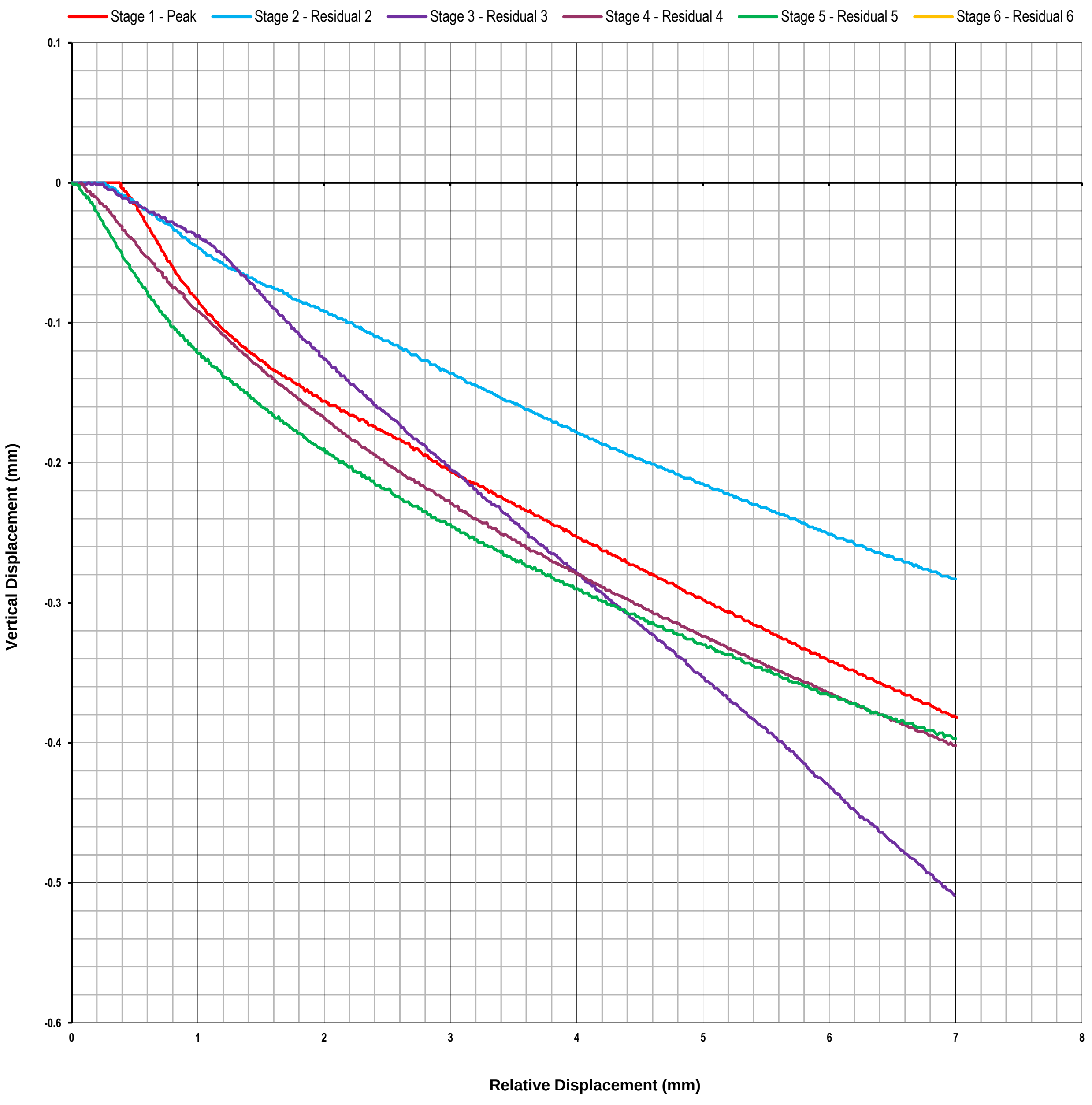
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Vertical Displacement/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on circular sample equation.

Graph not to scale

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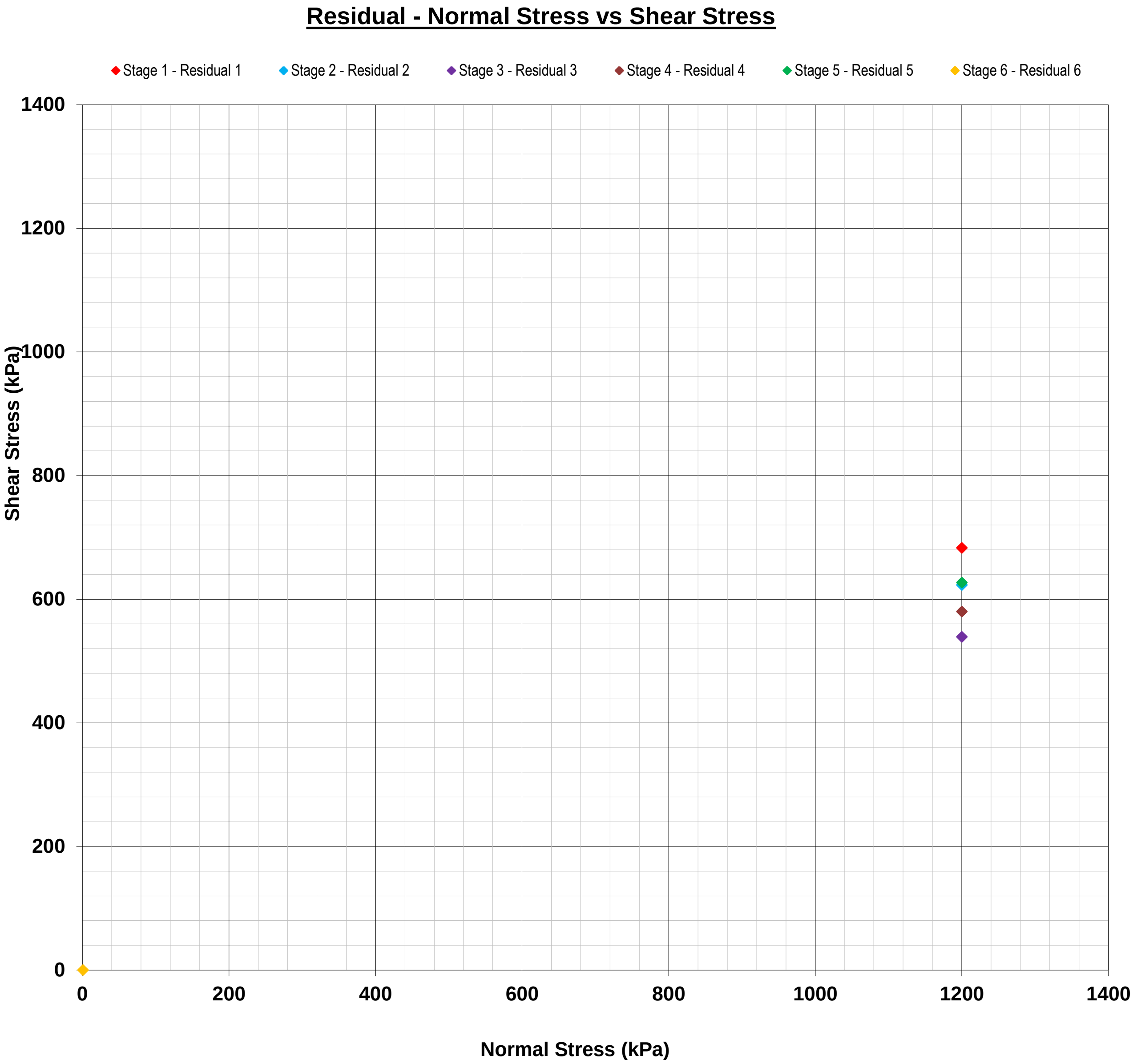
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS
Failure Criteria	**Residual @ 7 , 7 , 7 , 7 mm Displacement**		



Notes/Remarks:

Photo not to scale

Sample/s supplied by the client

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Tested at Trilab Brisbane Laboratory

Authorised Signatory

C. Purvis

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Laboratory No. 9926

Soil Rock Calibration

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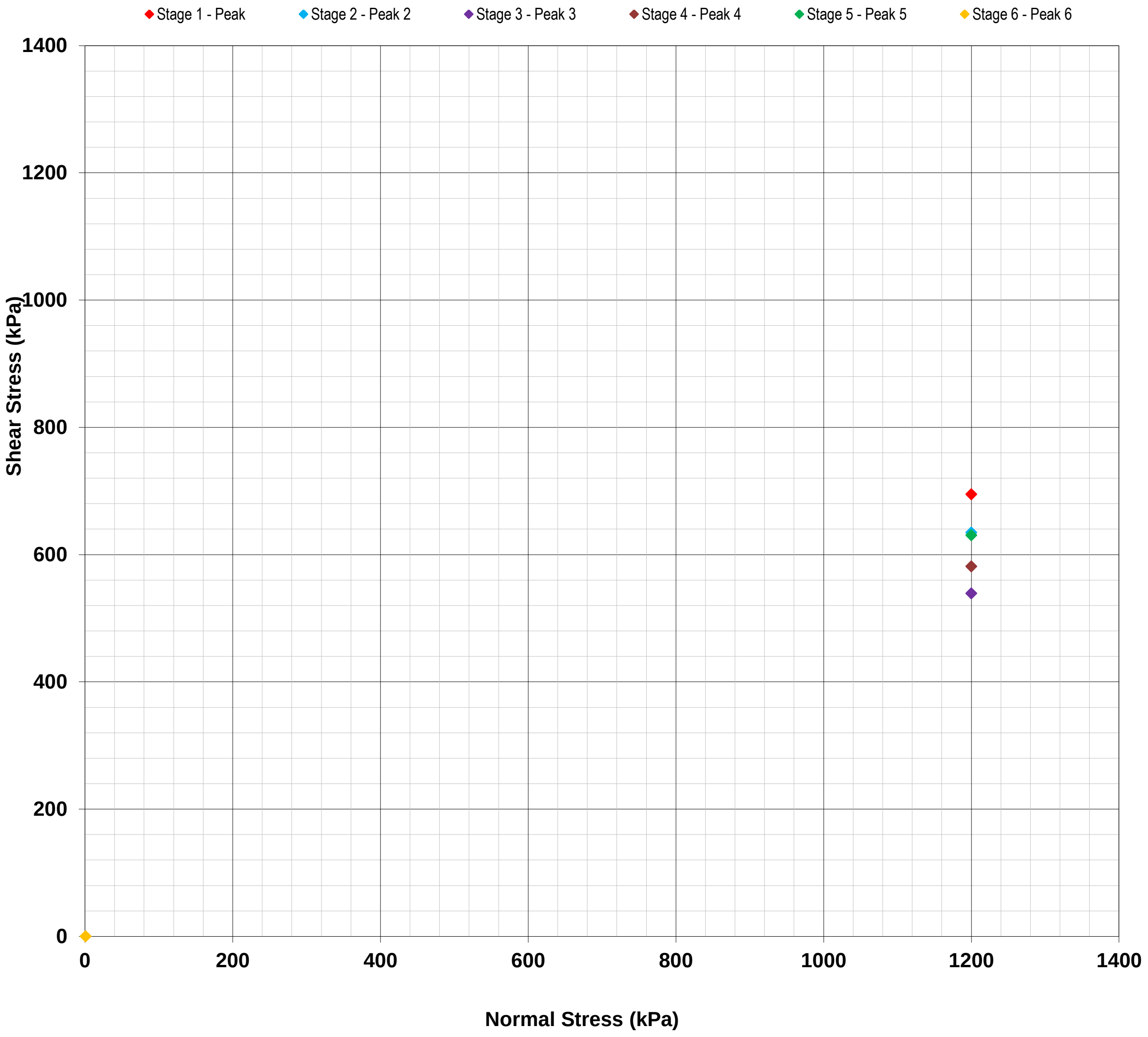
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Failure Criteria **Peak**

Peak - Normal Stress vs Shear Stress



Notes/Remarks:

Graph not to scale

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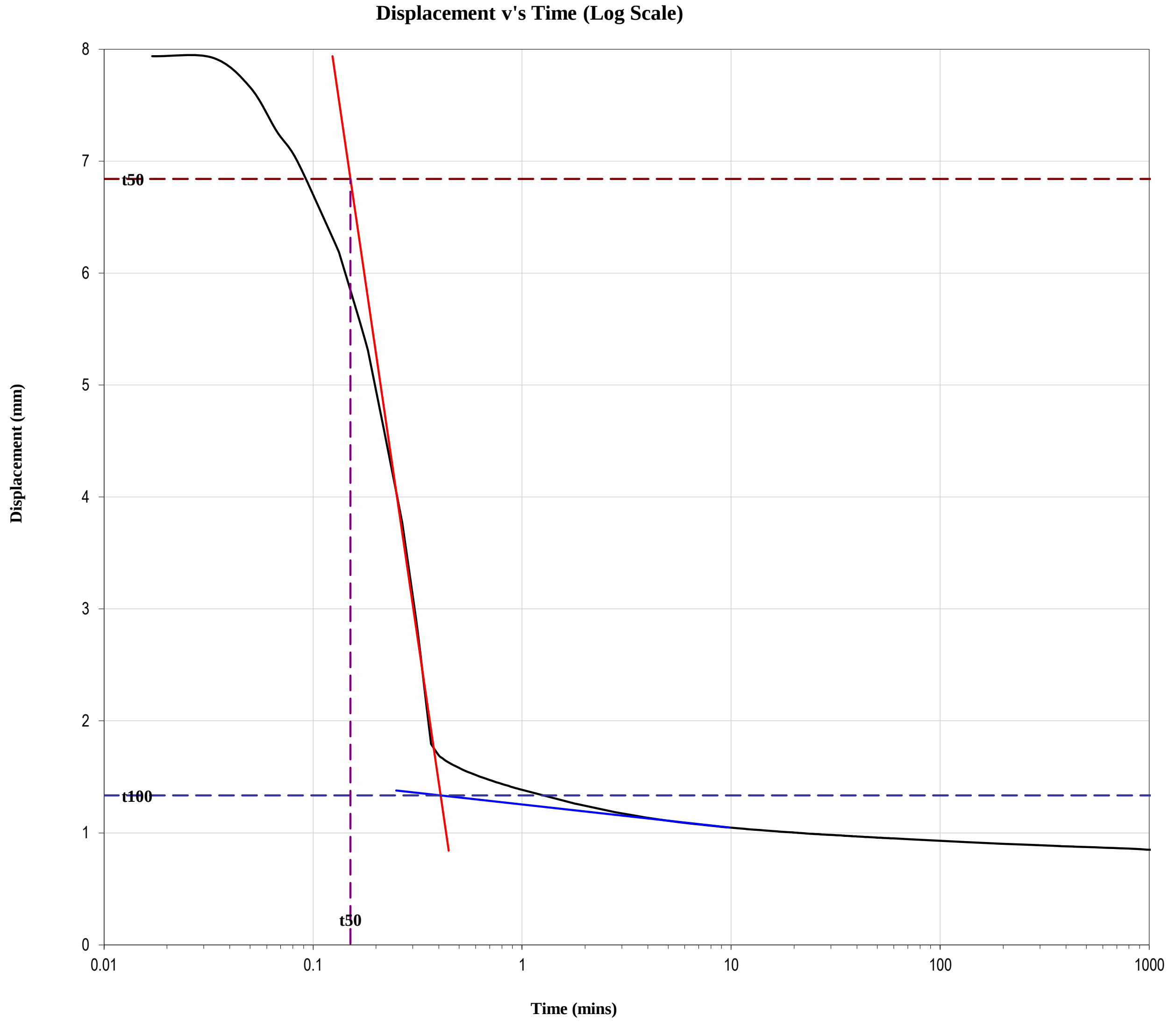
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Stage 1 Consolidation



t_{50}	0.15	mins
t_{100}	0.41	mins
Time to Failure =	342.04	mins
Estimated Displacement to Failure =	5	mm
Displacement Rate =	0.01462	mm/min

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	18060849- DS

Before and After Photos

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119A- DS
		Workorder No	0005507
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	8/02/2019
		Report Date	28/02/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - L2B	**Depth (m)**	24.50-25.00
Description	SILTY CLAY - brown	**Sample Type**	Single individual soil specimen - Remoulded.

SAMPLE DETAILS

Specimen Condition	Inundated
Specimen Dimensions (mm)	60*60
Rate of Strain (mm/min)	0.008
Initial Moisture Content (%)	34.2
Initial Wet Density(t/m^3)	1.87

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	6.00	500.2	272.5	500.2	276.3
Stage 2 - Residual 2	6.00	500.2	240.3	500.2	254.9
Stage 3 - Residual 3	6.00	500.2	195.9	500.2	196.1
Stage 4 - Residual 4	6.00	500.2	186.3	500.2	189.5
Stage 5 - Residual 5	6.00	500.2	178.5	500.2	183.6
Stage 6 - Residual 6	6.00	500.2	186.6	500.2	186.8

Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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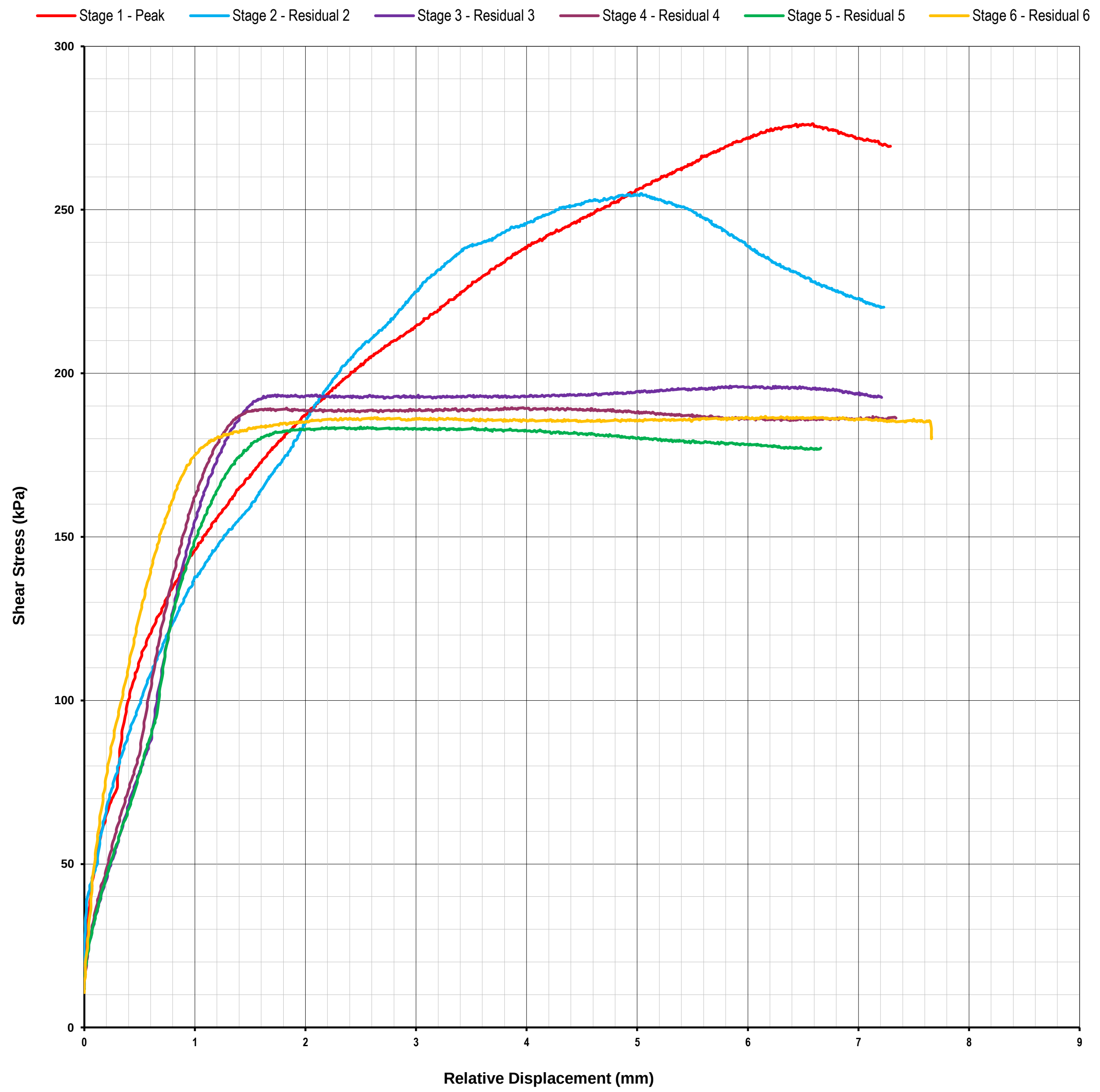
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119A- DS

Shear Stress/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

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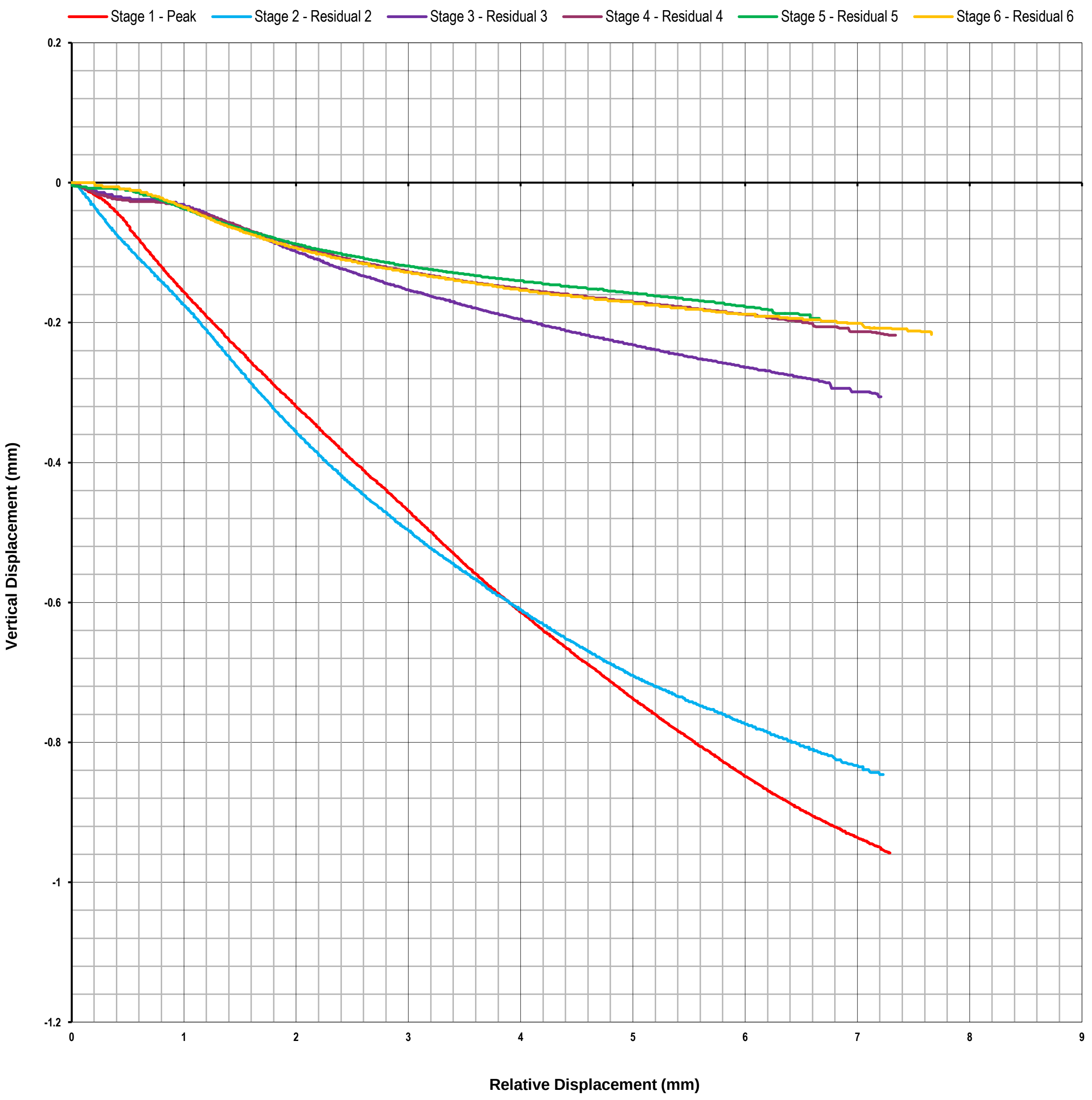
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119A- DS

Vertical Displacement/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

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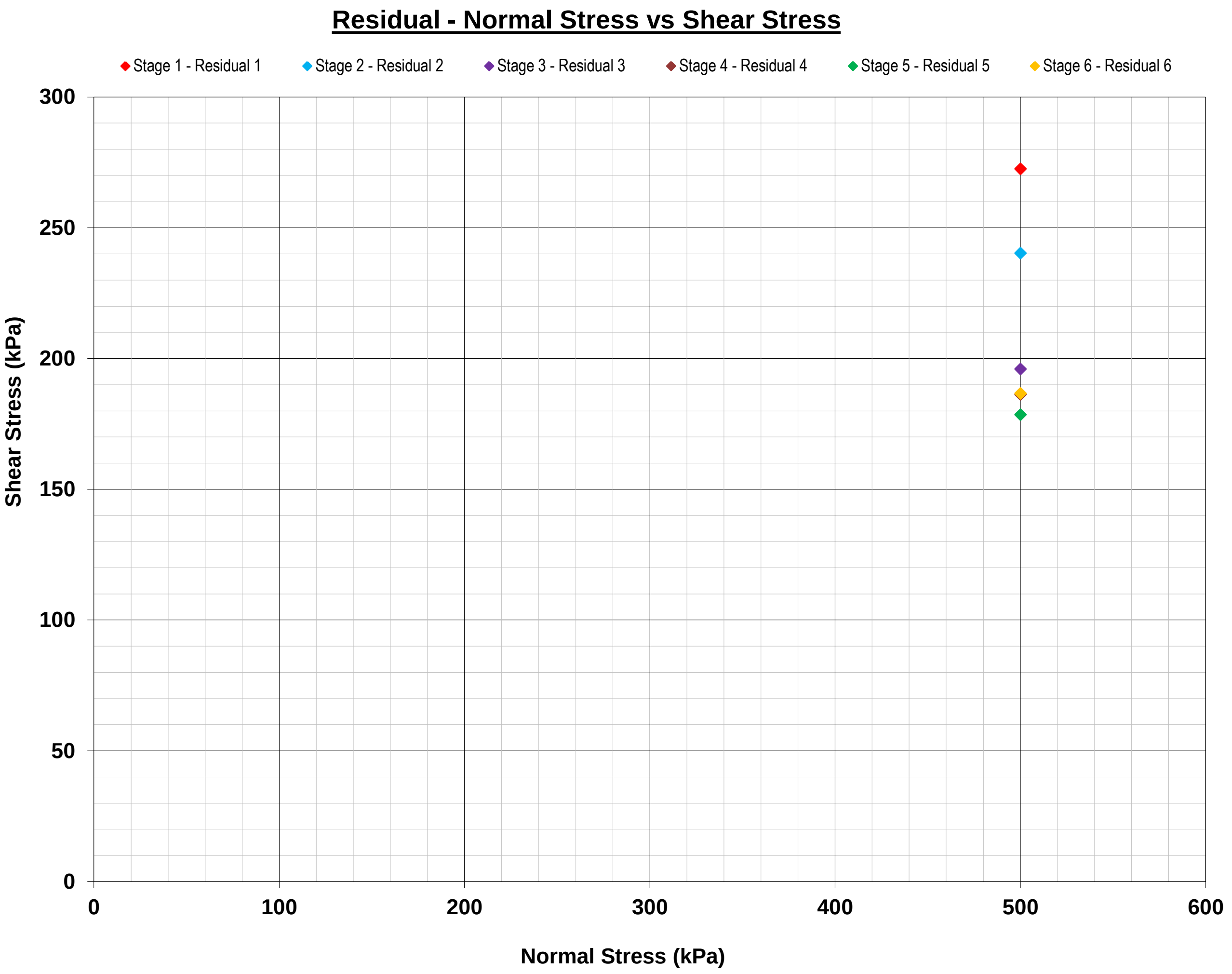
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119A- DS

Failure Criteria **Residual @ 6 , 6 , 6 , 6 mm Displacement**



Notes/Remarks:

Photo not to scale

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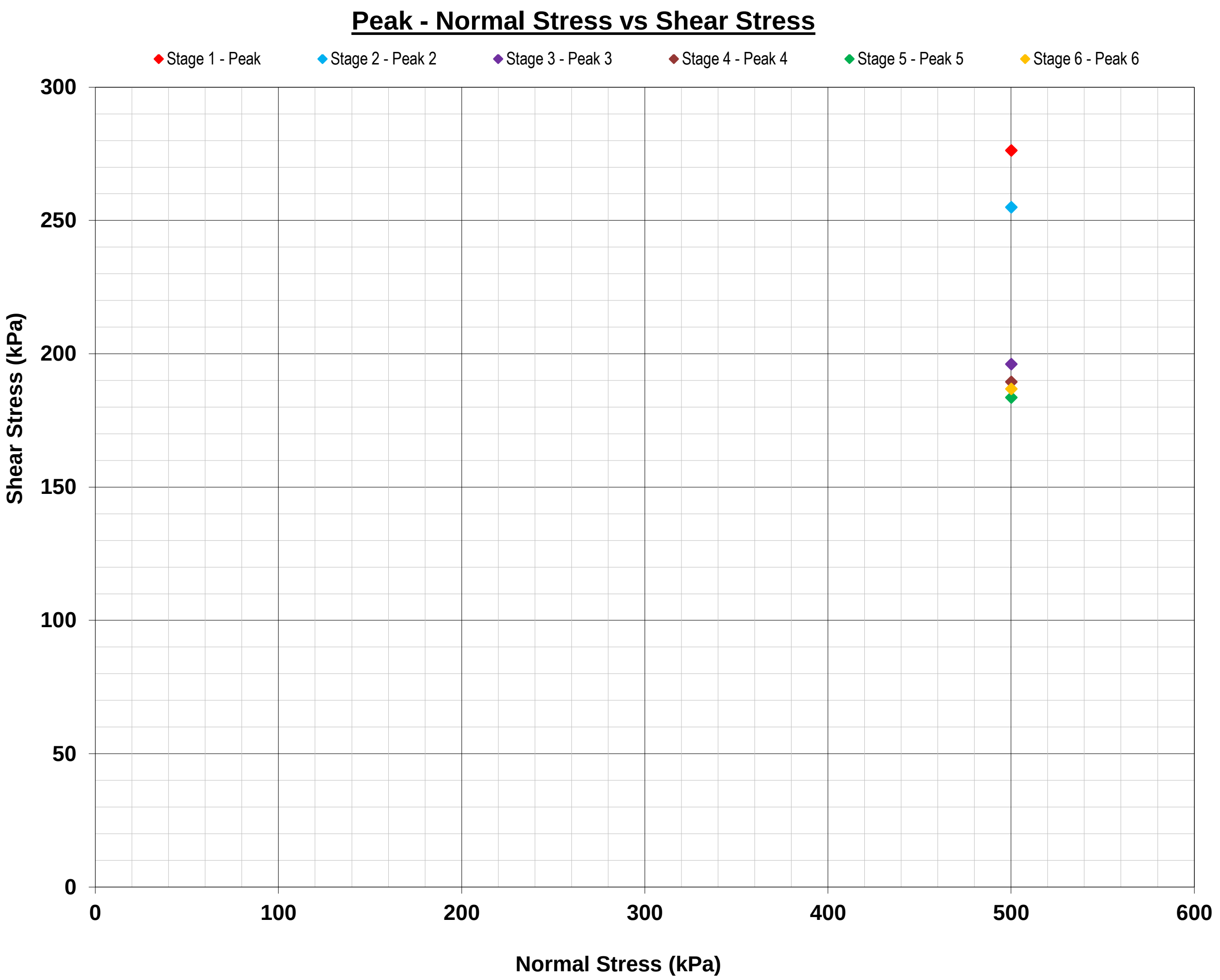
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119A- DS
Failure Criteria		**Peak**	



Notes/Remarks:

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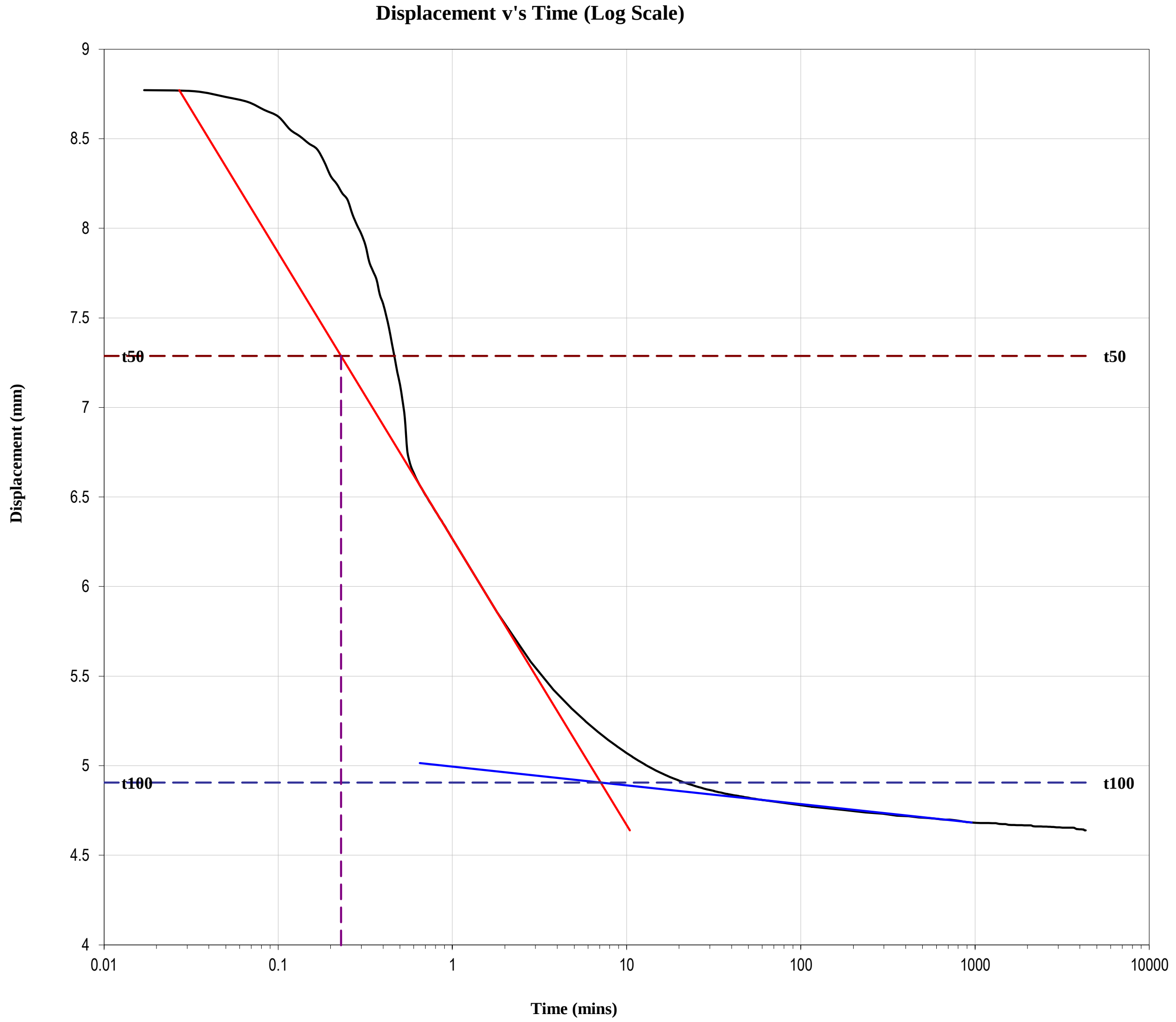
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119A- DS

Stage 1 Consolidation



t_{50}	0.23	mins
t_{100}	7.10	mins
Time to Failure =	364.37	mins
Estimated Displacement to Failure =	5	mm
Displacement Rate =	0.01372	mm/min

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119A- DS

Before and After Photos

Notes/Remarks:

Graph not to scale | Sample/s supplied by the client | REP07301

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119B- DS
		Workorder No	0005507
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	8/02/2019
		Report Date	28/02/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - L2B	**Depth (m)**	24.50-25.00
Description	SILTY CLAY - yellow/brown	**Sample Type**	Single individual soil specimen - Remoulded.

SAMPLE DETAILS

Specimen Condition	Inundated
Specimen Dimensions (mm)	60*60
Rate of Strain (mm/min)	0.008
Initial Moisture Content (%)	34.2
Initial Wet Density(t/m^3)	1.87

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	6.00	800.1	393.1	800.1	396.0
Stage 2 - Residual 2	6.00	800.1	310.0	800.1	366.3
Stage 3 - Residual 3	6.00	800.1	242.5	800.1	309.8
Stage 4 - Residual 4	6.00	800.1	231.7	800.1	273.6
Stage 5 - Residual 5	6.00	800.1	219.6	800.1	257.0
Stage 6 - Residual 6	6.00	800.1	227.9	800.1	248.1

Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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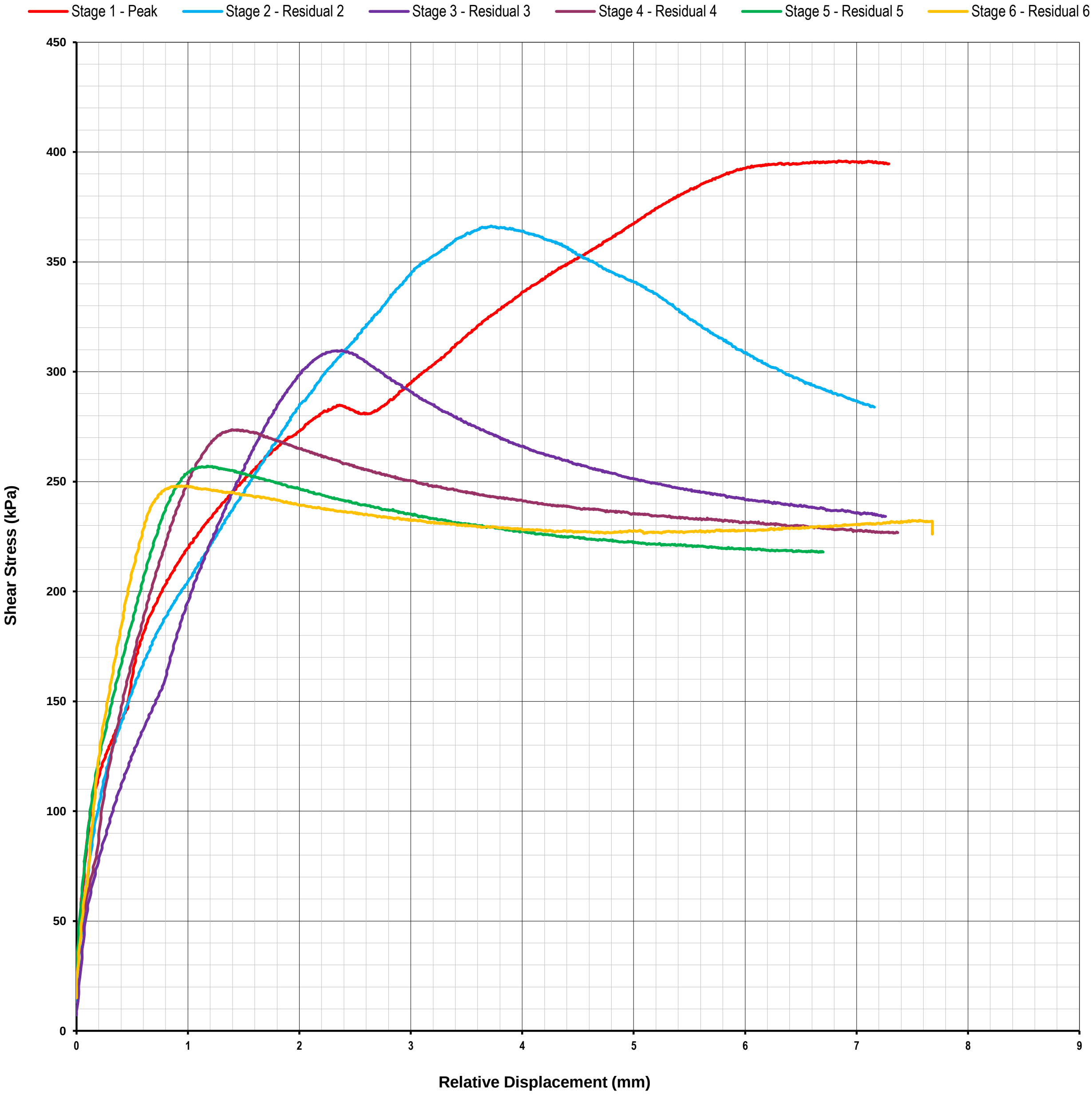
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119B- DS

Shear Stress/Relative Displacement Plot



Notes/Remarks:

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Graph not to scale

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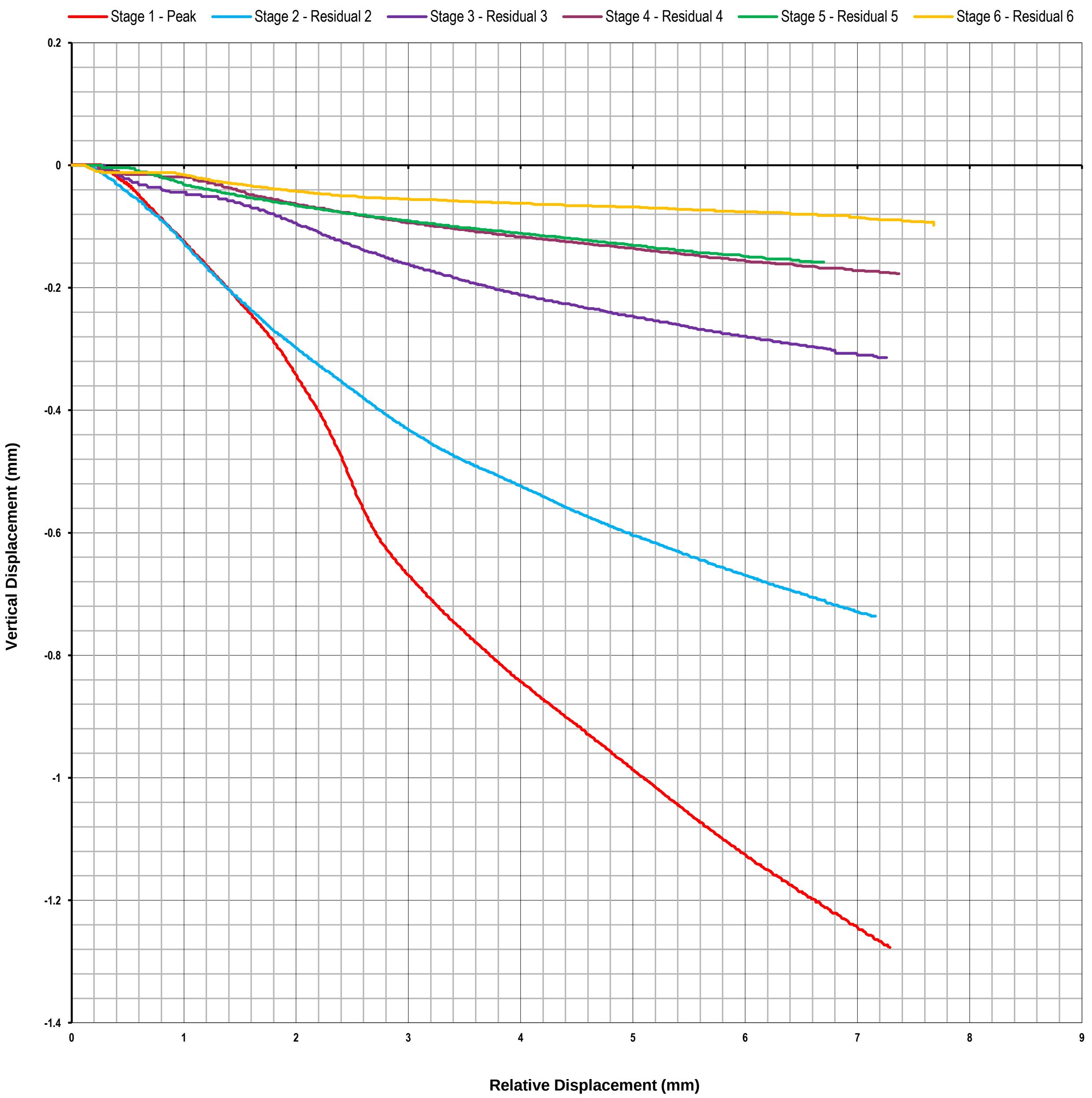
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119B- DS

Vertical Displacement/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

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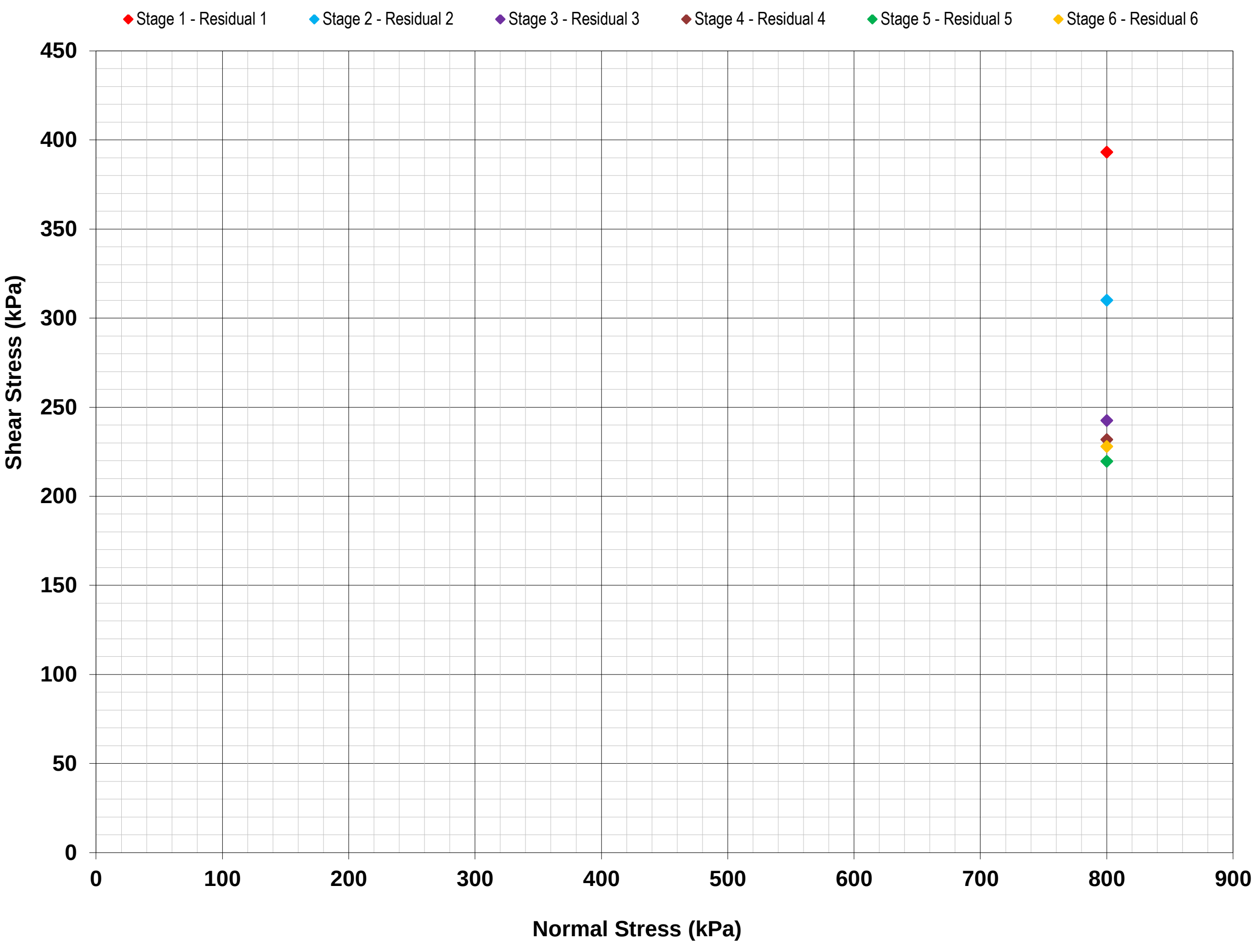
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119B- DS

Failure Criteria **Residual @ 6 , 6 , 6 , 6 mm Displacement**

Residual - Normal Stress vs Shear Stress



Notes/Remarks:

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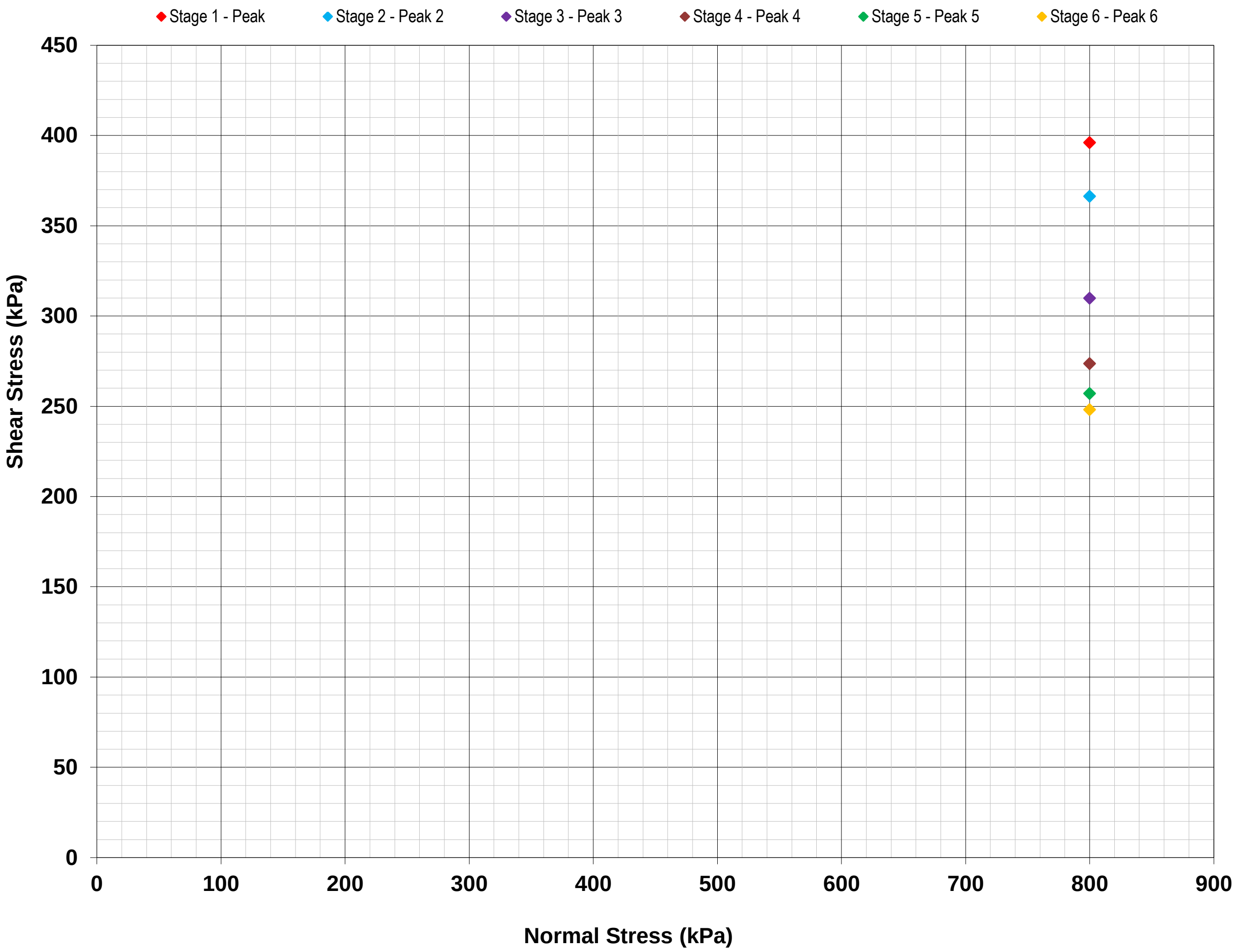
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119B- DS
Failure Criteria		**Peak**	

Peak - Normal Stress vs Shear Stress



Notes/Remarks:

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ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

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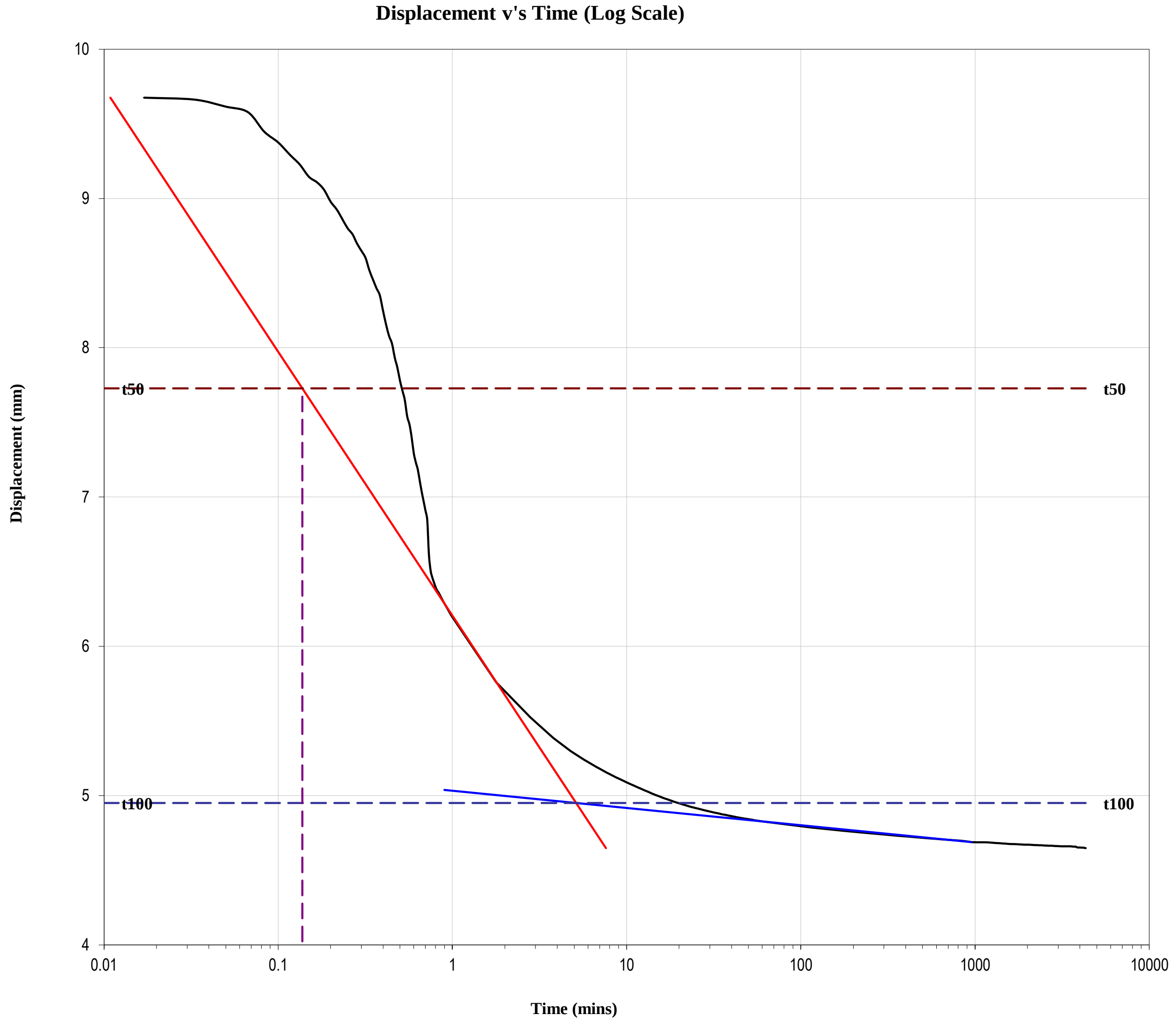
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119B- DS

Stage 1 Consolidation

Displacement v's Time (Log Scale)



t_{50}	0.14	mins
t_{100}	5.13	mins
Time to Failure =	386.38	mins
Estimated Displacement to Failure =	5	mm
Displacement Rate =	0.01294	mm/min

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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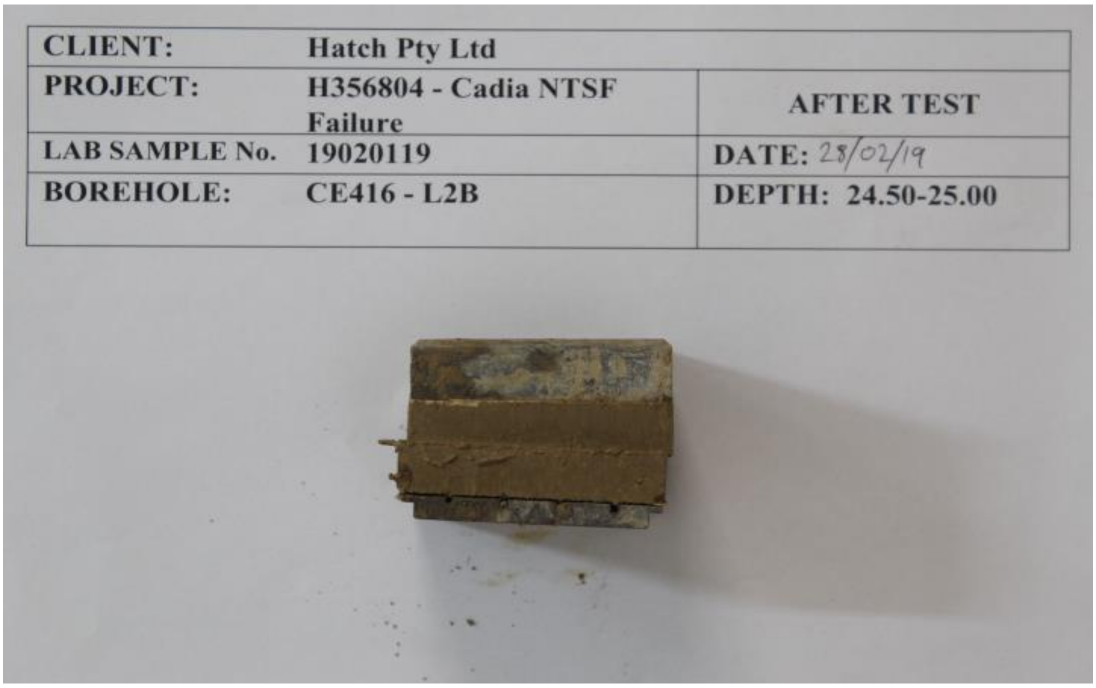
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119B- DS

Before and After Photos



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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119C- DS
		Workorder No	0005507
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	8/02/2019
		Report Date	28/02/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - L2B	**Depth (m)**	24.50-25.00
Description	SILTY CLAY - yellow/brown	**Sample Type**	Single individual soil specimen - Remoulded.

SAMPLE DETAILS

Specimen Condition	Inundated
Specimen Dimensions (mm)	60*60
Rate of Strain (mm/min)	0.008
Initial Moisture Content (%)	34.2
Initial Wet Density(t/m^3)	1.87

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	6.00	1200.0	301.6	1200.0	397.9
Stage 2 - Residual 2	6.00	1200.0	354.6	1200.0	471.5
Stage 3 - Residual 3	6.00	1200.0	348.7	1200.0	363.2
Stage 4 - Residual 4	6.00	1200.0	368.2	1200.0	368.6
Stage 5 - Residual 5	6.00	1200.0	361.8	1200.0	367.2
Stage 6 - Residual 6	-	-	-	-	-

Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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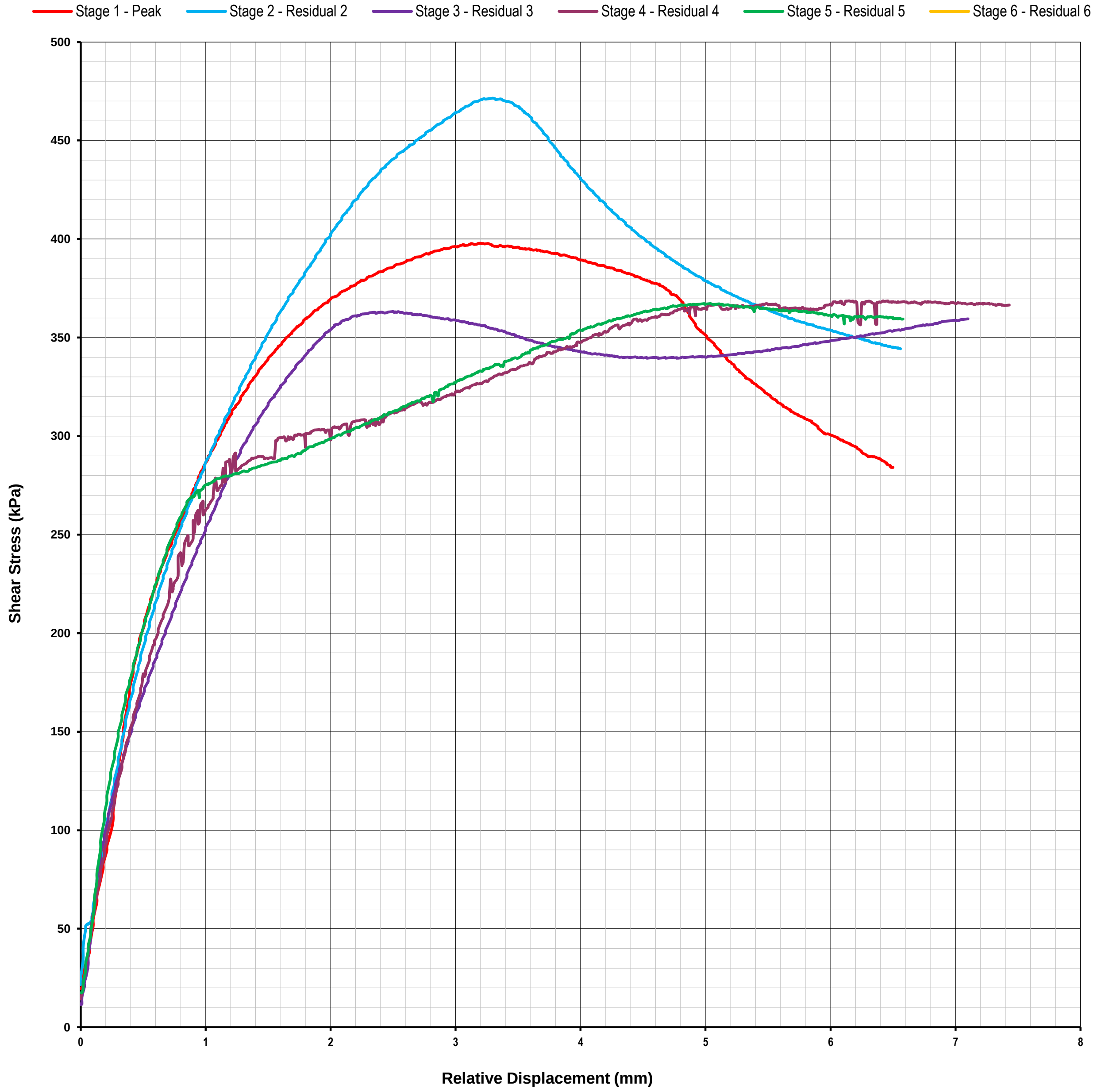
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119C- DS

Shear Stress/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

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Laboratory No. 9926

Trilab
Soil Rock Calibration

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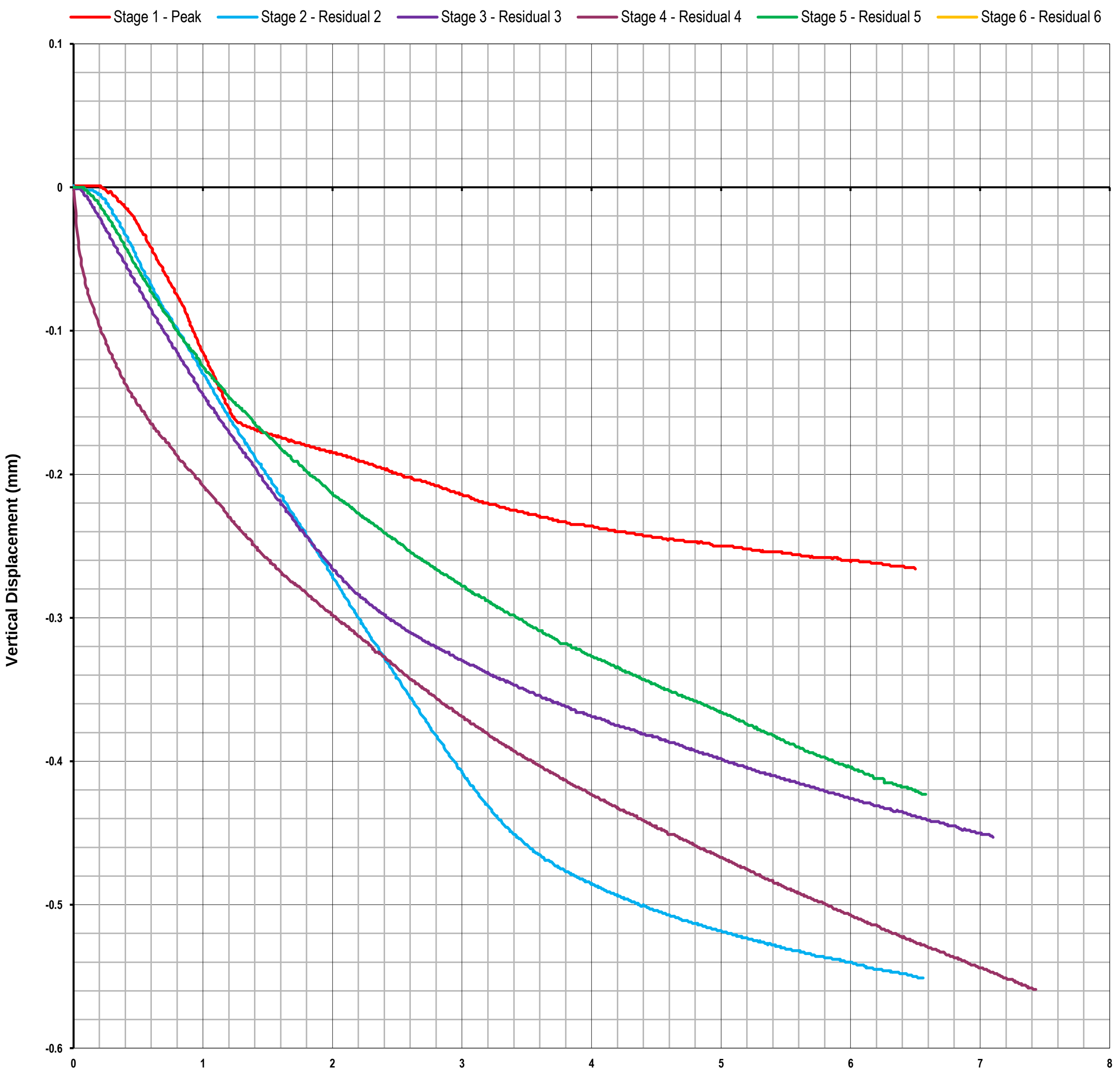
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119C- DS

Vertical Displacement/Relative Displacement Plot



Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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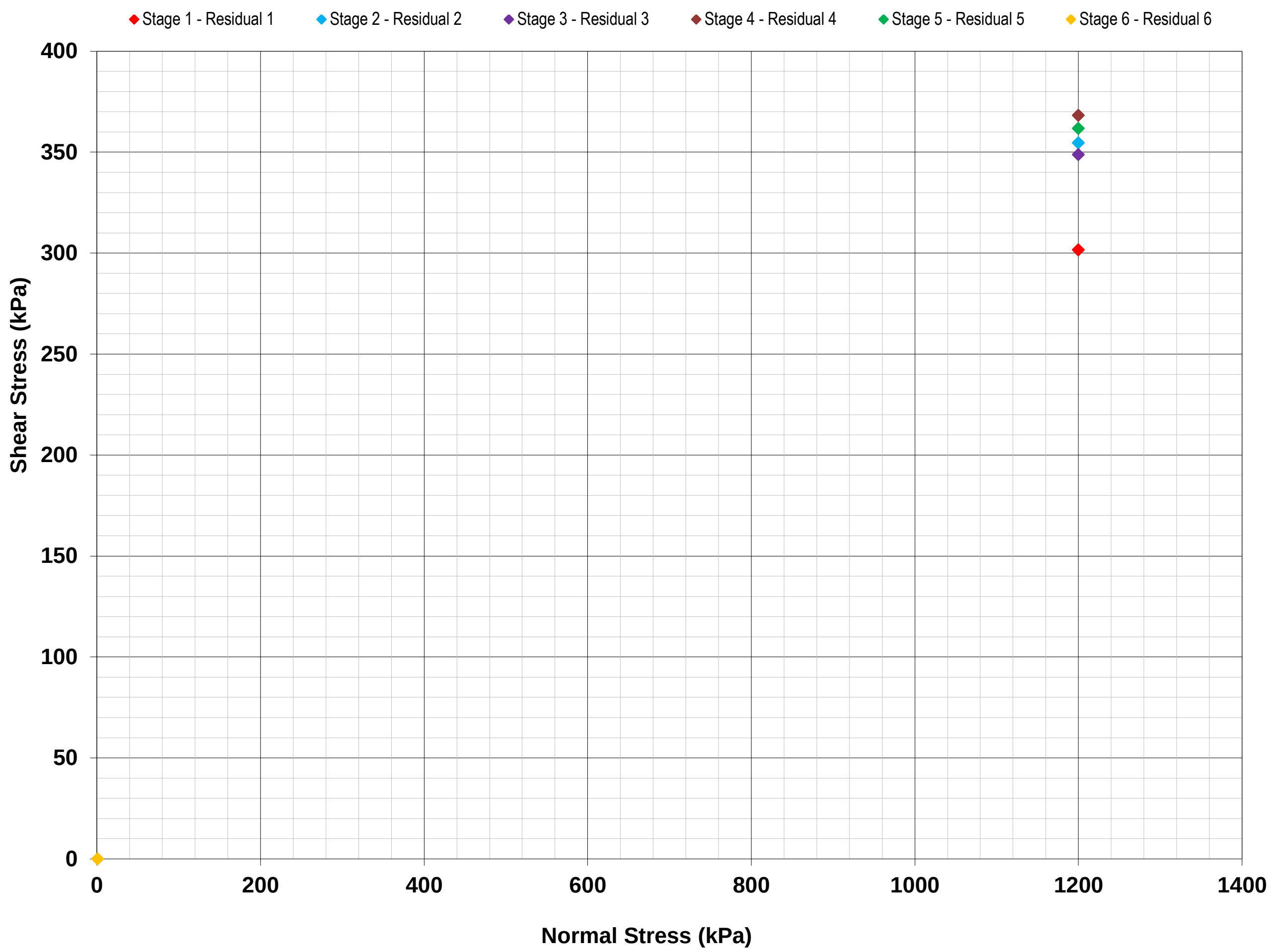
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119C- DS

Failure Criteria **Residual @ 6 , 6 , 6 , 6 mm Displacement**

Residual - Normal Stress vs Shear Stress



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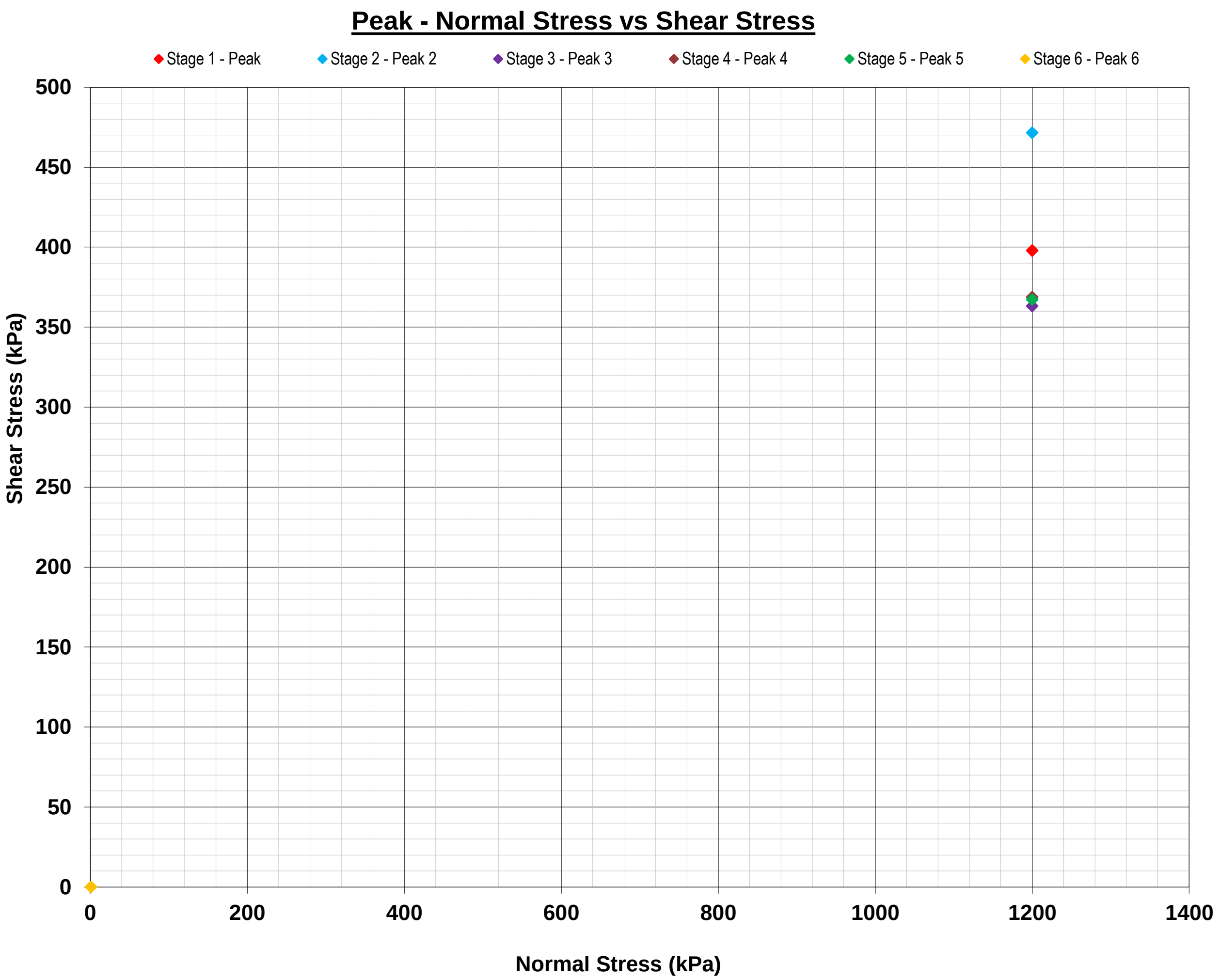
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119C- DS
Failure Criteria		**Peak**	



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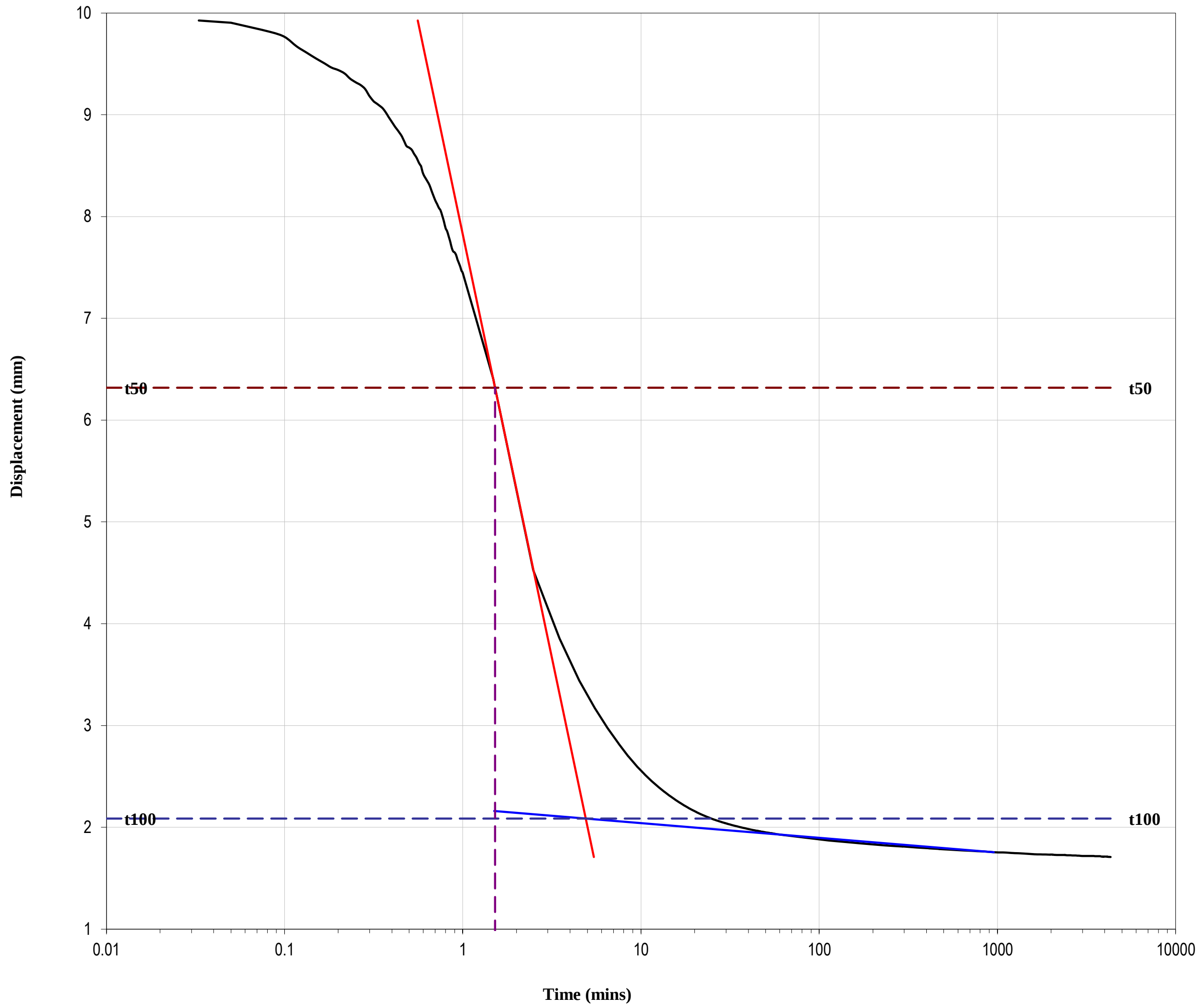
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119C- DS

Stage 1 Consolidation

Displacement v's Time (Log Scale)



t_{50}	1.52	mins
t_{100}	4.90	mins
Time to Failure =	315.92	mins
Estimated Displacement to Failure =	5	mm
Displacement Rate =	0.01583	mm/min

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119C- DS

Before and After Photos

Notes/Remarks:

Graph not to scale   Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119D- DS
		Workorder No	0005507
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	4/03/2019
		Report Date	13/03/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - L2B	**Depth (m)**	24.50-25.00
Description	SILTY CLAY - brown	**Sample Type**	Single individual soil specimen - Remoulded as requested by the client.

SAMPLE DETAILS

Specimen Condition	As Received
Specimen Dimensions (mm)	60*60
Rate of Strain (mm/min)	0.008
Initial Moisture Content (%)	33.9
Initial Wet Density(t/m^3)	1.88

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	7.50	500.0	228.7	500.0	254.6
Stage 2 - Residual 2	7.50	500.0	156.6	500.0	167.7
Stage 3 - Residual 3	7.50	500.0	140.6	500.0	140.6
Stage 4 - Residual 4	7.50	500.0	134.3	500.0	134.3
Stage 5 - Residual 5	-	-	-	-	-
Stage 6 - Residual 6	-	-	-	-	-

Notes/Remarks: **Maximum particle size tested -75 micron.**
Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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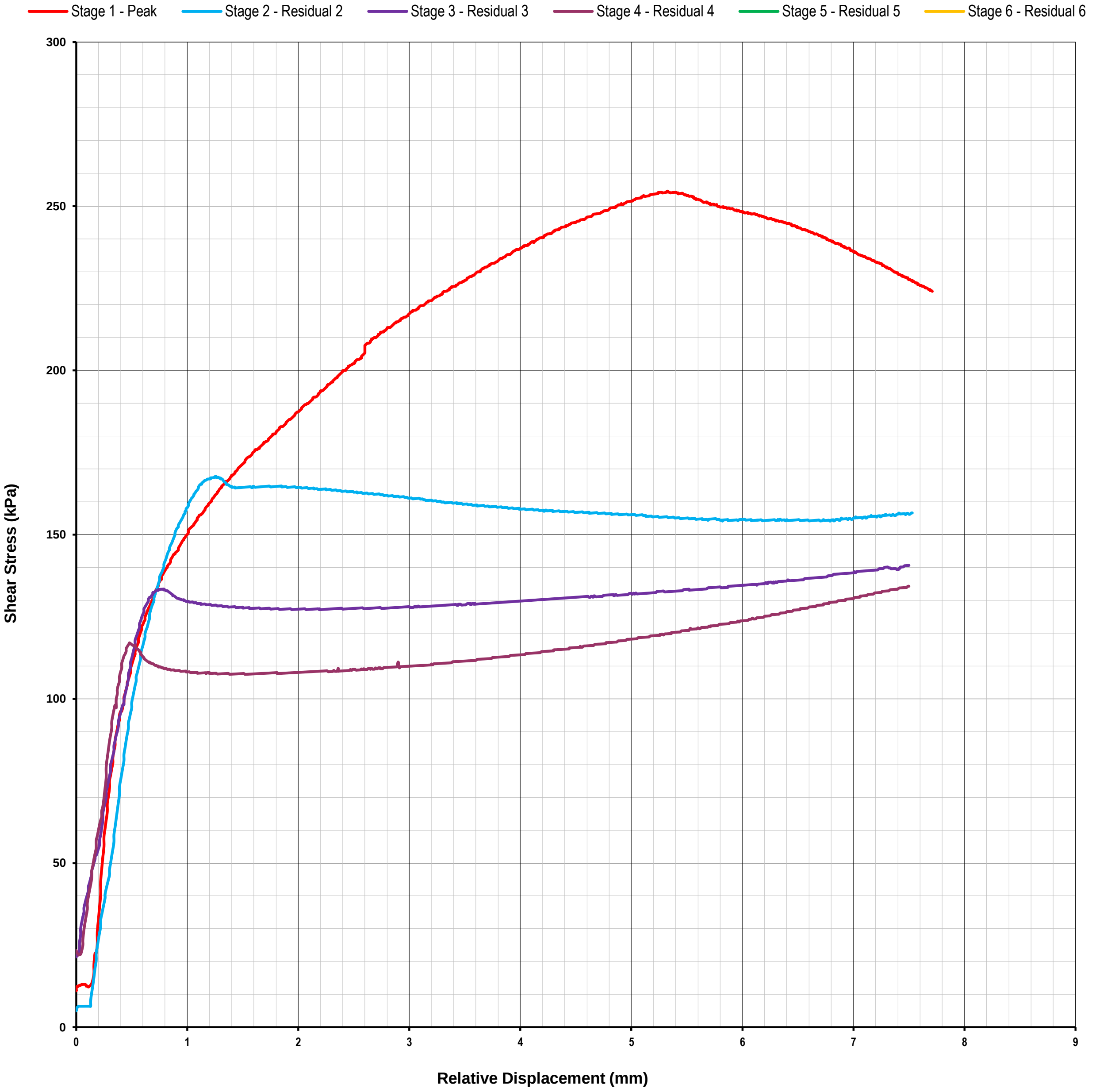
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119D- DS

Shear Stress/Relative Displacement Plot



Notes/Remarks: **Maximum particle size tested -75 micron.**

Note: Area correction based on square sample equation.

Graph not to scale

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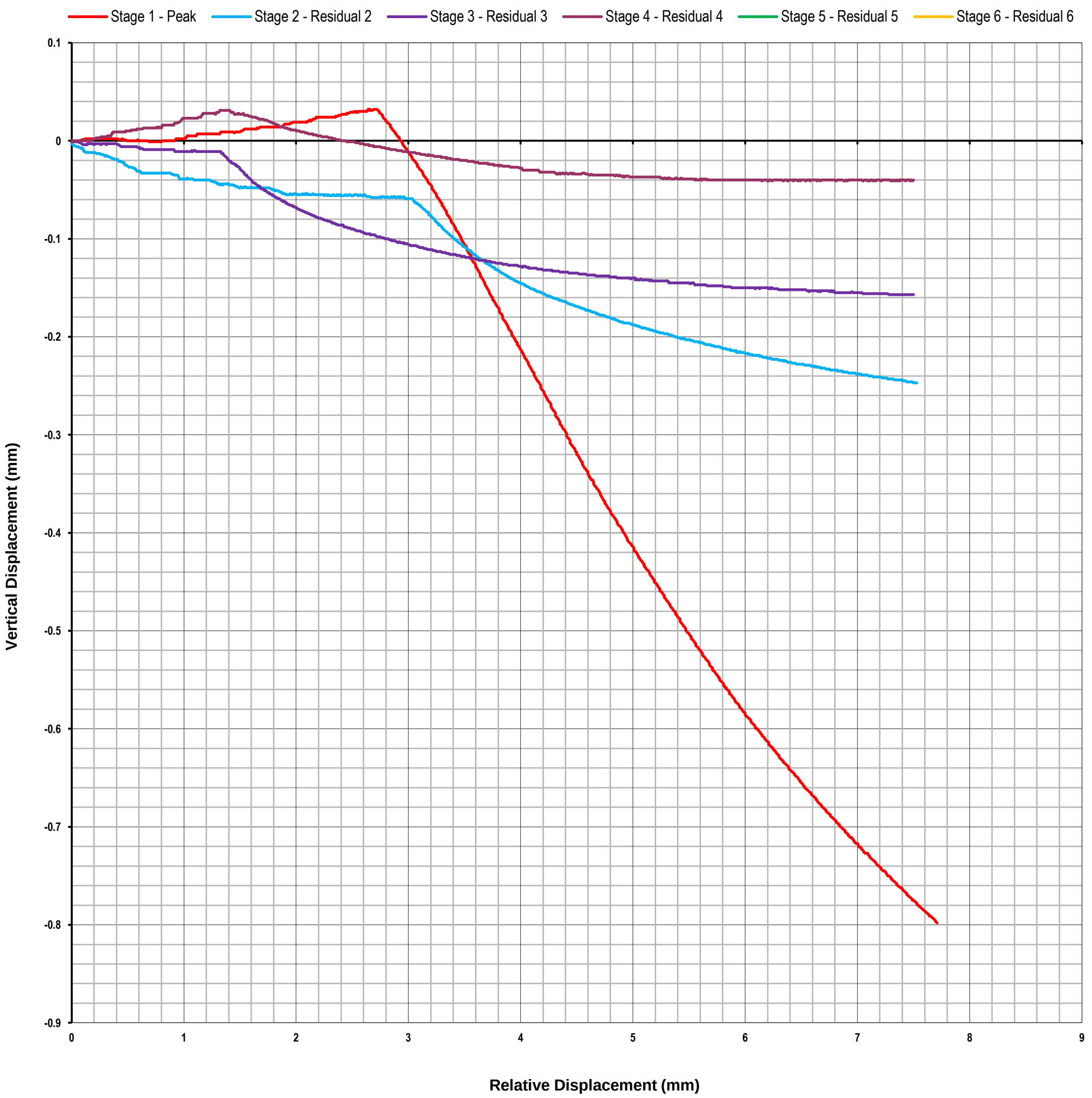
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119D- DS

Vertical Displacement/Relative Displacement Plot



Notes/Remarks: **Maximum particle size tested -75 micron.**

Note: Area correction based on square sample equation.

Graph not to scale

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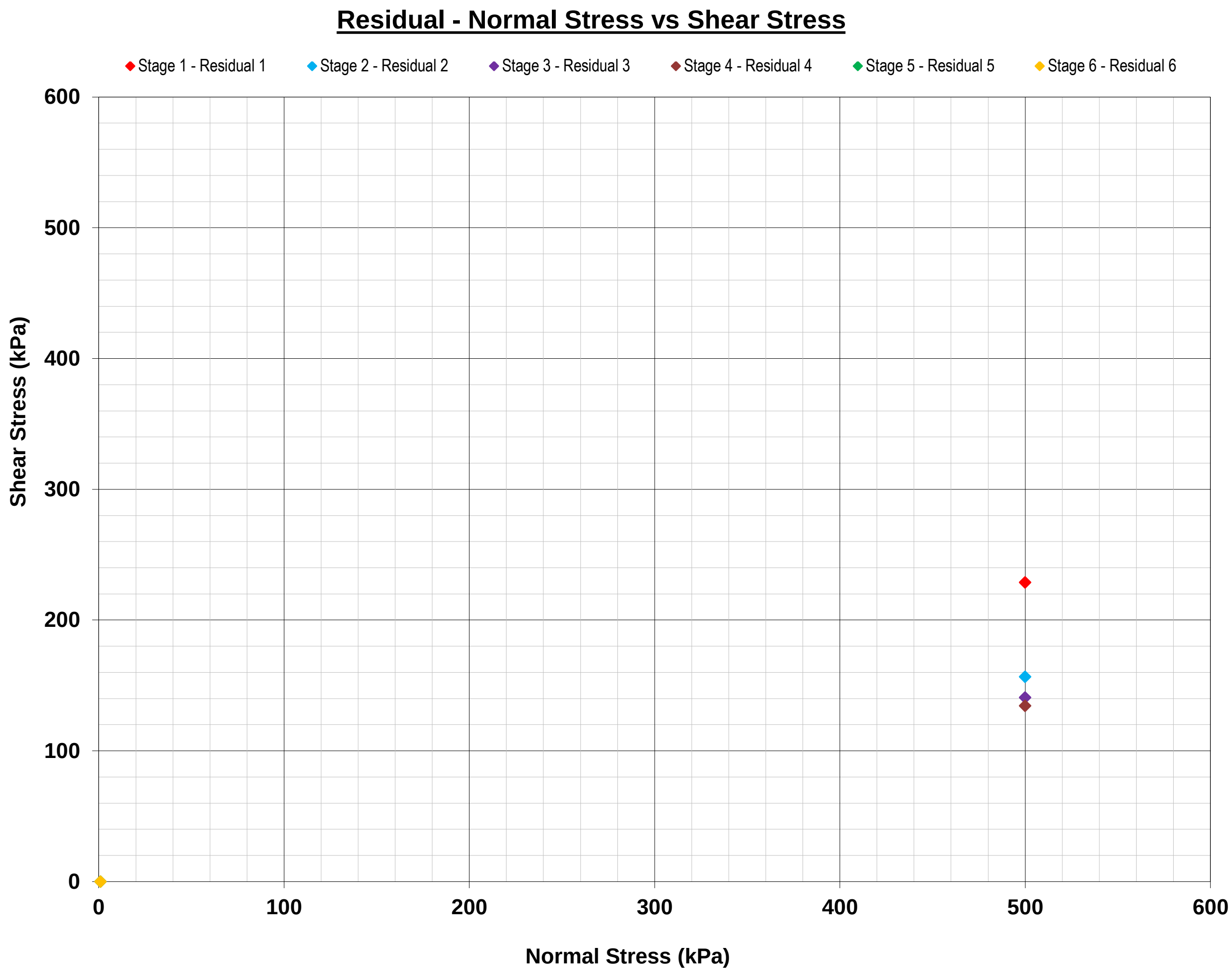
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119D- DS

Failure Criteria **Residual @ 7.5 , 7.5 , 7.5 , 7.5 mm Displacement**



Notes/Remarks:

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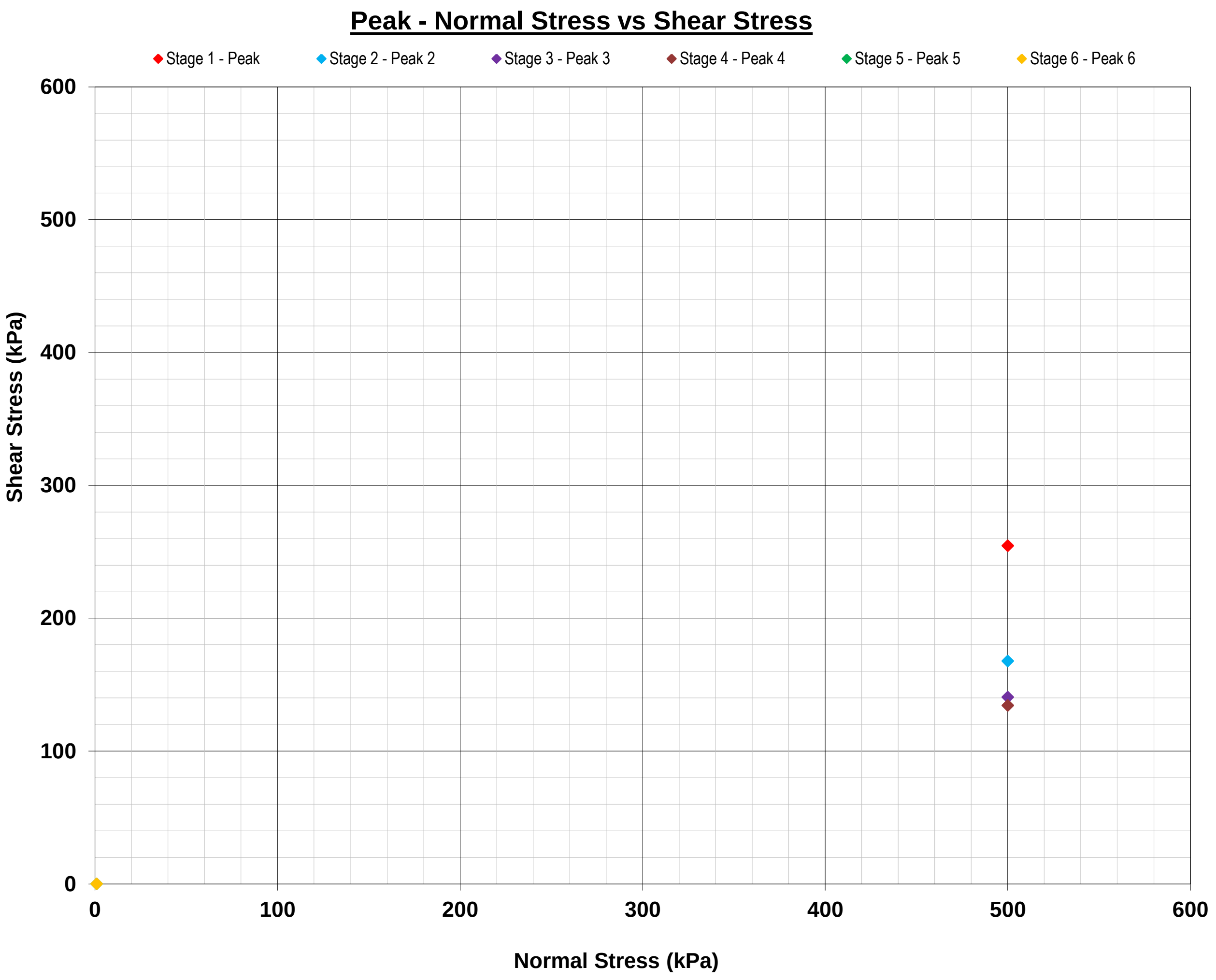
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119D- DS
Failure Criteria		**Peak**	



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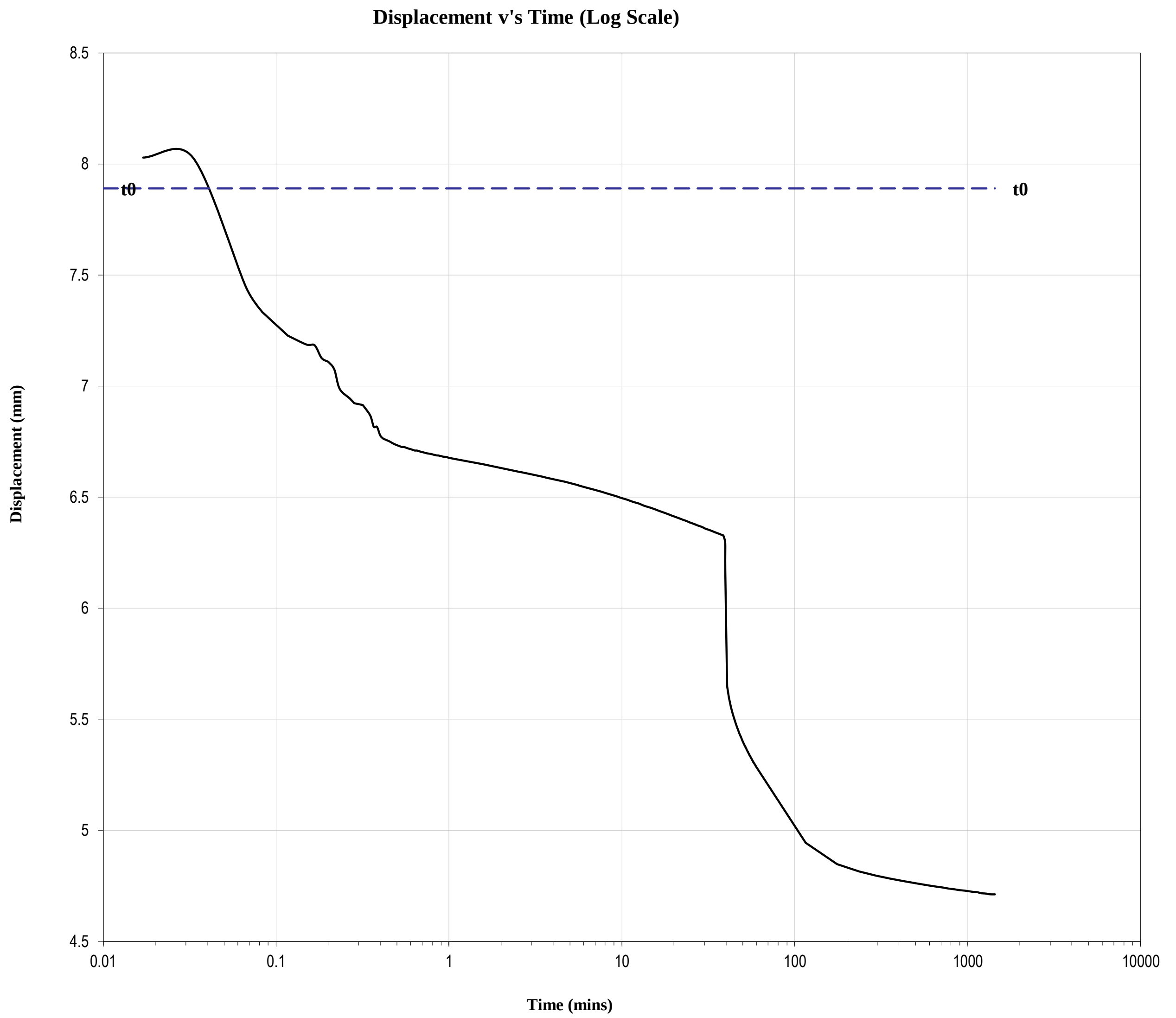
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119D- DS

Stage 1 Consolidation



Notes/Remarks:

Graph not to scale

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119D- DS

Before and After Photos

Notes/Remarks:

Graph not to scale

Sample/s supplied by the client

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DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119E- DS
		Workorder No	0005507
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date**	20/02/2019
		Report Date	13/03/2019
Project	H356804 - Cadia NTSF Failure		
Client ID	CE416 - L2B	**Depth (m)**	24.50-25.00
Description	SILTY CLAY - yellow/brown	**Sample Type**	Single individual soil specimen - Remoulded as requested by the client.

SAMPLE DETAILS

Specimen Condition	Inundated
Specimen Dimensions (mm)	60*60
Rate of Strain (mm/min)	0.008
Initial Moisture Content (%)	34.2
Initial Wet Density(t/m^3)	1.87

RESULTS OF TESTING

	RESIDUAL RESULTS			PEAK RESULTS	
Test Stage	**Residual Displacement (mm)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**	**Normal Stress (kPa)**	**Corrected Shear Stress (kPa)**
Stage 1 - Peak	6.00	1200.0	548.8	1200.0	552.0
Stage 2 - Residual 2	6.00	1200.0	341.4	1200.0	428.6
Stage 3 - Residual 3	6.00	1200.0	399.7	1200.0	400.6
Stage 4 - Residual 4	-	-	-	-	-
Stage 5 - Residual 5	-	-	-	-	-
Stage 6 - Residual 6	-	-	-	-	-

Notes/Remarks:

Note: Area correction based on square sample equation.

