TRANSNET SOC LTD

FEASIBILITY STUDY (FEL-3) FOR THE DEEPENING OF BERTHS 203 TO 205, PORT OF DURBAN – TRIAL ANCHOR CONTRACT

TRIAL ANCHOR CONTRACT – FACTUAL REPORT

ZAA 1370 | RPT | 060 REV A

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T: +27 (0) 21 791 9100
F: +27 (0) 21 790 4470
E: ZAAEPNA@ZAAEPNA.COM
WWW.ZAAENGINEERING.COM

PO BOX 26546
HOUT BAY
SOUTH AFRICA
7872

31 MELKHOUT CRES.
HOUT BAY
CAPE TOWN
7806

ZAA
ENGINEERING PROJECTS &
NAVAL ARCHITECTURE (PTY) LTD

REVISIONS					
REV	DATE	DESCRIPTION	DESIGNED BY	CHECKED BY	APPROVED BY
A	21 August 2015	Issue for Comment	MB	MC	JZ

AUTHORISATION			
AUTHORISED BY	NAME	SIGNATURE	DATE
DIRECTOR	J ZIETSMAN Pr Eng	John Zietsman	21 August 2015

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1.0 INTRODUCTION

This report provides a summary of the trial anchor project that was undertaken during the FEL3 phase of the 203 to 205 Berth Deepening Project between October 2013 and July 2015. The project was an investigative project that aimed to determine the achievable rock bond strength of the underlying rock to inform the design of ground anchors for the main marine works.

ZAA Engineering Projects & Naval Architecture (the Employer's Designer), on behalf of Transnet SOC LTD (the Employer), compiled the technical works information for the contract documents including the technical specification for the works, and after the requisite TCP procurement process, the contract was awarded by TCP to Esor Franki Ltd (the Contractor), a specialist geotechnical contractor.

Part 1 of the report details the construction activities of the Contractor during the contract, with specific focus on difficulties encountered during the works. This part aims to inform future geotechnical contractors of possible difficulties such that lessons learnt can be taken on board.

Part 2 of the report summarises the result from the anchor stressing. This part provides a prediction of the achievable rock bond strength and aims to inform the fixed length anchor design for the main berth deepening project as well as any other anchor designs on future projects within the port.

2.0 SCOPE OF TRIAL ANCHOR PROJECT

The scope of works for the project comprised the construction of six trial ground anchors in the Port of Durban at the western end of Berth 205 at Pier 2.

The Contractor's scope of work was:

- Drilling and logging of two exploratory boreholes.
  - Drilled at a declination of 45°, by means of rotary core drilling
  - Holes were drilled to a depth to allow for a minimum of 5 metres (measured vertically) of rock above the upper end of the fixed length of the anchor.
  - Minimum diameter of N-size (54 mm) core recovery
  - Actual rock strengths determined by unconfined compressive strength tests on the recovered core.
- Design and construction of a temporary load bearing beam against which the anchors were stressed.
- Design and construction of ground anchors with three metre fixed length.
- Installation and testing of six trial ground anchors (later reduced to three as described in Section 3.2).
  - Drilling of anchor holes at a declination of 45° with fixed length diameter of 280 mm (later reduced to 229 mm as described in Section 3.2).
  - Water testing anchor hole fixed length.
  - Installation and grouting of trial ground anchors with three metre fixed length.
  - Stressing of ground anchors to a minimum of twice the predicted geotechnical capacity

ZAA provided on site monitoring of the trial anchor works activities

The diameter of the trial anchor fixed length was based on the predicted diameter required for the ground anchors for the permanent works.

Refer to Annexure 1 for site layout details. Further detail on the scope of works for the project is contained in specification 1370-SPEC-0027 Rev C included in Annexure 2.

3.0 PART 1 CONSTRUCTION

3.1 Exploratory boreholes

Vertical exploratory borehole 1370-BHL03, drilled during the prior geotechnical investigation for the main works, was used to approximate the geotechnical profile for the trial anchors for tender design purposes.

Two additional inclined boreholes, BH EAT 02 and BH EAT 05, were drilled by the trial anchor contractor at the exact position and on the exact inclination as trial anchors 02 and 05 respectively. The exploratory holes were advanced by washbore drilling and casing in the unconsolidated soils and N-size core barrels were utilised to advance thought the soft rock. During exploratory drilling, rock rubble/boulders from the existing Berth 205 return wall rock fill foundation trench were intersected. Intersection of this rock rubble along the drilling line was unanticipated and required rotary core drilling to advance the N-size casing through to the underlying soils where washbore drilling could continue to the basement rock. Three rock samples from each exploratory borehole were sent to Thekwini Soils Lab CC for UCS testing. Pertinent details of the exploratory boreholes (EAT02 and EAT05) are summarised in Table 3.1 below and detailed logs are contained in Annexure 3.

Cores recovered from the exploratory boreholes revealed that the basement geology of the Pier 2, Berth 205 area is comprised of Dark brownish olive-green, moderately to highly weathered, closely to widely fractured, very soft rock, interbedded siltstone and mudstone, with hard calcrete lenses, of the St Lucia Formation. Highly weathered units and calcrete lenses are discontinuous and occur at irregular intervals in both the lateral and vertical. UCS results from the cores recovered varied between 0.6 MPa to 1.9 MPa (refer to Table 3.2).

Logs from the inclined exploratory boreholes EAT02 and EAT05 were used to determine the founding level of the fixed anchor portion thereby ensuring that the exact geotechnical profile and distribution of very soft rock, hard calcrete and highly weathered residual soil over the 3 m fixed length was known.

Table 3.1: Exploratory Borehole Summary

	1370-EAT02	**1370-EAT05**
Start Date	13-03-2014	01-04-2014
End Date	02-04-2014	17-04-2014
Start of rockfill	-14.281 CDP	-14.069 CDP
End of rockfill	-16.190 CDP	-14.635 CDP
Start of basement geology	-32.100 CDP	-31.320 CDP
End of hole	-40.940 CDP	-41.190 CDP
Generalised description of recovered core	9.870 m of basement geology intersected.	8.840 m of basement geology intersected.

Table 3.2: UCS Results

Sample No.	Stress at Failure (kPa)	Strain at failure (%)	Sample depth (CDP)
EAT02-UCS01	1275.7	0.69	-38.959
EAT02-UCS02	633.9	1.77	-39.101
EAT02-UCS03	1923.8	0.49	-39.560
EAT05-UCS01	1398.0	0.79	-38.563
EAT05-UCS02	748.1	1.38	-40.656
EAT05-UCS03	1723.7	0.60	-41.583

3.2 Casing installation

The Contractors' tendered method for ensuring stability of the free length hole comprised the installation of steel casing through the unconsolidated soils to the basement geology by means of washbore drilling. Intersection of the rock fill trench during exploratory drilling (see Section 3.1) necessitated a change of method of casing installation from washbore drilling (Boart Longyear DB520) to ODEX drilling (Casagrande C8). The ODEX drilling system is designed for casing installation through overburden and rock. This system utilises a pneumatically driven down-the-hole hammer (DTH) to drag the casing as the borehole is advanced. The ODEX DTH is attached to the leader casing by the casing shoe with subsequent casings being welded onto the leader casing. The largest available ODEX DTH that was compatible with the Casagrande C8 rig and washbore casing had a diameter of 229 mm diameter.

Washbore casings were on site prior to the discovery of rock fill along the intended anchor hole line, and for this reason the Contractor elected to install these casings with the ODEX DTH Casagrande C8 rig. Washbore casings are designed to passively slide into the borehole as the soil at the leader casing is washed away by flushing and rotation of the washbore. The ODEX DTH system actively pulls casings down the hole by hammering in addition to rotation and flushing. The ODEX system therefore exerts a greater stress on the casings than the washbore method.

Proprietary ODEX casings have a wall thickness of 6 mm with additional sections being welded together. Washbore casings have a wall thickness of 8 mm, which is reduced to about 3 mm along the threaded portions. During installation of the first anchor hole (Anchor Hole 6) the casing broke at approximately 9 m inclined depth. The Contractor managed to retrieve the casings and drilling string. The Contractor elected to weld a steel brace across each threaded joint for additional support. A second attempt with the improvised brace resulted in casing failure at 10 m inclined depth. A significantly larger brace was used for a third attempt at installing washbore casing with the ODEX DTH at Anchor Hole 6. Casings were advance to 43 m inclined depth (about 7 m before reaching basement rock) when the casing shoe failed, halting further advance or retrieval of the casings.