Graph not to scale

Sample/s supplied by the client

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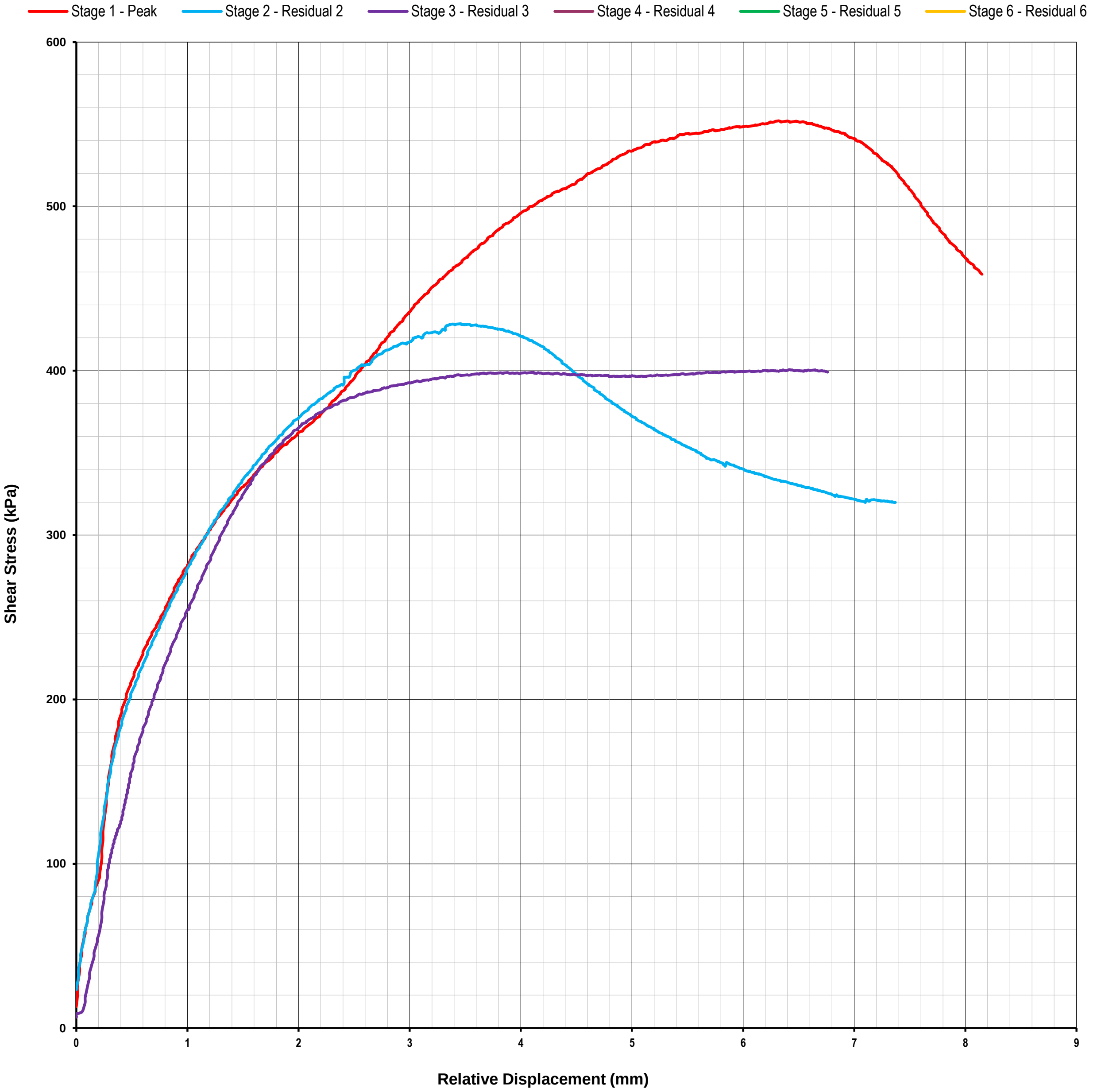
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119E- DS

Shear Stress/Relative Displacement Plot



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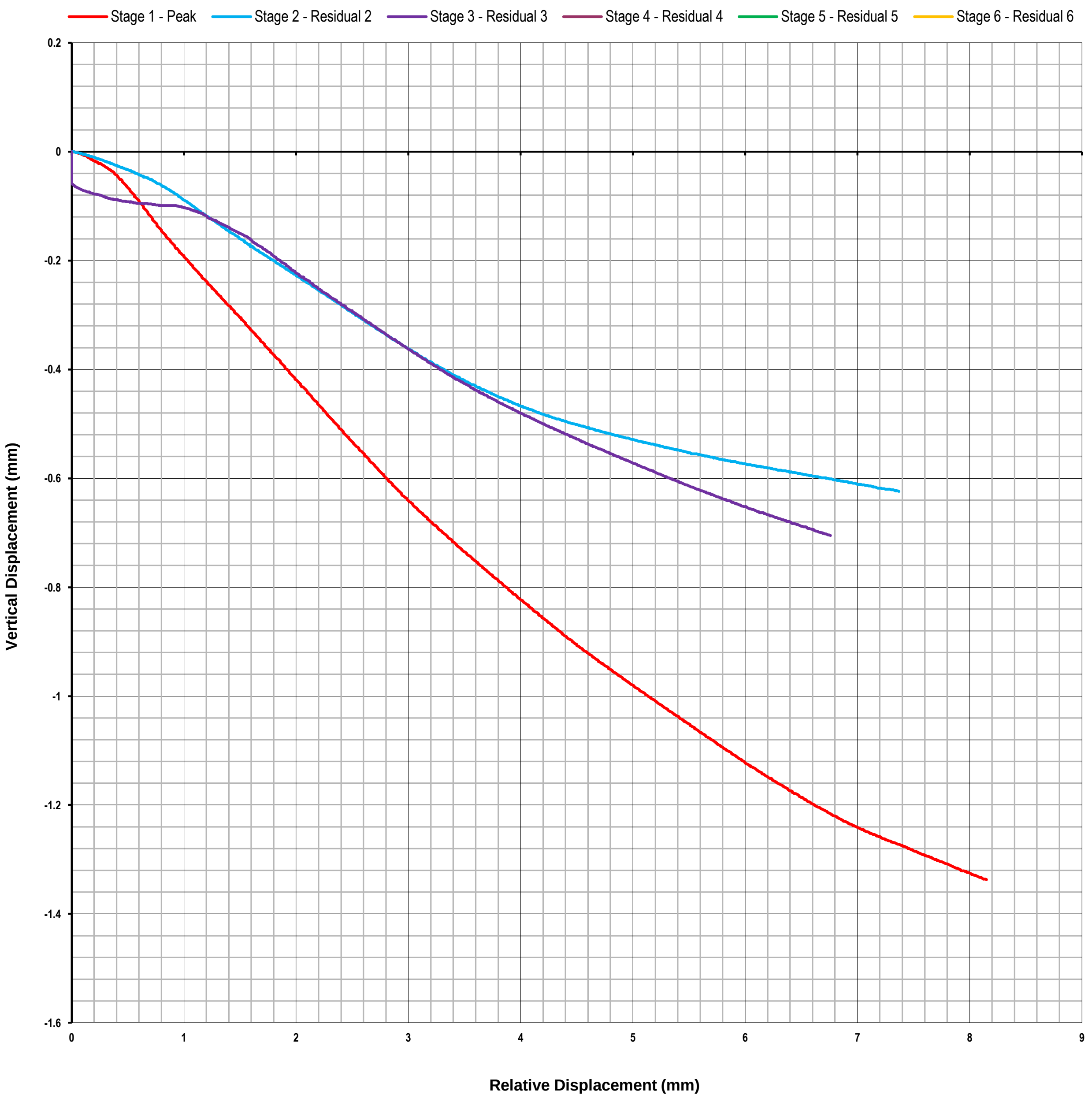
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119E- DS

Vertical Displacement/Relative Displacement Plot



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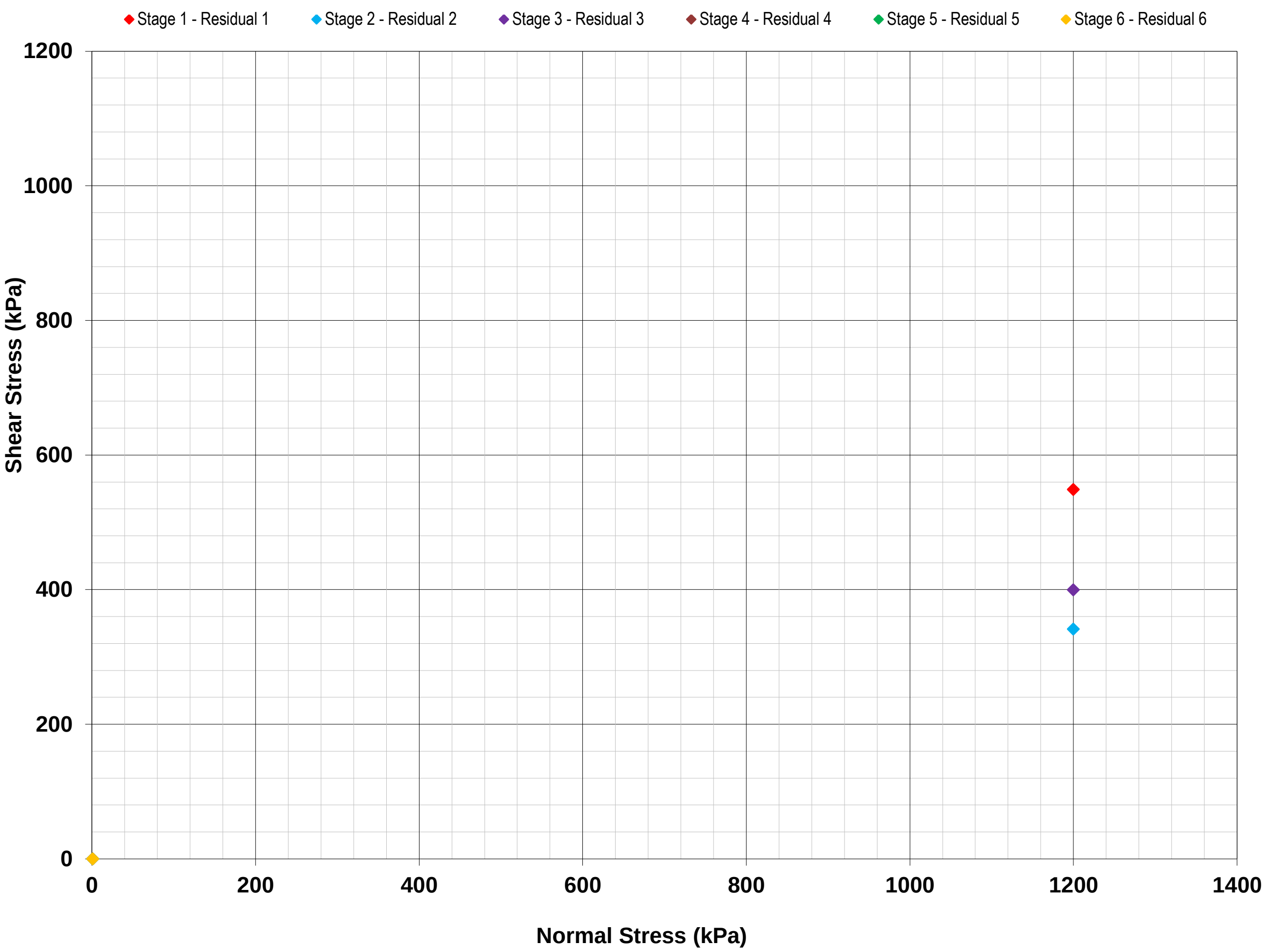
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119E- DS

Failure Criteria **Residual @ 6 , 6 , 6 , mm Displacement**

Residual - Normal Stress vs Shear Stress



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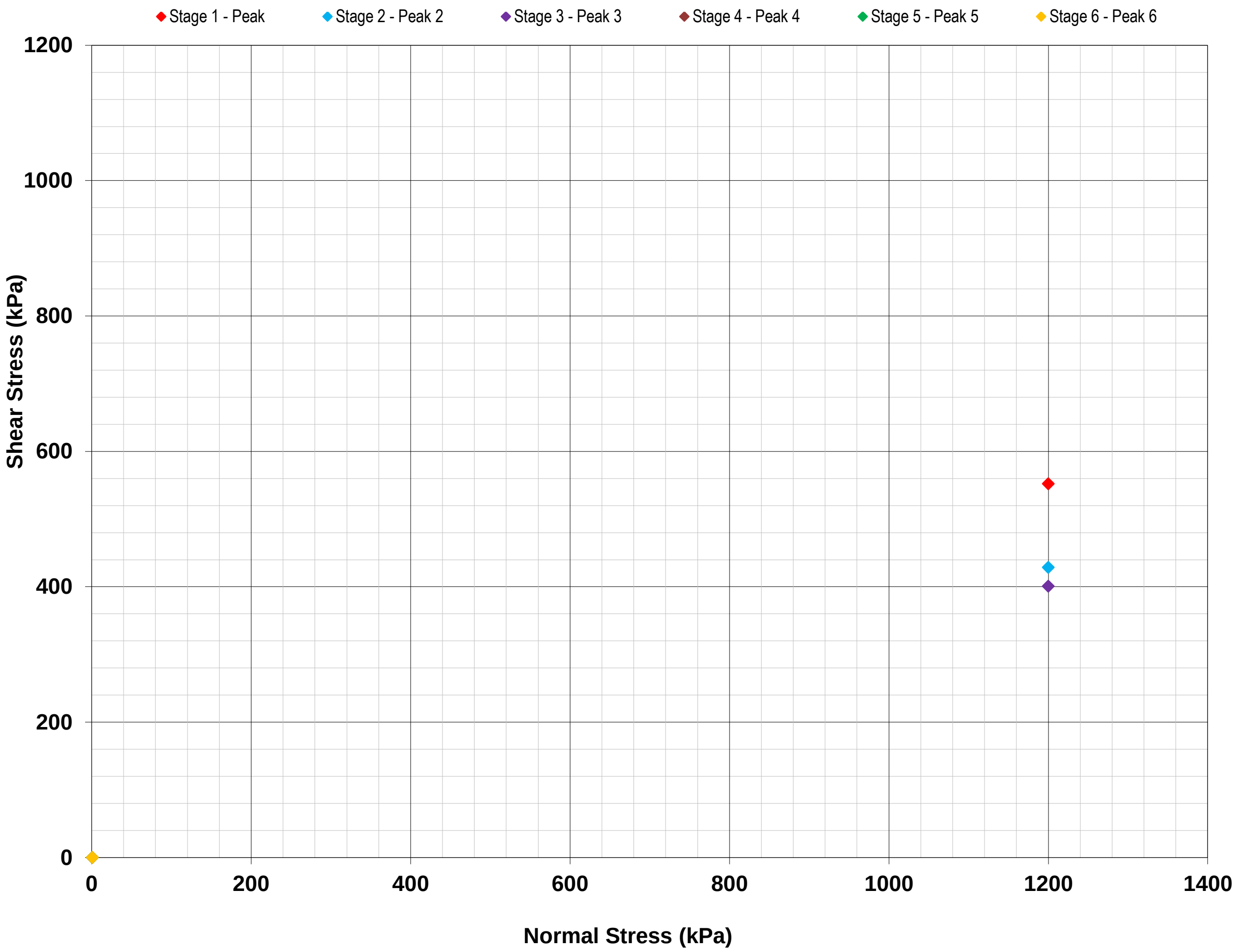
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119E- DS

Failure Criteria **Peak**

Peak - Normal Stress vs Shear Stress



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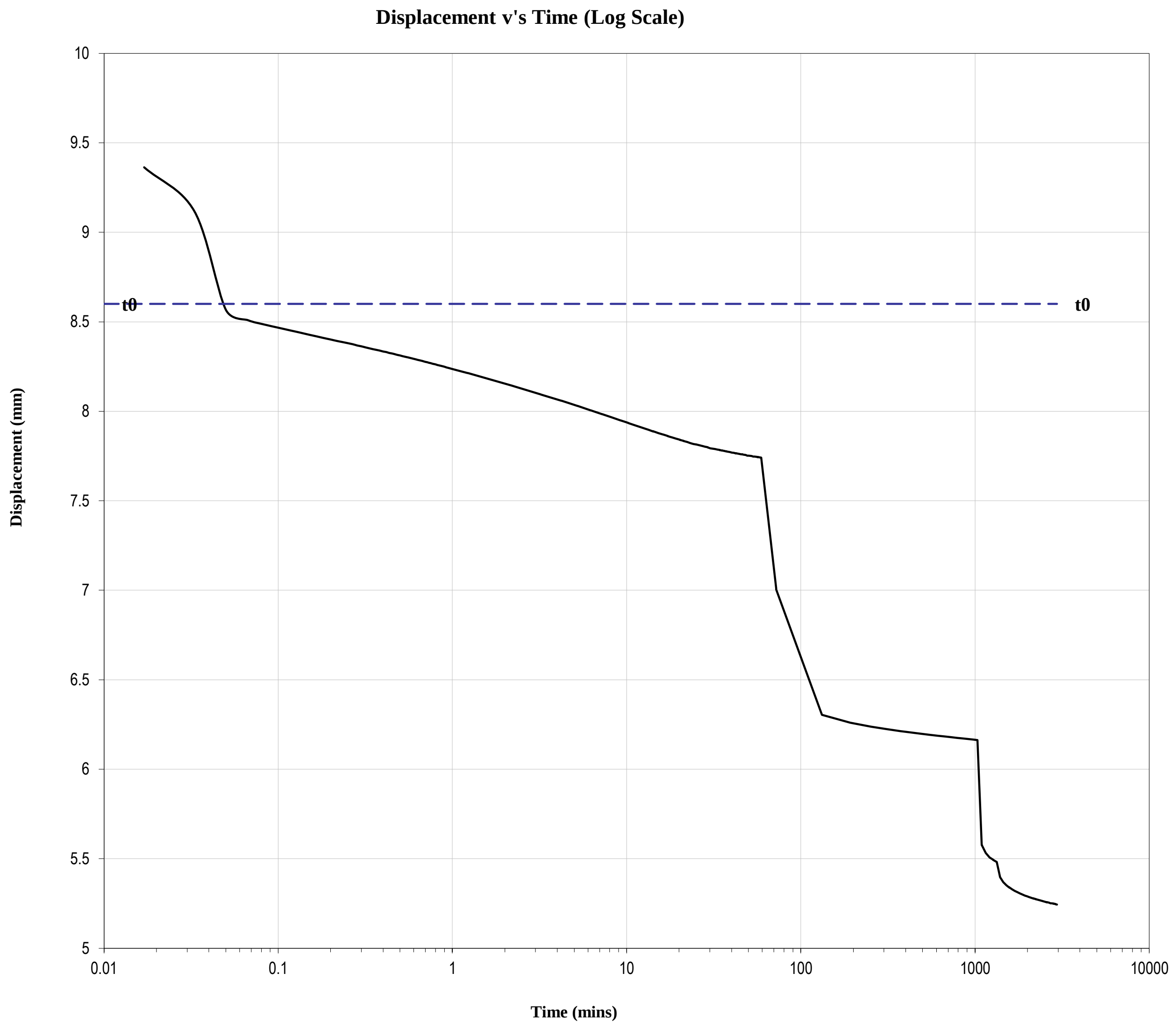
DIRECT SHEAR TEST REPORT

Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119E- DS

Stage 1 Consolidation



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Test Method: AS 1289.6.2.2 / KH2 based on K.H. Head Vol. 2

Client	Hatch Pty Ltd	**Report No.**	19020119E- DS

Before and After Photos

Notes/Remarks:

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Annexure DE
CIU Triaxial Tests - Golders

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

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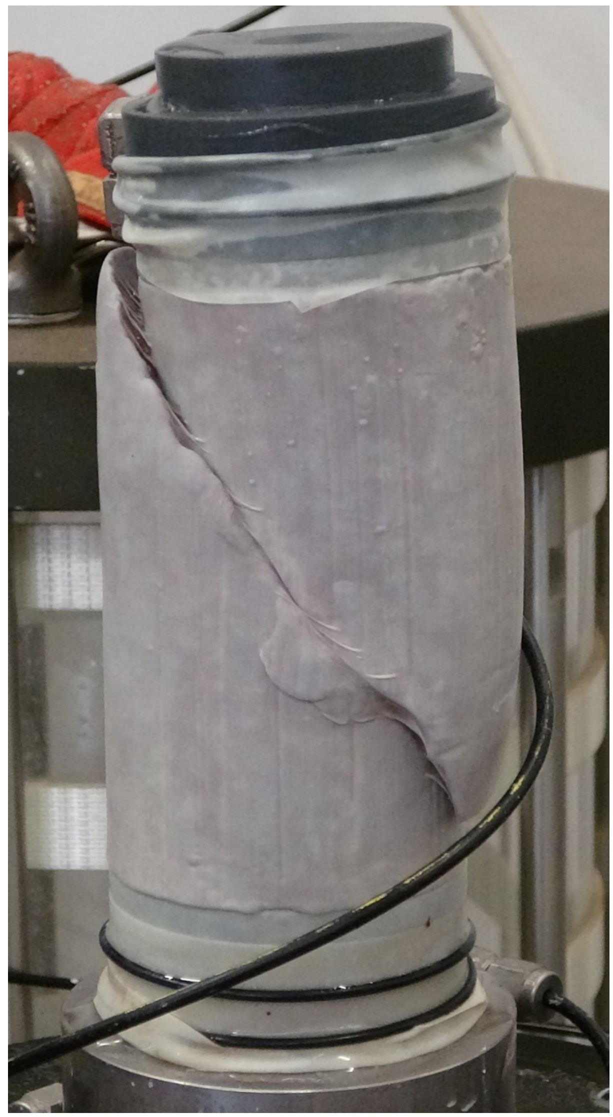
Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5m
Location:	Cadia Mine	**Test ID:**	18022 - TX1 1000kPa

Initial Height (mm):	133.8	Final Liquor Content (%):	41.3%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.5	Final Dry Density (t/m^3):	1.39	B Response (%):	98%
Trimmings GWC (%):	-	Final Void Ratio (-):	-	Mean Effective Consolidation Stress (kPa):	1000
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test



Sample After Test

Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

Triaxial Test Report

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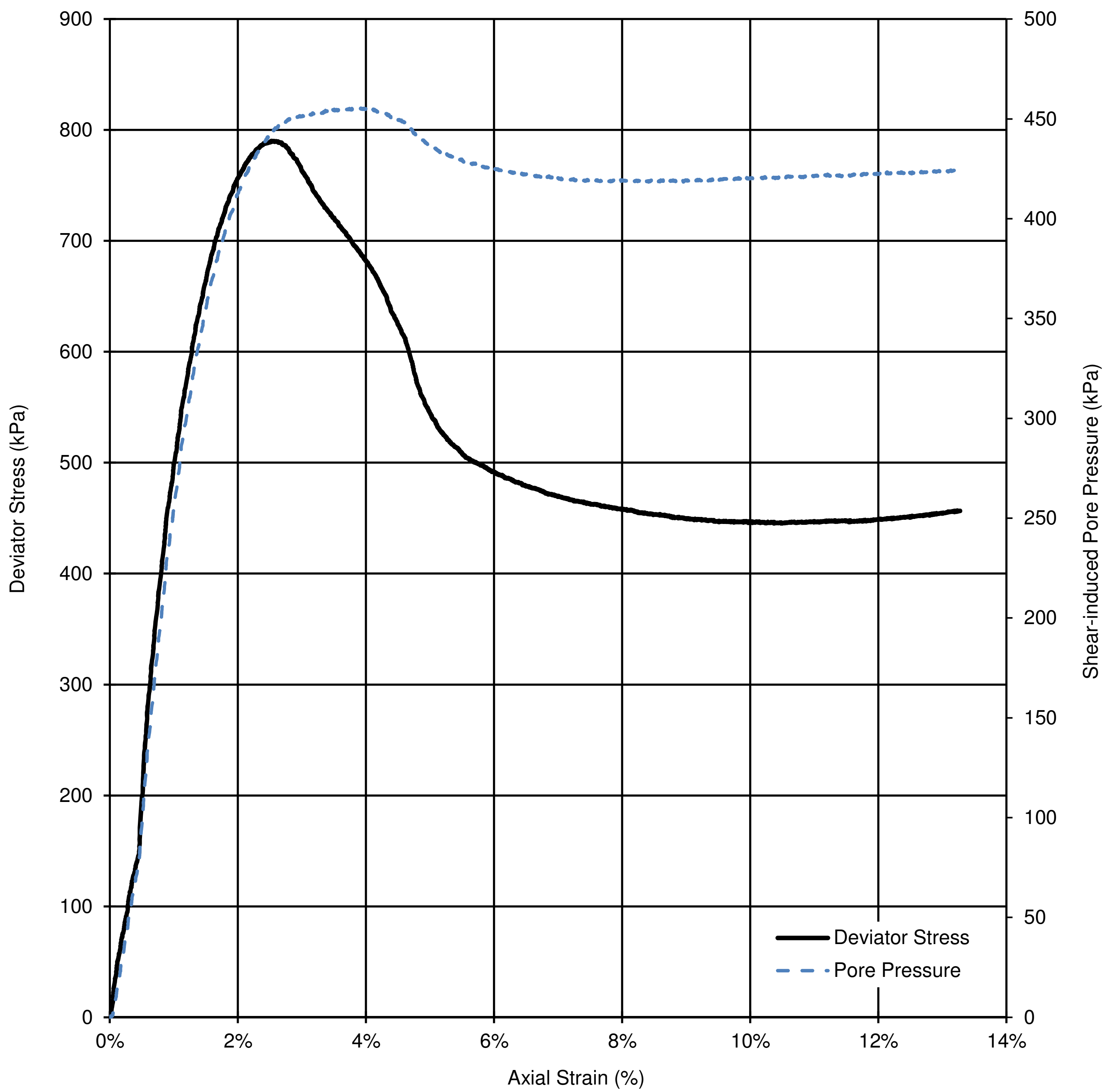
GOLDER

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5m
Location:	Cadia Mine	**Test ID:**	18022 - TX1 1000kPa

Initial Height (mm):	133.8	Final Liquor Content (%):	41.3%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.5	Final Dry Density (t/m^3):	1.39	B Response (%):	98%
Trimmings GWC (%):	43.5%	Final Void Ratio (-):	-	Mean Effective Consolidation Stress (kPa):	1000
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni

Triaxial Test Report

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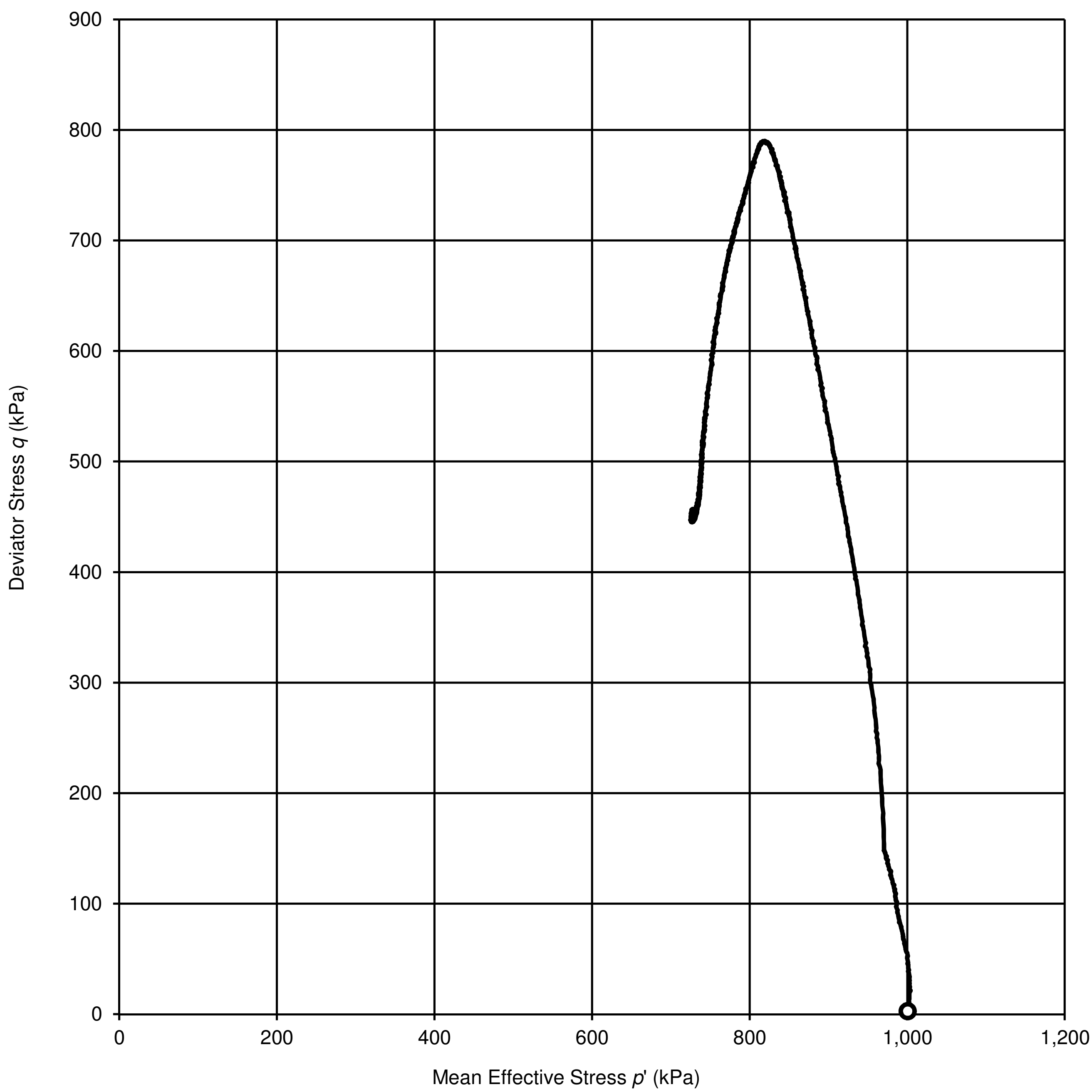
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5m
Location:	Cadia Mine	**Test ID:**	18022 - TX1 1000kPa

Initial Height (mm):	133.8	Final Liquor Content (%):	41.3%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.5	Final Dry Density (t/m^3):	1.39	B Response (%):	98%
Trimmings GWC (%):	43.5%	Final Void Ratio (-):	-	Mean Effective Consolidation Stress (kPa):	1000
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

Triaxial Test Report

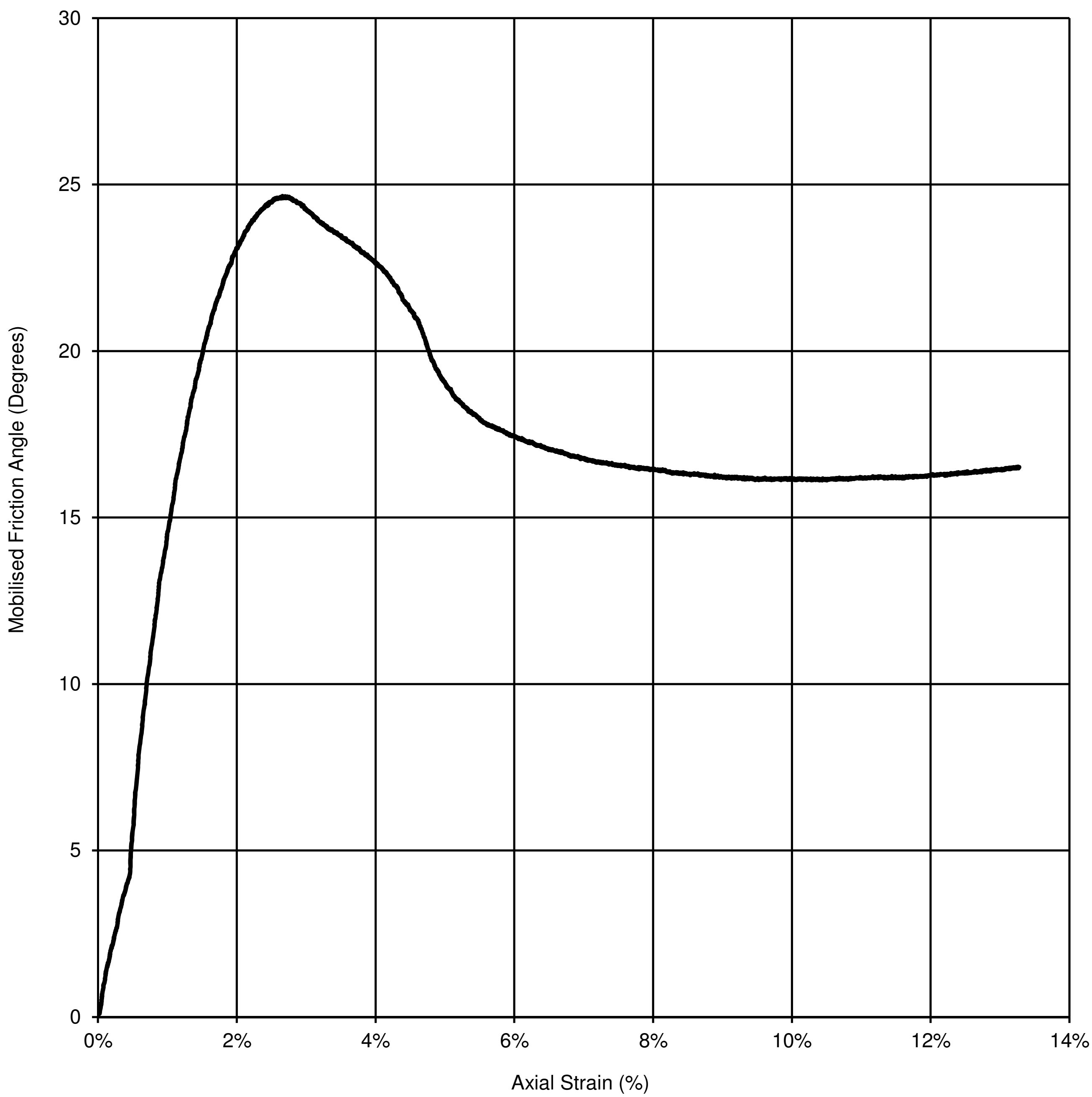
STRICTLY CONFIDENTIAL

Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5m
Location:	Cadia Mine	**Test ID:**	18022 - TX1 1000kPa

Initial Height (mm):	133.8	Final Liquor Content (%):	41.3%	Strain Rate (mm/min):	0.03
Initial Diameter (mm):	62.5	Final Dry Density (t/m^3):	1.39	B Response (%):	98%
Trimmings GWC (%):	43.5%	Final Void Ratio (-):	-	Mean Effective Consolidation Stress (kPa):	1000
Initial Dry Density (t/m^3):	1.28	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

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GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416 PT4 27.00-27.45
Location:	Cadia Mine	**Test ID:**	18024 - TX1 1000kPa

Initial Height (mm):	126.9	Final Liquor Content (%):	35.2%	Strain Rate (mm/min):	0.005
Initial Diameter (mm):	64.0	Final Dry Density (t/m^3):	1.47	B Response (%):	95%
Trimmings GWC (%):	36.5%	Final Void Ratio (-):	1.16	Mean Effective Consolidation Stress (kPa):	1001
Initial Dry Density (t/m^3):	1.40	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00

Sample Before Test

Sample After Test

Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

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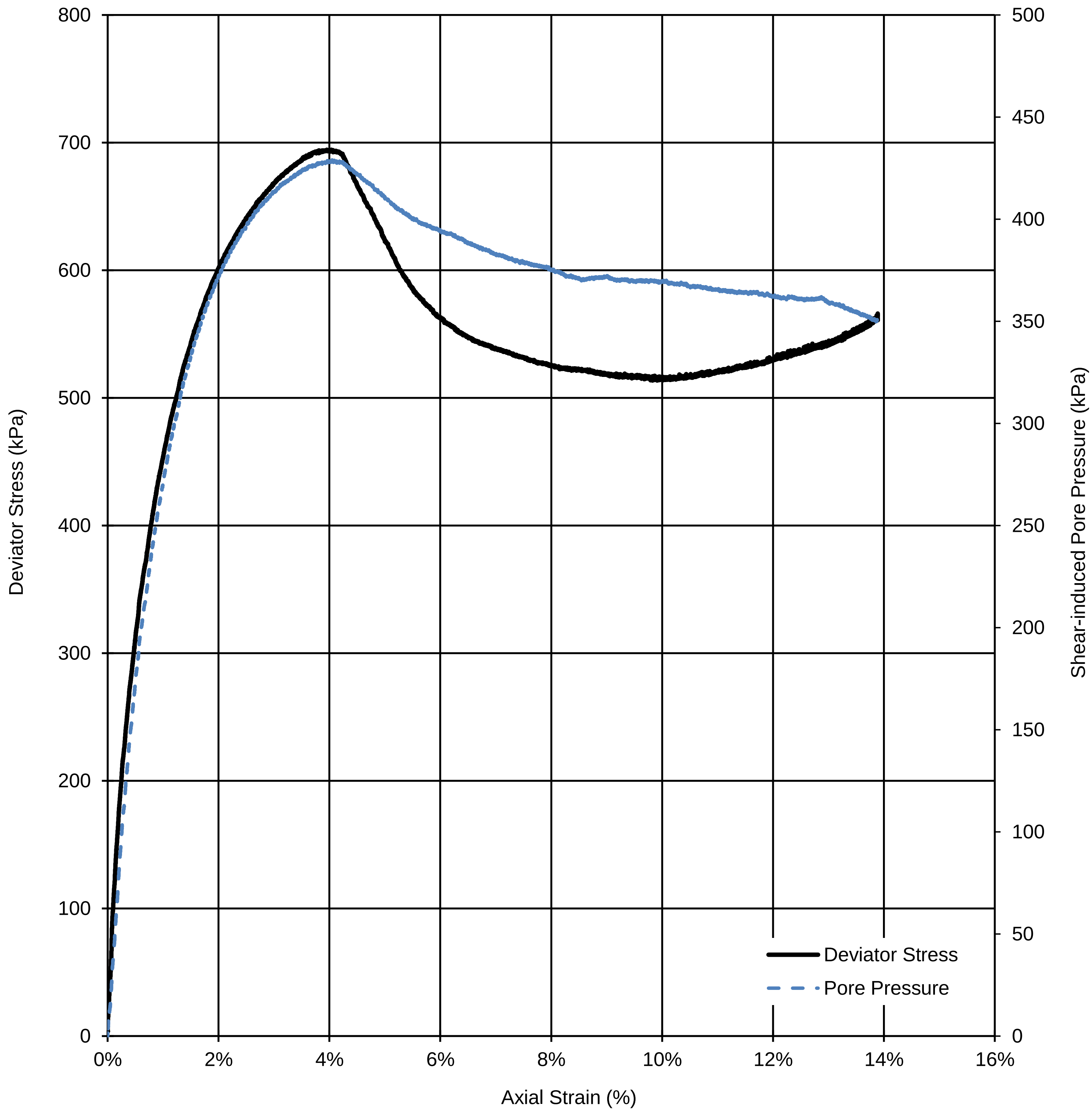
GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416 PT4 27.00-27.45
Location:	Cadia Mine	**Test ID:**	18024 - TX1 1000kPa

Initial Height (mm):	126.9	Final Liquor Content (%):	35.2%	Strain Rate (mm/min):	0.005
Initial Diameter (mm):	64.0	Final Dry Density (t/m^3):	1.47	B Response (%):	95%
Trimmings GWC (%):	36.5%	Final Void Ratio (-):	-	Mean Effective Consolidation Stress (kPa):	1001
Initial Dry Density (t/m^3):	1.33	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL		Reviewed by:	R. Fanni

Triaxial Test Report

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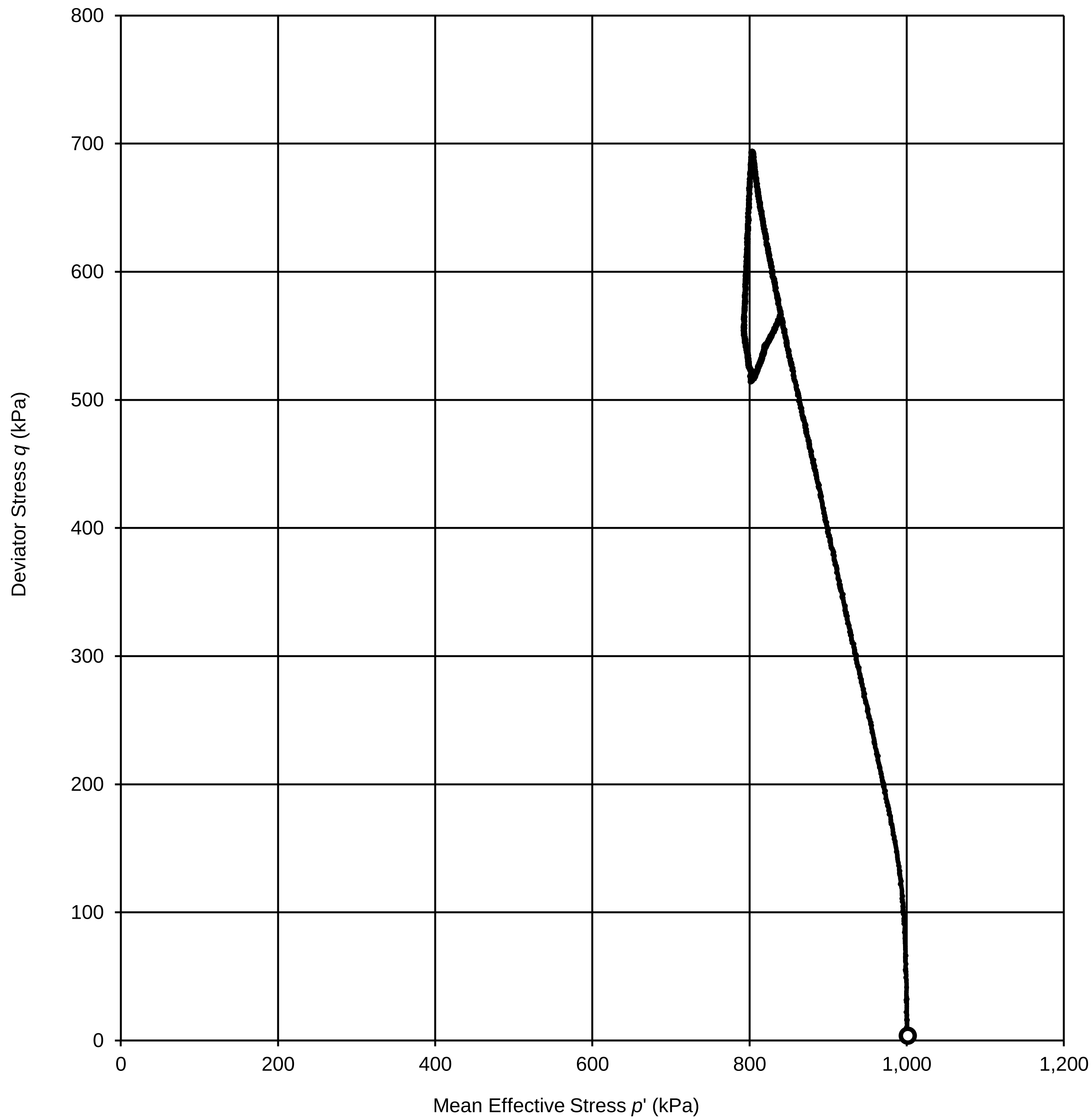
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416 PT4 27.00-27.45
Location:	Cadia Mine	**Test ID:**	18024 - TX1 1000kPa

Initial Height (mm):	126.9	Final Liquor Content (%):	35.2%	Strain Rate (mm/min):	0.005
Initial Diameter (mm):	64.0	Final Dry Density (t/m^3):	1.47	B Response (%):	95%
Trimmings GWC (%):	36.5%	Final Void Ratio (-):	1.02	Mean Effective Consolidation Stress (kPa):	1001
Initial Dry Density (t/m^3):	1.33	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

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Triaxial Test Report

Isotropically Consolidated Undrained (CIU)

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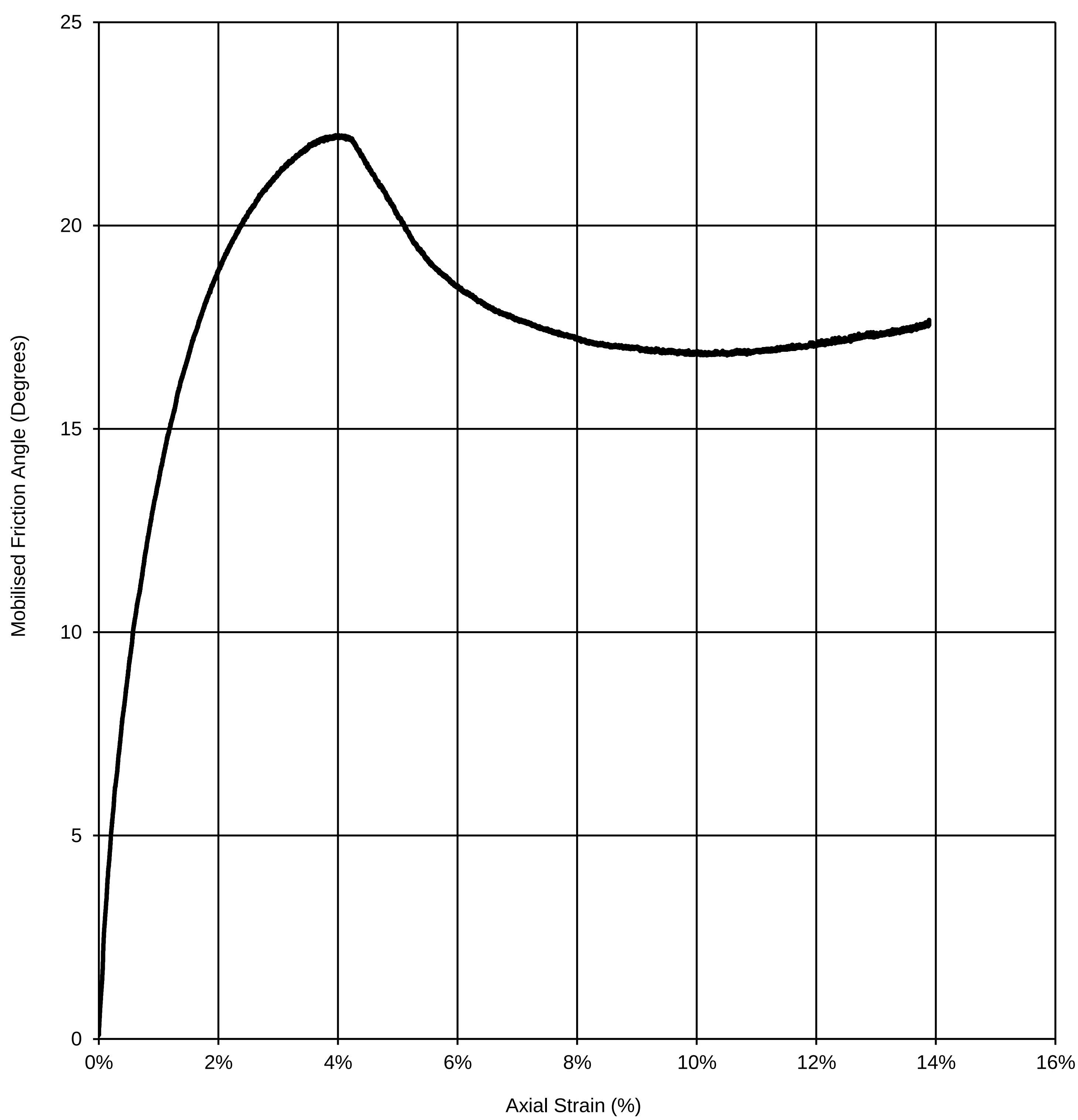
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	13/09/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416 PT4 27.00-27.45
Location:	Cadia Mine	**Test ID:**	18024 - TX1 1000kPa

Initial Height (mm):	126.9	Final Liquor Content (%):	35.2%	Strain Rate (mm/min):	0.005
Initial Diameter (mm):	64.0	Final Dry Density (t/m^3):	1.47	B Response (%):	95%
Trimmings GWC (%):	36.5%	Final Void Ratio (-):	-	Mean Effective Consolidation Stress (kPa):	1001
Initial Dry Density (t/m^3):	1.33	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	1.00



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

Triaxial Test Report

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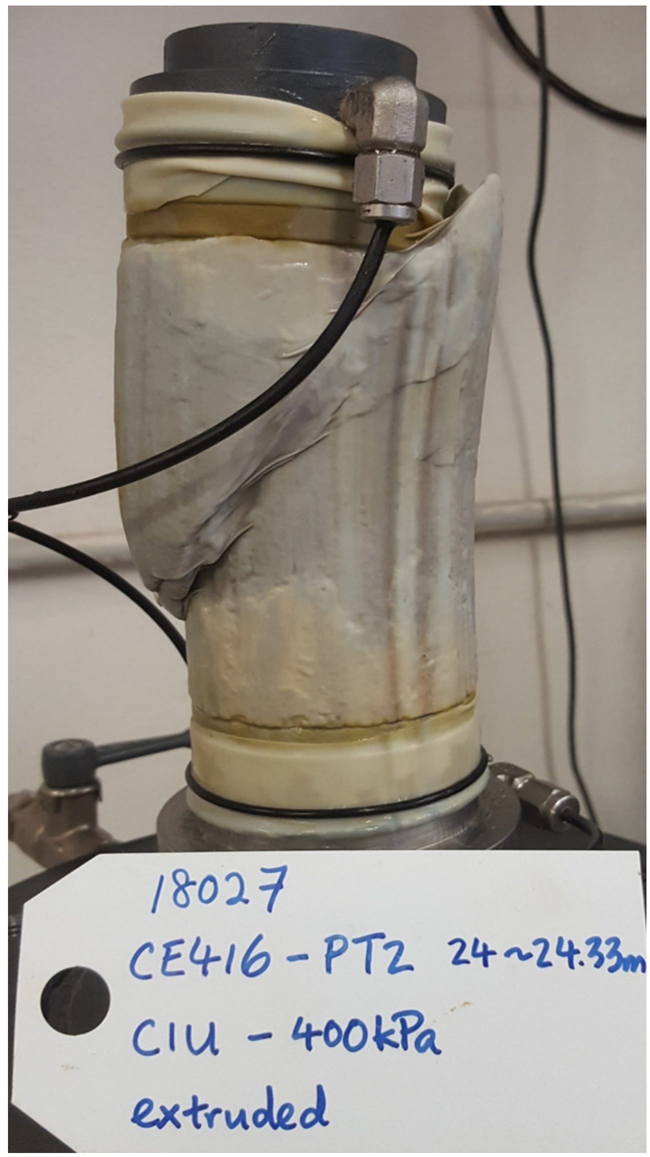
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	26/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416-PT2 24.00-24.33m
Location:	Cadia Mine	**Test ID:**	18027 - TX1 400kPa

Initial Height (mm):	126.0	Final Liquor Content (%):	28.8%	Strain Rate (mm/min):	0.002
Initial Diameter (mm):	62.3	Final Dry Density (t/m^3):	1.57	B Response (%):	96%
Trimmings GWC (%):	27.9%	Final Void Ratio (-):	0.82	Mean Effective Consolidation Stress (kPa):	402
Initial Dry Density (t/m^3):	1.54	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99

Sample Before Test



Sample After Test

Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

Triaxial Test Report

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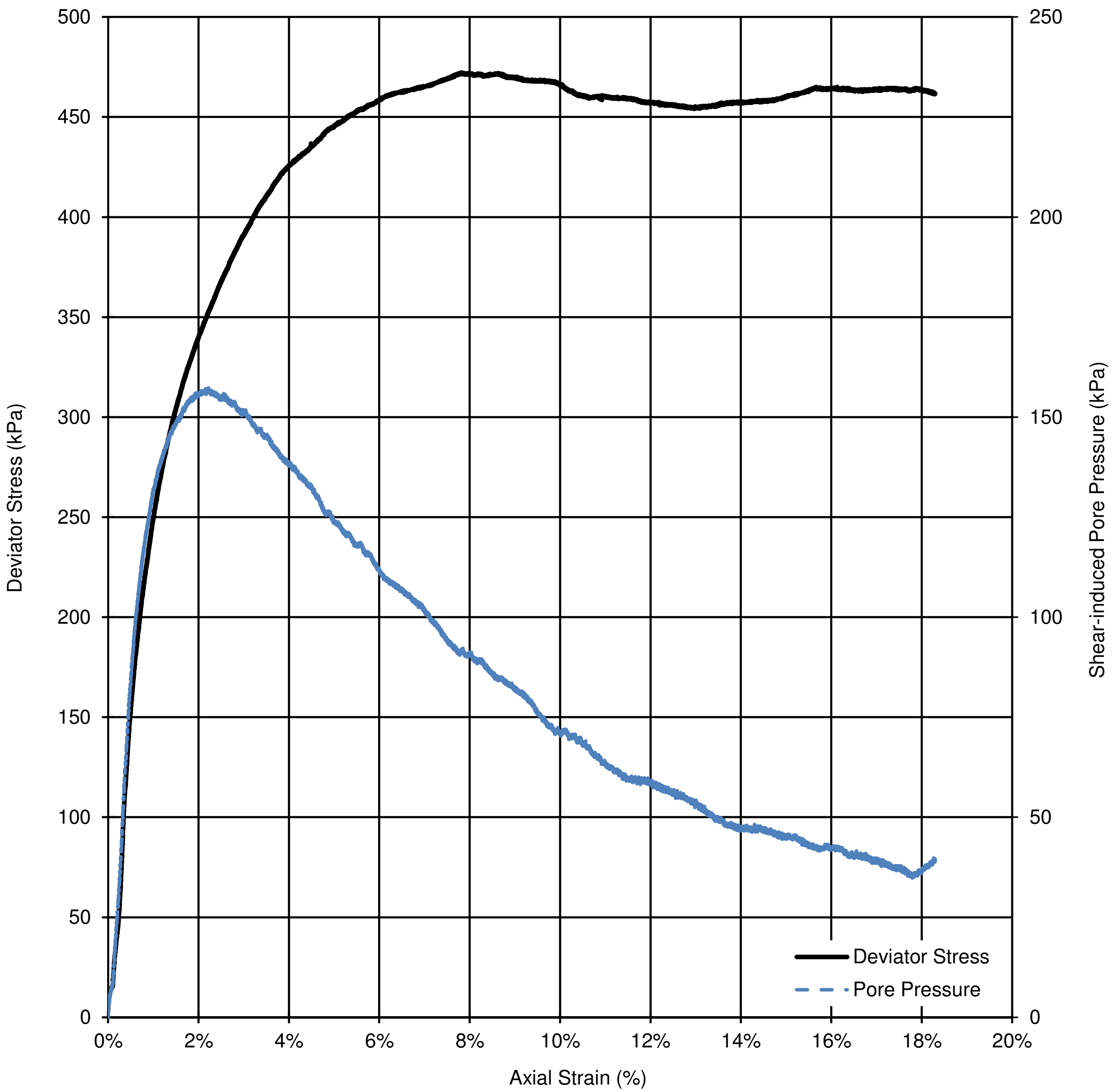
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	26/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416-PT2 24.00-24.33m
Location:	Cadia Mine	**Test ID:**	18027 - TX1 400kPa

Initial Height (mm):	126.0	Final Liquor Content (%):	28.8%	Strain Rate (mm/min):	0.002
Initial Diameter (mm):	62.3	Final Dry Density (t/m^3):	1.57	B Response (%):	96%
Trimmings GWC (%):	27.9%	Final Void Ratio (-):	0.82	Mean Effective Consolidation Stress (kPa):	402
Initial Dry Density (t/m^3):	1.54	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

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Triaxial Test Report

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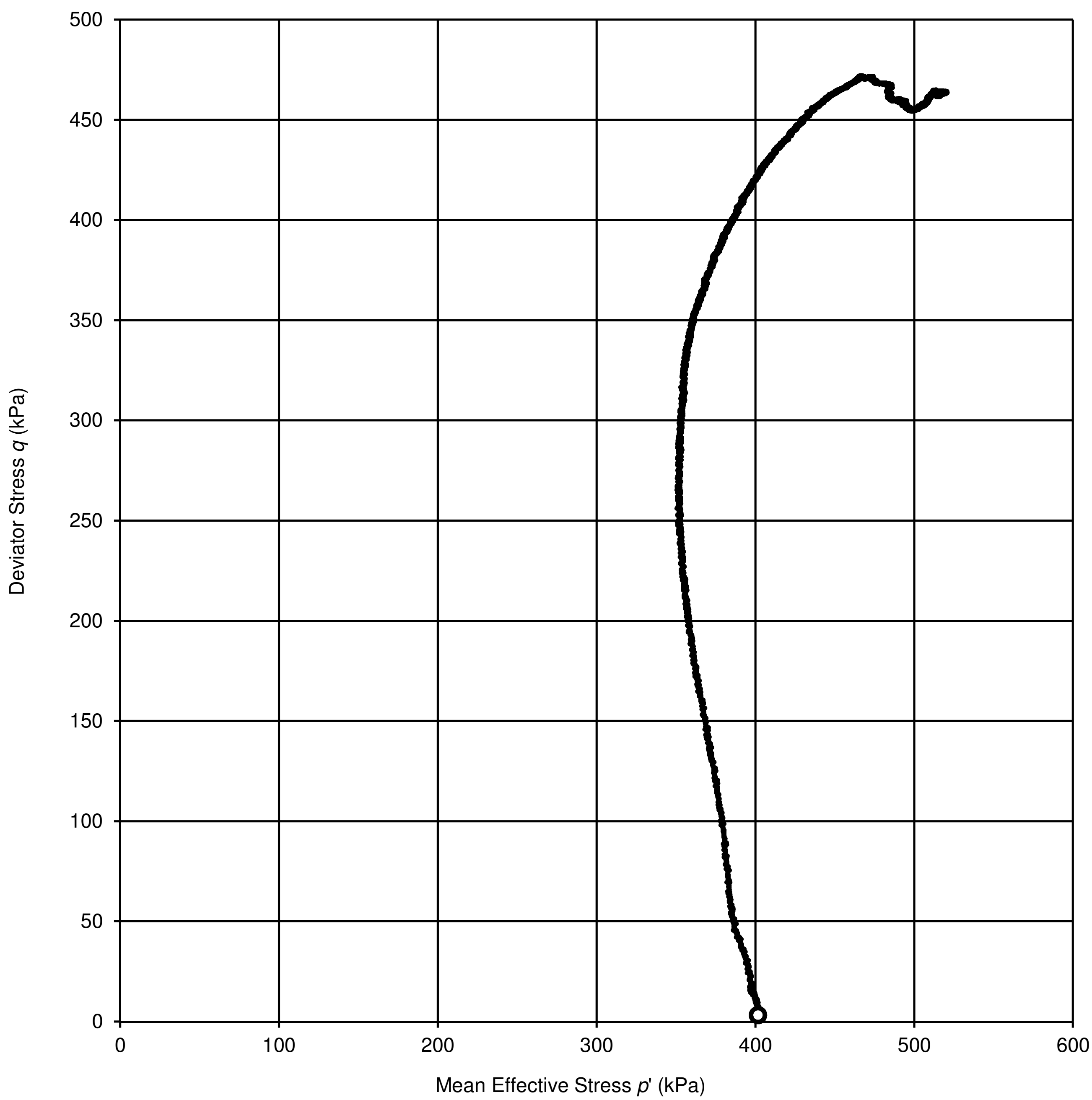
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	26/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416-PT2 24.00-24.33m
Location:	Cadia Mine	**Test ID:**	18027 - TX1 400kPa

Initial Height (mm):	126.0	Final Liquor Content (%):	28.8%	Strain Rate (mm/min):	0.002
Initial Diameter (mm):	62.3	Final Dry Density (t/m^3):	1.57	B Response (%):	96%
Trimmings GWC (%):	27.9%	Final Void Ratio (-):	0.82	Mean Effective Consolidation Stress (kPa):	402
Initial Dry Density (t/m^3):	1.54	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
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Triaxial Test Report

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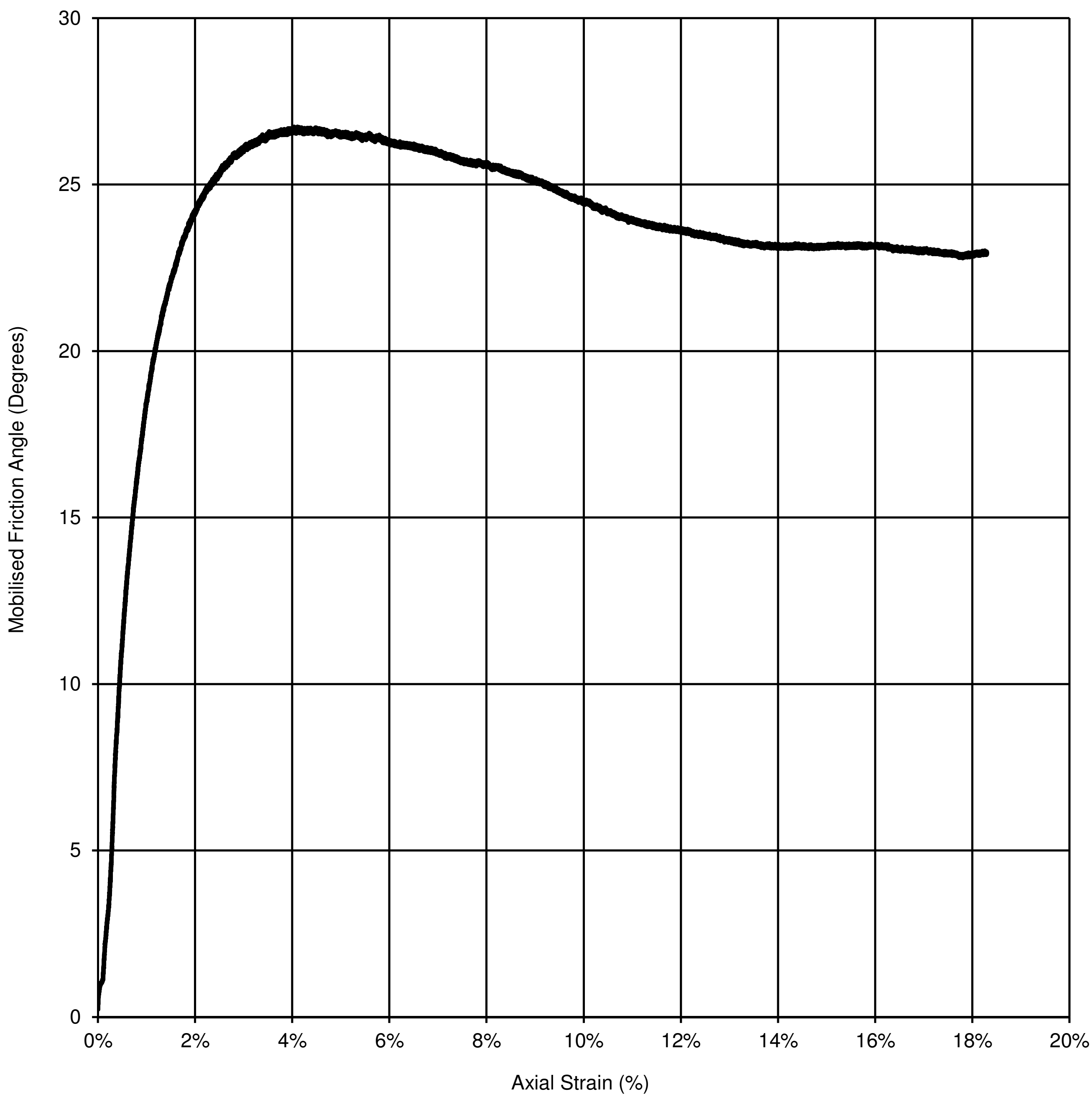
Isotropically Consolidated Undrained (CIU)

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	26/10/2018
Address:	61 Petrie Terrace, Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416-PT2 24.00-24.33m
Location:	Cadia Mine	**Test ID:**	18027 - TX1 400kPa

Initial Height (mm):	126.0	Final Liquor Content (%):	28.8%	Strain Rate (mm/min):	0.002
Initial Diameter (mm):	62.3	Final Dry Density (t/m^3):	1.57	B Response (%):	96%
Trimmings GWC (%):	27.9%	Final Void Ratio (-):	0.82	Mean Effective Consolidation Stress (kPa):	402
Initial Dry Density (t/m^3):	1.54	Final Liquor Solids Conc. (g/L):	-	Geostatic Stress Ratio K_0 (-):	0.99



Preparation Notes:	Sample was extruded and trimmed from push tube	Tested by:	I. Orea
		Reviewed by:	R. Fanni

Annexure DF
CIU Triaxial Tests – Trilabs

Trilab
Soil Rock Calibration

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Perth
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Queens Park
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Ph: +61 8 9258 8323

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18080195 - CU
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	6/09/2018
		Report Date:	25/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE407 - DH402 - PT2	**Depth (m):**	50.00-50.50
Description:	CLAY - dark grey and brown		

SAMPLE & TEST DETAILS

Initial Height:	127.1 mm	Initial Moisture Content:	23.1 %	Rate of Strain:	0.005 %/min
Initial Diameter:	62.8 mm	Final Moisture Content:	17.5 %	B Response:	97 %
L/D Ratio:	2.0 : 1	Wet Density:	2.13 t/m^3		
		Dry Density:	1.73 t/m^3		

Sample Type: Single Individual Undisturbed 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*
613 kPa	1101 kPa	488 kPa	488 kPa	672 kPa	842 kPa	429 kPa	1.964	413 kPa	2.99 %
812 kPa	1301 kPa	489 kPa	489 kPa	700 kPa	1177 kPa	601 kPa	1.958	576 kPa	4.69 %
1227 kPa	1703 kPa	476 kPa	476 kPa	800 kPa	1689 kPa	903 kPa	1.871	786 kPa	6.58 %

FAILURE ENVELOPES

Interpretation between stages :	**1 to 2**	**2 to 3**	**1 to 3**
Cohesion C' (kPa) :	**3.3**	**60.0**	**34.0**
Angle of Shear Resistance Φ' (Degrees) :	**18.7**	**15.0**	**16.3**
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received

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 Number
9926

Trilab
Soil Rock Calibration
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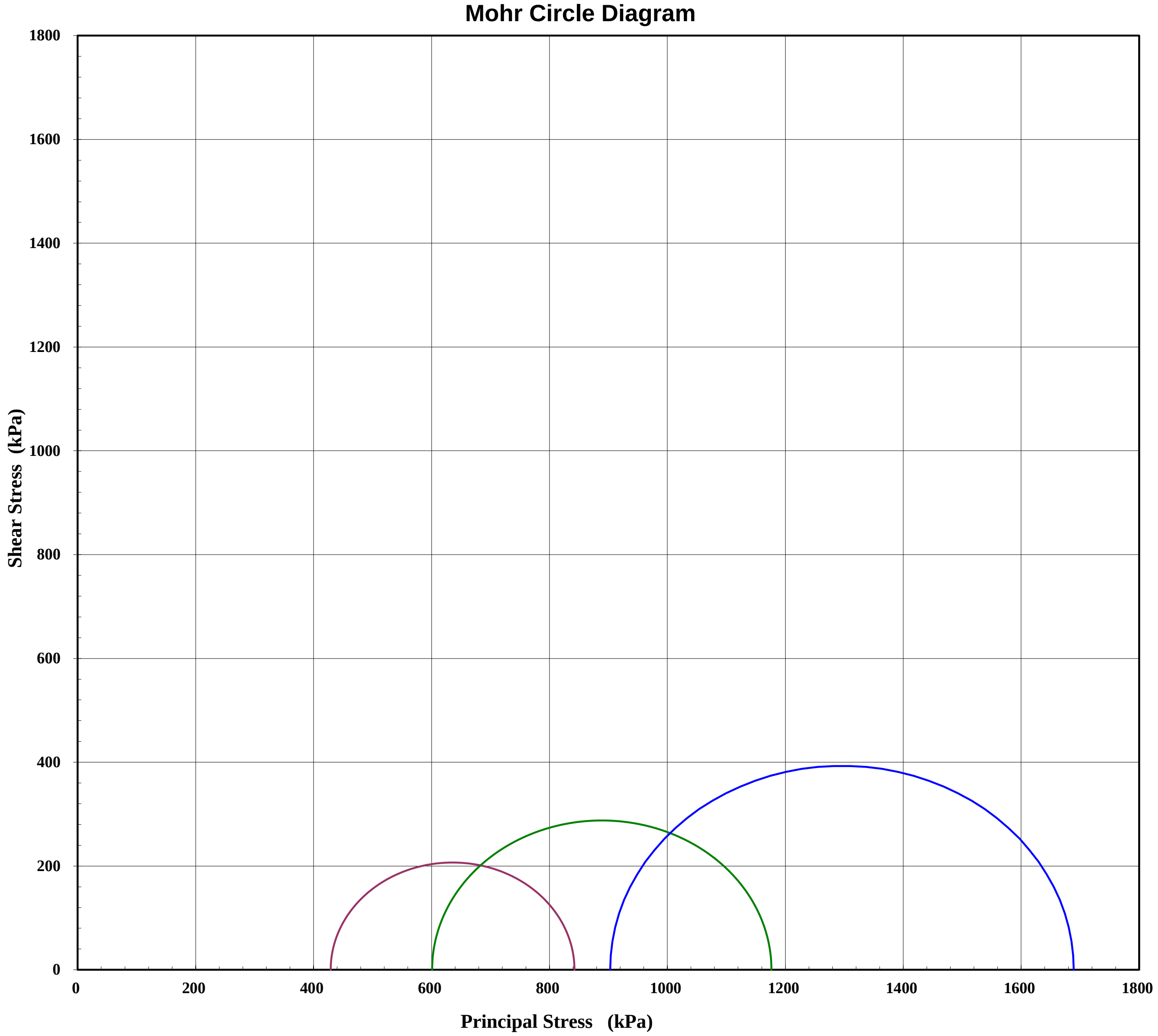
WA 6107
Ph: +61 8 9258 8323

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080195 - CU



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	3.3	60.0	34.0
Angle of Shear Resistance Φ' (Degrees) :	18.7	15.0	16.3

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

REP03001

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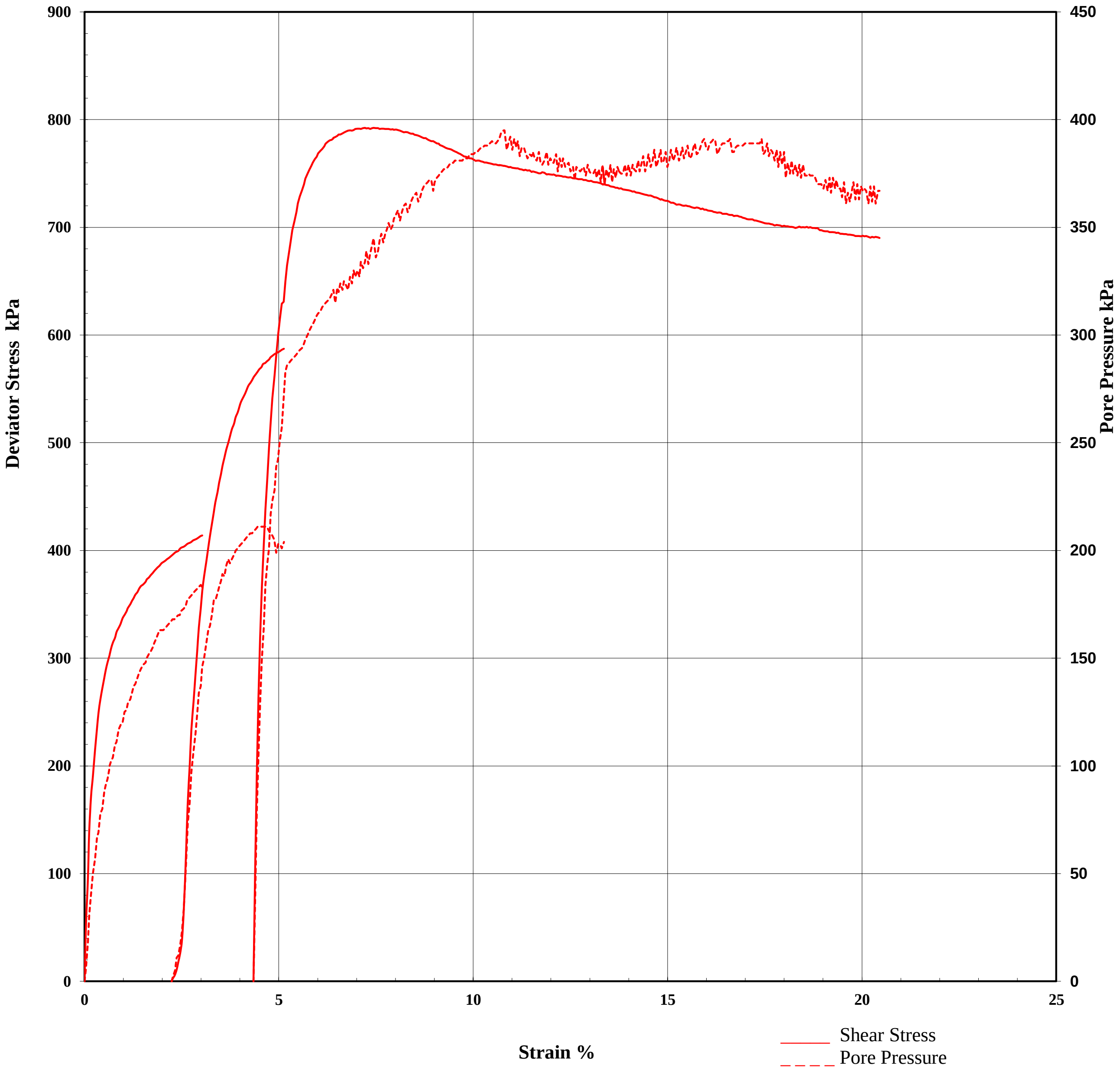
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080195 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

REP03001

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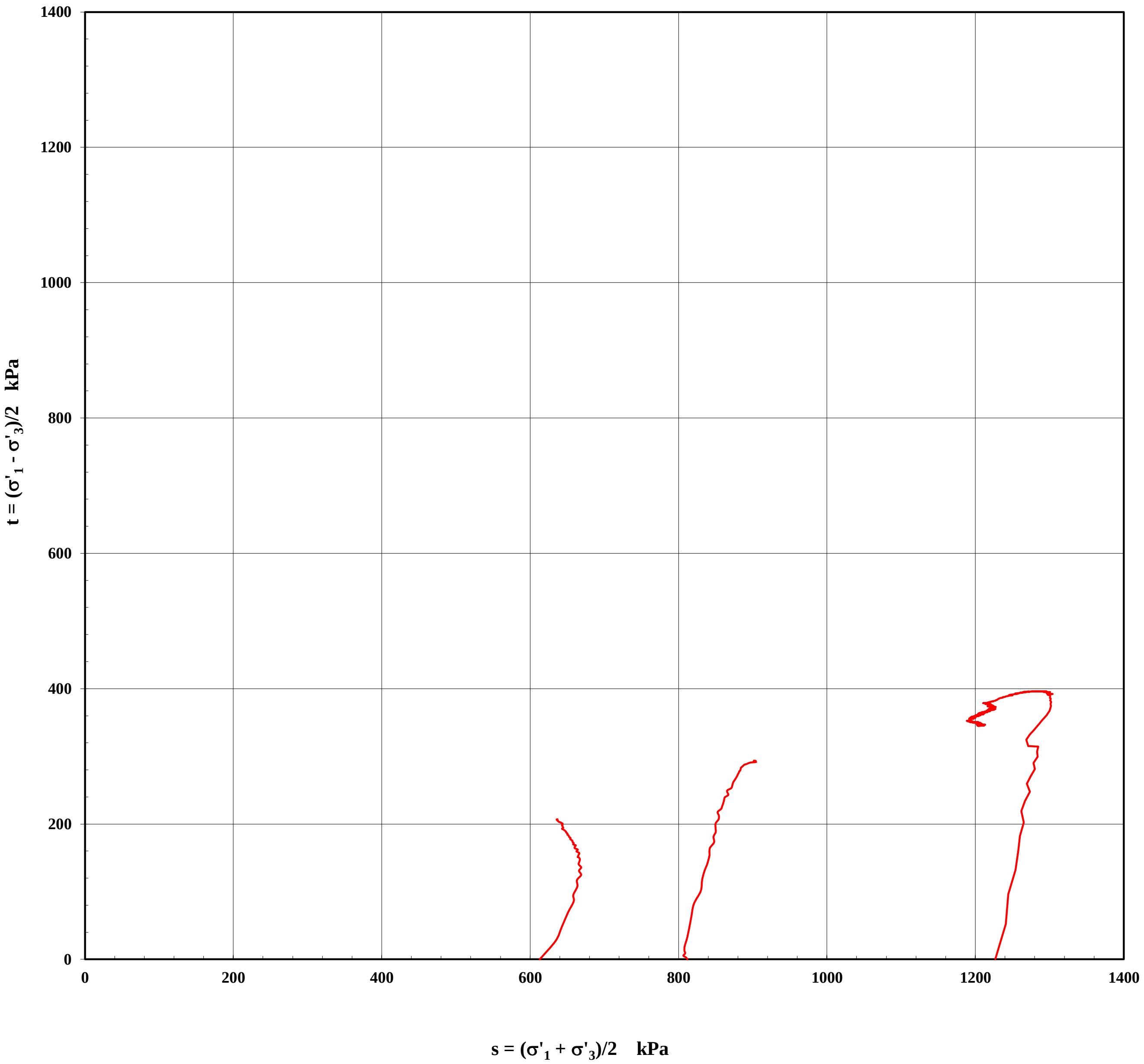
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080195 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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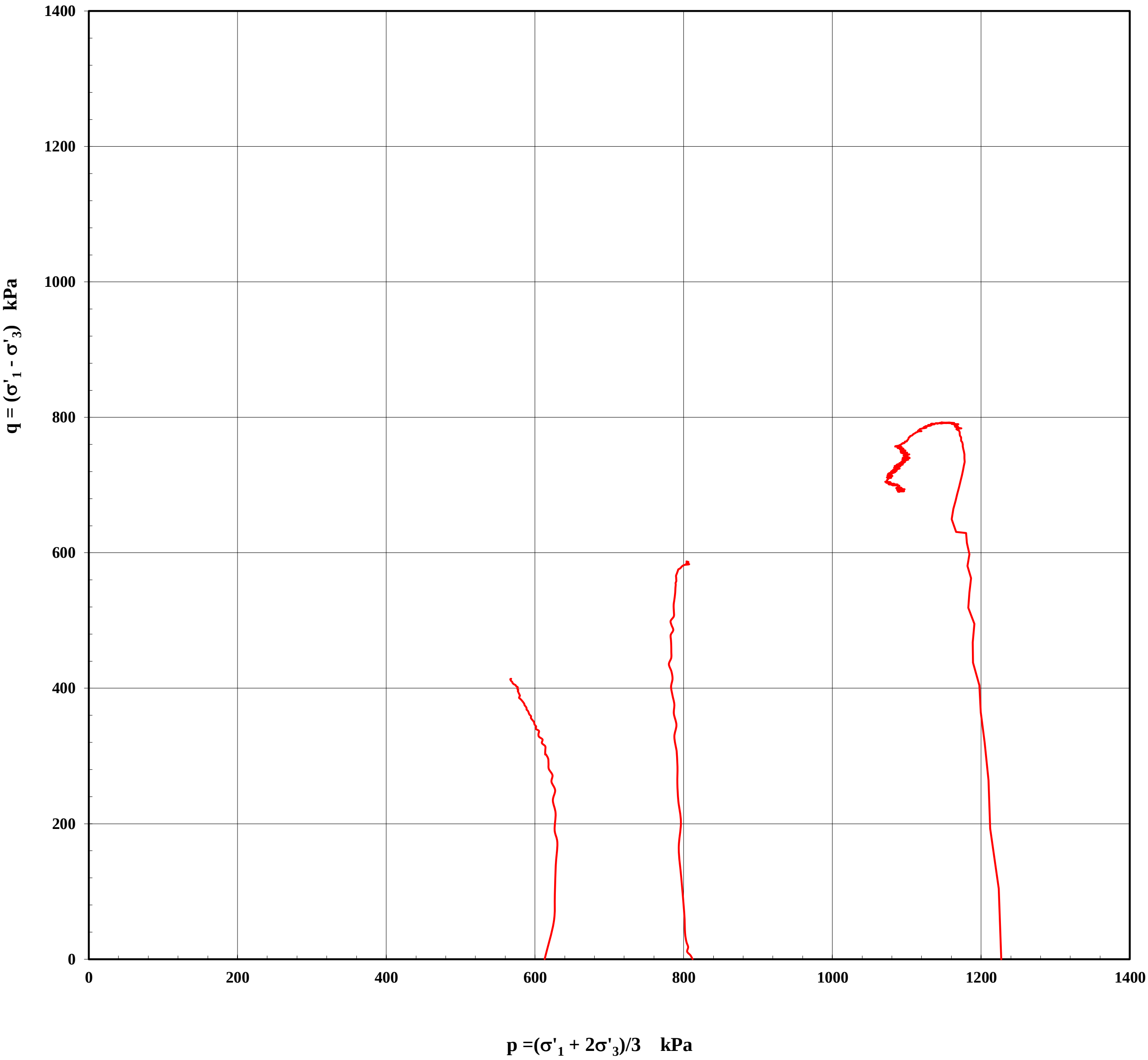
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080195 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18080195 - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

REP03001

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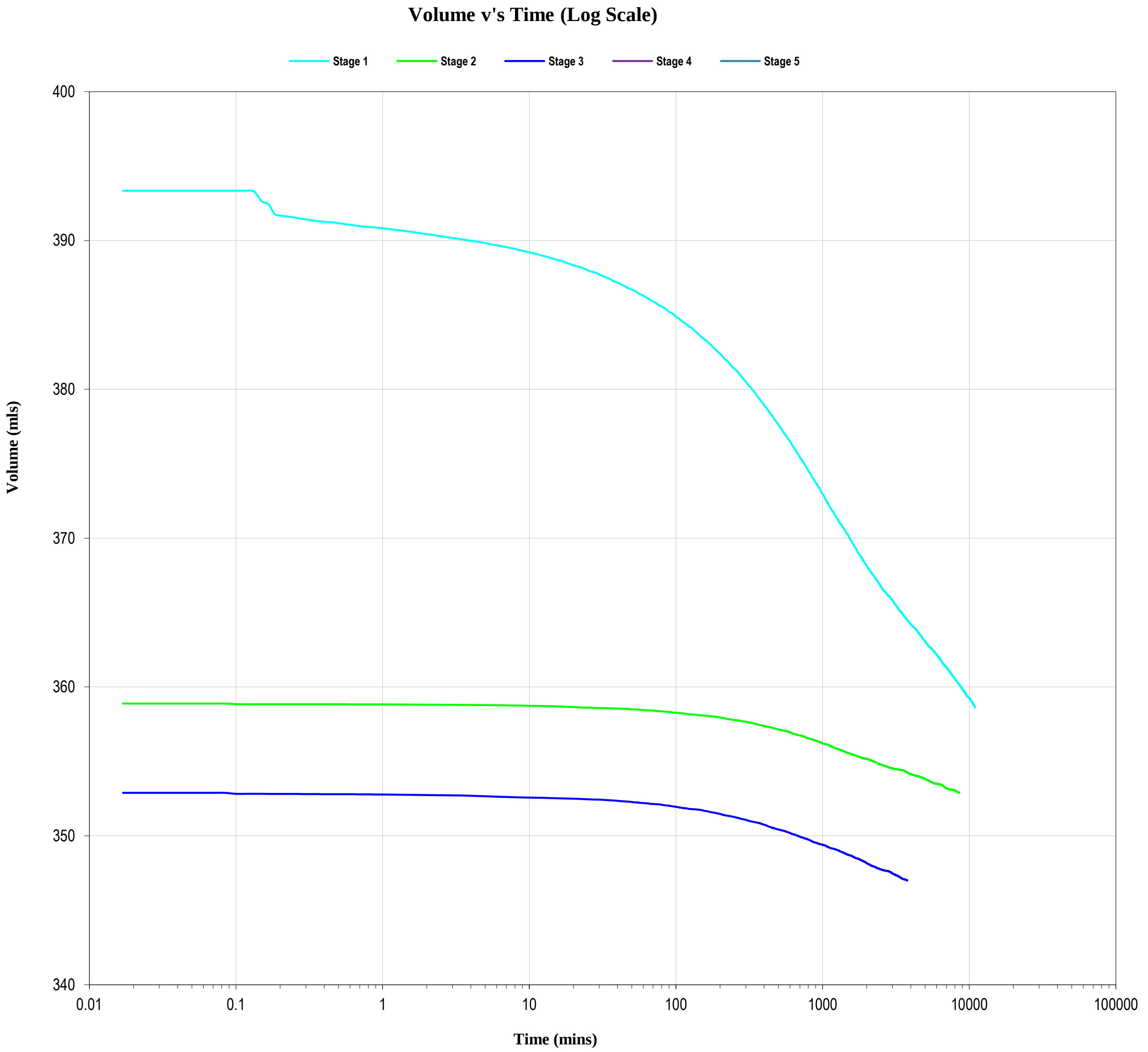
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18080195 - CU



	Stage 1	Stage 2	Stage 3
Cv (m^2/year) **:**	**0.04**	**0.01**	**0.05**
Mv (m^2/MN) **:**	**0.109**	**0.131**	**0.095**
k (m/s) **:**	**1.41E-12**	**2.63E-13**	**1.39E-12**

Remarks: Tested as Received

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.:**	18080196 - CU
		Workorder No.	0004644
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	17/08/2018
		Report Date:	12/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE407 - DH402 - PT3	**Depth (m):**	51.00-51.50
Description:	CLAY - brown		

SAMPLE & TEST DETAILS

Initial Height:	127.1	mm	Initial Moisture Content:	20.7	%	Rate of Strain:	0.004	%/min
Initial Diameter:	62.8	mm	Final Moisture Content:	15.9	%	B Response:	98	%
L/D Ratio:	2.0 : 1		Wet Density:	2.14	t/m^3			
			Dry Density:	1.77	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
1202 kPa	1698 kPa	496 kPa	496 kPa	973 kPa	1590 kPa	725 kPa	2.194	866 kPa	5.77 %

FAILURE ENVELOPES

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

Remarks: Tested as Received
Sample/s supplied by the client

REP03001

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory
C. Channon

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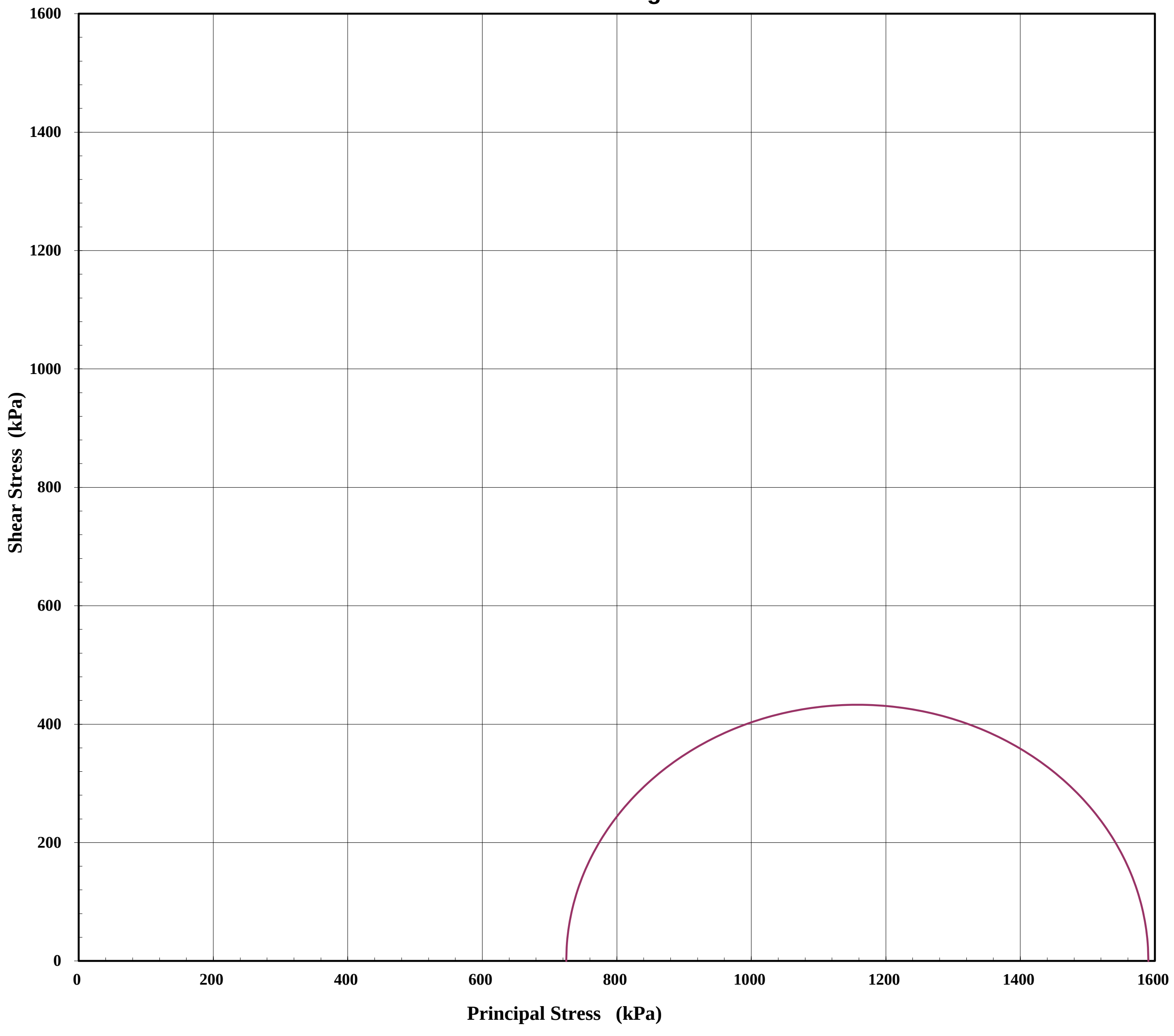
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080196 - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

REP03001

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

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Laboratory Number
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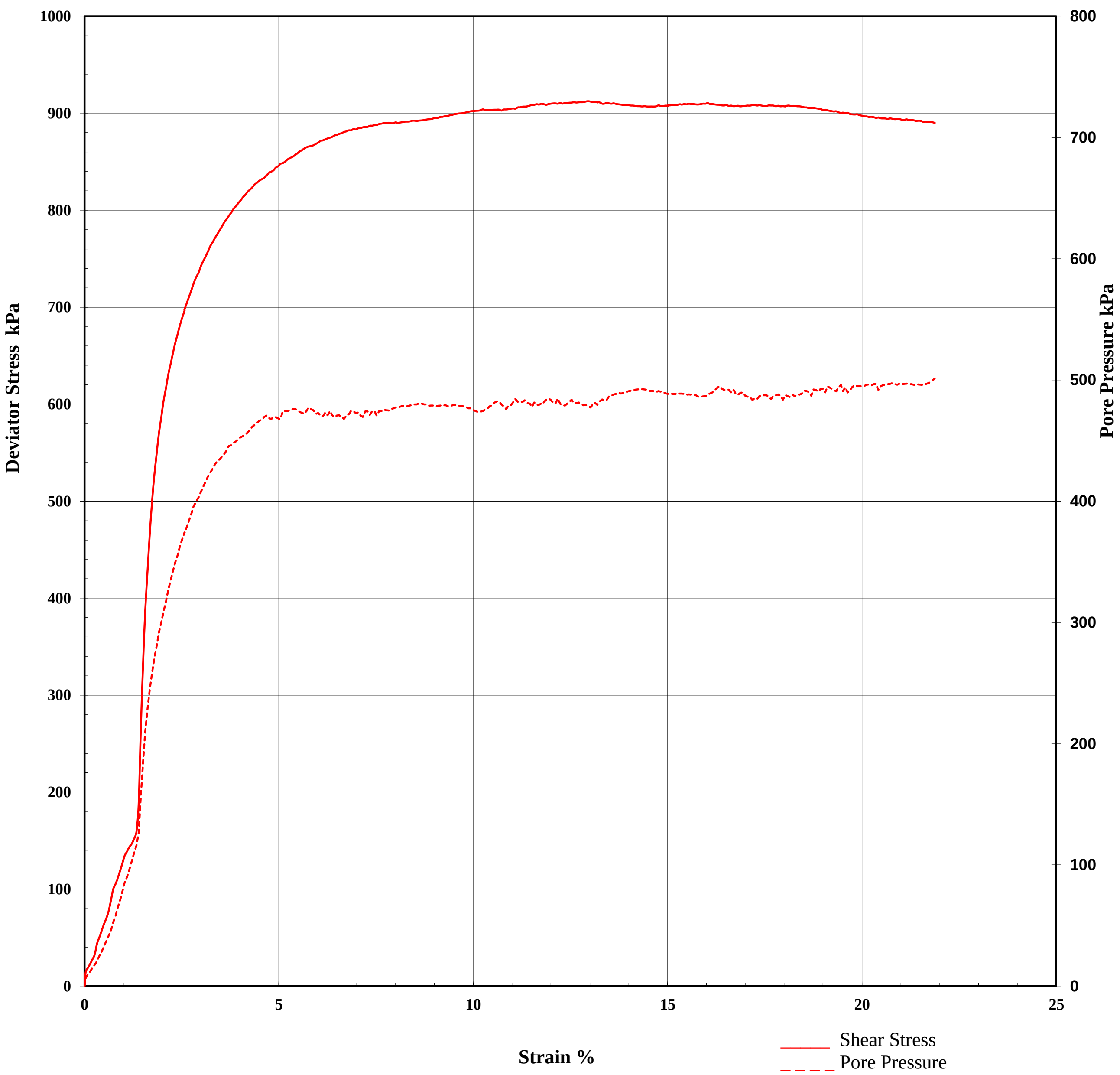
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080196 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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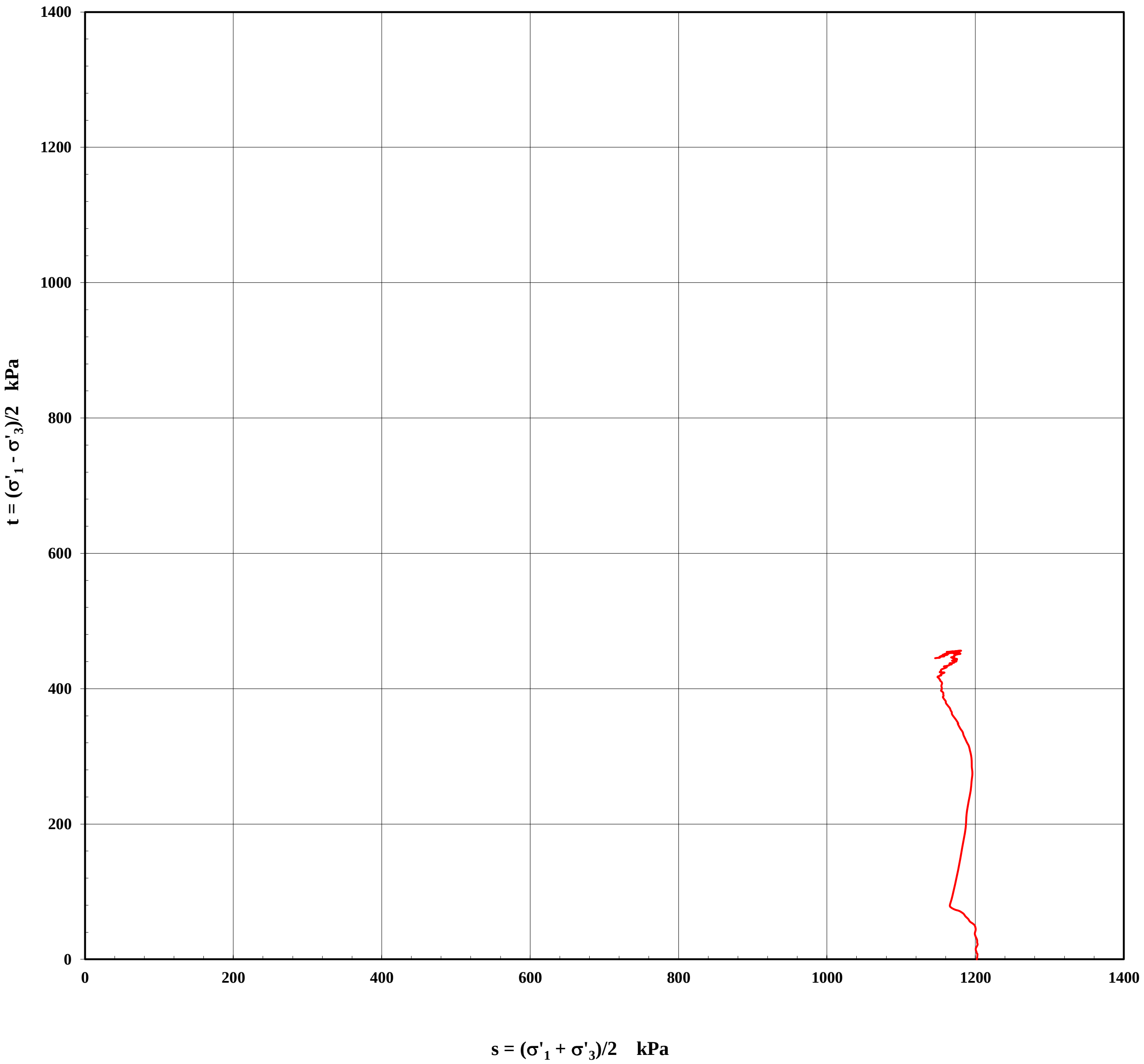
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080196 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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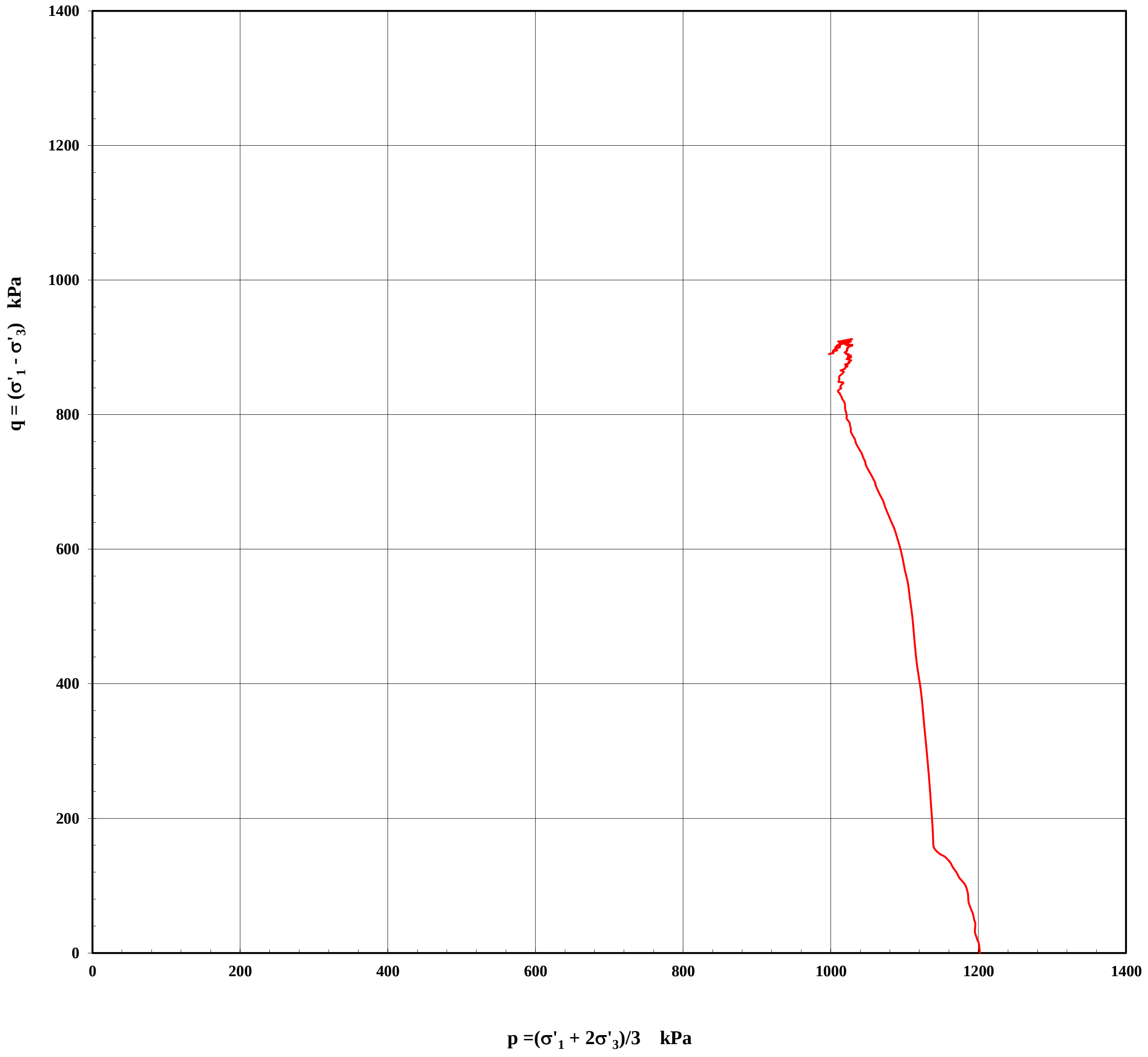
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080196 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18080196 - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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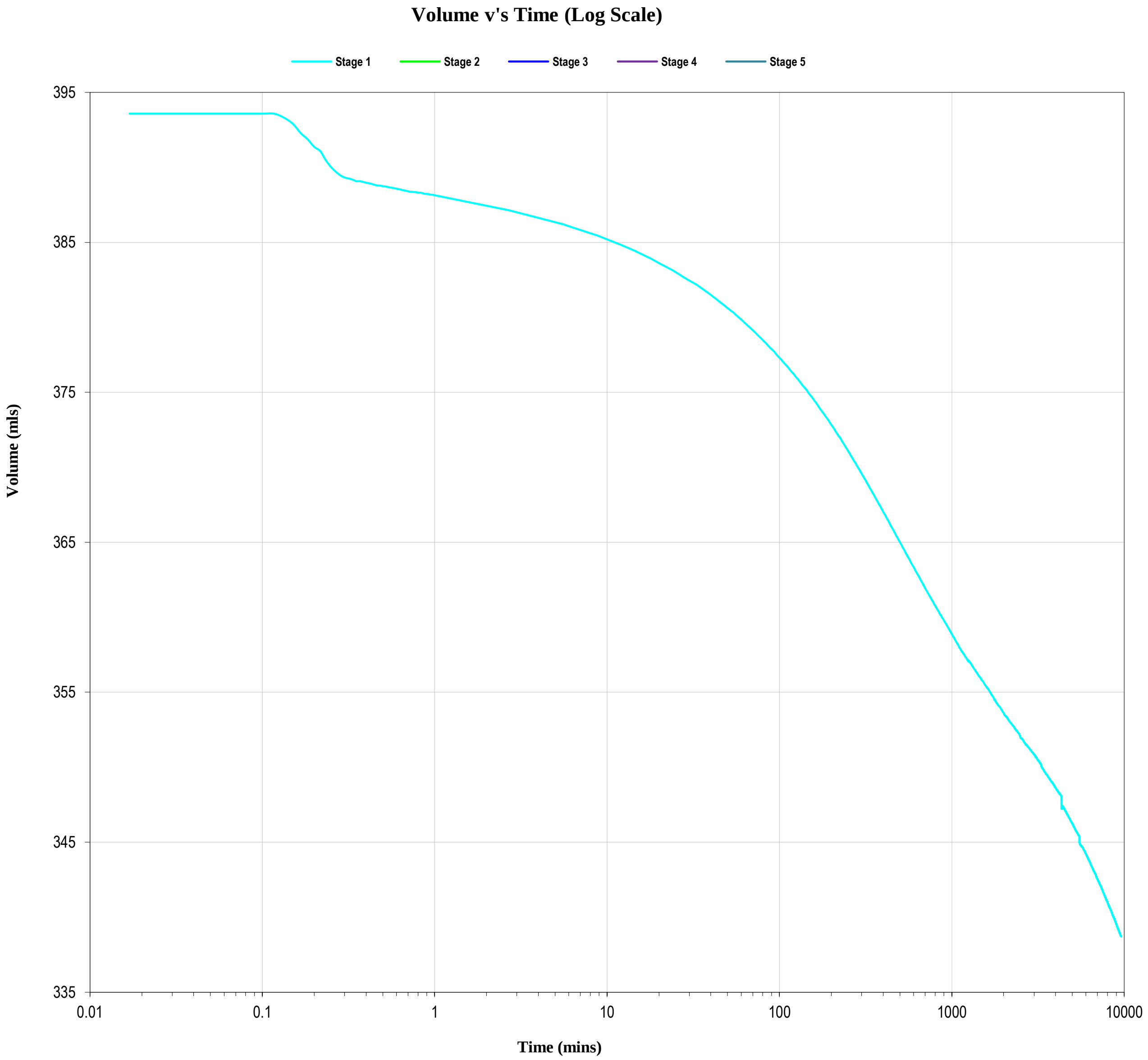
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080196 - CU



	Stage 1
Cv (m^2/year) **:**	**0.09**
Mv (m^2/MN) **:**	**0.074**
k (m/s) **:**	**2.10E-12**

Remarks: Tested as Received

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.:**	18080420 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	28/08/2018
		Report Date:	12/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE417 - DH406 L2B	**Depth (m):**	18.50-19.00
Description:	SILTY CLAY- orange and grey		

SAMPLE & TEST DETAILS

Initial Height:	130.7	mm	Initial Moisture Content:	38.6	%	Rate of Strain:	0.005	%/min
Initial Diameter:	60.1	mm	Final Moisture Content:	38.6	%	B Response:	97	%
L/D Ratio:	2.2 : 1		Wet Density:	1.82	t/m^3			
			Dry Density:	1.31	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
799 kPa	1299 kPa	500 kPa	500 kPa	938 kPa	881 kPa	361 kPa	2.439	520 kPa	3.58 %

FAILURE ENVELOPES

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

Remarks: Tested as Received

Sample/s supplied by the client

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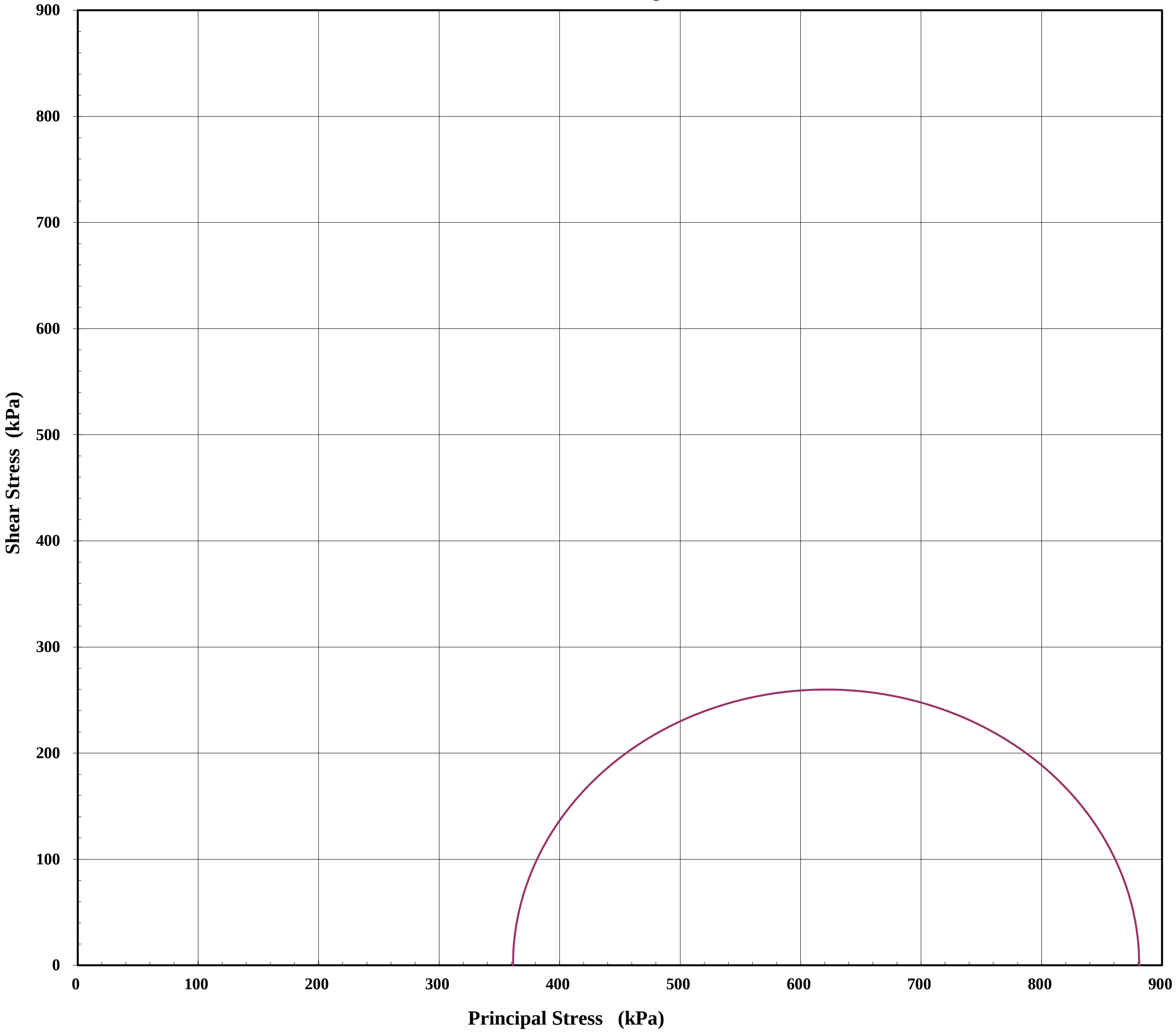
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080420 - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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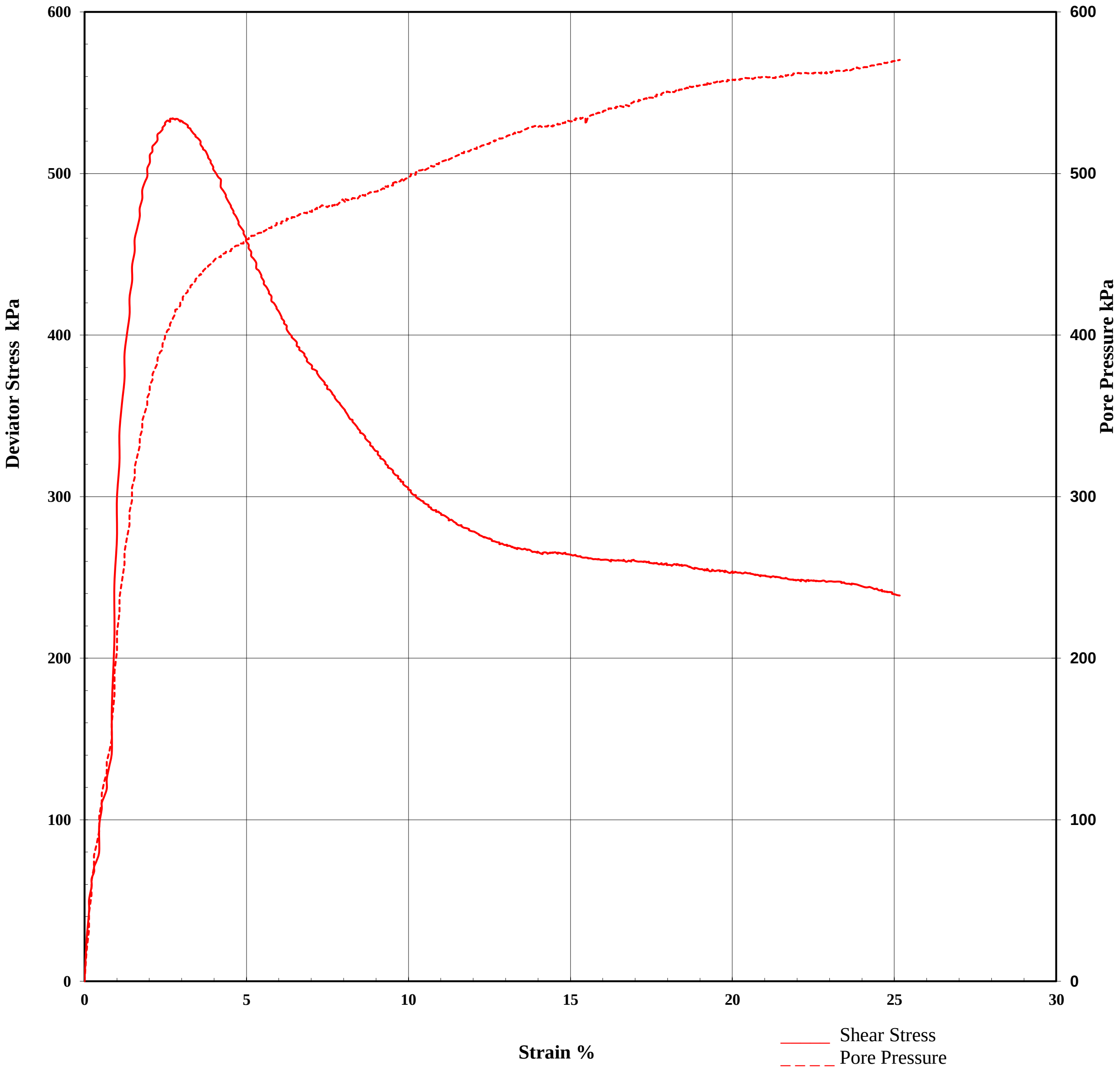
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080420 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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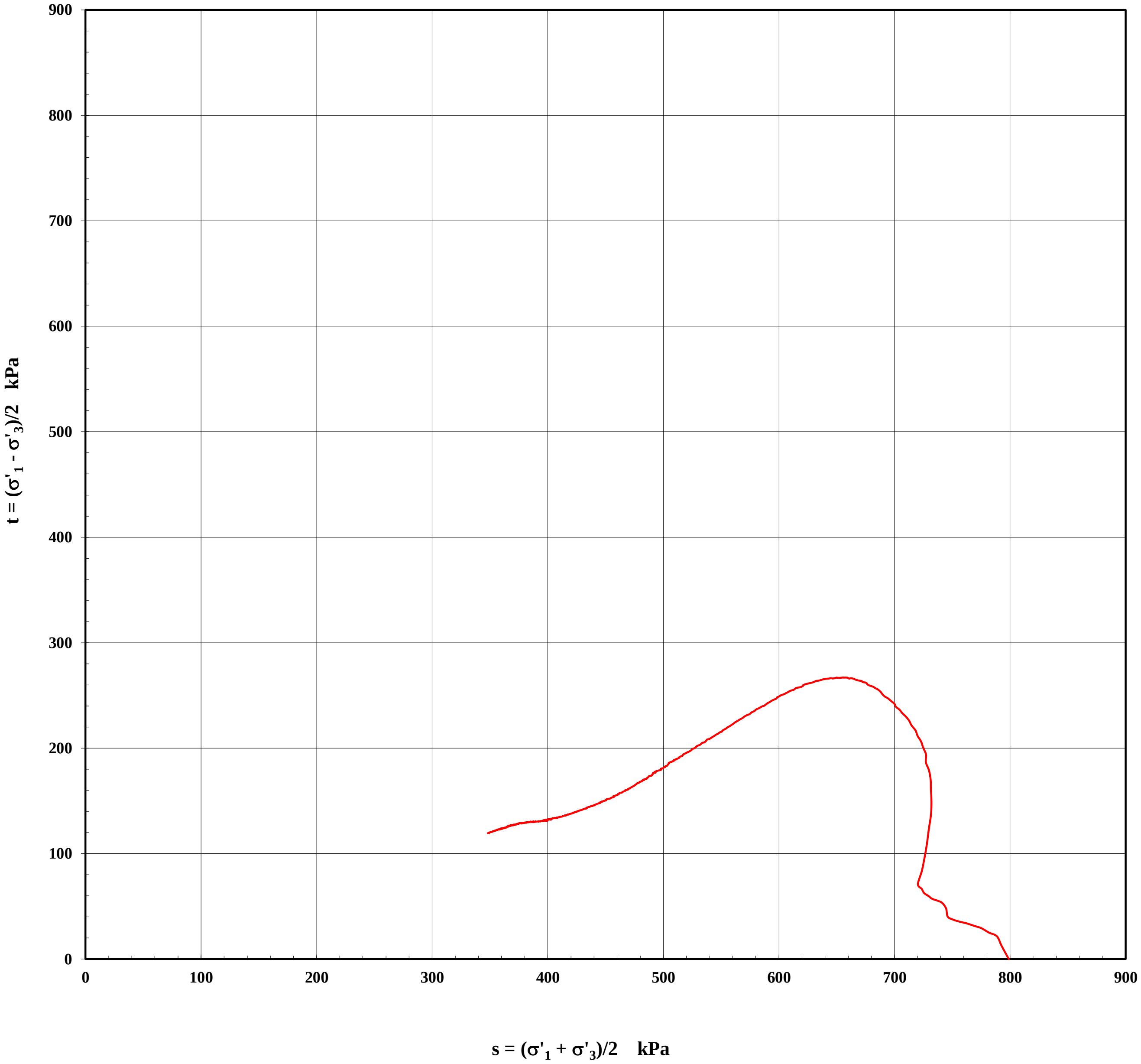
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080420 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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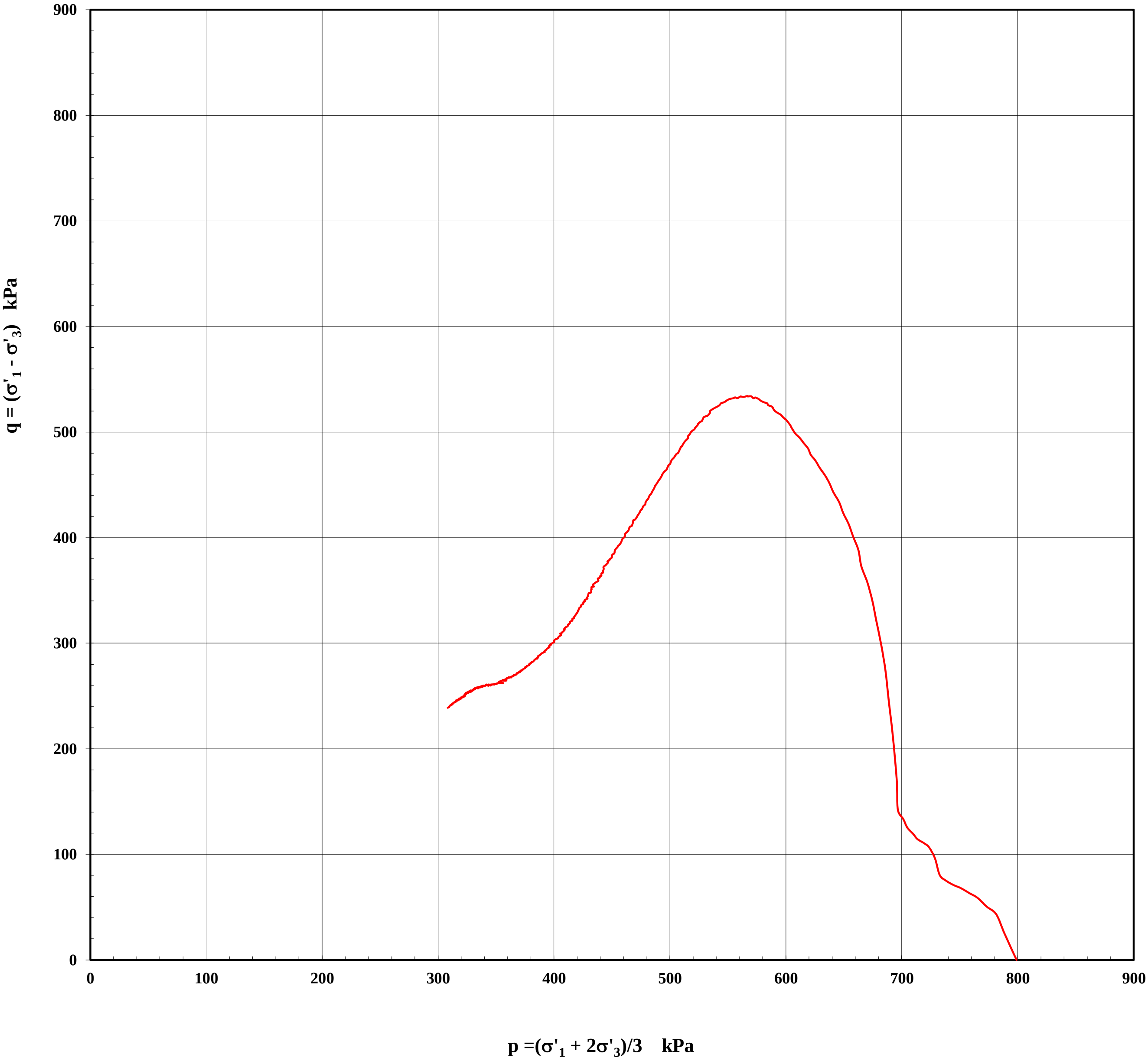
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080420 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18080420 - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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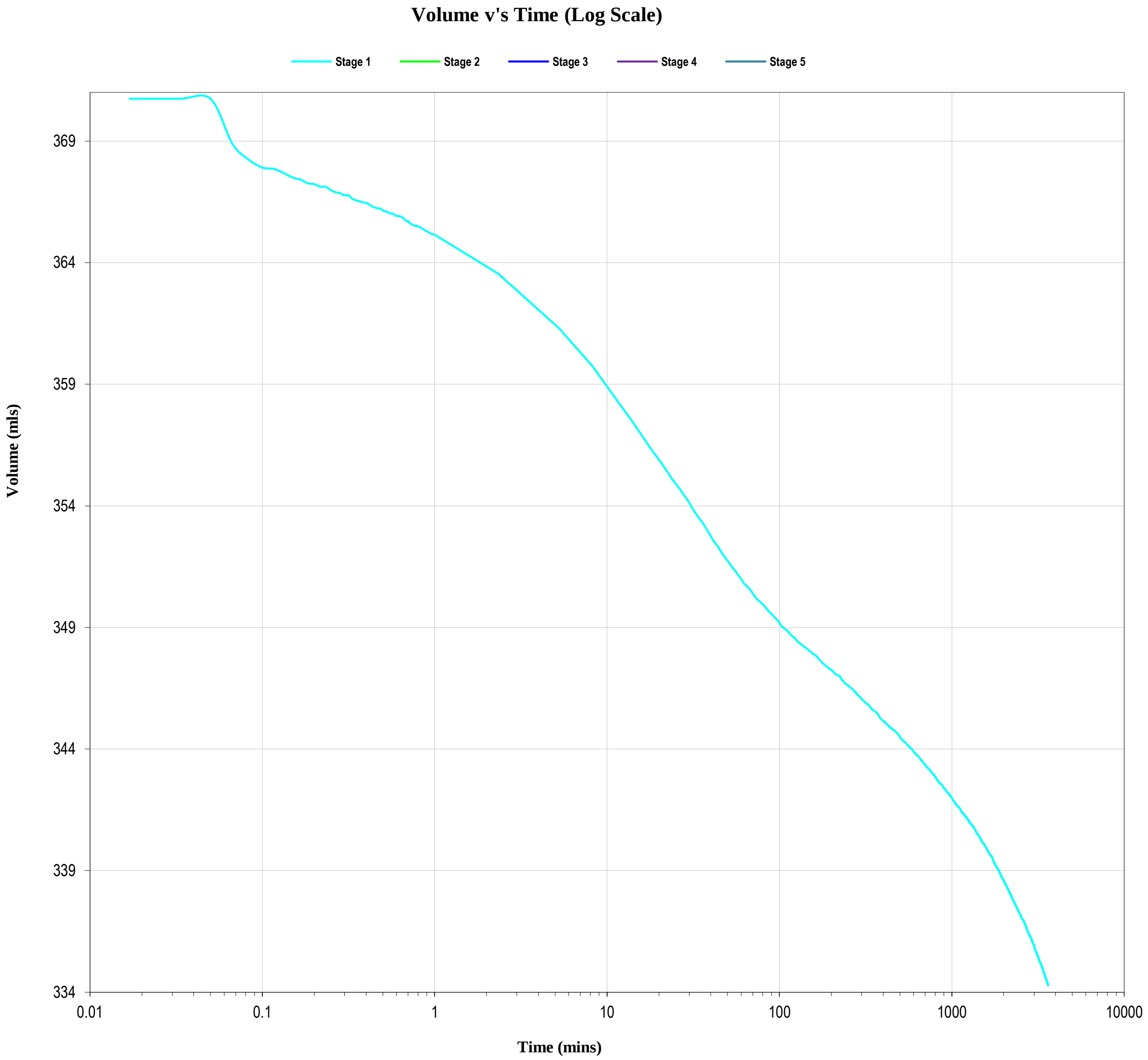
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080420 - CU



	Stage 1
Cv (m^2/year) **:**	**1.12**
Mv (m^2/MN) **:**	**0.069**
k (m/s) **:**	**2.39E-11**

Remarks: Tested as Received

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.:**	18080420 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	30/08/2018
		Report Date:	12/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE417 - DH406 L2B	**Depth (m):**	18.50-19.00
Description:	SILTY CLAY- orange and grey		

SAMPLE & TEST DETAILS

Initial Height:	130.8	mm	Initial Moisture Content:	41.1	%	Rate of Strain:	0.005	%/min
Initial Diameter:	63.9	mm	Final Moisture Content:	45.3	%	B Response:	98	%
L/D Ratio:	2.0 : 1		Wet Density:	1.72	t/m^3			
			Dry Density:	1.22	t/m^3			

Sample Type: Single Individual Undisturbed 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*
194 kPa	699 kPa	505 kPa	505 kPa	589 kPa	380 kPa	110 kPa	3.463	270 kPa	3.25 %
394 kPa	899 kPa	505 kPa	505 kPa	683 kPa	611 kPa	216 kPa	2.828	395 kPa	5.88 %

FAILURE ENVELOPES

Interpretation between stages : **1 to 2**
Cohesion C' (kPa) : **48.0**
Angle of Shear Resistance Φ' (Degrees) : **21.7**
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

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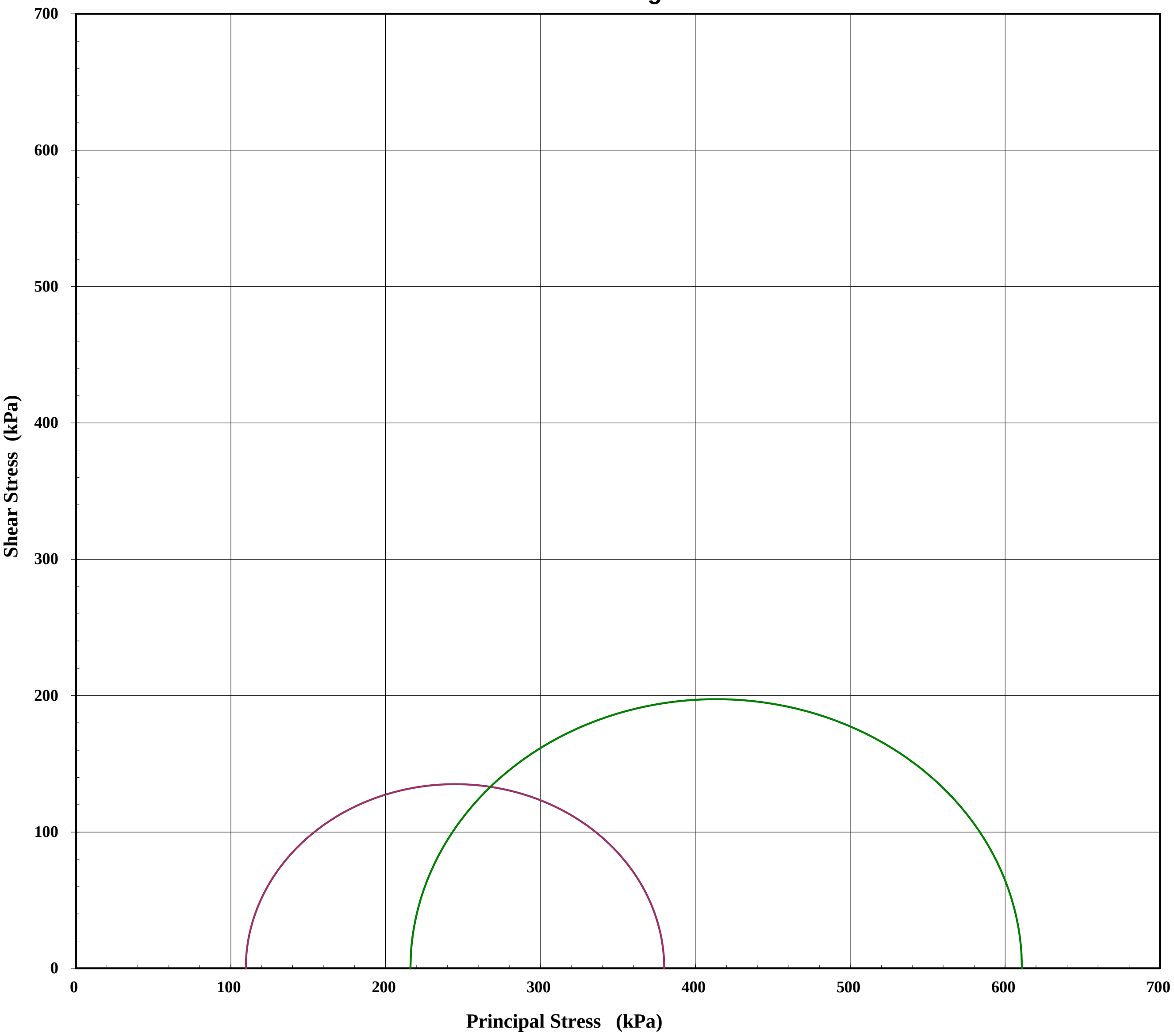
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080420 - CU

Mohr Circle Diagram



Interpretation between stages : 1 to 2
Cohesion C' (kPa) : 48.0
Angle of Shear Resistance Φ' (Degrees) : 21.7
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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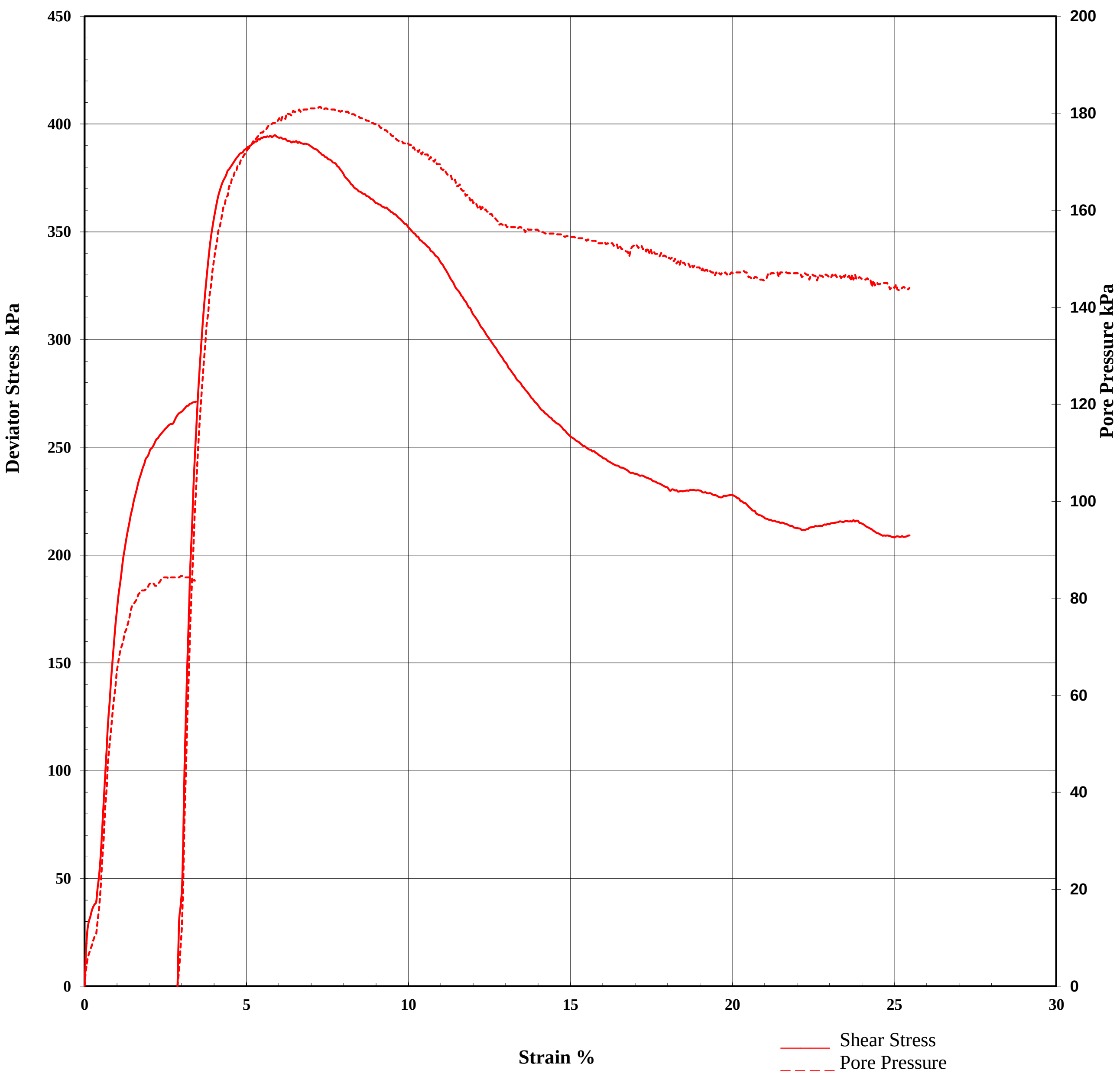
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080420 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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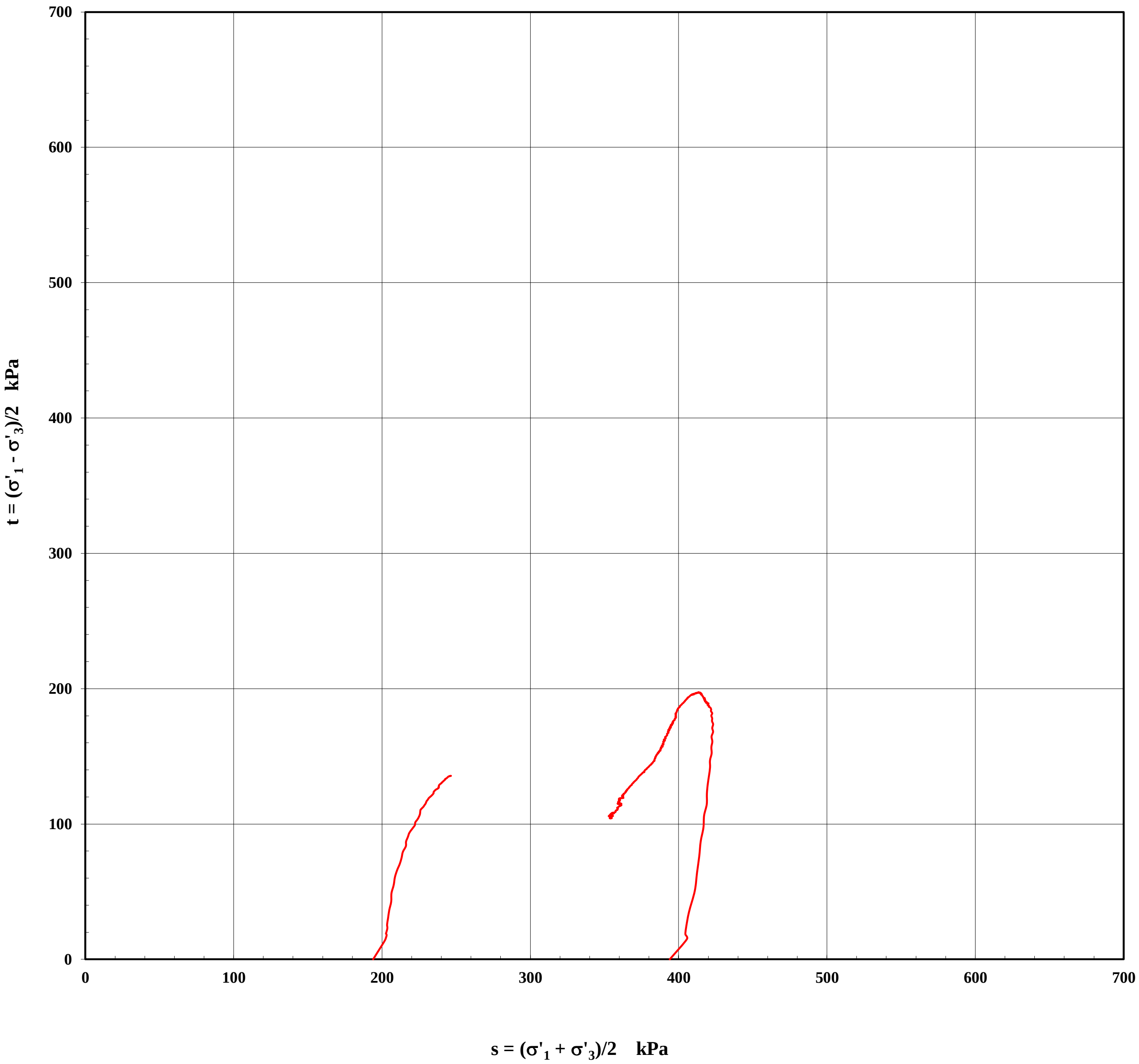
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080420 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

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Note: Graph not to scale

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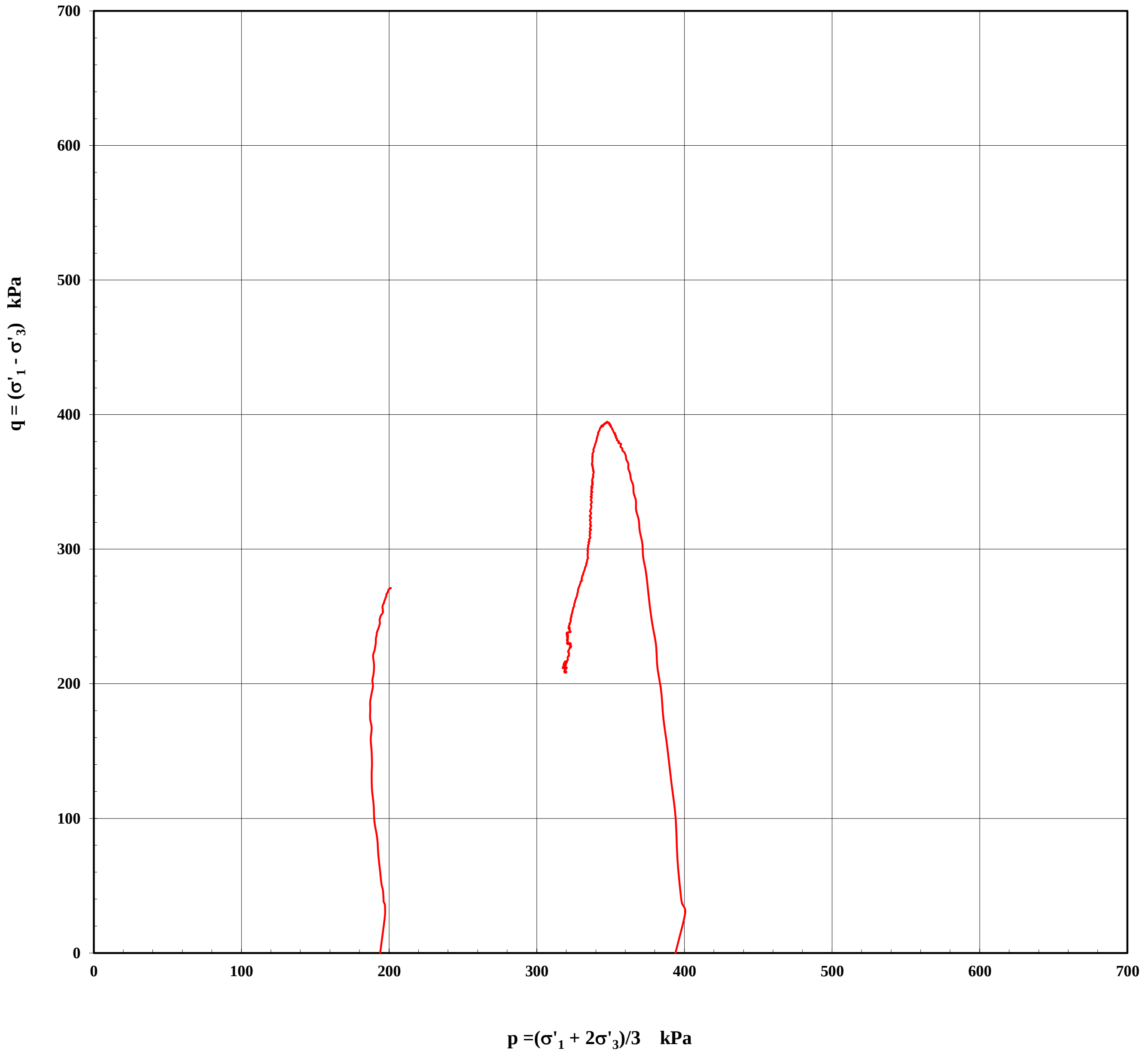
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080420 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18080420 - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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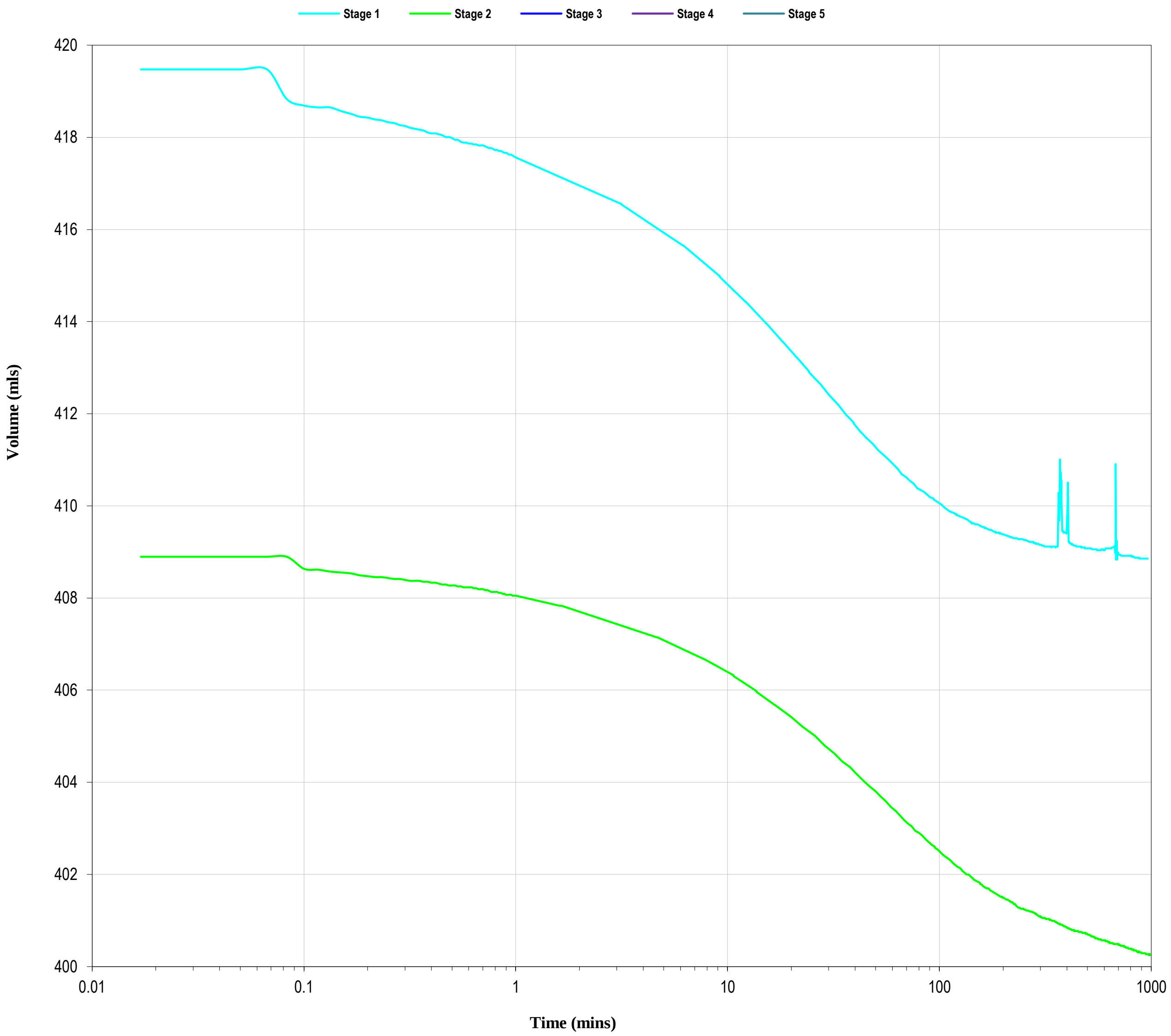
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080420 - CU

Volume v's Time (Log Scale)



	Stage 1	Stage 2
Cv (m^2/year) **:**	0.98	0.78
Mv (m^2/MN) **:**	0.118	0.109
k (m/s) **:**	3.60E-11	2.63E-11

Remarks: Tested as Received

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.:**	18080432 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	30/08/2018
		Report Date:	13/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE411A - DH409A L1	**Depth (m):**	14.50-15.00
Description:	SILTY CLAY- mottled orange yellow brown		

SAMPLE & TEST DETAILS

Initial Height:	131.6	mm	Initial Moisture Content:	24.6	%	Rate of Strain:	0.005	%/min
Initial Diameter:	61.3	mm	Final Moisture Content:	24.3	%	B Response:	99	%
L/D Ratio:	2.1 : 1		Wet Density:	2.04	t/m^3			
			Dry Density:	1.64	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
398 kPa	900 kPa	502 kPa	502 kPa	698 kPa	669 kPa	202 kPa	3.312	467 kPa	3.20 %
786 kPa	1296 kPa	510 kPa	510 kPa	880 kPa	1239 kPa	416 kPa	2.978	823 kPa	6.04 %
1194 kPa	1697 kPa	503 kPa	503 kPa	1063 kPa	1824 kPa	634 kPa	2.877	1190 kPa	8.47 %

FAILURE ENVELOPES

Interpretation between stages :	**1 to 2**	**2 to 3**	**1 to 3**
Cohesion C' (kPa) :	**40.2**	**37.2**	**39.2**
Angle of Shear Resistance Φ' (Degrees) :	**27.0**	**27.2**	**27.1**
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received

Sample/s supplied by the client

REP03001

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

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Laboratory Number
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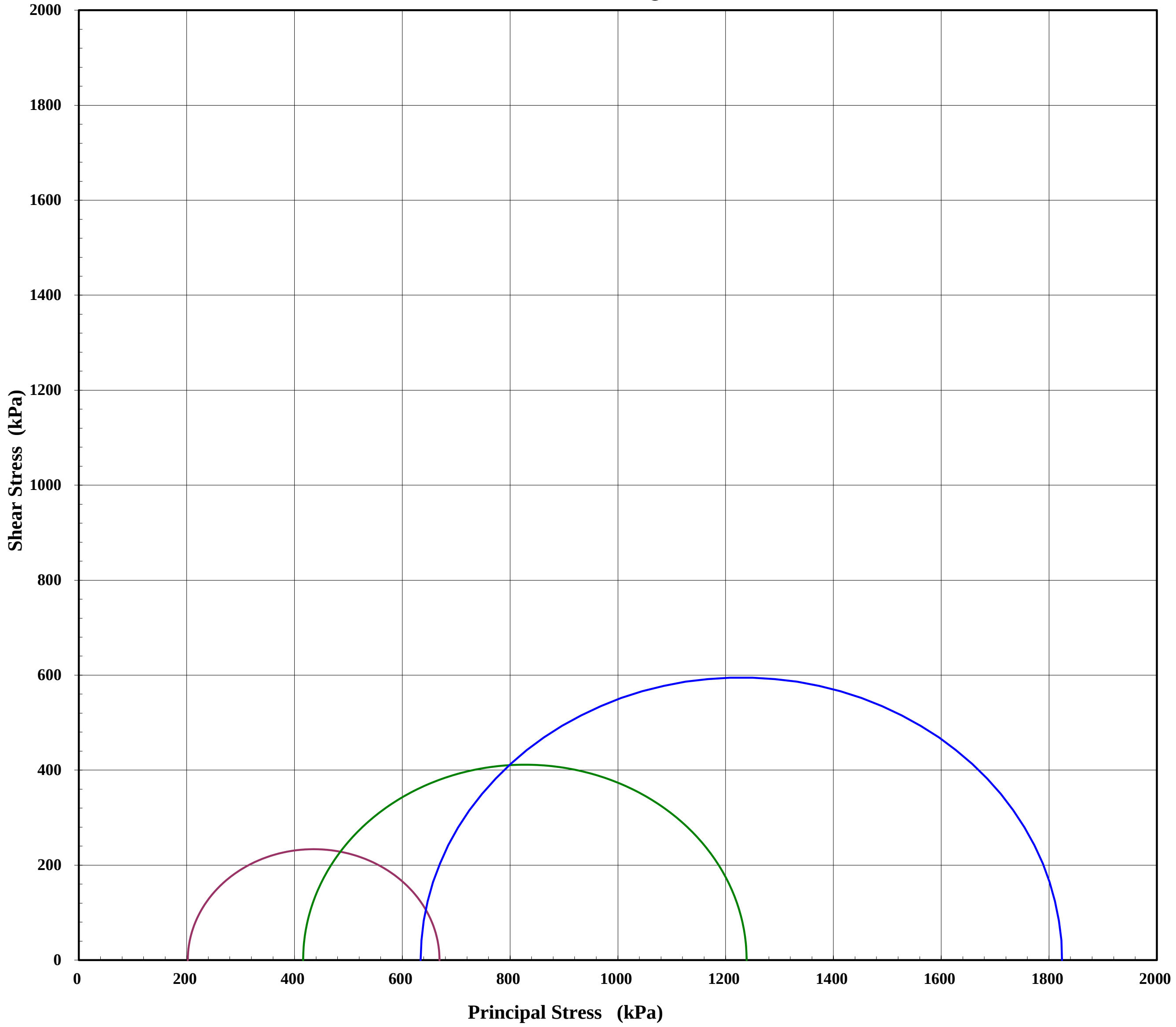
Ph: +61 8 9258 8323

TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080432 - CU

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	40.2	37.2	39.2
Angle of Shear Resistance Φ' (Degrees) :	27.0	27.2	27.1
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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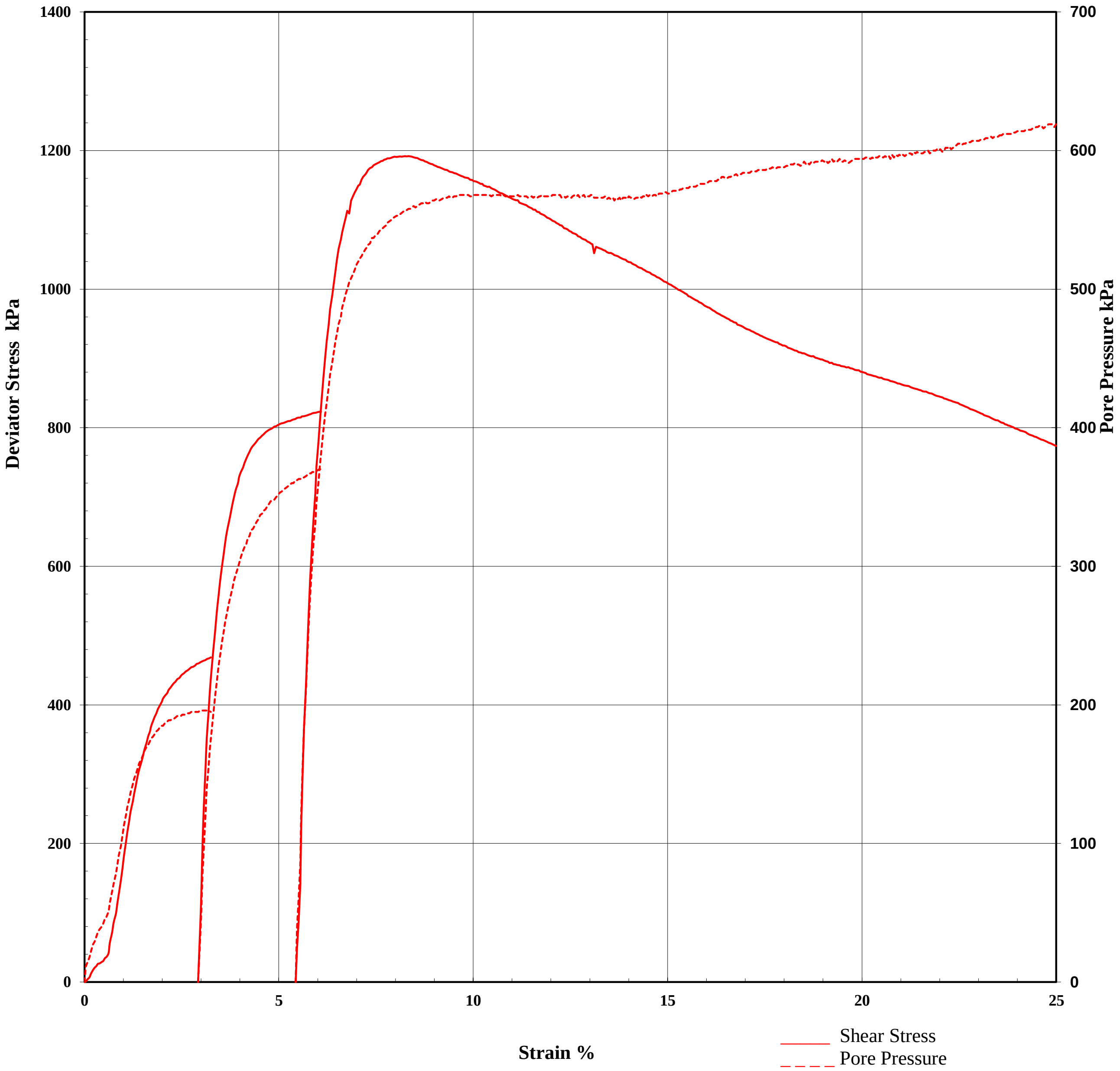
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080432 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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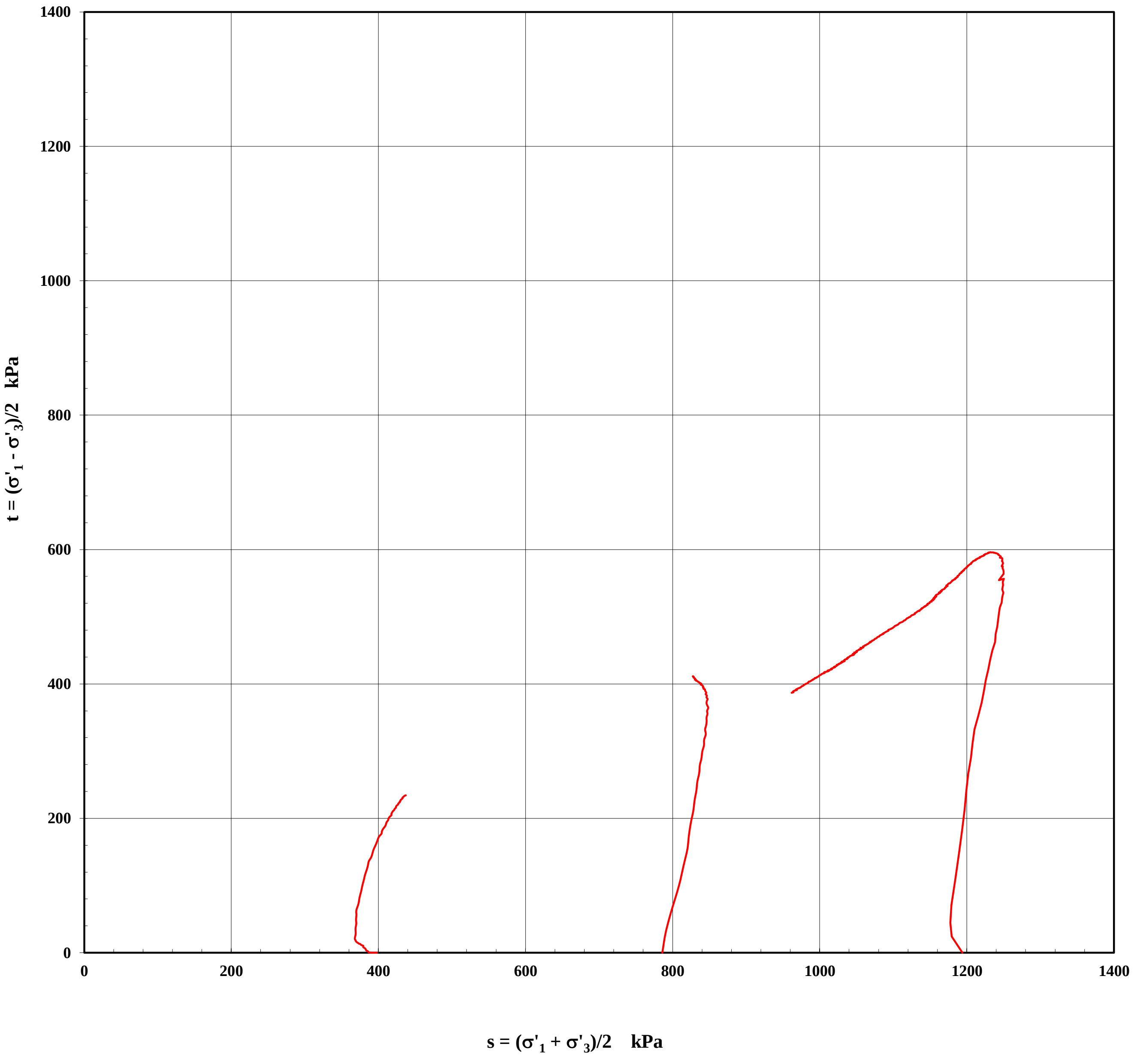
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080432 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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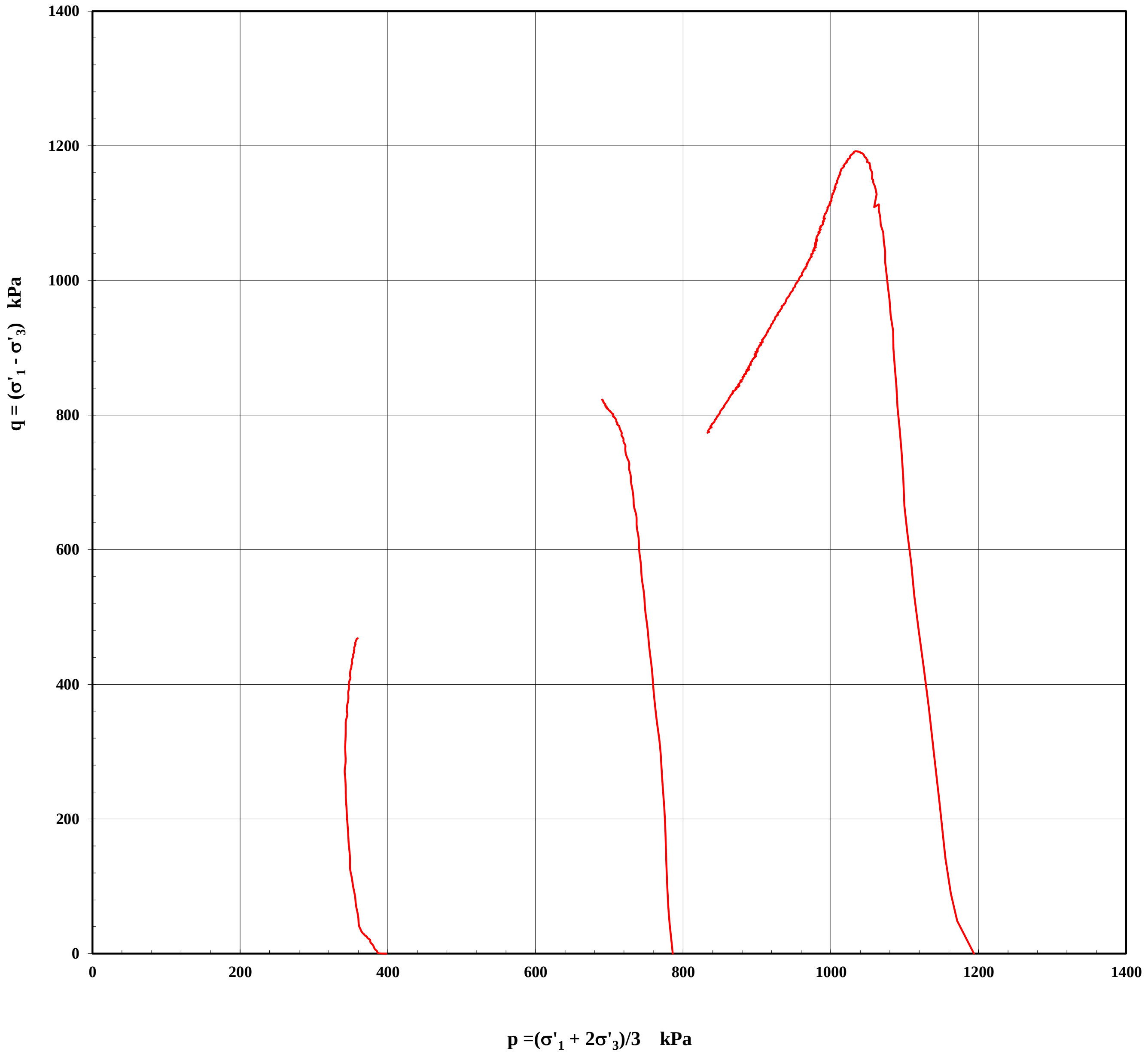
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080432 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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Sample/s supplied by the client

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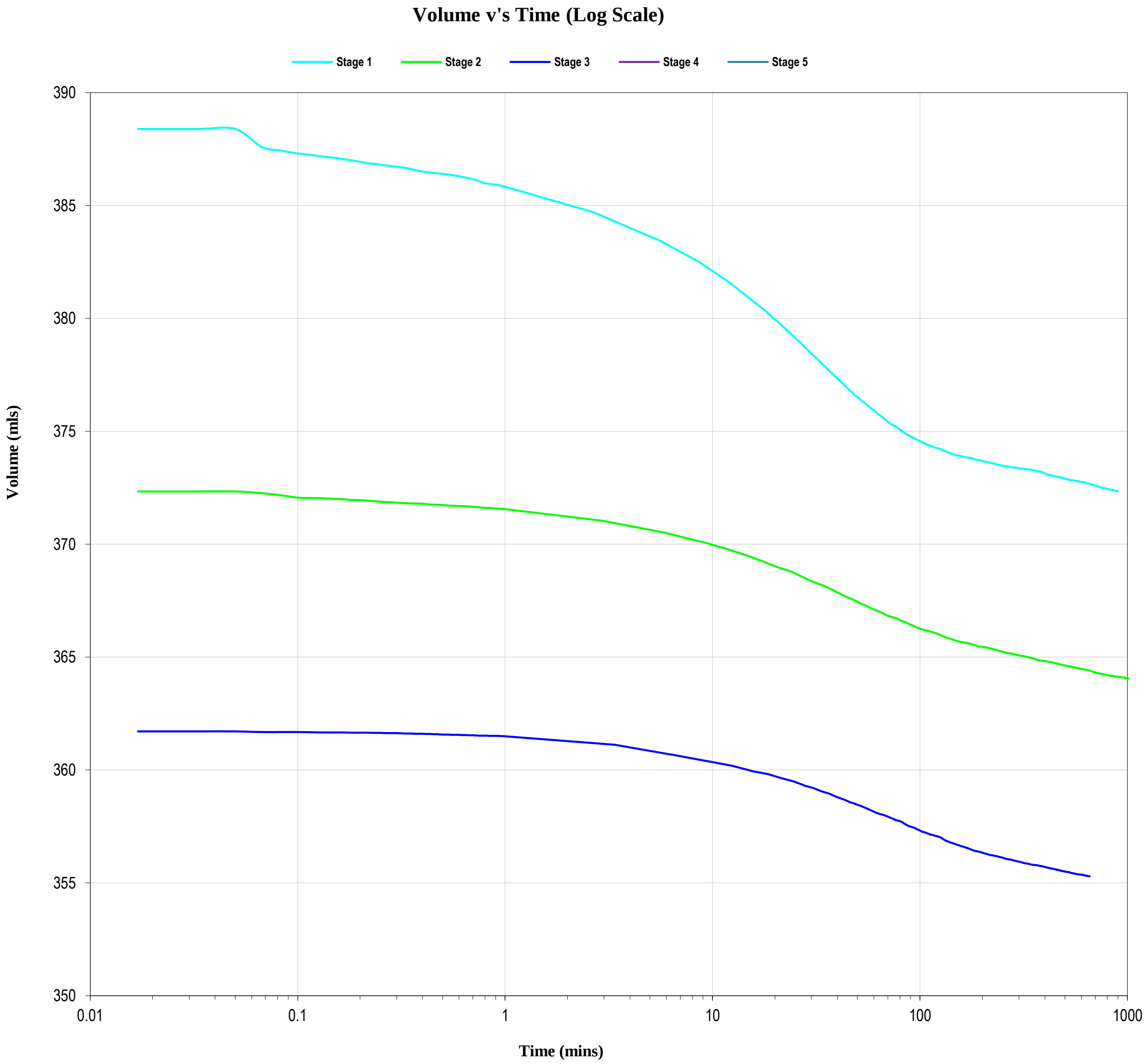

	Stage 1	Stage 2	Stage 3
Cv (m^2/year) **:**	**0.88**	**0.86**	**0.56**
Mv (m^2/MN) **:**	**0.091**	**0.076**	**0.070**
k (m/s) **:**	**2.47E-11**	**2.01E-11**	**1.22E-11**

Remarks: Tested as Received

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.:**	18080436 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	30/09/2018
		Report Date:	13/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE416 - DH407 L1B	**Depth (m):**	23.00-23.50
Description:	SILTY CLAY- orange brown		

SAMPLE & TEST DETAILS

Initial Height:	130.5	mm	Initial Moisture Content:	26.3	%	Rate of Strain:	0.006	%/min
Initial Diameter:	61.0	mm	Final Moisture Content:	28.1	%	B Response:	98	%
L/D Ratio:	2.1 : 1		Wet Density:	2.01	t/m^3			
			Dry Density:	1.59	t/m^3			

Sample Type: Single Individual Undisturbed 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*
1199 kPa	1698 kPa	499 kPa	499 kPa	1085 kPa	1592 kPa	613 kPa	2.598	979 kPa	3.10 %

FAILURE ENVELOPES

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

Remarks: Tested as Received

Sample/s supplied by the client

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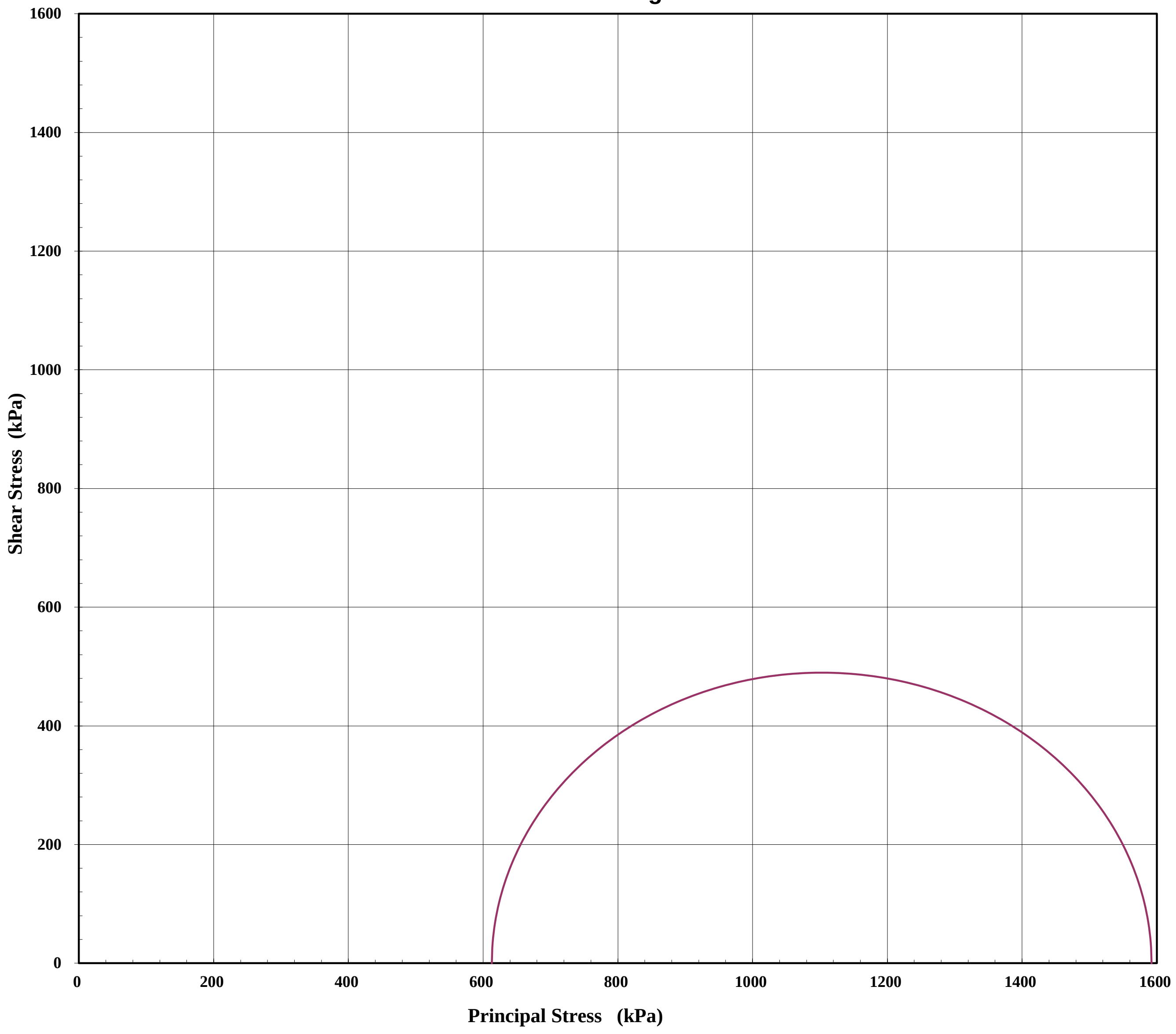
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18080436 - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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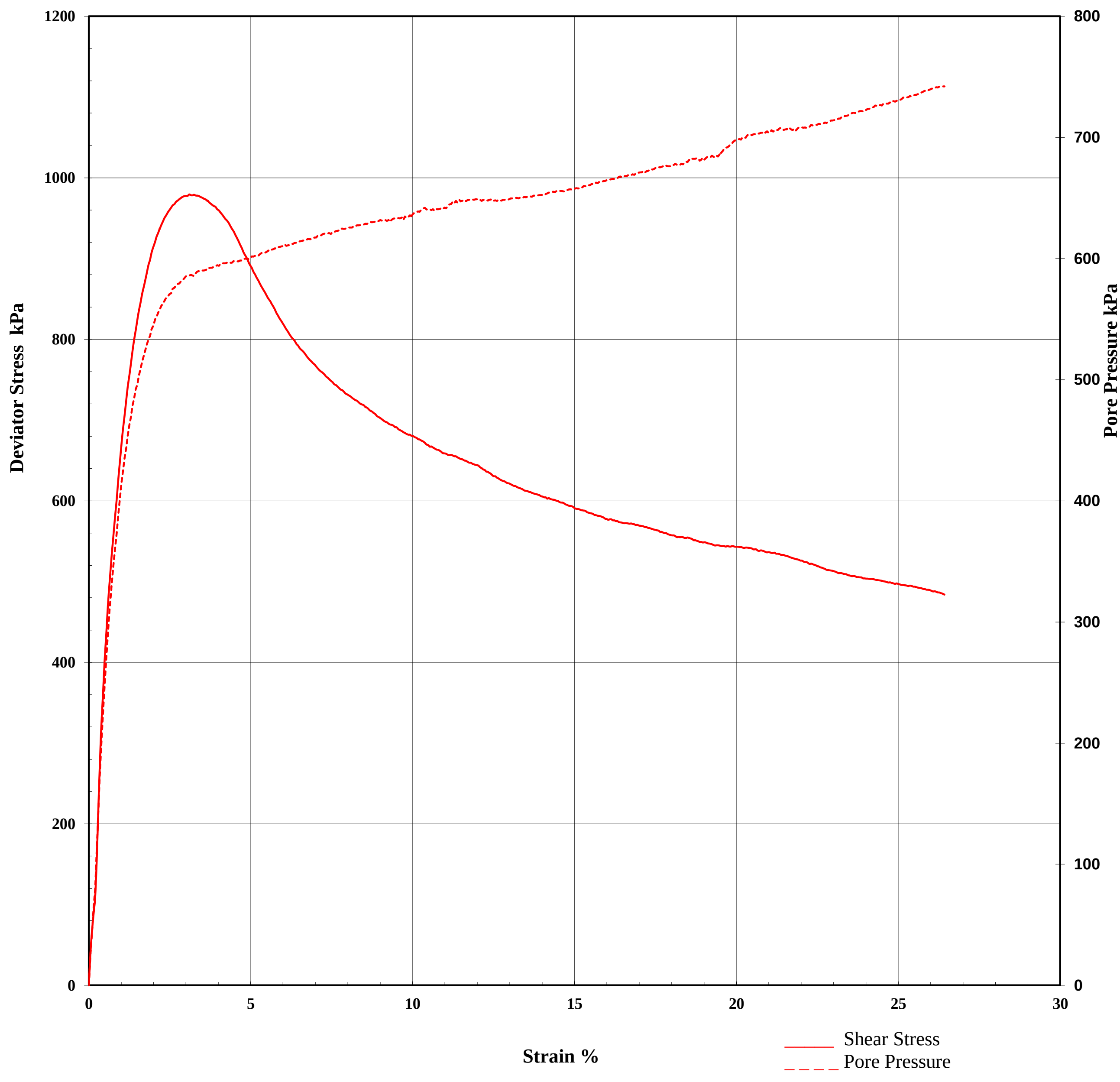
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080436 - CU

Stress/Strain & Pore Pressure/Strain Diagram



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Note: Graph not to scale

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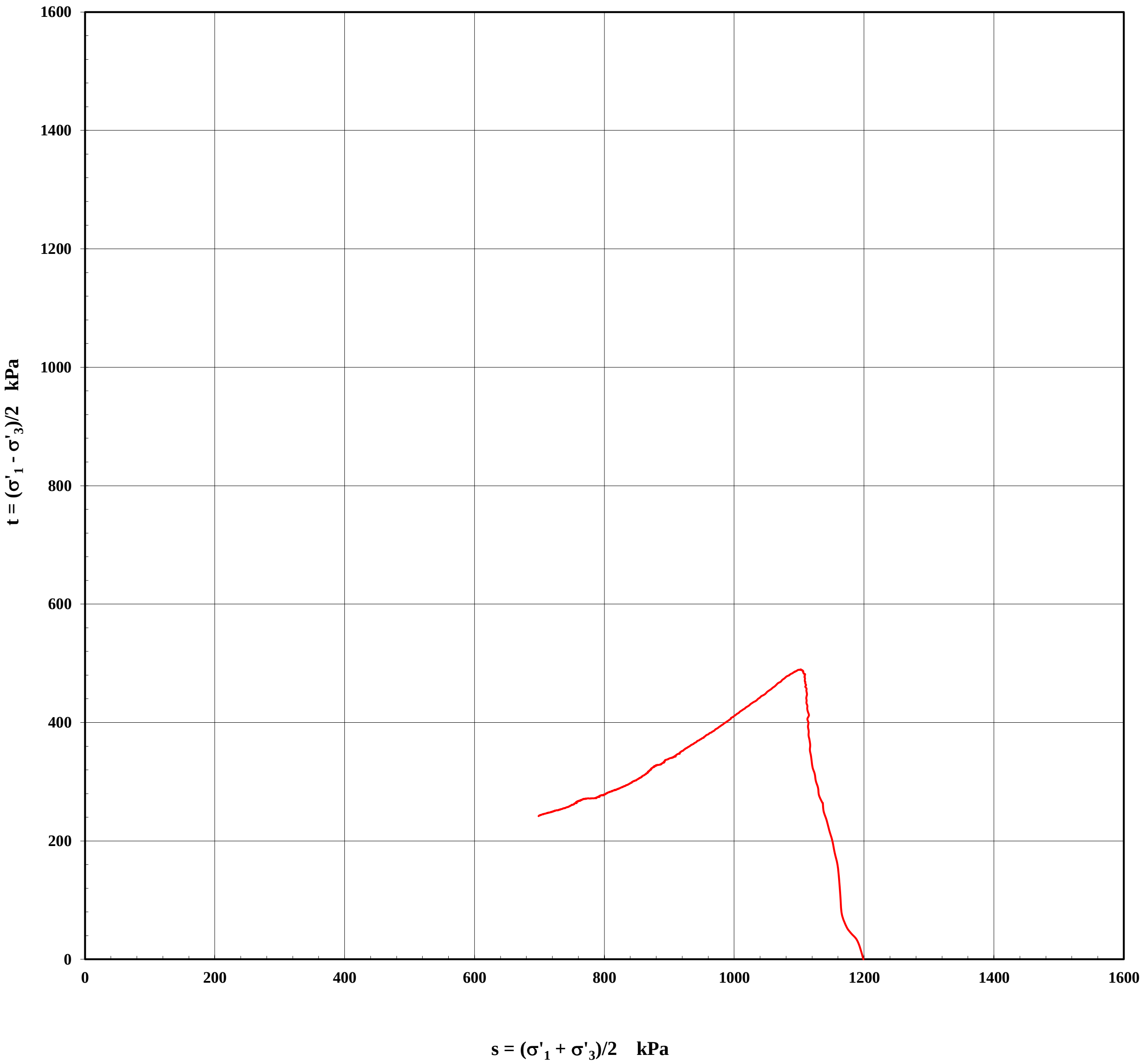
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080436 - CU

MIT Method - Effective Stress Path



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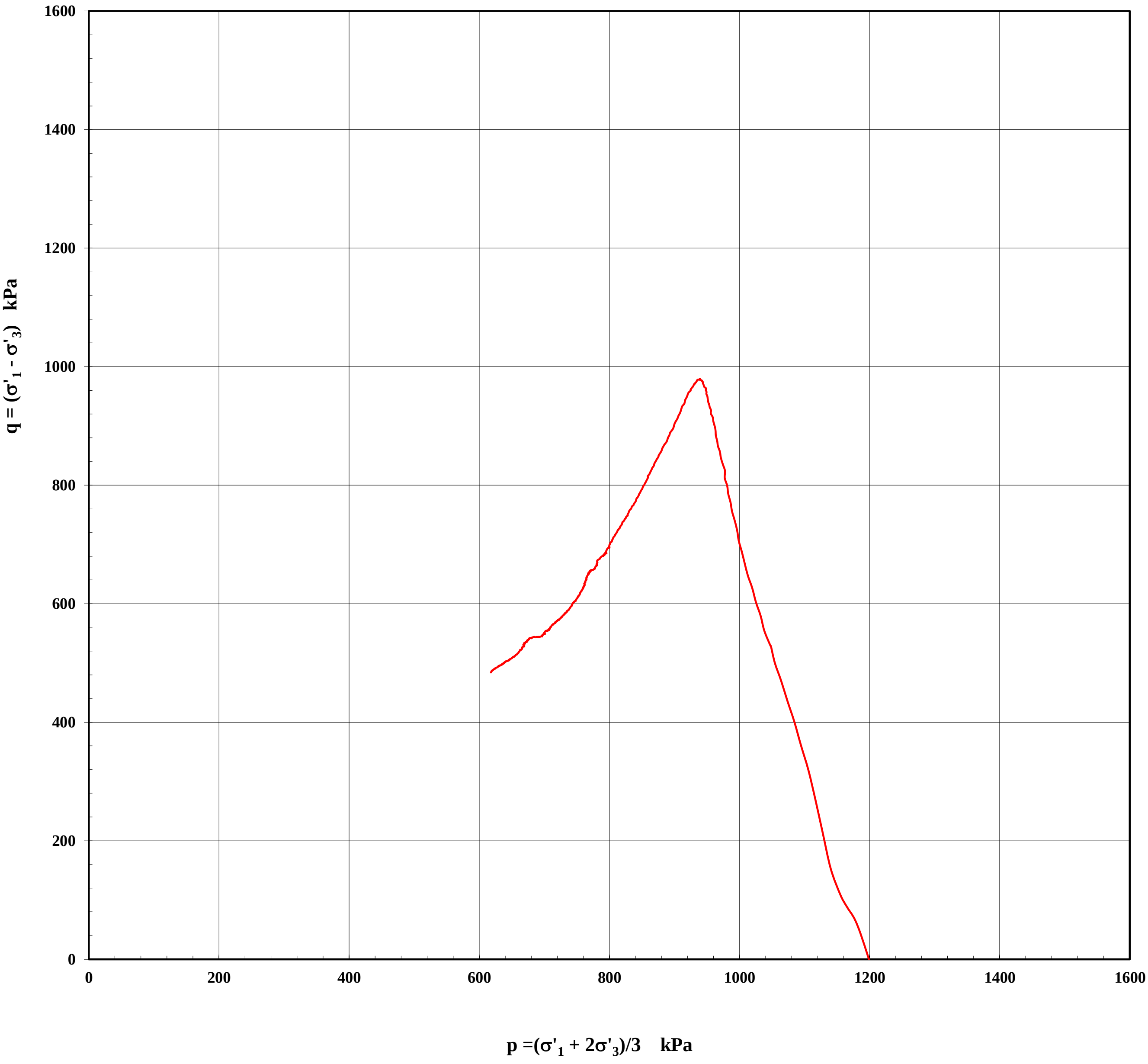
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080436 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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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.:** 18080436 - CU

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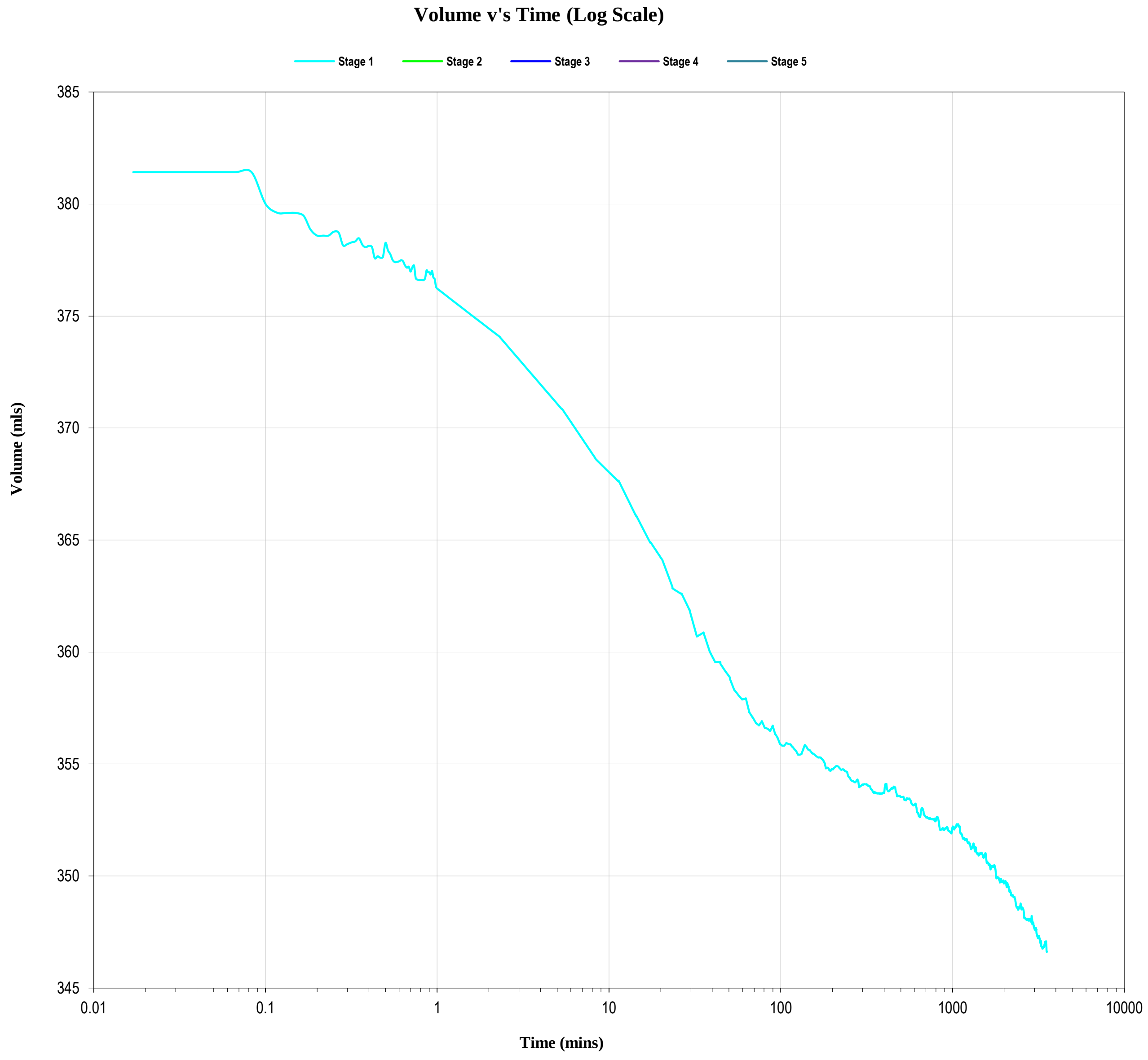
Client: Hatch Pty Ltd

Report No.: 18080436 - CU



	Stage 1
Cv (m^2/year) **:**	**0.95**
Mv (m^2/MN) **:**	**0.056**
k (m/s) **:**	**1.66E-11**

Remarks: Tested as Received

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.:**	18080436 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	30/08/2018
		Report Date:	13/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE416 - DH407 L1B	**Depth (m):**	23.00-23.50
Description:	SILTY CLAY- orange brown		

SAMPLE & TEST DETAILS

Initial Height:	129.9	mm	Initial Moisture Content:	28.0	%	Rate of Strain:	0.006	%/min
Initial Diameter:	61.0	mm	Final Moisture Content:	34.0	%	B Response:	97	%
L/D Ratio:	2.1 : 1		Wet Density:	2.01	t/m^3			
			Dry Density:	1.57	t/m^3			

Sample Type: Single Individual Undisturbed 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*
400 kPa	901 kPa	501 kPa	501 kPa	654 kPa	691 kPa	247 kPa	2.800	444 kPa	1.59 %
801 kPa	1302 kPa	501 kPa	501 kPa	791 kPa	1205 kPa	511 kPa	2.357	694 kPa	2.68 %

FAILURE ENVELOPES

Interpretation between stages : **1 to 2**
Cohesion C' (kPa) : **75.7**
Angle of Shear Resistance Φ' (Degrees) : **18.7**
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

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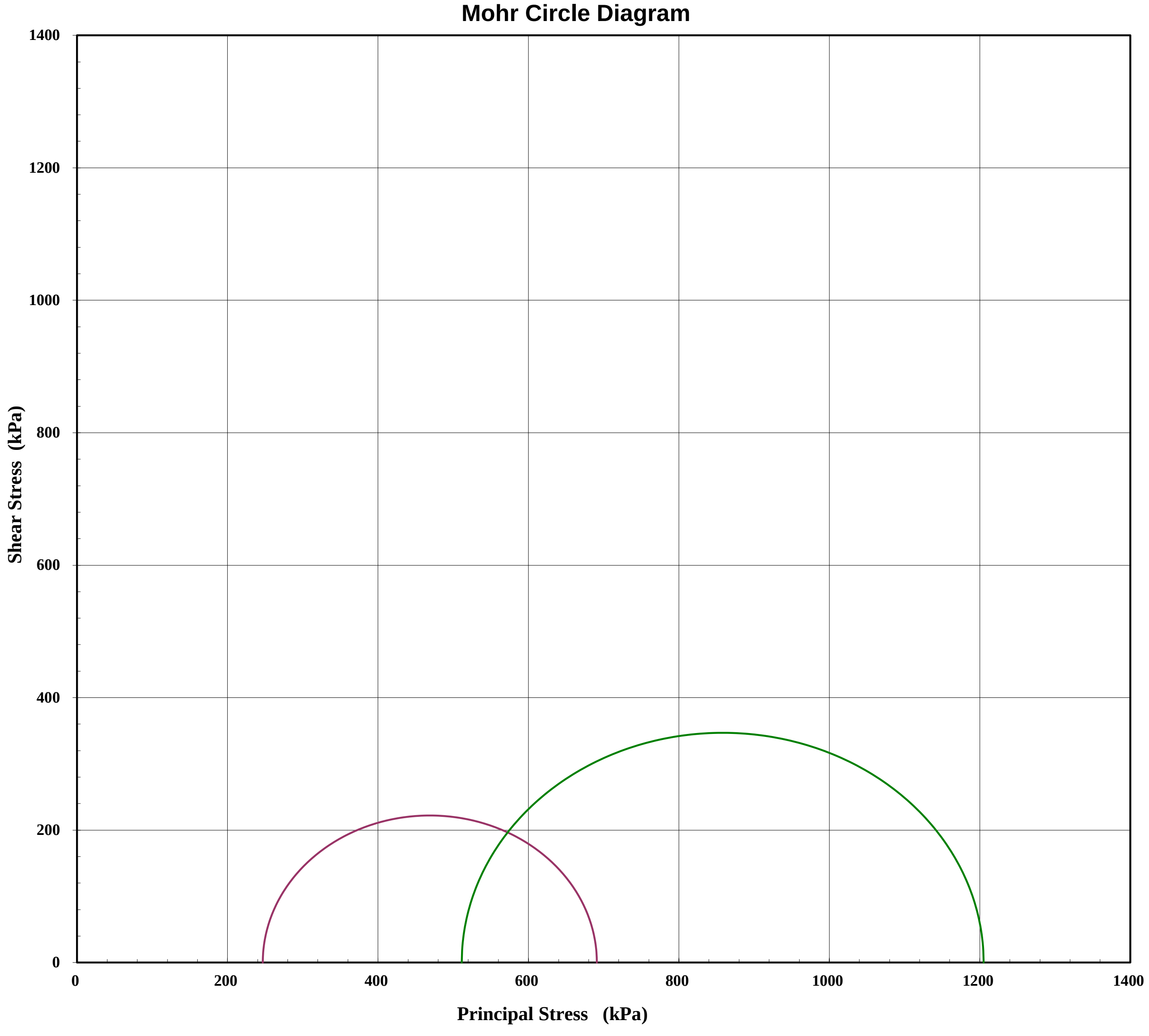
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080436 - CU



Interpretation between stages :	**1 to 2**
Cohesion C' (kPa) :	**75.7**
Angle of Shear Resistance Φ' (Degrees) :	**18.7**
Failure Criteria:	Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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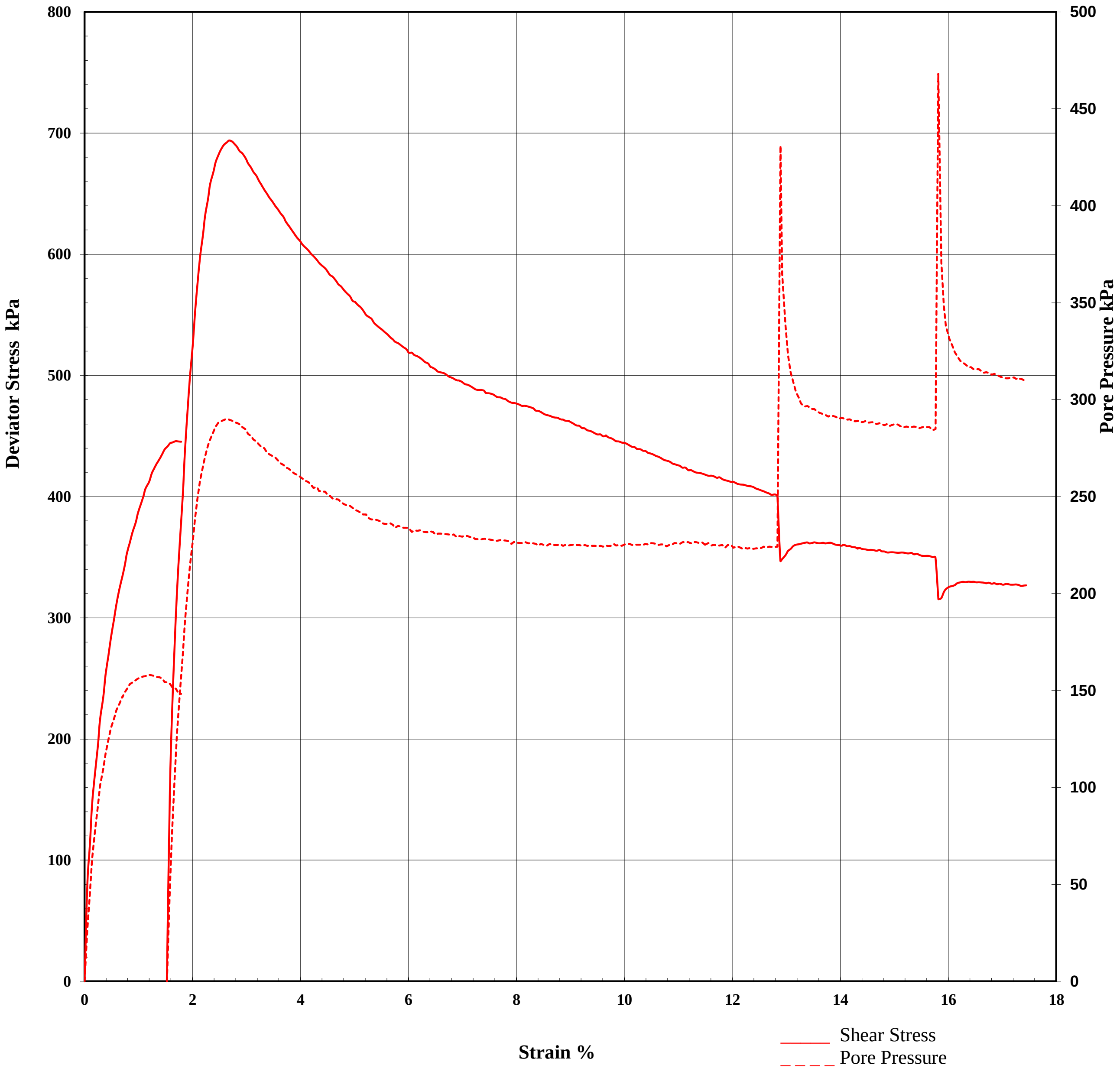
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080436 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

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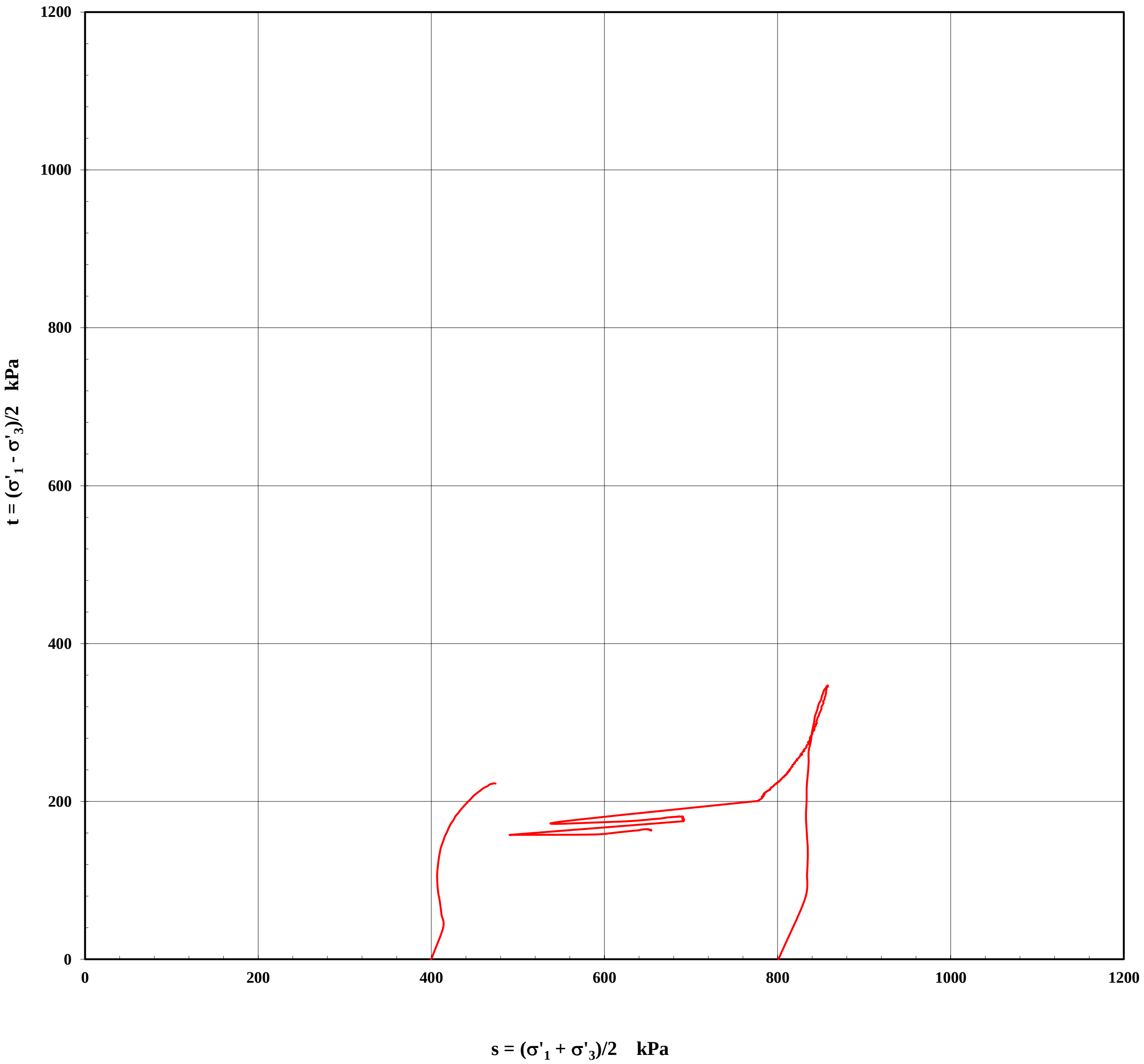
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080436 - CU

MIT Method - Effective Stress Path



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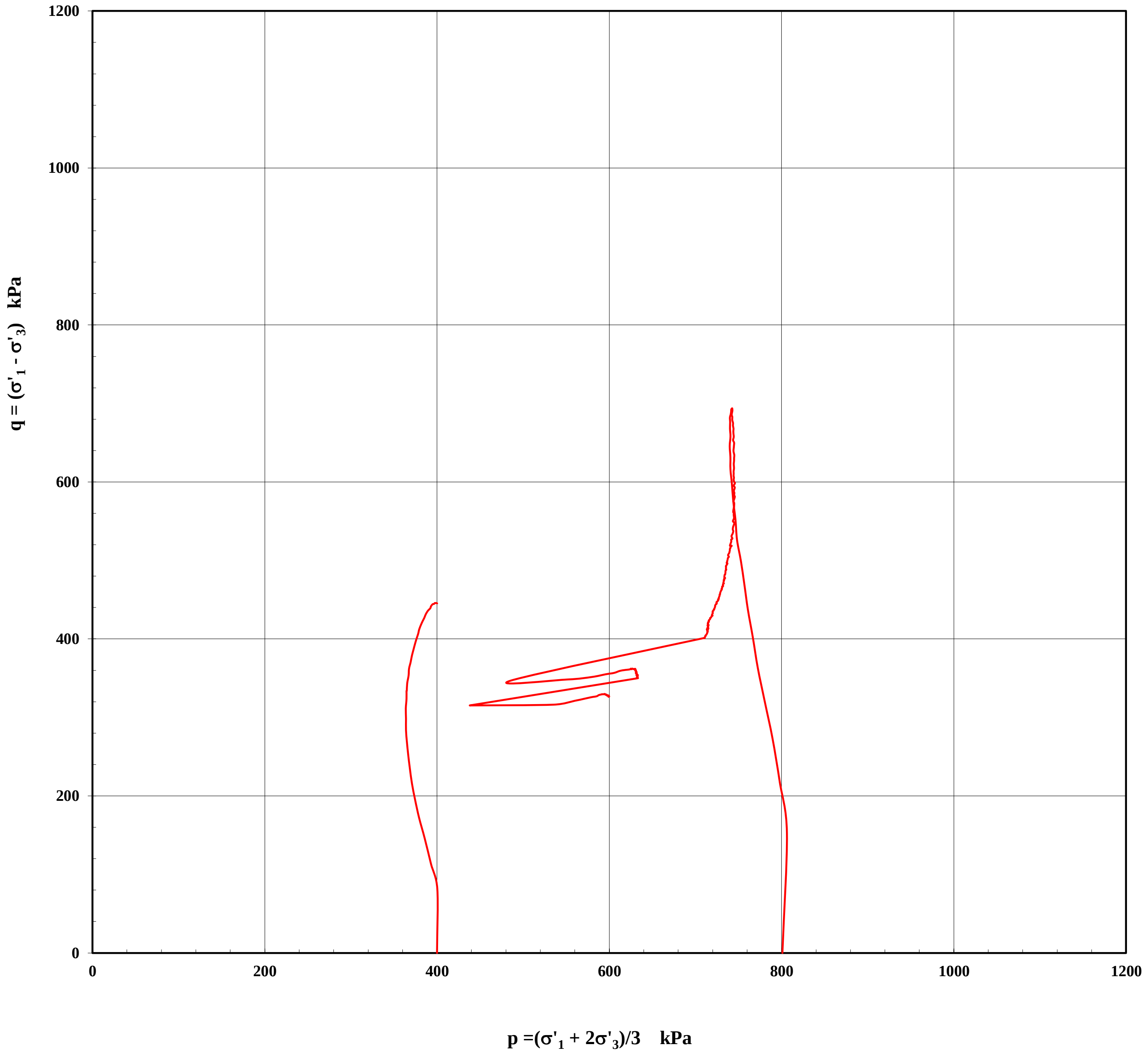
Client: Hatch Pty Ltd	**Report No.:** 18080436 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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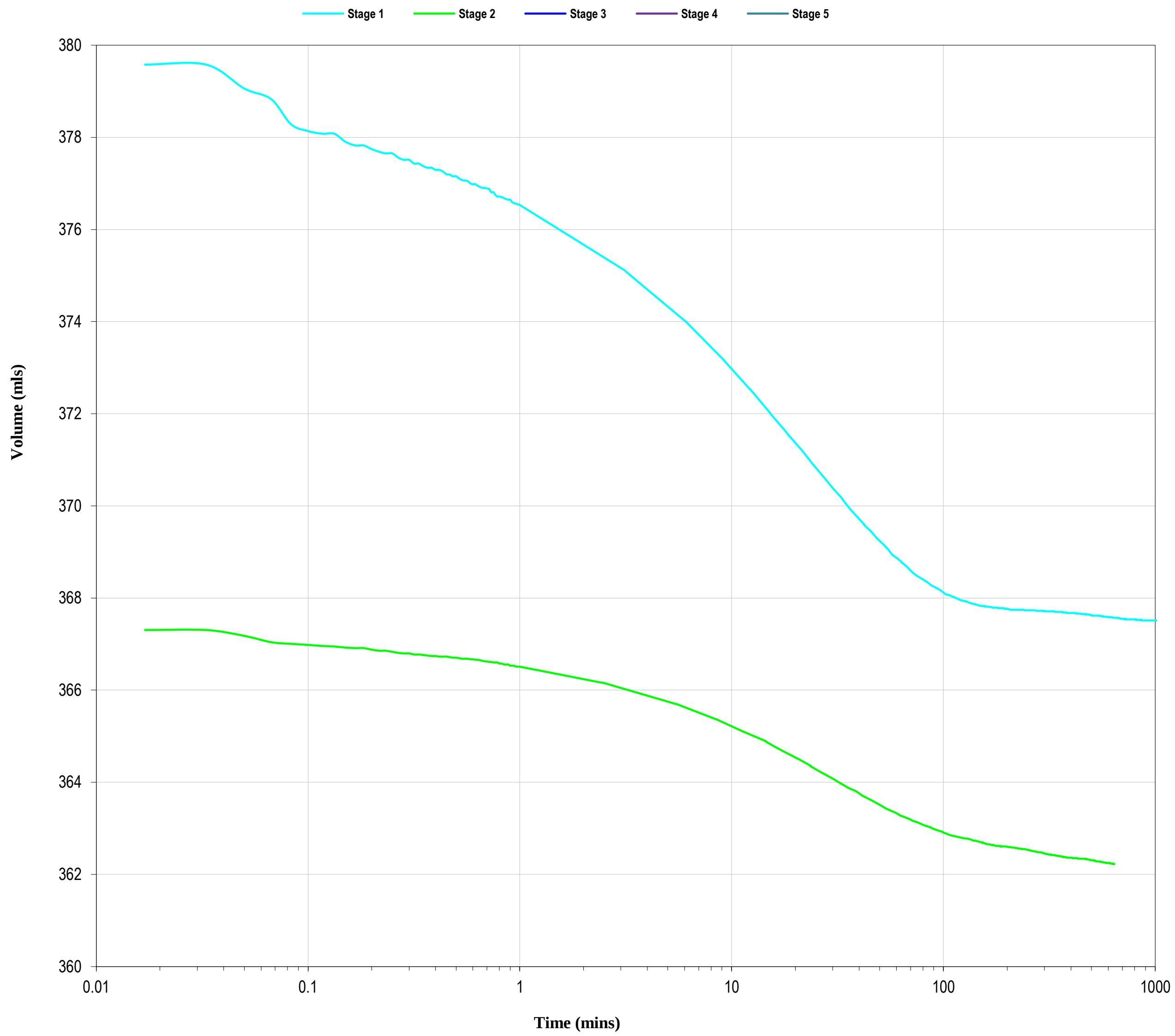
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080436 - CU