The Employers' Designer attributed the recurring casing failures experienced at Anchor Hole 6, to the thin casing wall along the threaded area and additional friction caused by the improvised casing braces, which are approximately 10 mm proud of the casing. At this stage the Employers' Designer recommended the use of proprietary ODEX casing for installation at the remaining anchor holes.

Table 3.3 resents casing details and Figure 3.1 shows improvised braces. The Contractor however chose to continue with the washbore casings and proposed that if/where the casing failed before reaching rock, advancing the anchor hole by drilling, grouting and re-drilling (drill-grout-drill method) to stabilise the uncased portion of the free length.

The drill-grout-drill method entails drilling a run and injecting a weak grout mix into the borehole as the drilling string is retracted. It is intended that the weak grout mix penetrates into the surrounding soil so as to provide a sufficient grout body that can be re-drilled leaving a thick enough grout wall to maintain stability of the free length during anchor installation and stressing. Figure 3.2 presents a conceptual section detailing the drill-grout-drill method and wandering of the drill string as evidenced by recovered core. This method does not allow for control of the grout body geometry and significant variation in thickness is observed. Repeated drill-grout-drill runs are required where the re-drilled grout body collapses. In 4 of the 6 anchor holes, casing failure occurred before the casing reached rock.

Repetitive collapse of the grout stabilised free length occurred at all anchor holes where the Contractor attempted the drill-grout-drill method, despite significant volumes (± 15 m^3) of grout being injected into voids. Material recovered from re-drilling of the grout body revealed that these collapses were caused by irregular grout body geometry, and drill string wandering resulting in an insufficient annulus of grouted material. Figure 3.3 shows the minimal penetration (15 to 20 mm) of grout into the surrounding soil and drill string wandering. When drilling at 45° over the required lengths the drill string is expected to dip while advancing through in situ soils. This natural wandering is further accentuated when re-drilling through the grout body as the drilling string is deflected by the harder grout into the softer soil. These two factors result in portions of the re-drilled anchor hole being exposed to unsupported in situ soil, which is highly susceptible to collapse.

After approximately ten months of unsuccessfully attempting the drill-grout-drill method at four of the anchor holes where casing installation did not reach basement rock, the Contractor abandoned this method elected to drill new anchor holes with proprietary ODEX casings.

Anchor Hole 1a and 6a were drilled with proprietary ODEX casing, which were successfully installed into basement rock. After successful installation of the casing at Anchor 6a, the down the hole drilling hammer got stuck, requiring significant time and effort to free and retrieve. Given the excessive delays that had already occurred during casing installation on the project and the urgency of anchor stressing results, the Employer at this stage elected to reduce the scope of works and duly issued a Project Managers Instruction (on 08 June 2015) tabling changes to the Works Information. These changes called for the abandonment of any further anchor installation work and commencement of stressing of the awaiting installed anchors. At this stage Anchor 5 had been stressed and Anchor 1a and Anchor 4 were ready to be stressed. All anchor hole drilling and casing activity to this point is summarised in Table 3.4.

Figure 3.1: Washbore casing brace

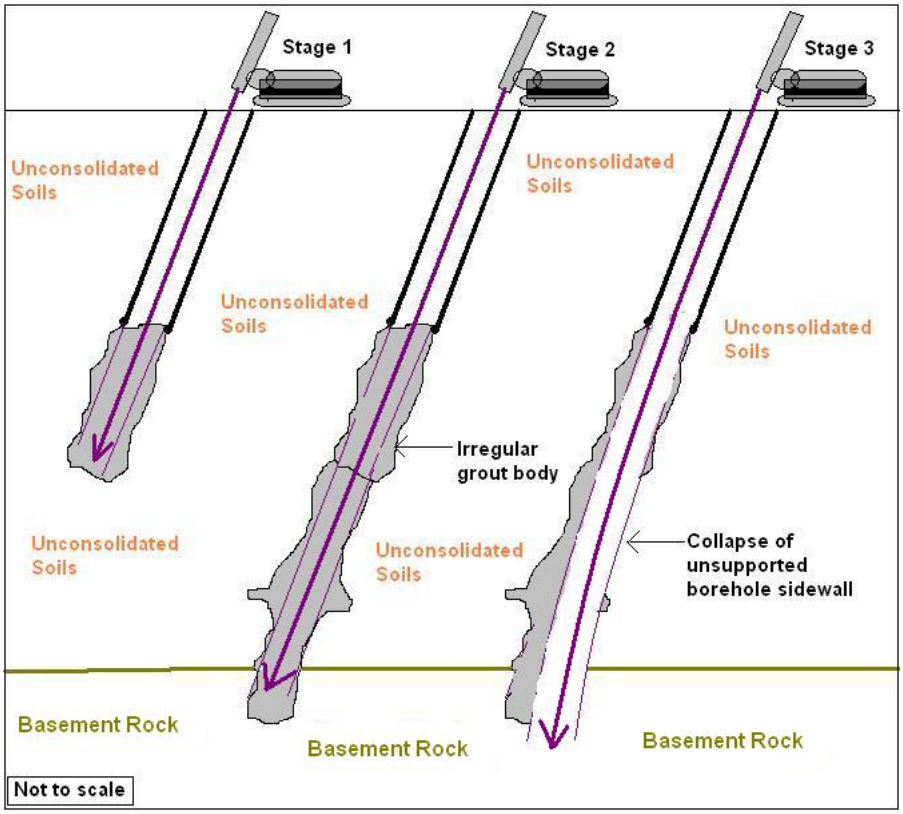


Figure 3.2: Drill-grout-drill method conceptual sketch

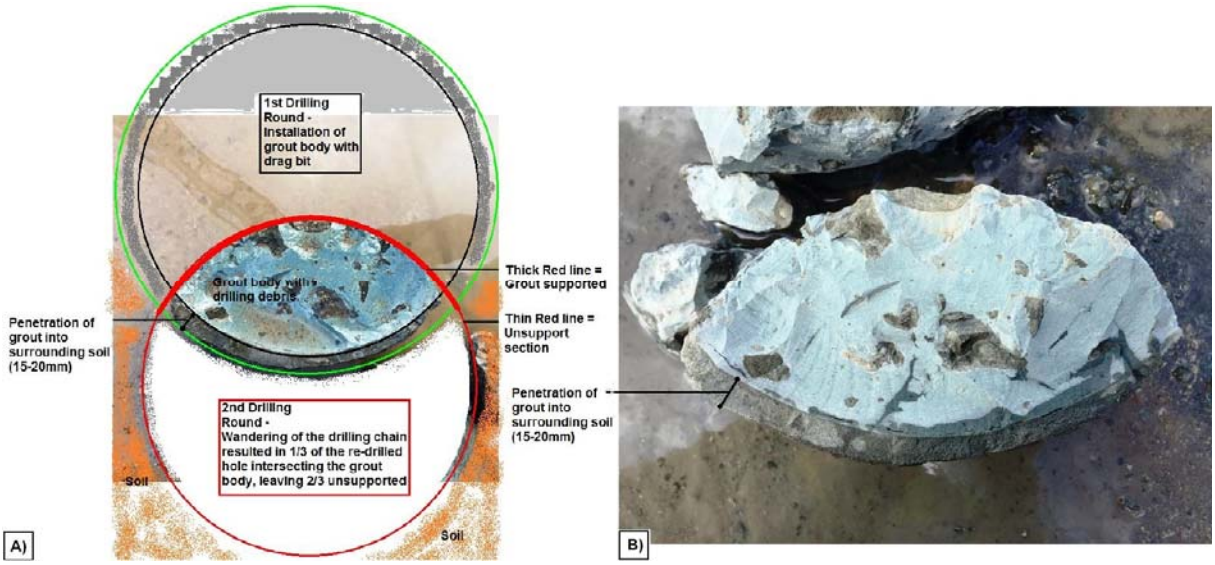


Figure 3.3: Re-drilled grout body

Table 3.3: Casing Specifications

	Washbore Casing	Proprietary ODEX Casing
OD (mm)	273	273
ID (mm)	257	261
Wall thickness	8	6
Minimum wall thickness	± 3	± 6
Primary join method	Threaded	Welded