Volume v's Time (Log Scale)



	Stage 1	Stage 2
Cv (m^2/year) **:**	**0.94**	**1.30**
Mv (m^2/MN) **:**	**0.077**	**0.056**
k (m/s) **:**	**2.25E-11**	**2.23E-11**

Remarks: Tested as Received

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.:**	18080439 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	30/09/2018
		Report Date:	13/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE416 - DH407 PT3	**Depth (m):**	25.50-26.95
Description:	SILTY CLAY- brown		

SAMPLE & TEST DETAILS

Initial Height:	129.3	mm	Initial Moisture Content:	38.7	%	Rate of Strain:	0.005	%/min
Initial Diameter:	63.3	mm	Final Moisture Content:	38.8	%	B Response:	97	%
L/D Ratio:	2.0 : 1		Wet Density:	1.85	t/m^3			
			Dry Density:	1.33	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
400 kPa	899 kPa	499 kPa	499 kPa	754 kPa	663 kPa	145 kPa	4.588	519 kPa	2.74 %
799 kPa	1298 kPa	499 kPa	499 kPa	893 kPa	1162 kPa	405 kPa	2.869	757 kPa	4.90 %
1203 kPa	1703 kPa	500 kPa	500 kPa	1008 kPa	1664 kPa	695 kPa	2.396	970 kPa	6.81 %

FAILURE ENVELOPES

Interpretation between stages :	**1 to 2**	**2 to 3**	**1 to 3**
Cohesion C' (kPa) :	**139.6**	**174.9**	**151.6**
Angle of Shear Resistance Φ' (Degrees) :	**18.3**	**15.6**	**16.9**
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

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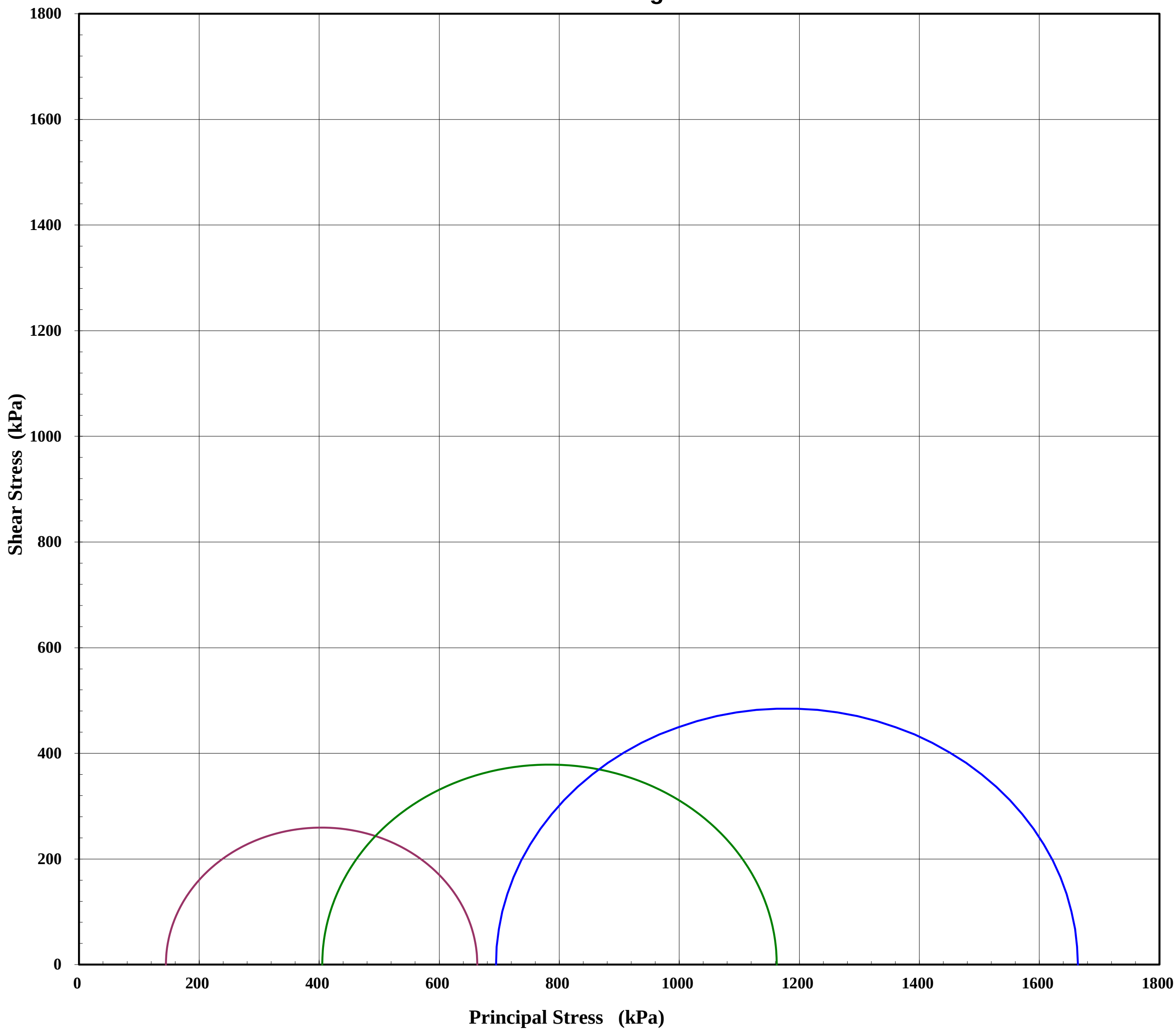
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080439 - CU

Mohr Circle Diagram



Interpretation between stages :	1 to 2	2 to 3	1 to 3
Cohesion C' (kPa) :	139.6	174.9	151.6
Angle of Shear Resistance Φ' (Degrees) :	18.3	15.6	16.9
Failure Criteria:	Peak Principal Stress Ratio		

Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

Note: Graph not to scale

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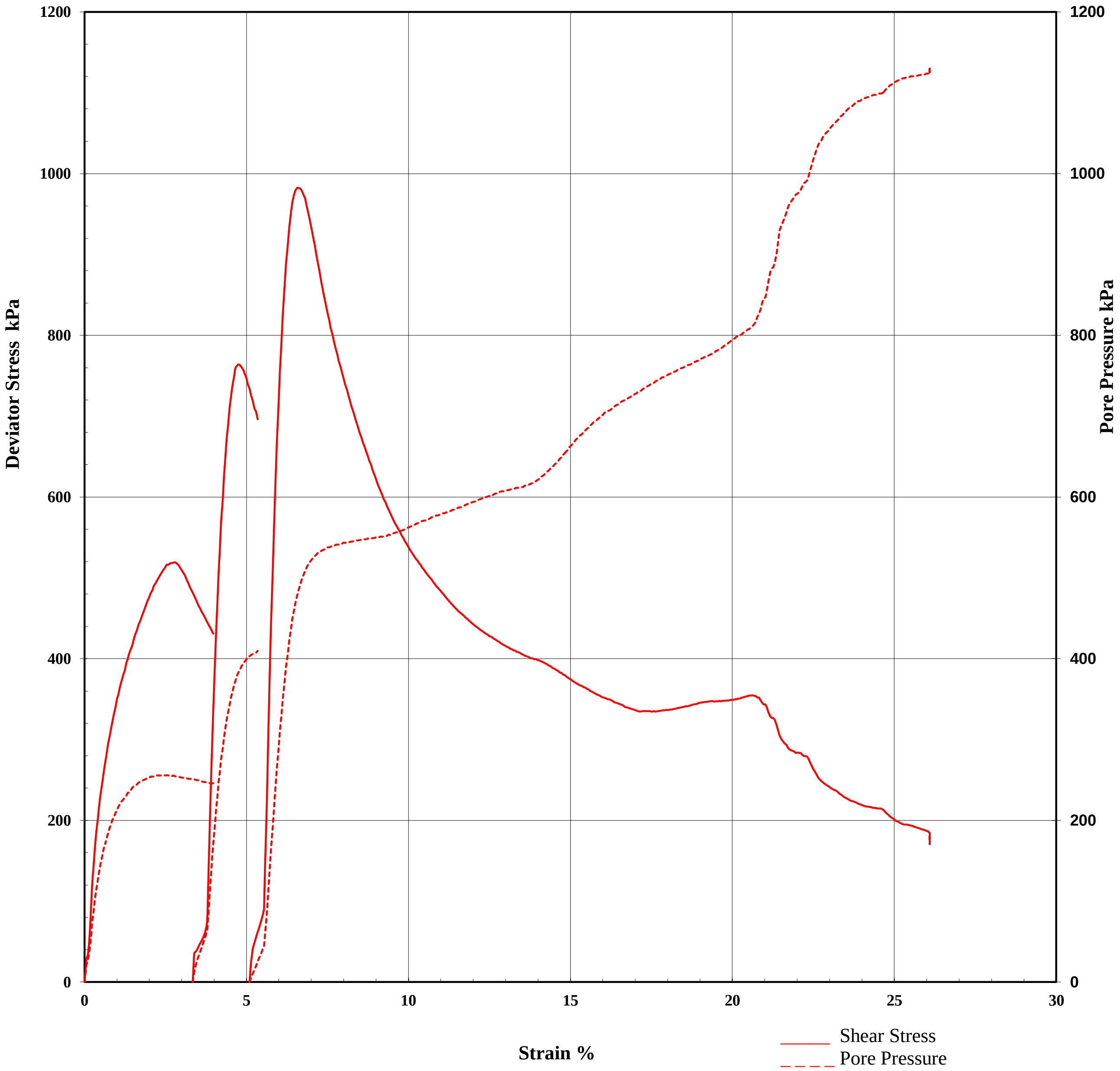
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080439 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

Note: Graph not to scale

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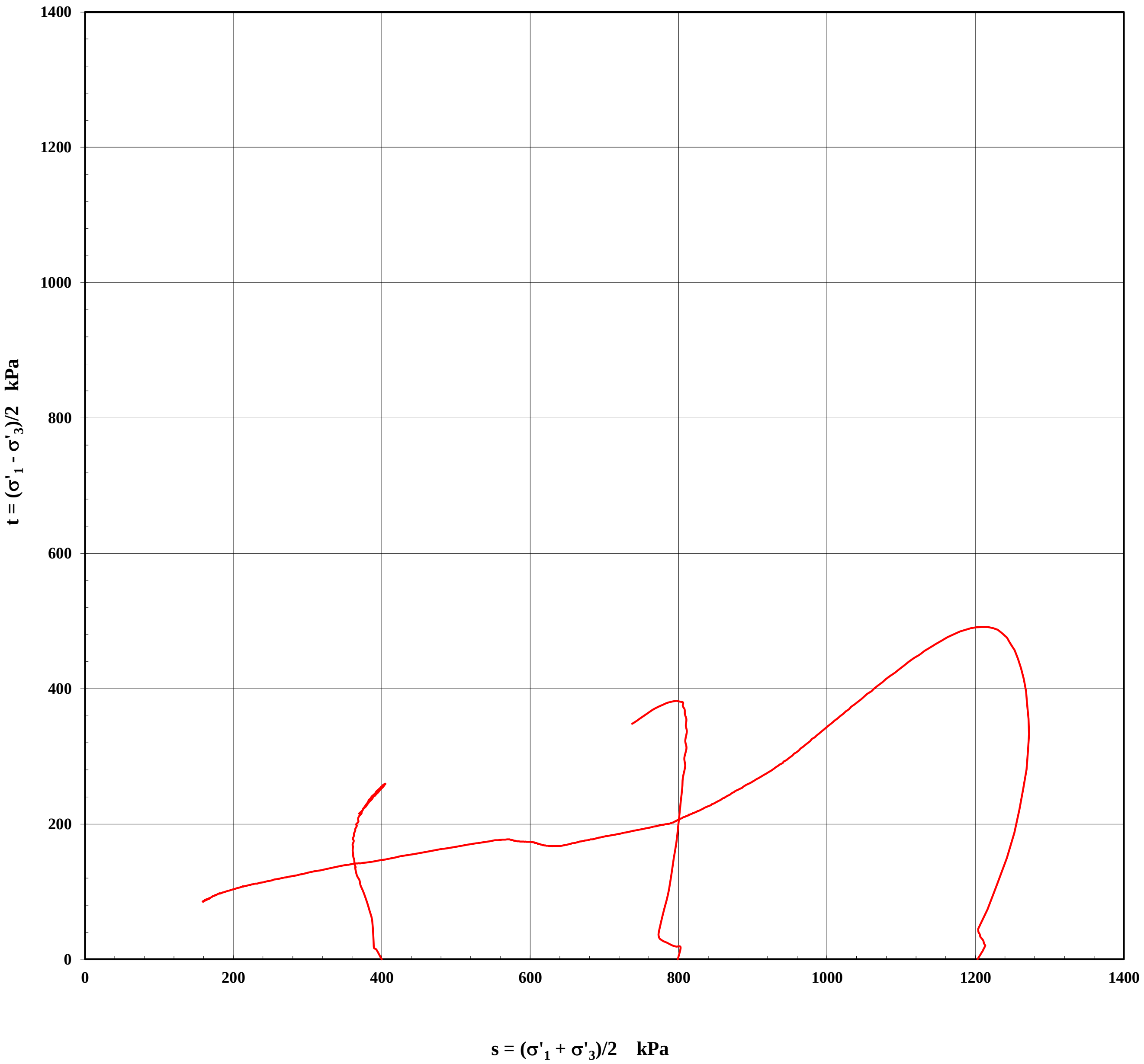
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080439 - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

Note: Graph not to scale

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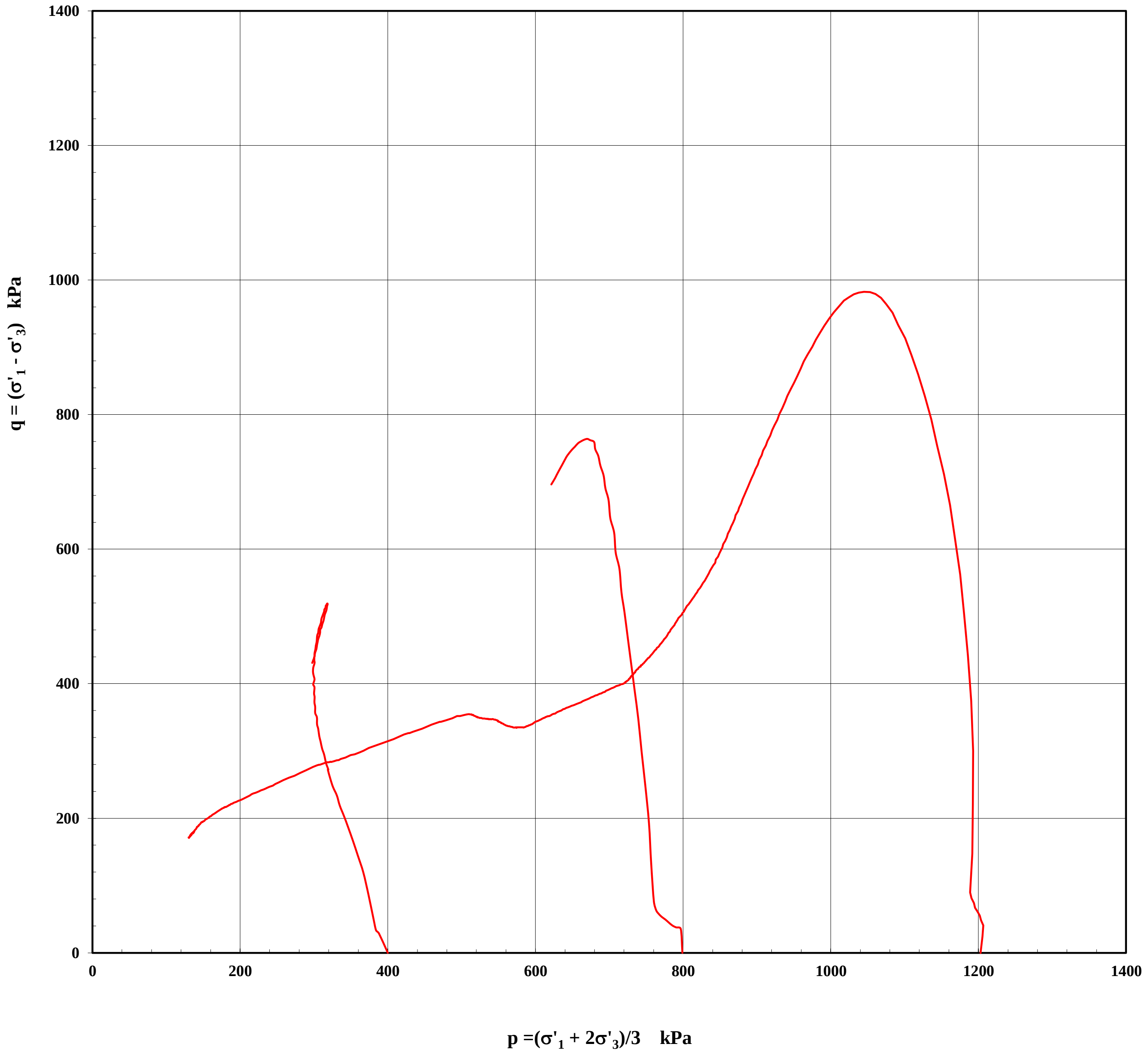
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080439 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

Note: Graph not to scale

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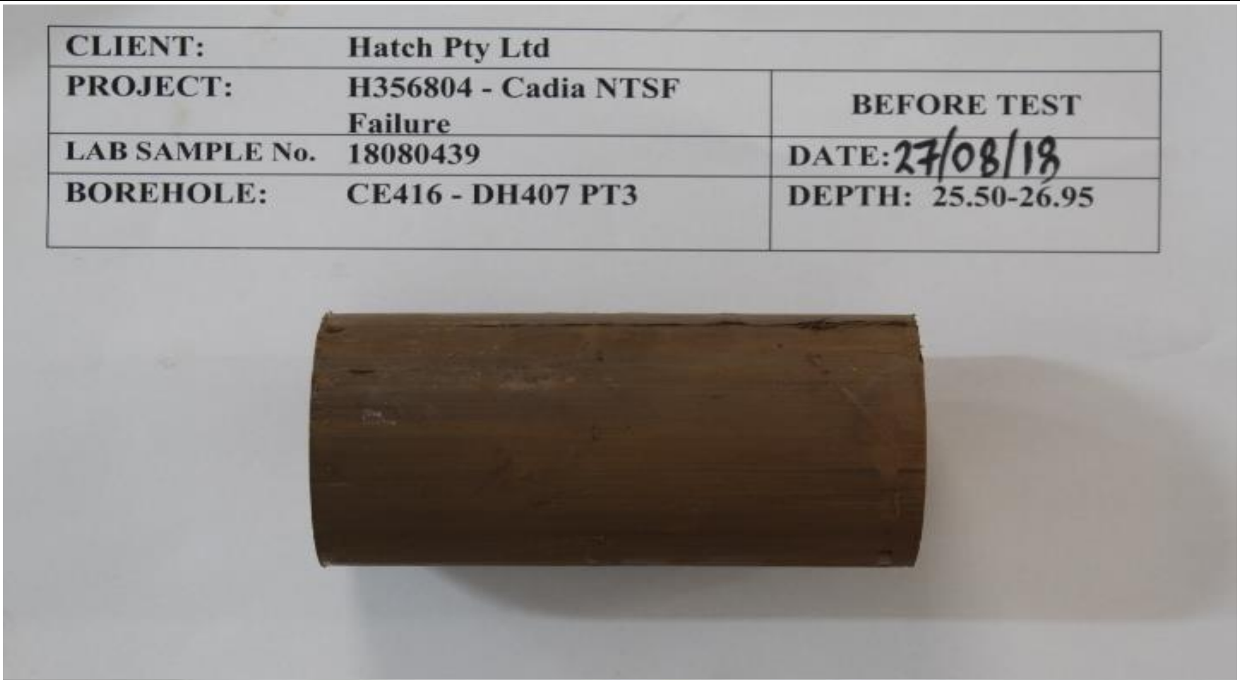
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080439 - CU



Remarks: Tested as Received. Sample considered to have failed on Stage 1.

Sample/s supplied by the client

Note: Photo not to scale

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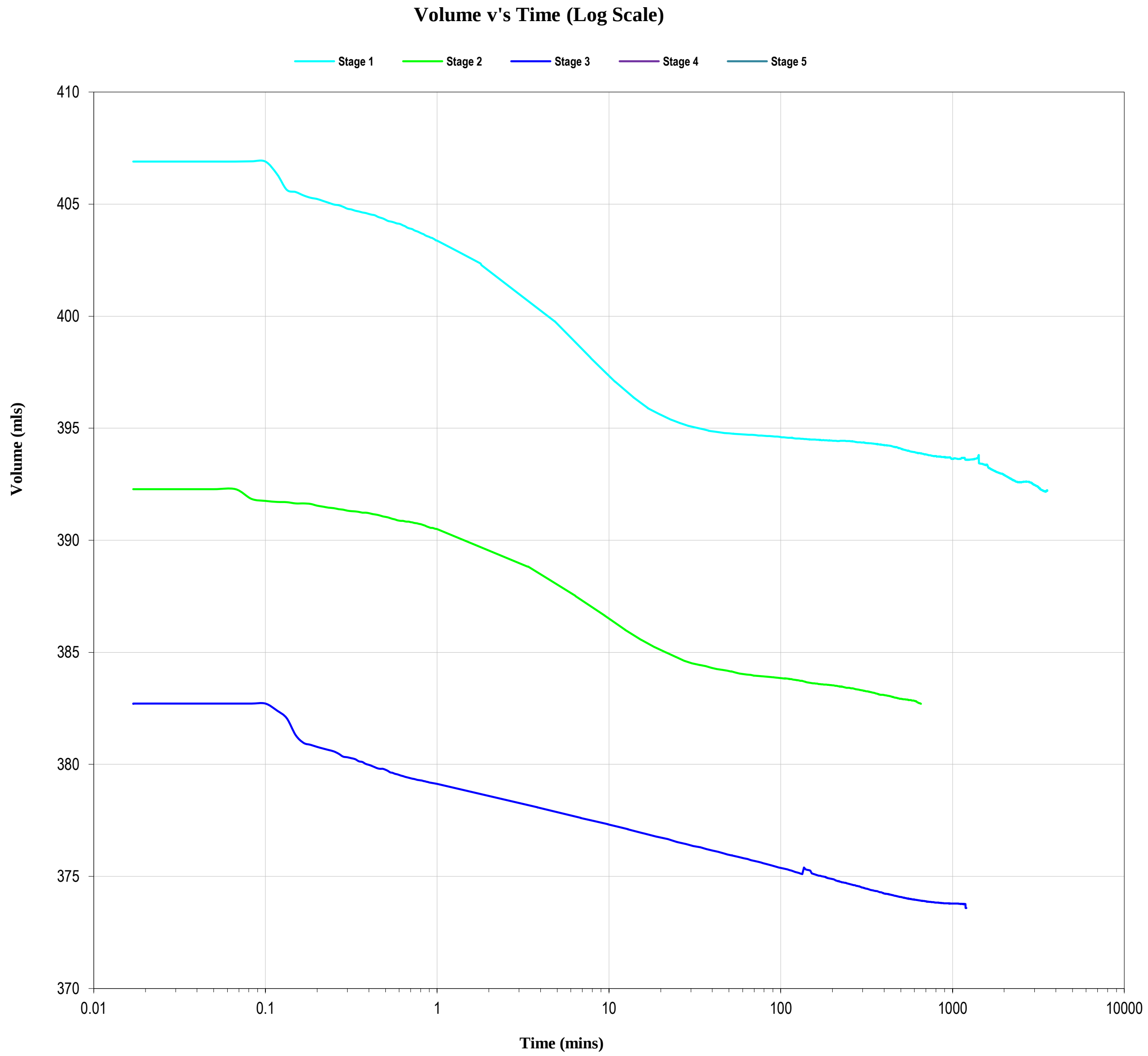
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080439 - CU



	Stage 1	Stage 1	Stage 1
Cv (m^2/year) **:**	**4.49**	**4.64**	**0.20**
Mv (m^2/MN) **:**	**0.073**	**0.070**	**0.068**
k (m/s) **:**	**1.01E-10**	**1.00E-10**	**4.14E-12**

Remarks: Tested as Received. Sample considered to have failed on Stage 1.

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.:**	18080441 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	30/09/2018
		Report Date:	13/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE416 - DH407 L3C	**Depth (m):**	26.50-27.00
Description:	SILTY CLAY- brown		

SAMPLE & TEST DETAILS

Initial Height:	129.3	mm	Initial Moisture Content:	37.8	%	Rate of Strain:	0.005	%/min
Initial Diameter:	61.4	mm	Final Moisture Content:	37.9	%	B Response:	97	%
L/D Ratio:	2.1 : 1		Wet Density:	1.88	t/m^3			
			Dry Density:	1.36	t/m^3			

Sample Type: Single Individual Undisturbed 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*
1204 kPa	1701 kPa	497 kPa	497 kPa	1046 kPa	1336 kPa	655 kPa	2.039	681 kPa	2.88 %

FAILURE ENVELOPES

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

Remarks: Tested as Received
Sample/s supplied by the client

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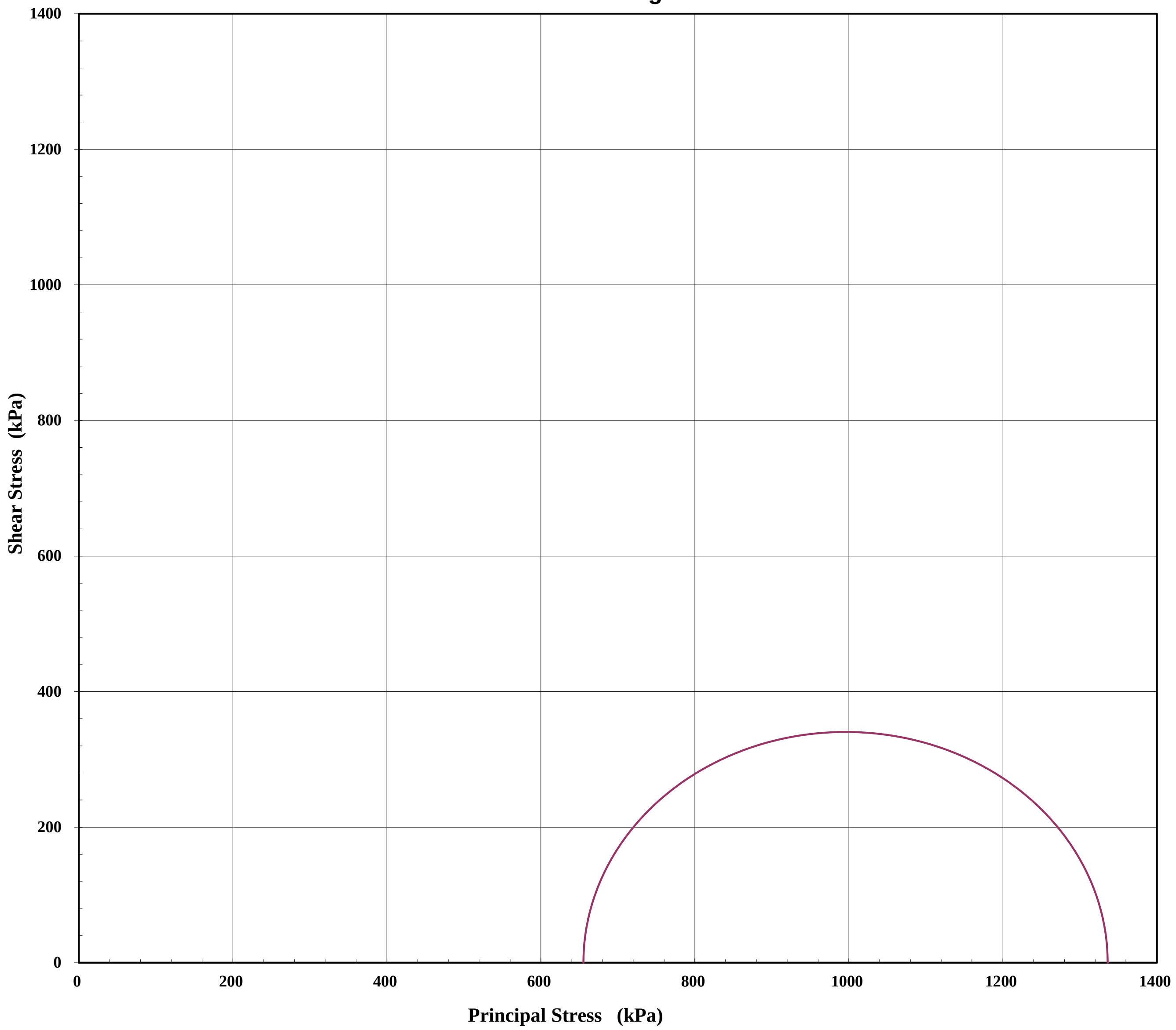
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080441 - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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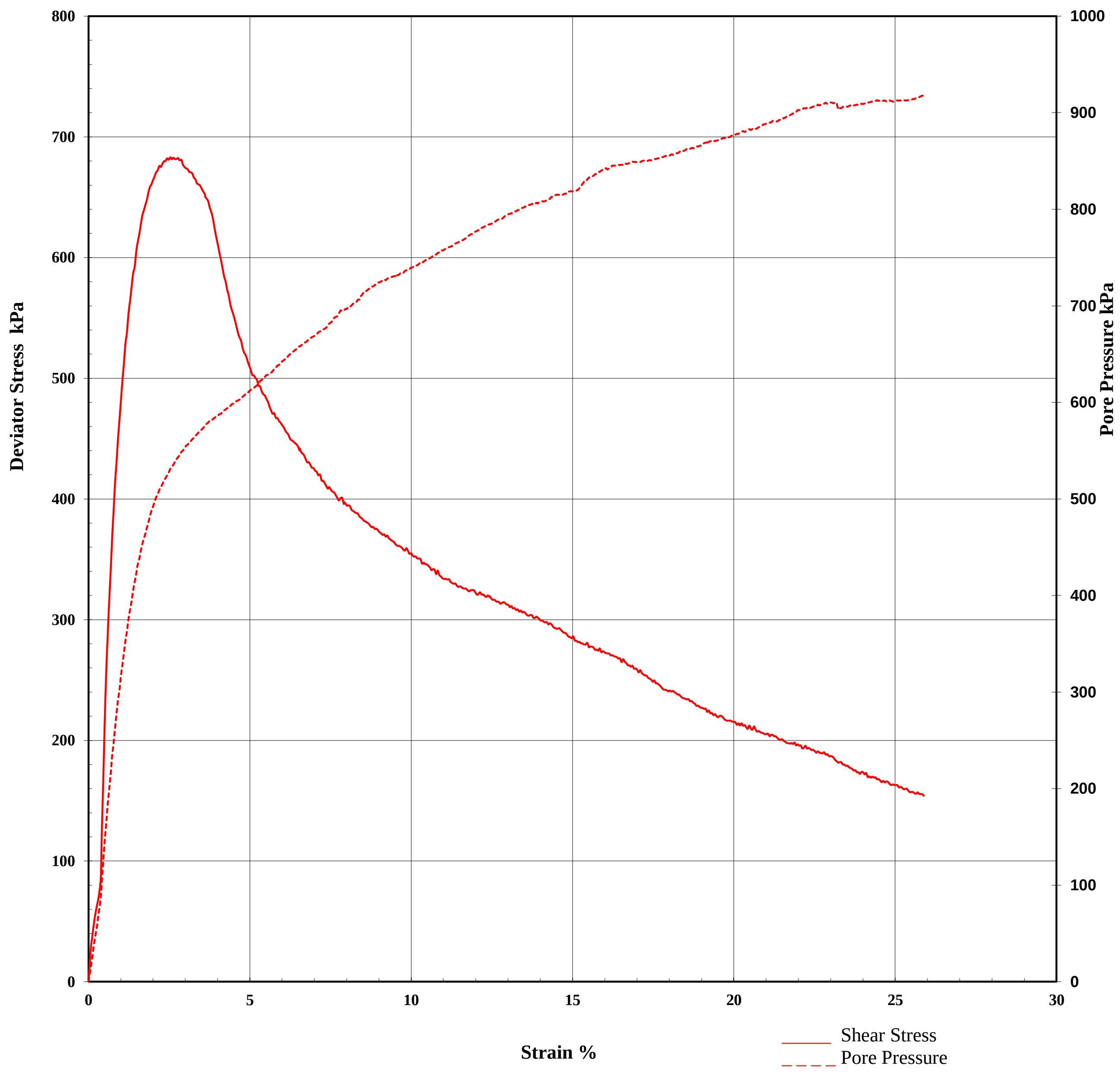
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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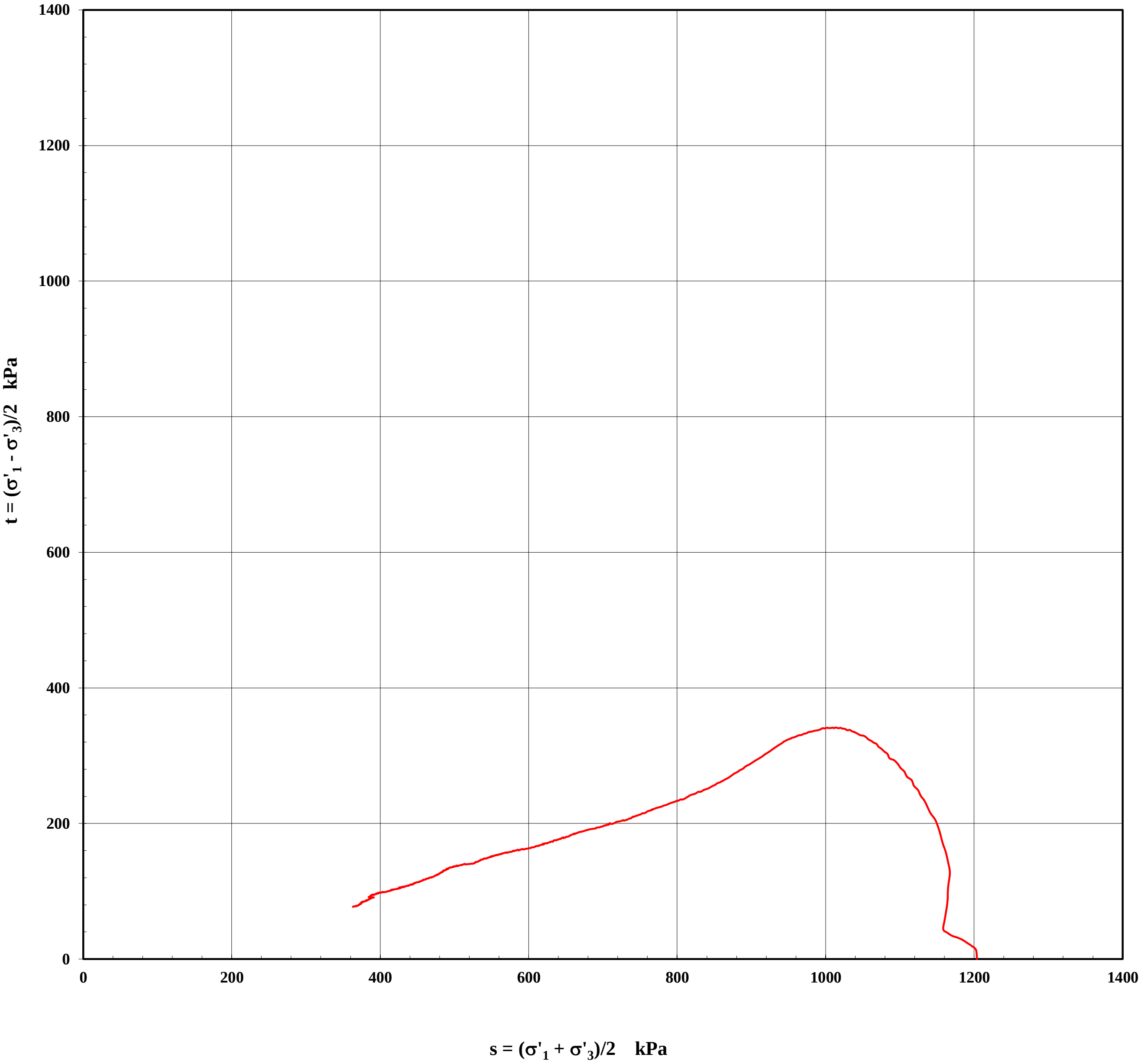
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU

MIT Method - Effective Stress Path



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Note: Graph not to scale

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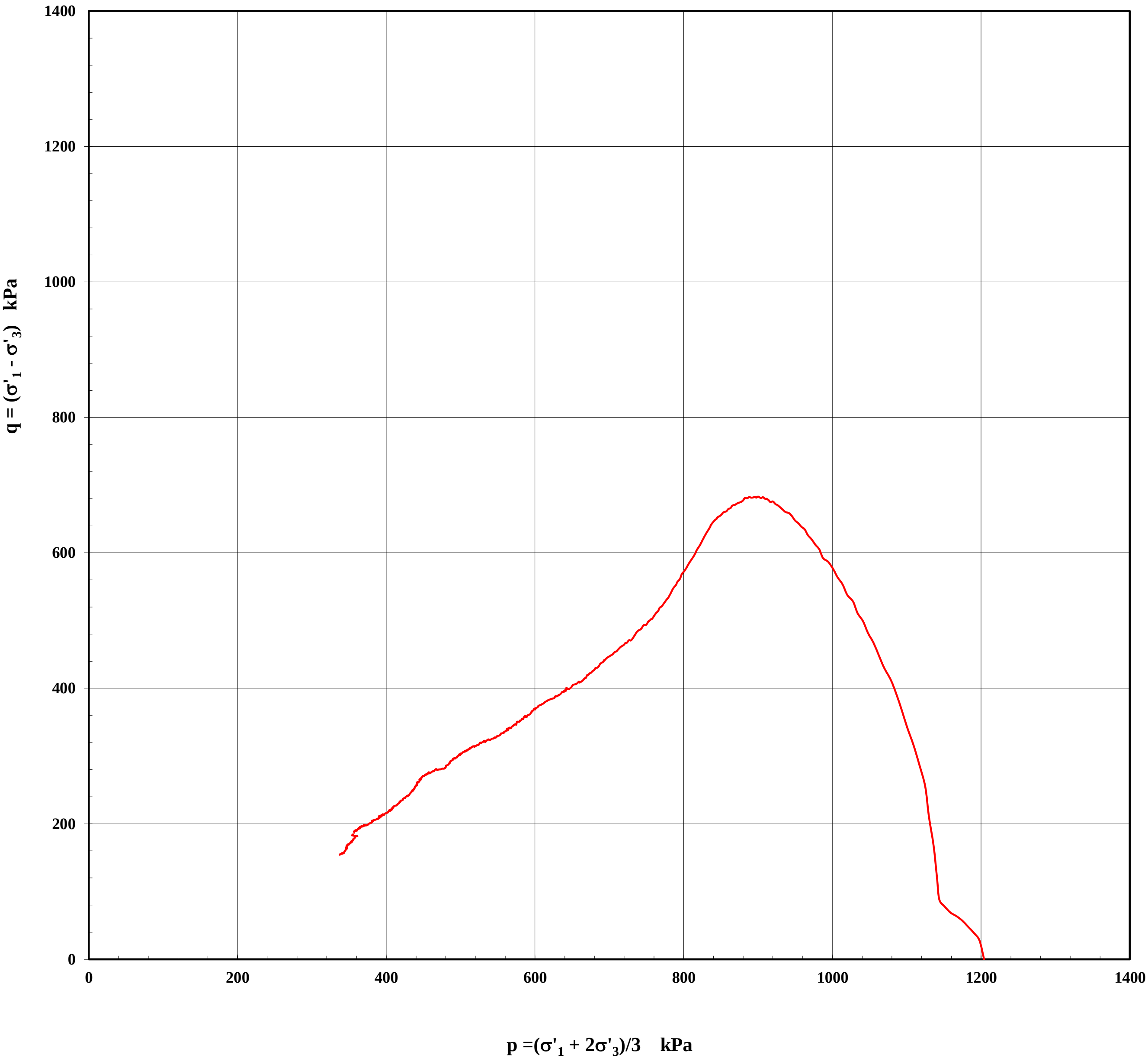
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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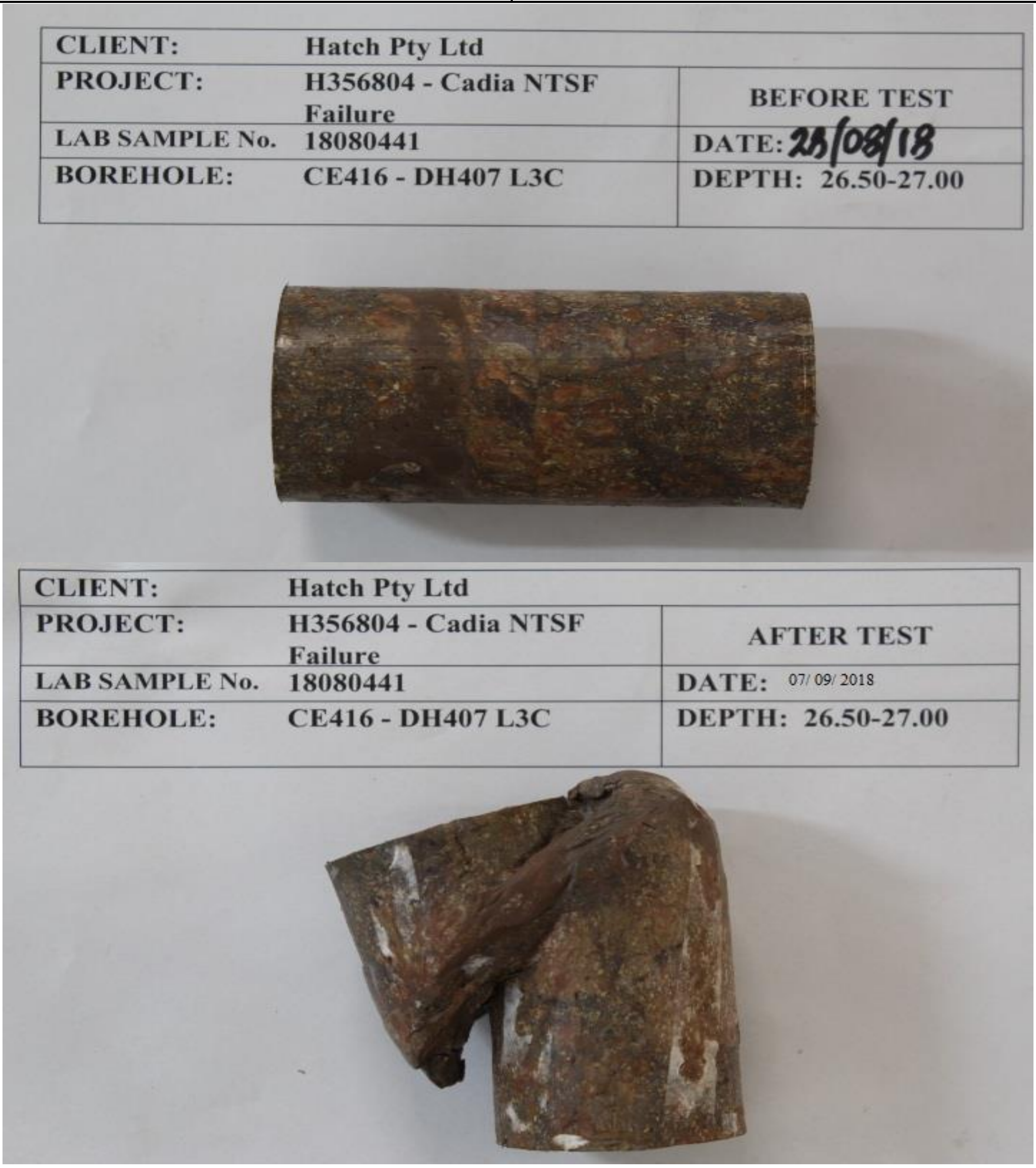
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU



Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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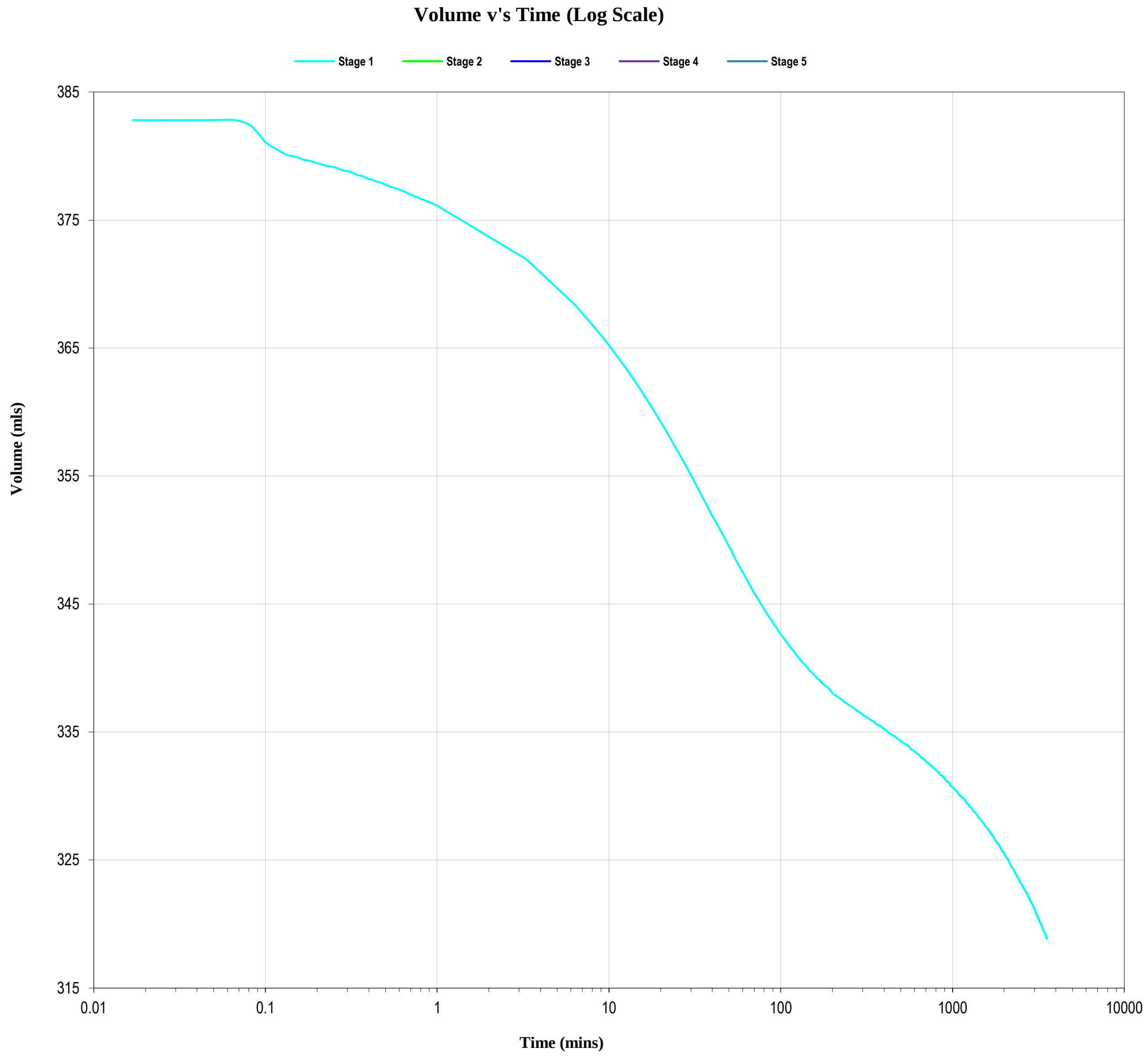
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU



	Stage 1
Cv (m^2/year) **:**	**0.71**
Mv (m^2/MN) **:**	**0.092**
k (m/s) **:**	**2.02E-11**

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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TRIAXIAL TEST REPORT

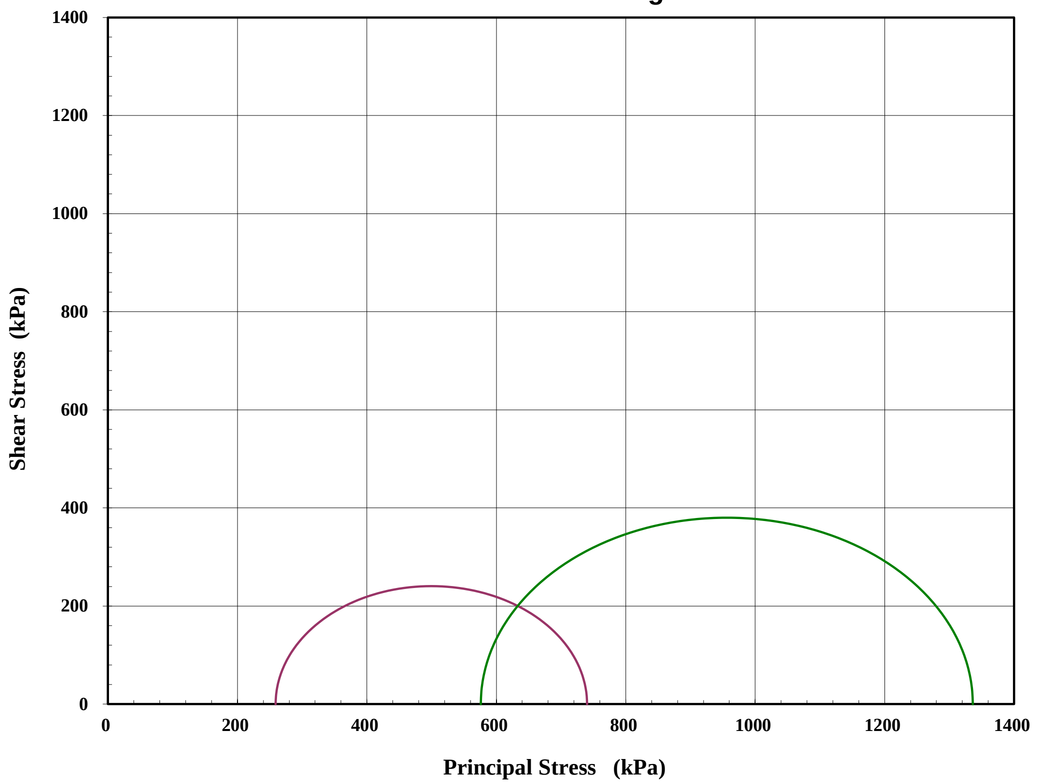
Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18080441 - CU
		Workorder No.	0004681
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	30/08/2018
		Report Date:	13/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE416 - DH407 L3C	**Depth (m):**	26.50-27.00
Description:	SILTY CLAY - brown		

SAMPLE & TEST DETAILS

Initial Height:	131.2	mm	Initial Moisture Content:	35.6	%	Rate of Strain:	0.005	%/min
Initial Diameter:	61.1	mm	Final Moisture Content:	34.5	%	B Response:	100	%
L/D Ratio:	2.1 : 1		Wet Density:	1.91	t/m^3			
			Dry Density:	1.41	t/m^3			

Mohr Circle Diagram



Interpretation between stages :	**1 to 2**
Cohesion C' (kPa) :	**92.4**
Angle of Shear Resistance Φ' (Degrees) :	**17.8**
Failure Criteria:	Peak Principal Stress Ratio

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received
Sample/s supplied by the client		Note: Graph not to scale	**Page 1 of 6**

REP03001

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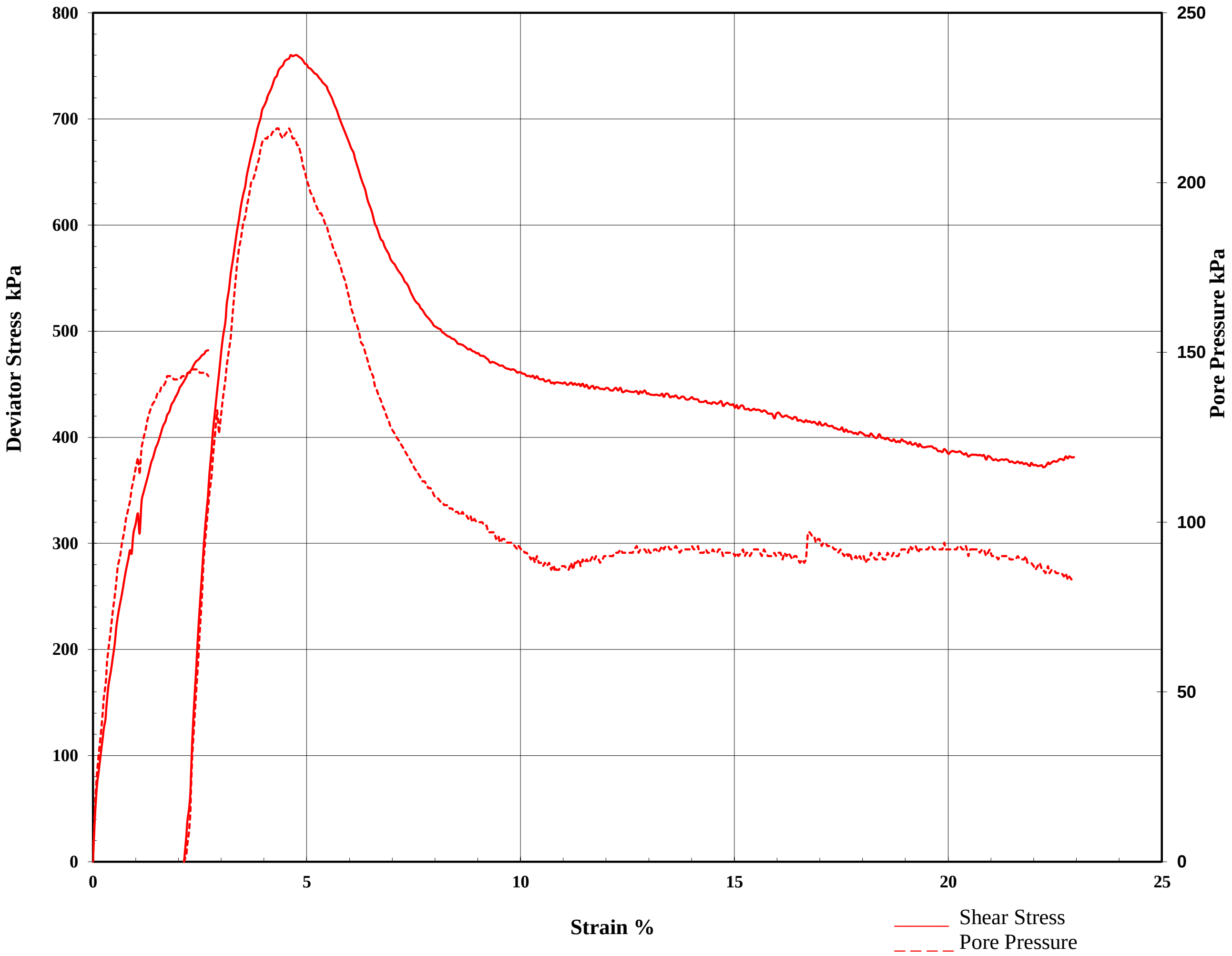
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU

Stress/Strain & Pore Pressure/Strain Diagram



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*
403 kPa	905 kPa	502 kPa	502 kPa	646 kPa	740 kPa	259 kPa	2.858	481 kPa	2.64 %
791 kPa	1295 kPa	504 kPa	504 kPa	719 kPa	1336 kPa	576 kPa	2.320	760 kPa	4.63 %

Sample Type: Single Individual Undisturbed Specimen Remarks: Tested as Received

Sample/s supplied by the client Note: Graph not to scale

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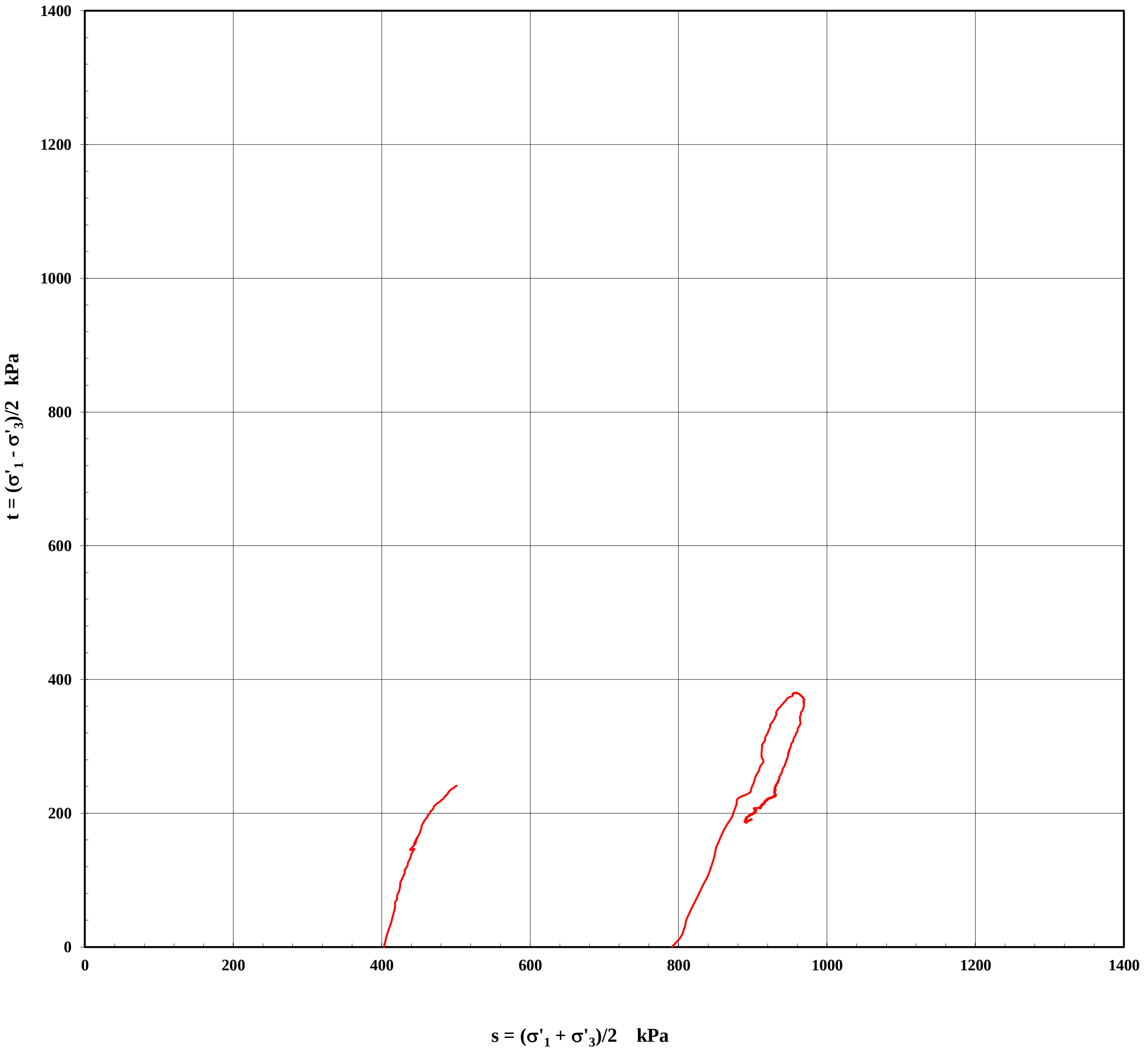
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU

MIT Method - Effective Stress Path



Note: Graph not to scale.

Sample Type: Single Individual Undisturbed Specimen	Remarks: Tested as Received
Sample/s supplied by the client	Note: Graph not to scale

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Authorised Signatory

C. Channon

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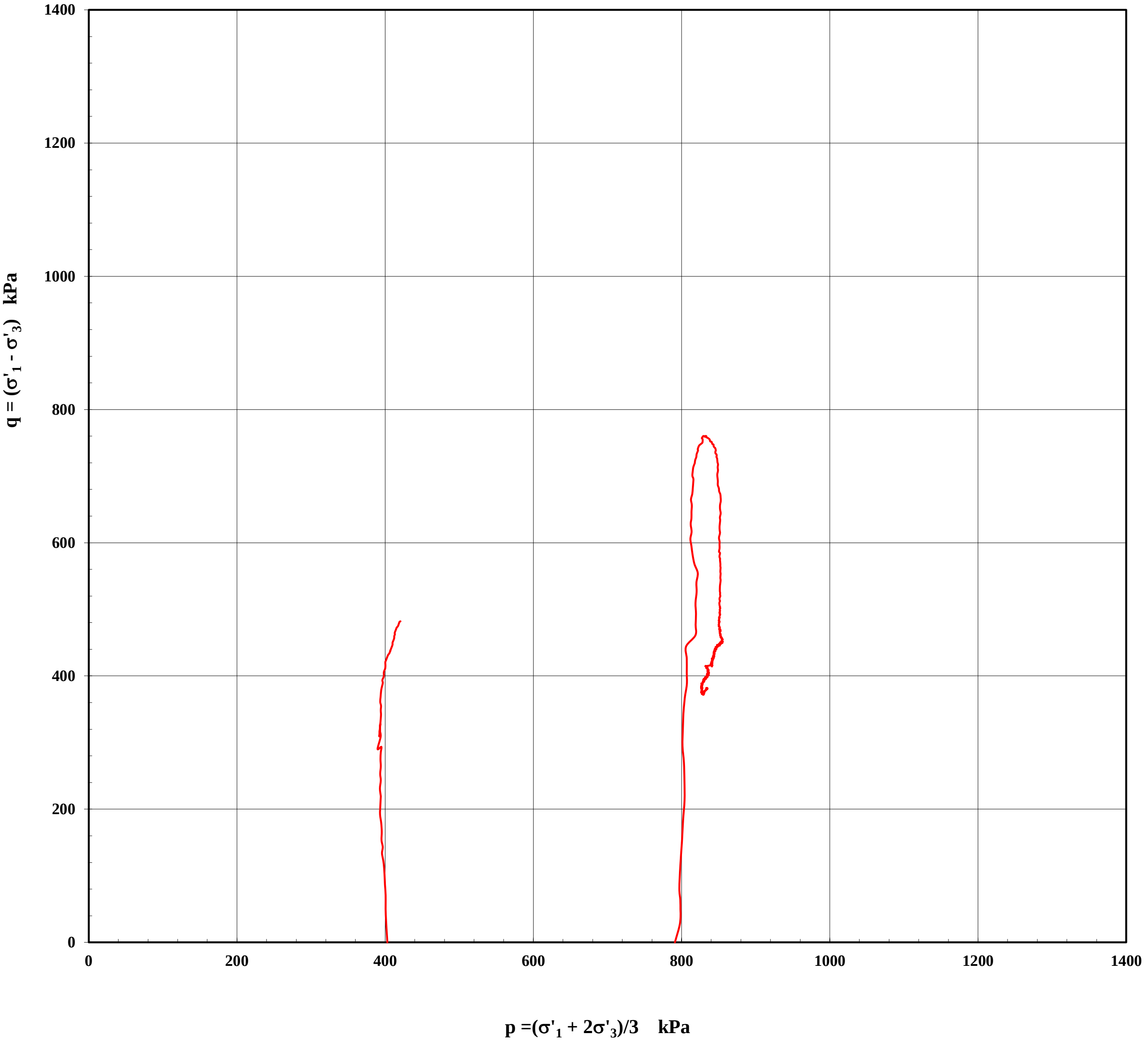
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18080441 - CU

Cambridge Method - Effective Stress Path



Note: Graph not to scale.

Sample Type: Single Individual Undisturbed Specimen	Remarks: Tested as Received
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.:** 18080441 - CU

Sample Type:	Single Individual Undisturbed Specimen	Remarks:	Tested as Received
Sample/s supplied by the client		Note: Graph not to scale	**Page 5 of 6**

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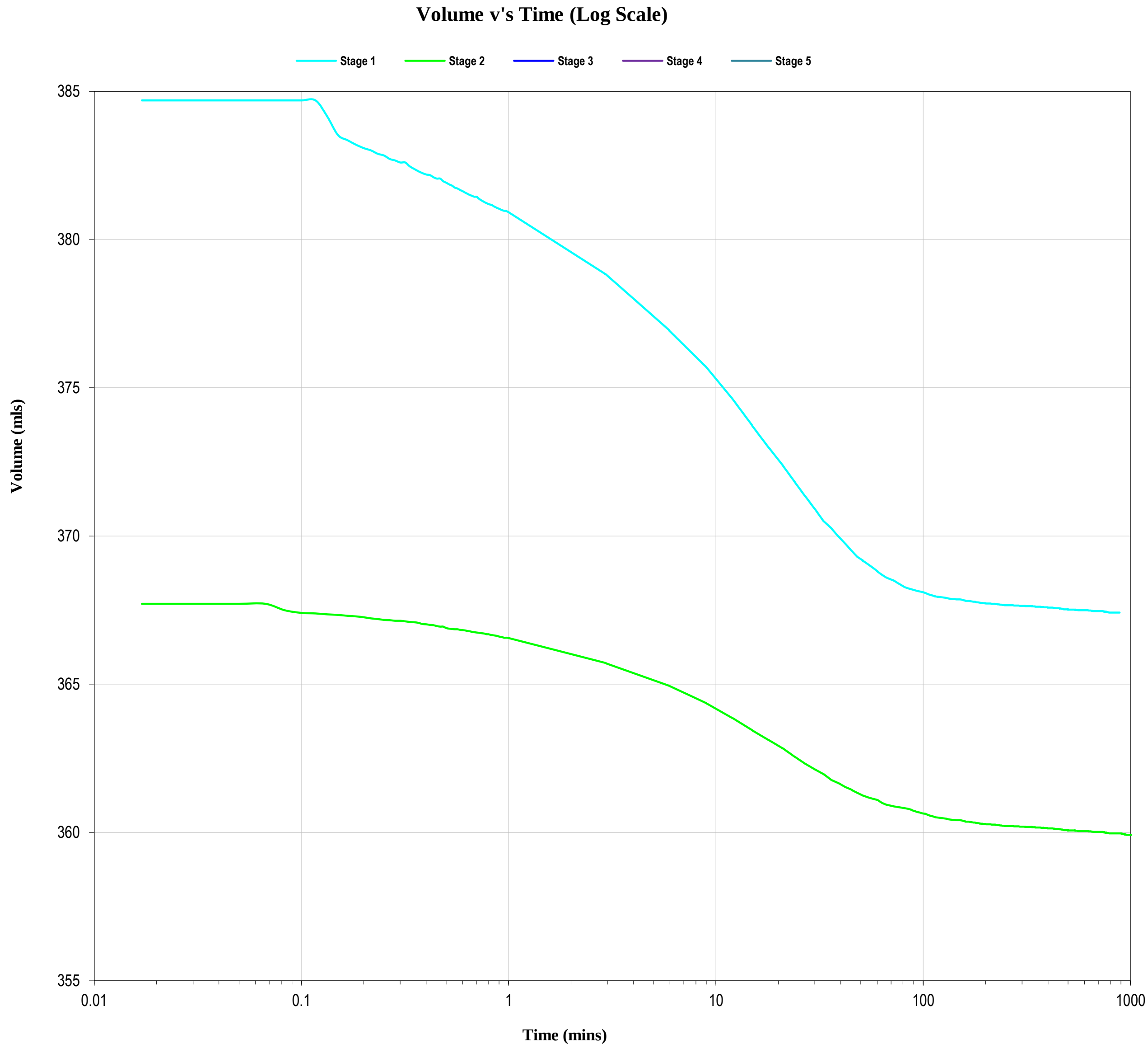
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18080441 - CU



	Stage 1	Stage 2
Cv (m²/year) :	1.33	1.84
Mv (m²/MN) :	0.107	0.079
k (m/s) :	4.42E-11	4.53E-11

Sample Type: Single Individual Undisturbed Specimen

Remarks: Tested as Received

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.:**	18090290A - CU
		Workorder No.	0004846
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	25/09/2018
		Report Date:	4/10/2018
Project:	H356804 - Cadia NTSF Failure - Request 8		
Client Id.:	CE432 - L1B	**Depth (m):**	19.80-20.30
Description:	SILTY CLAY - brown/pale-brown		

SAMPLE & TEST DETAILS

Initial Height:	131.4	mm	Initial Moisture Content:	24.2	%	Rate of Strain:	0.005	%/min
Initial Diameter:	61.5	mm	Final Moisture Content:	24.8	%	B Response:	97	%
L/D Ratio:	2.1 : 1		Wet Density:	2.00	t/m^3			
			Dry Density:	1.61	t/m^3			

Sample Type: Single Individual Undisturbed 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*
202 kPa	700 kPa	498 kPa	498 kPa	576 kPa	574 kPa	124 kPa	4.632	450 kPa	2.08 %
400 kPa	899 kPa	499 kPa	499 kPa	653 kPa	952 kPa	246 kPa	3.869	706 kPa	3.64 %

FAILURE ENVELOPES

Interpretation between stages : **1 to 2**
Cohesion C' (kPa) : **54.3**
Angle of Shear Resistance Φ' (Degrees) : **30.8**
Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received
Sample/s supplied by the client

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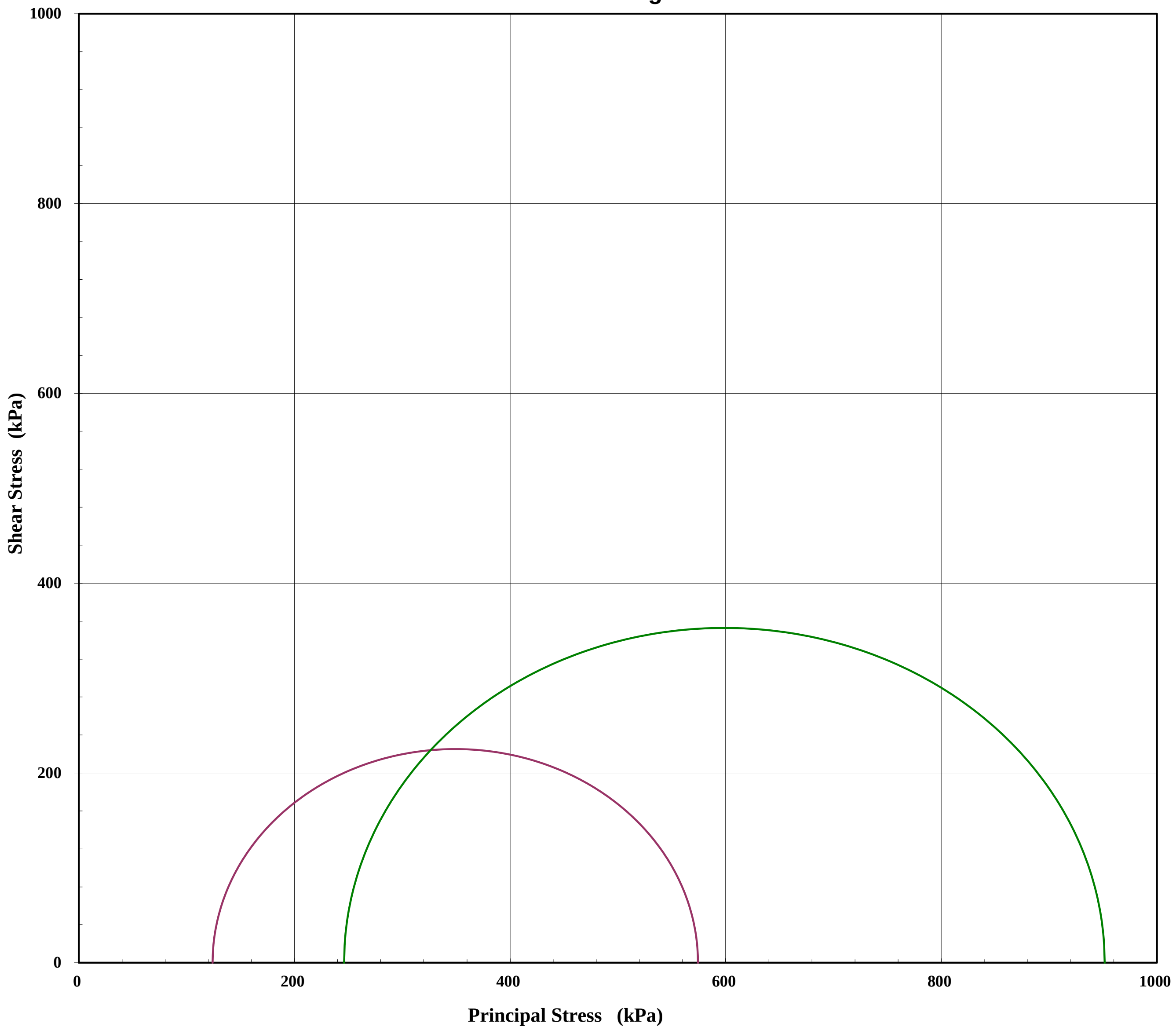
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18090290A - CU

Mohr Circle Diagram



Interpretation between stages :	**1 to 2**
Cohesion C' (kPa) :	**54.3**
Angle of Shear Resistance Φ' (Degrees) :	**30.8**
Failure Criteria:	Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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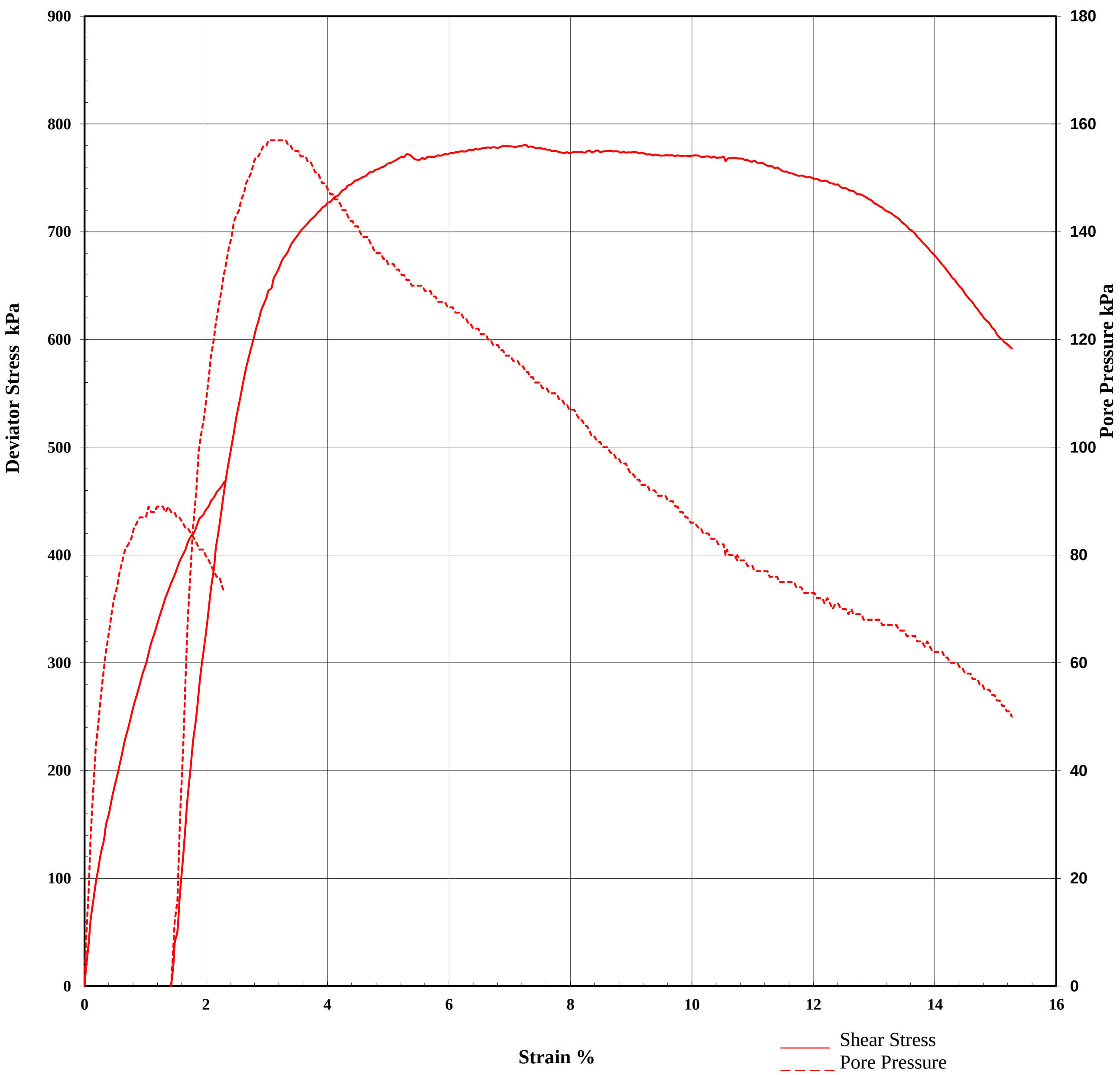
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290A - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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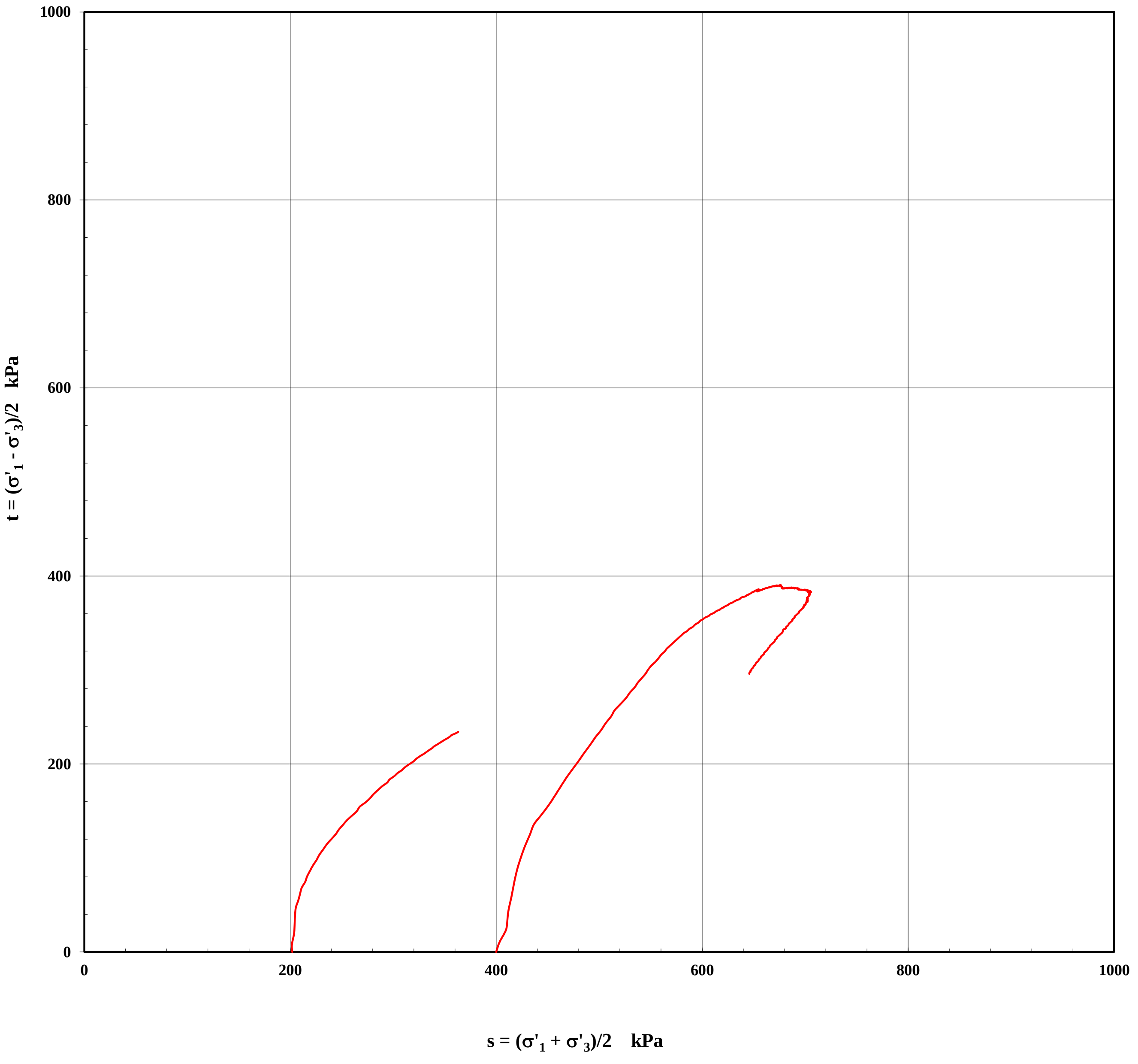
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18090290A - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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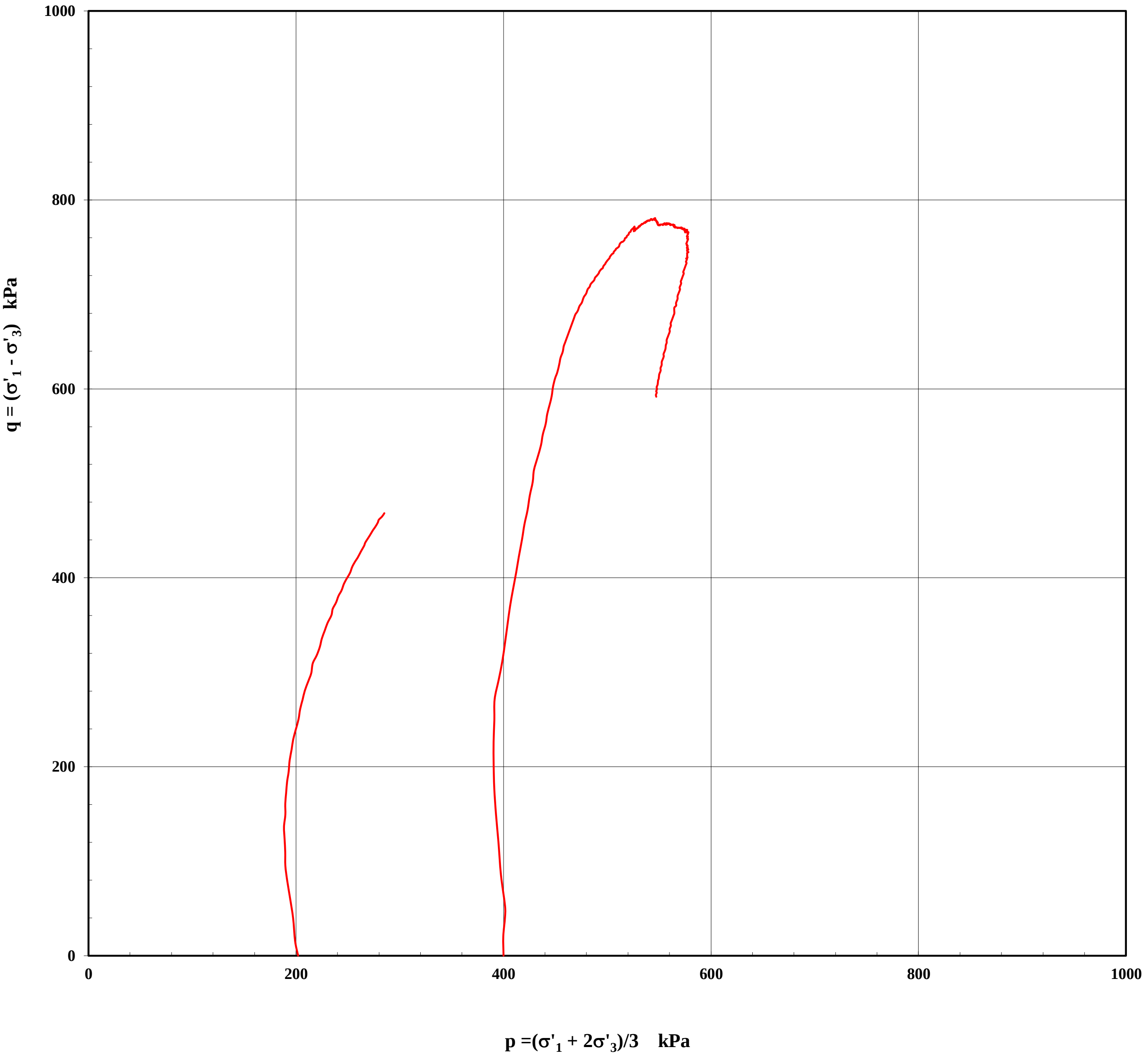
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290A - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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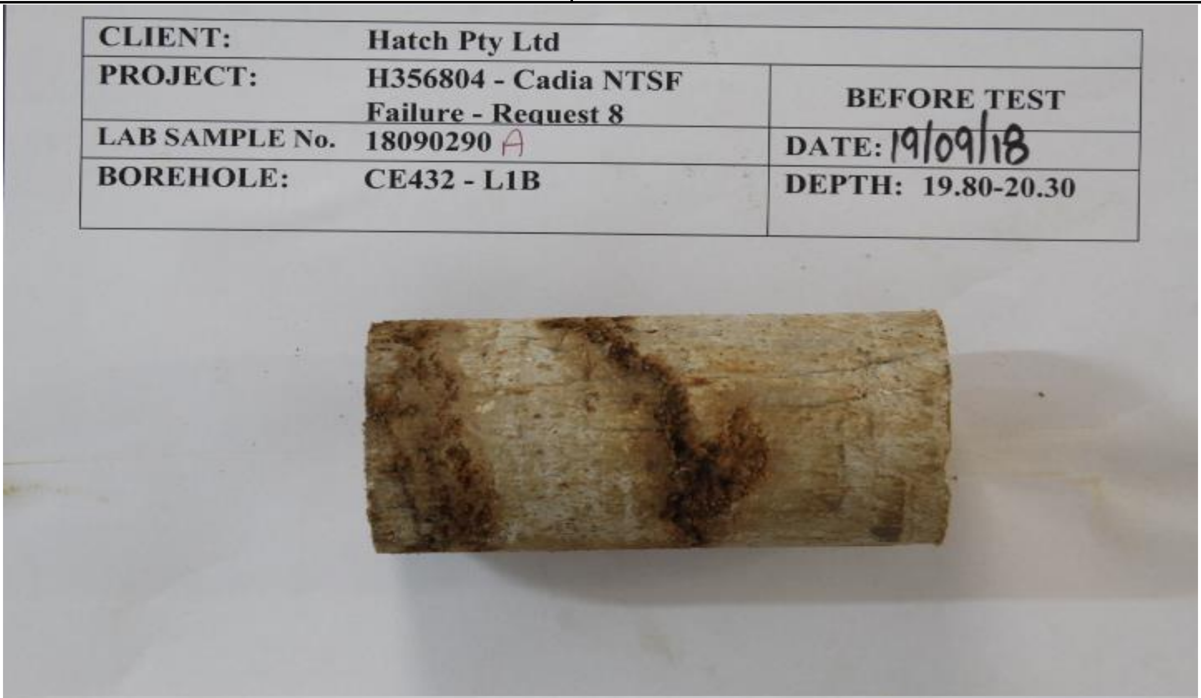
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18090290A - CU



Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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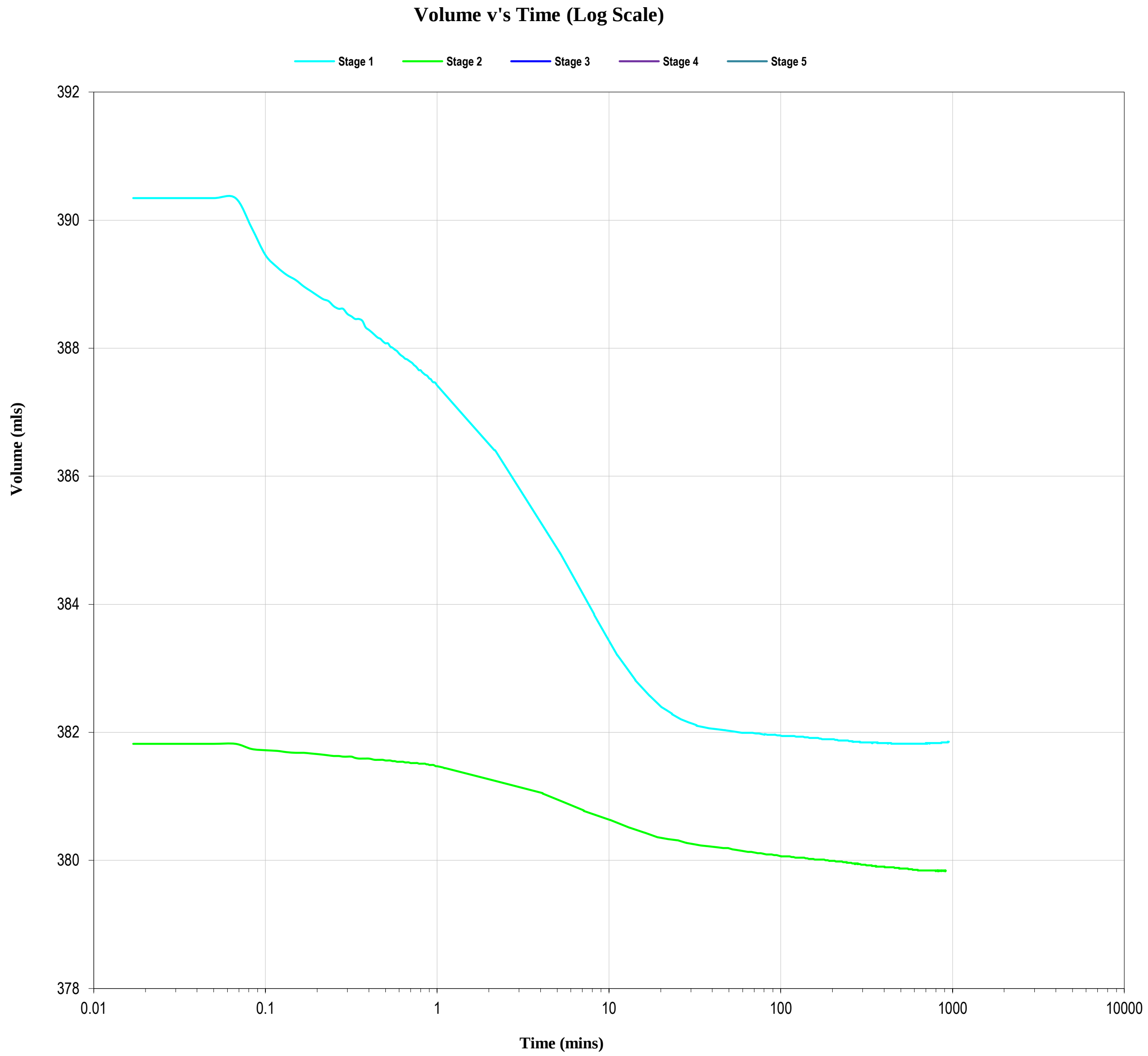
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290A - CU



	Stage 1	Stage 2
Cv (m^2/year) **:**	**4.10**	**6.06**
Mv (m^2/MN) **:**	**0.104**	**0.064**
k (m/s) **:**	**1.32E-10**	**1.21E-10**

Remarks: Tested as Received

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.:**	18090290B - CU
		Workorder No.	0004846
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	27/09/2018
		Report Date:	4/10/2018
Project:	H356804 - Cadia NTSF Failure - Request 8		
Client Id.:	CE432 - L1B	**Depth (m):**	19.80-20.30
Description:	SILTY CLAY -brown/ pale-brown		

SAMPLE & TEST DETAILS

Initial Height:	134.1	mm	Initial Moisture Content:	24.2	%	Rate of Strain:	0.005	%/min
Initial Diameter:	61.2	mm	Final Moisture Content:	25.6	%	B Response:	96	%
L/D Ratio:	2.2 : 1		Wet Density:	1.98	t/m^3			
			Dry Density:	1.59	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
795 kPa	1299 kPa	504 kPa	504 kPa	915 kPa	1392 kPa	384 kPa	3.629	1009 kPa	3.77 %

FAILURE ENVELOPES

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

Remarks: Tested as Received
Sample/s supplied by the client

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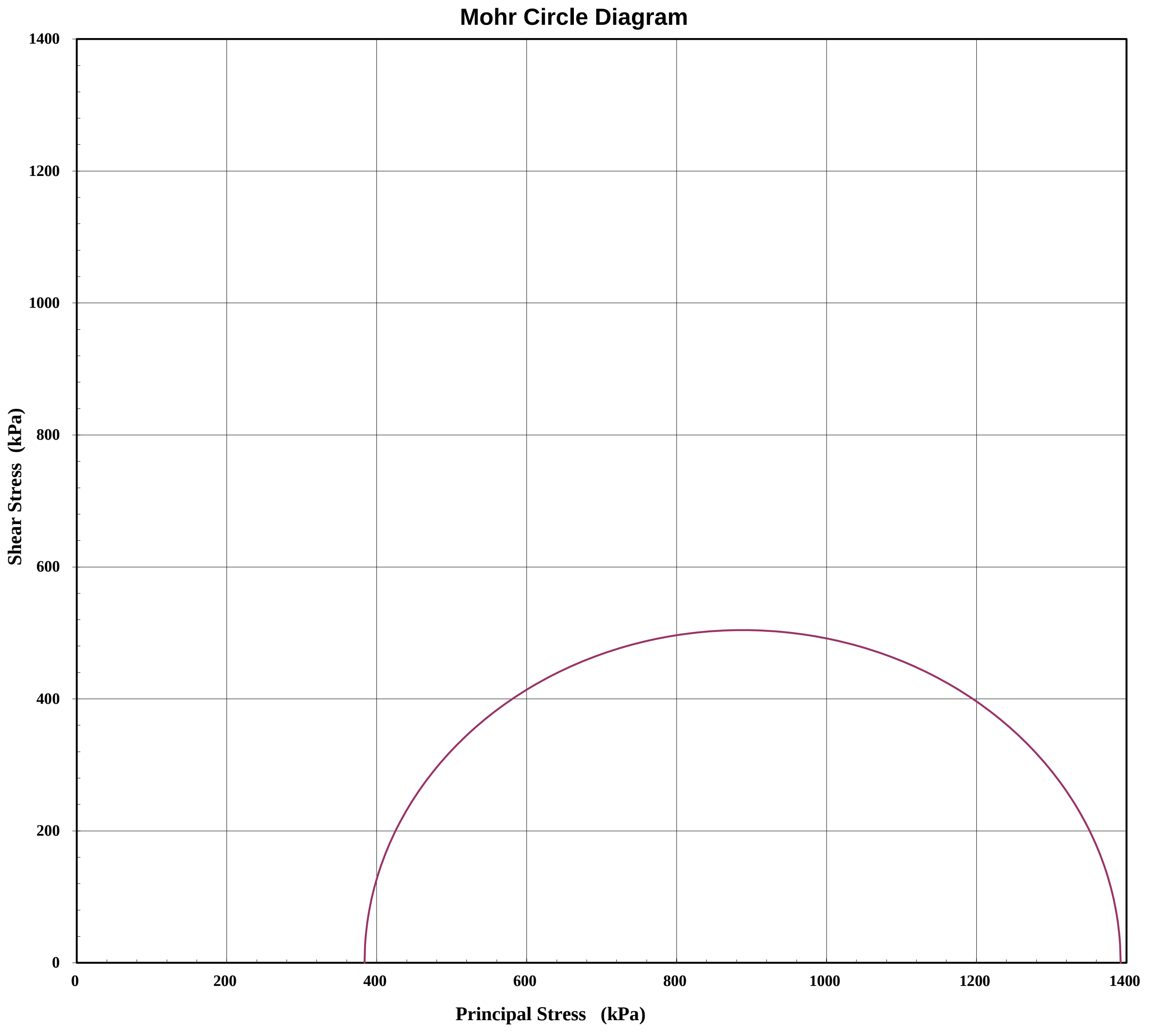
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client:	Hatch Pty Ltd	**Report No.:**	18090290B - CU



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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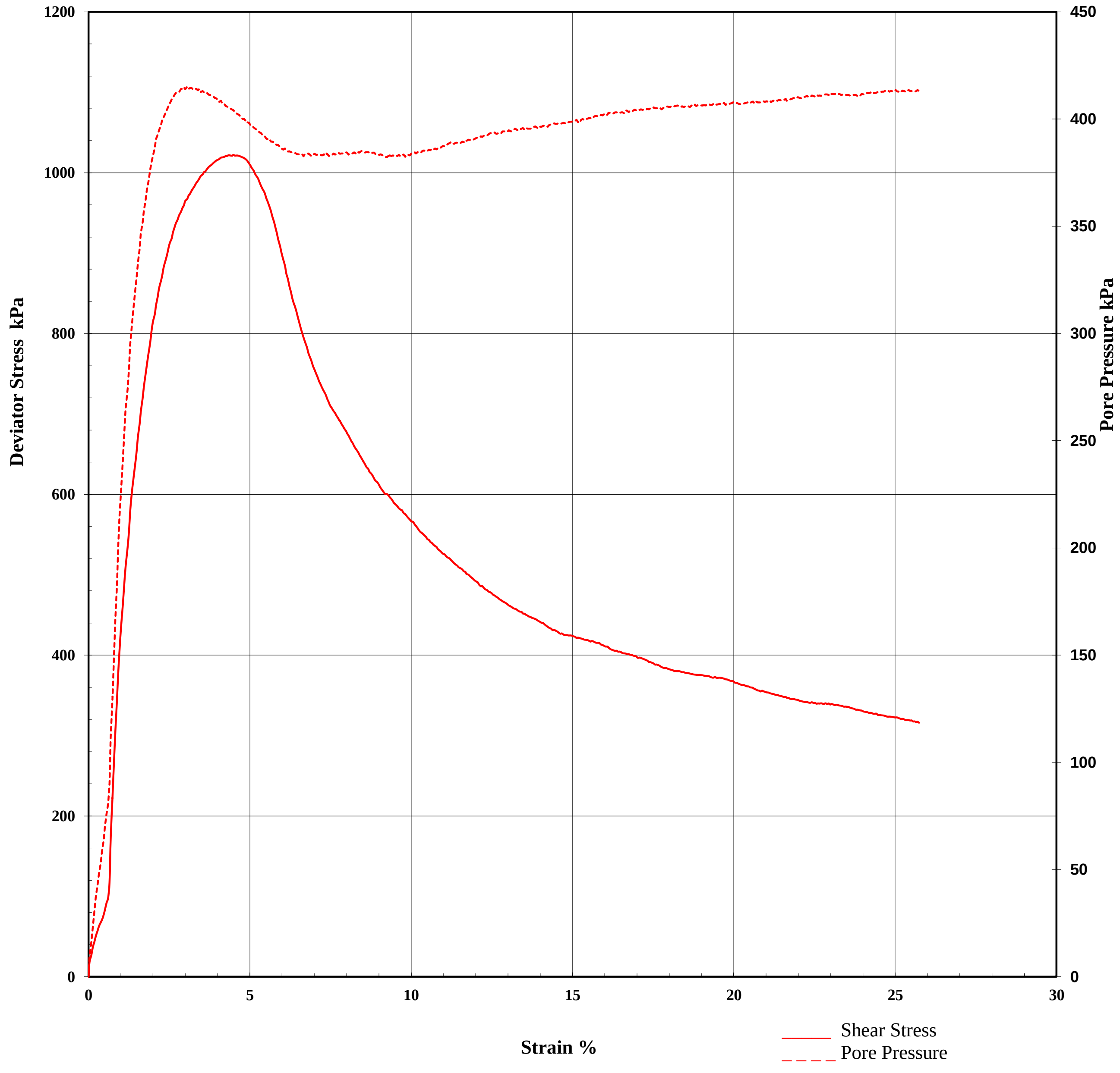
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18090290B - CU

Stress/Strain & Pore Pressure/Strain Diagram



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Note: Graph not to scale

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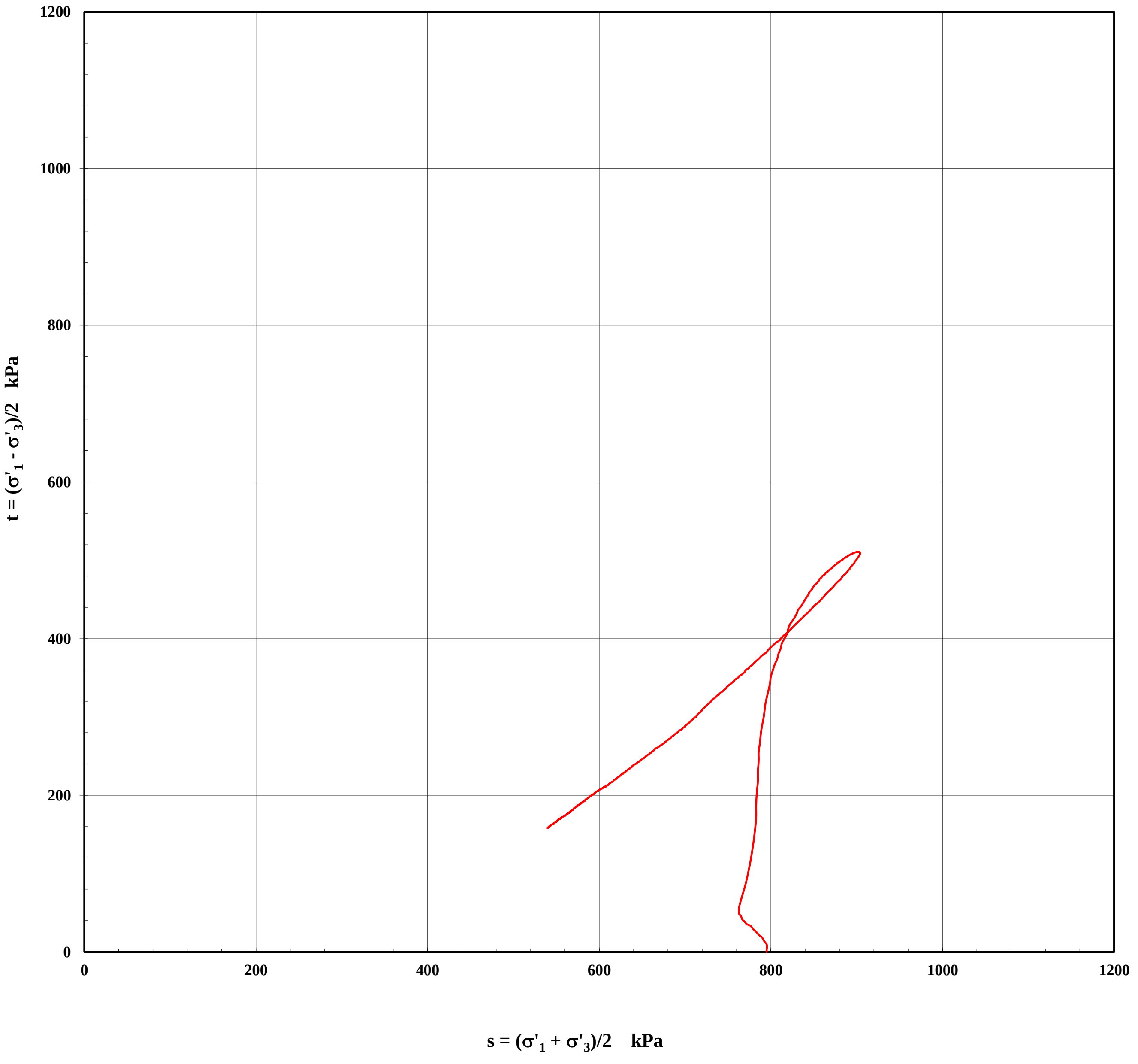
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290B - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

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Note: Graph not to scale

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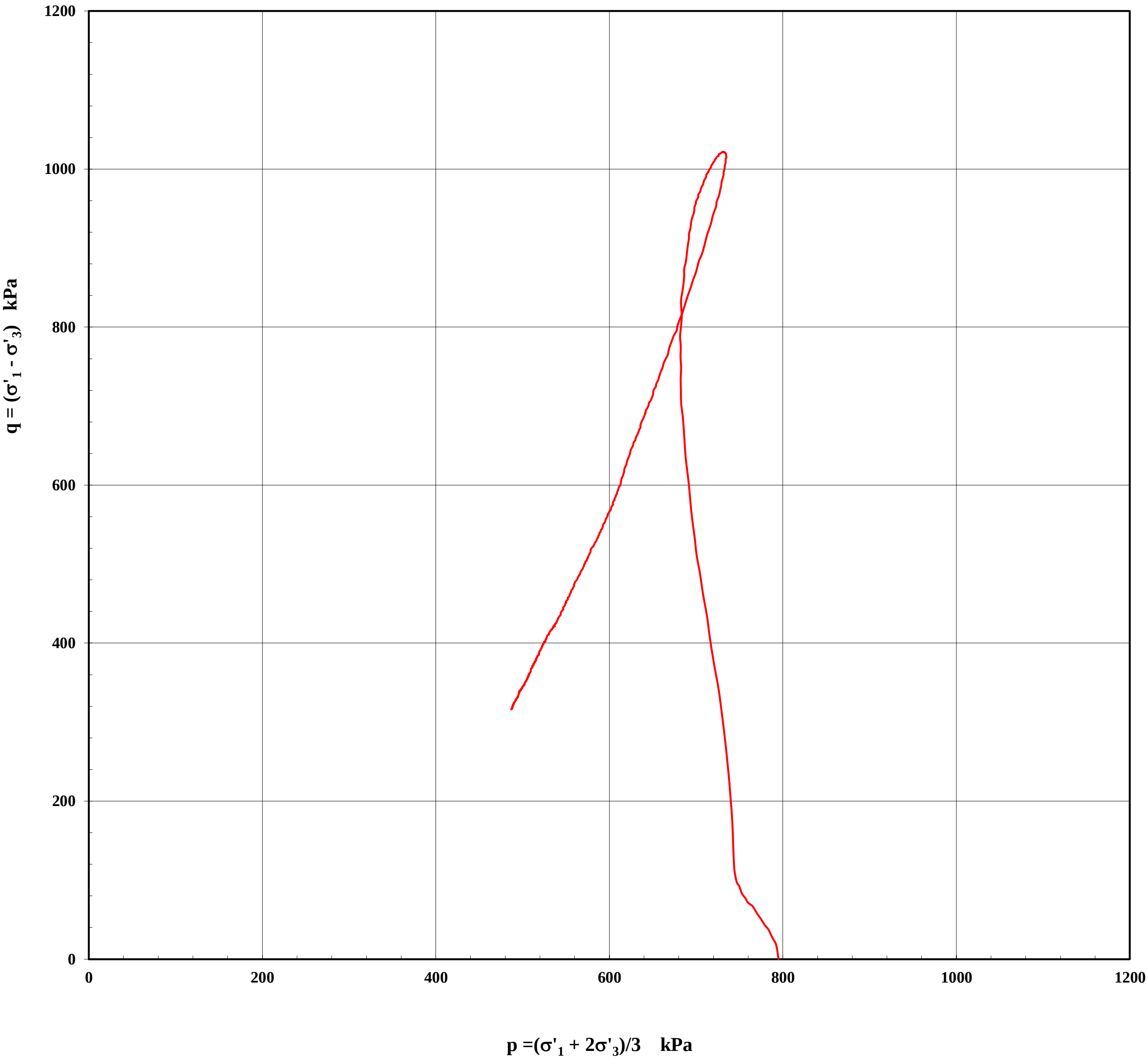
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18090290B - CU

Cambridge Method - Effective Stress Path



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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18090290B - CU

Remarks: Tested as Received

Sample/s supplied by the client

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TRIAXIAL TEST REPORT

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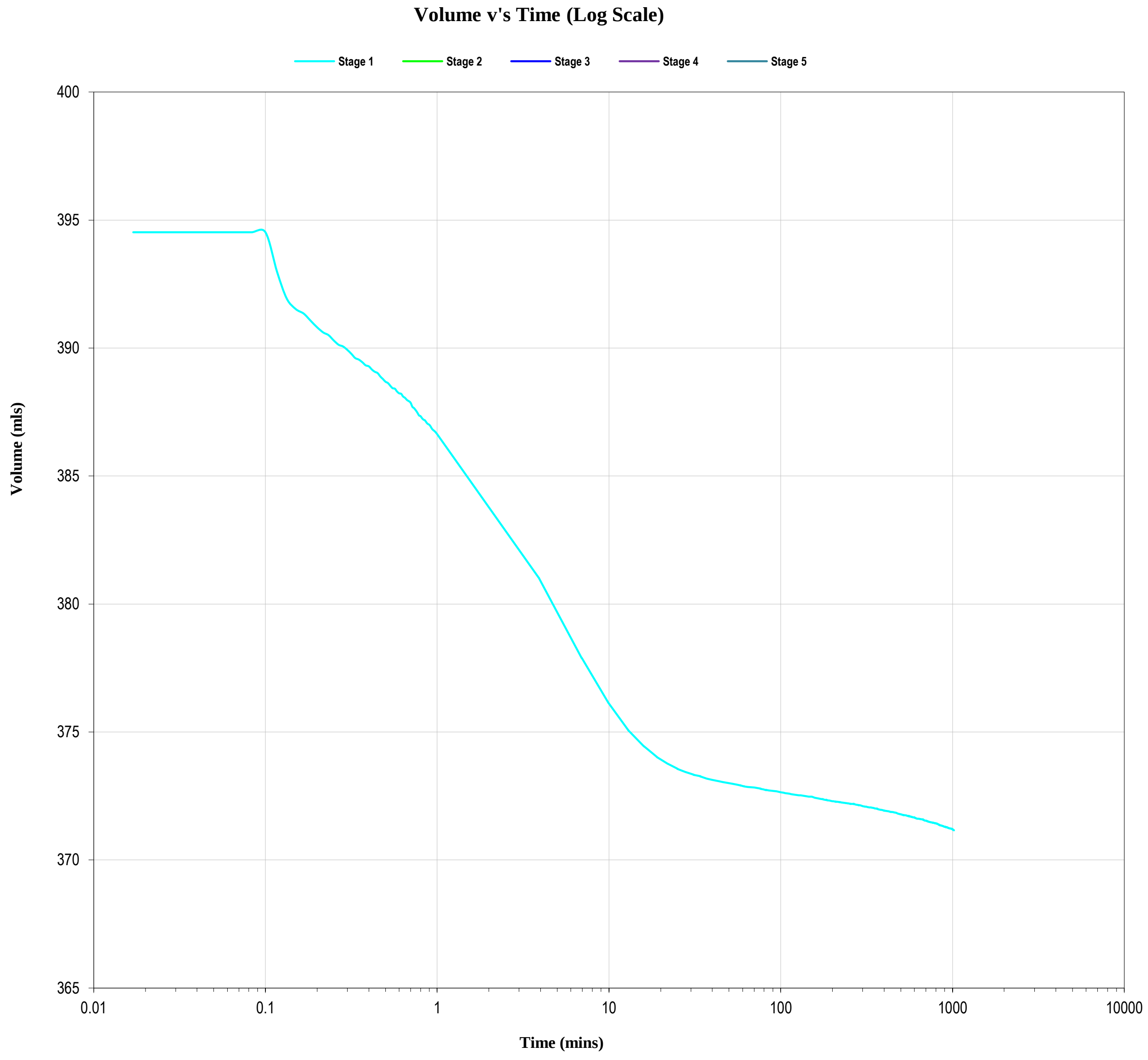
Client: Hatch Pty Ltd

Report No.: 18090290B - CU



	Stage 1
Cv (m^2/year) **:**	**5.02**
Mv (m^2/MN) **:**	**0.066**
k (m/s) **:**	**1.04E-10**

Remarks: Tested as Received

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.:**	18110003A - CU
		Workorder No.	0005081
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	2/11/2018
		Report Date:	15/11/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE432 - L1C - Lexan	**Depth (m):**	20.30-20.80
Description:	SILTY CLAY- grey and orange brown		

SAMPLE & TEST DETAILS

Initial Height:	128.0	mm	Initial Moisture Content:	28.2	%	Rate of Strain:	0.002	%/min
Initial Diameter:	60.8	mm	Final Moisture Content:	27.8	%	B Response:	98	%
L/D Ratio:	2.1 : 1		Wet Density:	1.94	t/m^3			
			Dry Density:	1.52	t/m^3			

Sample Type: Single Individual Undisturbed 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*
196 kPa	700 kPa	504 kPa	504 kPa	583 kPa	481 kPa	117 kPa	4.099	364 kPa	2.35 %

FAILURE ENVELOPES

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

Remarks: Tested as Received
Sample/s supplied by the client

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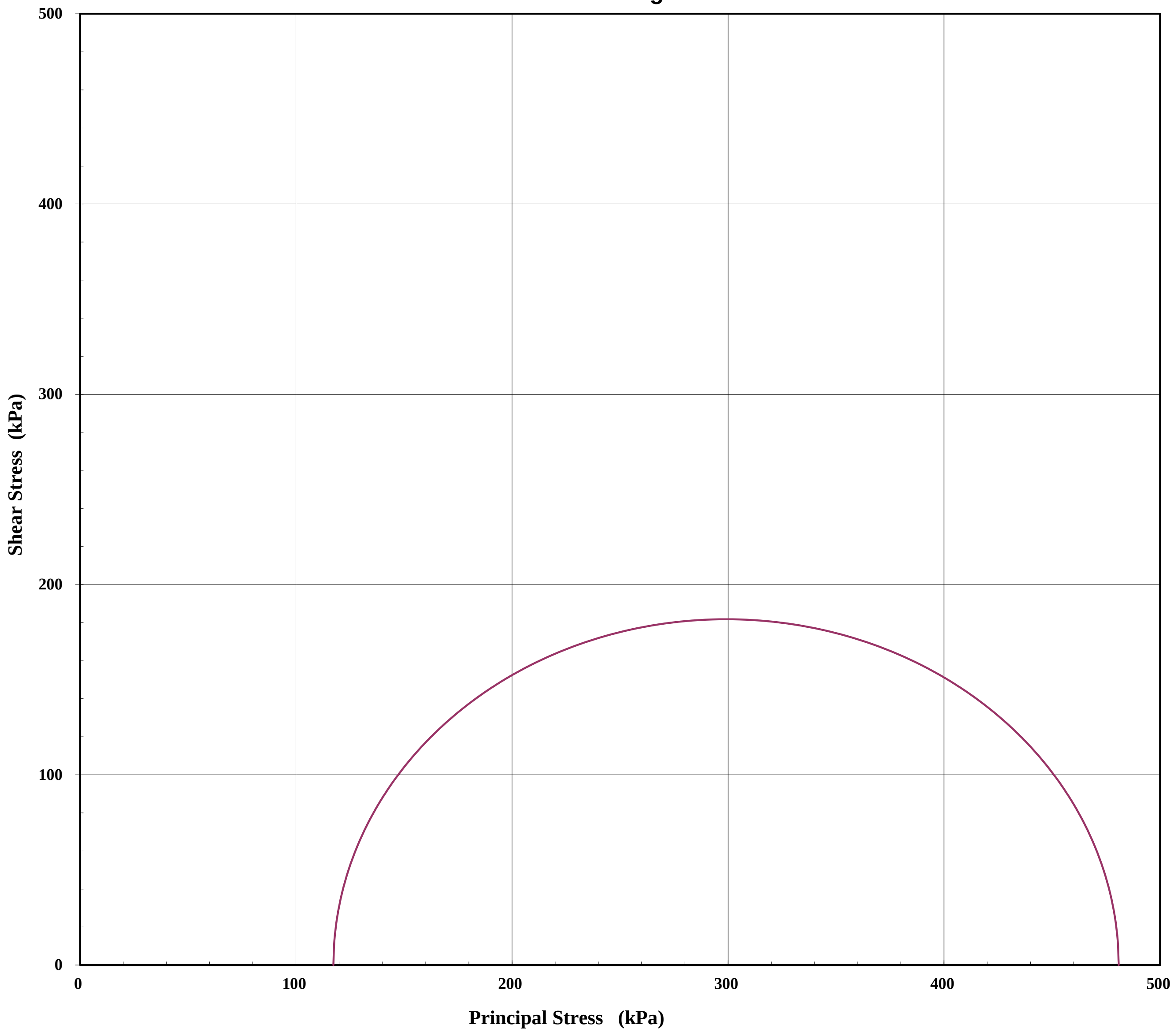
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003A - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

REP03001

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Tested at Trilab Brisbane Laboratory.

Authorised Signatory

C. Channon

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Laboratory Number
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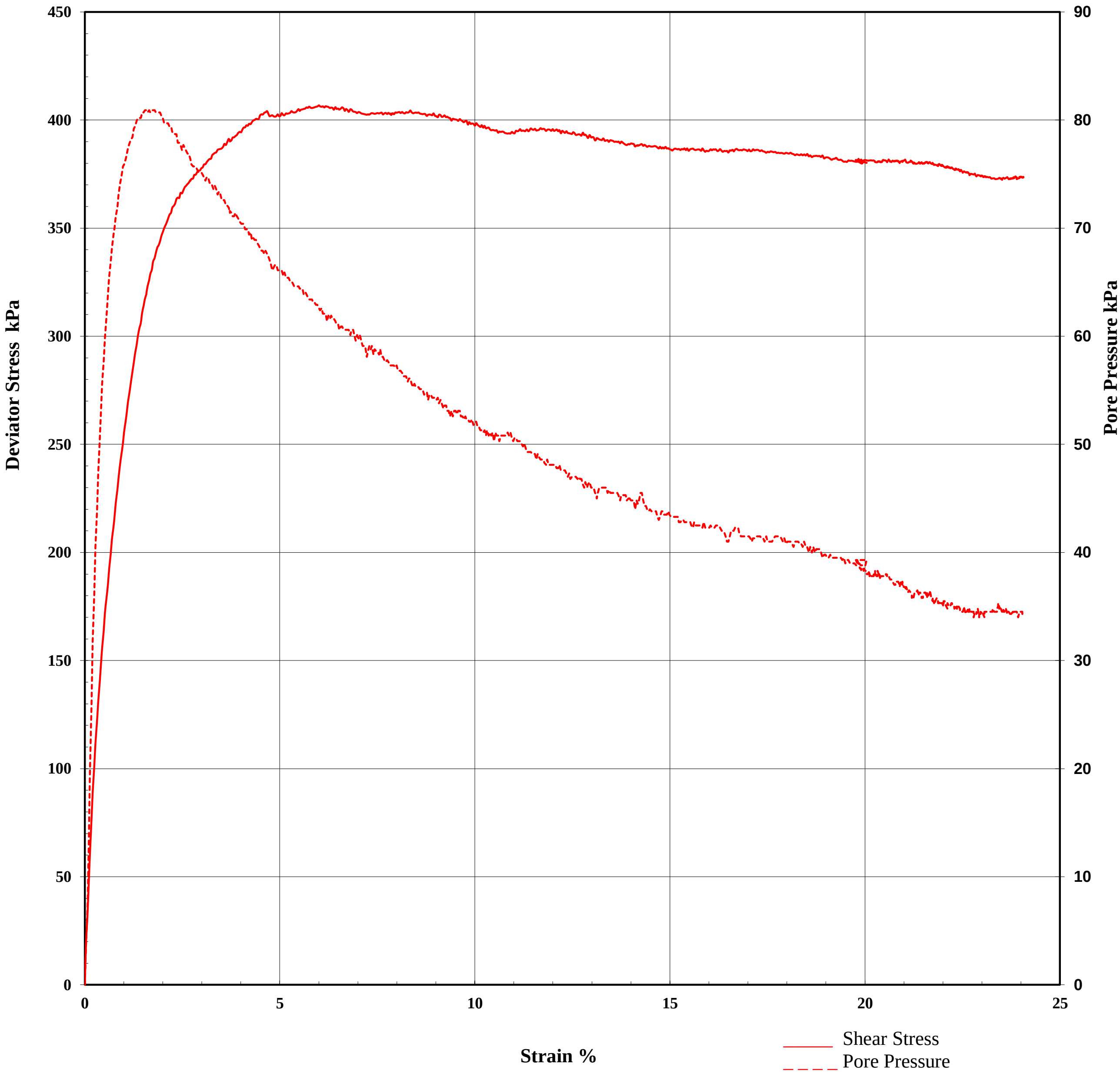
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003A - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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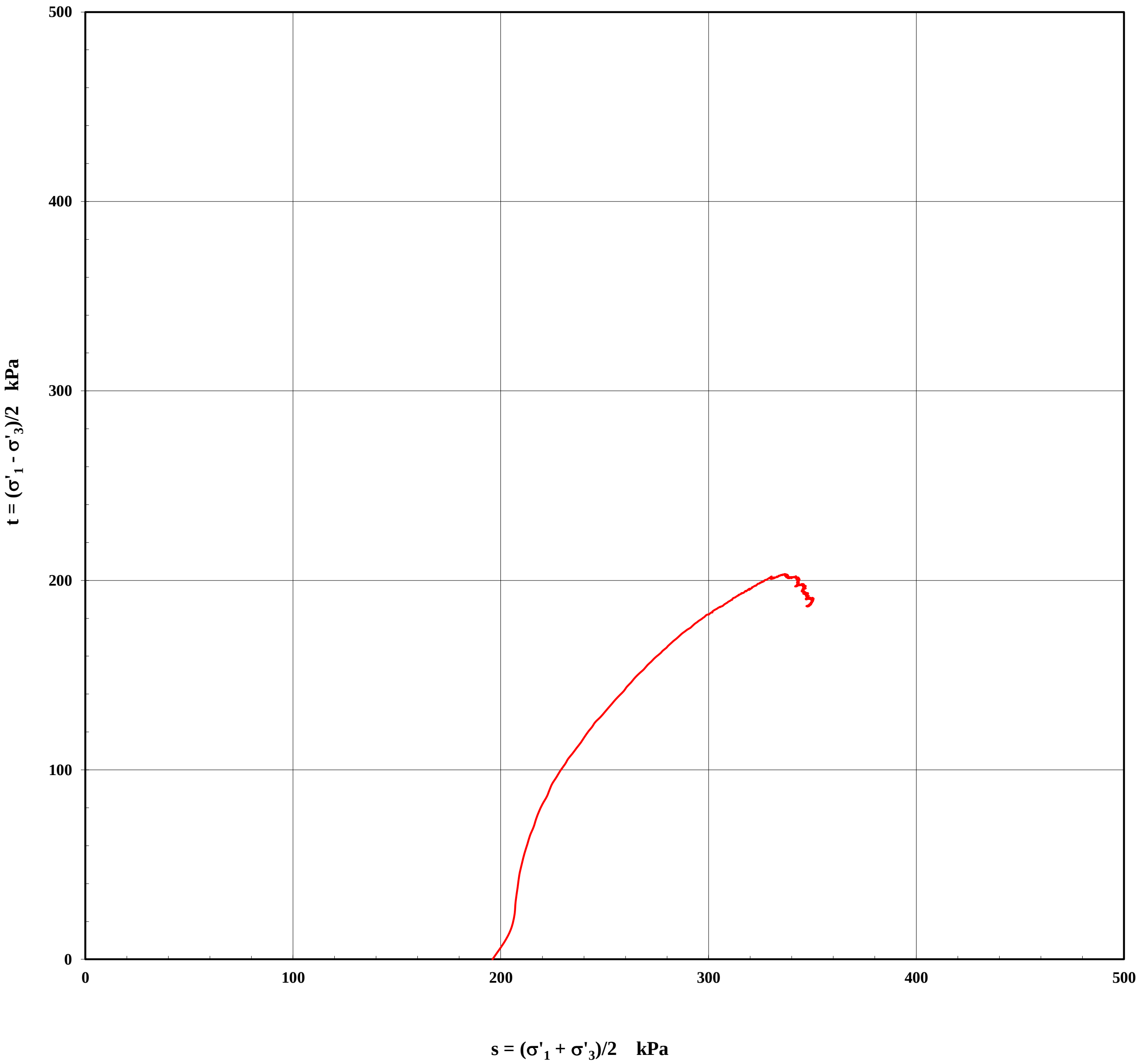
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003A - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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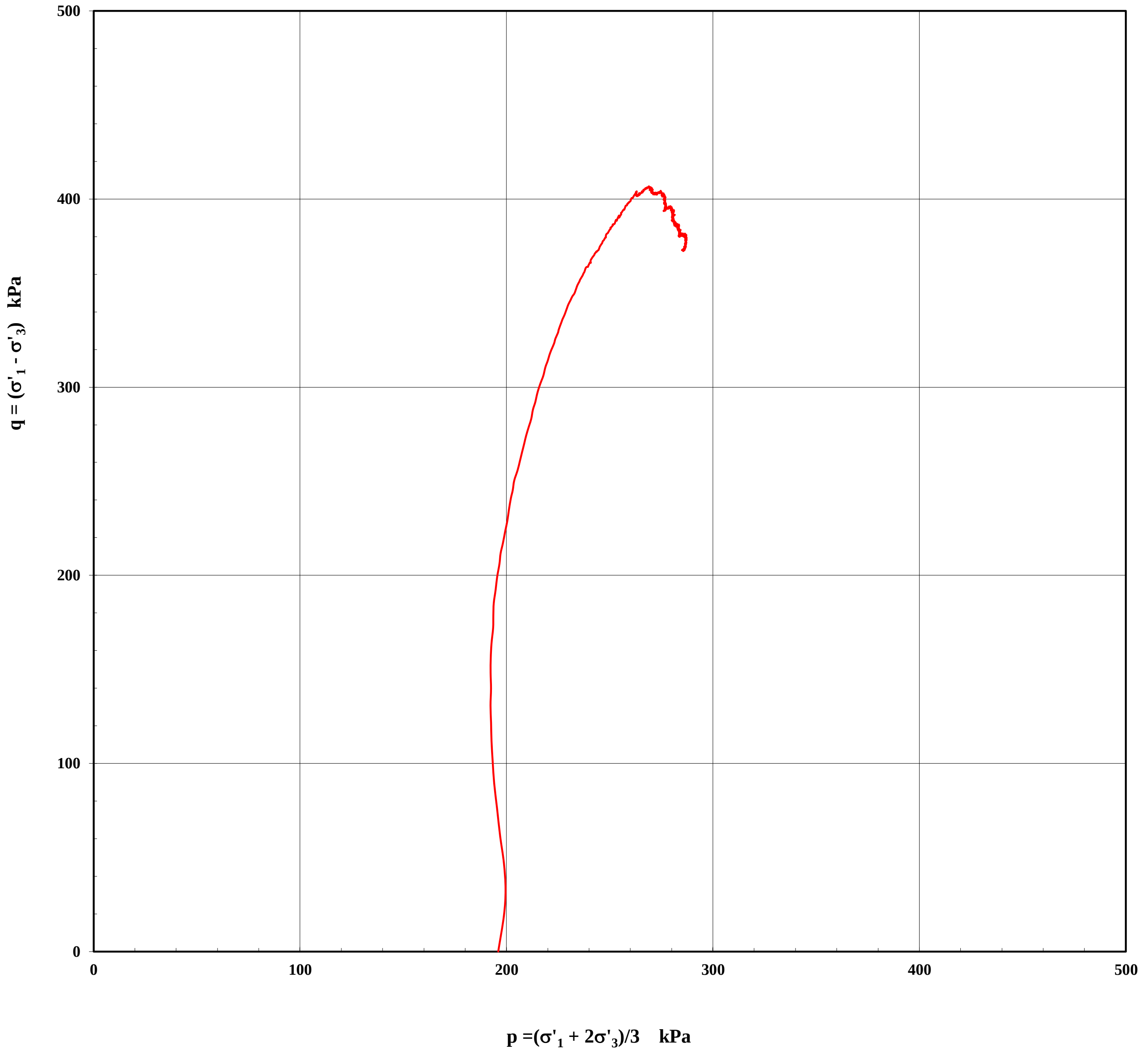
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003A - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18110003A - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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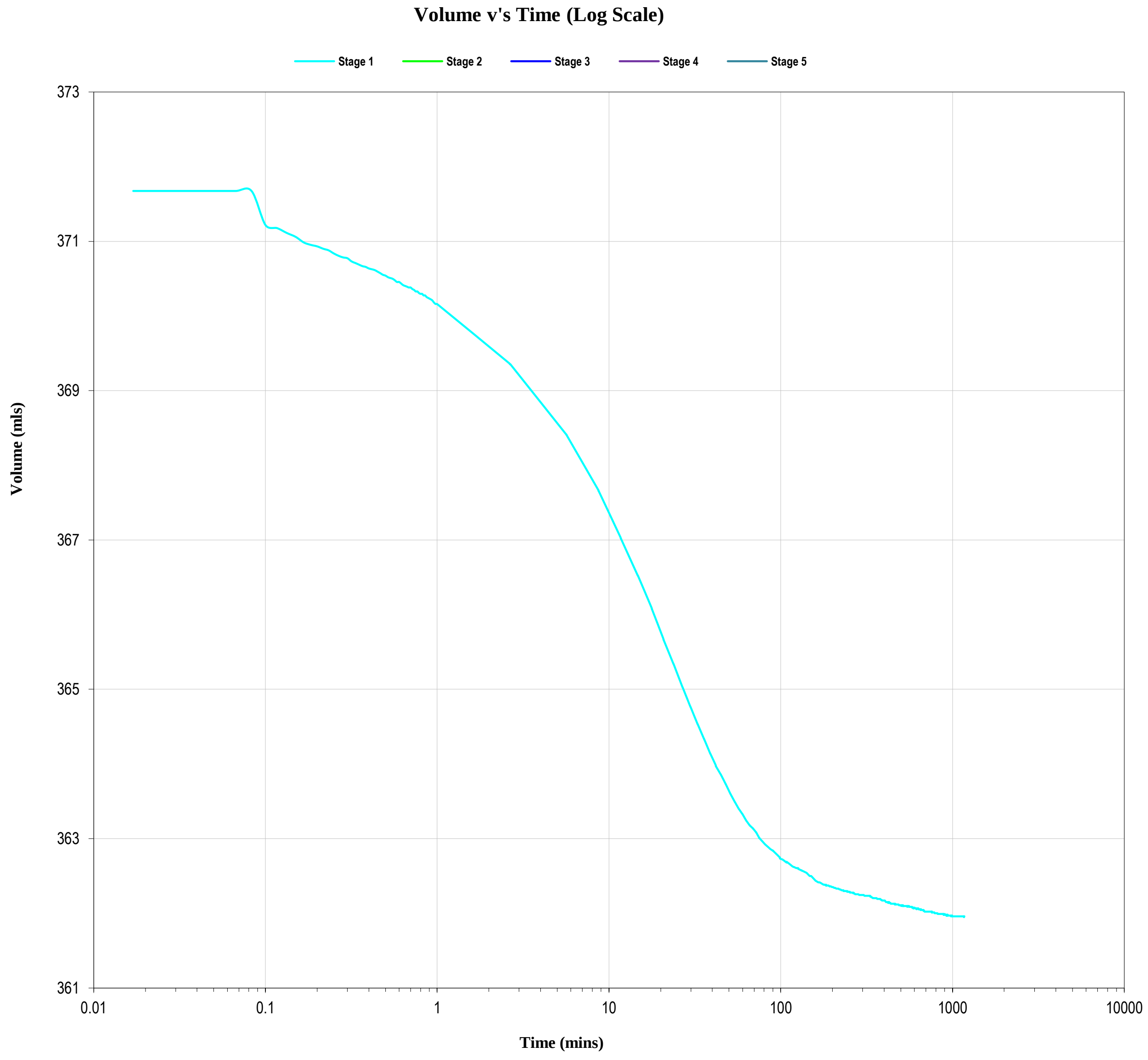
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110003A - CU



	Stage 1
Cv (m^2/year) **:**	**1.08**
Mv (m^2/MN) **:**	**0.124**
k (m/s) **:**	**4.14E-11**

Remarks: Tested as Received

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.:**	18110003B - CU
		Workorder No.	0005081
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	8/11/2018
		Report Date:	16/11/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE432 - L1C - Lexan	**Depth (m):**	20.30-20.80
Description:	SILTY CLAY - brown/orange/yellow		

SAMPLE & TEST DETAILS

Initial Height:	129.0	mm	Initial Moisture Content:	28.2	%	Rate of Strain:	0.002	%/min
Initial Diameter:	61.3	mm	Final Moisture Content:	25.4	%	B Response:	97	%
L/D Ratio:	2.1 : 1		Wet Density:	1.95	t/m^3			
			Dry Density:	1.52	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
398 kPa	800 kPa	402 kPa	402 kPa	576 kPa	844 kPa	224 kPa	3.766	620 kPa	2.36 %

FAILURE ENVELOPES

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

Remarks: Tested as Received
Sample/s supplied by the client

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Authorised Signatory
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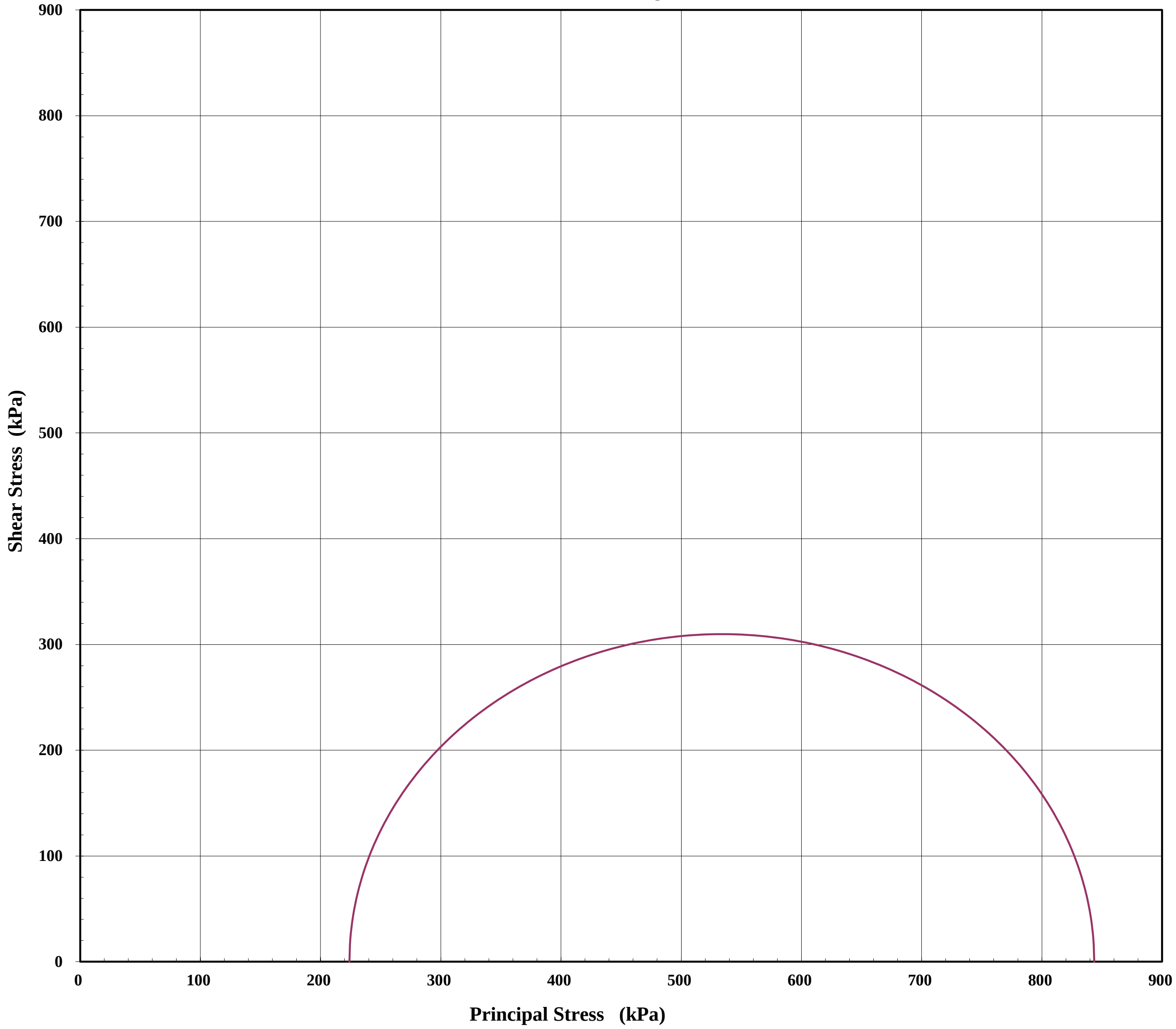
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003B - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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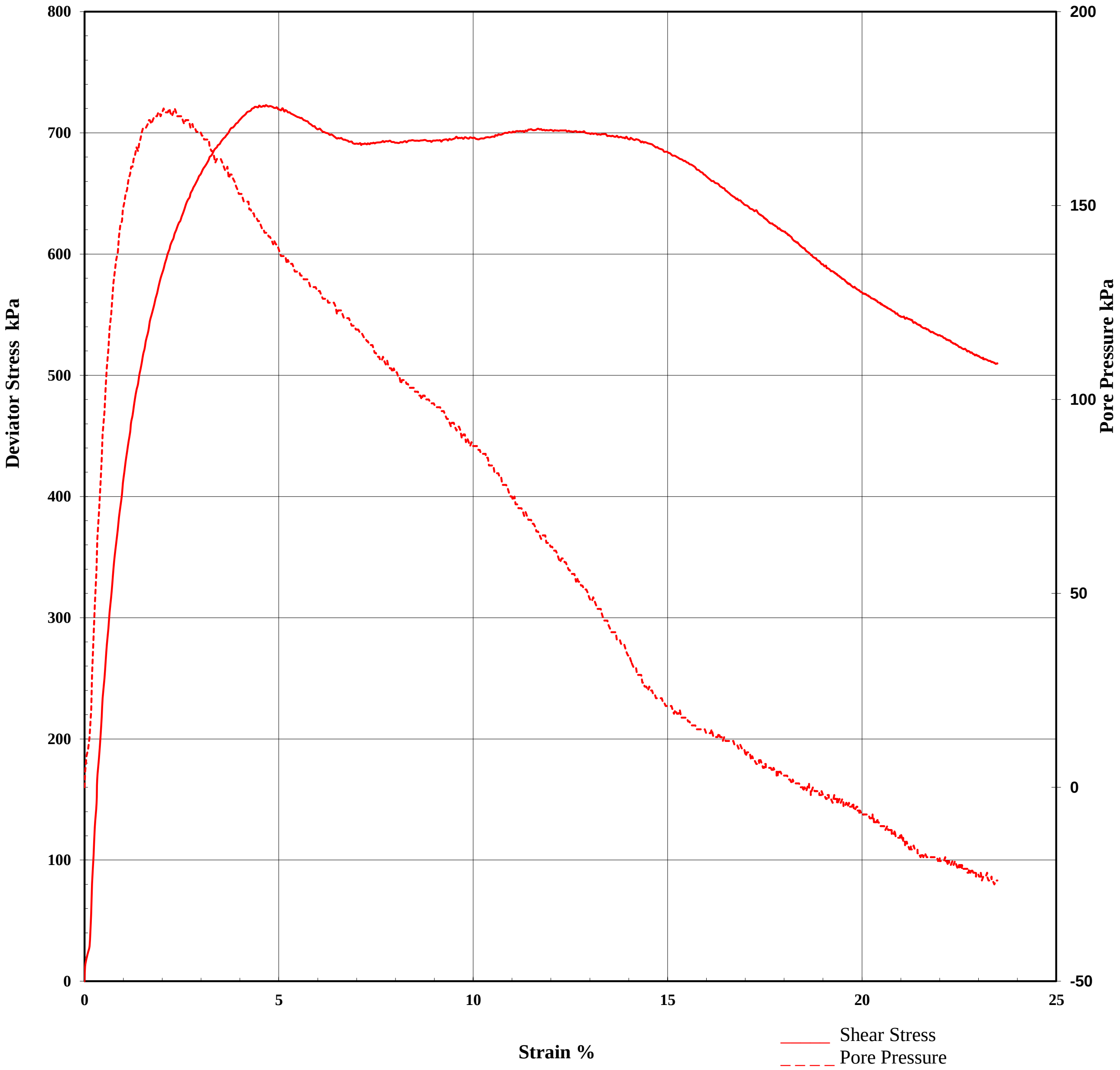
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003B - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

REP03001

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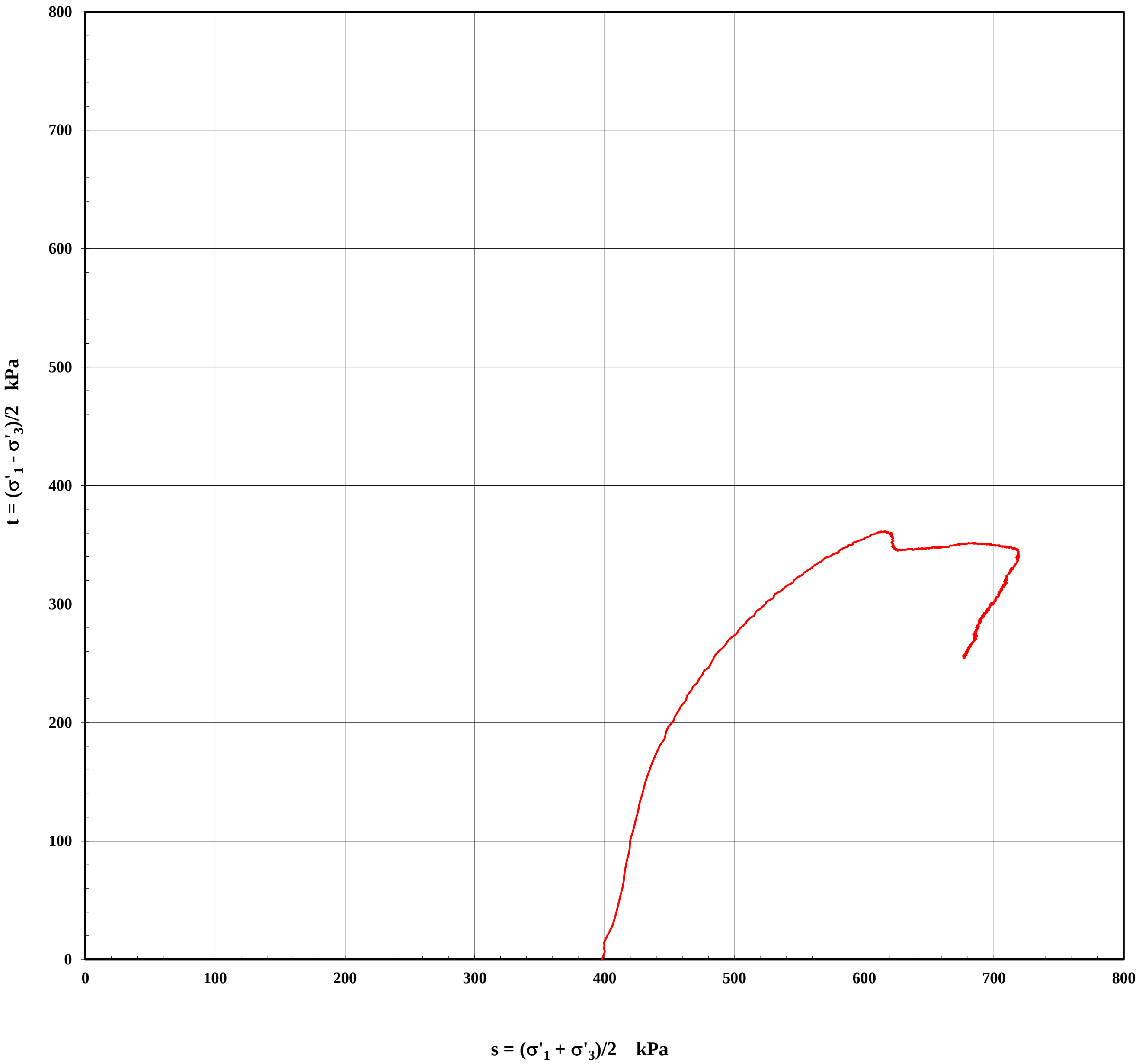
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003B - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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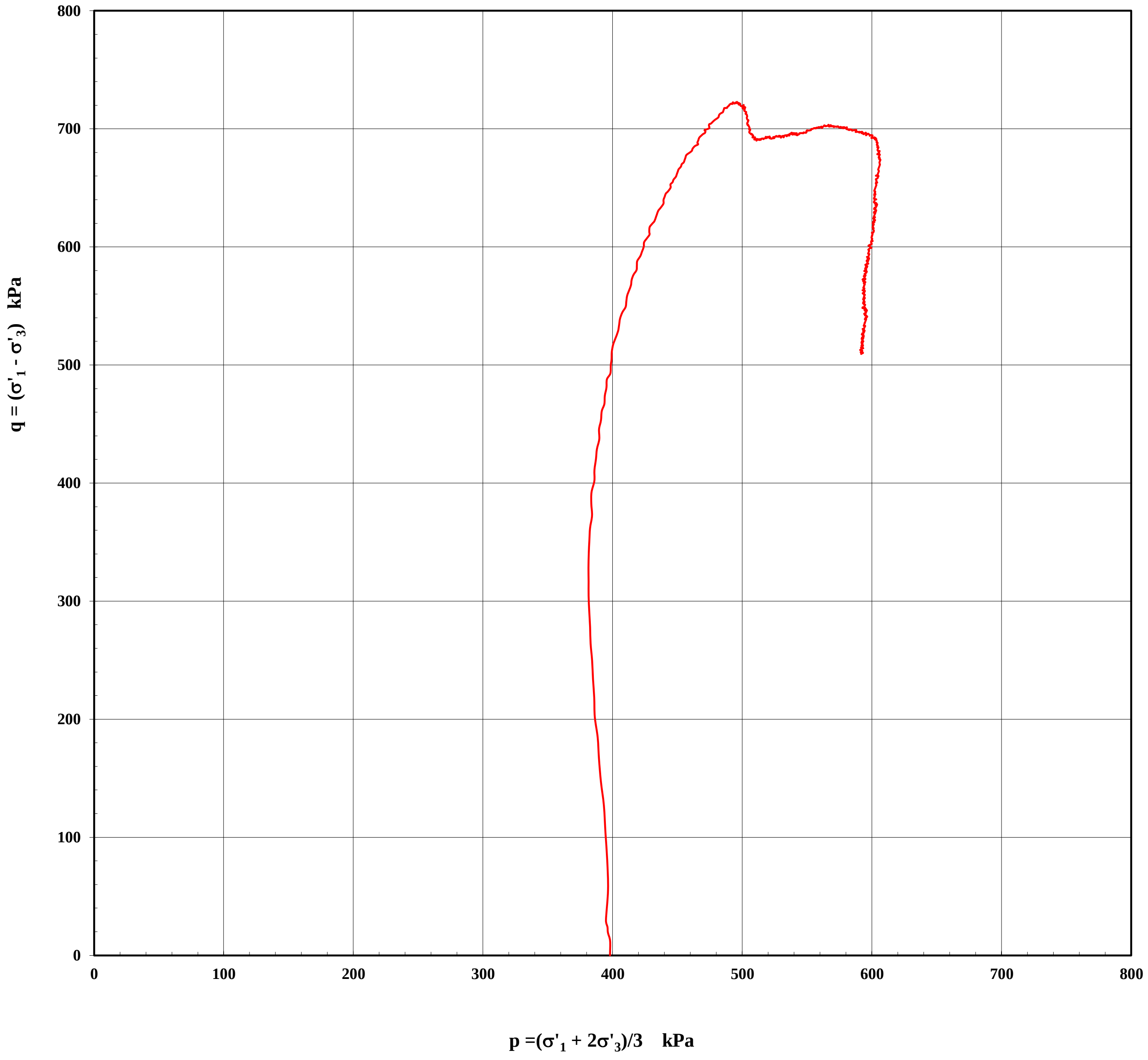
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110003B - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18110003B - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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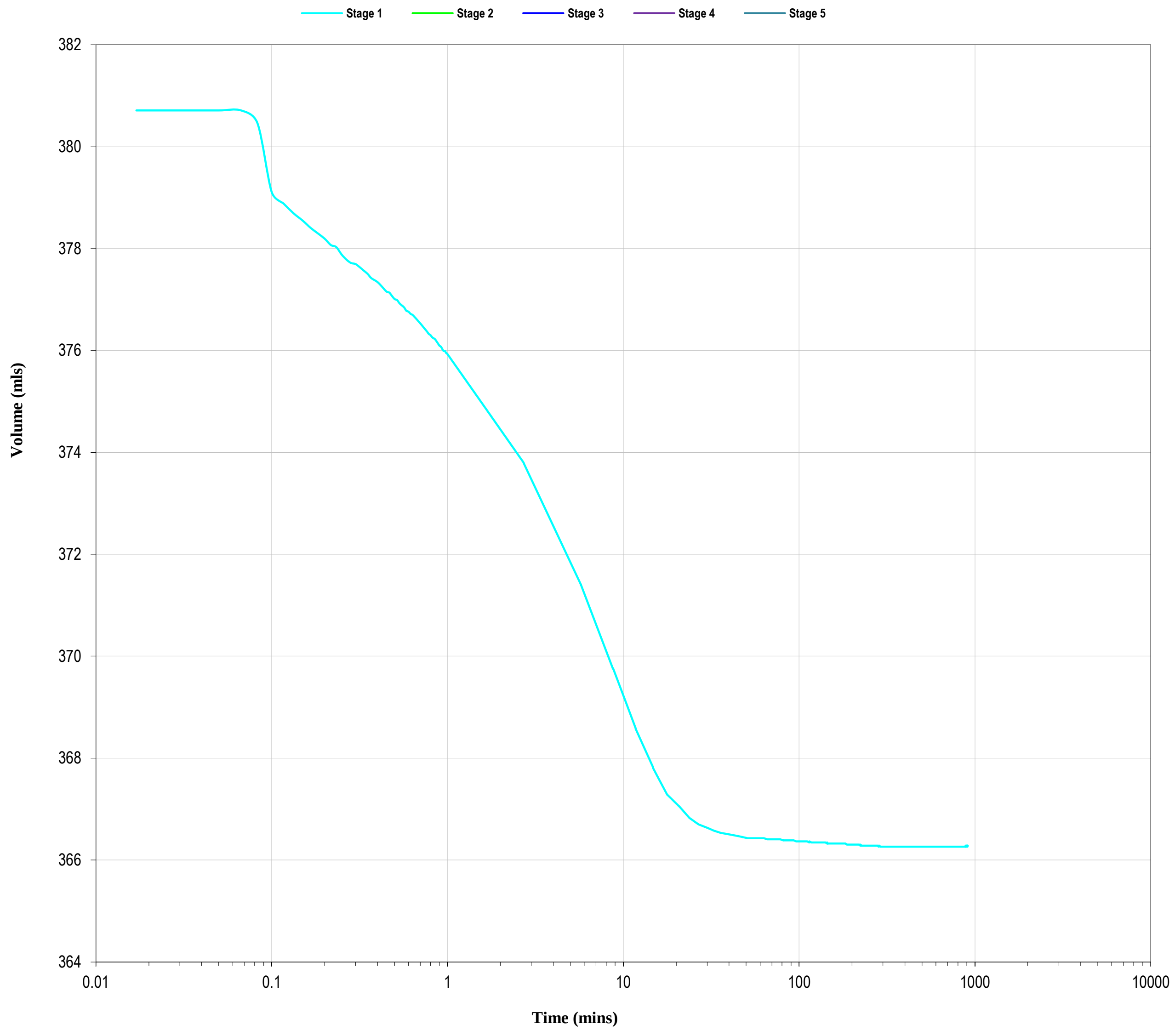
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110003B - CU

Volume v's Time (Log Scale)



	Stage 1
Cv (m^2/year) **:**	**3.69**
Mv (m^2/MN) **:**	**0.094**
k (m/s) **:**	**1.07E-10**

Remarks: Tested as Received

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.:**	18110004A - CU
		Workorder No.	0005081
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	2/11/2018
		Report Date:	15/11/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE432 - L2 - Lexan	**Depth (m):**	22.80-23.20
Description:	SILTY CLAY- yellow brown		

SAMPLE & TEST DETAILS

Initial Height:	128.3	mm	Initial Moisture Content:	17.5	%	Rate of Strain:	0.004	%/min
Initial Diameter:	61.6	mm	Final Moisture Content:	20.3	%	B Response:	98	%
L/D Ratio:	2.1 : 1		Wet Density:	2.00	t/m^3			
			Dry Density:	1.70	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
400 kPa	900 kPa	500 kPa	500 kPa	669 kPa	892 kPa	231 kPa	3.857	661 kPa	3.28 %

FAILURE ENVELOPES

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

Remarks: Tested as Received
Sample/s supplied by the client

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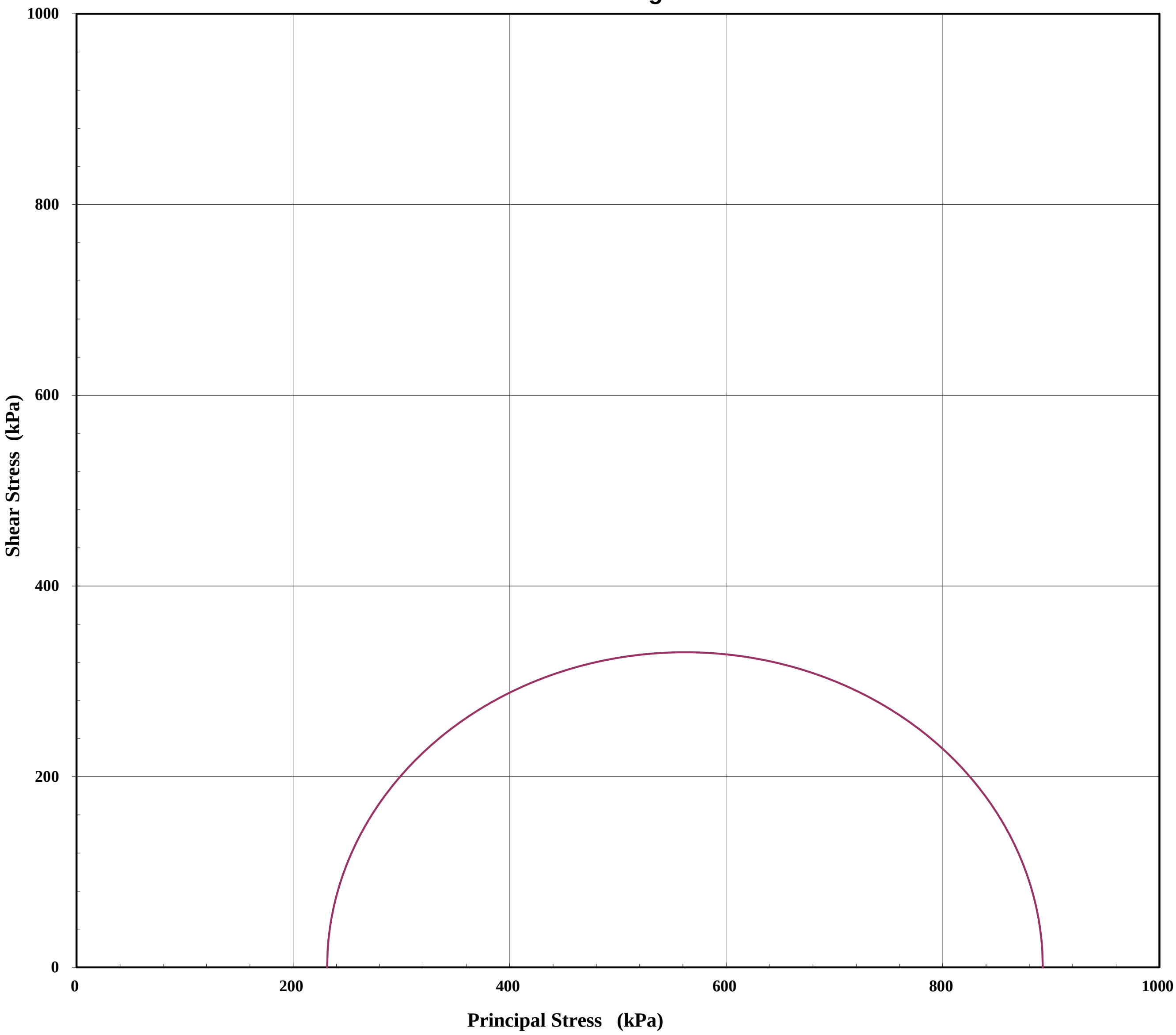
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110004A - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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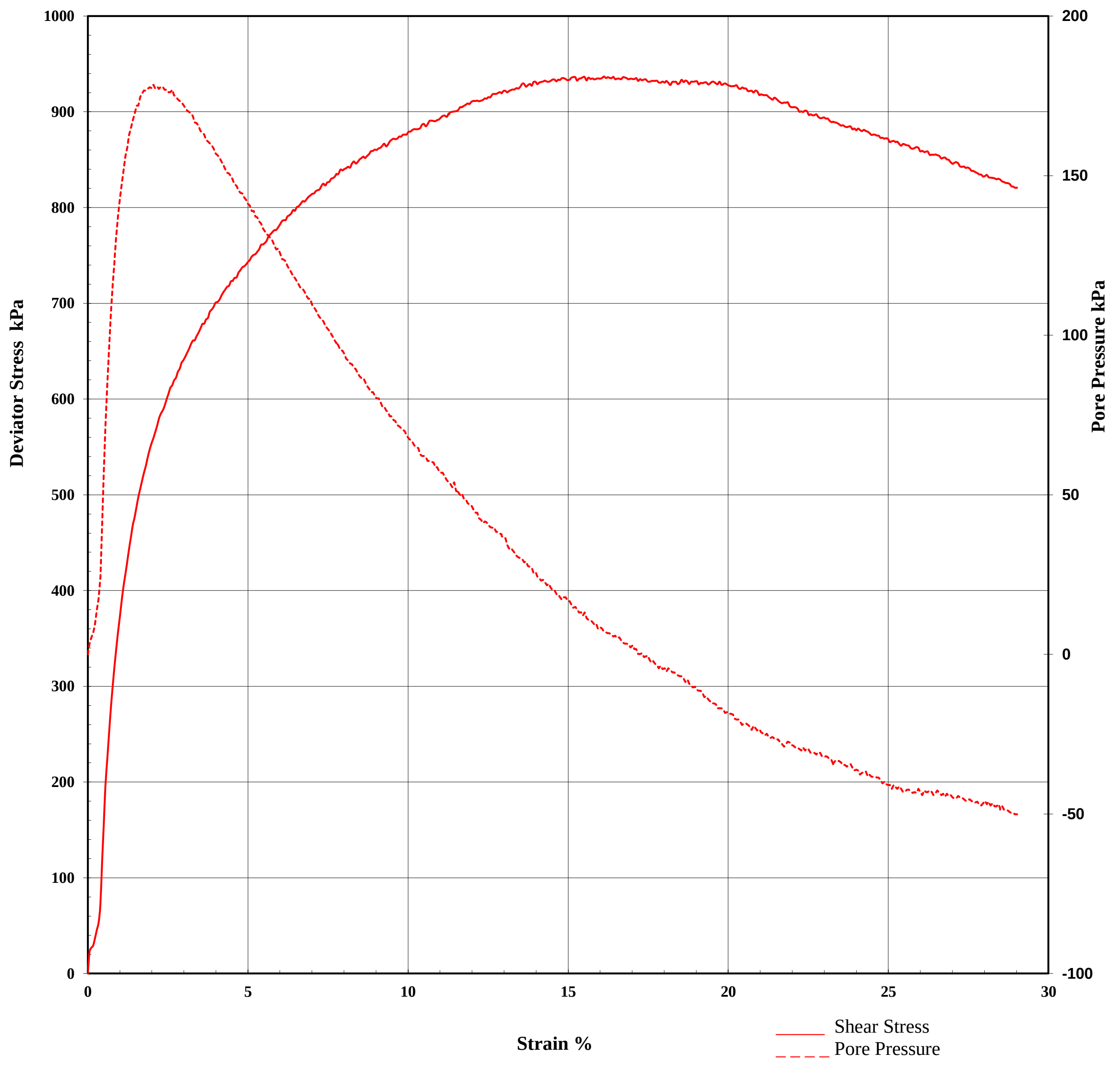
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110004A - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

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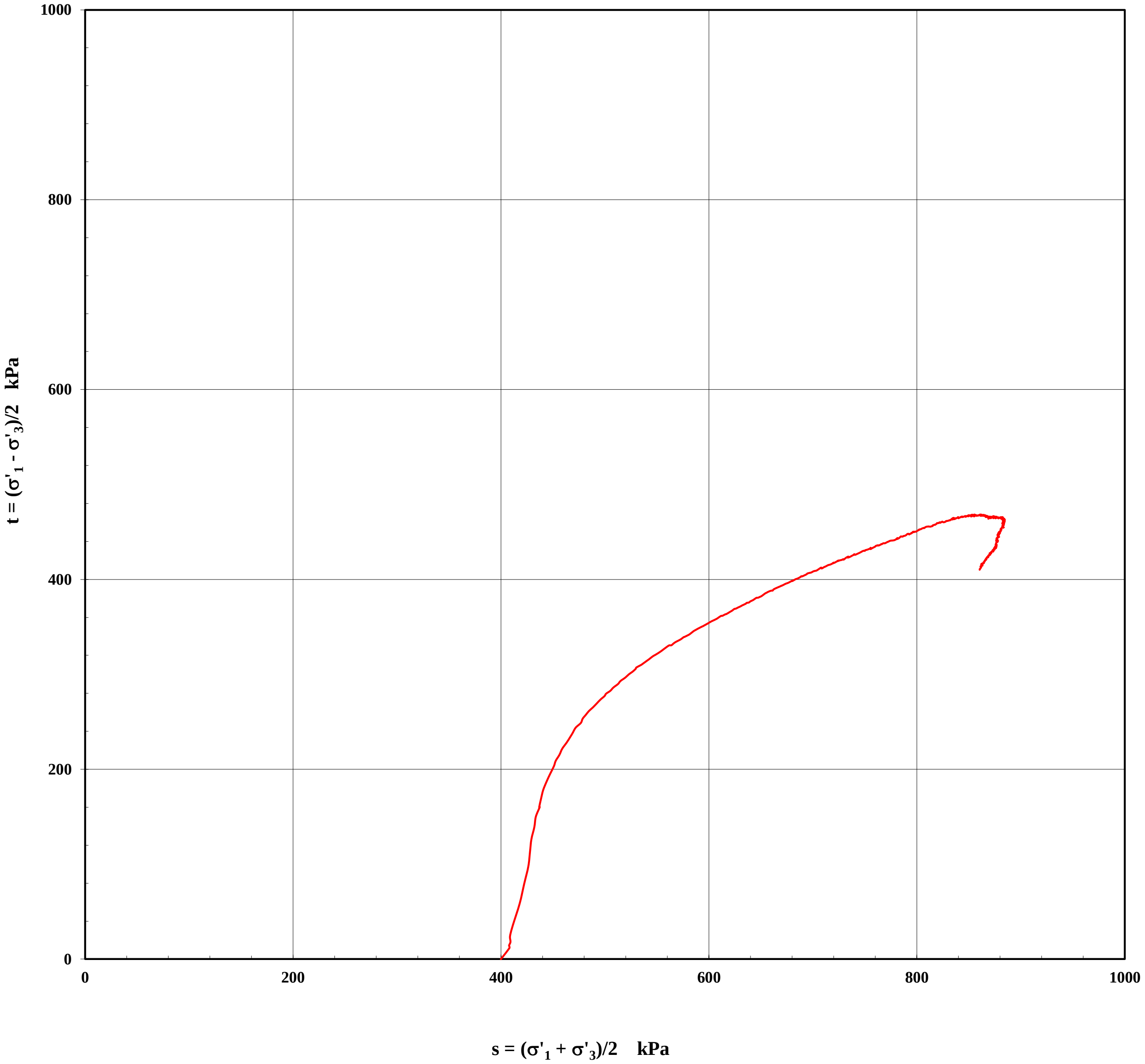
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110004A - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

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Note: Graph not to scale

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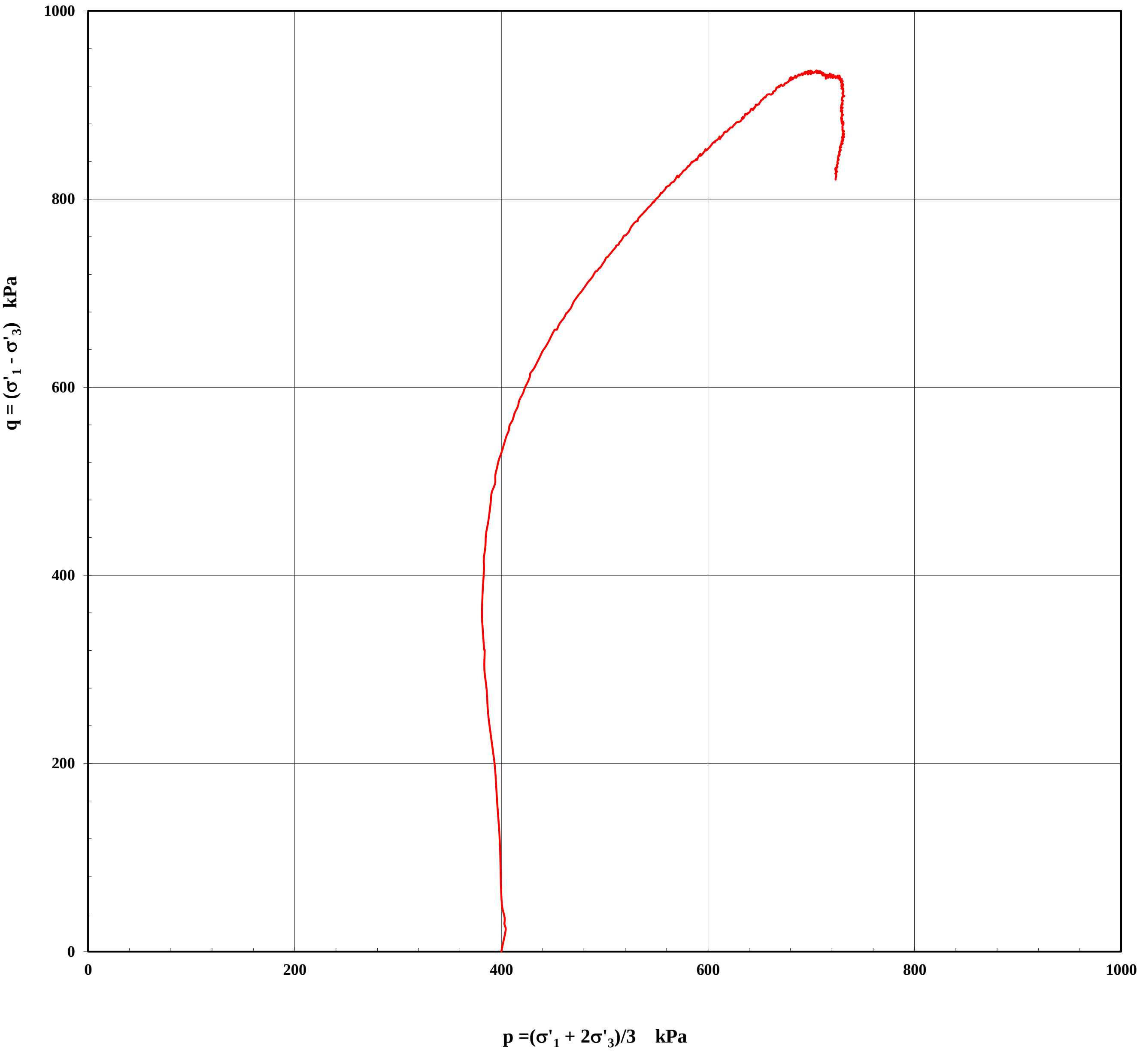
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110004A - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18110004A - CU

Remarks: Tested as Received

Sample/s supplied by the client

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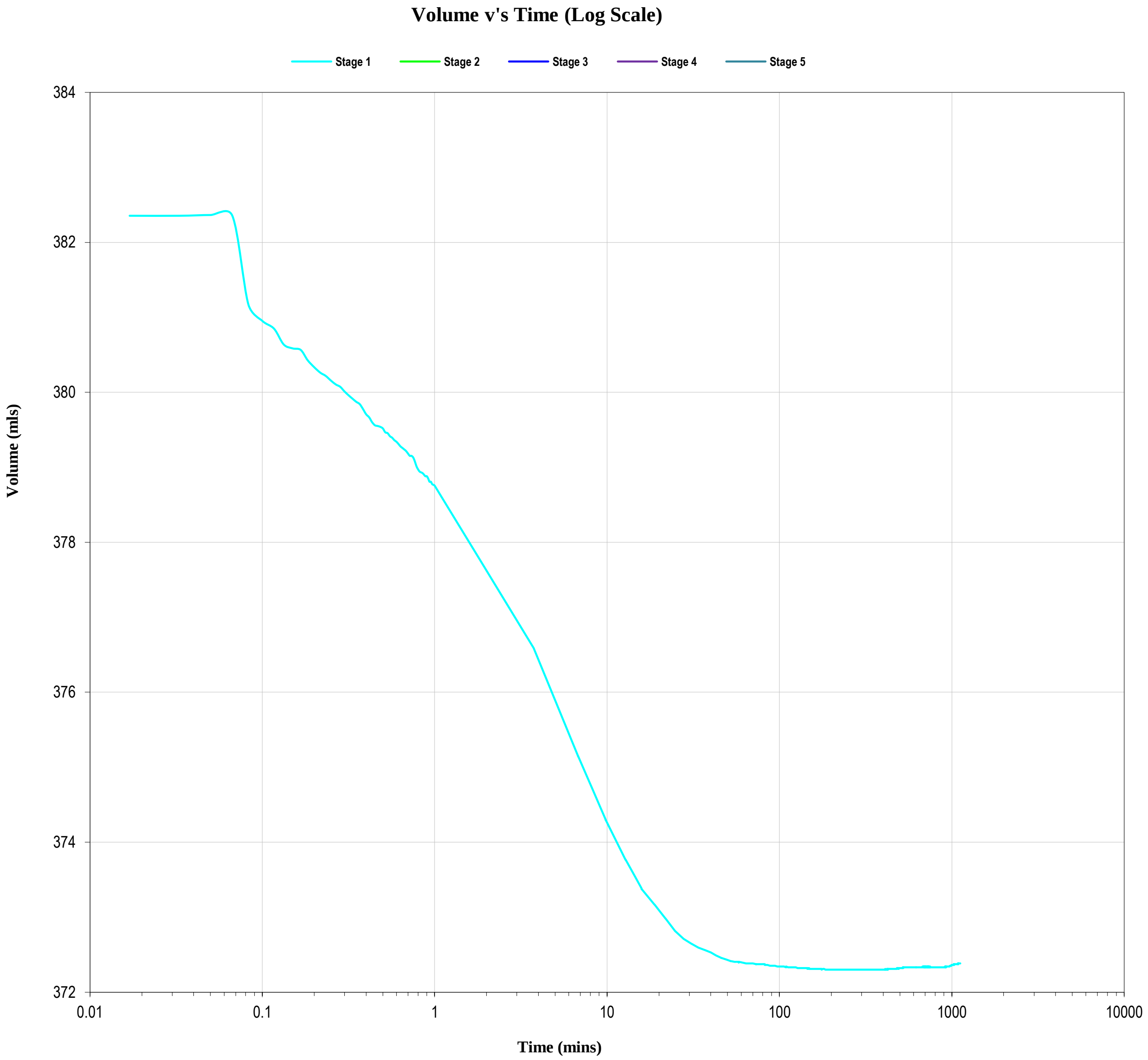
Client: Hatch Pty Ltd

Report No.: 18110004A - CU



	Stage 1
Cv (m^2/year) **:**	**3.72**
Mv (m^2/MN) **:**	**0.065**
k (m/s) **:**	**7.49E-11**

Remarks: Tested as Received

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.:**	18110004B - CU
		Workorder No.	0005081
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	6/11/2018
		Report Date:	15/11/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE432 - L2 - Lexan	**Depth (m):**	22.80-23.20
Description:	SILTY CLAY- yellow brown		

SAMPLE & TEST DETAILS

Initial Height:	128.7	mm	Initial Moisture Content:	17.5	%	Rate of Strain:	0.004	%/min
Initial Diameter:	59.6	mm	Final Moisture Content:	20.3	%	B Response:	99	%
L/D Ratio:	2.2 : 1		Wet Density:	2.00	t/m^3			
			Dry Density:	1.70	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
800 kPa	1299 kPa	499 kPa	499 kPa	800 kPa	1657 kPa	499 kPa	3.322	1158 kPa	4.00 %

FAILURE ENVELOPES

Interpretation between stages :

Cohesion C' (kPa) :

Angle of Shear Resistance Φ' (Degrees) :

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

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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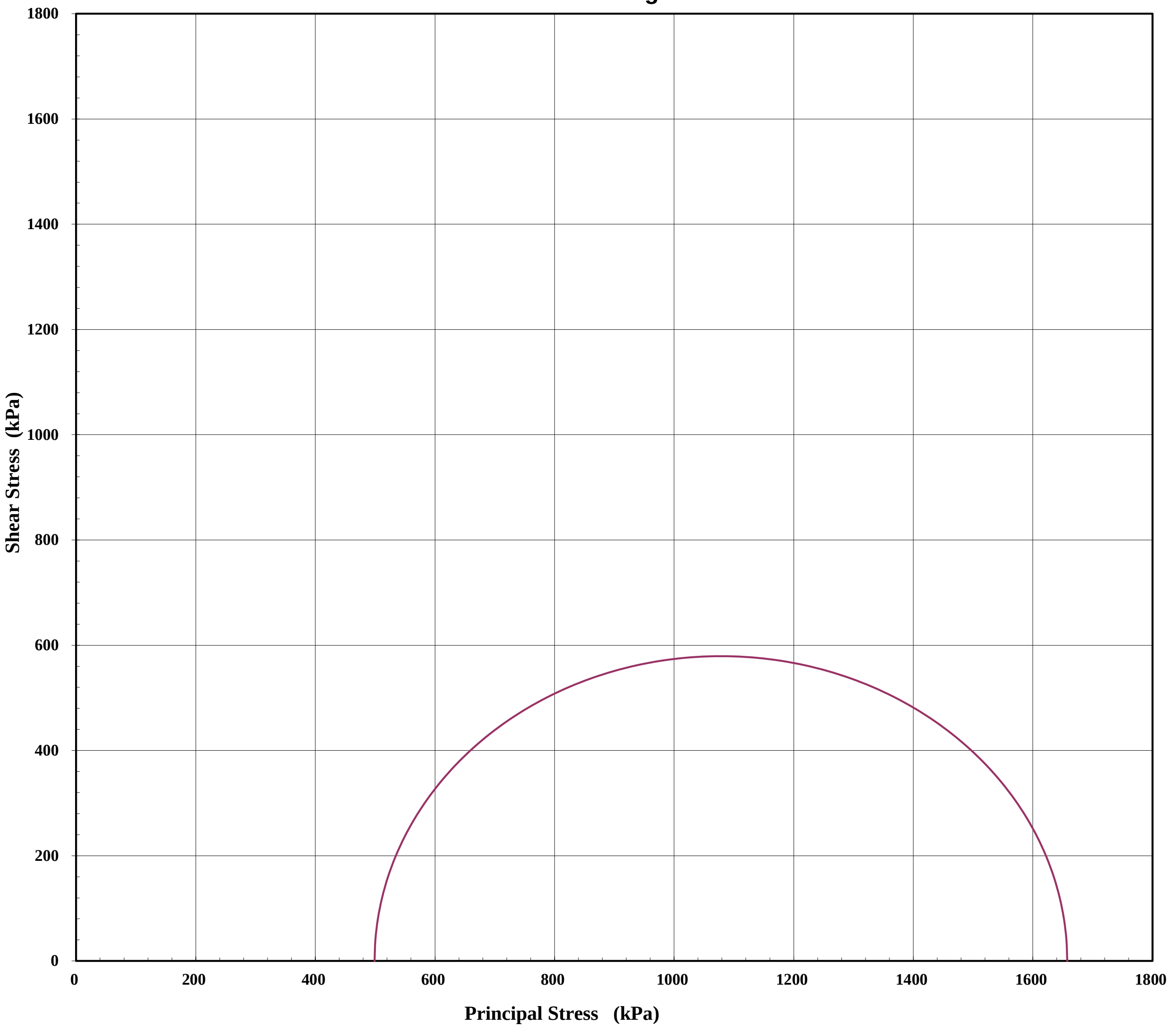
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110004B - CU

Mohr Circle Diagram



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

Remarks: Tested as Received
Sample/s supplied by the client

Note: Graph not to scale

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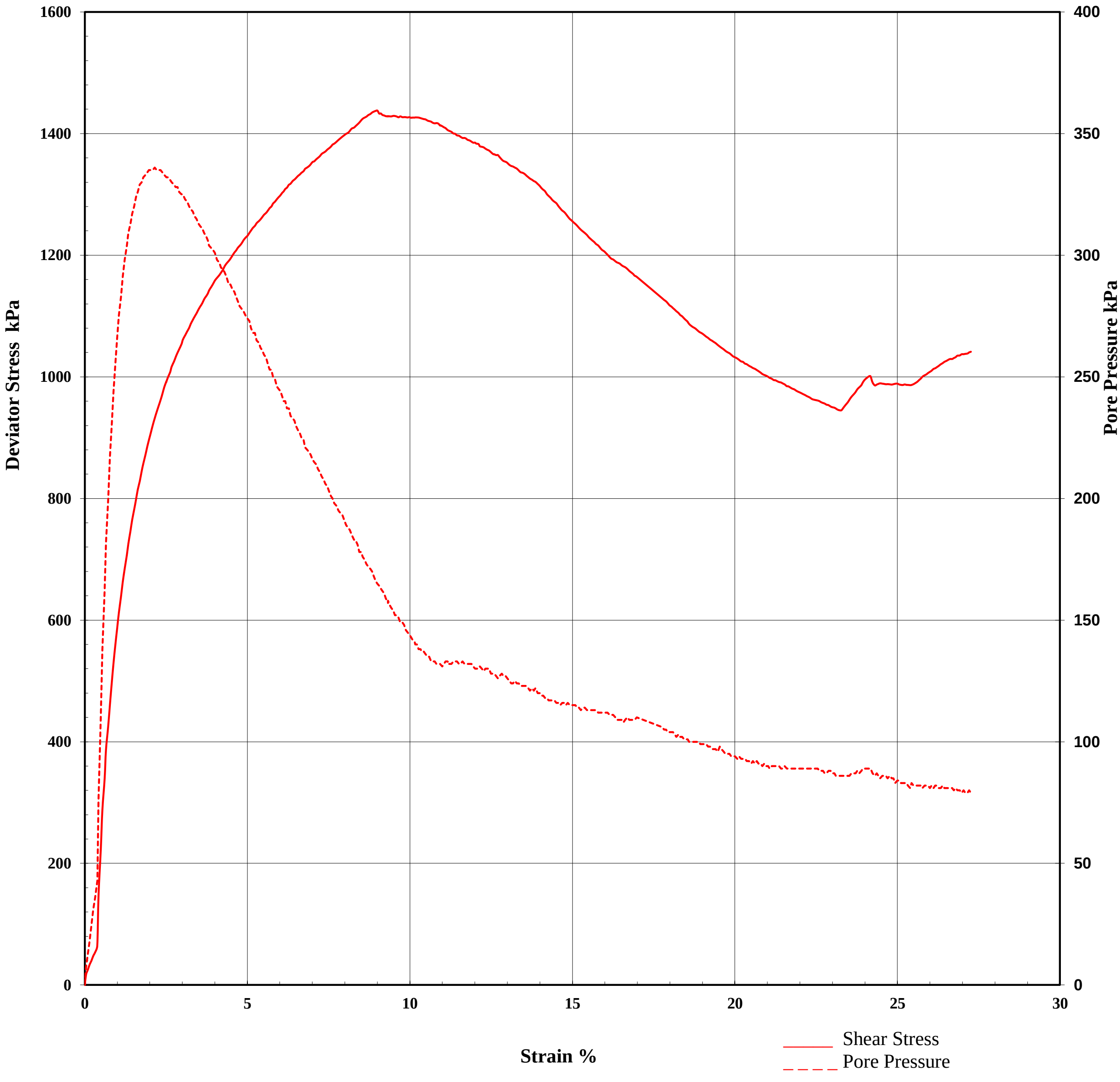
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110004B - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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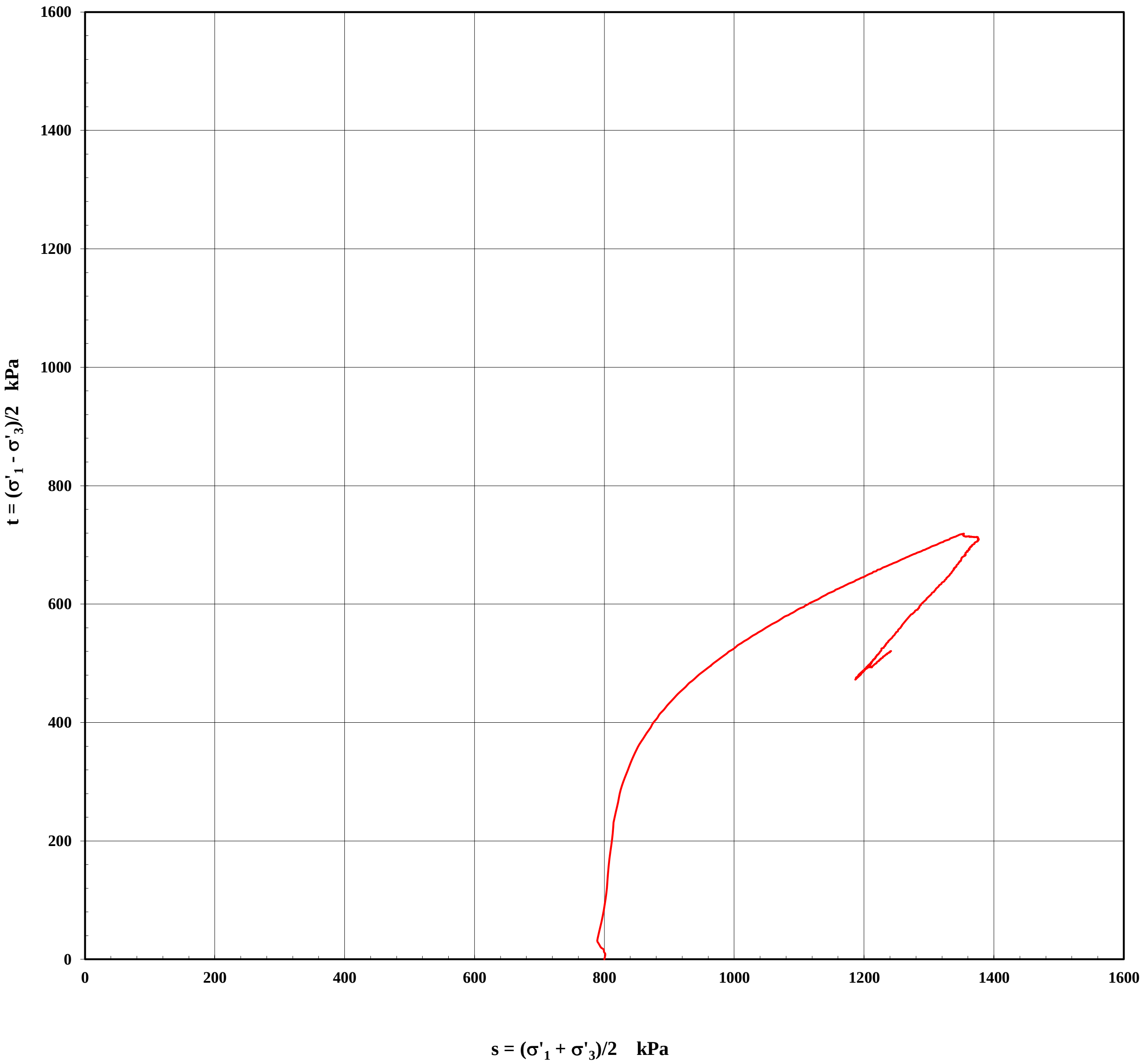
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110004B - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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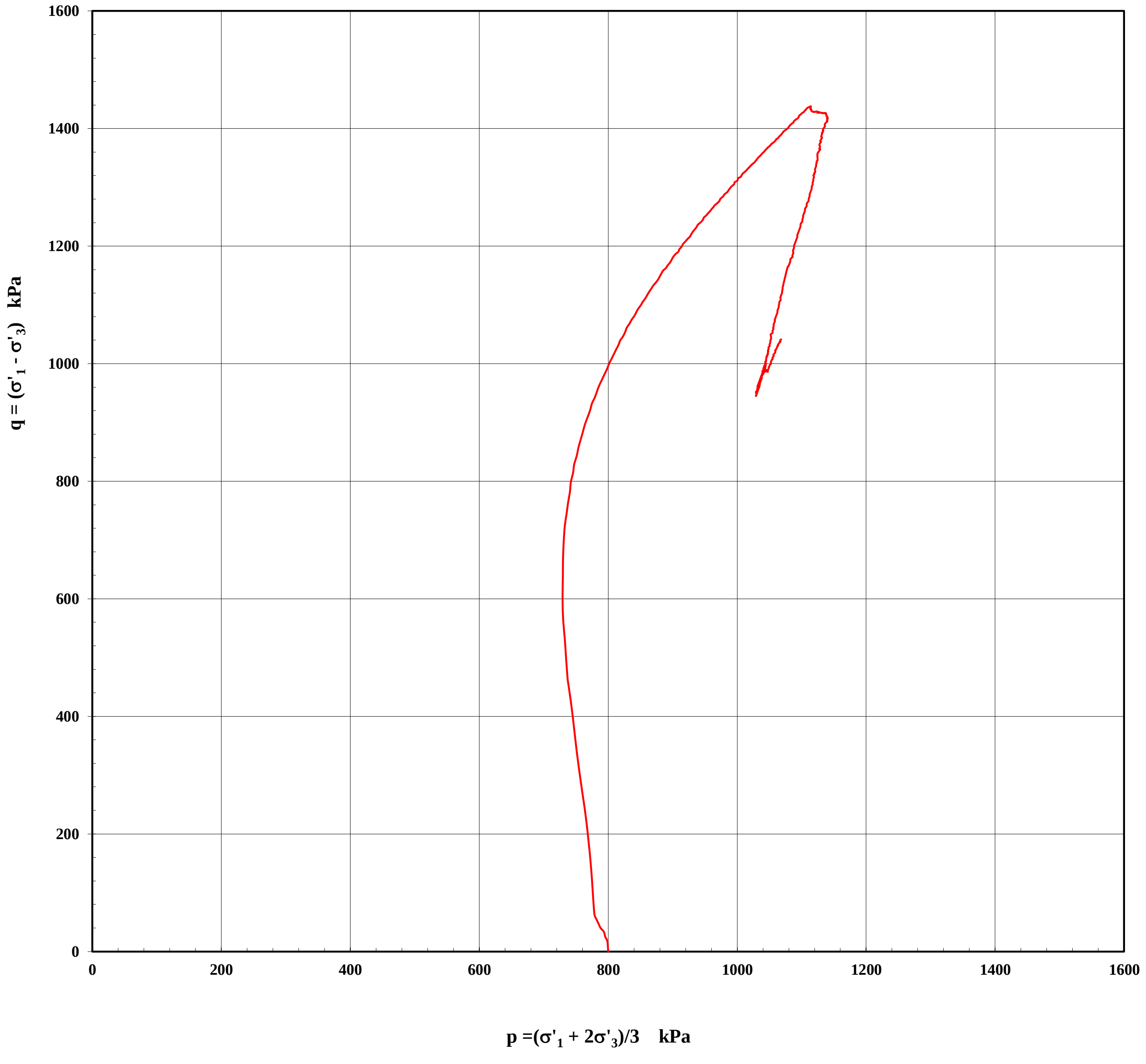
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110004B - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18110004B - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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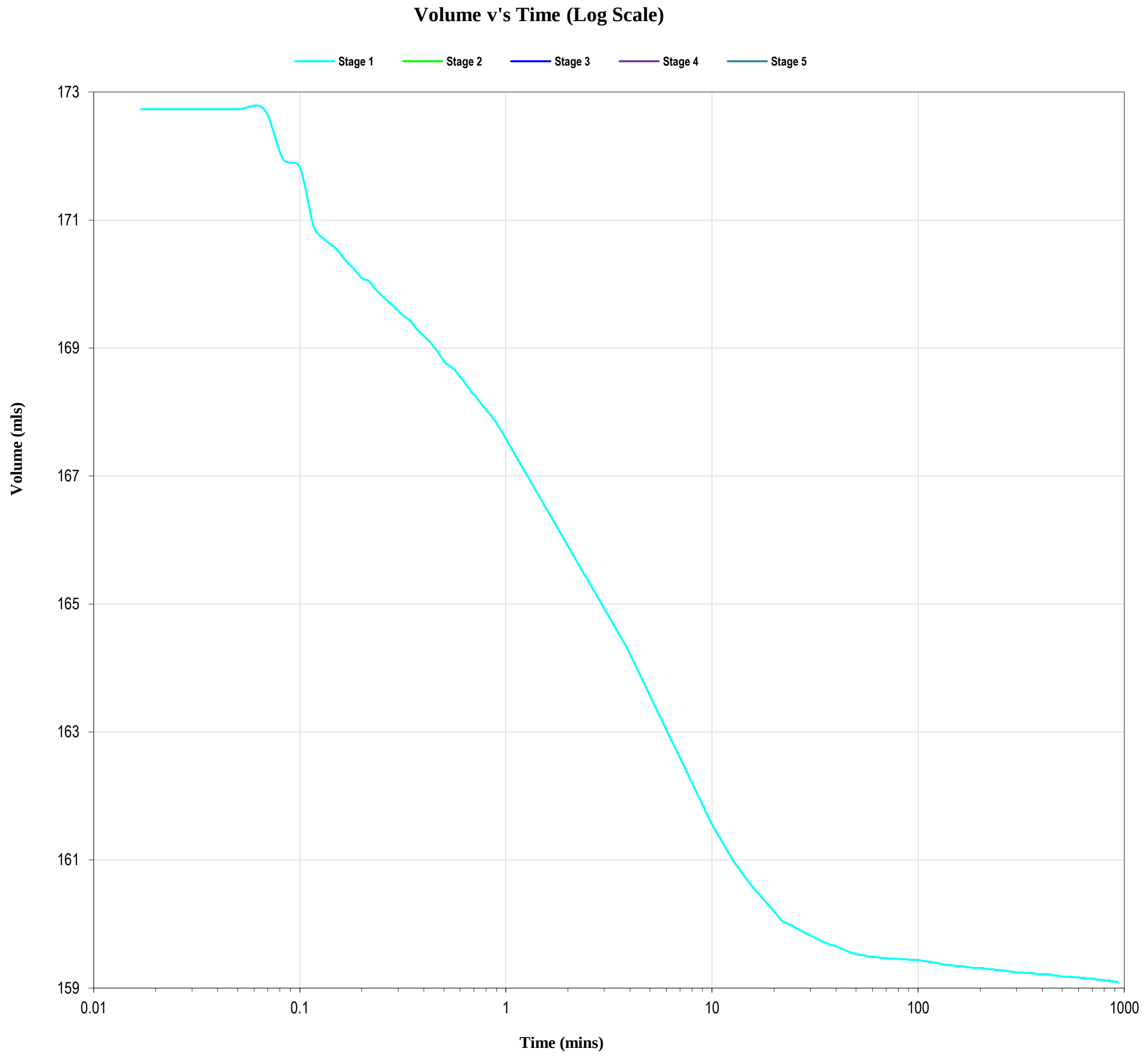

	Stage 1
Cv (m^2/year) **:**	3.37
Mv (m^2/MN) **:**	0.694
k (m/s) **:**	7.25E-10

Remarks: Tested as Received

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.:**	18110006A - CU
		Workorder No.	0005081
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	6/11/2018
		Report Date:	15/11/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE416 - L1C	**Depth (m):**	23.50-24.00
Description:	SILTY CLAY- orange/brown		

SAMPLE & TEST DETAILS

Initial Height:	129.4	mm	Initial Moisture Content:	26.4	%	Rate of Strain:	0.002	%/min
Initial Diameter:	61.5	mm	Final Moisture Content:	28.5	%	B Response:	97	%
L/D Ratio:	2.1 : 1		Wet Density:	2.00	t/m^3			
			Dry Density:	1.58	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
400 kPa	802 kPa	402 kPa	402 kPa	562 kPa	777 kPa	240 kPa	3.239	537 kPa	3.06 %

FAILURE ENVELOPES

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

Remarks: Tested as Received
Sample/s supplied by the client

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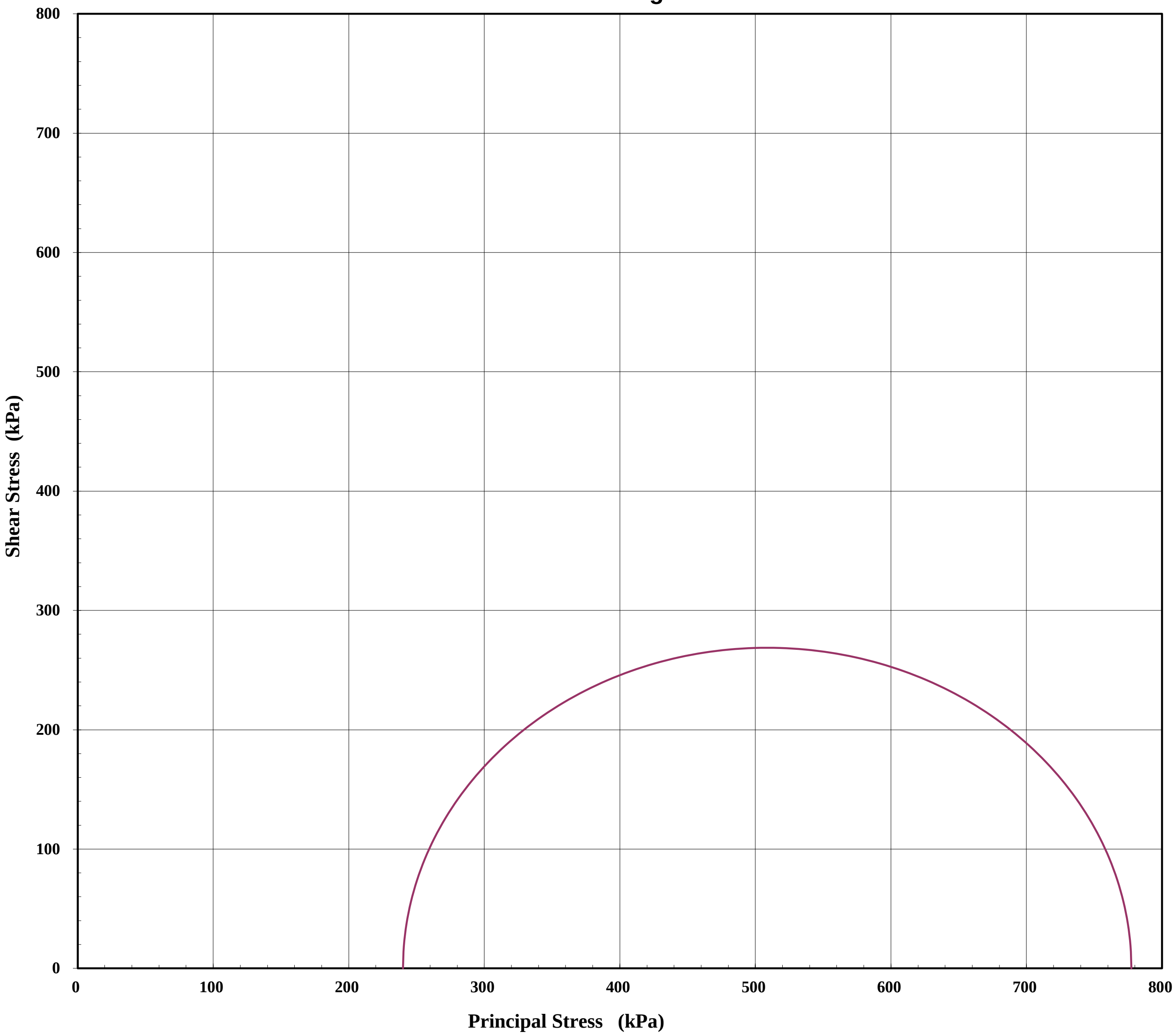
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110006A - CU

Mohr Circle Diagram



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

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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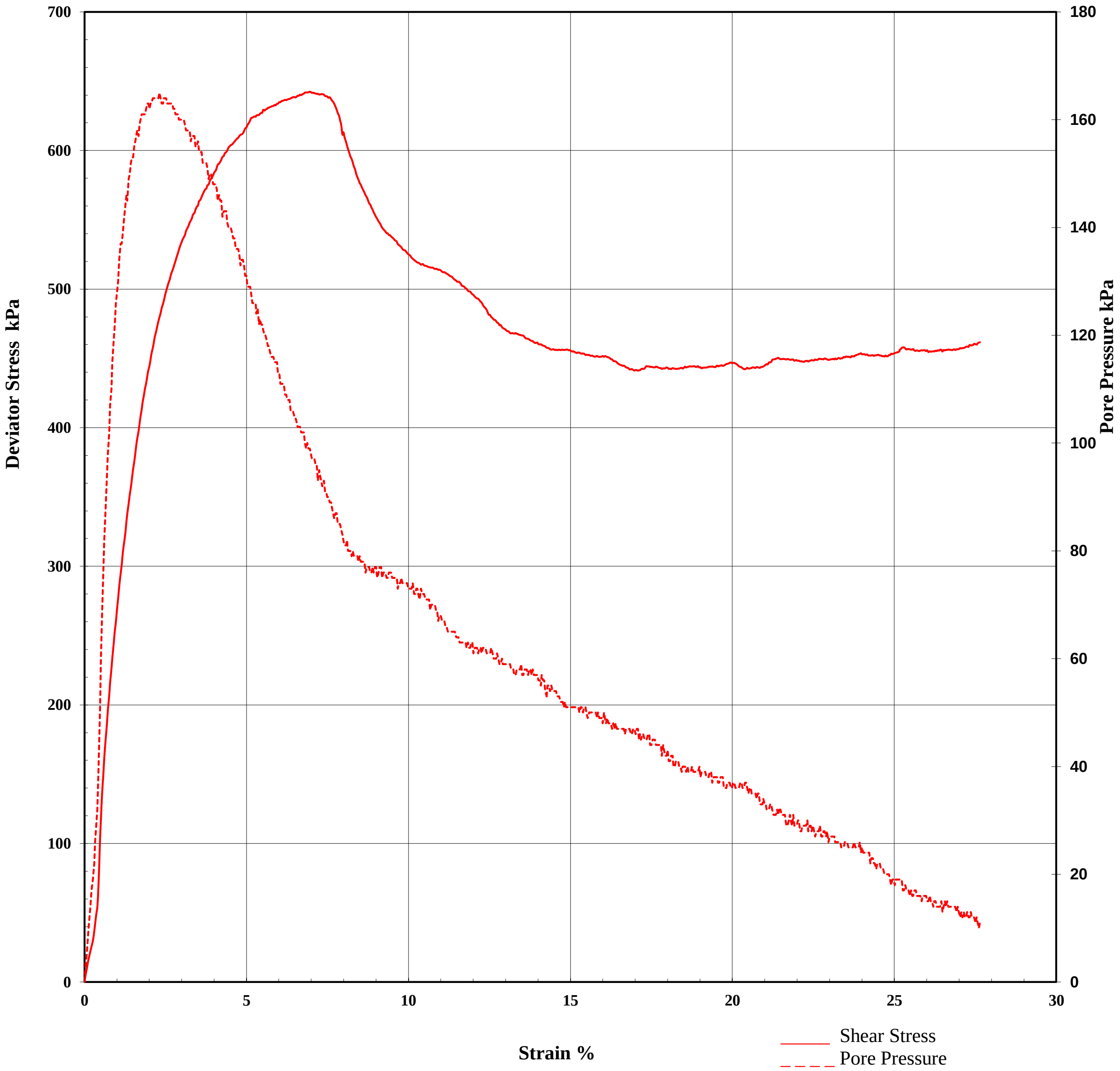
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110006A - CU

Stress/Strain & Pore Pressure/Strain Diagram



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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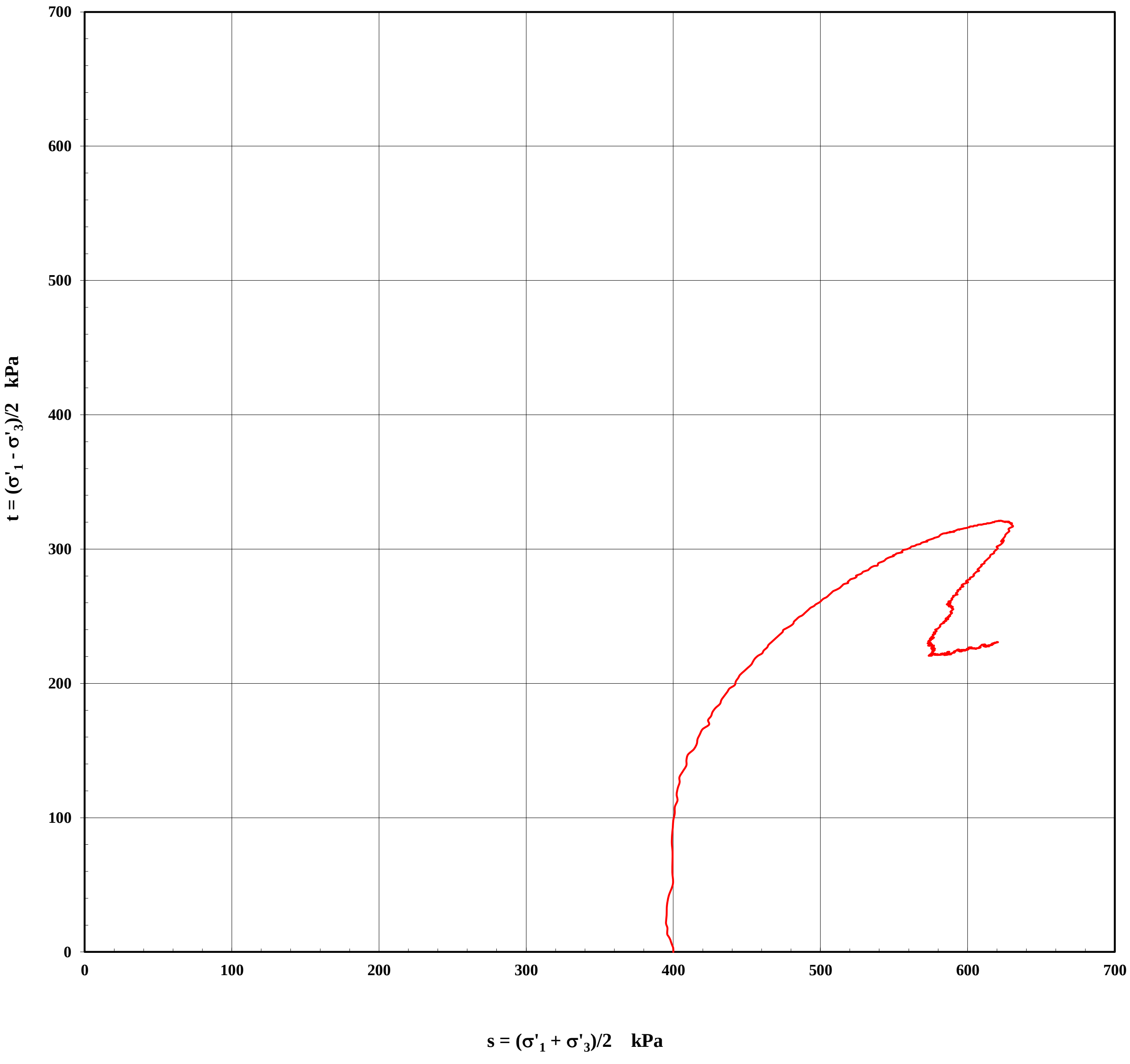
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110006A - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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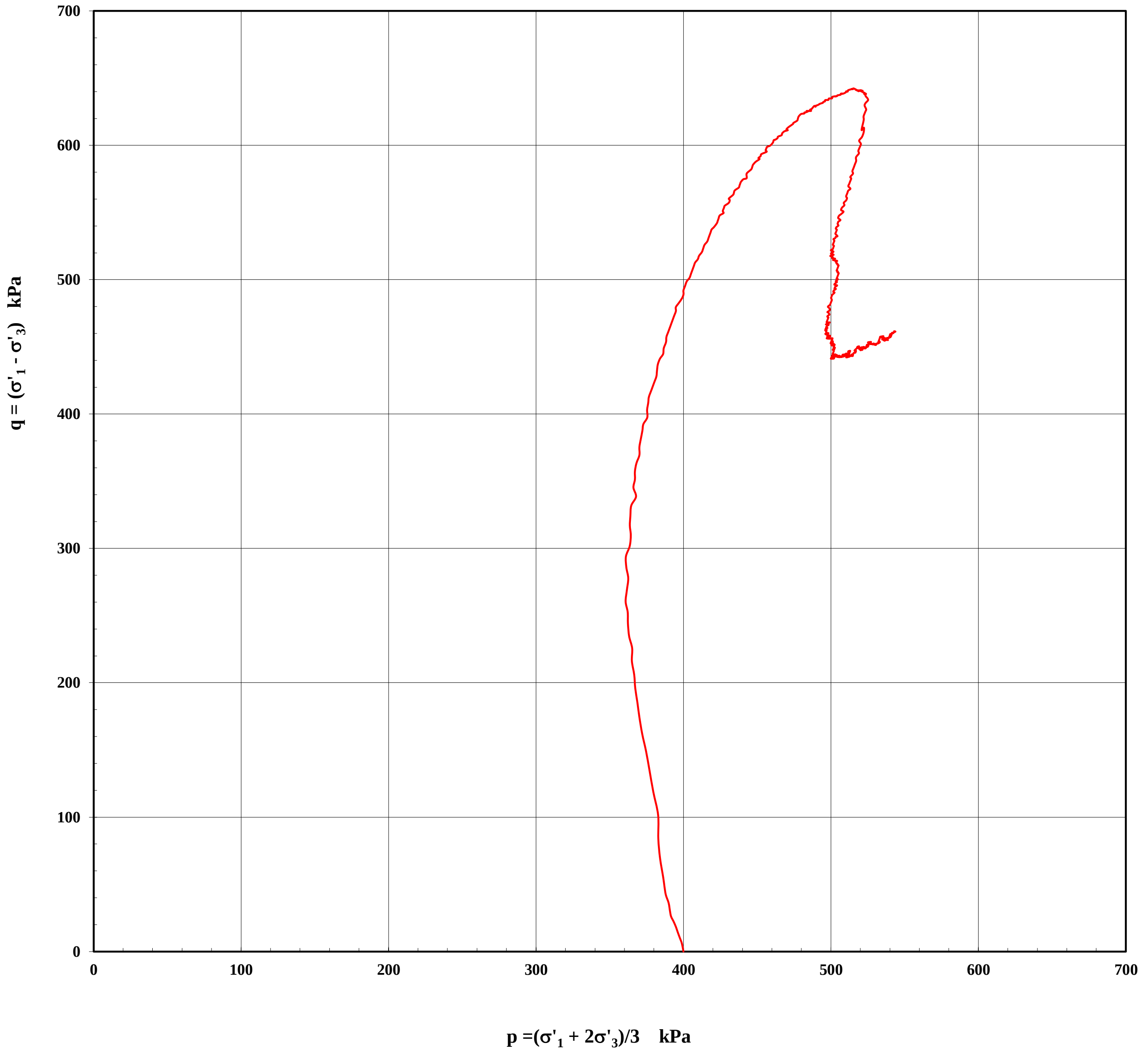
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110006A - CU