Table 3.4: Anchor hole details

Anchor Hole No.	Anchor hole status	Casing installation details
1a	Casings successfully installed. Anchor installed.	ODEX casing, installed ± 6 m into rock
1	Drill-grout-drill method failed after water test. Removed from scope of works.	Washbore casing failed ± 11 m before rock
2	Drill-grout-drill method failed. Removed from scope of works	Washbore casing failed ± 4 m before rock
3	Drill string lost down hole. Abandoned by Contractor.	Washbore casing failed ± 13 m before rock
4	Casings successfully installed. Anchor installed.	Washbore casing installed ± 6 m into rock
5	Casings successfully installed. Anchor installed.	Washbore casing installed ± 6 m into rock
6	Drill-grout-drill method failed. Removed from scope of works	Washbore casing failed ± 7 m before rock
6a	Casings successfully installed. Removed from scope of works.	ODEX casing, installed ± 10 m into rock

3.3 Anchor installation

Fixed lengths of the three successfully installed anchors (Anchor 1a, 4 & 5) were drilled using the drag bit. During the trial anchor project the Contractor increased (by welding) or decreased (by grinding off) the drilling diameter of the drag bit depending on the drilling operation. There was a noted decrease in drag bit diameter (-4 Ø) after completion of drilling through rock, resulting from mechanical wear of welded portions. Recorded drag bit diameters used for drilling of fixed length runs are presented in Table 3.5. Fixed length runs were over drilled by about 0.5 m to create a sump into which excess drilling debris could settle without affecting the fixed length.

An airlift pump was utilised to clean the fixed length of all drilling debris before water testing commenced. Each anchor fixed length was isolated by means of a pneumatic packer and water tested to pressures of at least 100 kPa above the local water table level. None of the anchor holes required grout sealing as water leakage did not exceed the specified maximum allowable loss of 1 litre/minute measured over a ten minute period, refer to Table 3.5 for details. After this, a second period of airlift cleaning was carried out to ensure that all remaining drilling debris and drilling additives (such as bentonite, drilling foam & Eazymix) were flushed from the anchor hole.

Two mobile cranes operating in tandem were used to lift the anchors and lower them down the anchor hole to a pre-marked point. While each anchor was suspended in place, three times the predicted volume (± 0.35 m^3) of anchor grout was batched and injected into the anchor hole from the base, ensuring that the fixed length was free of voids. The anchor grout design mix was designed to attain the minimum required strength of 40 MPa at 28 days. Grout cube test results showed that the 40 MPa minimum was attained within two weeks. The Contractor attributes this early strength to better mixing on the large scale in comparison to laboratory scale mixing. All anchors were successfully installed within 72 hrs of drilling the fixed length.

Table 3.5: Anchor installation details

Anchor No.	Fixed length drilling method & size	Water test	Grout cube strength
4	Drag bit, 225 Ø	Passed < 10 litres loss over 10 minutes	40 MPa attained within 12 days
5	Drag bit, 225 Ø	Passed < 10 litres loss over 10 minutes	40 MPa attained within 12 days
6a	Drag bit, 222 Ø	Passed 0 litres loss over 10 minutes	40 MPa attained within 12 days

The Contractors' anchor design employed 13 cables each with an ultimate strength of 279 kN, giving the complete anchor tendon an ultimate strength of 3627 kN. These 13 cables and a HDPE pipe were bound together with steel wire and spacers. The HDPE pipe was used to inject anchor grout into the base of the anchor hole. The 3 m fixed length relies on additional spacer to keep the anchor centralised. Refer to Annexure 5 for full anchor design and fabrication details.

3.4 Stressing

The specification with regard to anchor stressing stipulated that the Contractor provide stressing equipment to conduct anchor stressing in accordance with BS 8081:1989 Section 11.2 using Table 13 for loading cycles. The stressing jack that the Contractor mobilised on site had insufficient stroke to achieve the full range of loading cycles as stipulated in the specification. The Contractor therefore had to employ a series of stressing spacers to achieve the full loading range. The anchor was locked off at maximum travel of the jack allowing the stressing head to be reset so that progressive cycles could be carried out above the lock-off load. From the lock-off load the anchor would again be stressed cyclically to the maximum travel of the jack.

A 100 MPa a hydraulic jack with ram area of 41417 mm^2 was used to apply force to the anchor tendons via the stressing head. The jack was positioned on top of a jacking box. The jacking box was used to allow space for the lock-off head and the addition of spacers to achieve lock off at progressively higher loads. Anchor stressing equipment is depicted in Figure 3.4 and Figure 3.5 with additional detail provided in Annexure 6. A load cell was used during stressing of Anchor 5, but was excluded from stressing apparatus at Anchor 4 and 1a due to an undetermined technical malfunction and load was calculated based on jack pressures and ram cylinder area.

During the stressing of first anchor (Anchor 5) and after the second lock-off, a tendon cable failed at approximately 55 MPa (2294 kN or ± 63 % f_{pu}). The characteristic proof strength (f_{pu}) of the tendon was recalculated based on 12 tendon cables. Anchor stressing was continued until multiple tendon cables failed and stressing was halted. Similarly, stressing of Anchor 4 and Anchor 1a were terminated due to premature tendon failure.

The Employers' Designer attributes the premature failure of the anchor tendons to excessive mechanical wear at the lock-off head. The Contractors' method for applying progressive lock-off loads while maintaining the ability to achieve cyclic loading resulted in each lock-off load being applied to the same place along the tendon cables. This repetitive pinching of the cables at the same point significantly reduced the ultimate anchor tendon capacity. Figure 3.6, shows the effect of pinching on the tendon cable and collets.

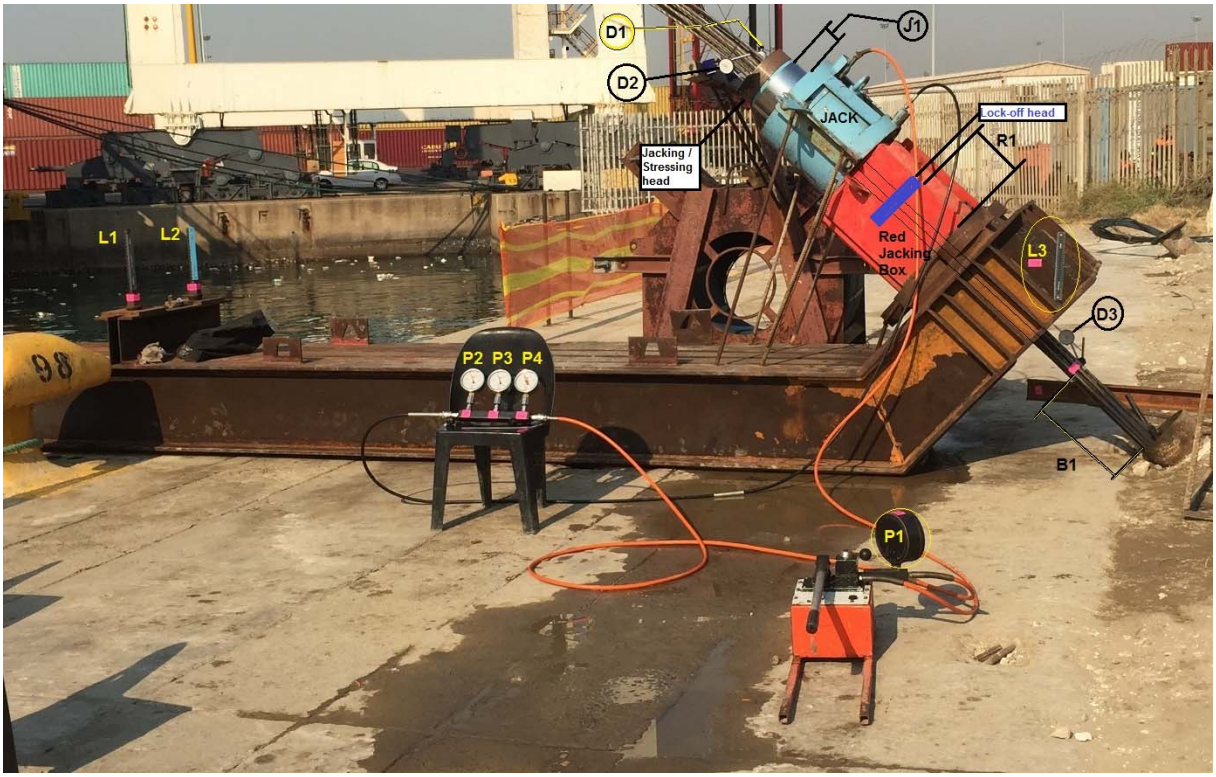


Figure 3.4: Anchor stressing equipment (Anchor 4, side view)

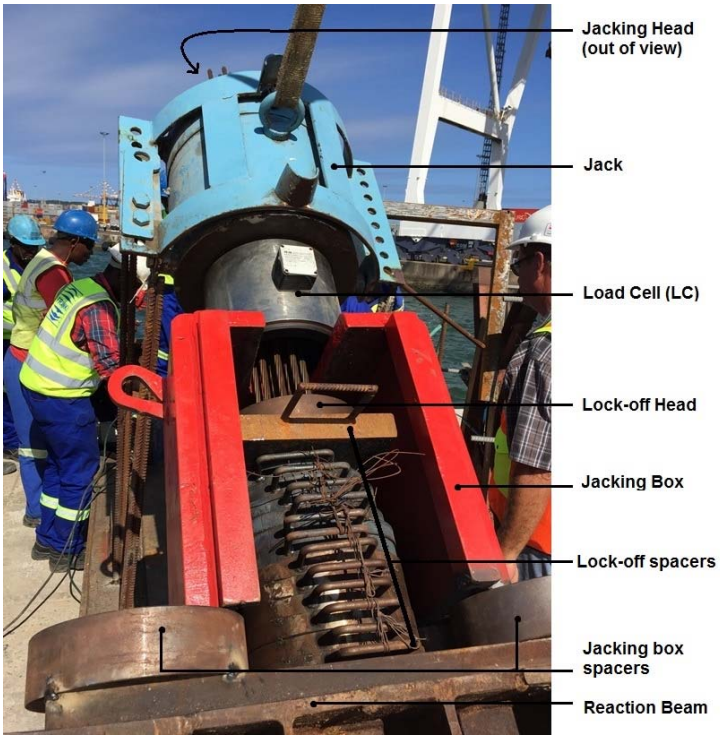


Figure 3.5: Anchor stressing Equipment (Anchor 5, head-on view)

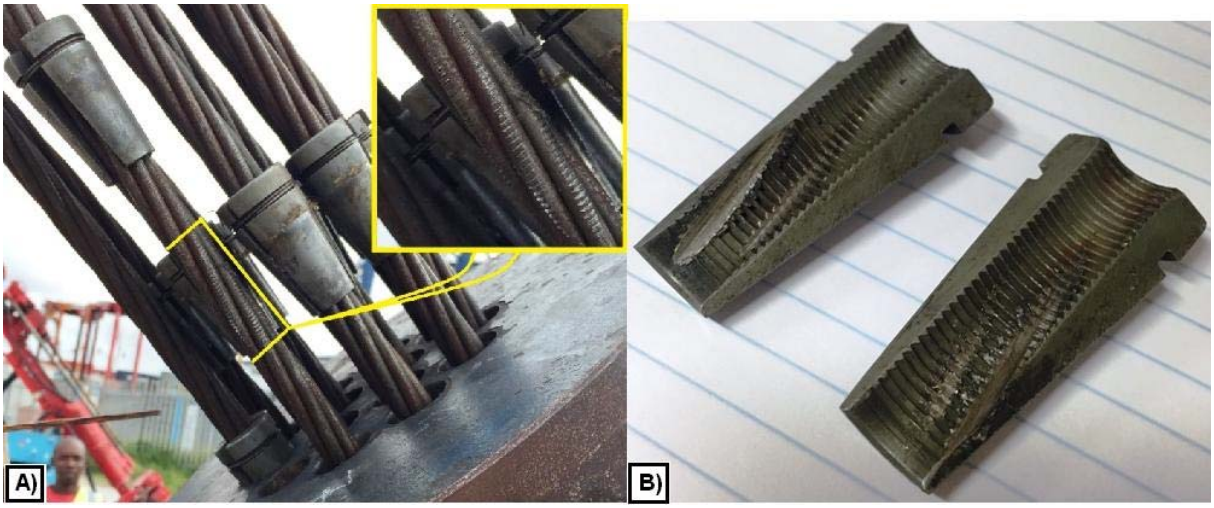


Figure 3.6: Tendon wear, collet and cable damage

4.0 PART 2 STRESSING RESULTS

Stressing of all three anchors (Anchors 1a, 4 and 5) was terminated due to premature tendon failure. No failure of the anchors at the rock grout interface was recorded.

A summary of anchor stressing results is presented in Table 4.1 and stress vs strain graphs are presented in Figure 4.2 and Figure 4.3.

Of the three anchors, Anchor 5 achieved the highest load (2795 kN) before tendon failure. The estimated rock bond capacity of this anchor has been calculated at 1318 kPa, which is twice the estimate capacity (650 kPa).

Table 4.1: Anchor stressing summary

Anchor	Max P (MPa)	Max Load (kN)	% f_{pu} of Tendon	% of predicted geotech capacity	Max Extension (mm)	Rock bond capacity at maximum load (kPa)
1a	60.0	2503	69.0	183.9	398	1196
4	53.5	2232	61.5	161.9	340	1052
5	67.0	2795	77.0	202.7	468	1318