Cambridge Method - Effective Stress Path



Remarks: Tested as Received

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.:** 18110006A - CU

Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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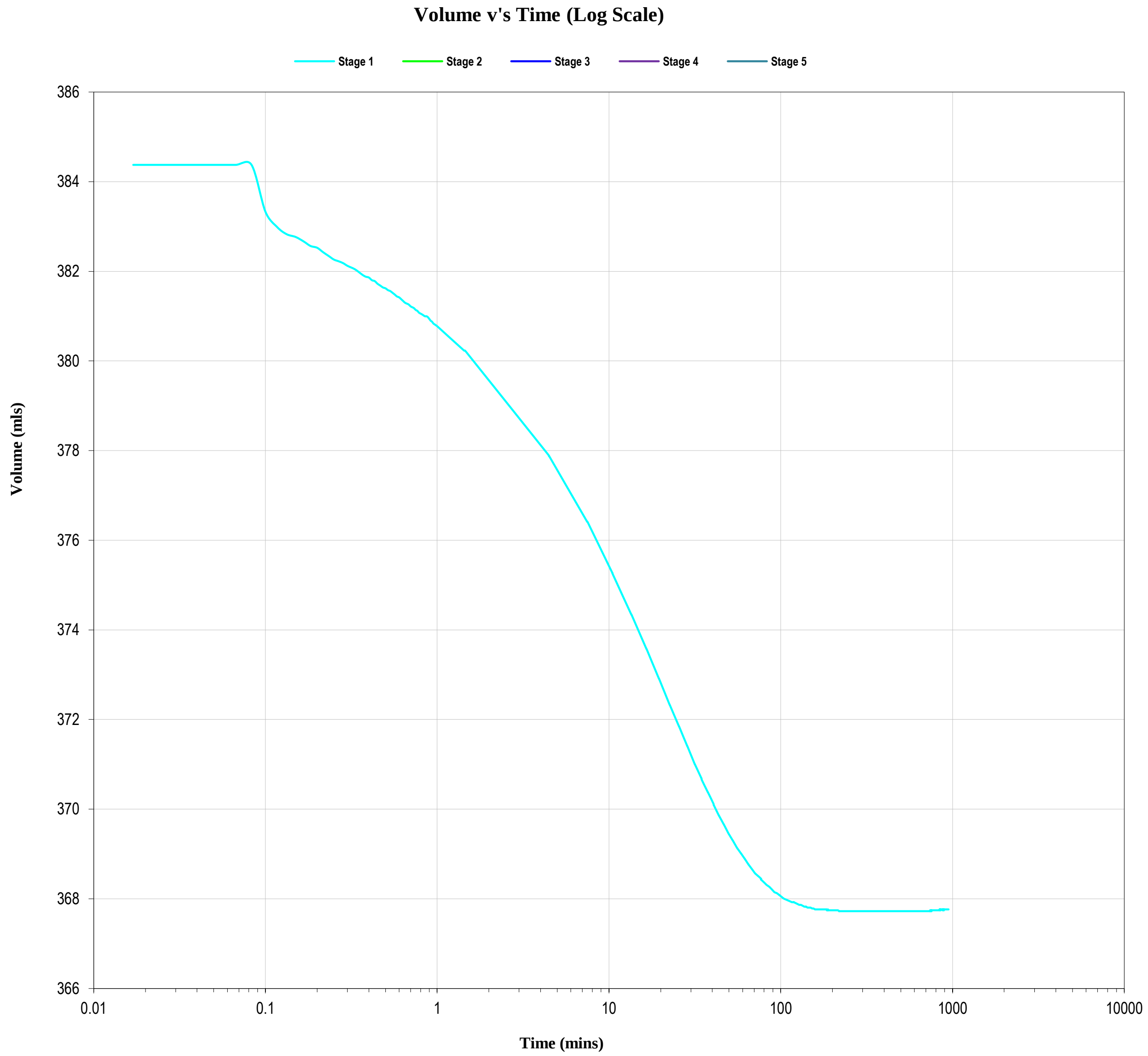
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110006A - CU



	Stage 1
Cv (m^2/year) **:**	**1.09**
Mv (m^2/MN) **:**	**0.108**
k (m/s) **:**	**3.63E-11**

Remarks: Tested as Received

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.:**	18110006B - CU
		Workorder No.	0005081
Address	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	7/11/2018
		Report Date:	15/11/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE416 - L1C	**Depth (m):**	23.50-24.00
Description:	SILTY CLAY - orange/brown		

SAMPLE & TEST DETAILS

Initial Height:	129.7	mm	Initial Moisture Content:	26.4	%	Rate of Strain:	0.002	%/min
Initial Diameter:	61.4	mm	Final Moisture Content:	27.5	%	B Response:	97	%
L/D Ratio:	2.1 : 1		Wet Density:	2.00	t/m^3			
			Dry Density:	1.59	t/m^3			

Sample Type: Single Individual Undisturbed Specimen

TEST RESULTS

FAILURE DETAILS

Effective Pressure	Confining Pressure	Back Pressure	Initial Pore	Failure Pore	*Principal Effective Stresses*			*Deviator Stress*	*Strain*
					σ'_1	σ'_3	σ'_1 / σ'_3		
796 kPa	1301 kPa	505 kPa	505 kPa	609 kPa	1849 kPa	692 kPa	2.672	1157 kPa	4.45 %

FAILURE ENVELOPES

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

Remarks: Tested as Received

Sample/s supplied by the client

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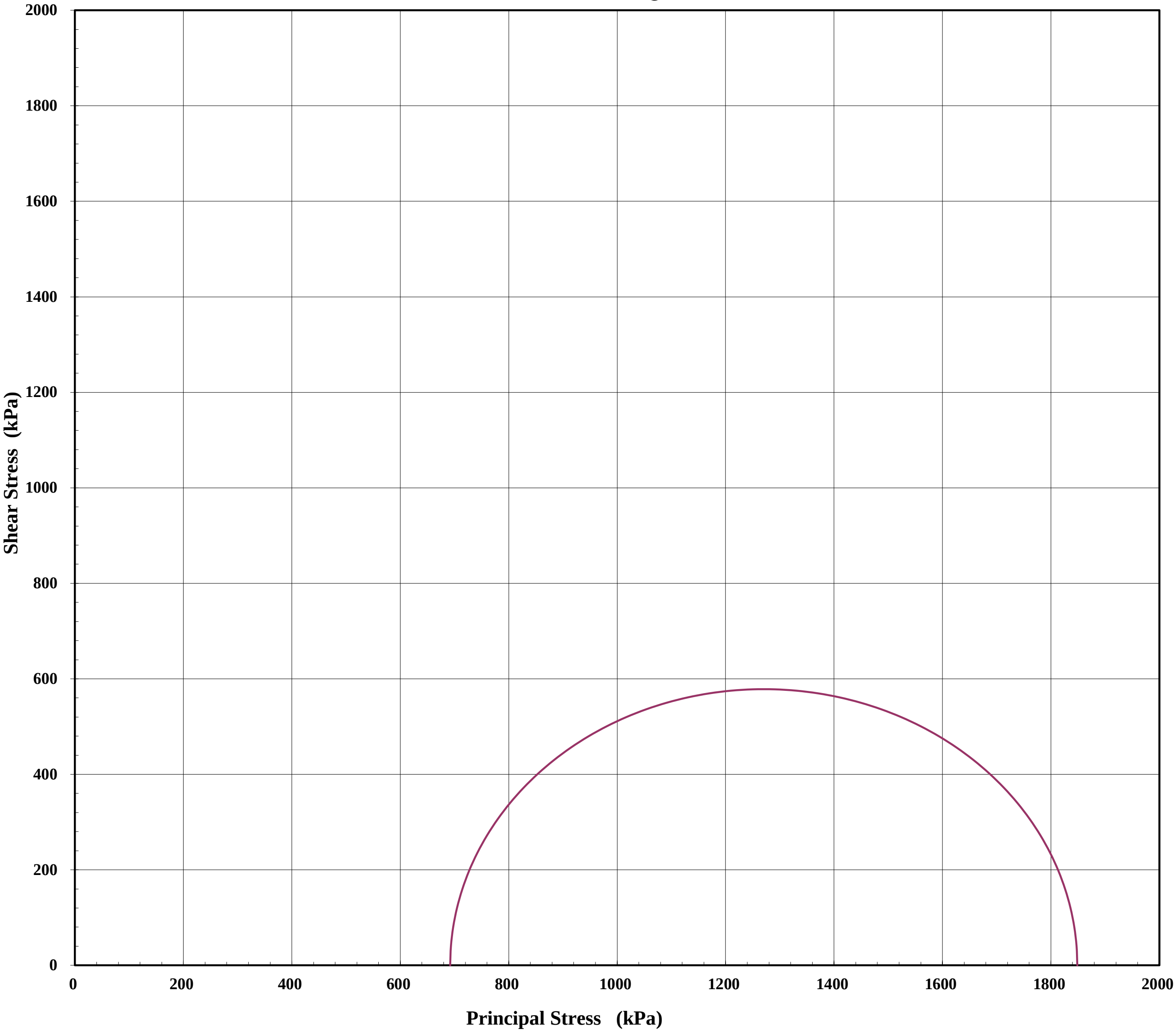
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110006B - CU

Mohr Circle Diagram



Interpretation between stages :

Cohesion C' (kPa) :

Angle of Shear Resistance Φ' (Degrees) :

Failure Criteria: Peak Principal Stress Ratio

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

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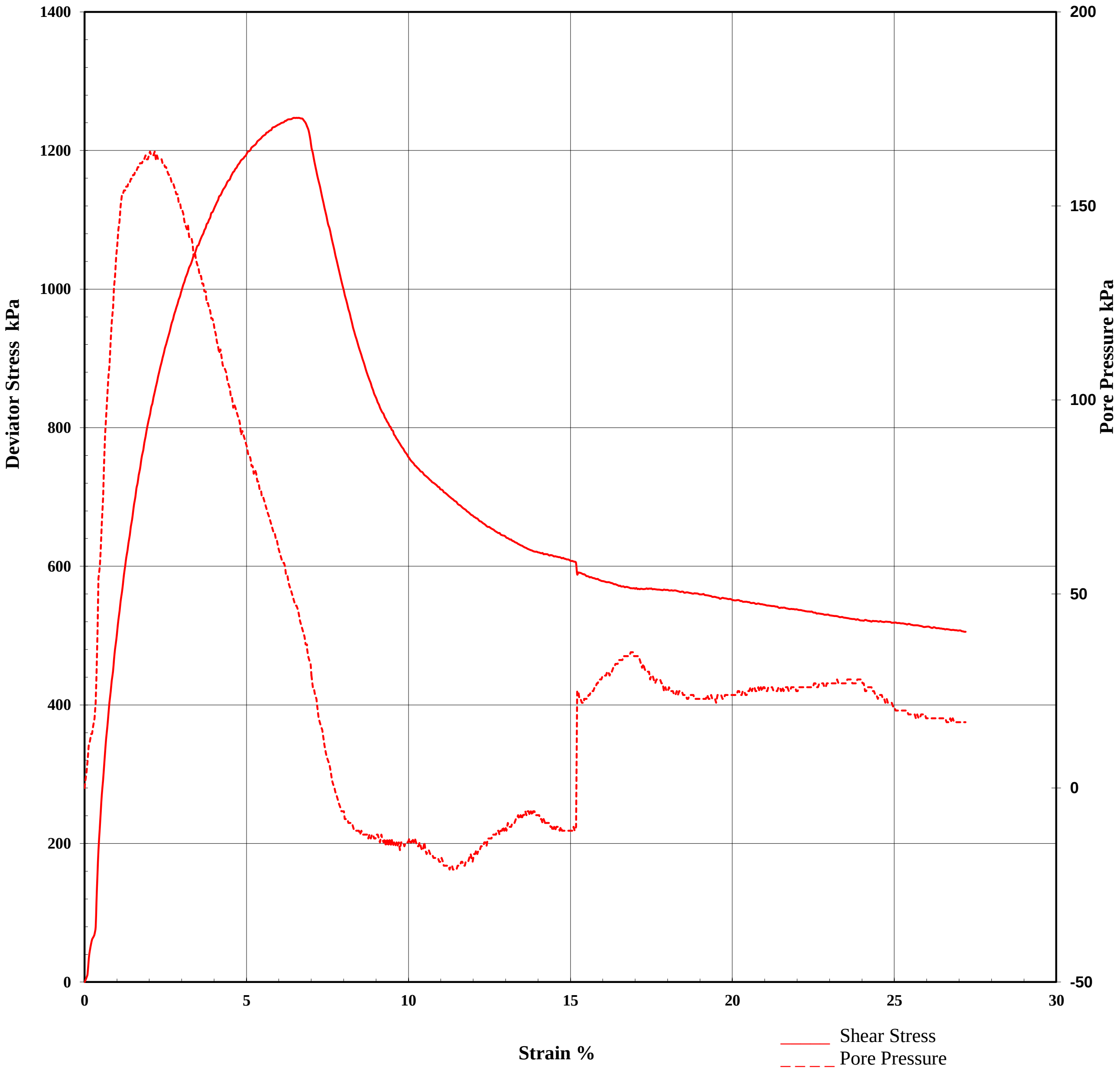
Stress/Strain & Pore Pressure/Strain Diagram



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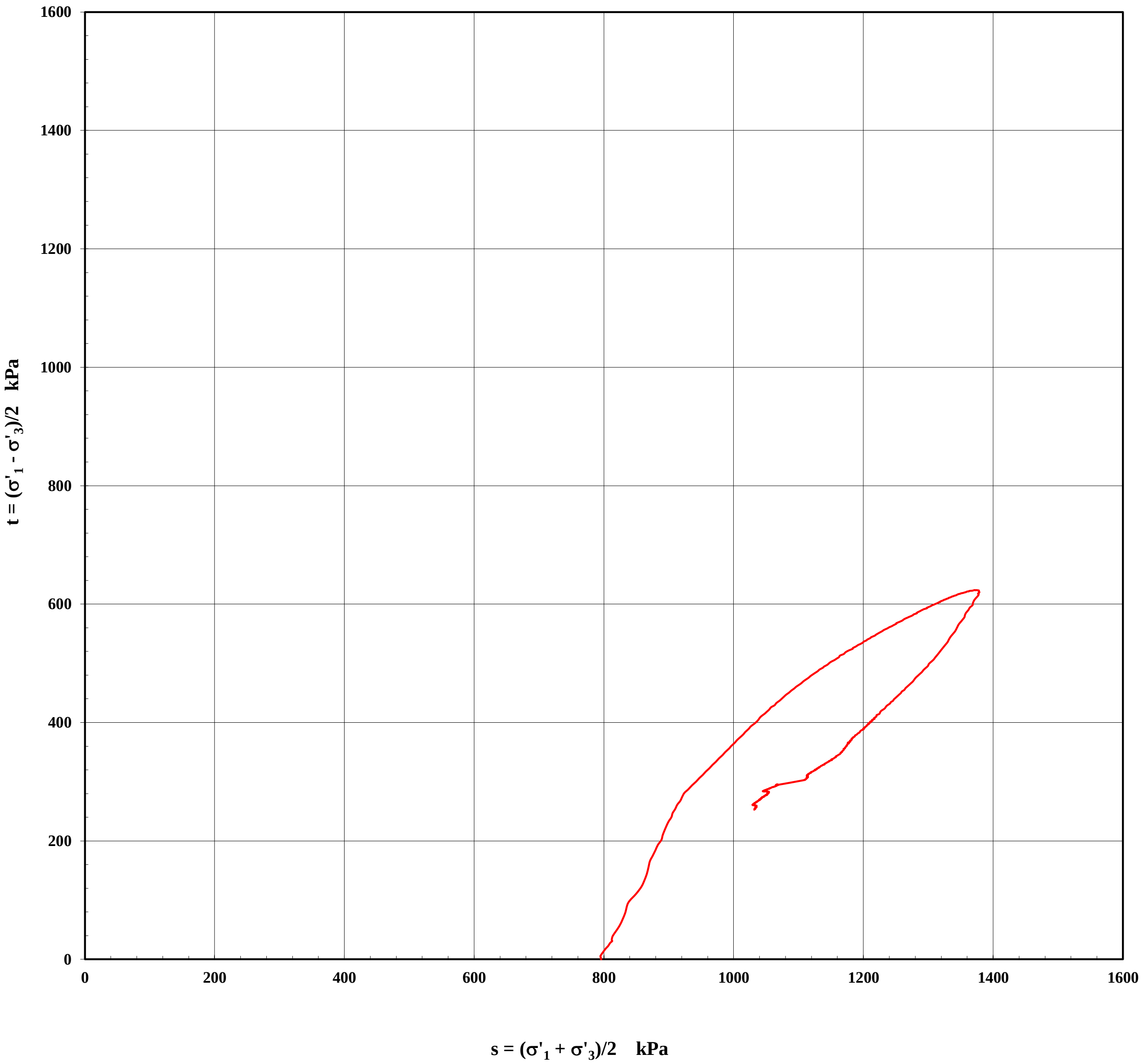
TRIAXIAL TEST REPORT

Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd

Report No.: 18110006B - CU

MIT Method - Effective Stress Path



Remarks: Tested as Received

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Note: Graph not to scale

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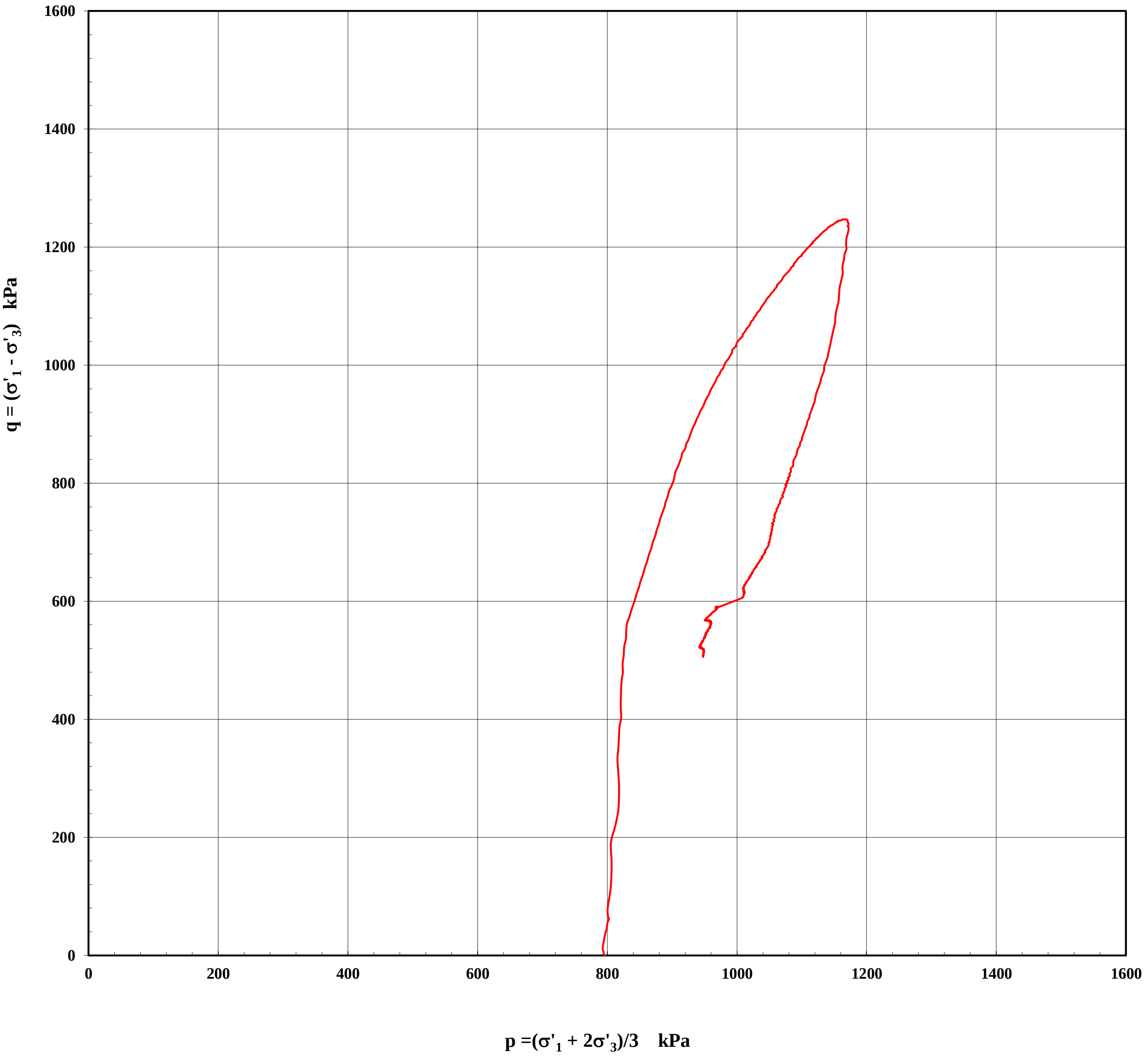
Test Method: AS1289.6.4.2

Client: Hatch Pty Ltd	**Report No.:** 18110006B - CU

Cambridge Method - Effective Stress Path



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Sample/s supplied by the client

Note: Graph not to scale

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Test Method: AS1289.6.4.2

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Remarks: Tested as Received

Sample/s supplied by the client

Note: Photo not to scale

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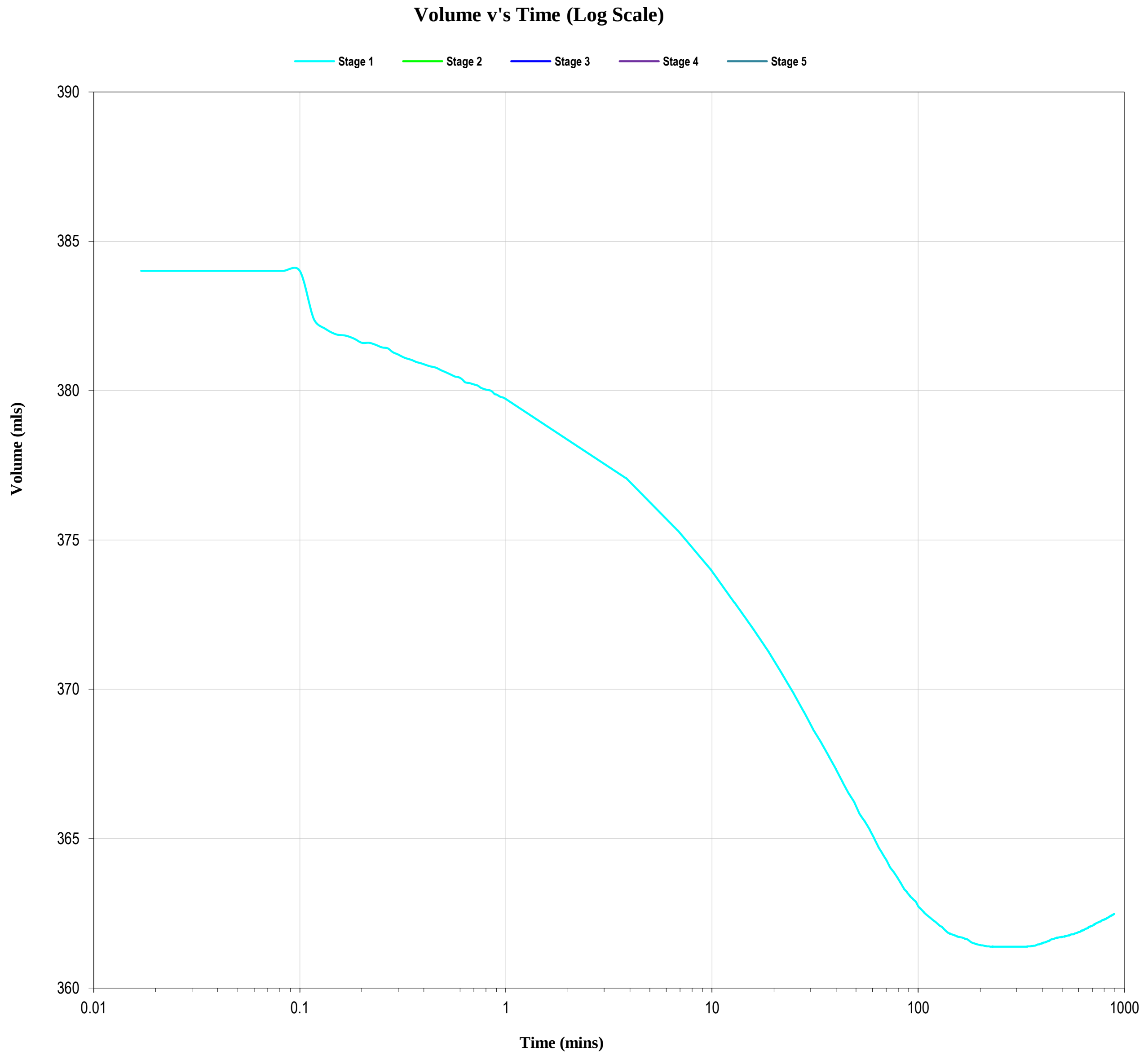
Client: Hatch Pty Ltd	**Report No.:** 18110006B - CU



	Stage 1
Cv (m^2/year) **:**	**0.69**
Mv (m^2/MN) **:**	**0.073**
k (m/s) **:**	**1.56E-11**

Remarks: Tested as Received

Sample/s supplied by the client

Note: Graph not to scale

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Laboratory Number 9926

Annexure DG
Oedometer Consolidation Tests

Trilab
Soil Rock Calibration

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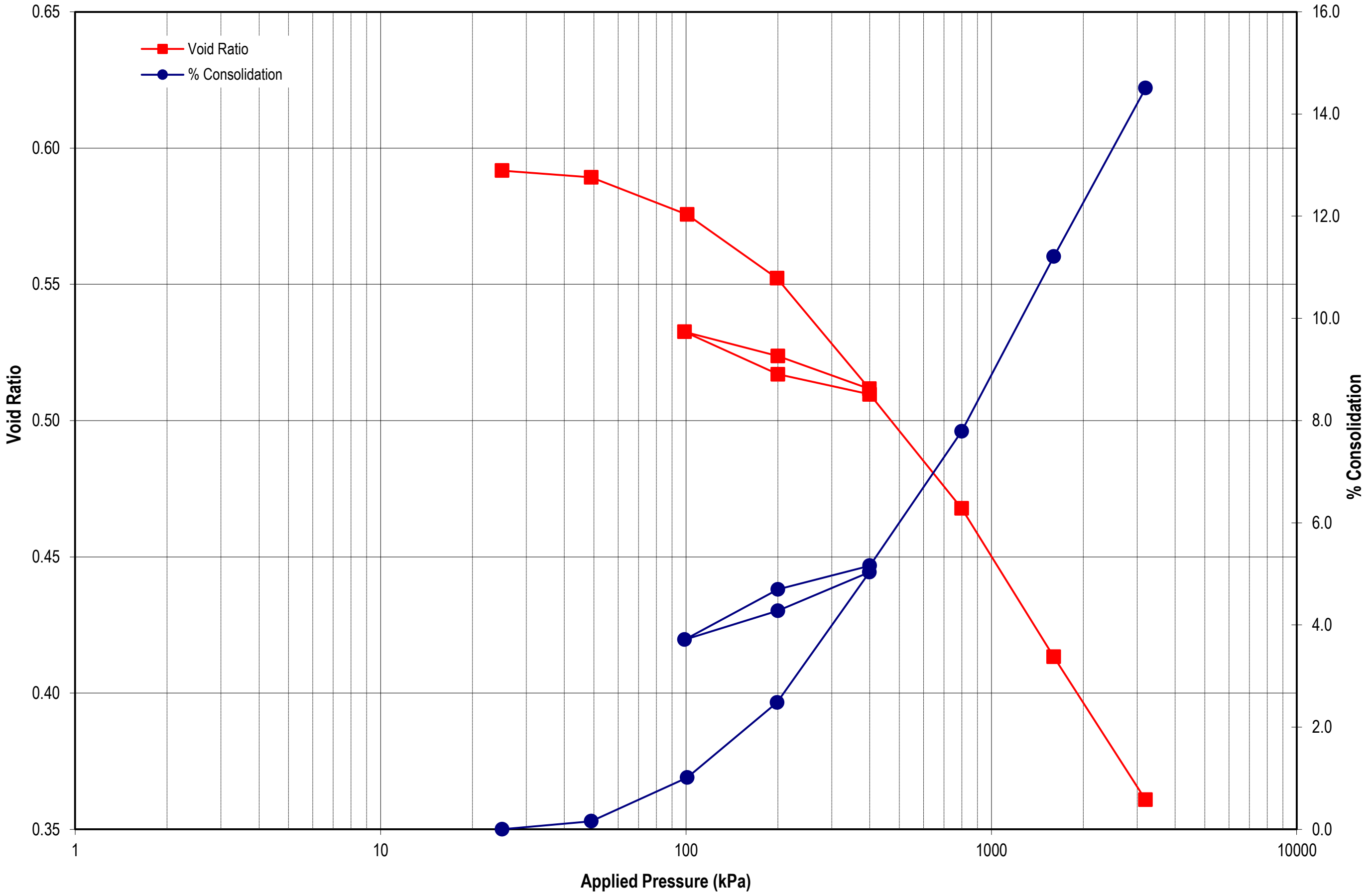
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080196-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.:	CE407 - DH402 - PT3	**Depth (m):**	51.00-51.50
Description:	CLAY- grey brown		



Wet Density (t/m^3):	1.99	Initial Moisture (%):	22.2	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.57	Initial Voids Ratio:	0.578	Initial Degree of Saturation (%):	100.0
Undisturbed sample supplied by the client		Remarks:	Tested as Received	Page 1 of 2	

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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.:**	18080196-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.:	CE407 - DH402 - PT3	**Depth (m):**	51.00-51.50
Description:	CLAY- grey brown		

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	25-49	0.009	1.5E-09	3.79	74.12	0.066	0.39	0.2
2	49-101	0.043	1.5E-09	0.87	29.23	0.165	0.85	1.0
3	101-199	0.079	1.4E-09	0.81	29.71	0.151	1.76	2.5
4	199-399	0.134	7.7E-10	0.43	18.90	0.131	1.78	5.0
5	399-200	0.040	2.3E-10	0.71	18.25	0.040	0.35	4.3
6	200-99	0.029	1.8E-11	0.26	0.97	0.058	1.21	3.7
7	99-200	0.051	4.7E-10	0.86	14.96	0.101	0.42	4.7
8	200-400	0.024	1.2E-10	0.88	15.63	0.024	1.12	5.2
9	400-800	0.139	3.9E-10	0.24	18.01	0.069	3.36	7.8
10	800-1602	0.181	6.4E-12	0.23	0.44	0.046	3.05	11.2
11	1602-3200	0.175	1.0E-11	0.29	1.38	0.023	2.75	14.5

Remarks: Tested as Received

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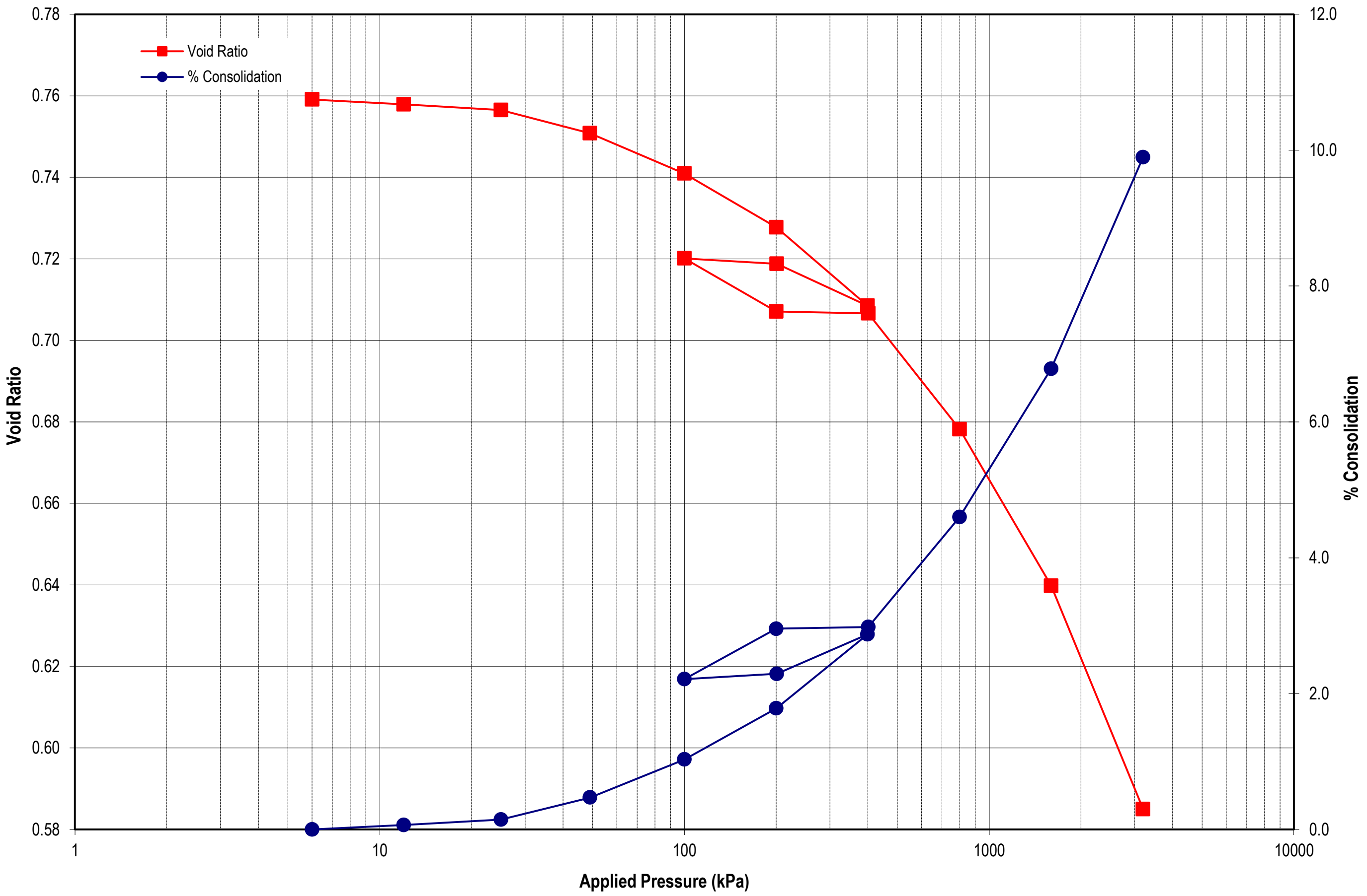
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080417-OED
		Workorder No.	4681
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	22/08/2018
		Report Date:	11/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE412 - DH405 SA8	**Depth (m):**	65.50-66.00
Description:	SANDY SILT- brown		



Wet Density (t/m^3):	1.89	Initial Moisture (%):	26.1	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.64	Initial Voids Ratio:	0.758	Initial Degree of Saturation (%):	91.5
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.:**	18080417-OED
		Workorder No.	4681
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	22/08/2018
		Report Date:	11/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE412 - DH405 SA8	**Depth (m):**	65.50-66.00
Description:	SANDY SILT- brown		

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	6-12	0.004	4.9E-09	20.37	139.76	0.113	0.43	0.1
2	12-25	0.004	2.2E-09	271.75	117.66	0.061	0.32	0.1
3	25-49	0.019	4.6E-09	4.26	108.68	0.135	0.45	0.5
4	49-100	0.032	1.4E-09	6.10	41.79	0.110	0.64	1.0
5	100-200	0.044	3.0E-09	264.48	128.06	0.076	0.92	1.8
6	200-399	0.064	1.7E-09	167.26	98.24	0.056	1.23	2.9
7	399-201	0.035	2.6E-09	5.12	275.97	0.030	0.09	2.3
8	201-100	0.004	2.5E-10	13.52	105.92	0.008	0.11	2.2
9	100-200	0.043	1.2E-09	63.10	51.76	0.076	0.04	3.0
10	200-401	0.002	2.9E-11	171.58	69.79	0.001	0.32	3.0
11	401-800	0.095	6.3E-10	72.55	48.55	0.042	1.84	4.6
12	800-1599	0.128	8.3E-10	149.00	93.92	0.029	2.66	6.8
13	1599-3200	0.182	2.0E-10	38.79	30.65	0.021	3.68	9.9

Remarks: Tested as Received

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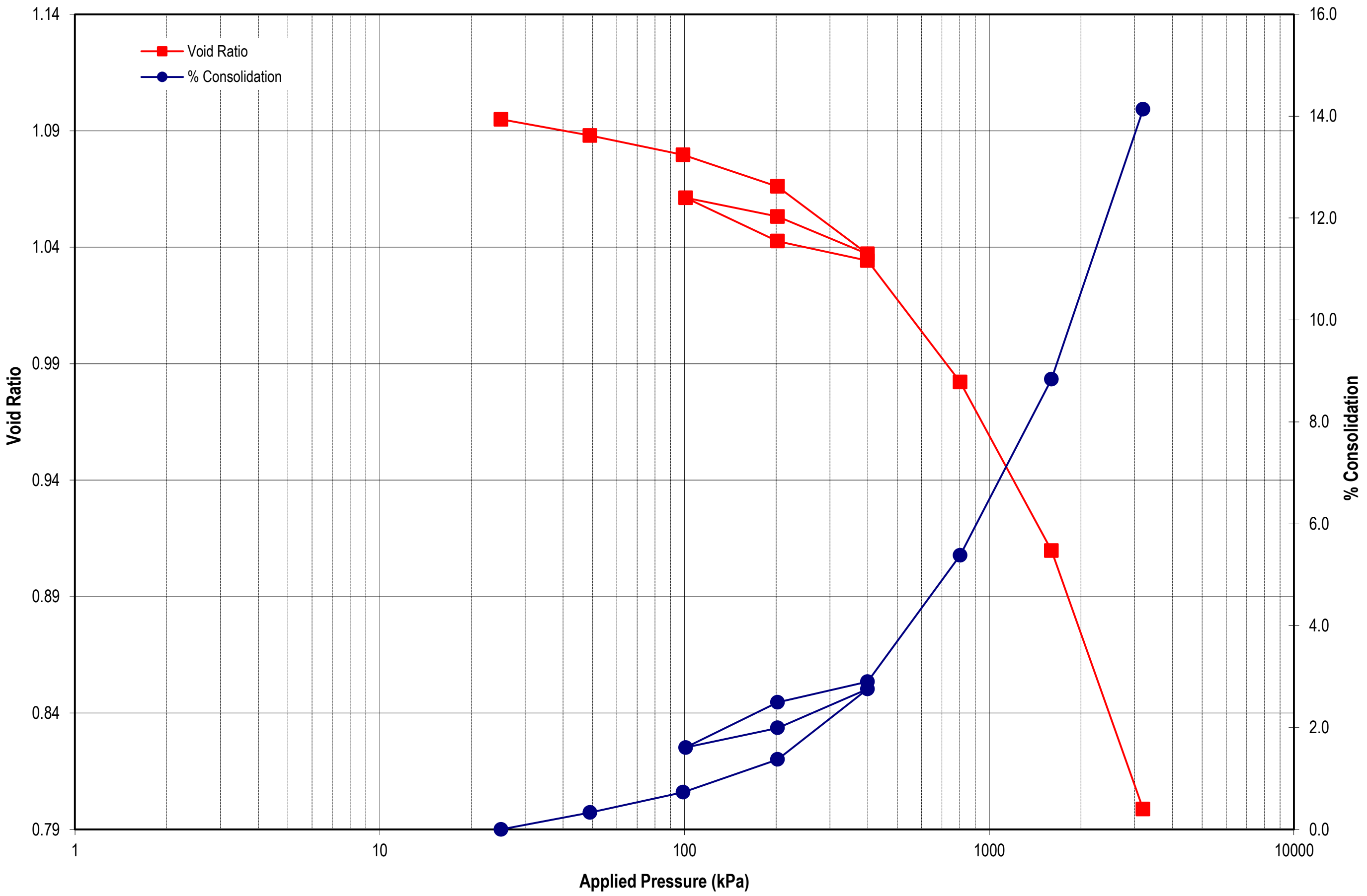
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080420-OED
		Workorder No.	4681
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	22/08/2018
		Report Date:	7/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE417 - DH406 L2B	**Depth (m):**	18.50-19.00
Description:	SILTY CLAY- grey		



Wet Density (t/m^3):	1.74	Initial Moisture (%):	45.5	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.49	Initial Voids Ratio:	1.077	Initial Degree of Saturation (%):	100.0
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.:**	18080420-OED
		Workorder No.	4681
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	22/08/2018
		Report Date:	7/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE417 - DH406 L2B	**Depth (m):**	18.50-19.00
Description:	SILTY CLAY- 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	25-49	0.024	6.1E-09	10.56	141.94	0.138	0.37	0.3
2	49-99	0.027	3.2E-09	29.20	130.22	0.080	0.79	0.7
3	99-202	0.044	2.3E-09	15.22	117.88	0.063	0.88	1.4
4	202-399	0.098	1.2E-09	6.00	53.23	0.071	1.45	2.8
5	399-202	0.054	1.4E-09	5.13	109.19	0.040	0.25	2.0
6	202-101	0.027	7.1E-10	2.54	58.96	0.039	0.55	1.6
7	101-202	0.062	2.0E-09	9.29	73.06	0.089	0.19	2.5
8	202-399	0.028	3.8E-10	9.91	58.59	0.021	0.73	2.9
9	399-803	0.171	1.6E-10	2.41	8.09	0.063	1.95	5.4
10	803-1602	0.241	7.6E-11	1.24	5.39	0.046	3.52	8.8
11	1602-3199	0.370	4.1E-10	0.87	36.75	0.036	5.96	14.1

Remarks: Tested as Received

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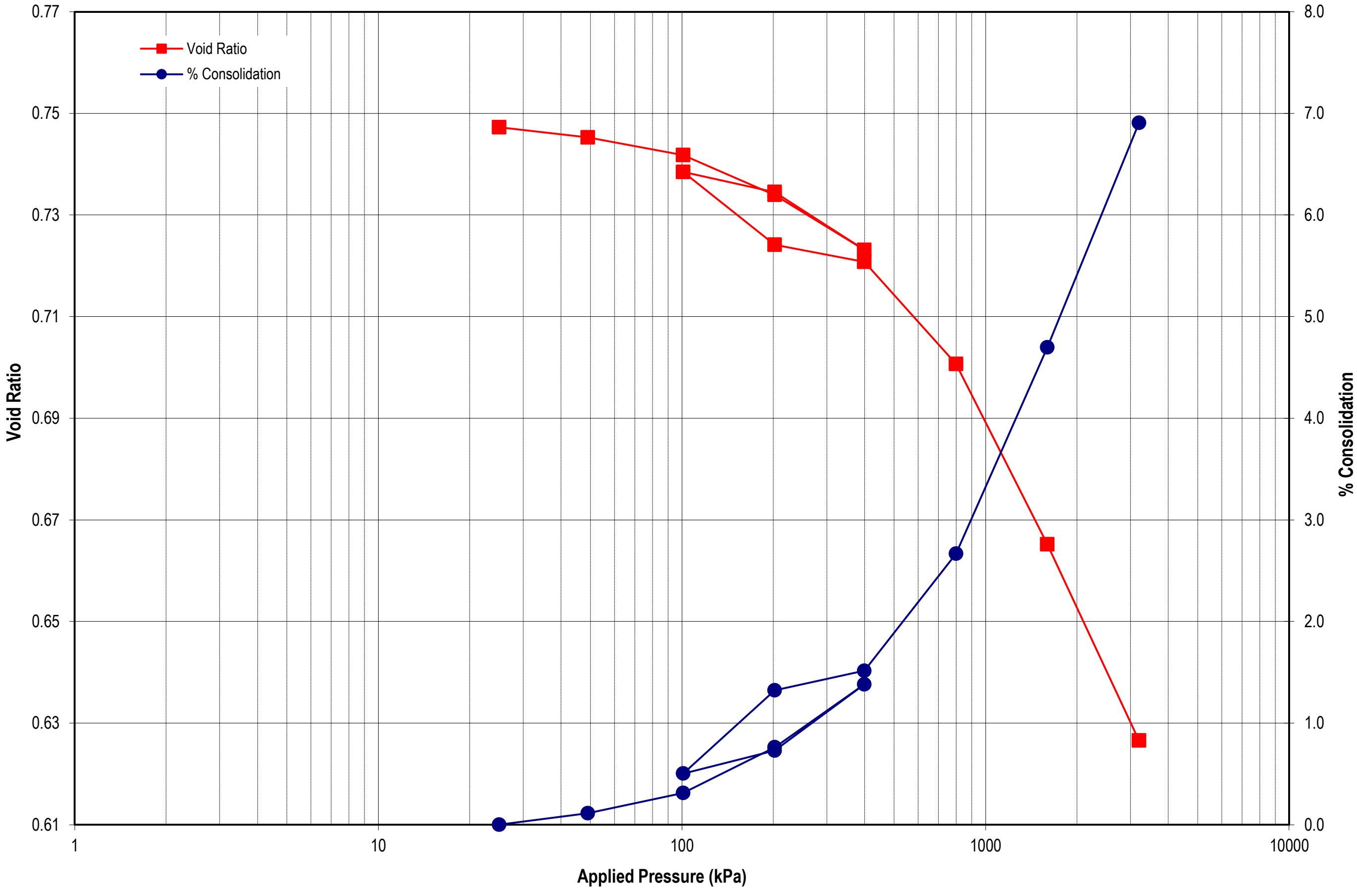
OEDOMETER TEST REPORT

Test Method: AS1289.6.6.1, 3.5.1

Client:	Hatch Pty Ltd	**Report No.:**	18080432-OED
		Workorder No.	4681
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	23/08/2018
		Report Date:	10/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE411A - DH409A L1	**Depth (m):**	14.50-15.00
Description:	SILTY CLAY- yellow brown		



Wet Density (t/m^3):	1.96	Initial Moisture (%):	26.0	Test Condition:	Inundated on load
Particle Density (t/m^3):	2.70	Initial Voids Ratio:	0.732	Initial Degree of Saturation (%):	97.1
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.:**	18080432-OED
		Workorder No.	4681
Address:	PO Box 425 SPRING HILL QLD 4004	**Test Date:**	23/08/2018
		Report Date:	10/09/2018
Project:	H356804 - Cadia NTSF Failure		
Client Id.:	CE411A - DH409A L1	**Depth (m):**	14.50-15.00
Description:	SILTY CLAY- yellow brown		

TEST RESULTS

Stage	Load (kPa)	Cc	k (m/s)	Cv (m^2/yr) t_{50}	t_{90}	Mv ($kPa^{-1}x10^{-3}$)	C_a x 10^{-3}	% Consolidation
1	25-49	0.007	1.4E-09	21.54	97.38	0.047	0.26	0.1
2	49-101	0.011	1.3E-09	11.59	113.47	0.038	0.36	0.3
3	101-202	0.026	6.1E-10	35.07	44.07	0.045	0.71	0.8
4	202-399	0.037	1.1E-09	28.25	111.99	0.032	0.88	1.4
5	399-202	0.039	1.9E-09	16.54	183.12	0.034	0.05	0.7
6	202-101	0.013	3.9E-10	8.70	55.25	0.022	0.13	0.5
7	101-202	0.047	1.8E-09	26.75	70.33	0.081	0.10	1.3
8	202-399	0.011	1.9E-10	37.39	62.81	0.010	0.29	1.5
9	399-800	0.067	5.8E-10	31.59	64.15	0.029	1.46	2.7
10	800-1599	0.118	4.0E-10	17.49	48.82	0.026	1.99	4.7
11	1599-3202	0.128	1.5E-10	12.74	34.34	0.014	2.98	6.9

Remarks: Tested as Received

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Laboratory Number 9926

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT1

IPO Number: 2018-017
Sample ID: 2018-017-004
Borehole ID: CE411
Depth: 3.13 m to 3.18 m

Test Details:	
Test ID:	CE-OED-01
Tested By:	BB/SL/KM
Date:	11/09/2018
Checked By:	TC
Date:	27/9/2018

Sample Details:	Initial	Final
Sample Diameter (mm) :	60.0	60.0
Sample Height (mm) :	21.85	18.22
Dry Density (t/m^3) :	1.52	1.79
Moisture Content (%) :	26.2 *	22.6
Soil Particle Density (t/m^3) :	2.79	

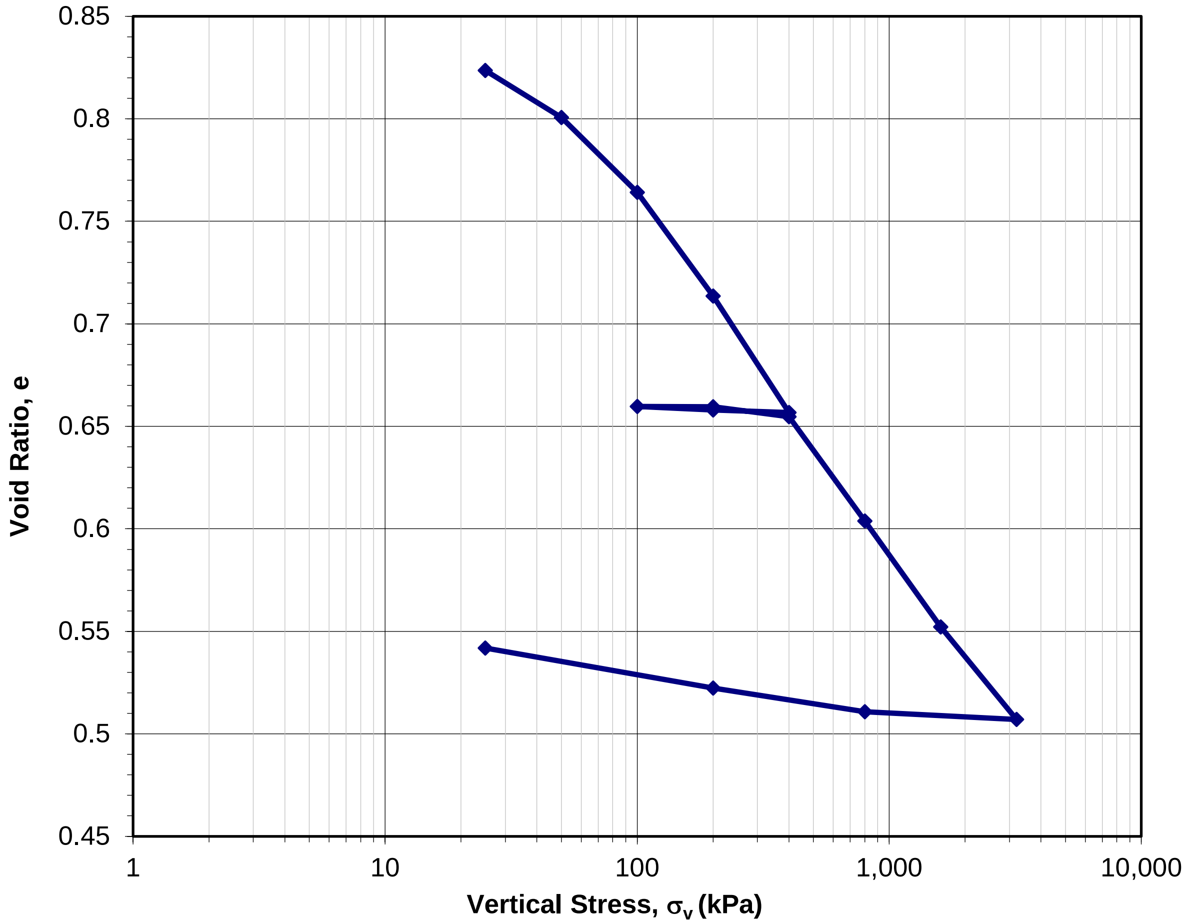
*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample

1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1

Stage		**σ_v**	**e**	**c_v**	**m_v**	**k**
		kPa		**m^2/year**	**m^2/kN**	**m/sec**
Loading	1	25	0.824	-	1.0E-03	-
	2	50	0.801	528.8	5.0E-04	8.2E-08
	3	100	0.764	639.8	4.1E-04	8.1E-08
	4	200	0.714	821.5	2.9E-04	7.3E-08
	5	400	0.657	966.9	1.7E-04	5.0E-08
Unloading	6	200	0.658	-	-	-
	7	100	0.660	-	-	-
Re-Loading	8	200	0.660	-	-	-
	9	400	0.655	-	-	-
Loading	10	800	0.604	2,132.8	7.7E-05	5.1E-08
	11	1,600	0.552	2,011.5	4.0E-05	2.5E-08
	12	3,200	0.507	1,973.8	1.8E-05	1.1E-08
Unloading	13	800	0.511	-	-	-
	14	200	0.522	-	-	-
	15	25	0.542	-	-	-

Client:	Newcrest Mining	**IPO Number:**	2018-017
Project:	Cadia NTSF Failure - Laboratory Testing	**Sample ID:**	2018-017-004
Location:	Cadia Valley Operations	**Borehole ID:**	CE411
Sample No.:	PT1	**Depth:**	3.13 m to 3.18 m

1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1



Cadia NTSF Failure - Laboratory Testing
1-Dimensional Consolidation

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT2

IPO Number: 2018-017
Sample ID: 2018-017-006
Borehole ID: CE411A
Depth: 12.91 m to 12.95 m

Test Details:	
Test ID:	CE-OED-02
Tested By:	BB/KM/SL
Date:	05/09/2018
Checked By:	TC
Date:	27/9/2018

Sample Details:	Initial	Final
Sample Diameter (mm) :	60.0	60.0
Sample Height (mm) :	25.50	25.05
Dry Density (t/m^3) :	1.52	1.62
Moisture Content (%) :	25.8 *	26.9
Soil Particle Density (t/m^3) :	2.87	

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample

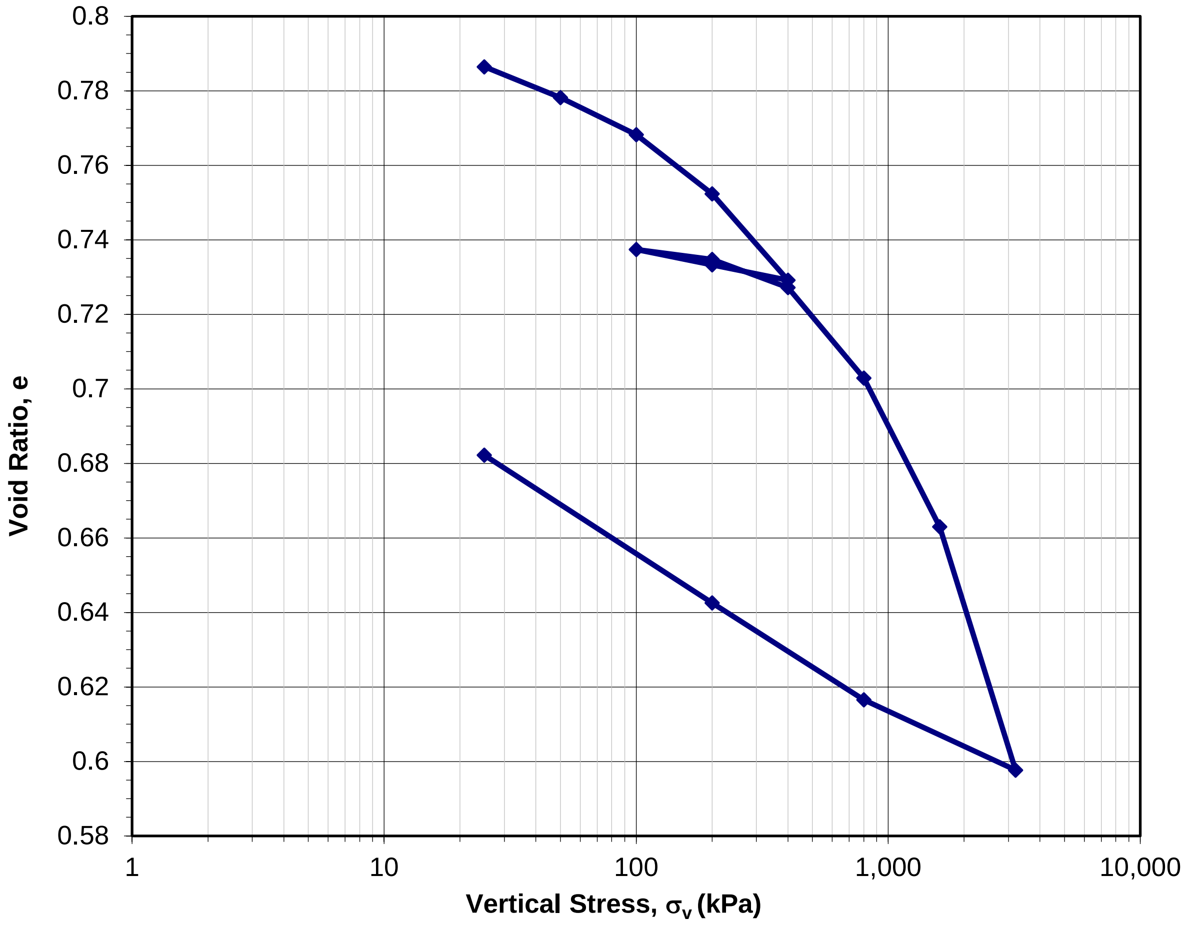
1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1

Stage		σ_v	e	c_v	m_v	k
		kPa		**m^2/year**	**m^2/kN**	**m/sec**
Loading	1	25	0.786	-	4.6E-04	-
	2	50	0.778	1,233.9	1.9E-04	7.1E-08
	3	100	0.768	1,972.9	1.1E-04	6.9E-08
	4	200	0.752	2,007.9	9.0E-05	5.6E-08
	5	400	0.729	2,595.8	6.6E-05	5.3E-08
Unloading	6	200	0.733	-	-	-
	7	100	0.737	-	-	-
Re-Loading	8	200	0.735	-	-	-
	9	400	0.727	-	-	-
Loading	10	800	0.703	2,236.8	3.5E-05	2.4E-08
	11	1,600	0.663	848.8	2.9E-05	7.7E-09
	12	3,200	0.598	1,264.5	2.5E-05	9.6E-09
Unloading	13	800	0.617	-	-	-
	14	200	0.643	-	-	-
	15	25	0.682	-	-	-

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT2

IPO Number: 2018-017
Sample ID: 2018-017-006
Borehole ID: CE411A
Depth: 12.91 m to 12.95 m

1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1



Cadia NTSF Failure - Laboratory Testing
1-Dimensional Consolidation

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

IPO Number: 2018-017
Sample ID: 2018-017-015
Borehole ID: CE411A
Depth: 16.70 m to 16.74 m

Test Details:	
Test ID:	CE-OED-03
Tested By:	BB/SL/KM
Date:	11/09/2018
Checked By:	TC
Date:	27/9/2018

Sample Details:	Initial	Final
Sample Diameter (mm) :	60.0	60.0
Sample Height (mm) :	22.13	21.54
Dry Density (t/m^3) :	1.44	1.45
Moisture Content (%) :	30.9 *	34.7
Soil Particle Density (t/m^3) :	2.83	

*Moisture content calculated using trimmings; may not be equal to moisture content of whole sample

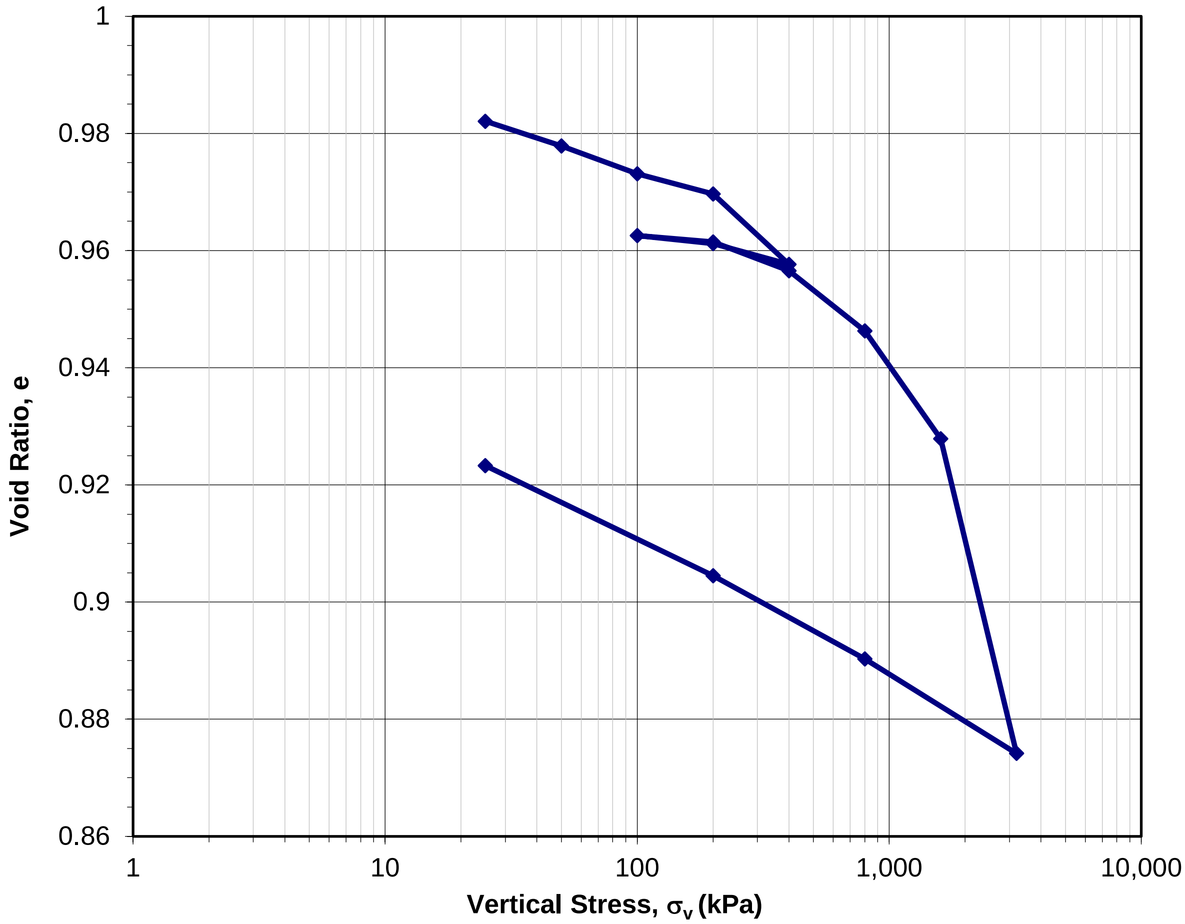
1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1

Stage		σ_v	e	c_v	m_v	k
		kPa		**m^2/year**	**m^2/kN**	**m/sec**
Loading	1	25	0.982	-	4.0E-04	-
	2	50	0.978	2,330.5	8.6E-05	6.2E-08
	3	100	0.973	2,944.2	4.8E-05	4.4E-08
	4	200	0.970	4,052.3	1.7E-05	2.2E-08
	5	400	0.958	5,118.7	3.0E-05	4.9E-08
Unloading	6	200	0.961	-	-	-
	7	100	0.963	-	-	-
Re-Loading	8	200	0.961	-	-	-
	9	400	0.957	-	-	-
Loading	10	800	0.946	4,754.6	1.3E-05	1.9E-08
	11	1,600	0.928	4,446.5	1.2E-05	1.6E-08
	12	3,200	0.874	1,834.9	1.7E-05	9.9E-09
Unloading	13	800	0.890	-	-	-
	14	200	0.905	-	-	-
	15	25	0.923	-	-	-

Client: Newcrest Mining
Project: Cadia NTSF Failure - Laboratory Testing
Location: Cadia Valley Operations
Sample No.: PT5

IPO Number: 2018-017
Sample ID: 2018-017-015
Borehole ID: CE411A
Depth: 16.70 m to 16.74 m

1-DIMENSIONAL CONSOLIDATION TEST
Test Method: AS 1289.6.6.1



Cadia NTSF Failure - Laboratory Testing
1-Dimensional Consolidation

Annexure DH
CRS Consolidation Tests

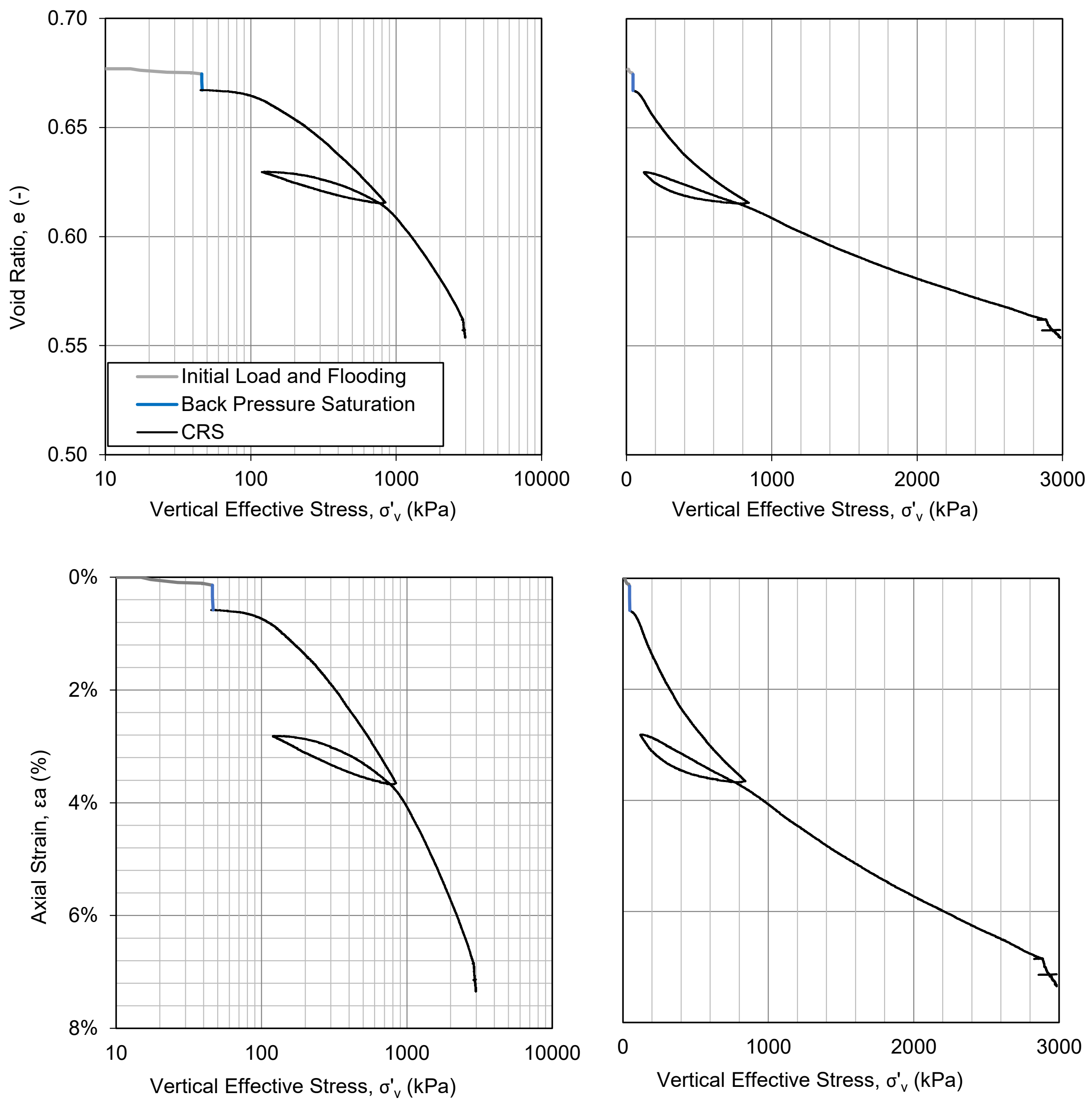
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP401 0.7-1.0m
Location:	Cadia Mine		18005 - CRS1

Diameter (mm)	60.0	Specific gravity (-)	2.80
Initial water content (trimmings) (%)	21.3%	Initial Void Ratio (-)	0.68
Initial Height (mm)	18.44	Initial Dry Density (t/m^3)	1.67
Final water content (specimen) (%)	22.6%	Average strain rate (%/hour)	0.2%



Preparation Notes:

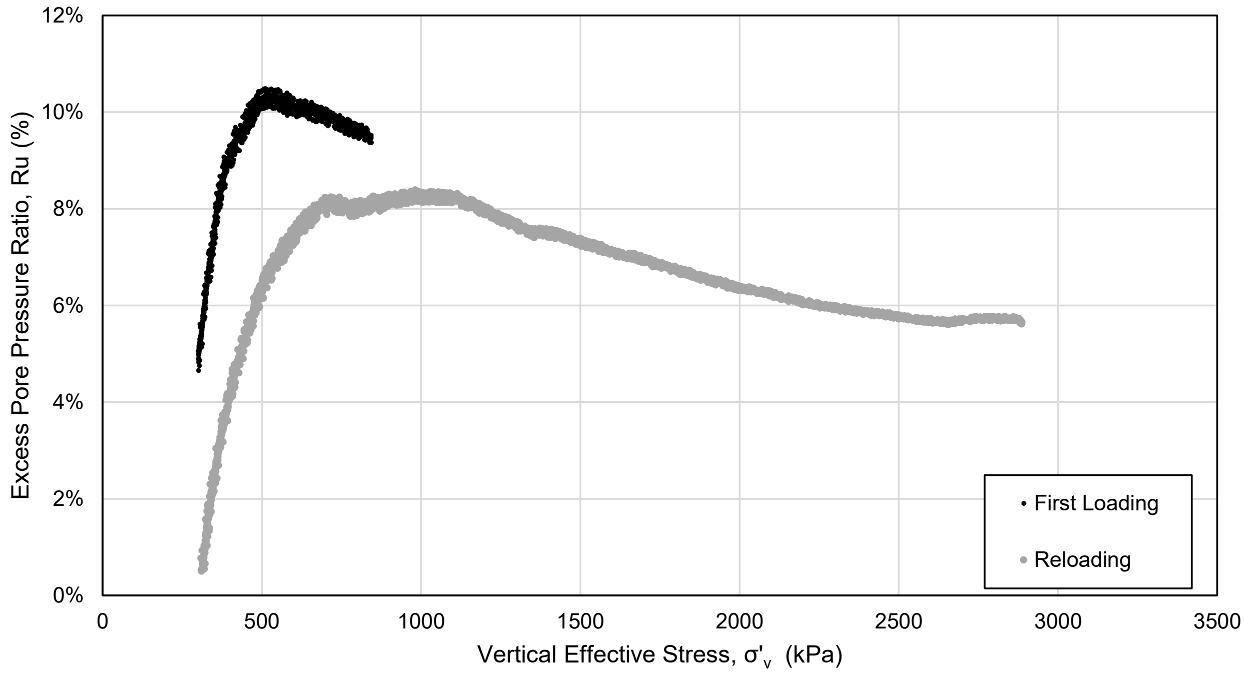
Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding: Undertaken under constant height conditions
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)

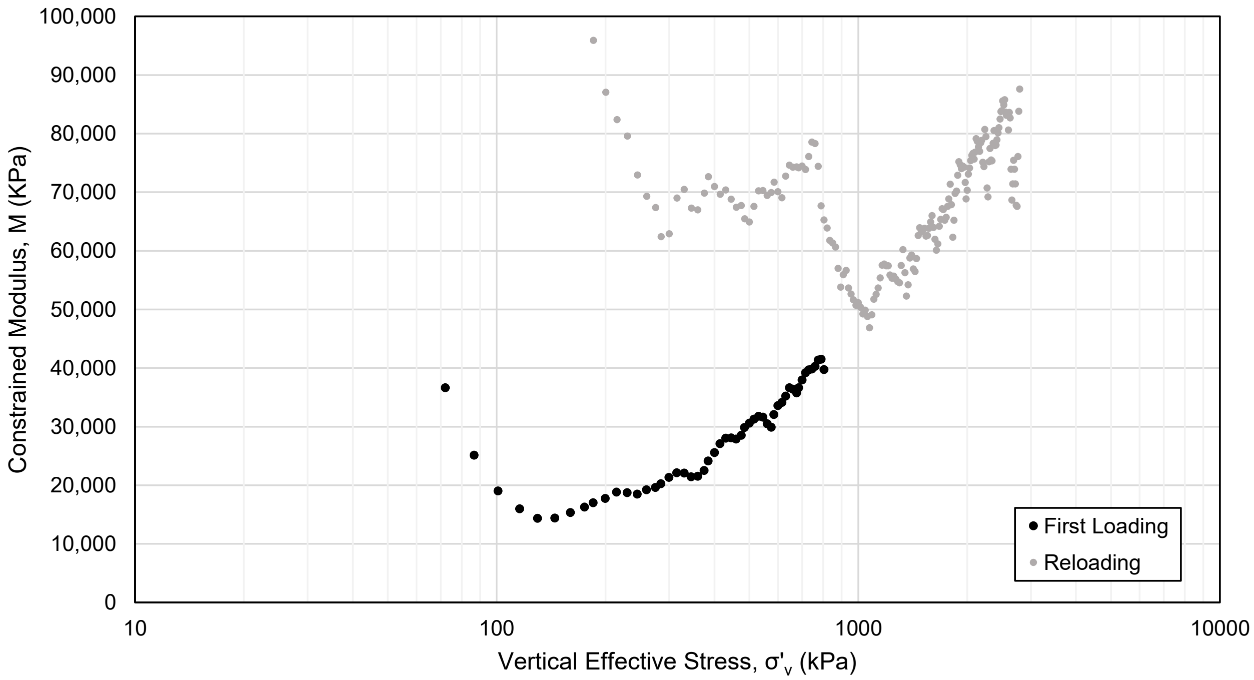
THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL	Tested by:	I.Orea
	Reviewed by:	R.Fanni / D.Reid

Constant Rate of Strain Consolidation Test

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP401 0.7-1.0m
Location:	Cadia Mine		18005 - CRS1





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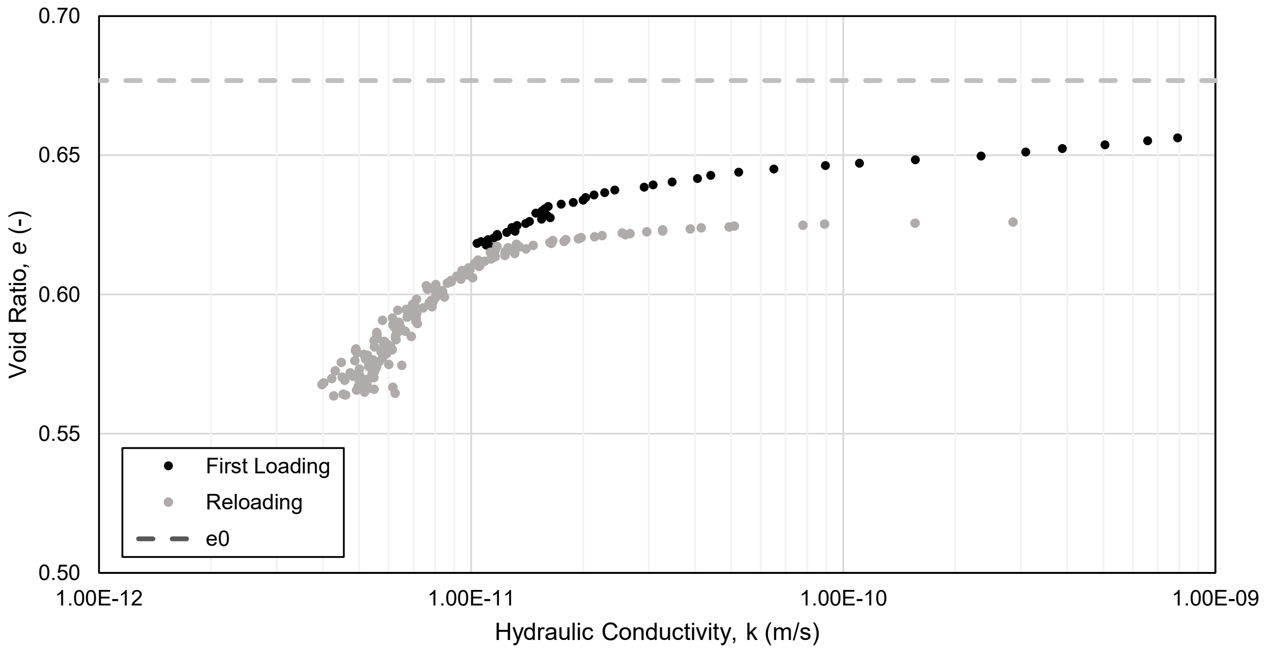
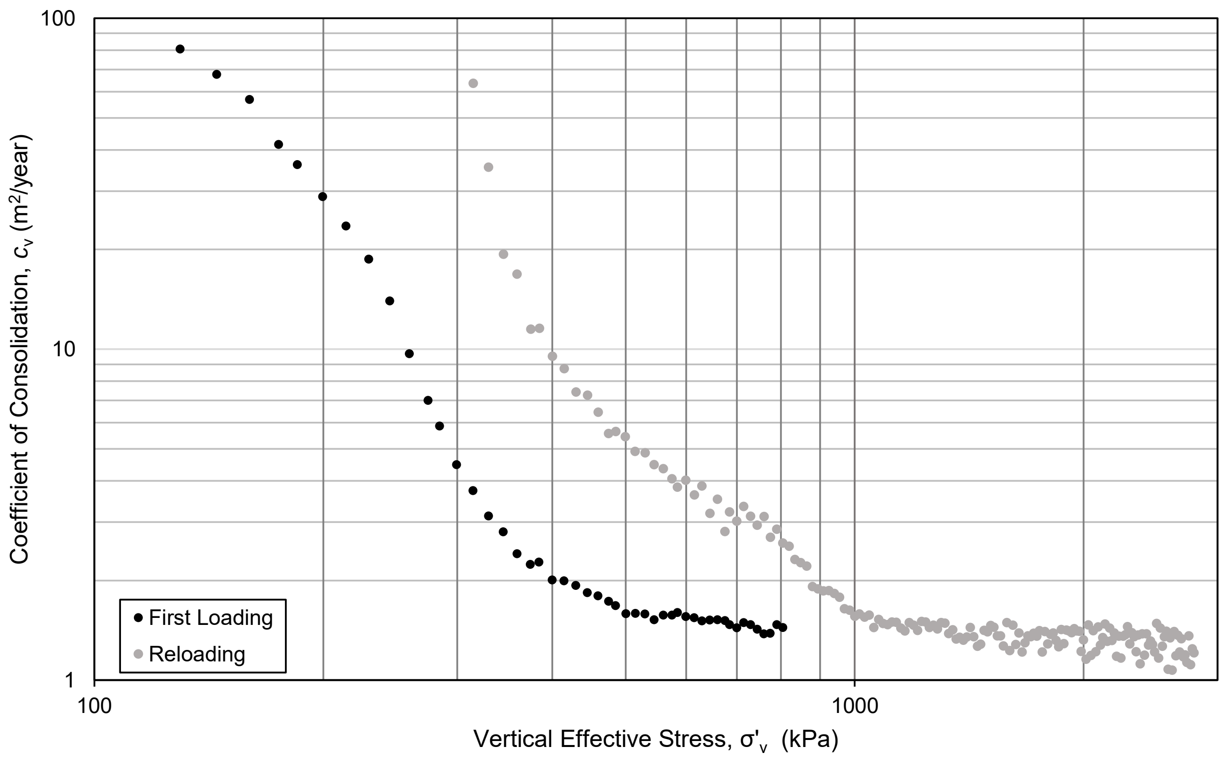
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP401 0.7-1.0m
Location:	Cadia Mine		18005 - CRS1





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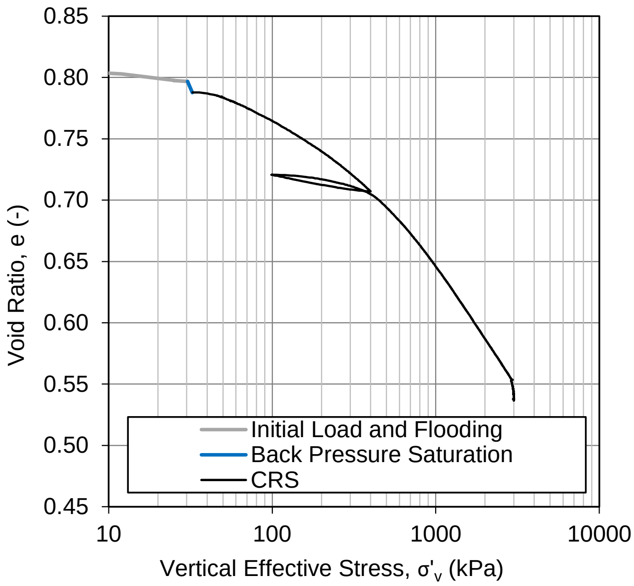
Constant Rate of Strain Consolidation Test

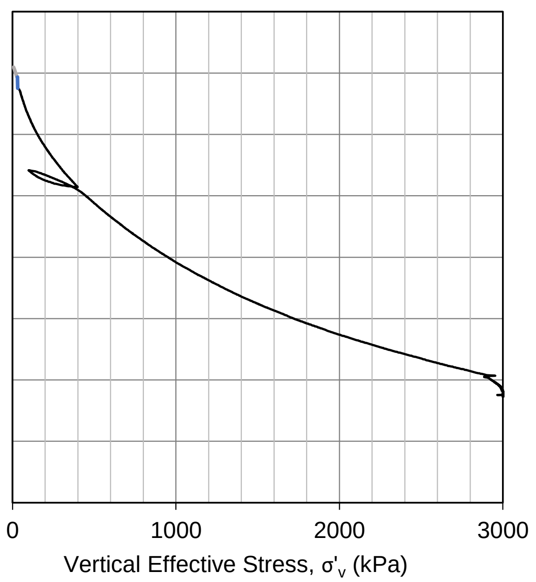
GOLDER

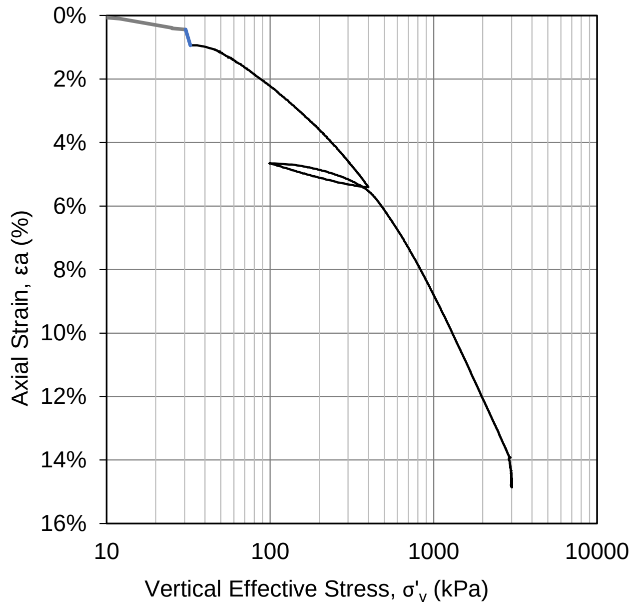
Perth Laboratory
84 Guthrie Street, Osborne Park

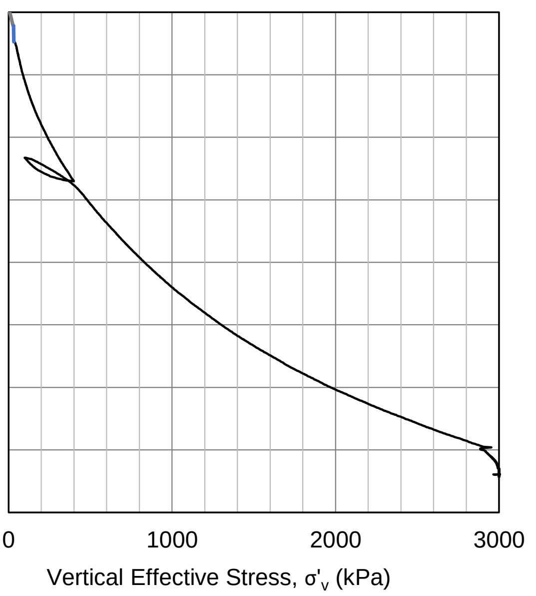
Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2 m
Location:	Cadia Mine		18006 - CRS2

Diameter (mm)	60.0	Specific gravity (-)	2.75
Initial water content (trimmings) (%)	22.6%	Initial Void Ratio (-)	0.80
Initial Height (mm)	18.68	Initial Dry Density (t/m^3)	1.52
Final water content (specimen) (%)	26.6%	Average strain rate (%/hour)	4.7%









Preparation Notes:

Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding: Undertaken under constant height conditions
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)

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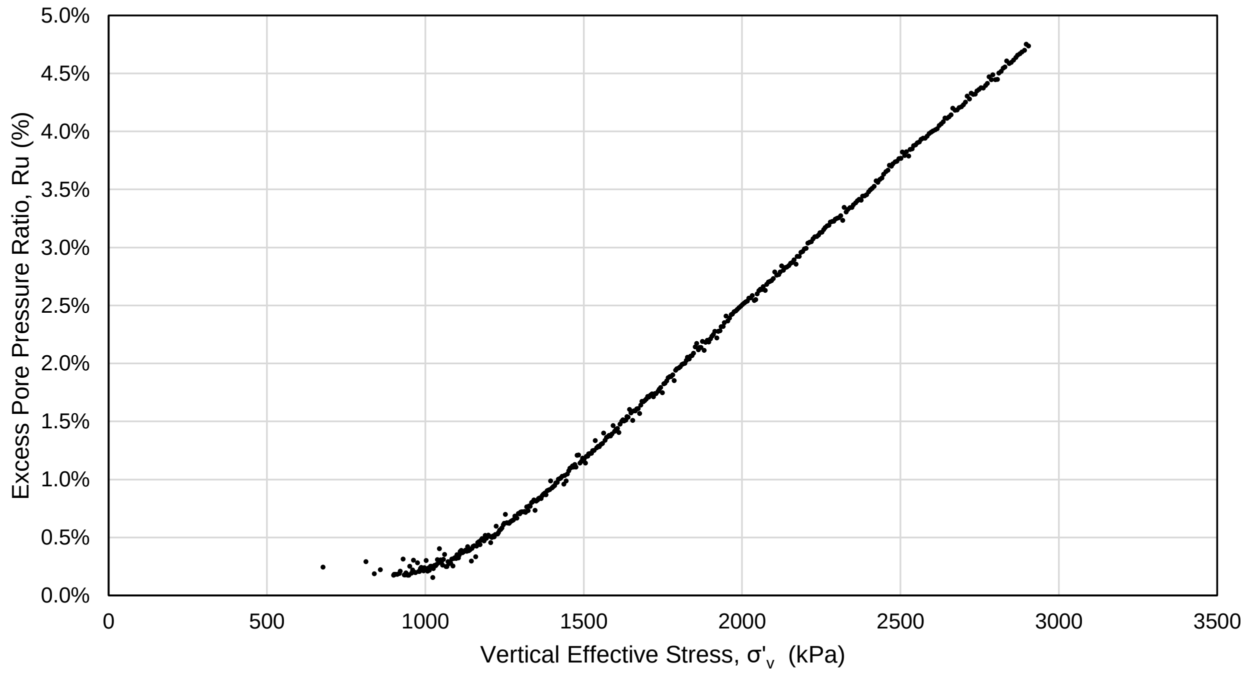
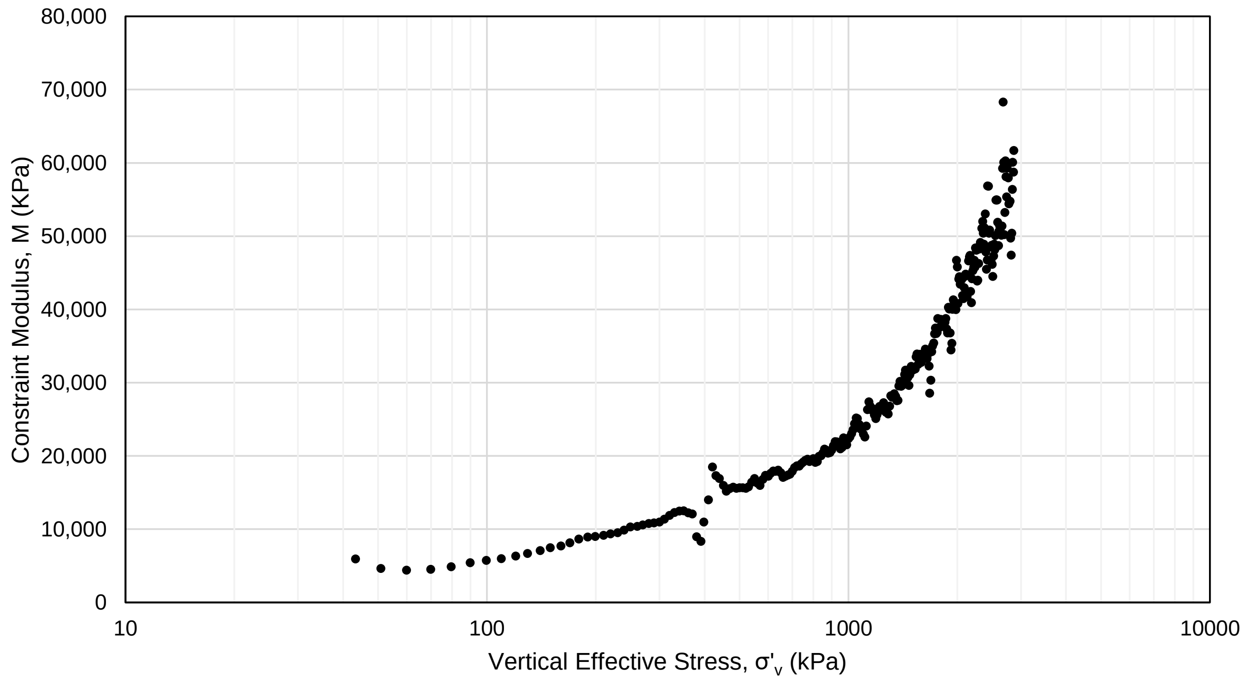
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2 m
Location:	Cadia Mine		18006 - CRS2





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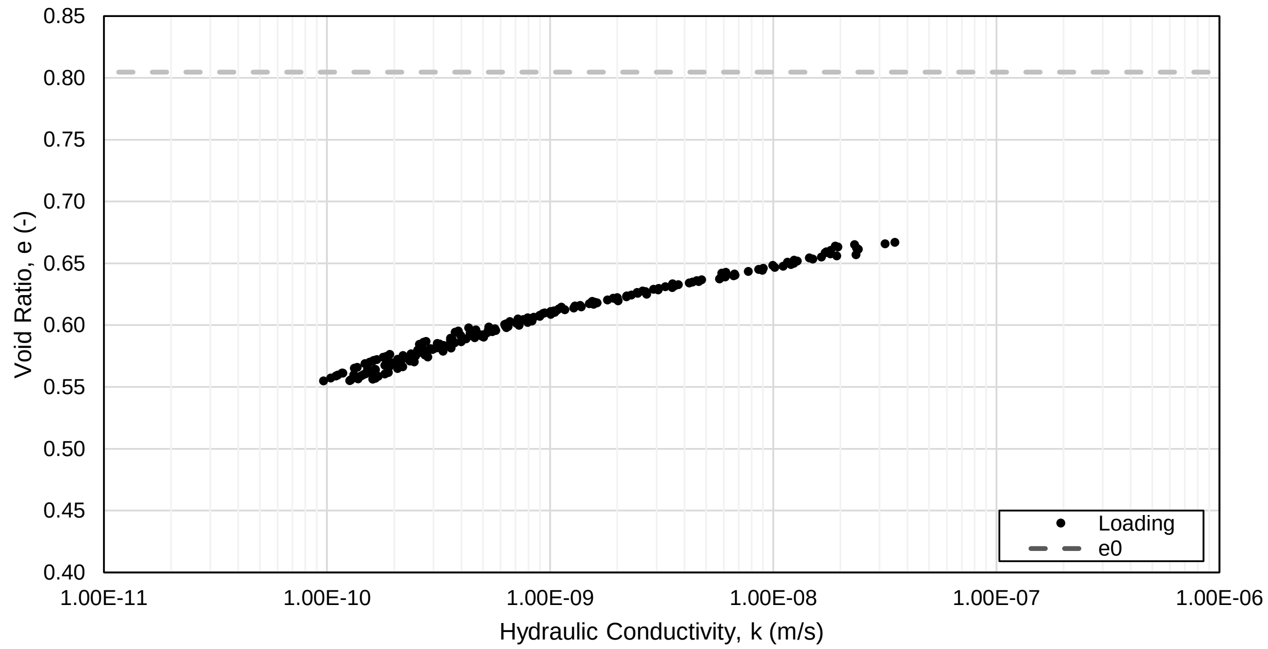
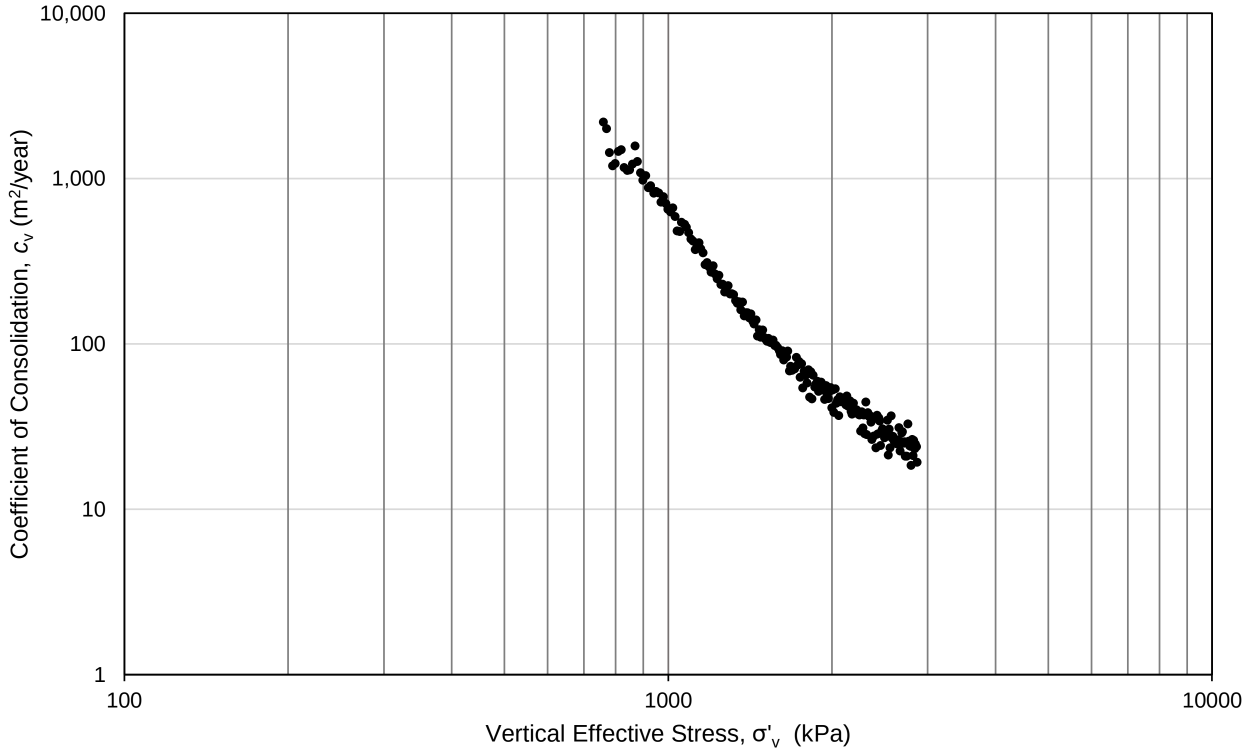
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2 m
Location:	Cadia Mine		18006 - CRS2





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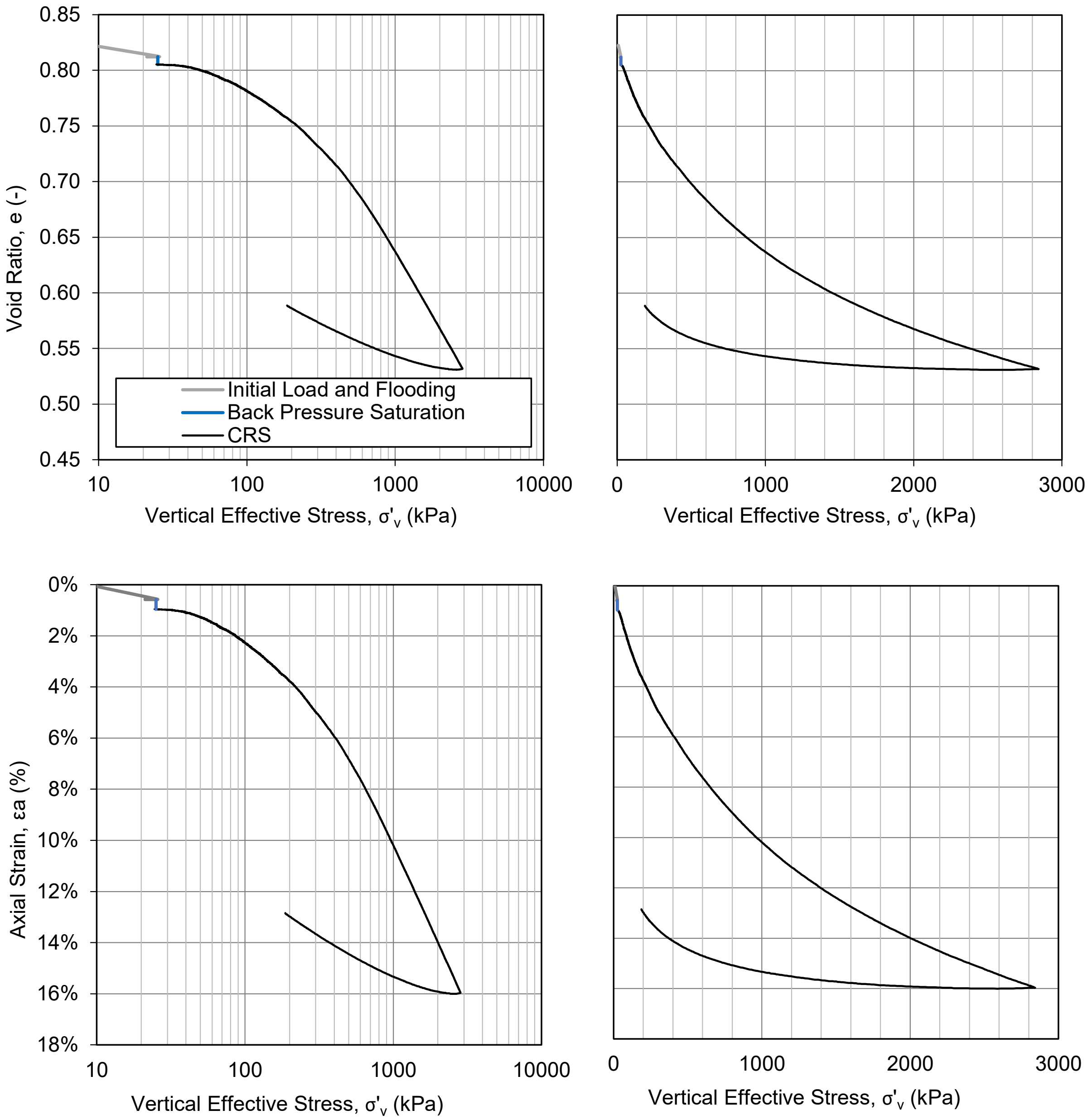
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2 m
Location:	Cadia Mine		18006 - CRS1

Diameter (mm)	60.0	Specific gravity (-)	2.75
Initial water content (trimmings) (%)	27.4%	Initial Void Ratio (-)	0.82
Initial Height (mm)	18.47	Initial Dry Density (t/m^3)	1.51
Final water content (specimen) (%)	28.0%	Average strain rate (%/hour)	3.9%



Preparation Notes:

Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding: Undertaken under constant height conditions
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)

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Constant Rate of Strain Consolidation Test