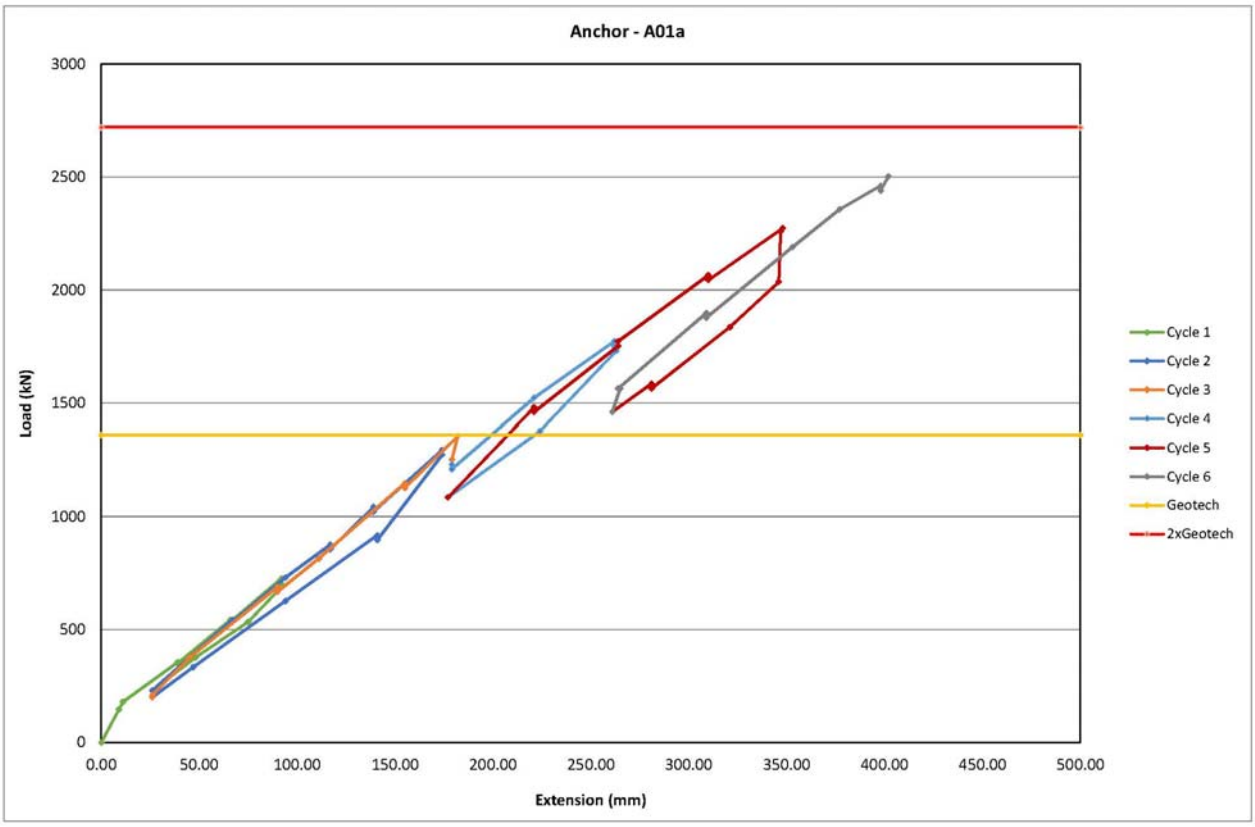


Figure 4.1: Anchor 1a, stress vs strain

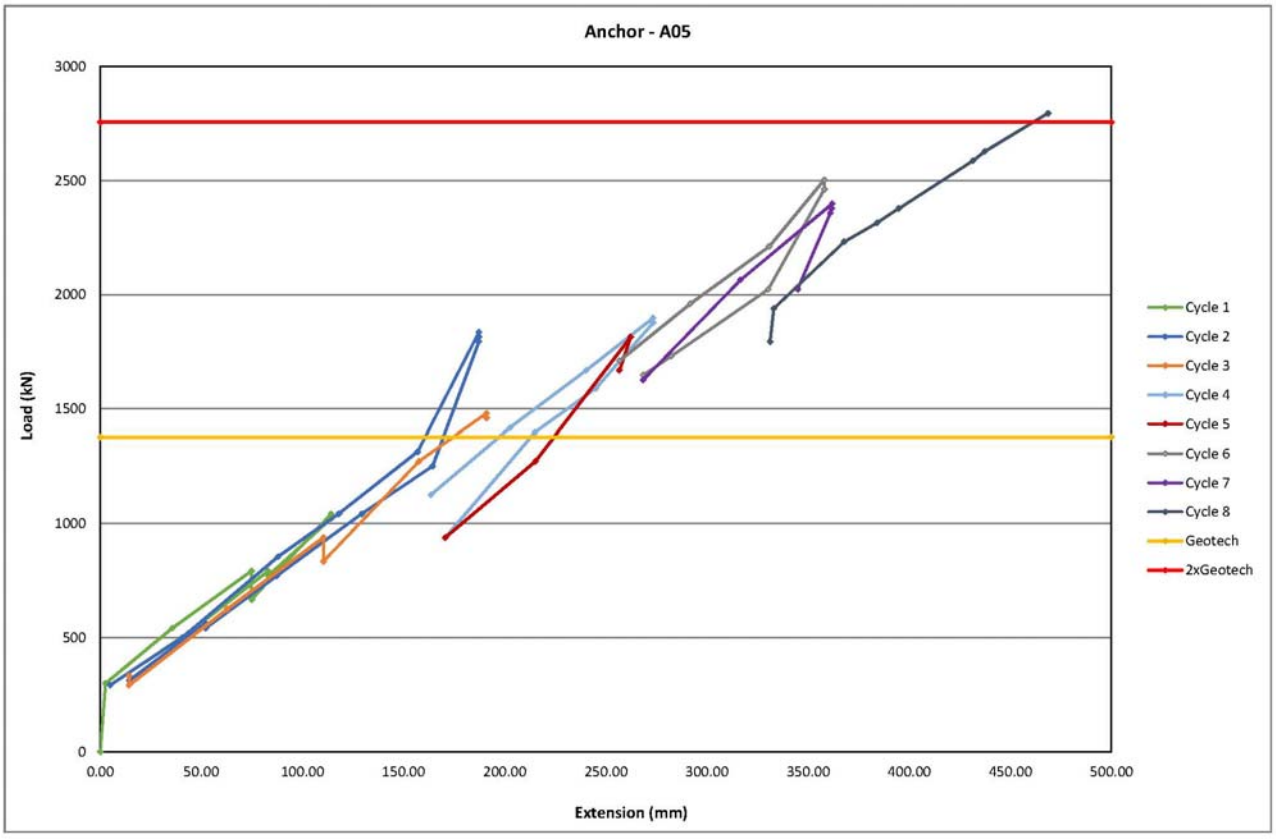


Figure 4.2: Anchor 4, stress vs strain

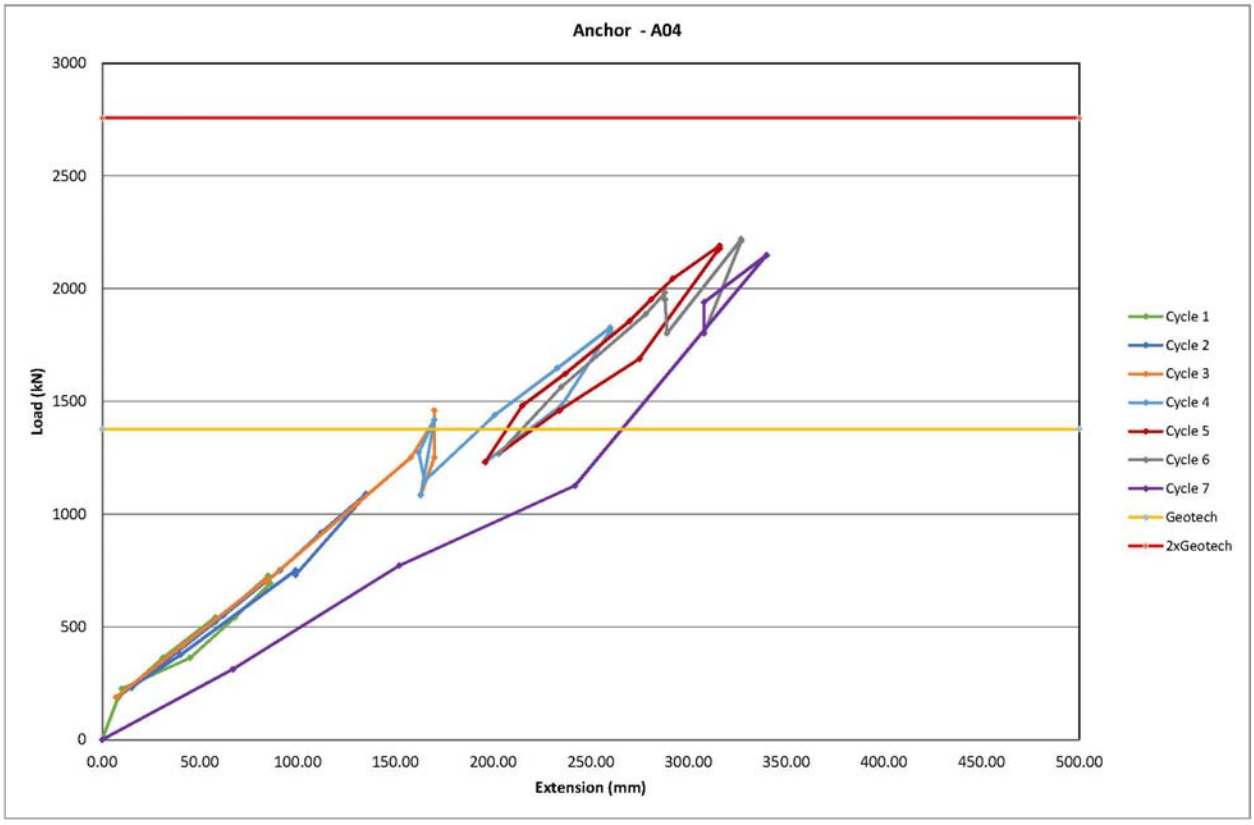


Figure 4.3: Anchor 5, stress vs strain

5.0 CONCLUSIONS

The trial anchor project proved to be a difficult project with extensive time and cost overruns. This was due to both unforeseen geotechnical conditions (unforeseen rock rubble) and in the opinion of the Employer's designer, inadequate and inappropriate drilling and stressing equipment and methodologies employed by the Contractor.

The drill-grout-drill method for supporting the anchor hole free length may be adequate for short length boreholes, however proved to be inefficient for the length and angle required. Anchor installation proved trouble free where casings were successfully installed into the basement rock.