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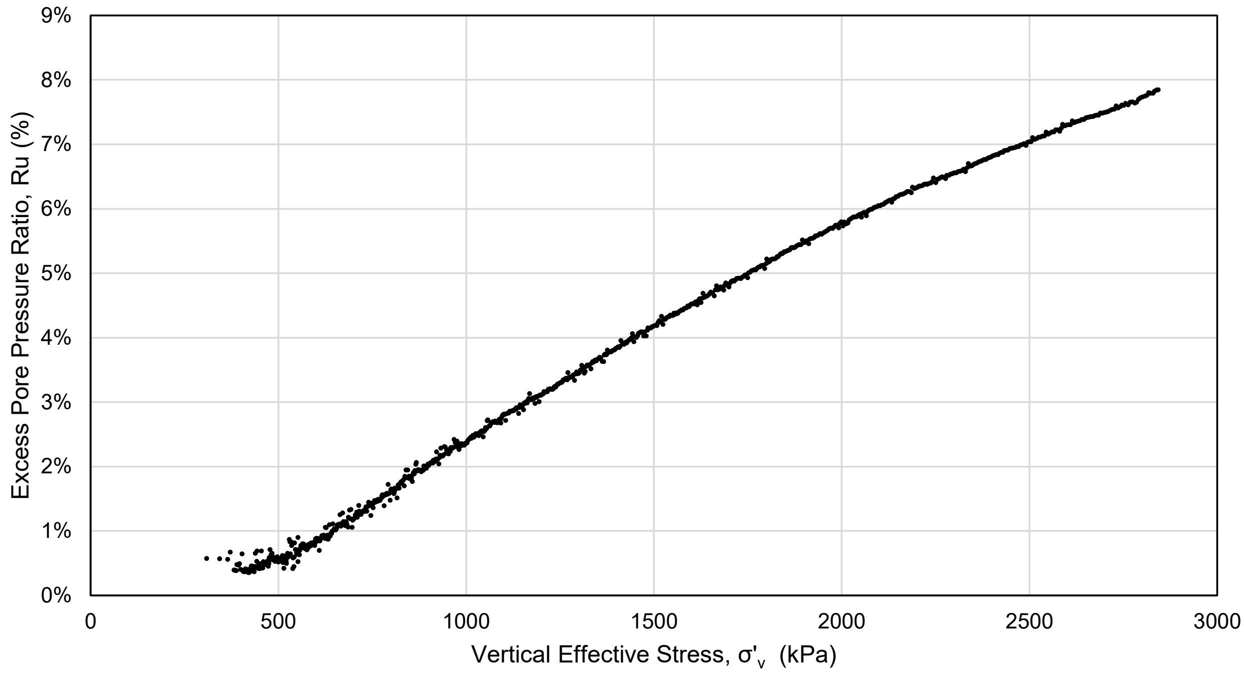
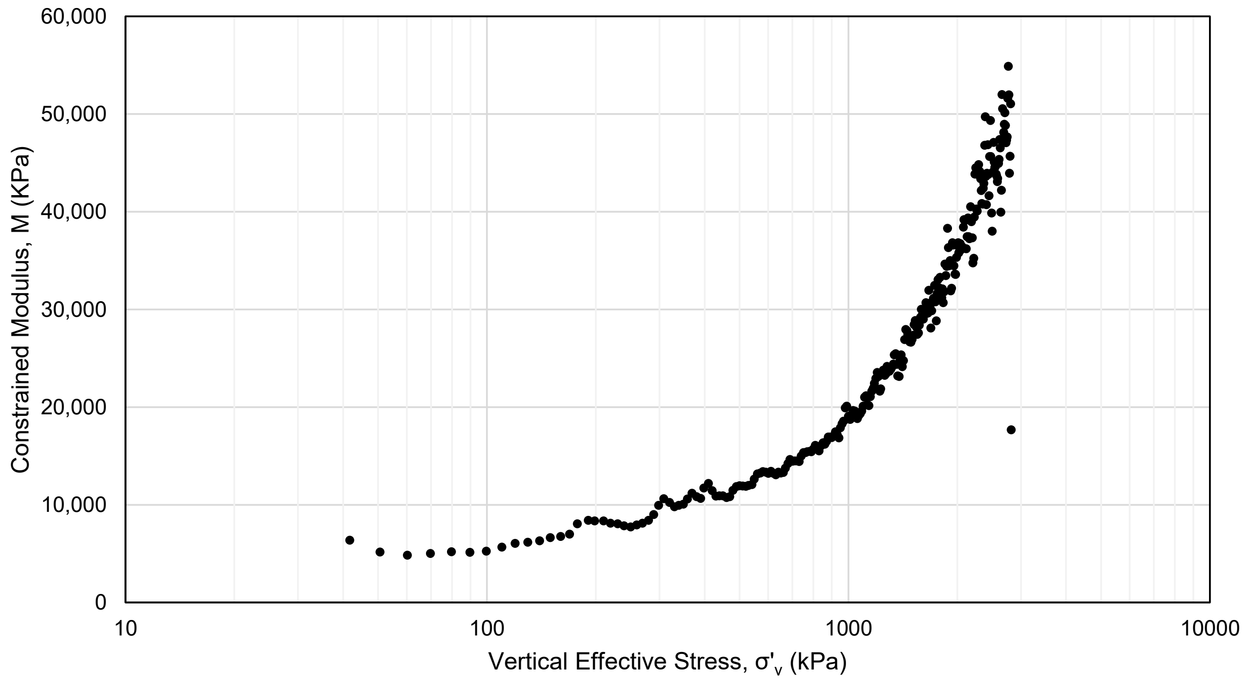
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2 m
Location:	Cadia Mine		18006 - CRS1





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Constant Rate of Strain Consolidation Test

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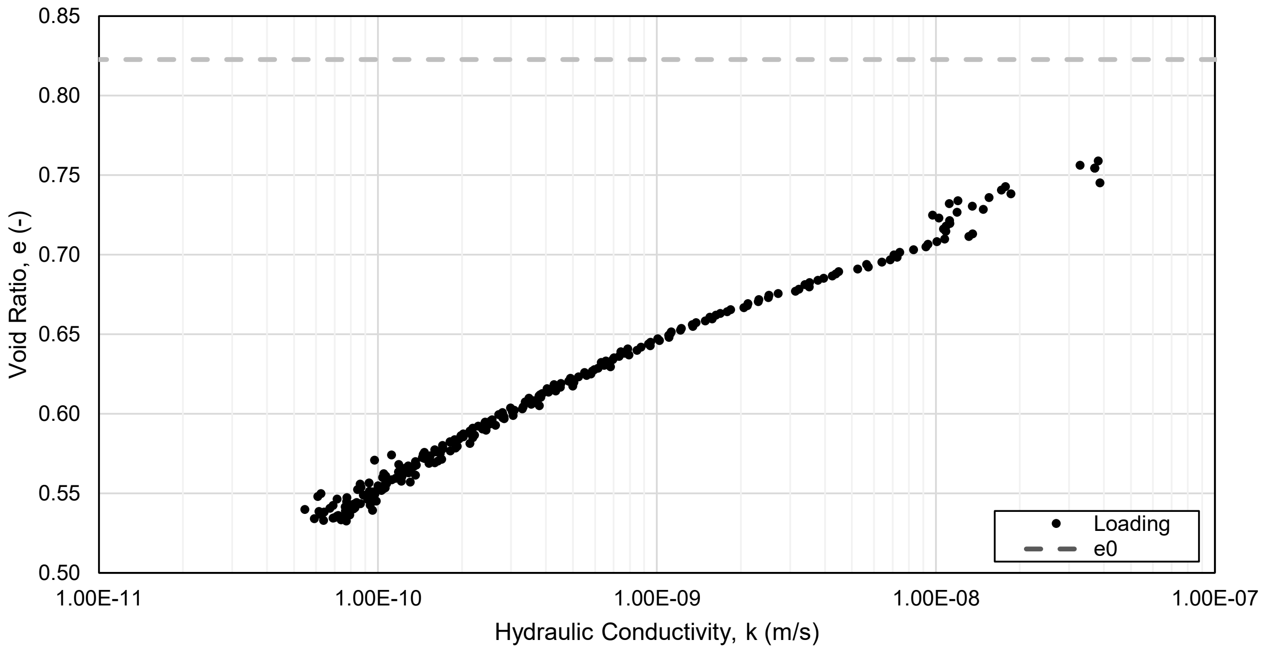
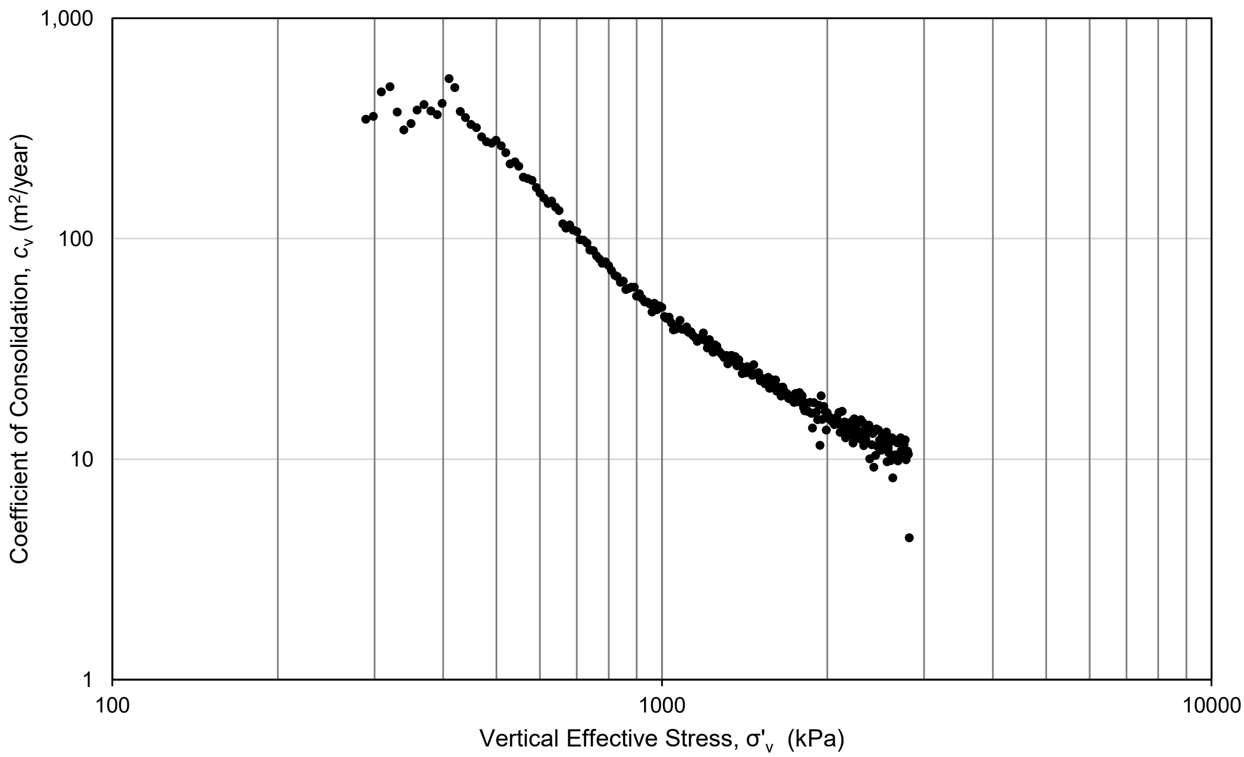
Client:	Hatch	**Date:**	2/7/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	TP405 1.9-2.2 m
Location:	Cadia Mine		18006 - CRS1





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Constant Rate of Strain Consolidation Test

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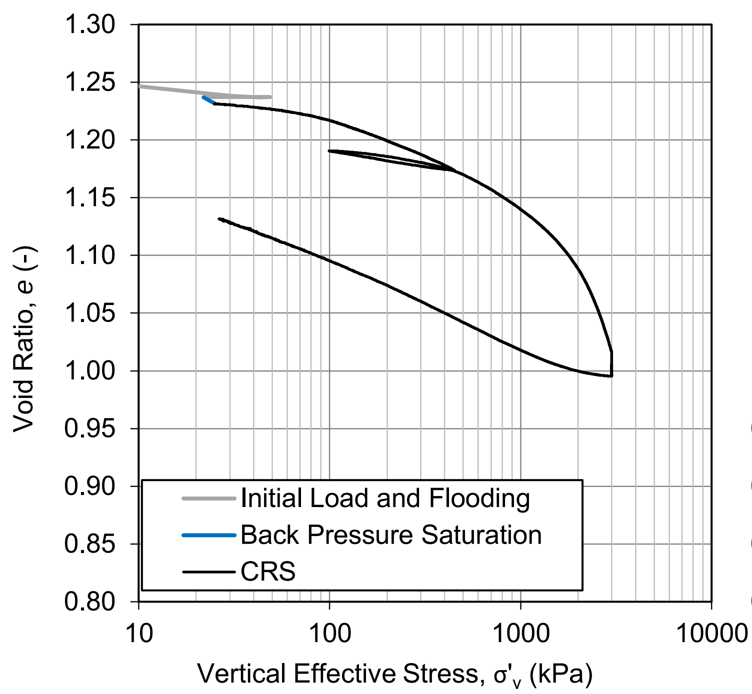
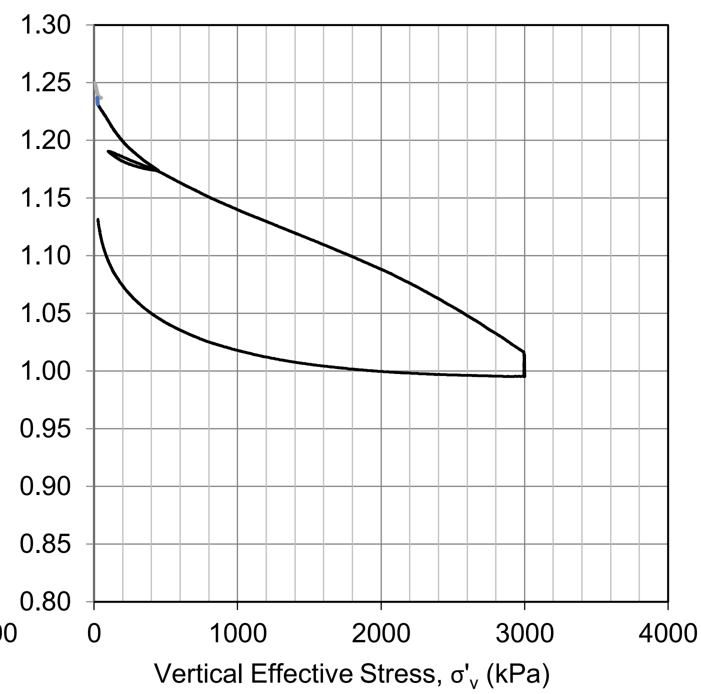
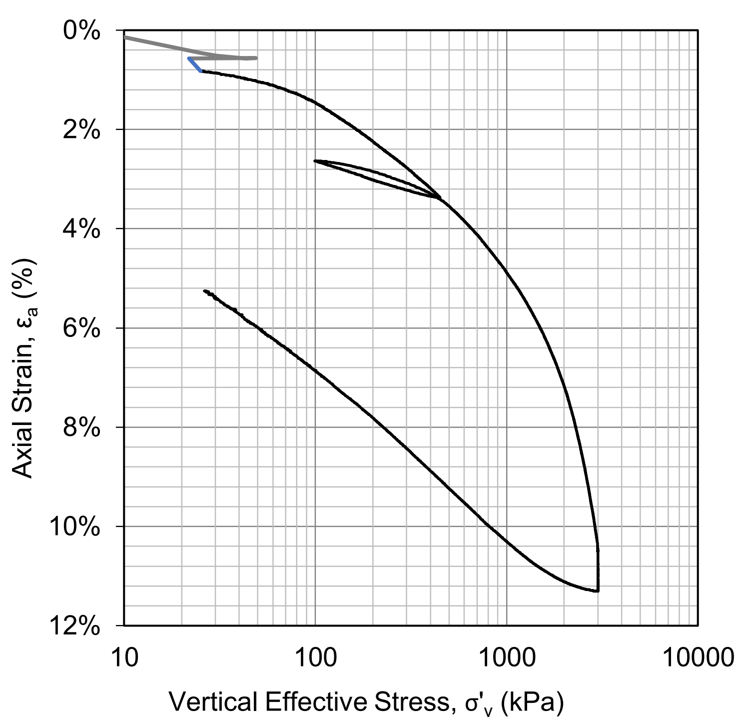
Perth Laboratory
84 Guthrie Street, Osborne Park

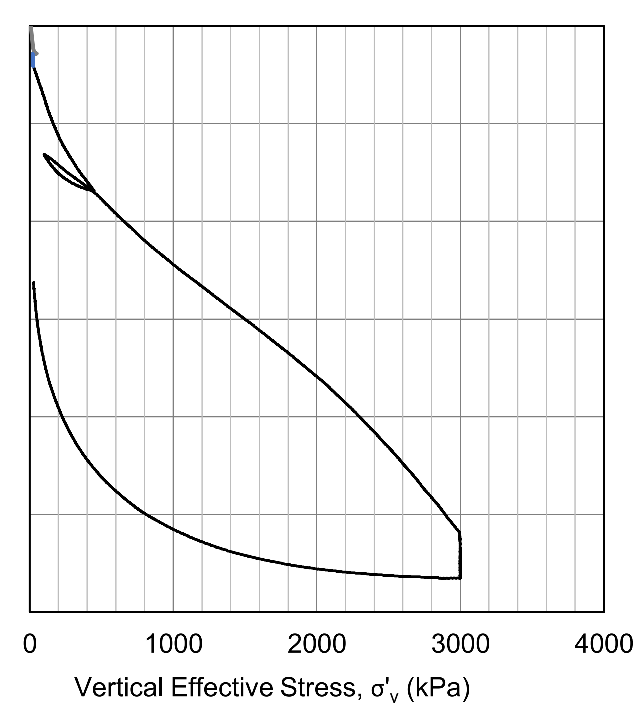
Client:	Hatch	**Date:**	17/08/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5 m
Location:	Cadia Mine		18022 - CRS1

Diameter (mm)	60.0	Specific gravity (-)	2.89
Initial water content (trimmings) (%)	41.5%	Initial Void Ratio (-)	1.25
Initial Height (mm)	18.76	Initial Dry Density (t/m^3)	1.28
Final water content (specimen) (%)	43.0%	Average strain rate (%/hour)	1.3%









Preparation Notes:

Testing procedure: ASTM D4186
1. Specimen Preparation: Extruded from tube
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO_2 prior to flooding with deaired demineralised water
4. Flooding and back pressure saturation: Initially undertaken under constant height conditions; switched to constant stress (25 kPa) during back pressure saturation
5. Maximum cell pressure: 500kPa (ramped over 1 days with double drainage)

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	Reviewed by:	R.Fanni

Constant Rate of Strain Consolidation Test

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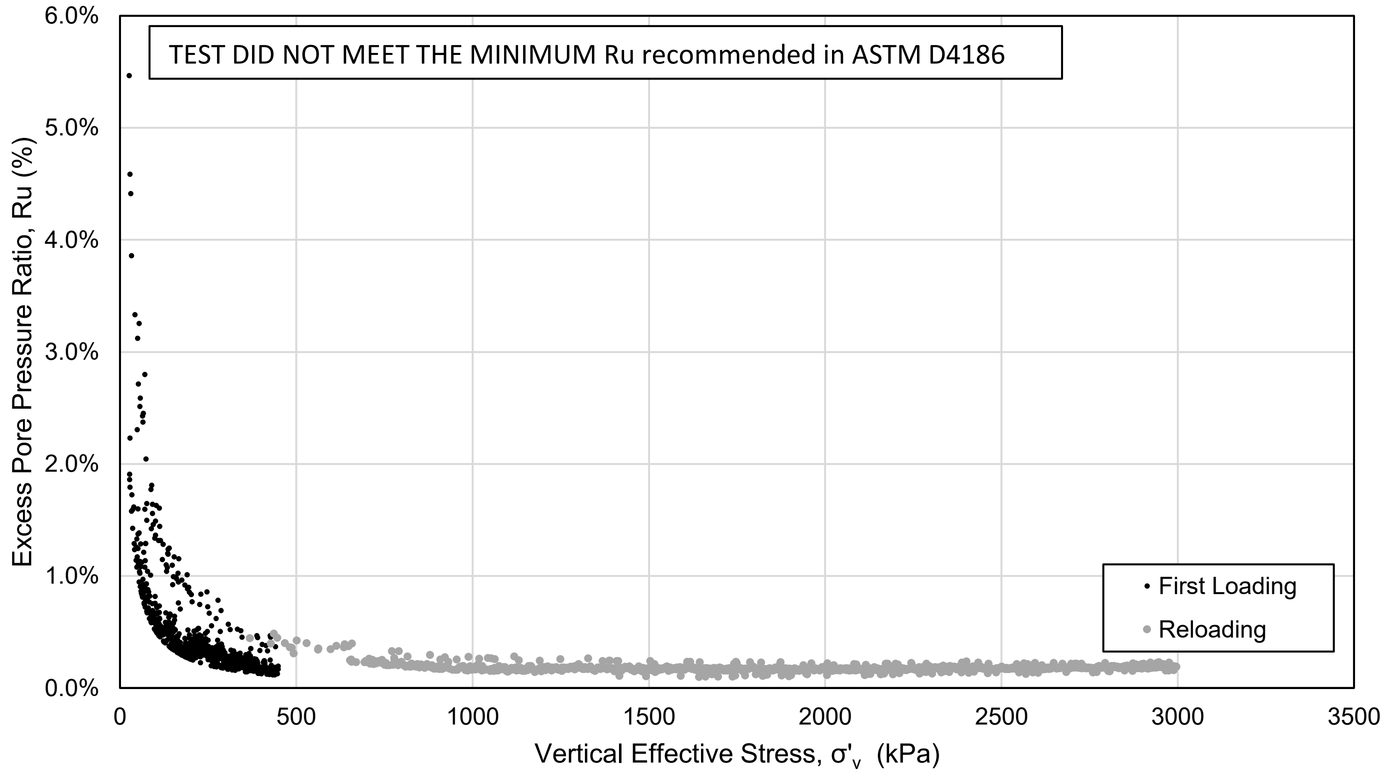
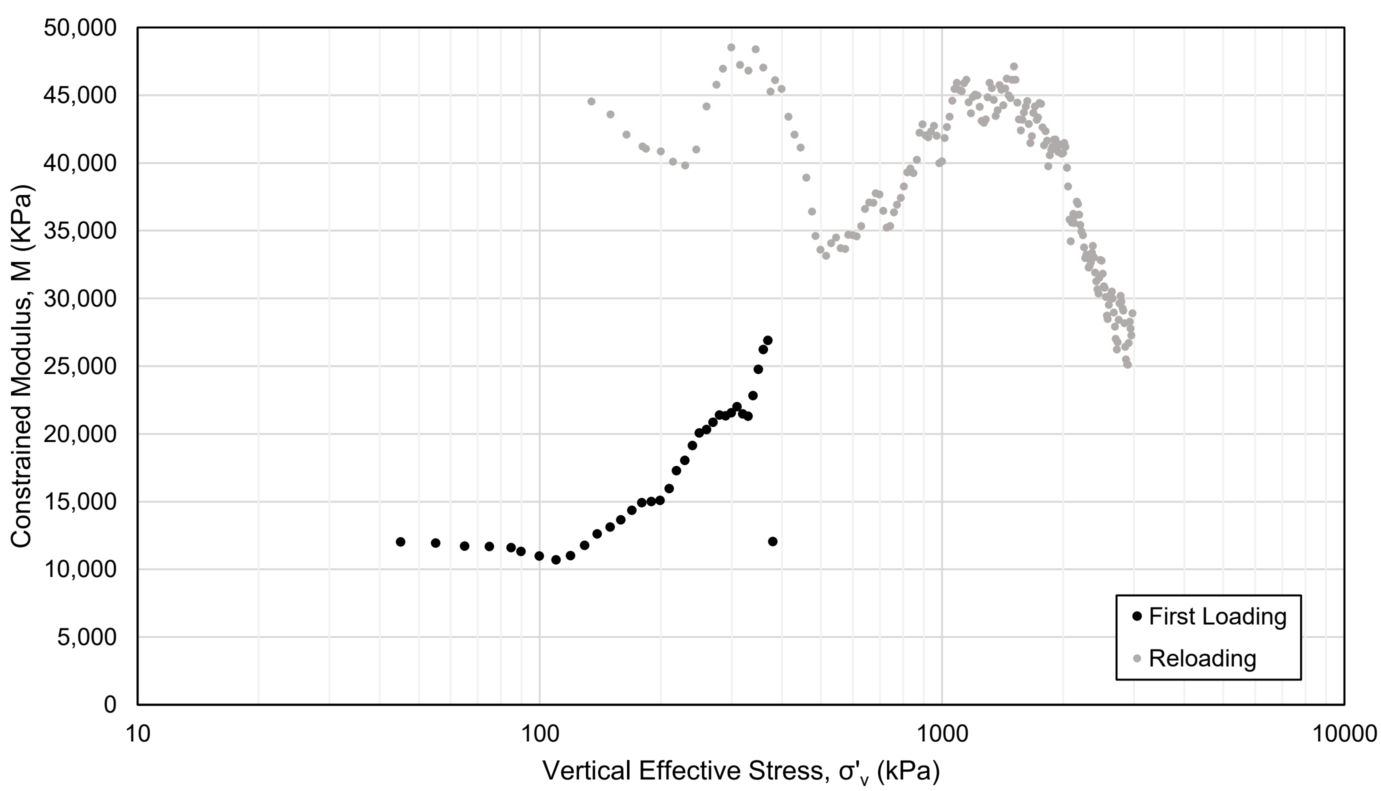
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	17/08/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5 m
Location:	Cadia Mine		18022 - CRS1





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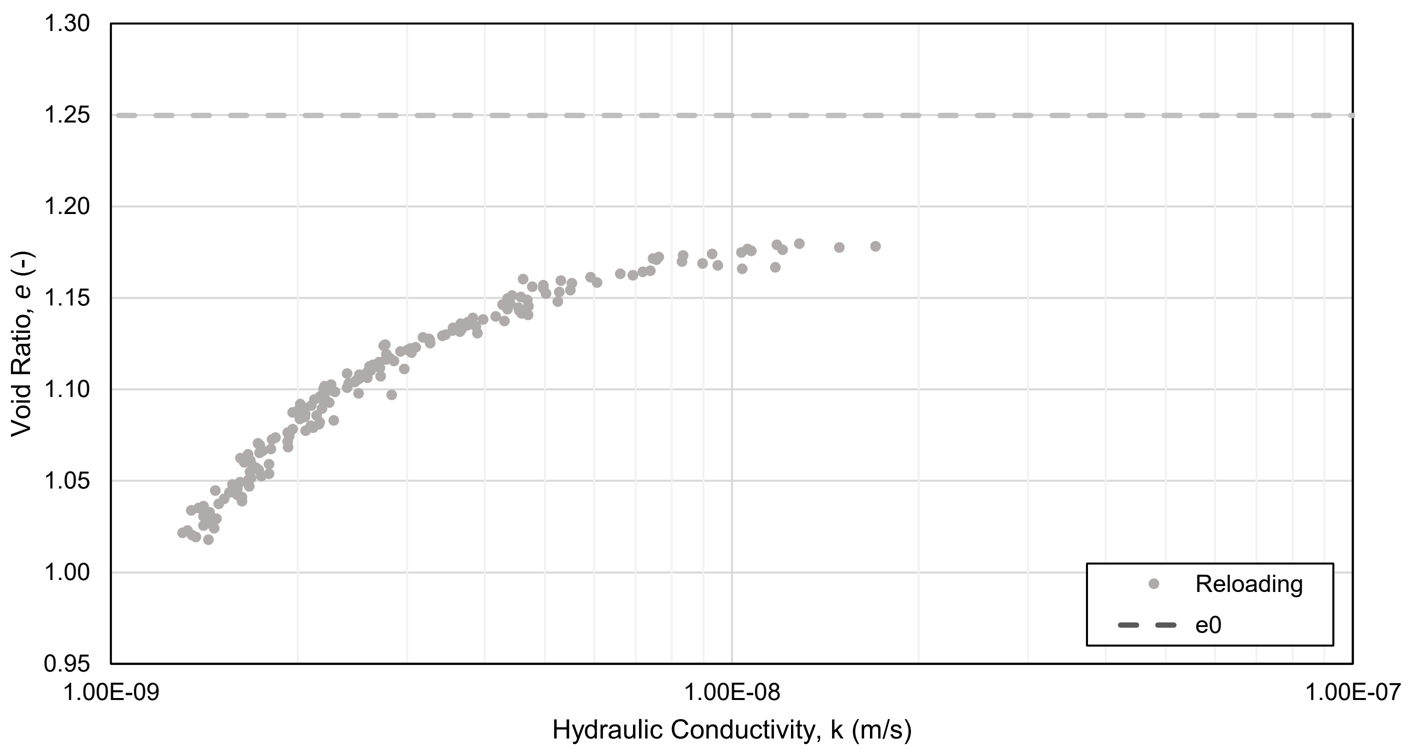
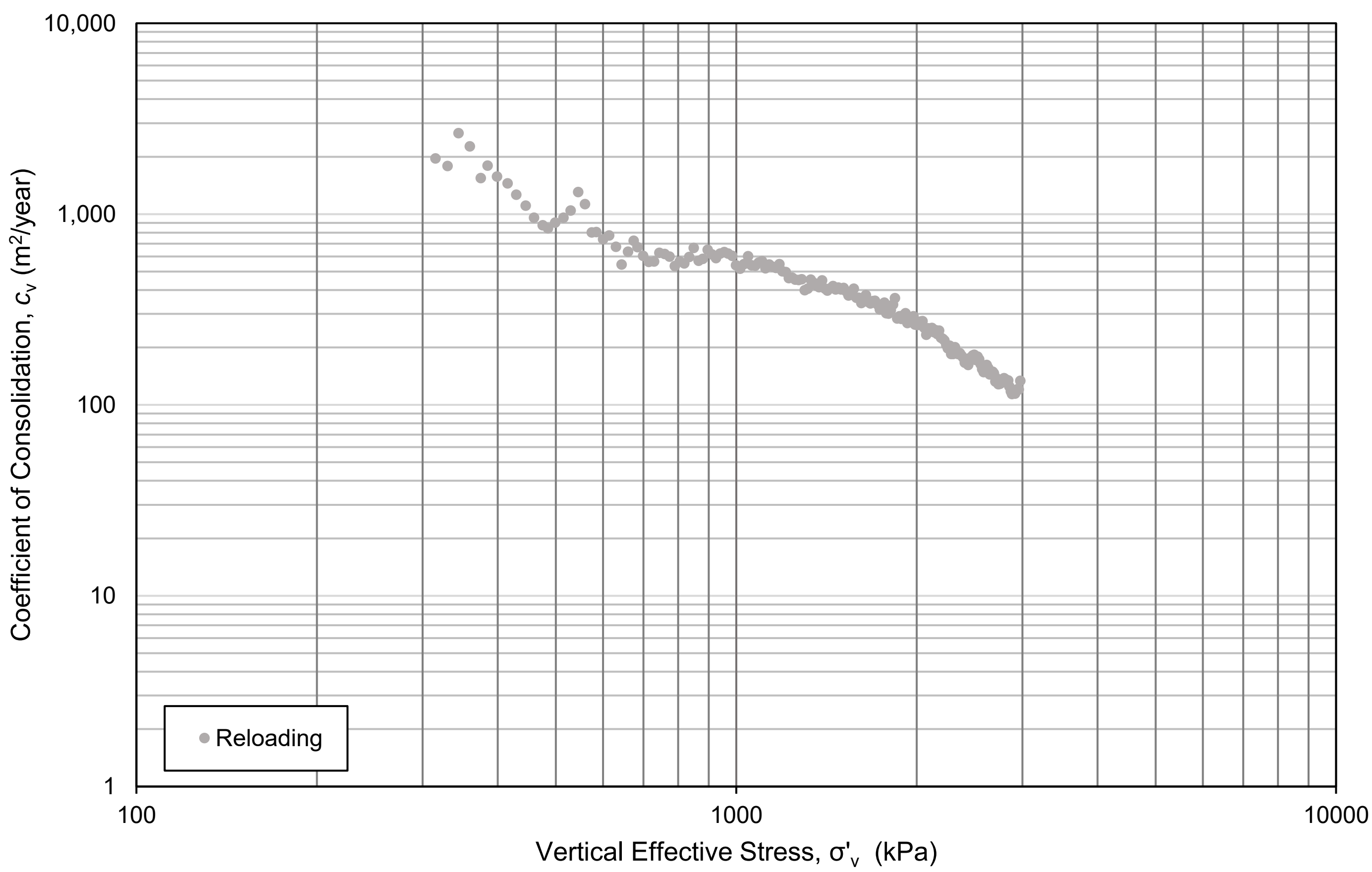
Client:	Hatch	**Date:**	17/08/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE415-PT1 6.0-6.5 m
Location:	Cadia Mine		18022 - CRS1





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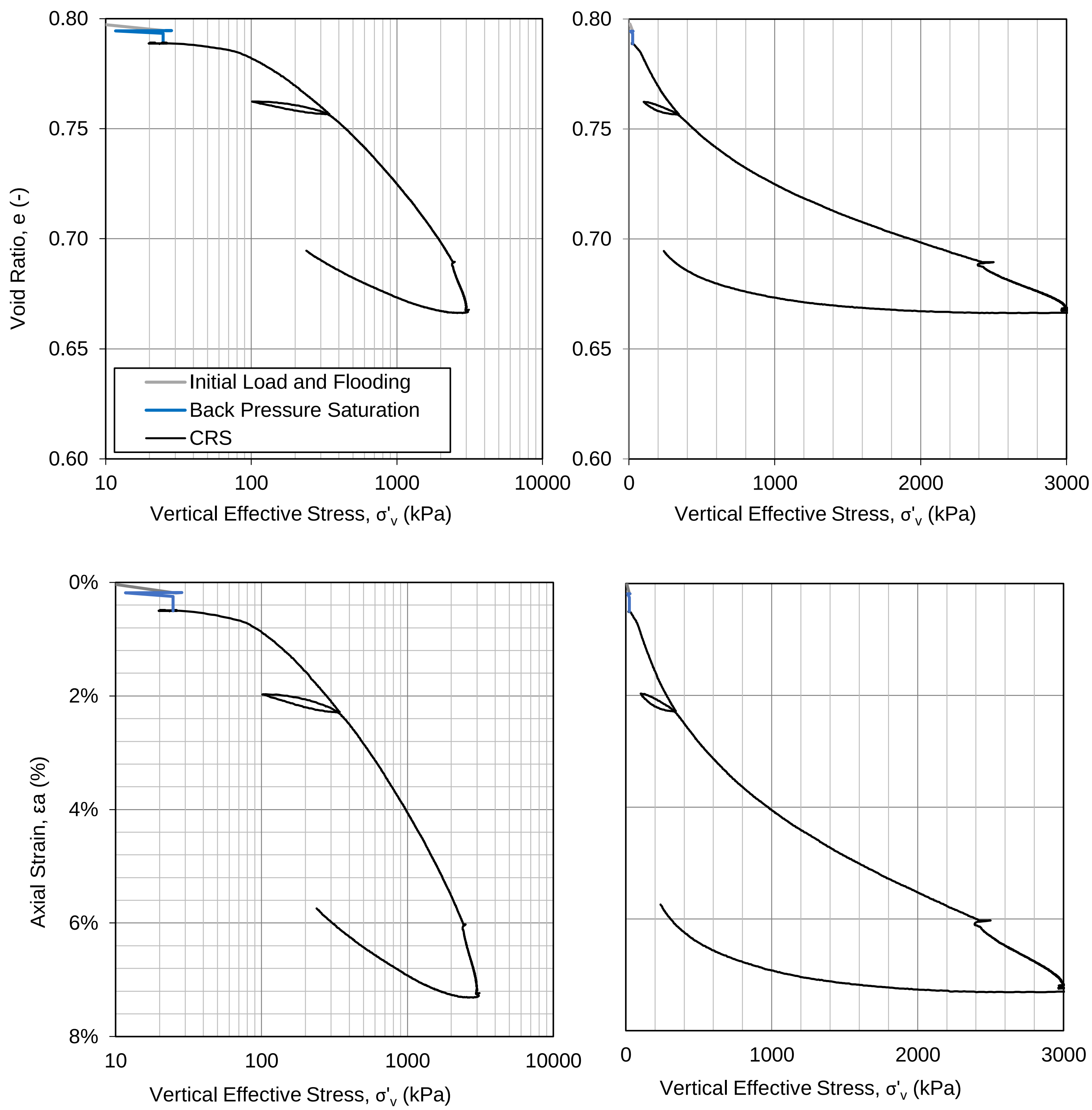
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	11/09/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE417-PT1 16.5-16.86m
Location:	Cadia Mine		18023 - CRS1

Diameter (mm)	60.0	Specific gravity (-)	2.74
Initial water content (trimmings) (%)	27.4%	Initial Void Ratio (-)	0.80
Initial Height (mm)	18.75	Initial Dry Density (t/m^3)	1.52
Final water content (specimen) (%)	29.2%	Average strain rate (%/hour)	3.2%



Preparation Notes:

Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding and back pressure saturation: Undertaken under constant height conditions and switched to constant stress (25kPa) during back pressure saturation
5. Maximum cell pressure: 500kPa (ramped over 2 days with double drainage)
6. Constant head permeability tests undertaken at 25 kPa and 3000 kPa total stresses

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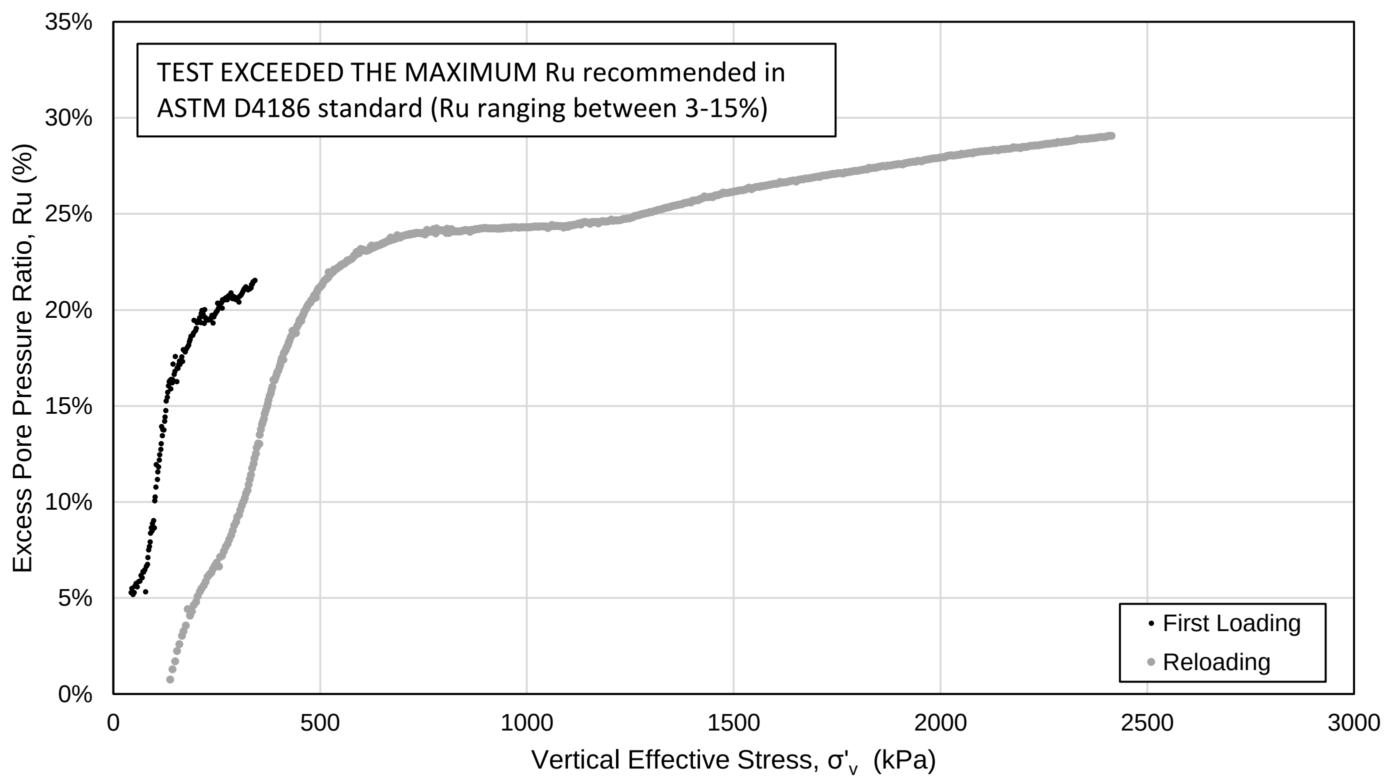
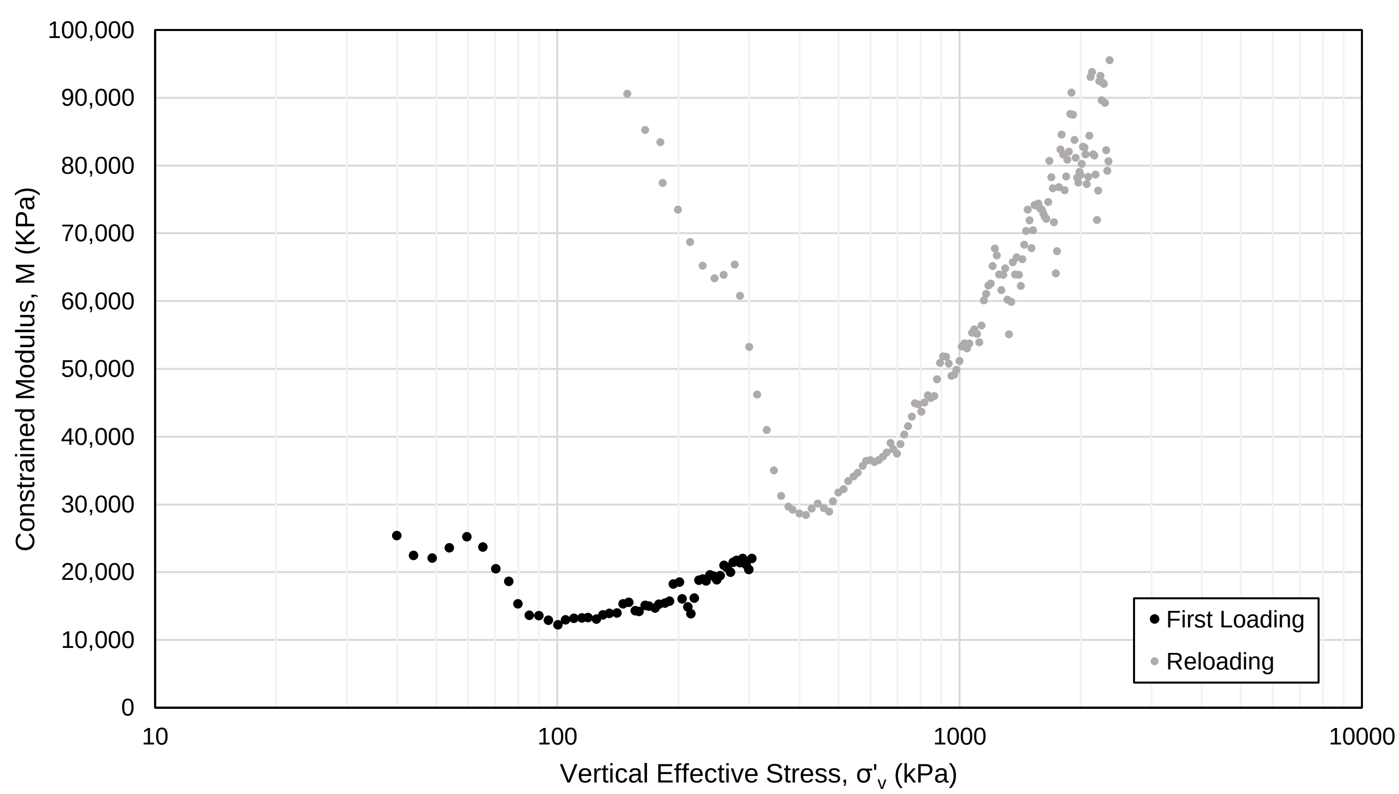
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	11/09/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE417-PT1 16.5-16.86m
Location:	Cadia Mine		18023 - CRS1





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GOLDER

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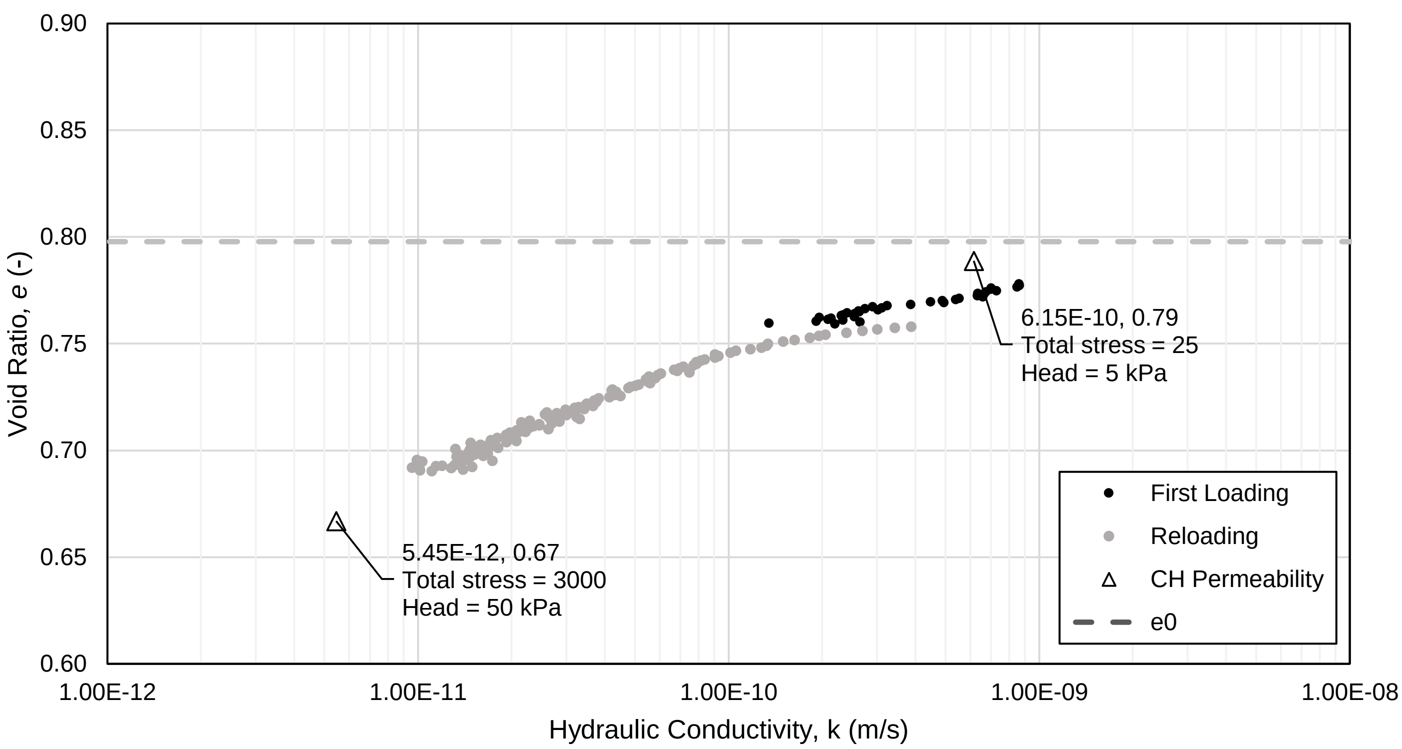
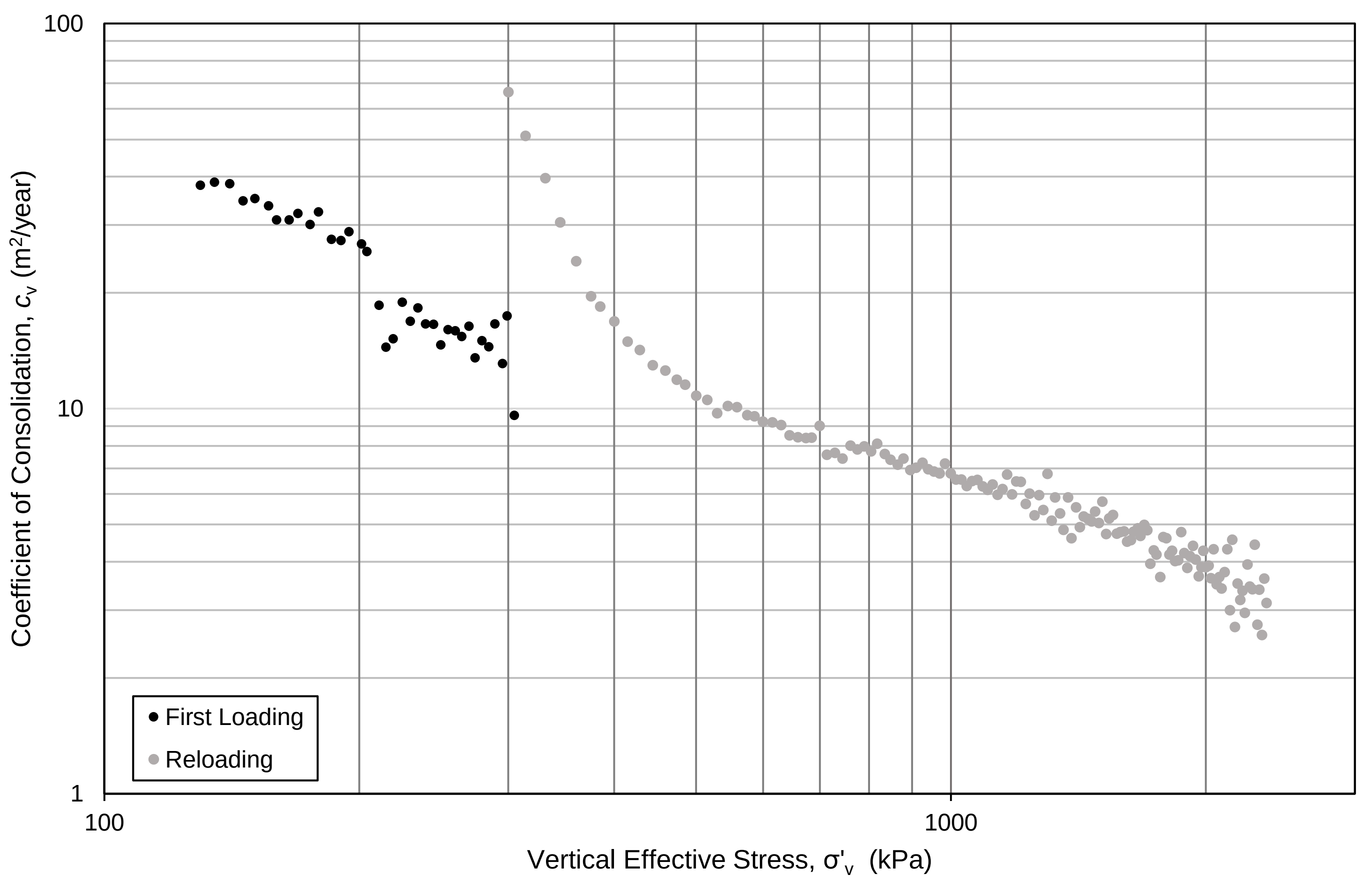
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	11/09/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE417-PT1 16.5-16.86m
Location:	Cadia Mine		18023 - CRS1





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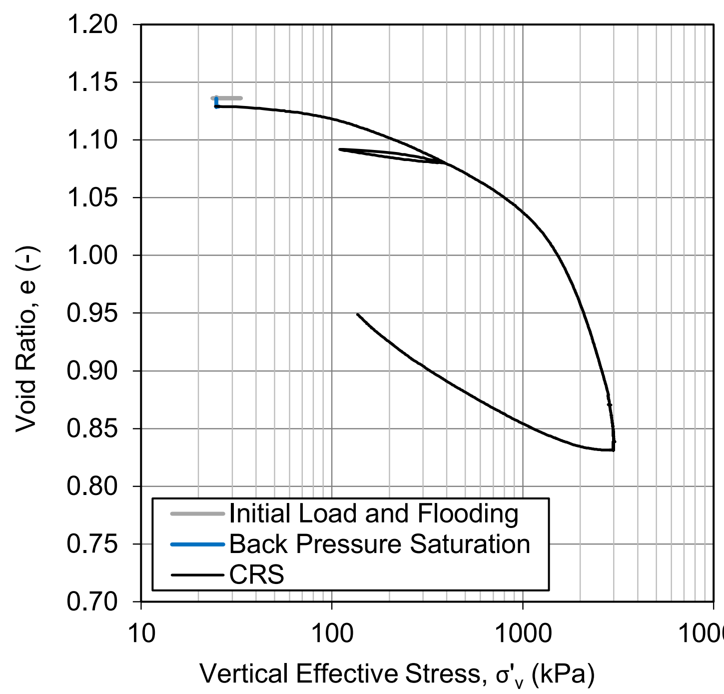
Constant Rate of Strain Consolidation Test

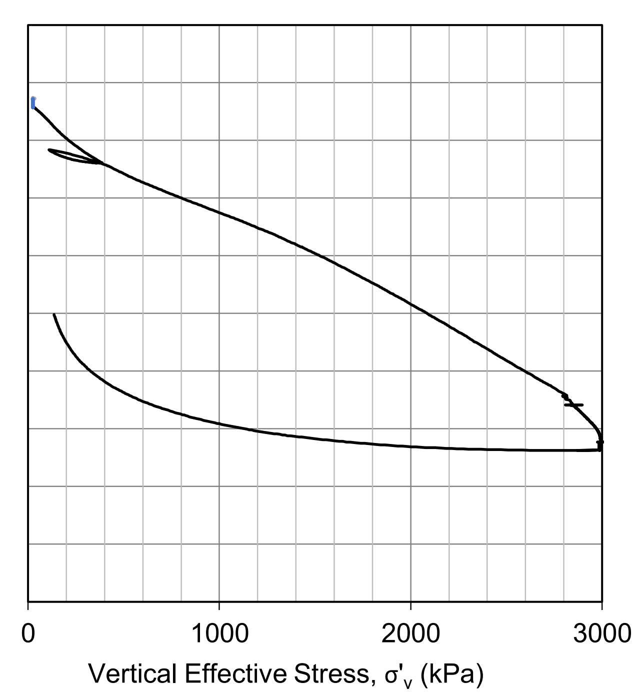
GOLDER

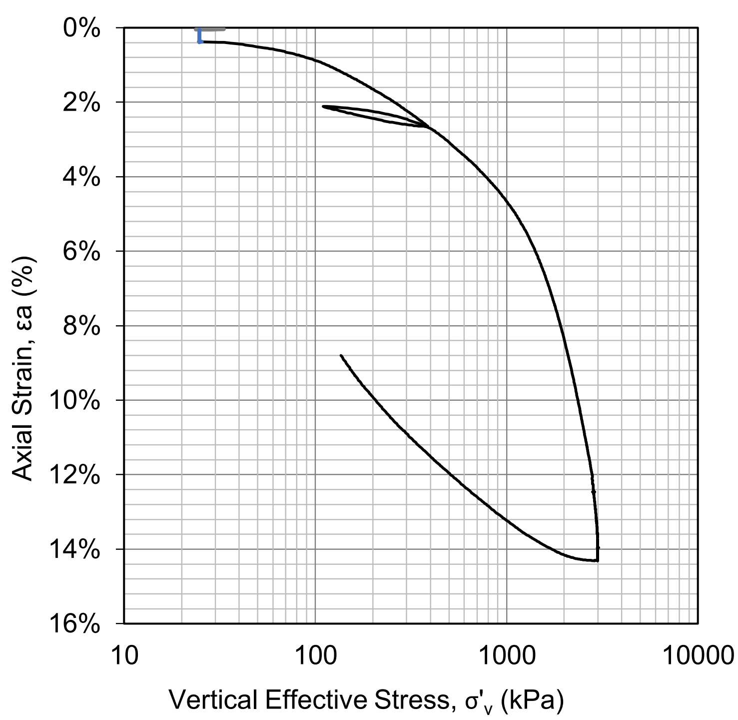
Perth Laboratory
84 Guthrie Street, Osborne Park

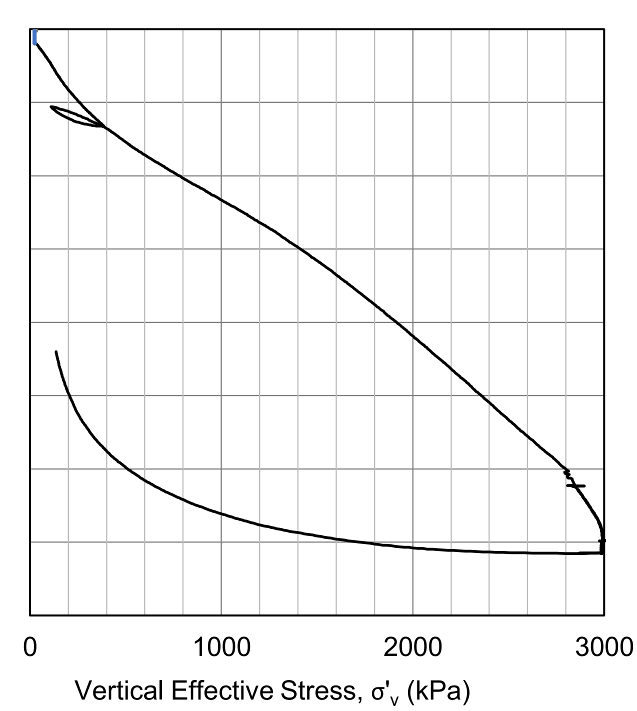
Client:	Hatch	**Date:**	3/09/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416 PT4 27.00-27.45m
Location:	Cadia Mine		18024 - CRS1

Diameter (mm)	60.0	Specific gravity (-)	2.90
Initial water content (trimmings) (%)	37.9%	Initial Void Ratio (-)	1.14
Initial Height (mm)	18.76	Initial Dry Density (t/m^3)	1.35
Final water content (specimen) (%)	40.6%	Average strain rate (%/hour)	6.1%









Preparation Notes:

Testing procedure: ASTM D4186
1. Specimen Preparation: Trimmed from block
2. Maximum constant stress prior to flooding: 25kPa
3. Saturation: Cell flushed with CO2 prior to flooding deaired demineralised water
4. Flooding and back pressure saturation: Undertaken under constant height conditions and switched to constant stress (25 kPa) during back pressure saturation
5. Maximum cell pressure: 500kPa (ramped over 1 days with double drainage)
6. Constant head permeability tests undertaken at 25 kPa and 3000 kPa total stresses

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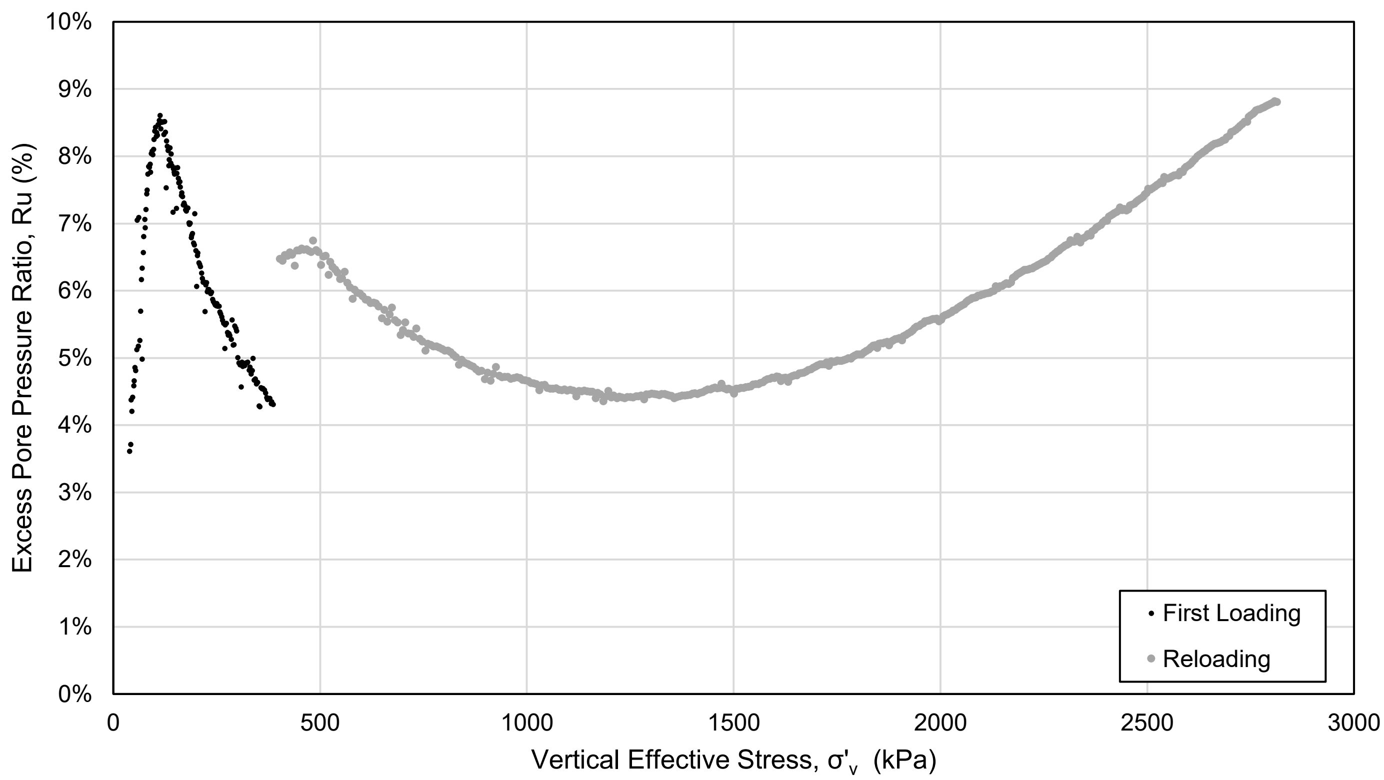
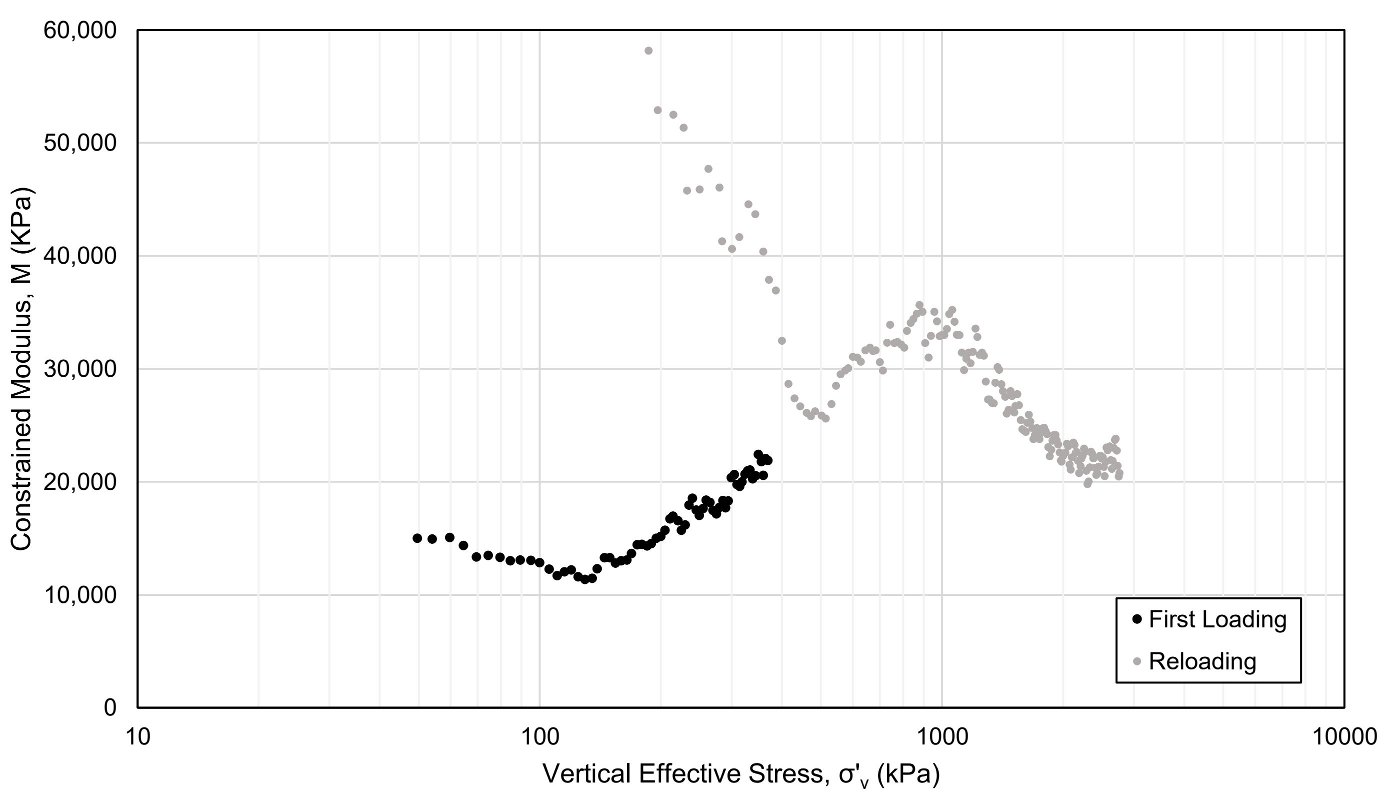
Constant Rate of Strain Consolidation Test

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	3/09/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416 PT4 27.00-27.45m
Location:	Cadia Mine		18024 - CRS1





THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Tested by:	I.Orea
Reviewed by:	R.Fanni

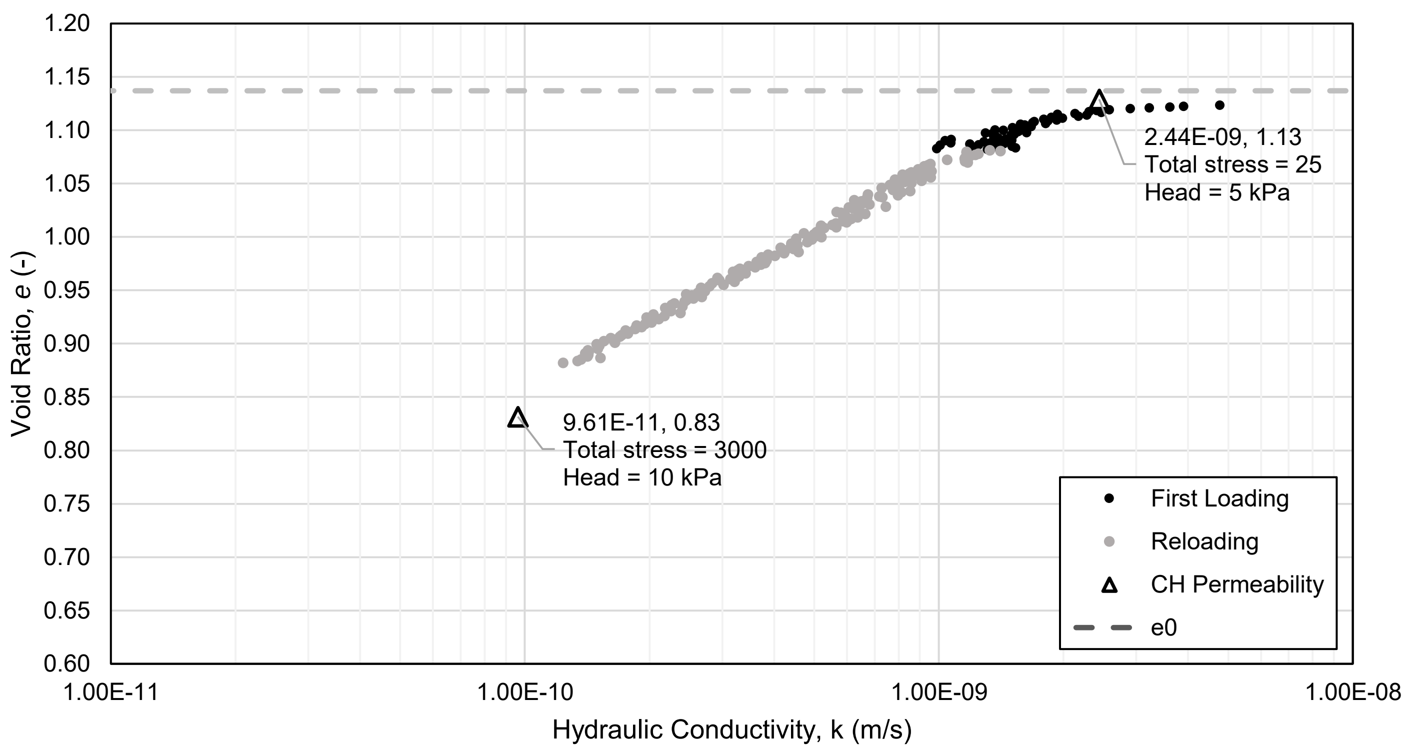
Constant Rate of Strain Consolidation Test

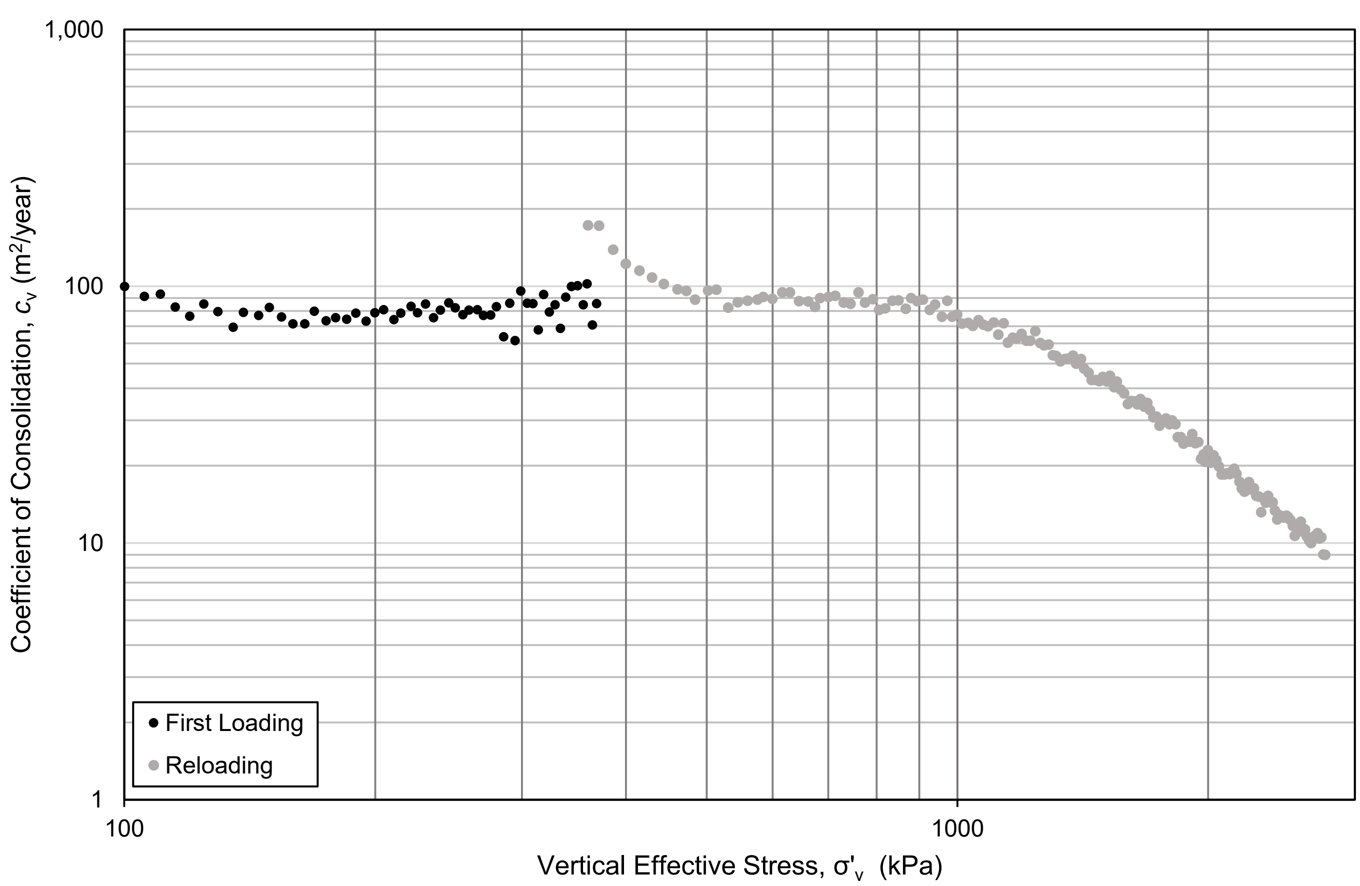
STRICTLY CONFIDENTIAL

GOLDER

Perth Laboratory
84 Guthrie Street, Osborne Park

Client:	Hatch	**Date:**	3/09/2018
Address:	61 Petrie Terrace Brisbane	**Project No.:**	18101980
Project:	NTSF Embankment Failure ITRB	**Sample ID:**	CE416 PT4 27.00-27.45m
Location:	Cadia Mine		18024 - CRS1





THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Tested by:	I.Orea
Reviewed by:	R.Fanni

Annexure DI
Miscellaneous Tests

microanalysis australia

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1341
Sample: 18_1341_01
Client ID: PL01-BS1 0.0-0.5m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th of 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 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

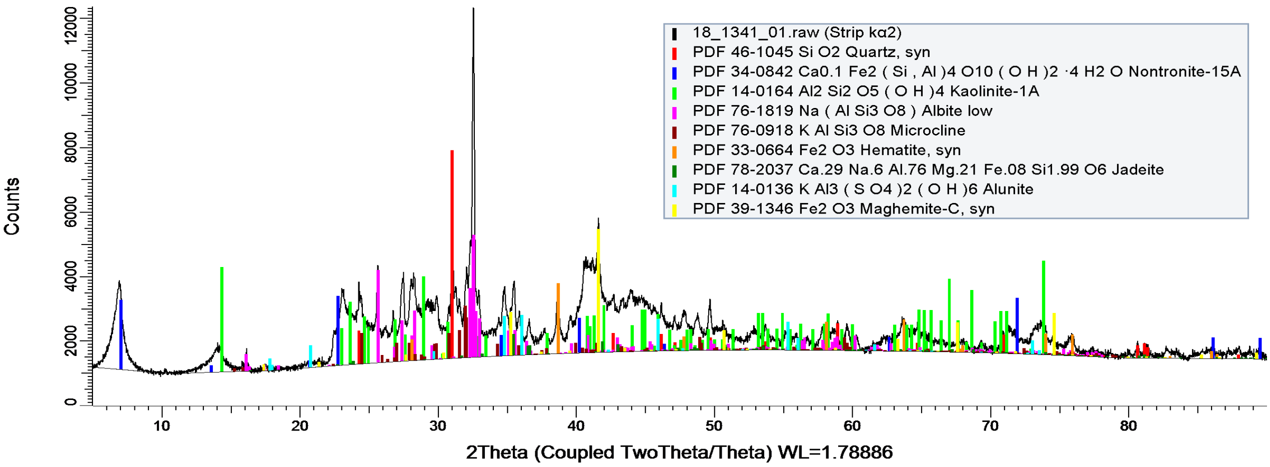
No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method 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 low (Na (Al Si3 O8))	31	good
Kaolinite-1A (Al2 Si2 O5 (O H)4)	17	medium
Microcline (K Al Si3 O8)	14	good
Nontronite-15A (Ca0.1 Fe2 (Si , Al)4 O10 (O H)2 ·4 H2 O)	11	medium
Quartz, syn (Si O2)	10	good
Maghemite-C, syn (Fe2 O3)	5	medium
Hematite, syn (Fe2 O3)	5	good
Alunite (K Al3 (S O4)2 (O H)6)	3	low
Jadeite (Ca.29 Na.6 Al.76 Mg.21 Fe.08 Si1.99 O6)	3	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: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Owen Carpenter, B.Sc.(Physics)

microanalysis australia

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1341
Sample: 18_1341_02
Client ID: TP401-BL1 0.7-1.0m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th of 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 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

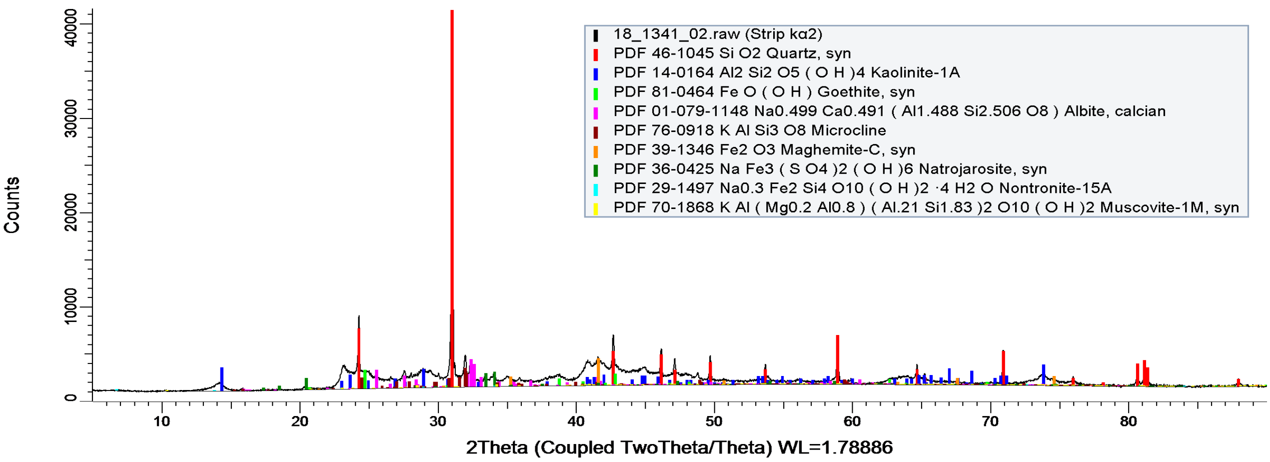
No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method 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
Quartz, syn (Si O2)	42	good
Albite, calcian (Na0.499 Ca0.491 (Al1.488 Si2.506 O8))	19	good
Microcline (K Al Si3 O8)	12	good
Kaolinite-1A (Al2 Si2 O5 (O H)4)	9	medium
Maghemite-C, syn (Fe2 O3)	7	medium
Natrojarosite, syn (Na Fe3 (S O4)2 (O H)6)	6	good
Goethite, syn (Fe O (O H))	3	medium
Muscovite-1M, syn (K Al (Mg0.2 Al0.8) (Al.21 Si1.83)2 O10 (O H)2)	1	low
Nontronite-15A (Na0.3 Fe2 Si4 O10 (O H)2 ·4 H2 O)	1	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: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Owen Carpenter, B.Sc.(Physics)

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microanalysis australia

37 Kensington Street
East Perth
WA 6004

Client: Golder Associates Pty Ltd
Job number: 18_1341
Sample: 18_1341_03
Client ID: TP405-BL1 1.9-2.2m
Date: 21-08-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 13th of 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 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

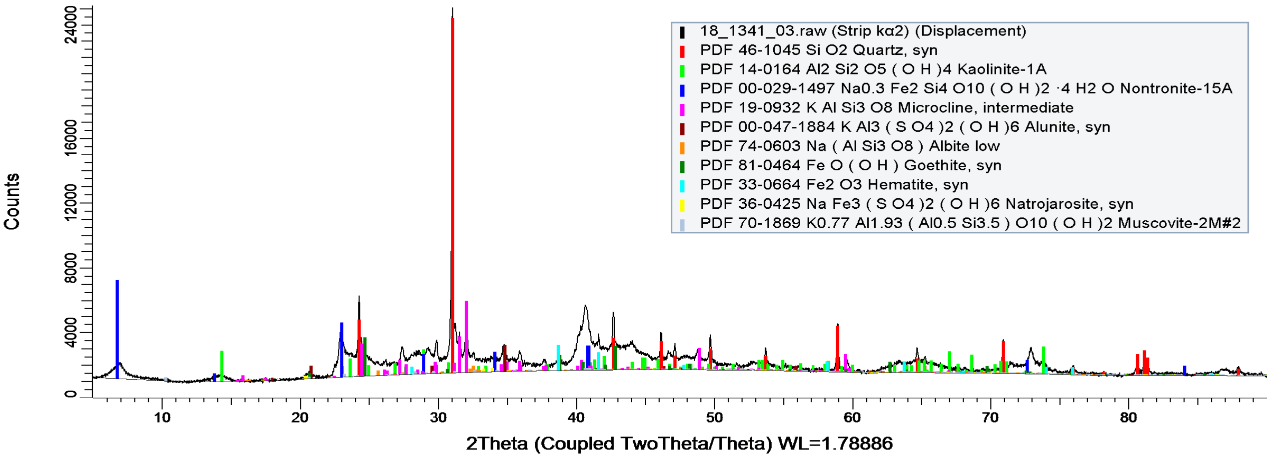
No standards were used in the quantification process. The concentrations were calculated using the peak area integration method where the area of the 100% peak for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method 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
Quartz, syn (Si O2)	28	good
Nontronite-15A (Na0.3 Fe2 Si4 O10 (O H)2 ·4 H2 O)	26	medium
Microcline, intermediate (K Al Si3 O8)	19	good
Kaolinite-1A (Al2 Si2 O5 (O H)4)	8	medium
Alunite, syn (K Al3 (S O4)2 (O H)6)	7	medium
Goethite, syn (Fe O (O H))	4	medium
Hematite, syn (Fe2 O3)	3	medium
Albite low (Na (Al Si3 O8))	3	medium
Muscovite-2M#2 (K0.77 Al1.93 (Al0.5 Si3.5) O10 (O H)2)	2	low
Natrojarosite, syn (Na Fe3 (S O4)2 (O H)6)	1	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: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Owen Carpenter, B.Sc.(Physics)

microanalysis australia

37 Kensington
Street
East Perth

Client: Golder Associates Pty Ltd
Job number: 18_1484
Sample: 18_1484_01
Client ID: CE406 SA3 22.2-22.3m
Date: 14-09-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 5th of September 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 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

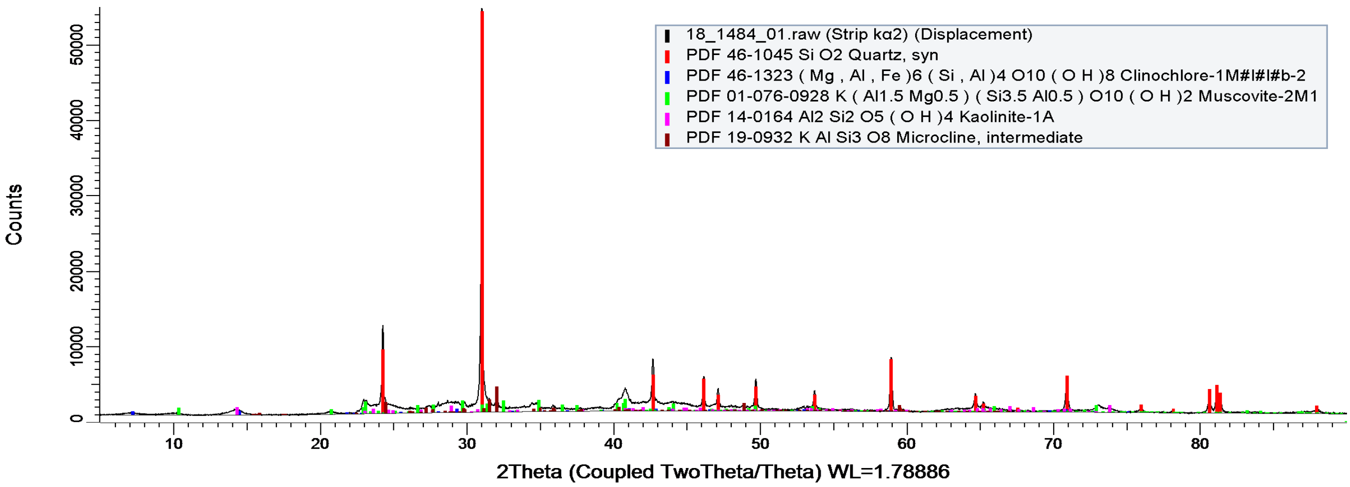
No standards were used in the quantification process. The concentrations were calculated using the normalized reference intensity ratio method where the intensity of the 100% peak divided by the published I/Ic value for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for slight attention to be paid to preferred orientation but is limited in considering other factors including but not limited to; variable crystallinity, alteration, fluorescence, substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Quartz, syn (Si O2)	57	good
Microcline, intermediate (K Al Si3 O8)	20	good
Muscovite-2M1 (K (Al1.5 Mg0.5) (Si3.5 Al0.5) O10 (O H)2)	16	medium
Kaolinite-1A (Al2 Si2 O5 (O H)4)	4	medium
Clinochlore-1M#I#I#b-2 ((Mg , Al , Fe)6 (Si , Al)4 O10 (O H)8)	2	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: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Michael Simeoni, B.Sc.(Chemistry), M.Sc. (Science Administration), Ph.D.

microanalysis australia

37 Kensington Street
East Perth

Client: Golder Associates Pty Ltd
Job number: 18_1484
Sample: 18_1484_02
Client ID: CE416 PT4 27.0-27.45m
Date: 14-09-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 5th of September 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 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

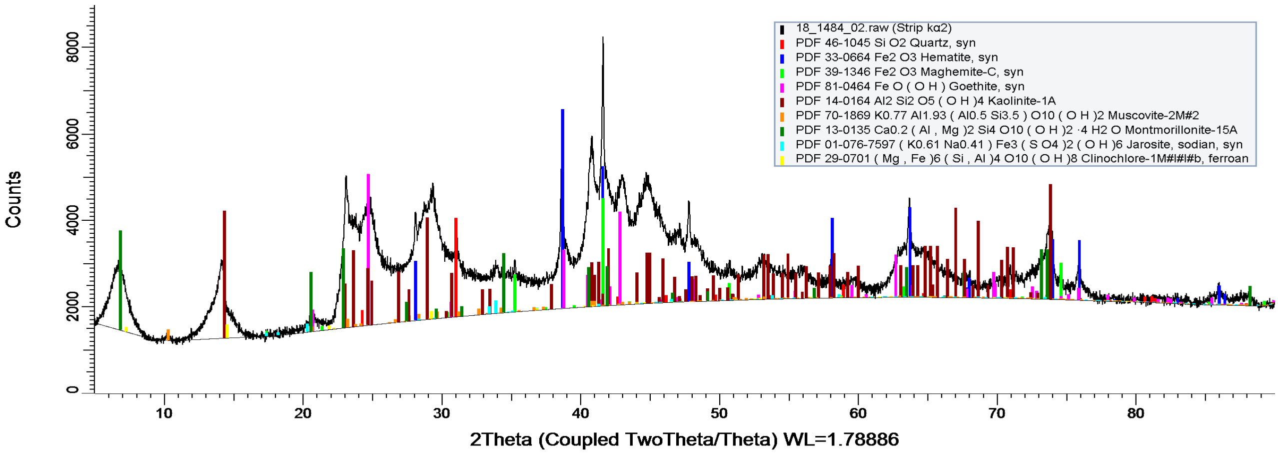
No standards were used in the quantification process. The concentrations were calculated using the normalized reference intensity ratio method where the intensity of the 100% peak divided by the published I/Ic value for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for slight attention to be paid to preferred orientation but is limited in considering other factors including but not limited to; variable crystallinity, alteration, fluorescence, substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Kaolinite-1A (Al2 Si2 O5 (O H)4)	25	medium
Montmorillonite-15A (Ca0.2 (Al , Mg)2 Si4 O10 (O H)2 ·4 H2 O)	19	medium
Hematite, syn (Fe2 O3)	16	good
Maghemite-C, syn (Fe2 O3)	15	good
Goethite, syn (Fe O (O H))	11	good
Quartz, syn (Si O2)	6	good
Muscovite-2M#2 (K0.77 Al1.93 (Al0.5 Si3.5) O10 (O H)2)	5	medium
Clinochlore-1M#I#I#b, ferroan ((Mg , Fe)6 (Si , Al)4 O10 (O H)8)	3	low
Jarosite, sodian, syn ((K0.61 Na0.41) Fe3 (S O4)2 (O H)6)	1	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: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Michael Simeoni, B.Sc.(Chemistry), M.Sc. (Science Administration), Ph.D.

STRICTLY CONFIDENTIAL

microanalysis australia

37 Kensington
Street
East Perth

Client: Golder Associates Pty Ltd
Job number: 18_1484
Sample: 18_1484_03
Client ID: CE415 PT1 6.0-6.5m
Date: 14-09-18
Analysis : Semi-quantitative XRD analysis

Sample preparation

The sample was supplied by the client to Microanalysis Australia on 5th of September 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 4.2. An up-to-date ICDD card set was used. The X-ray source was cobalt radiation.

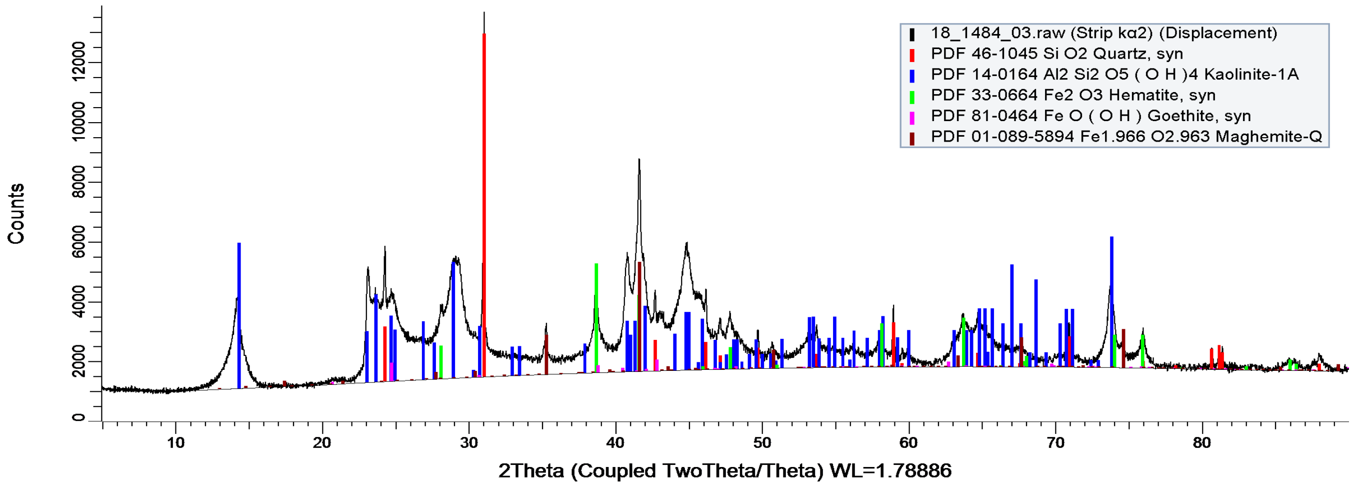
No standards were used in the quantification process. The concentrations were calculated using the normalized reference intensity ratio method where the intensity of the 100% peak divided by the published I/Ic value for each mineral phase is summed and the relative percentages of each phase calculated based on the relative contribution to the sum. This method allows for slight attention to be paid to preferred orientation but is limited in considering other factors including but not limited to; variable crystallinity, alteration, fluorescence, substitution and lattice strain.

Summary

The phases are listed in order of interpreted concentration:

Mineral phase	Concentration (%)	ICDD match probability
Kaolinite-1A (Al2 Si2 O5 (O H)4)	43	medium
Quartz, syn (Si O2)	30	good
Hematite, syn (Fe2 O3)	13	good
Maghemite-Q (Fe1.966 O2.963)	12	medium
Goethite, syn (Fe O (O H))	2	medium

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: Ian Davies, B.Sc.(Chemistry)
Reported: Ian Davies, B.Sc.(Chemistry)
Approved: Michael Simeoni, B.Sc.(Chemistry), M.Sc. (Science Administration), Ph.D.

Dry Density Moisture Content Relationship Report

In accordance with

AS 1289.5.1.1

Perth Laboratory
84 Guthrie Street Osborne Park
Perth WA 6017
P: +61 8 9441 0700 F: +61 8 9441 0701
www.golder.com
perthlab@golder.com.au

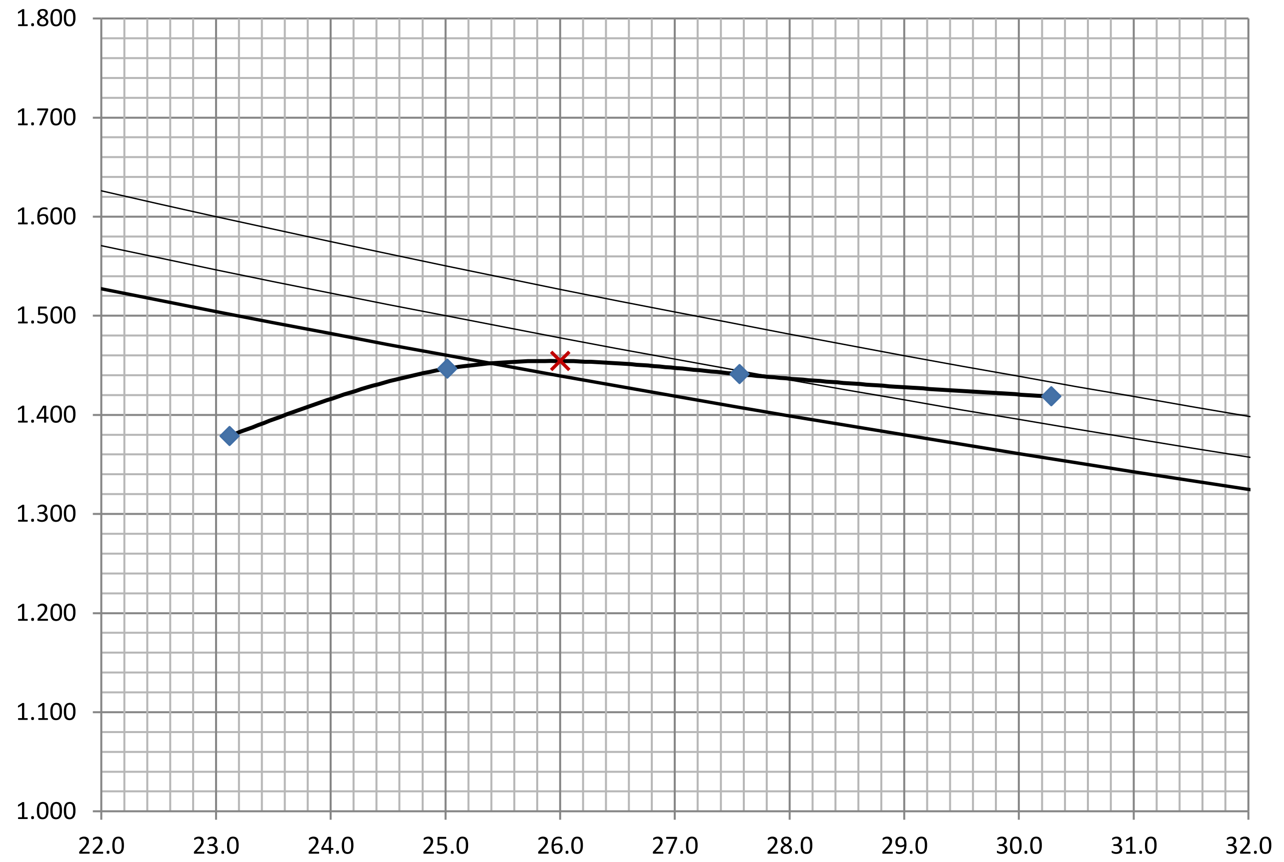
Client:	Hatch	**Project No.:**	18101981
Address	61 Petrie Terrace, Brisbane	**Date:**	29/06/18
Project:	NTSF Embankment Failure ITRB		
Location:	Cadia Mine		
Lab Ref No.:	180609	**Sample Id:**	PL-BS1
		Depth:	0-0.5m

AS 1726 - Soil Classification:CH Description: Sandy CLAY

Test Procedure: AS 1289.5.1.1 Mould Type : A Type (1litre) Natural Moisture Content 33.5%

Oversize material excluded from test: 0% retained on the 19 sieve.

Zero Air Voids for Particle Densities 2.3, 2.4 & 2.5 t/m³



Maximum Dry Density	**1.45 t/m³**
Optimum Moisture	**26.0 %**

Notes:
1. Tested as supplied.
2. Material was reused on negative 6 point due to insufficient sample.
3. This test certificate replaces test certificate reference 18101981_180609_TR-180078_MDD_Rev0

PLF1-008 RL2 24/08/2017

Certificate Reference: **18101981_180609_TR-180078_MDD_Rev1**

NATA

NATA Accreditation No: 1961 Perth

Accredited for compliance with ISO/IEC 17025

THIS DOCUMENT SHALL ONLY BE REPRODUCED IN FULL

Sean Lenihan

Sean Lenihan - Senior Laboratory Technician

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1826989**	Page	: 1 of 2
Client	: **TRILAB PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR CHRIS CHANNON	Contact	: Customer Services EB
Address	: 346A BILSEN RD GEEBUNG QLD, AUSTRALIA 4031	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3265 5656	Telephone	: +61-7-3243 7222
Project	: H356804 - Cadia NTSF Failure	Date Samples Received	: 07-Nov-2018 13:08
Order number	: 1811017	Date Analysis Commenced	: 13-Nov-2018
C-O-C number	: ----	Issue Date	: 15-Nov-2018 12:11
Sampler	: ----		
Site	: ----		
Quote number	: EN/333		
No. of samples received	: 1		
No. of samples analysed	: 1		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Client sample ID*	**18110181 / CE417 - DH406 L2B / 18.50-19.00m**	**----**	**----**	**----**	**----**
			Client sampling date / time	07-Nov-2018 00:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1826989-001**	**--------**	**--------**	**--------**	**--------**
				Result	----	----	----	----
EA101: Loss on Ignition								
Loss on Ignition @ 550°C	----	0.1	%	**7.1**	**----**	**----**	**----**	**----**

Annexure DJ
Laboratory Test Procedures

Simple Shear – Rigid Boundary Laboratory Testing Procedure

Document Number: FAM-18552

Responsible Person: APAC Director of GeoConsulting

3	Issued for Use	Surendra Rajkarnikar Laboratory Engineer	Terry Chang Laboratory Manager	David Williams APAC Director of GeoConsulting	22/05/2018
Rev	**Description**	**Prepared**	**Checked**	**Approved**	**Date**

RECORD OF CHANGES

Revision	Reason for Change	Page Number(s)
3	■ Updated formatting to Fugro Standard ■ Updated references	■ Throughout ■ Throughout
2	Review and updated	
1	OpCo removed and replaced with Fugro	

CONTENTS

1. OBJECTIVES

This procedure sets out methods for simple shear tests (monotonic, creep and cyclic) on undisturbed and reconstituted samples using the two different types of rigid boundary type simple shear apparatus at the Fugro Advanced Geotechnical Laboratory (AGLab) (namely Geocomp and Geojac). In these apparatus the specimen is confined using stack of rings. The test shall be conducted in a temperature controlled environment.

2. SCOPE

This test procedure applies to tests carried out in AGLab and field laboratories under AGLab control. Use Simple Shear Mono Static SS - (Geojac) Test Worksheet (FAM-18184), Simple Shear Mono Static - (GeoComp) Test Worksheet (FAM-18206), Simple Shear Mono Static SS - (Geojac) Creep Test Worksheet (FAM-18180) in conjunction with this procedure.

3. RESPONSIBILITIES

AGLab Manger

The AGLab Laboratory Manager has the responsibility to ensure that this procedure will be carried out by a trained and competent operator in accordance with the AGLab Laboratory Manual (FAM-17562).

Test Operator

The Test Operator has the responsibility to comply with this test procedure and where applicable the related processes and procedures stated in the AGLab Procedures Manual (FAM-17563).

4. APPARATUS

i. Normal loading device for applying normal load to the sample which is capable of maintaining constant load during the consolidation phase of a test, and allow continuous adjustment of displacement/load during shearing such that the specimen change in height is not more than 0.05% when using either active or passive height control;

ii. Horizontal loading device for applying load to the specimen with sufficient capacity and control to deform the specimen at the required rate of displacement;

iii. Two load cells, one for measuring normal load and one for measuring shear load, with an accuracy of ±1% of the applied maximum load for a given test;

iv. Two displacement measuring devices, one for vertical displacement and one for shear displacement, with an accuracy of at least 0.25% of full range;

v. Rigid stacked rings for providing lateral confinement to the sample. The thickness of the individual stacked rings is less than 1/10th of the specimen thickness in order to allow relatively uniform shear deformation;

vi. Water bath or burette, which stores distilled water for supplying water to the sample;

vii. A base pedestal and a top cap with drainage outlets of the same diameter as the test specimen;

viii. The top end cap is designed to have a central seating to connect to the axial load cell mounted to the loading ram;

ix. A shear slide table (base carrier) to hold the base pedestal, which allows at least 30% shear strain;

x. Guide to align the top cap during sample preparation, if required;
xi. Top and bottom skirting rings, which are designed to securely hold the specimen and transfer shear to the specimen without horizontal slippage at the interface;
xii. Porous discs with diameter slightly smaller than the specimen diameter and can be recessed into the top cap and base pedestal such that the contact interface is flush with the edge of the cap;
xiii. Filter paper of same diameter as the test specimen;
xiv. Seamless rubber membrane of internal diameter equal to or slightly less than the specimen diameter;
xv. O-rings of internal diameter slightly smaller than the diameter of the end caps;
xvi. Membrane stretcher and O-ring placing tool;
xvii. Trimming devices, e.g. cutting ring, wire saw, or spatulas;
xviii. Apparatus for determination of moisture content as described in AS1289.2.1.1;
xix. Balance with a limit of performance not greater than 0.1% of the specimen mass or 0.05g whichever is greater;
xx. Measuring device with a precision of not less than 0.1 mm.
xxi. Compaction mould with an extension collar and of the same internal diameter as the specimen;
xxii. Spacer plug with diameter slightly smaller than the specimen diameter, to which a removable lifting handle can be fitted.