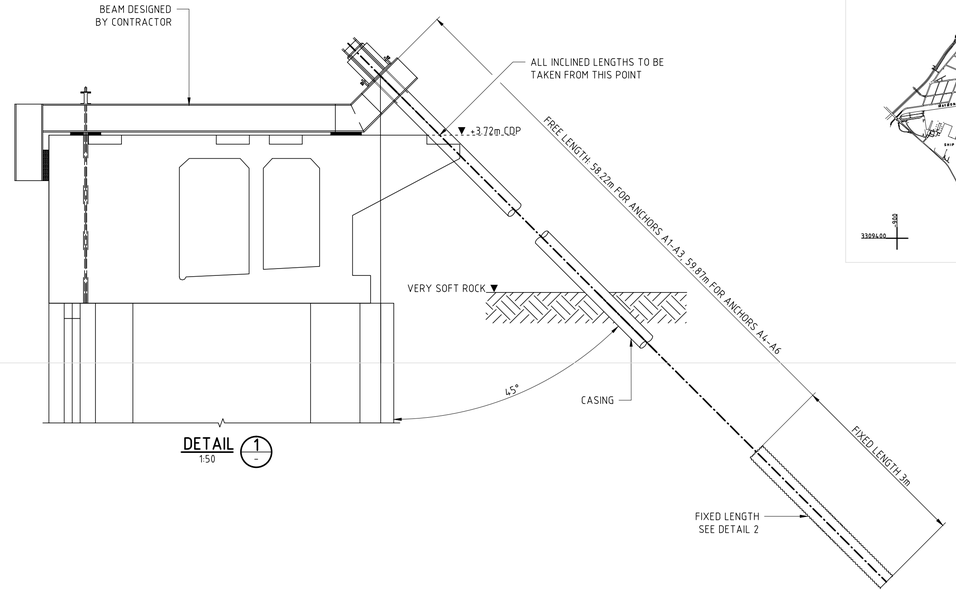
Mechanical damage to the tendons resulted in premature failure and prevented stressing to the specified loads. Tendon failure below the design load can be prevent by increase the factor of safety of the tendon design and revising the anchor stressing methodology and equipment to reduce the number of lock-offs required.

Despite the above difficulties, the project has proven that with the appropriate drilling and stressing equipment and methodologies, anchors of this length and diameter can be installed and that the very soft rock present can achieve a rock bond capacity of at least 1300 kPa. This is significantly greater than the predicted capacity.

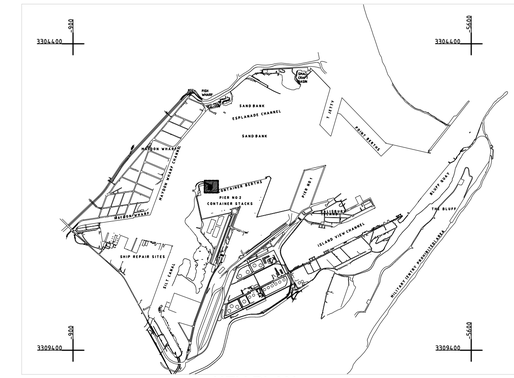
ANNEXURE 1 – DRAWING 1370-107 C02

DO NOT SCALE - IF IN DOUBT, ASK

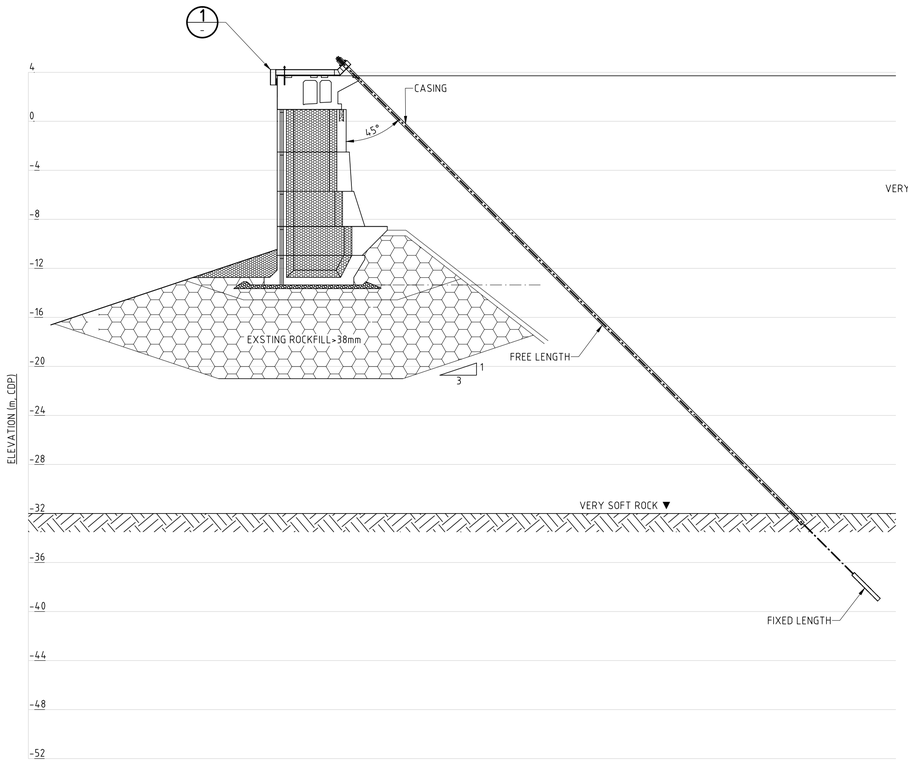
PLAN
1:500



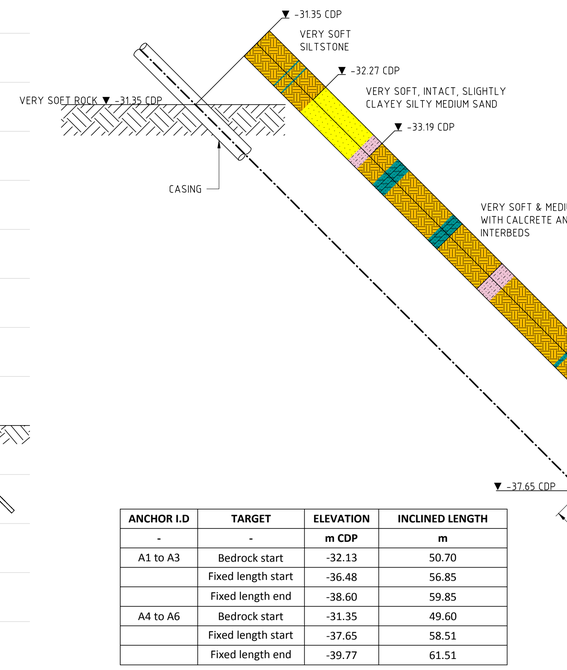
DETAIL 1
1:50



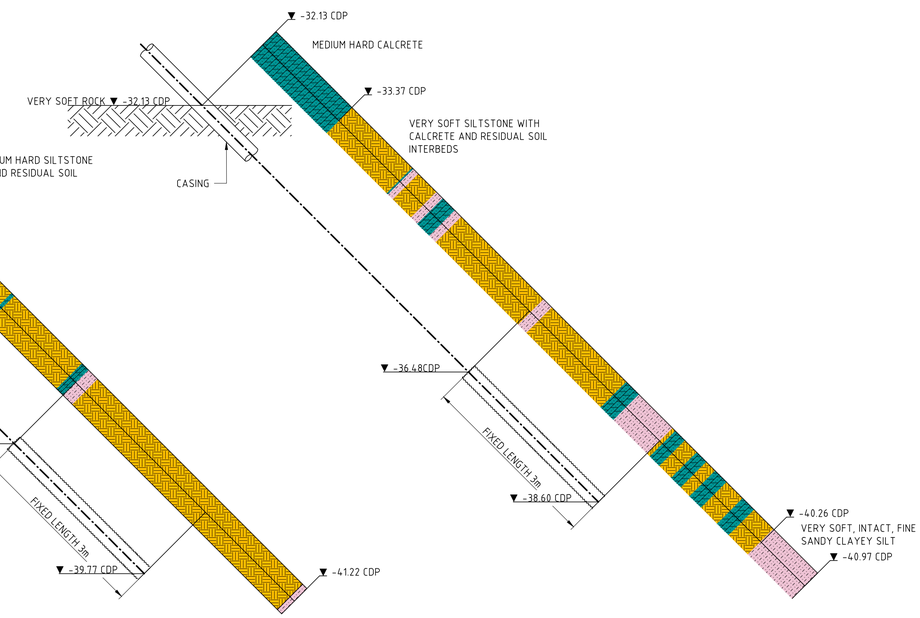
KEY PLAN



SECTION A
1:250



ANCHORS A4-A6



ANCHORS A1-A3

ANCHOR I.D	TARGET	ELEVATION	INCLINED LENGTH
-	-	m CDP	m
A1 to A3	Bedrock start	-32.13	50.70
	Fixed length start	-36.48	56.85
	Fixed length end	-38.60	59.85
A4 to A6	Bedrock start	-31.35	49.60
	Fixed length start	-37.65	58.51
	Fixed length end	-39.77	61.51