5. RELATED DOCUMENTS

5.1 References

Title	Document No.
ASTM Standard: Standard Test Method for Consolidated Undrained Direct Simple Shear Testing of Cohesive Soils.	ASTM D6528-07
Australian Standard: Methods of testing soils for engineering purposes - Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (standard method)	AS1289.2.1.1-2005
Australian Standard: Methods of Testing Soils for Engineering Purposes – Definitions and General Requirements	AS1289.0-2014
AGLab Procedures Manual	FAM-17563
AGLab Laboratory Manual	FAM-17562

5.2 Records

Title	Document No.	Responsibility	Retention Period
Geojac Mono Blank Test Worksheet	FAM-18184	Laboratory Manager	7 Years
Simple Shear GeoComp Blank Test Worksheet	FAM-18206	Laboratory Manager	7 Years
Simple Shear Geojac Creep Blank Test Worksheet	FAM-18180		
Test Report	AGLab report	Laboratory Manager	7 Years

5.3 Superseded Documents

This document has been prepared and approved as part of the Fugro APAC BMS implementation. This document is a consolidation of similar pre-existing Fugro APAC Service Line specific process and does not introduce significant change to the BMS of Fugro operations within APAC. Documentation incorporated into, and superseded by this Procedure are:

- Simple Shear – Rigid Boundary Laboratory Testing Procedure (aL-PT45)

6. SAMPLE TESTING

The following describes the sample preparation method for simple shear using stacked rings confining system. The sample diameter can be between 45 mm and 80 mm, and the minimum height shall be 14 mm. The height to diameter ratio shall not exceed 0.4.

6.1 Undisturbed Sample

i. If required, the sample will be X-rayed prior to testing to check for suitability;
ii. Extrude sufficient material from the sampling tube to prepare the test sample.
iii. Gently push the cutting ring along the axis of the sample until the ring is fully embedded into the sample. Trim off the excess material so that the sample is flush with the edges of the ring by using appropriate trimming devices. Ensure that both the top and bottom ends of the specimen are trimmed flush with the ring;
iv. Measure and record the weight of the specimen and the cutting ring to the nearest 0.01 g;
v. Measure and record the diameter and height of the specimen to the nearest 0.01 mm;
vi. Determine the initial moisture content from the excess material trimmed off from the specimen in accordance with AS1289.2.1.1.
vii. Place a saturated porous disc and moist filter paper on the base pedestal. Gently push the test specimen from the ring to the base pedestal. After that, place the second porous disc and moist filter paper on top of the specimen followed by the top end cap. Sample preparation guide should be used to align the top and bottom caps, if applicable.
viii. Using the membrane stretcher and O-ring placing tool, place the rubber membrane around the specimen, using O-rings to seal the membrane to the base pedestal;
ix. Gently lower the skirting ring over the specimen until it rests on the O-ring, ensuring that the skirt protrudes at least 2-3 mm from the soil surface. Place the stack of smooth Teflon coated rings around the sample followed by the top skirting ring. The total thickness of the stacked rings should be such that at the end of consolidation, the top soil surface should be at least 2 mm above stacked rings. Use an O-ring to seal the membrane to the top end cap. Lock the stacked rings using locating pins;

6.2 Reconstituted Sample

There are a number of methods to prepare a reconstituted specimen.

6.2.1 Compaction Method

This method can be used for different types of materials (both find and coarse grained materials) and generally includes:

i. Determine the dry density and moisture content required to prepare the sample;
ii. Determine the total weight of specimen required, adding an extra 10% for initial moisture content determination;
iii. Measure and record the height, internal diameter, to 0.01mm and the weight of the compaction mould, to 0.01g;

iv. Measure the depth of the extension collar, and the thickness of the spacer plug, to 0.1 mm. The thickness of the spacer plug should be equal to the depth of the extension collar. Fit the collar securely to the top of the mould.
v. Place a saturated porous disc and moist filter paper on the base pedestal;
vi. The material will be placed into the mould in three layers. Place one portion of the material into the mould. Compact the soil using a tamping rod until the thickness of material is about one-third of the height of the mould. The top surface of the compacted layer must be scarified before adding the next layer. Add another portion of the material to form a second layer and compact the soil until the height is about two-third of the height of the mould. Finally, add the last portion of the material into the mould, followed by the spacer plug. Compact the sample until the top of the plug is flush with the top of the collar.
vii. Remove the spacer plug and extension collar from the mould. Trim off the excess material so that the test specimen is flush with the edges of the mould by using appropriate trimming devices.
viii. Measure and record the weight of the specimen and the mould to the nearest 0.01g;
ix. Determine the initial moisture content from the leftover material in accordance with AS1289.2.1.1.
x. Transfer the test specimen to the base pedestal as described in clause 6.1 (vii) to 6.1 (ix).

6.2.2 Slurry Consolidation Method

This method can be used to reconstitute fine-grained specimens, e.g. silts and clays.

i. Sample can be prepared from undisturbed or disturbed materials;
ii. Mix material thoroughly by adding water until the mixture is homogenous and forming a thin paste;
iii. Apply vacuum to remove the entrapped air from the sample;
iv. Pour the slurry into a stainless steel tube with two-way drainage, ensuring that there is no entrapped air bubbles in the sample;
v. Allow the sample to settle on its own weight until no further settlement occurs;
vi. Apply a small seating load (1 to 2 kPa) to the sample and allow it to settle until no further settlement occurs;
vii. Apply load increments such as to double the previous load until final consolidation pressure is achieved. In each loading stage, allow the sample to consolidate before adding the next increment;
viii. On completion of the consolidation, the specimen is extruded from the tube. Prepare the specimen in accordance to steps specified in clause 6.1 (Undisturbed sample)

6.2.3 Vibration Method

This method can be used for oven-dried or wet granular material.

i. Place a porous disc and a filter paper on the base pedestal and a rubber membrane around the base pedestal. Use O-rings to seal the membrane to the base pedestal;

ii. Lower the skirting ring over the base pedestal until it rests on the O-ring. Place the stack of smooth Teflon coated rings on top of the bottom skirting ring, followed by the top skirting ring. The total thickness of the stacked rings should be such that at the end of consolidation, the top soil surface should be at least 2 mm above the stacked rings. Lock the stacked rings using locating pins;
iii. Fully stretch and fold the membrane over the top of skirting ring such that the surface of membrane is smooth and wrinkle free;
iv. Measure the diameter and required height of the mould assembly to the nearest 0.1 mm;
v. Attach the mould assembly to the vibrating table.
vi. Determine the total mass of material required to the prescribed density to the nearest 0.01 g. Adding an extra 10% for initial moisture content determination;
vii. Pour all the material into the empty space contained by membrane and stacked rings, followed by the spacer plug and the surcharge;
viii. Vibrate the sample with surcharge weight until the required height is reached. Amplitude of vibration should be selected in such a way that he target density is achieved within a few minutes without violent shaking;
ix. Gently remove the spacer plug from the specimen. Put the filter paper and porous stone, followed by the top end cap on top of the specimen;
x. Fold up the membrane around the top end cap and seal with O-rings

7. PROCEDURE

7.1 Sample Set Up

i. Transfer the sealed specimen to the base carrier of the machine. Lock the base pedestal to the base carrier. Lower the vertical loading ram and connect it to the top end cap.

ii. For system using water bath (e.g. Geocomp machine) for supplying water to the specimen, inundate the specimen with water by filling the water bath with distilled water to the level of specimen height;

iii. For system using burette (e.g. Geojac machine) for supplying water to the specimen, attach flow tubing or drainage lines to base pedestal and top end cap. Add distilled water to burette. Flush water through the specimen using a small head difference equivalent to about 3 kPa until all visible air has been removed from the drainage lines. Adjust the position of the drainage pipes to equalise the top and bottom pressures;

iv. Start the DSS test program and input specimen details, test details and test parameters. Note that the test is performed using a semi-automated system for test control and data acquisition, which allows the user to define the test conditions by entering the specimen information and test parameters into the system. Set the interval of readings to be taken. Ensure that all the readings (loads and displacements) are recorded by the data logger

7.2 Consolidation

i. Set the target consolidation pressure and consolidation time target. Ensure that the consolidation time is sufficiently longer for the sample to fully consolidate.

ii. Start the test;

iii. Observe the vertical displacement change when the target pressure is reached. Allow the specimen to be fully consolidated before proceeding to the next step. Taylor’s root time plot method is monitored to ensure that the specimen is fully consolidated

7.3 Monotonic Shear

i. For Geojac system, lock the vertical loading ram into fixed position to maintain constant specimen height;

ii. Remove the pin from the stacked rings;

iii. Specify the strain rate and maximum displacement (or strain limit);

iv. Start the test and shear the specimen at the preselected shear rate in the specified direction;

v. The test is continued until the stopping criteria or limit of machine is reached, whichever occurred first

7.4 Creep Test

Creep is time dependent shear deformation caused by constant shear stress. The test is performed by having a sustained shear stress on the specimen and measuring the shear strain against time. (**Note: The following procedure is only applicable for Geojac machine using Digishear software**).

i. Calculate the target shear load where the creep test to be performed;
ii. Program a data acquisition schedule in the system (manual mode) based on time, which will be used for creep data processing;
iii. Stop consolidation phase.
iv. Remove the pin from the stacked rings;
v. In the 'Shear' mode interface, specify the strain limit and a very small displacement rate to ensure that the height is maintained during creep. The displacement rate selected should be small enough and does not cause significant effect on the test;
vi. In the load control tab of Horizontal axis window (manual mode), using the load control feature, specify target shear load and required ramp time;
vii. Start the time based data acquisition (manual mode);
viii. Click the "Start" button on the "Shear" mode interface to begin the dummy shear test;
ix. Click the "Start" button on the Horizontal axis window (manual mode) to begin the creep test;
x. In this phase, the specimen will be sheared at the preselected ramp time until target shear load is reached. The specimen will then be allowed to creep while maintaining the shear load constant;
xi. The test is continued until there is no horizontal movement or the specified strain limit is reached

7.5 Cyclic Shear Test

Cyclic shear test consists of cyclic shearing phase and post-cyclic monotonic shearing phase. (**Note: The following procedure is only applicable for Geocomp system**).

7.5.1 Cyclic Shearing

i. Cyclic shearing can be either stress controlled or displacement controlled. The test information required for a cyclic test include:
   a. Number of cycles.
   b. Frequency or cycle period;
   c. For stress controlled mode, specify the cyclic stress ratio and the strain limit to be applied, .
   d. For displacement controlled mode, specify the cyclic strain and the minimum stress ratio to be applied.
   e. The termination criteria could be maximum number of cycles, or either maximum strain limit (for stress cyclic) or the minimum stress ratio (for strain cyclic), whichever occurs first.
   f. Start the test. The test is continued until the stopping criteria or limit of the machine is reached.

7.5.2 Post – Cyclic Monotonic Shearing (Optional)

i. In this phase, the specimen is sheared monotonically after the cyclic shearing phase;
ii. Specify the strain rate and maximum displacement (or strain limit) required for the test;
iii. The test is continued until the stopping criteria or equipment limit is reached

7.6 Sample Removal

i. Disconnect cell from vertical loading ram. Release vertical and horizontal loads.
ii. Dismantle the setup and remove the specimen from the machine.
iii. Take photographs of the tested sample.
iv. Determine final moisture content by taking a portion of material from the specimen in accordance with AS1289.2.1.1.

8. CALCULATION

Calculate the initial density, ρ_t of the specimen:

$$\rho_t = \frac{1000\ m_o}{H_o A_o} \quad (1)$$

where

ρ_t	=	Initial density of the specimen, in t/m^3
m_o	=	Initial mass of specimen, in grams
H_o	=	Thickness of the specimen, in mm
A_o	=	Cross-sectional area of the specimen, in mm^2 $A_0 = \frac{\pi D_0^2}{4}$
D_o	=	Diameter of the specimen, in mm

Calculate the initial dry density, ρ_d of the specimen:

$$\rho_d = \frac{100\ \rho_t}{100 + w_o} \quad (2)$$

where

ρ_d	=	Initial dry density of the specimen, in t/m^3
w_o	=	Initial moisture content of the specimen, in percent.

Calculate axial strain, ε_a, for a given applied load:

$$\varepsilon_a = \frac{\Delta H}{H} . 100 \quad (3)$$

where

ε_a	=	Axial strain, in %
ΔH	=	Change in height of the specimen, mm
H	=	H_o, initial height of specimen during consolidation phase calculation, mm
H	=	H_f, Height of specimen after consolidation during shear phase calculation, mm

Calculate shear strain, γ, for a given applied load:

$$\gamma = \frac{\Delta L}{H_{eff}} .100 \quad (4)$$

where

γ	=	Shear strain, in %
ΔL	=	Change in horizontal displacement, mm
H_{eff}	=	Total height of specimen between stacked rings

Calculate the vertical stress, σ_v, for a given applied load:

$$\sigma_v = \frac{1000\ F}{A} \tag{5}$$

where

F	=	Measured applied vertical load, N.
A	=	Cross-sectional area of the specimen, in mm^2

Calculate the shear stress, τ_{xy} for a given load:

$$\tau_{xy} = \frac{1000\ F_h}{A} \tag{6}$$

where

τ_{xy}	=	Shear stress, kPa
F_h	=	Measured applied horizontal load, N.
A	=	Cross-sectional area of the specimen, in mm^2

Calculate stress ratio for a given load:

$$\text{Stress ratio} = \frac{\tau_{xy}}{\sigma_v} \tag{7}$$

where

Stress ratio	=	Stress ratio based on horizontal (xy) plane
σ_v	=	Vertical stress, kPa

Calculate the excess pore water pressure, Δu:

$$\Delta u = \sigma_{vo} - \sigma_v \tag{8}$$

where

σ_{v0}	=	Initial vertical stress, kPa
σ_v	=	Vertical stress during shearing, kPa

9. TEST REPORT

9.1 General

The following results and general information are reported:

i. Project title and client;
ii. Date of test;
iii. Laboratory where the test was performed;
iv. Identifying number of specimen (i.e. client's identifying number, laboratory sample id, etc.);
v. Reference to this procedure

9.2 Standard Reporting for Sample Details and Consolidation Phase

i. Initial and final moisture content to 0.1%;
ii. Initial dry density, of the specimen to 0.01 t/m^3;
iii. Initial specimen diameter and height to 0.1 mm.
iv. Consolidation stress (kPa).
v. For consolidation phase:
   a. Plot of vertical stress against time;
   b. Plot of axial strain against time

9.3 Standard Reporting for Monotonic Shear Test

i. Shearing rate (mm/min), for monotonic test.
ii. Plot of shear stress against shear strain;
iii. Plot of stress ratio against shear strain;
iv. Plot of vertical stress against shear strain;
v. Plot of pore pressure against shear strain;
vi. Plot of shear stress against effective vertical stress

9.4 Standard Reporting for Creep Test

i. Creep stress, in kPa
ii. Plots of shear stress against time (during ramping stage and for the whole duration of the test);
iii. Plots of shear strain against time (during ramping stage and for the whole duration of the test);
iv. Plots of normal stress against time (during ramping stage and for the whole duration of the test).

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)

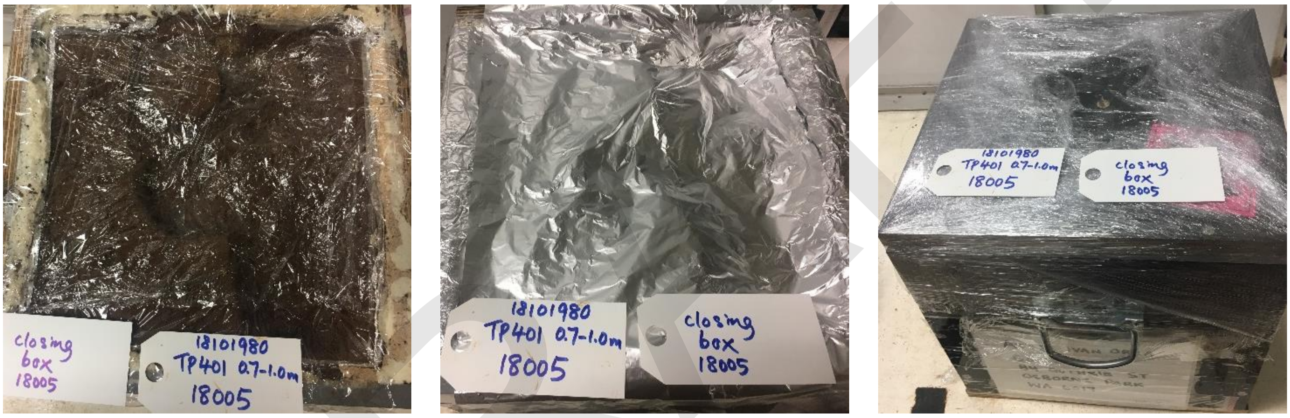


Figure 6: Wrapping and sealing block sample after coring

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.

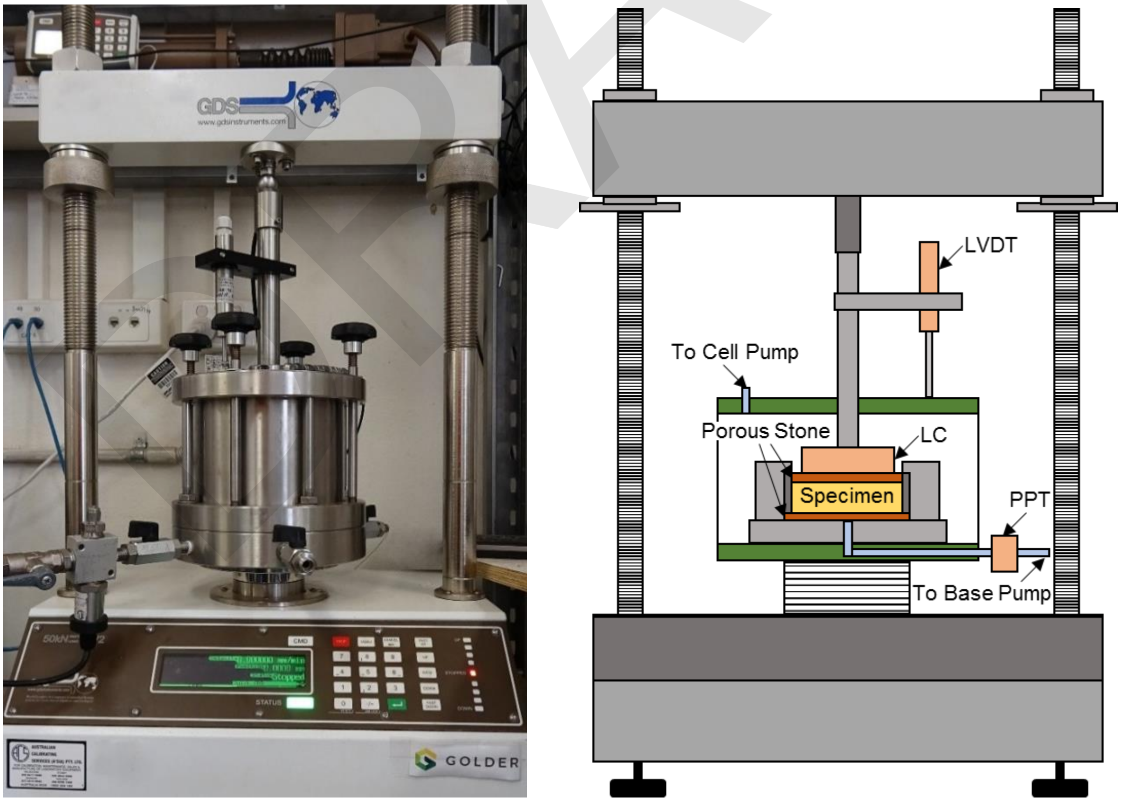


Figure 1: GDS load frame with stainless-steel CRS cell (left) and schematic of CRS testing device (right)

[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.

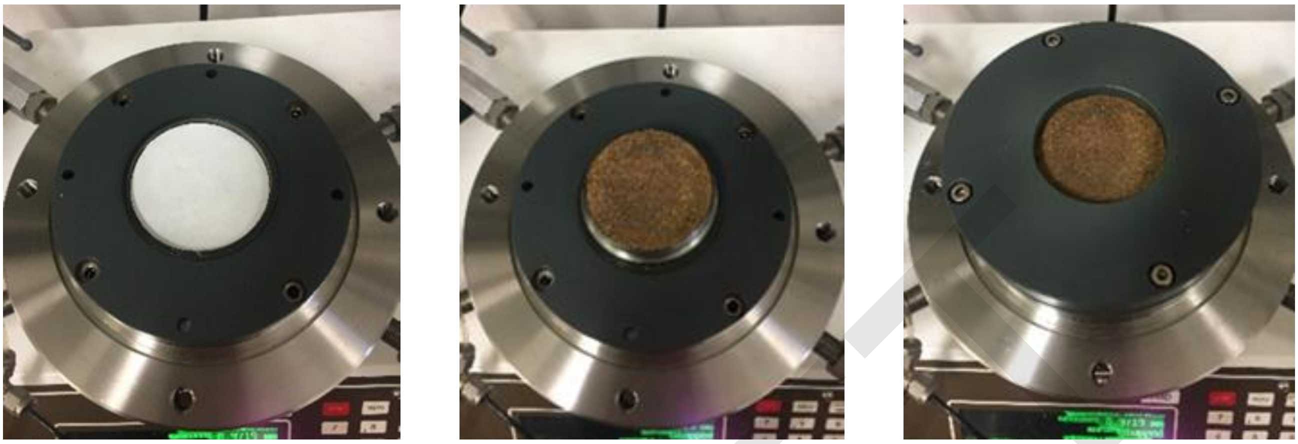


Figure 2: CRS test device setup: base porous stone and filter paper (left), specimen in stainless-steel ring with top porous stone and filter paper (middle), sealing components assembled (right)

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)

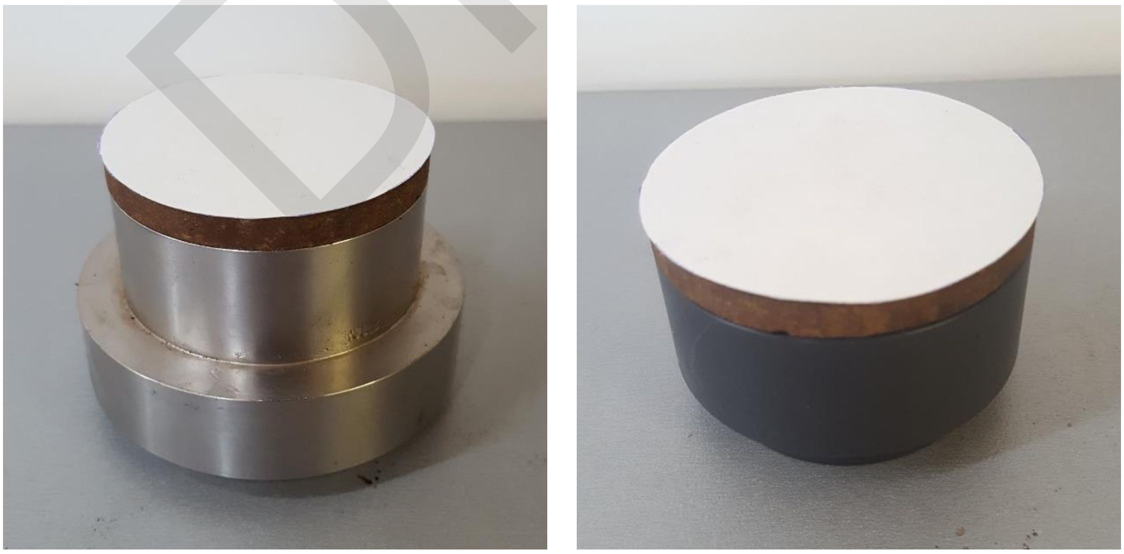


Figure 2: Standard triaxial end caps with porous stones and filter papers

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

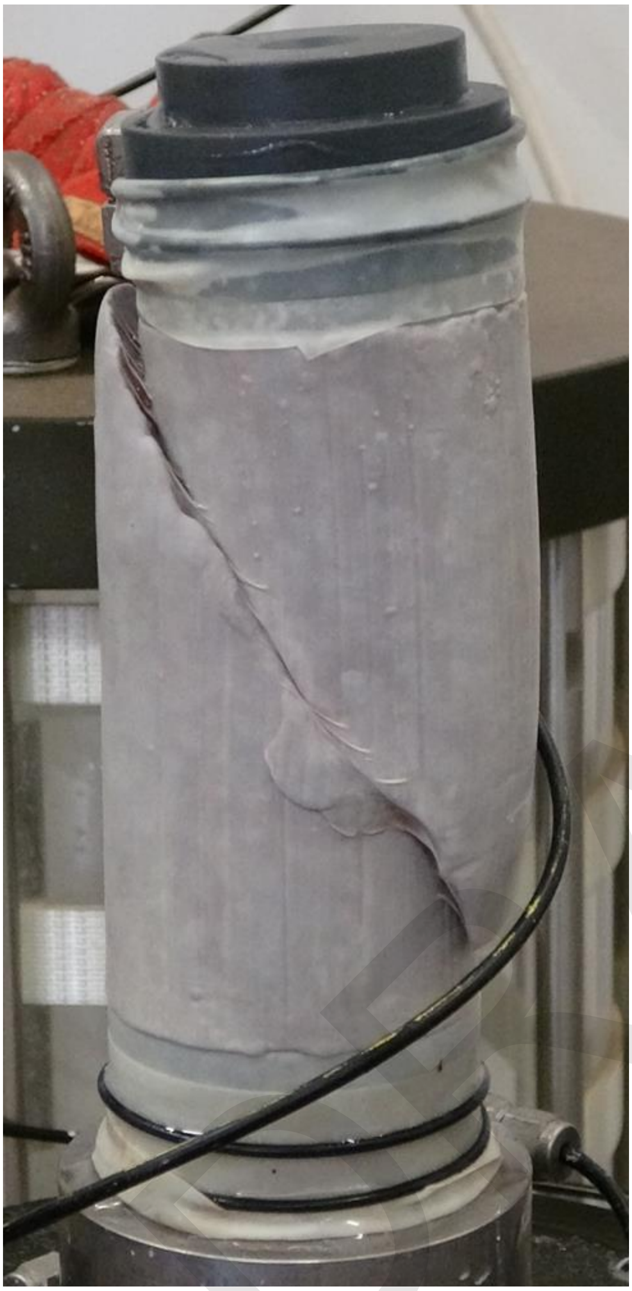


Figure 2: End of test typical deformed specimen with a slip plane

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.

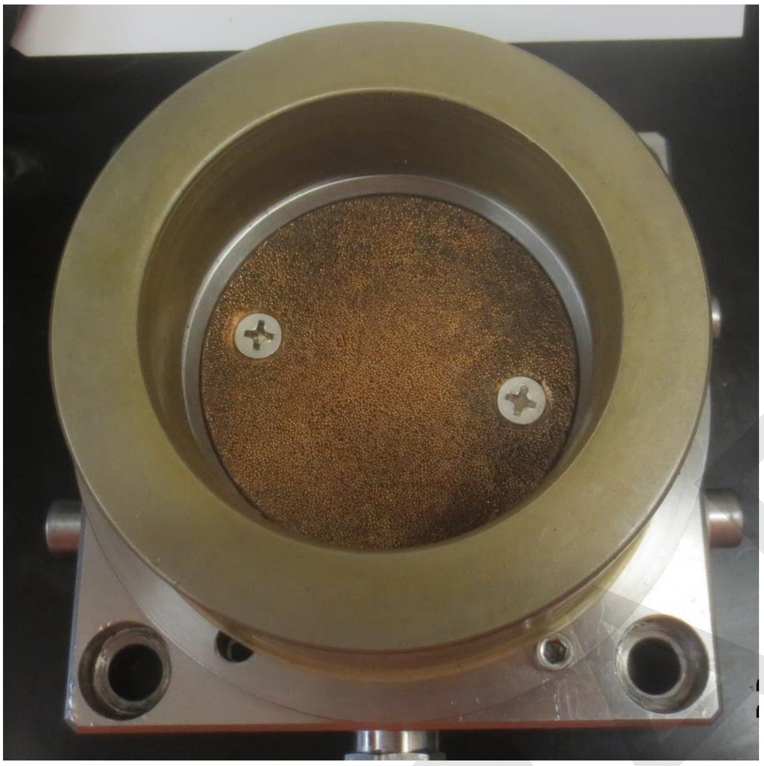


Figure 2: DSS prepared with rings and membrane

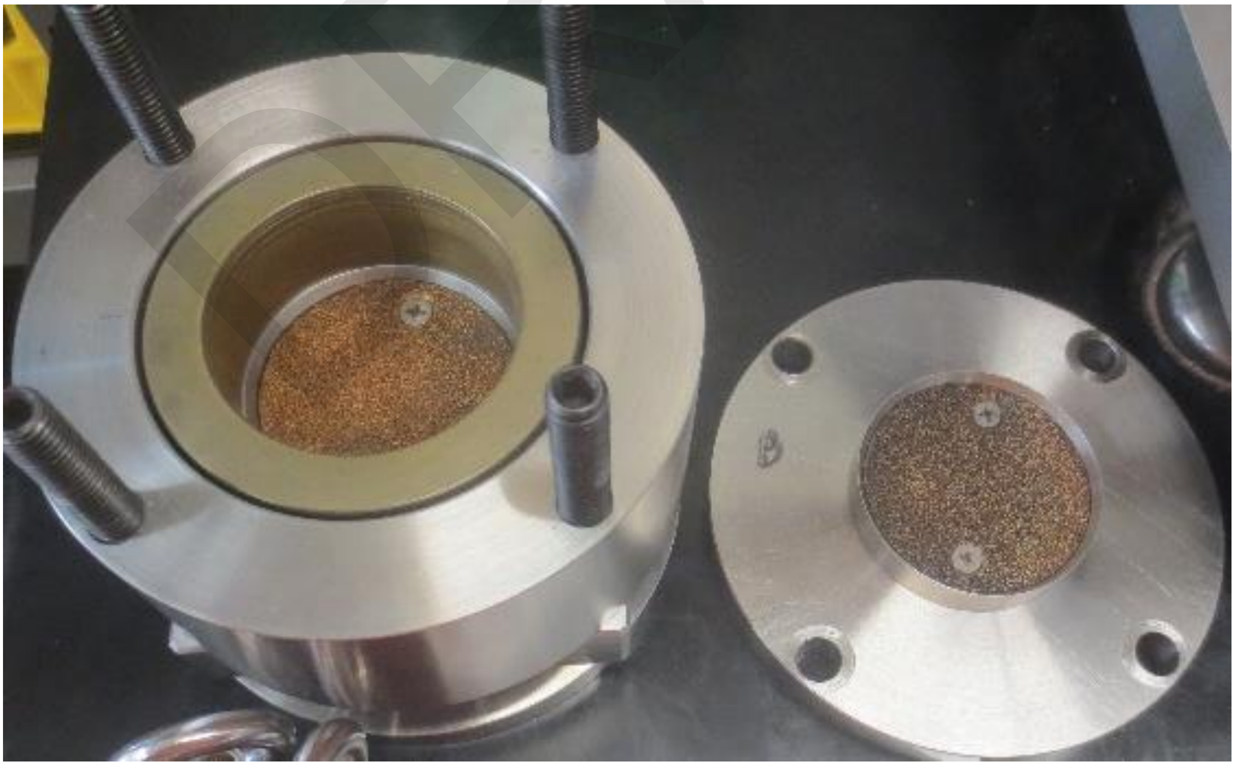


Figure 3: DSS bolted to the base of mould (left) and top end platen attached to top cap of mould (right)

Figure 4: DSS specimen inside compactor mould: before compaction (left) and after compaction (right)

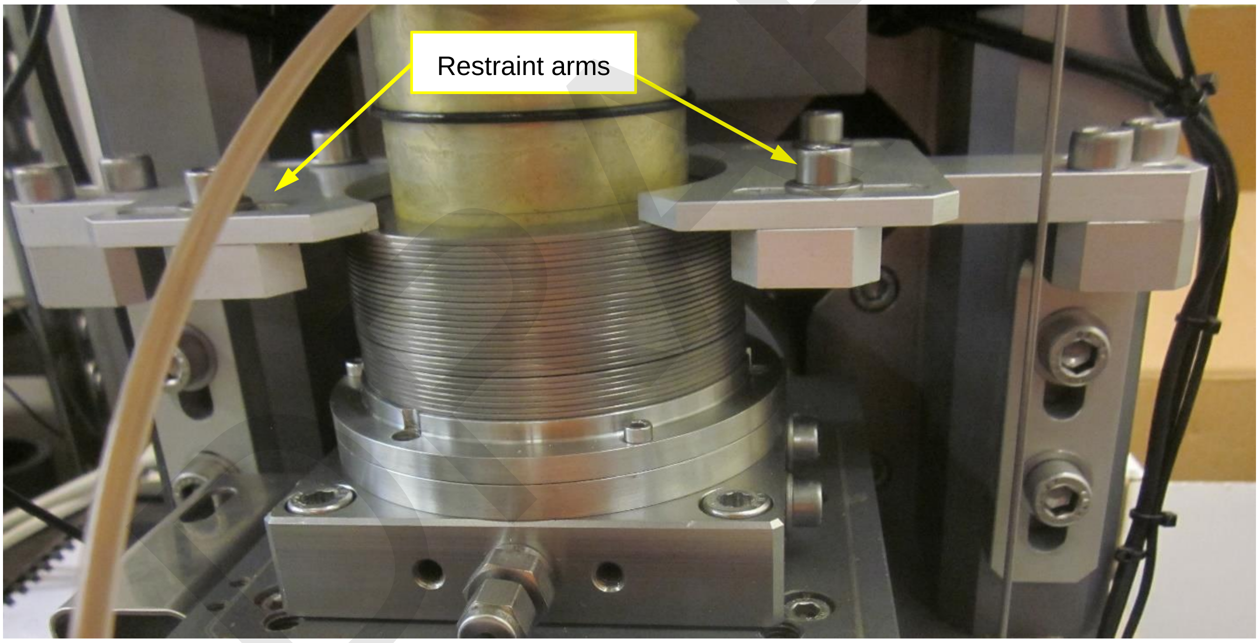


Figure 5: DSS device assembled with restraint arms mounted

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

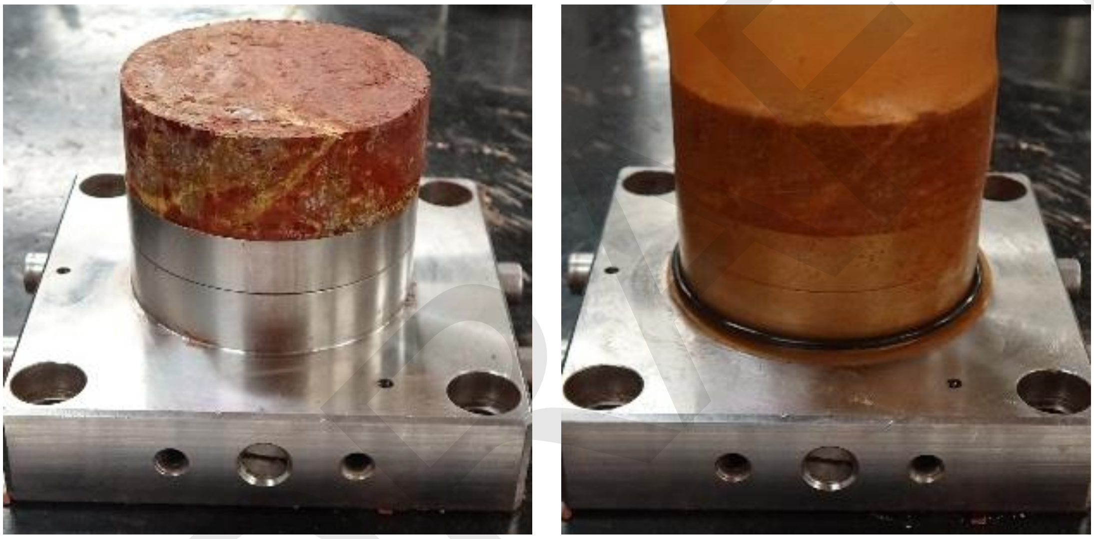


Figure 3: Trimmed specimen on DSS base platen (left) and covered with membrane (right)

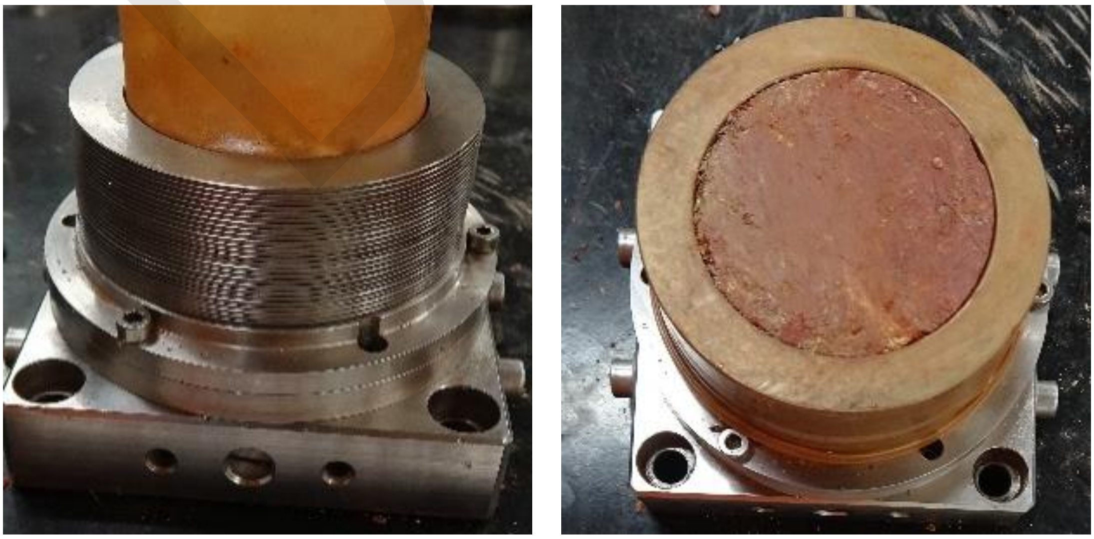


Figure 4: DSS rings in place (left) and membrane folded outwards for DSS device assembly (right)

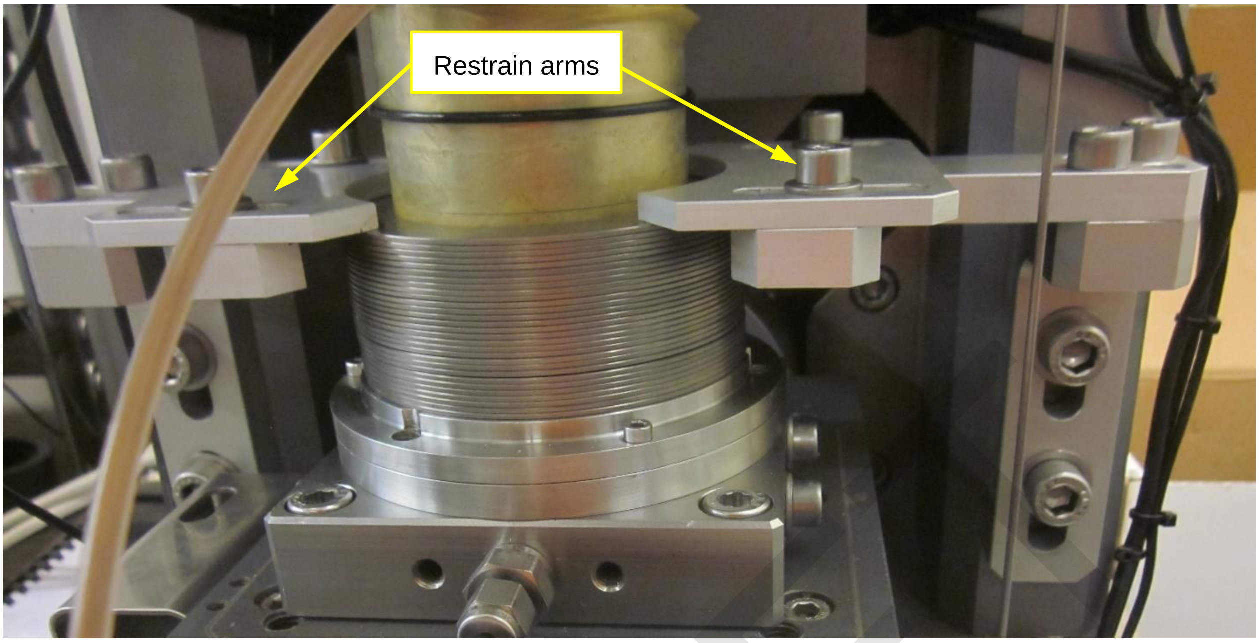


Figure 5: DSS device assembled with restrain arms mounted

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.

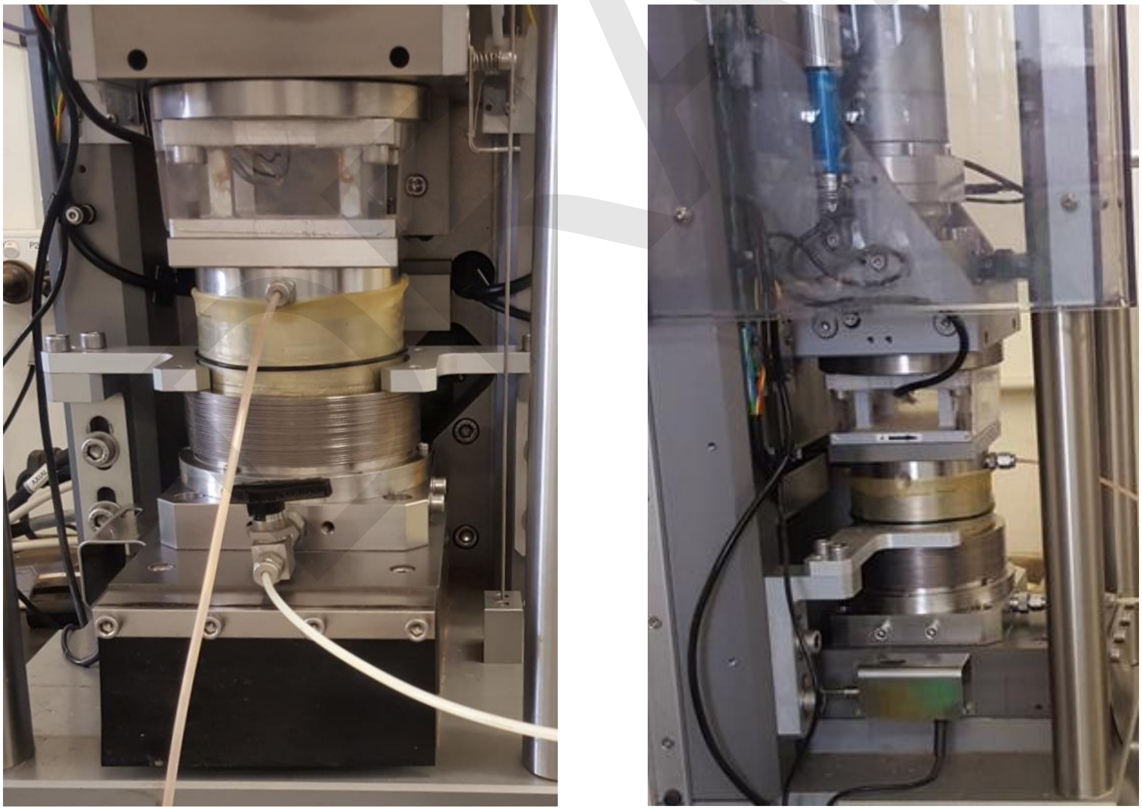


Figure 1: GDS electro-mechanical DSS device

[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).

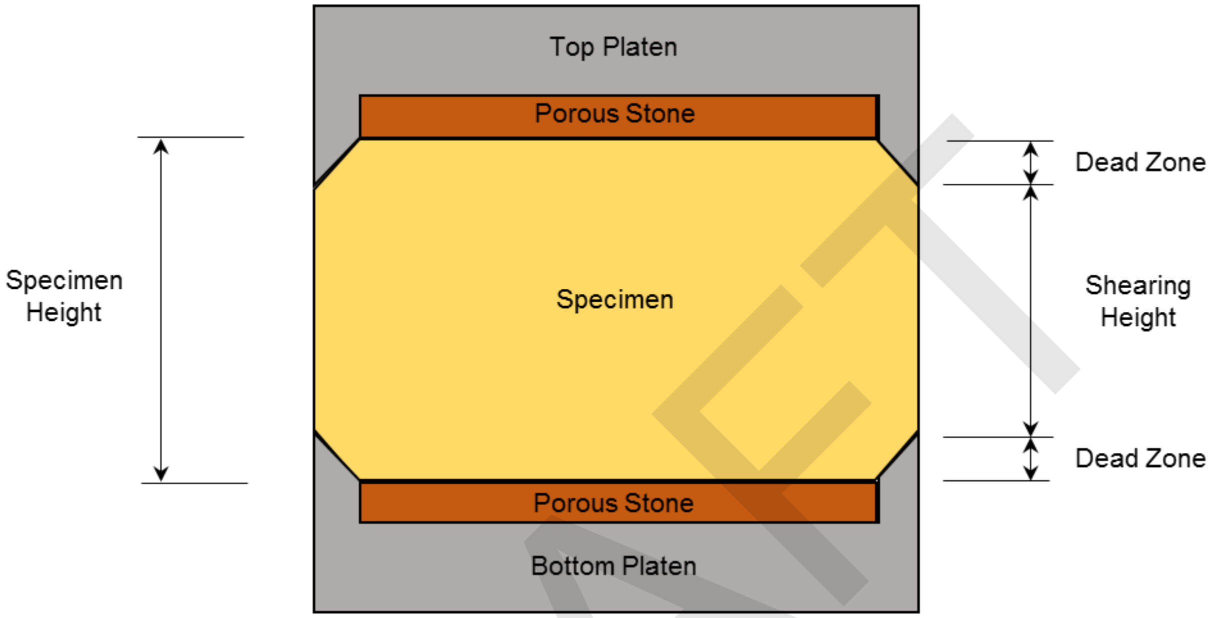


Figure 2: Schematic of DSS specimen between dead zone end platens

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.

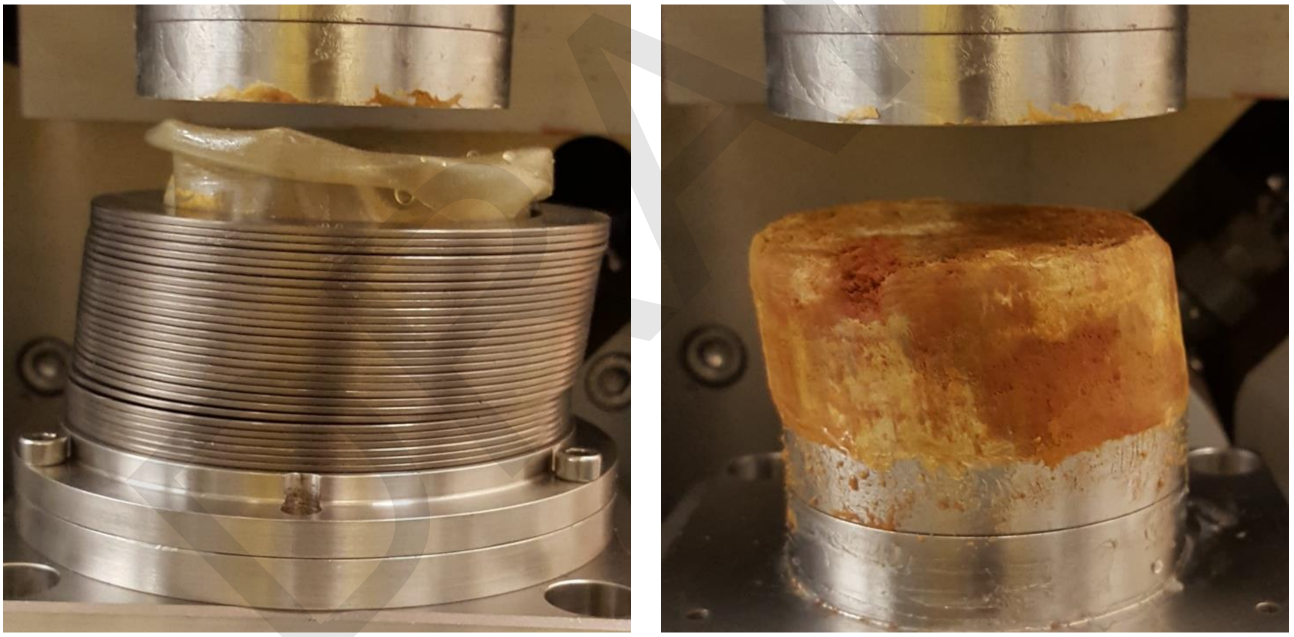


Figure 4: End of test specimen

[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.

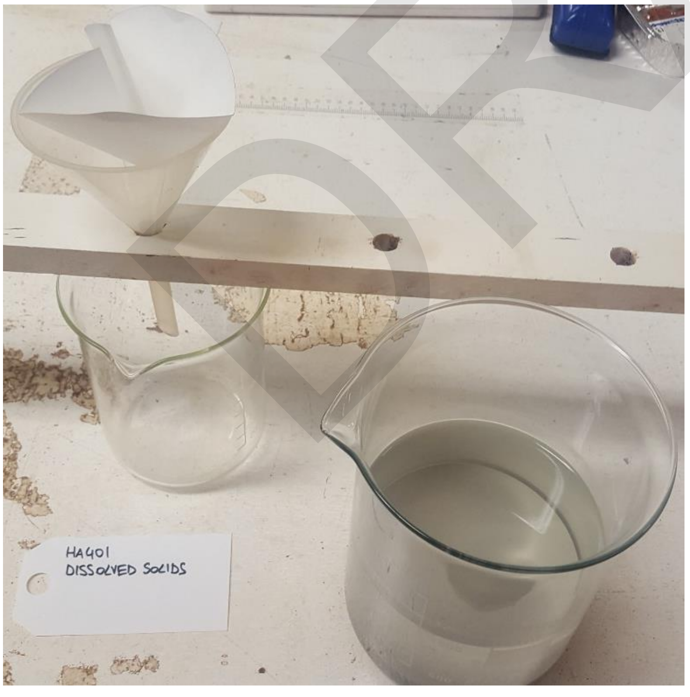


Figure 1: Filter-funnel setup and specimen before decanting

[1] GAPMW 1.1.2 Bulk Sample Preparation

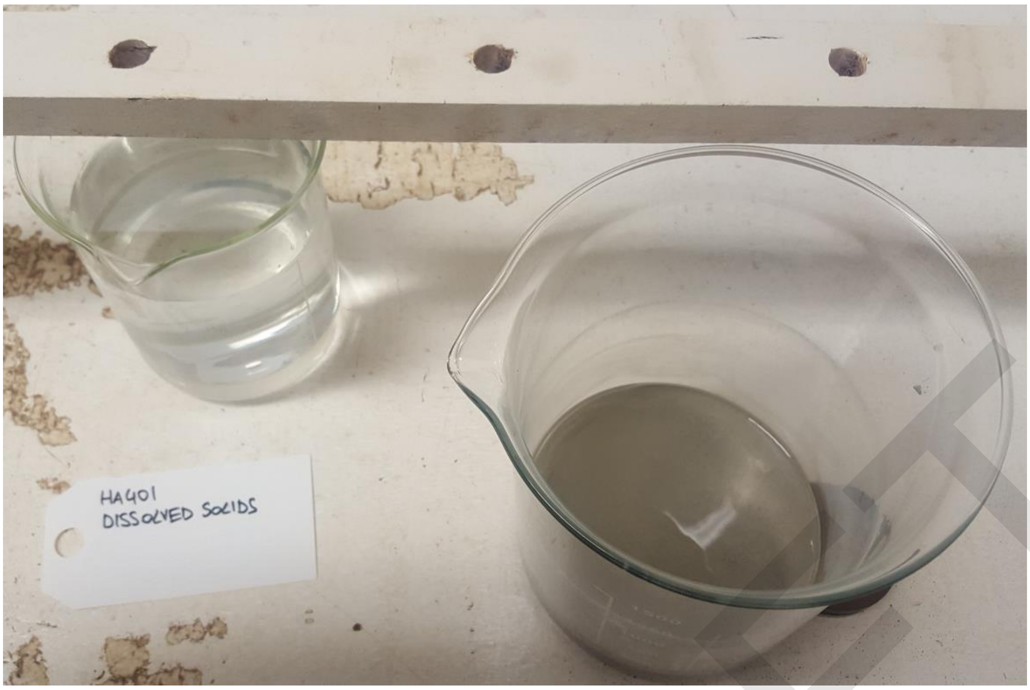


Figure 2: Decanted clear solution and specimen after decanting

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.

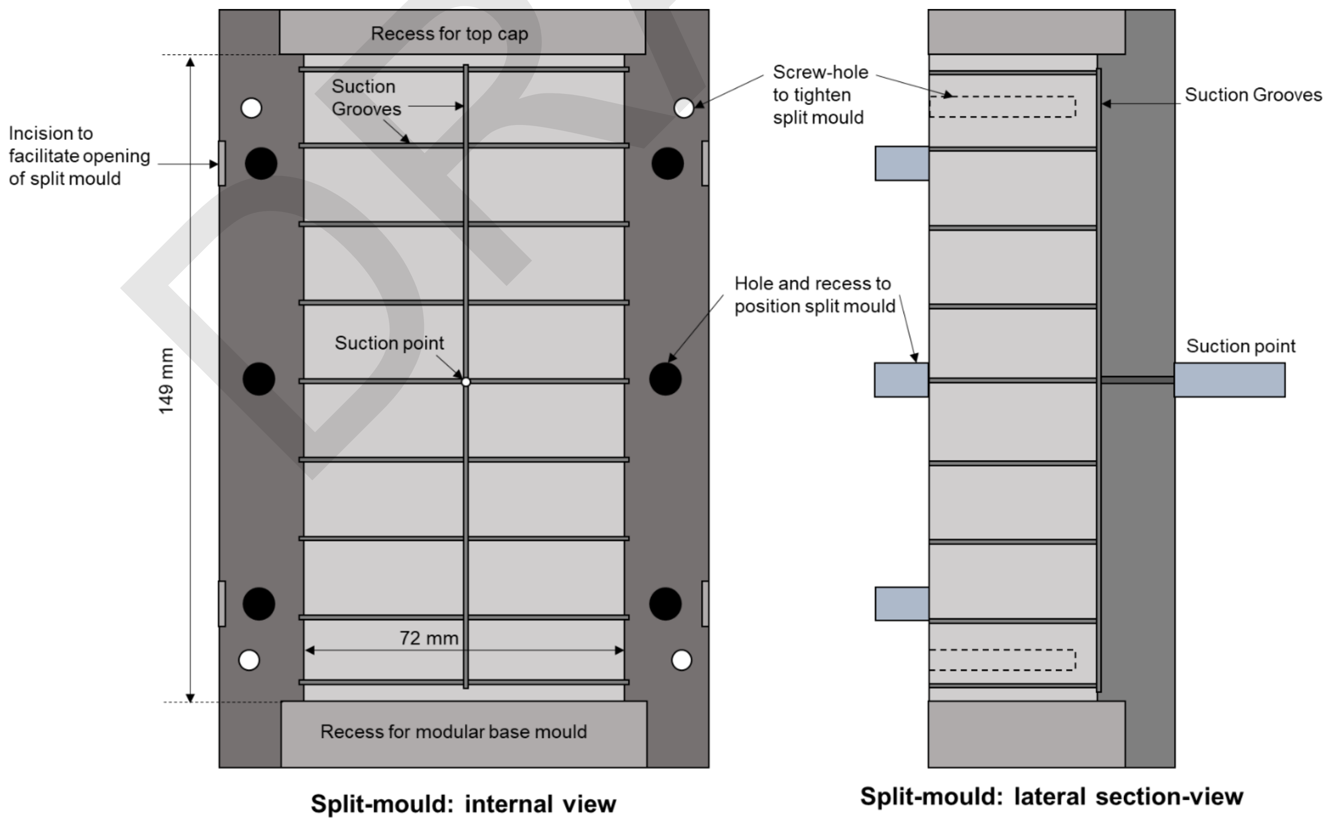


Figure 1: Split mould schematic view

Figure 2: Split mould internal (left) and external view (right)

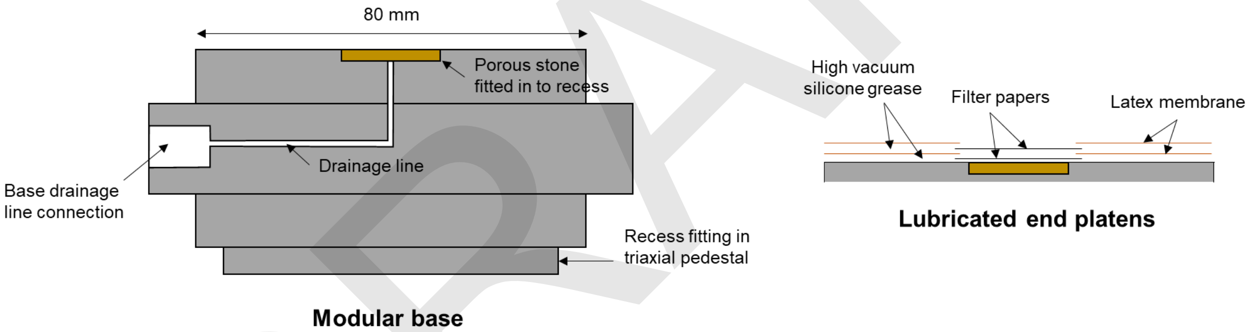


Figure 3: Modular base (left) and lubricated end platens (right)

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.

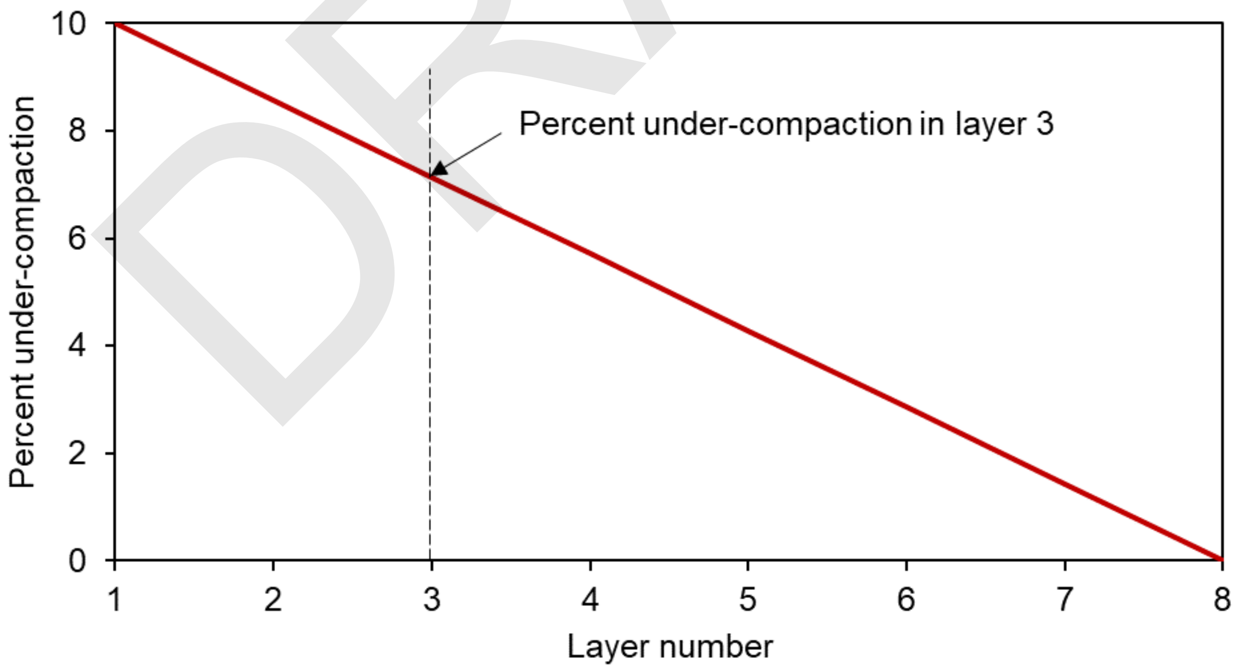


Figure 5: Under-compaction percent used for tamping of the loose specimens

[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.

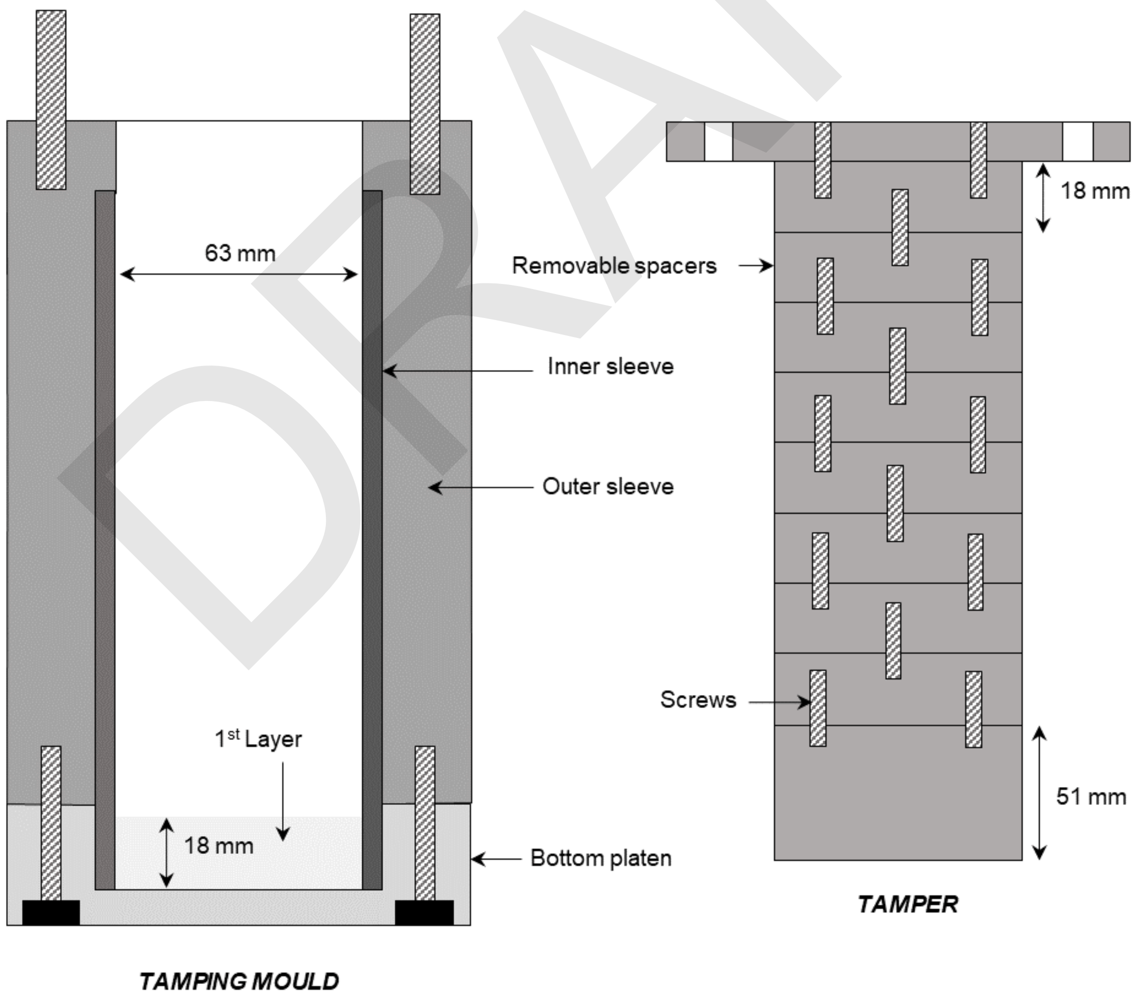


Figure 1: Tamper schematic view

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)

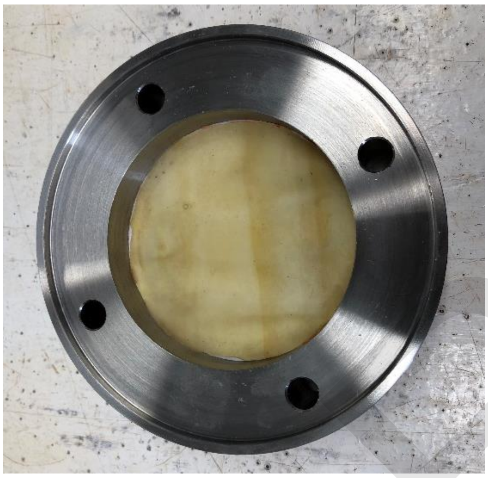


Figure 3: Mould base platen with sandwich of paper filter, latex membrane and paper filter at its bottom

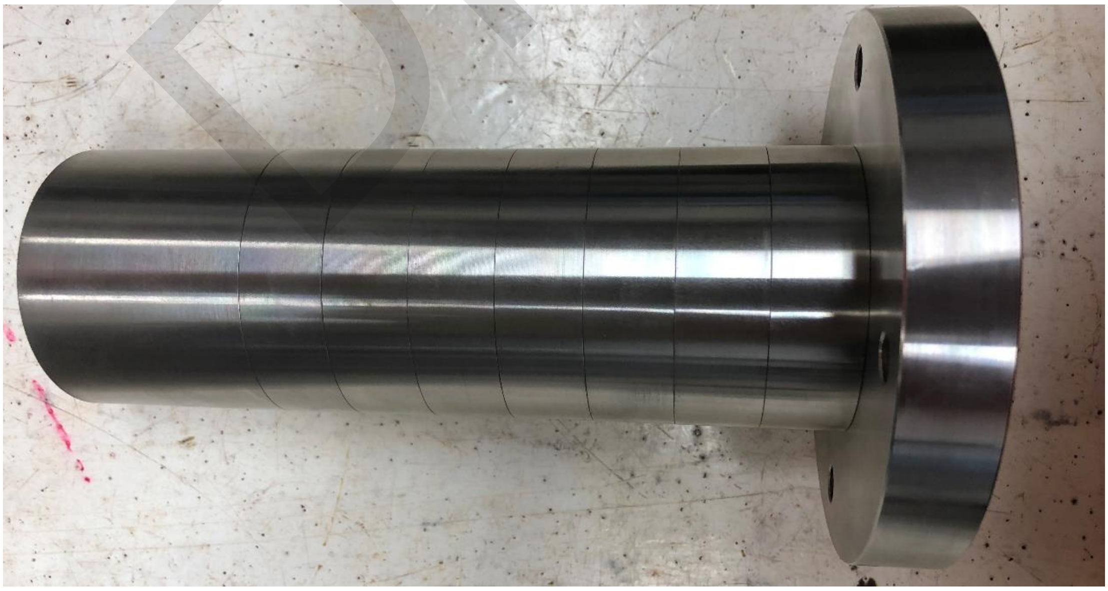


Figure 4: Tamper with top platen to allow controlling the tamping height

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.

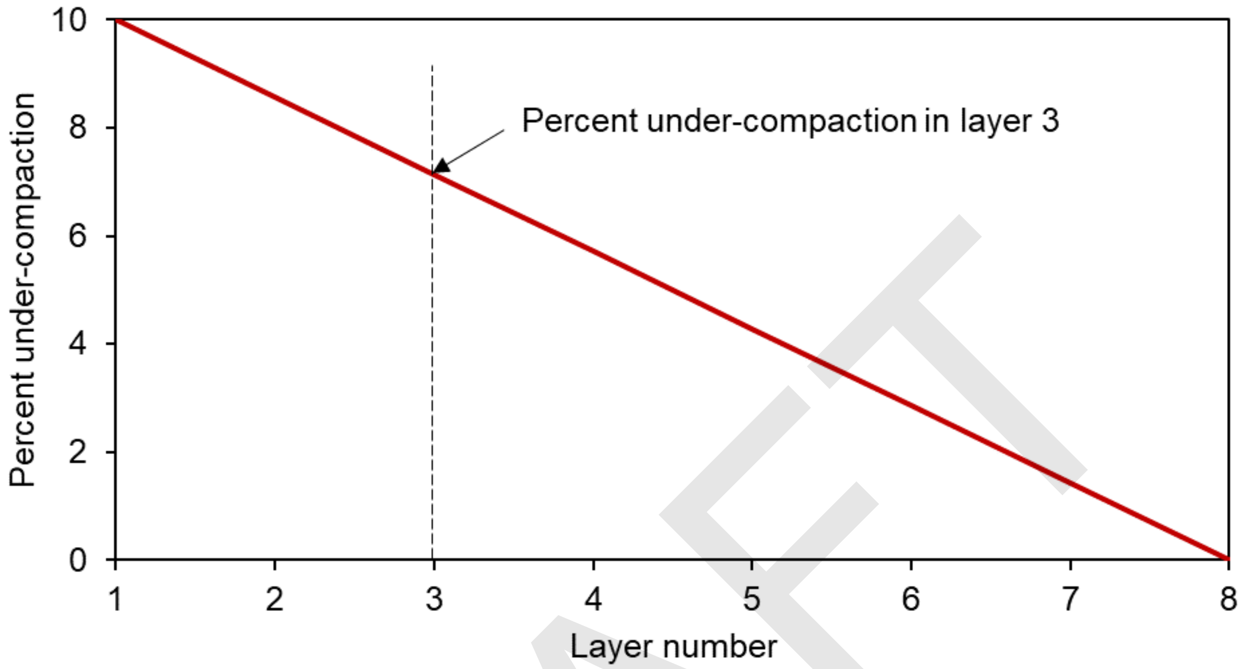


Figure 7: Typical under-compaction percent used for tamping of the dense specimens

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)

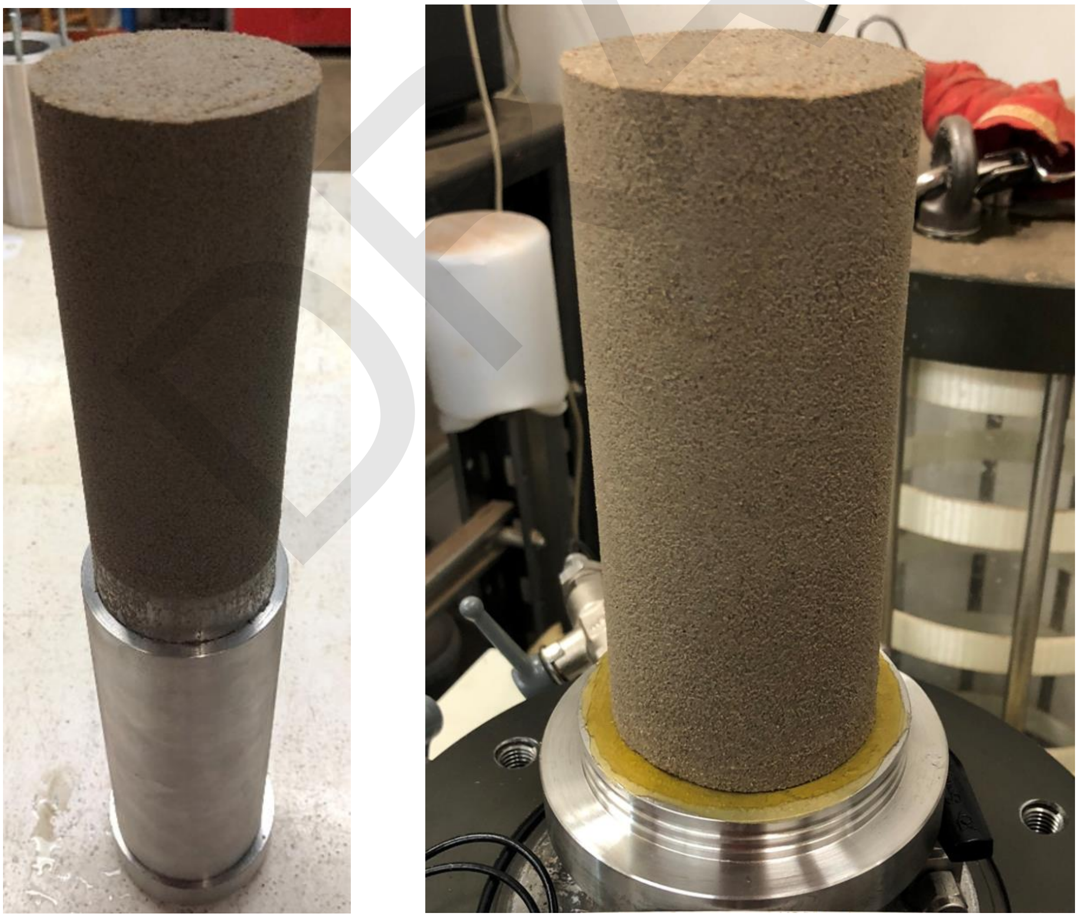


Figure 10: Specimen extruded using tamper (left) and sample on triaxial base platen (right)

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

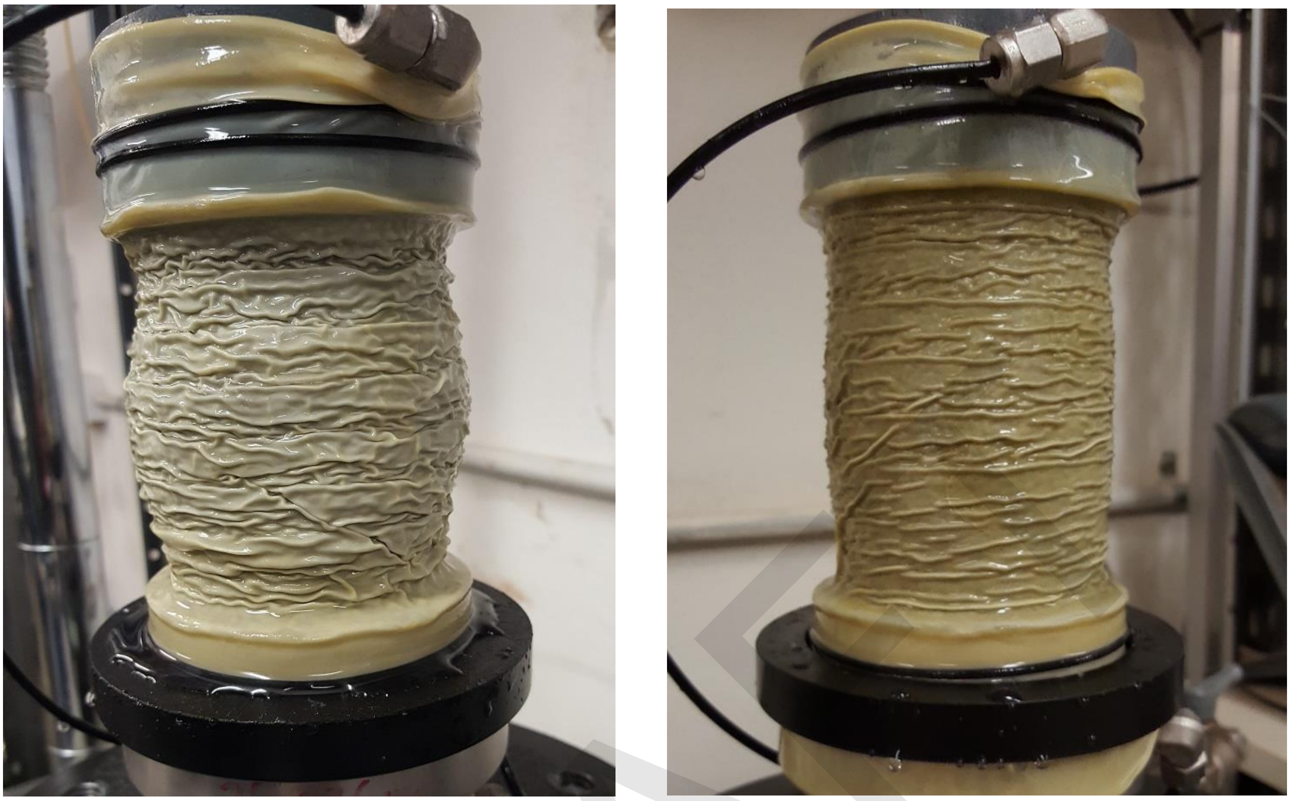


Figure 2: End of test typical deformed specimen to a parabola shape (left) and right cylinder shape (right)

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

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[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.

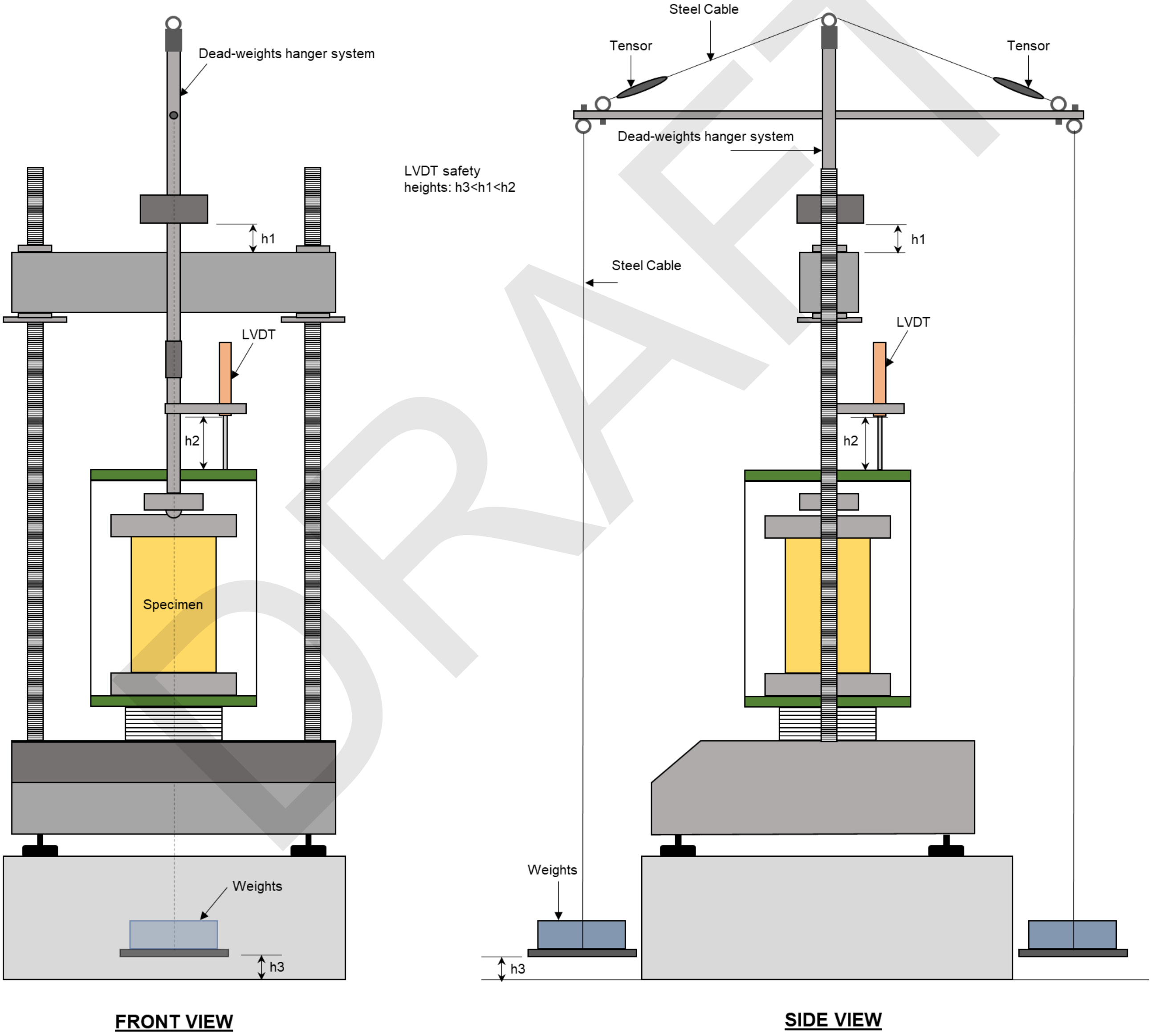


Figure 1: Front and side view of triaxial device modified for CSD testing using a dead-weights hanger system

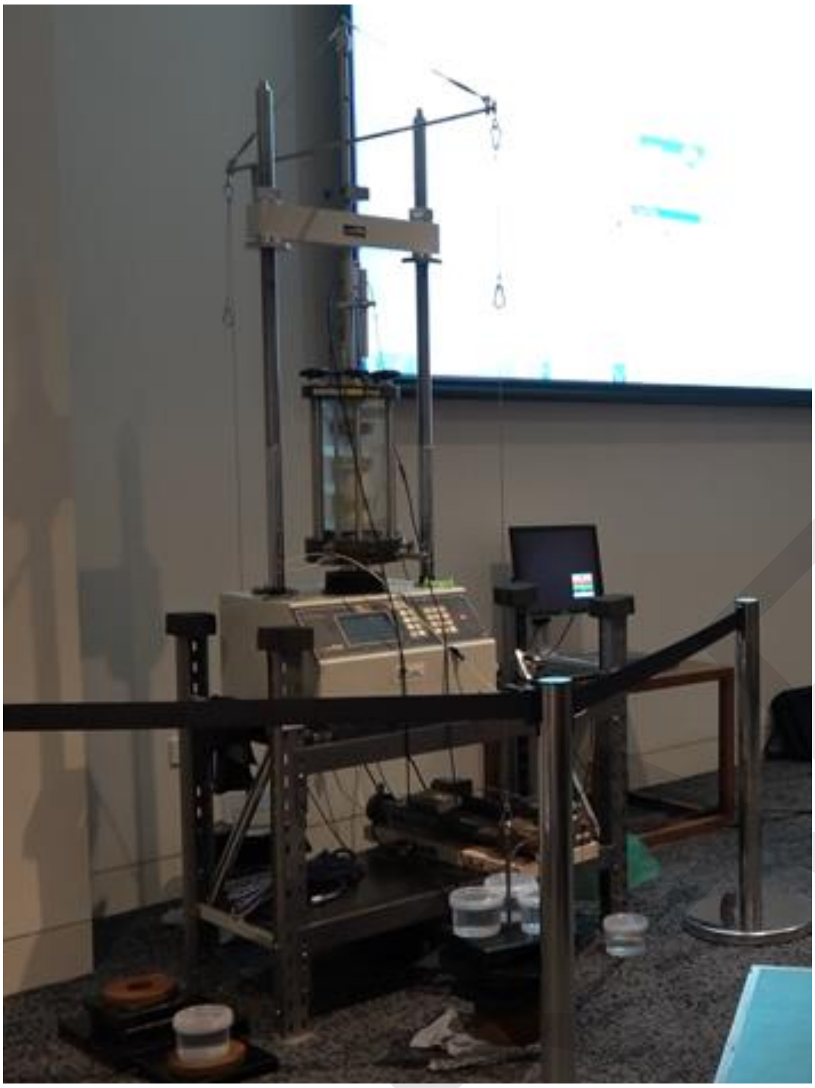


Figure 2: CSD triaxial during testing

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.

STEP 1. Specimen preparation

STEP 2. Suction applied to specimen to maintain its shape

STEP 3. Initial specimen dimensions taken

STEP 4 and 5. Assembling of triaxial device and specimen docking

STEP 6 and 7. CO_2 and water flushing

STEP 8. Back pressure saturation

STEP 9. B-Check

STEP 10. Unloading back pressure

STEP 11. Dissembling of triaxial cell and measure of new specimen dimensions for K_0 consolidation

STEP 12. Reloading back pressure

STEP 13. Anisotropic consolidation (15 kPa/hour)

STEP 14. Standby consolidation under K_0 for 24 hours

STEP 15. CSD stage increasing back pressure to 10 kPa/hour

STEP 16. Void ratio determination

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.

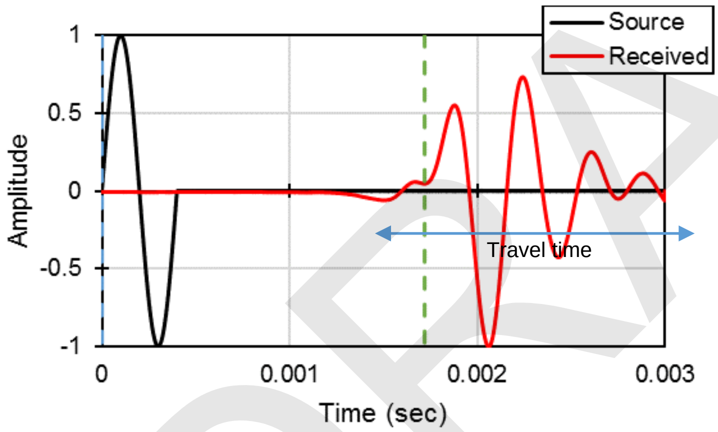


Figure 1: Transmitted and received signals using bender element system

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

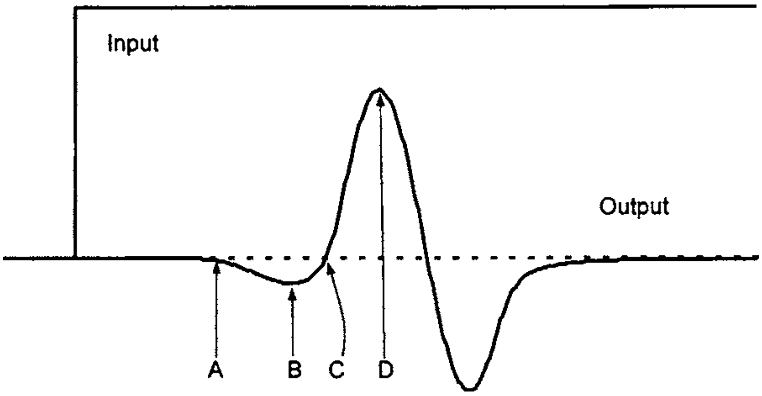


Figure 2: Different first arrival points as described by Lee and Santamarina, 2005

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

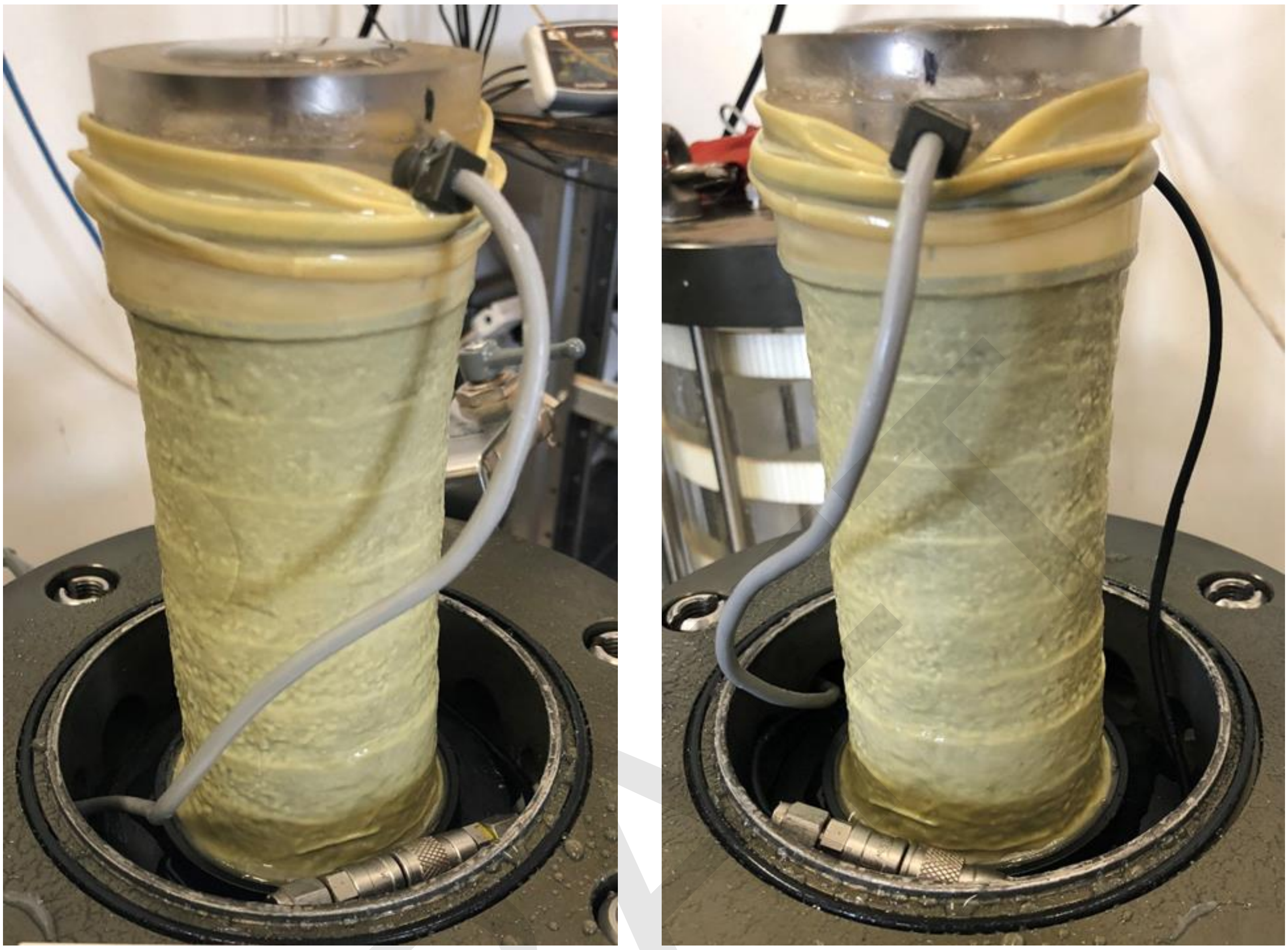


Figure 4: Specimen condition prior to K_0 consolidation (left) and at end of test (right)

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

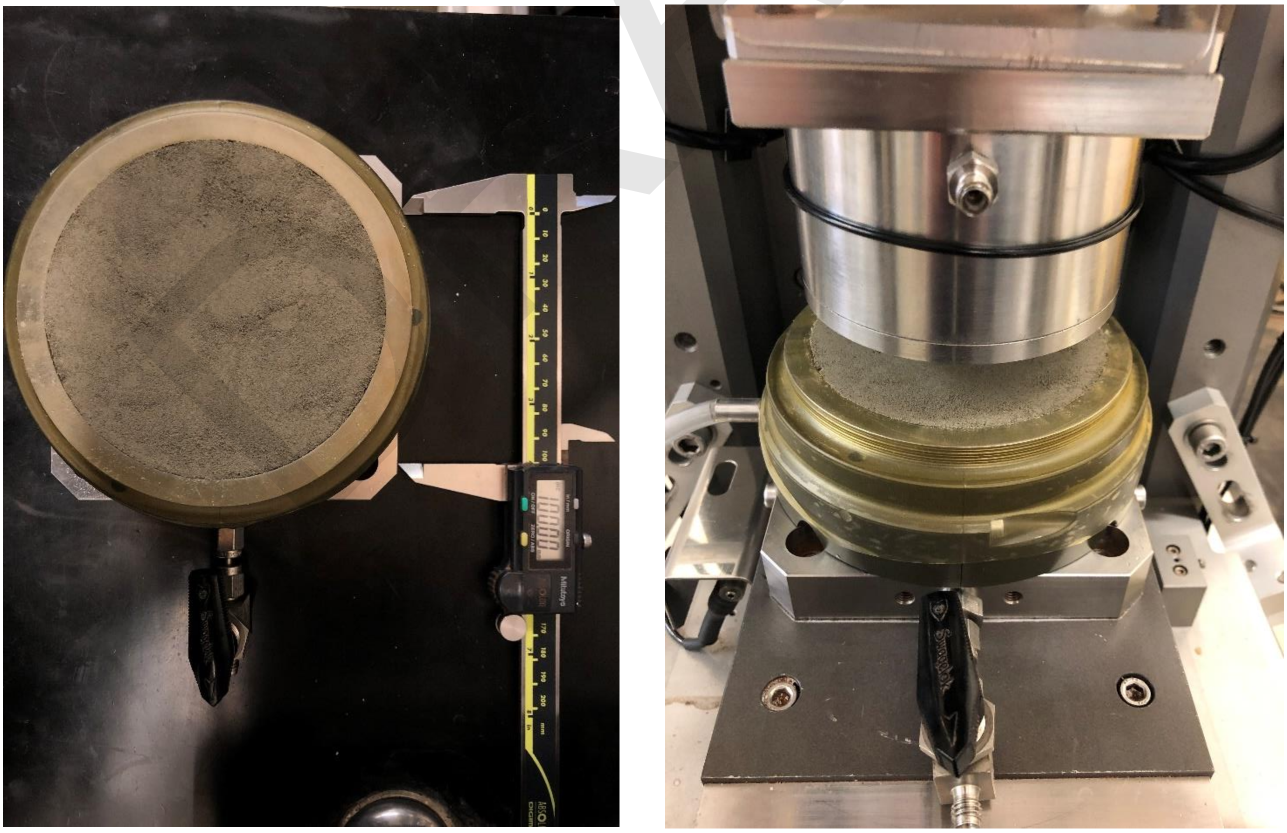
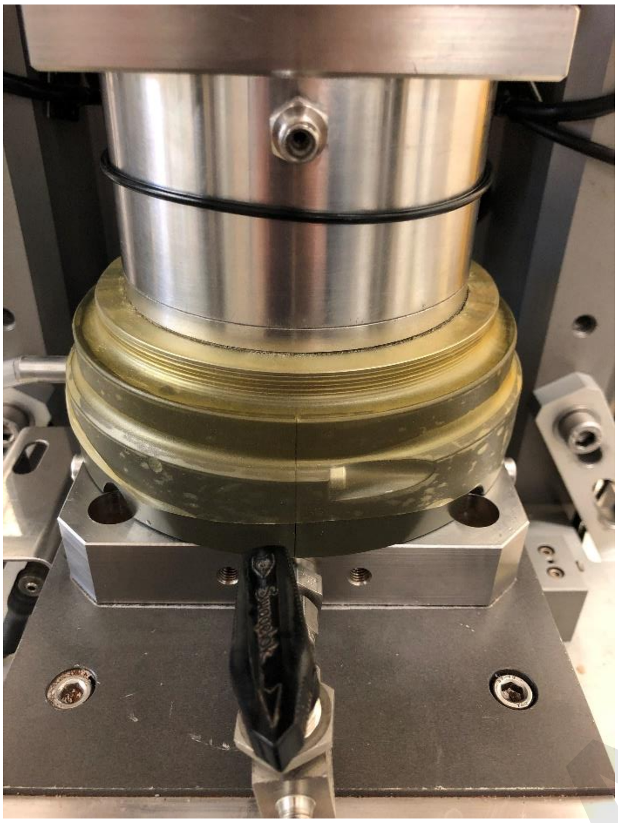


Figure 3: Tamped specimen outside DSS device (left) and fitted on the DSS base while still under suction (right)



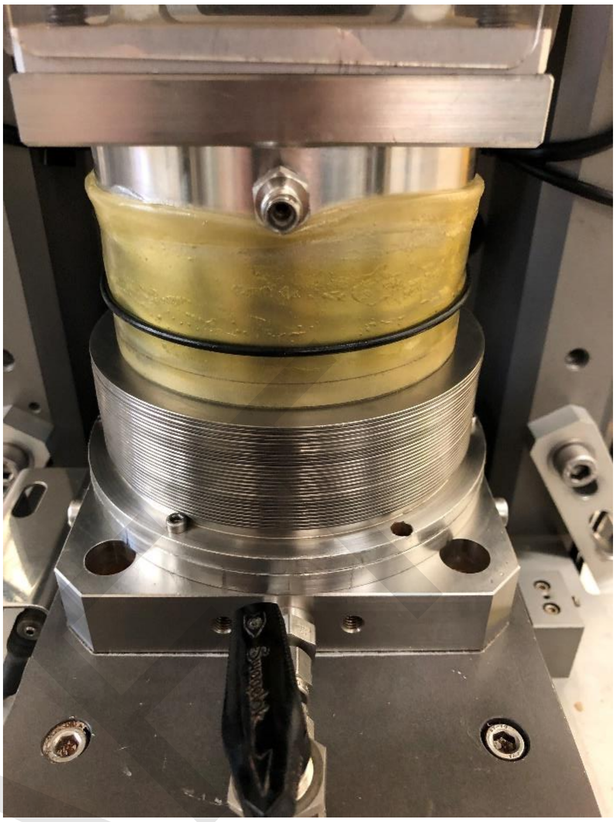
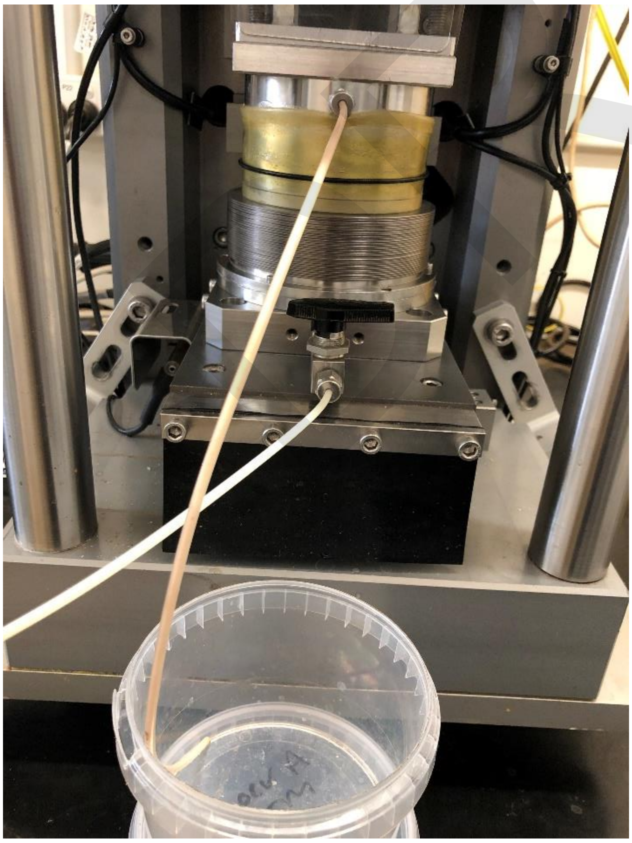


Figure 4: Top DSS platen lowered down to specimen surface (left) and with specimen preparation mould dissembled (right)



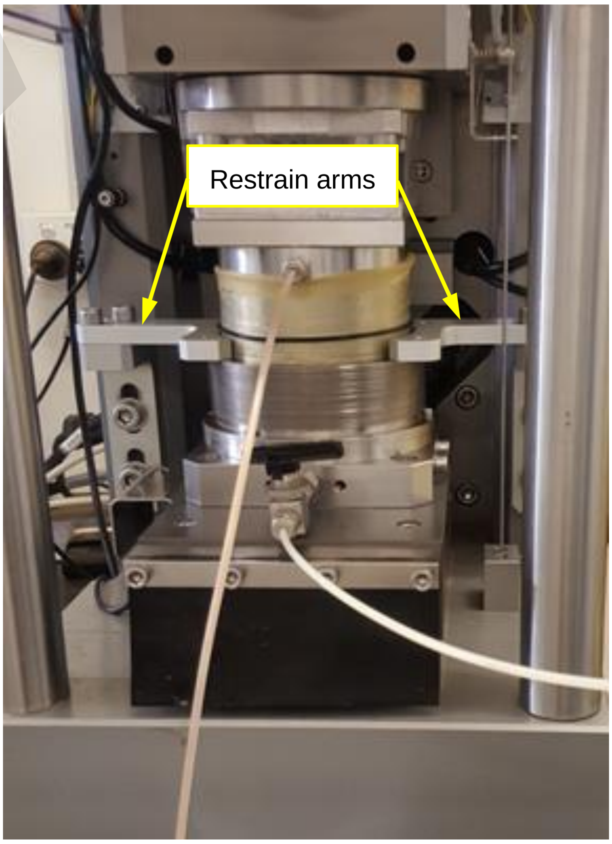


Figure 5: DSS device assembled without (left) and with (right) restrain arms mounted

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.

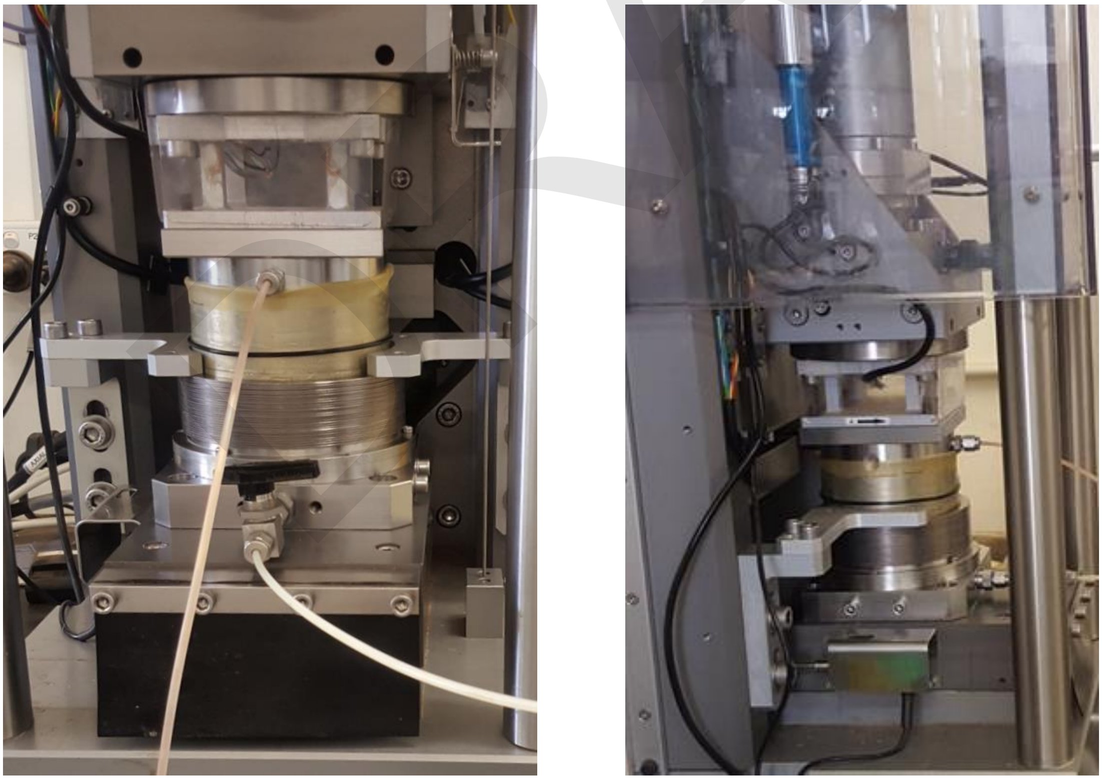


Figure 1: GDS electro-mechanical DSS device

[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