DETAIL 2
1:50

DRAWING NO.	REFERENCE
REFERENCE DRAWINGS	

Engineers
ZAA ENGINEERING PROJECTS & NAVAL ARCHITECTS
PO Box 26546
HOUT BAY 7872
Tel: +2721 791 9100
EMAIL : zaaepna@zaaepna.com
31 Melkhout Crescent
HOUT BAY 7806
Fax: +2721 790 4470
www.zaaepna.com

1370-DWG-107 C02 A

NO.	DESCRIPTION	BY	CHK'D	APP'D	DATE
C02	ANCHORS 1A & 6A ADDED	DC	MB	MC	15.08.17
C01	BOREHOLE LOG DEPTHS ALTERED	DC	MH	MC	14.10.14
C00	BOREHOLE LOGS ADDED	DC	MC	JZ	14.02.06
P02	ROCK STORAGE SITES ADDED	MC	WV	JZ	13.09.17
P01	FOR INFORMATION	WV	MC	JZ	13.05.17
P00	FOR APPROVAL	WV	TB	JZ	13.02.20

REVISIONS / ISSUE AUTHORIZATION

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AREA MANAGER				
PROJECT MGR.				
DIVISION				
DIV.	TITLE	NAME	SIGNATURE	DATE

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DRAWN	DC		14 10 15
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ENG. COORD	MC		14 10 15
DISCIP. ENG			
ENG. MANAGER			
AREA MANAGER			
PR.ENG. / PR.TECH.			
NAME	M. COMMINOS		DATE
SIGNATURE			14 10 15
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TRANSNET

DURBAN CONTAINER TERMINAL
GEOTECHNICAL INVESTIGATION
TEST ANCHORS
GENERAL ARRANGEMENT

PROJECT NUMBER	DV	FBS	DIS.	TYPE	DRG NO.	SHT.	REV.	ID

Q:\1370 TCP 408 FEL 3 BERTHS 203 AND 205\Z-DRAWINGS\DWGS\1370-DWG-107- REV C02 TEST ANCHORS.DWG
DANIEL.E.COLSON
2015-08-17

ANNEXURE 2 – TRIAL ANCHOR SPECIFICATION

TRANSNET SOC LTD

DEEPENING OF BERTHS 203 TO 205

PORT OF DURBAN

SPECIFICATION – TRIAL ANCHORS

ZAA 1370 | SPEC | 027 REV C

18 July 2014

T: +27 (0) 21 791 9100
F: +27 (0) 21 790 4470
E: ZAAEPNA@ZAAEPNA.COM
WWW.ZAAENGINEERING.COM

PO BOX 26546
HOUT BAY
SOUTH AFRICA
7872

31 MELKHOUT CRES.
HOUT BAY
CAPE TOWN
7806

ZAA
ENGINEERING PROJECTS &
NAVAL ARCHITECTURE (PTY) LTD

REVISIONS					
REV	**DATE**	**DESCRIPTION**	**DESIGNED BY**	**CHECKED BY**	**APPROVED BY**
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C	18 July 2014	Revised due to change in anchor diameter and fixed lengths	MH	MB, AH	MC

AUTHORISATION			
AUTHORISED BY	**NAME**	**SIGNATURE**	**DATE**
DIRECTOR	J ZIETSMAN Pr Eng	John Zietsman	18 July 2014

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1.0 SCOPE OF SPECIFICATION

This specification is a project specific technical specification issued for the feasibility study for the proposed deepening of Berths 203 to 205 – Pier 2, Durban Container Terminal.

The scope of this specification covers the *Employer's* requirements for the construction of a series of trial ground anchors. Six inclined anchors will be positioned at 3 meter centres along a line adjacent to the existing return wall, and are expected to intercept bedrock at approximate depths of -32m CD.

The anchors will be drilled to a depth to allow for a minimum of 5 meters (measured vertically) of rock above the upper end of the fixed length of the anchor. The expected bedrock quality is very soft rock.

The scope of this specification covers:

- Drilling and logging of exploratory borehole
- The design and construction of a temporary anchor jacking beam
- Drilling of holes, supply, installation and grouting of trial ground anchors
- Stressing of the ground anchors
- Decommissioning requirements for the ground anchors and anchor beam

The specification contains requirements for Materials, Equipment, construction, tolerances in workmanship and testing.

2.0 PURPOSE OF TRIALS

The *Employer* is seeking to establish the ultimate resistance of an anchor at the ground/grout interface. Wherever possible, the relevant aspects of the design and installation of the anchor shall also be applicable to the design of the anchors for the final works.

3.0 STANDARDS AND EMPLOYER SPECIFICATIONS

The following *Employer* and industry standardised specifications are referenced in this specification and form part of the Works Information. Standard specifications referenced within the specifications listed below also form part of the Works Information:

3.1 Employer's General Specifications

- 1370-SPEC -002 – Concrete for Marine Construction

3.2 Industry standard specifications

The governing codes and standards for this specification shall be:

- BS 8081:1989 Standard Code of Practice for Ground Anchors
- BS EN 1537:2000 Execution of Special Geotechnical Work: Ground Anchors
- BS 5930:1999 Code of Practice for Site Investigations
- BS 5896 Specification for High Tensile Steel Wire and Stands for Prestressing Concrete
- BS 1881 Testing Concrete: Method of Testing Concrete
- SANRAL Standard specification for subsoil investigations - 2010

All materials and workmanship shall be in accordance with the appropriate International Standards current at the time of tender, including those listed in this specification, except that where the requirements of the Standards are in conflict with this Specification, the latter shall take precedence.

4.0 GENERAL

4.1 Samples and Testing

The *Contractor* shall submit to the *Supervisor* samples of all materials proposed for use in the works together with a list of suppliers to be employed. The consent in writing shall be obtained for all such samples and sources of supply and no changes shall subsequently be made without the *Supervisor* approval. The *Supervisor* shall have access to all sources of supply for the purpose of inspecting and any testing of samples.

4.2 Approvals

All materials, processes, installation procedures and plant used in connection with this specification will be subject to the approval of the *Supervisor*. The *Contractor* shall supply in good time samples that he proposes to use for the grout and shall furnish evidence that the cement, water and if, relevant, aggregates comply with the requirements of the clauses below.

4.3 Method Statements

Prior to commencement of the trial ground anchor installation, the *Contractor* shall submit for acceptance a detailed report on the design of the anchors and an associated method statement. The method statement shall include a programme and full details of both type and quantity of all the equipment he proposes to use, and the order of carrying out the work. The Contractor shall not commence with drilling of the ground anchors or construction of the anchor beam until the Supervisor has accepted the report and method statements.

5.0 EXPLORATORY BOREHOLES

Two exploratory rotary cored holes (with a minimum 54 mm diameter) shall be drilled at a declination of 45° at the exact position of two of the trial anchors to allow for detailed logging and confirmation of the materials. The boreholes shall be drilled prior to the drilling for the ground anchors holes.

Drilling methods, method of core recovery and storage of cores shall be in accordance with BS 5930 or the Standard Specification for Subsoil Investigations – SANRAL 2010. Logging of the core will be undertaken by the *Employer's* Designer.

The actual rock strengths in the anchor trial area shall be determined by conducting unconfined compressive strength tests on the rock cores obtained from the two exploratory boreholes.

The boreholes shall be grouted up with a 10 MPa grout after completion of the drilling and logging of the boreholes.

6.0 DESIGN

The trial ground anchorages shall be tested to failure, and shall not form part of the anchorages to be used in permanent works, nor will they require corrosion protection.

6.1 Parts of the works designed by the *Employer*

The *Employer's* designer will be responsible for the design of the fixed anchor length, the founding level of the anchor and the diameter of the fixed anchor.

6.1.1 Fixed anchor length

Six 3 meter bond lengths will be employed to investigate the ultimate pull out loads per meter in the rock. The positions of these fixed lengths are shown in drawing **1370-DWG-107 C00.**

The predicted load required to induce anchorage failure for the fixed lengths is shown in Table 6.1.1 below. This load has been calculated using an upper bound ultimate rock bond stress of 650 kPa.

Table 6.1.1: Predicted Load Required to Induce Anchorage Failure

Fixed Length (m)	Load (kN)
3	1400

6.1.2 Founding level

The holes shall be drilled to a depth into bedrock ensuring a minimum of 5 meters of rock occurs above the upper end of the fixed length of the anchor (measured vertically). Based on this requirement and the available boreholes logs, the predicted free length of the anchor will be approximately 63m. This length is based on the depth to bedrock encountered in BH L03 which was drilled near the test area. A copy of the borehole log for BH L03 is included in the Site Information.

The *Employer's* designer will monitor the rock chippings from the drilling operation and shall determine once the 5m requirement has been achieved to his satisfaction. The *Contractor* shall co-operate with the *Employer's* designer in this regard and shall provide the Employer's designer with the drill chippings.

6.1.3 Fixed anchor diameter

The fixed anchors shall have a diameter of 229mm.

6.2 Parts of the works designed by the *Contractor*

6.2.1 Ground anchor components

The *Contractor* shall be responsible for the structural design of the anchor components (fixed anchor details, tendons and anchor head) and shall design these components to have a characteristic strength (f_{pu}) of 2.5 times the predicted geotechnical capacity.

6.2.2 Reaction Beam

The *Contractor* shall be responsible for the design of a reaction / jacking beam against which the anchors will be stressed in accordance with the following:

- The beam shall be designed to resist all jacking loads such that it does not fail at ultimate load
- The beam shall be designed such that deflection of the beam at the anchor bearing plate under maximum jacking loads does not exceed 5mm.
- The beam shall be attached to the existing quay wall capping beam. Modification/demolition of the existing cantilever at the back of the capping beam is permitted.
- The *Contractor*'s designer is to ensure that the beam is designed such that the jacking loads transferred from the beam to the existing quay wall do not destabilise or fail the existing capping beam. The designer is to check for sliding, overturning and bearing of the existing capping beam.

6.2.3 Acceptance of Contractor's design

The *Contractor* shall not install any ground anchorages until the *Project Manager or Supervisor* has accepted the *Contractor's* design.

7.0 TENDONS

Tendons shall be formed from stress relieved wire strands according to BS 5896. The maximum relaxation of stress in the strand stressed to 70% of the actual breaking load shall be 3.5% after 1000 hours at 20±2°C.

Centralisers shall be provided on tendons to ensure a minimum cover of 10 mm of grout at suitable centres depending on angle of inclination of anchor. Centralisers shall not be bulky or compressible and shall minimise debonding at the grout/tendon interface.

The characteristic strength of the tendon shall be as per the requirements in section 6.2.1

8.0 MATERIALS AND CONSTRUCTION

8.1 Reaction beam

The reaction beam shall be constructed in accordance with the *Contractor's* Works Information and the *Employer's* requirements as detailed in section 6.2.2 above. The beam can be constructed of either reinforced concrete or structural steel work. Concrete construction shall be in accordance with *Employer* specification 1370-SPEC-002 Concrete in Marine Environment.

8.2 Drilling of Anchor Holes

Drilling equipment shall be suitable for the strata to be encountered and to install the anchorages at the required depths and angle of inclination.

The method of drilling shall be selected to minimise the disturbance of the surrounding soil and to prevent the possible formation of sinkholes.

Holes shall be drilled to the diameter specified by the *Employer*. Where necessary, casing shall be provided to bridge gaps or to prevent collapse of holes. On completion of drilling, holes shall be plugged at the anchorage to prevent entry of foreign materials.

The *Contractor* shall record the length, diameter and direction of all holes prior to inserting tendons.

After each hole has been drilled and flushed out, the hole shall be sounded to ascertain whether "fall-in" or "blow-out" has occurred, and whether it will prevent the tendon being fully homed. An additional 0.3 m to 0.7 m may be added to the hole length to accommodate any detritus that cannot be removed.

The flushing medium employed shall not have an adverse effect on the strength properties of the bedrock over the fixed length of the ground anchorage. The *Contractor* is to submit proposals for any flushing to be agreed by the *Supervisor*.

The volume of material removed during drilling shall be monitored to ascertain possible collapse of the borehole.

8.3 Drilling Tolerances

The deviation of the drill hole from the specified alignment shall not exceed 1 in 30.

Localised distortions shall not exceed 20 mm in any 3 m length of drill.

Maximum acceptance set up error shall be ±2° in any direction.

The borehole collar axis at the anchor head shall be positioned within a radial tolerance of 75 mm.

8.4 Water Testing of Anchor Holes

Water testing shall be carried out after drilling of the anchor hole has been completed by isolating the fixed anchor length with a pneumatic packer and injecting water at an excess pressure head relative to the local water table level of 100 kN/m². In the case of cement based grouts, pre-grouting is not required if leakage of water loss in the hole or fixed anchor section of the hole does not exceed 1 litre/minute measured over a period of 10 minutes.

If the rate of loss of water exceeds the flow criteria given above, then either a similar leakage test substituting cement grout for water shall be carried out or the hole shall be waterproofed by pre-grouting.

Holes adjacent to a hole being tested for water-tightness shall be monitored and recorded by the Contractor during the test to detect inter-hole connections.

If there is outflow of water from the adjacent hole or there are fissures in the surrounding ground that will affect the proper execution of anchorage grouting then the tested hole shall be water-proofed by pre-grouting.

Measured flows shall be related to 'excess head' and therefore the position of the water table shall be carefully monitored and recorded. The applied pressures inducing the flow shall be kept as low as possible.

8.5 Pre-Grouting of Anchor Holes

Pre-grouting, if required, shall be carried out by filling the hole with grout at an excess pressure not exceeding 10kPa in relation to the water level and re-drilling shall be carried out within 4 to 8 hours. The hole shall be tested for water tightness and if the test fails, the pre-grouting operation shall be repeated. If the pre-grouting is not successful after two trials, pressure grouting will be required.

8.6 Grout and Grouting of Anchor Holes

Immediately prior to grouting the hole shall be flushed with water to remove detritus produced by insertion of the tendon.

The grout, the grouting procedure and the equipment used shall be approved by the *Supervisor*.

The grout shall attain an unconfined compressive strength of 40MPa minimum at 28 days; six 100 mm cube samples (one for each anchor hole) shall be manufactured, cured and tested in accordance with BS 1881.

The water/cement ratio shall not exceed 0.45.

The bleeding of the grout at 20°C should generally not exceed 2% of the volume 3 hours after mixing and have a maximum of 4% of the volume.

The *Contractor* shall ensure that the required grouted fixed lengths are achieved. In this respect, the *Contractor* shall determine the most suitable method of grouting and checking the grout length. The method will probably include a suitable tremmie tube placed so that the grout is injected from the bottom of the hole upwards under a controlled pressure in one continuous operation to ensure complete encasement of the tendon anchorage.

Care shall be taken to ensure that injection pressures are not so high as to cause undue disturbance to the ground or rock.

Each borehole shall be monitored for excessive loss of grout as determined by the *Supervisor* after tendon homing and grouting has been carried out. Where grout loss is excessive the tendon shall be removed and cleaned, the hole flushed of grout and water or pre-grouting tests shall be carried out as described in Clause 4.3.

Full records of the quantity of grout injected shall be kept for each anchor installation in addition to all the relevant properties of the grout including strength, bleed, flow, shrinkage or expansion and setting times.

8.7 Installation of Anchors

Tendon homing and grouting shall be carried out within 72 hours of drilling the fixed anchor length.

A sleeve or nose cone shall be provided which shall minimise the risk of tendon or hole damage during homing.

The tendons shall be inserted at a steady controlled rate.

Tendons shall be securely fastened to prevent longitudinal movement during grouting.

The fixed anchor length of the anchorage shall be centrally located in the hole.

8.8 Stressing of Anchors

Stressing procedures and equipment shall comply with BS 8081:1989.

Stressing shall not commence until the grout forming the fixed anchor has achieved a crushing strength of 40MPa.

All stressing and load measurement equipment shall be approved by the *Supervisor* and the equipment shall be suitable for achieving the objective of the trial anchor programme.

Loads shall be monitored concurrently by load cell and by calibrated jack pressure, with the results correlated. The Contractor shall prove the repeatability of the load cells.

The test loading and recording shall be in accordance with BS 8081:1989 Section 11.2 using Table 13 for the loading cycle. Should the anchor not fail at twice the predicted geotechnical capacity as detailed in section 6.1.1 ,the maximum load should terminate at a limit equal to 95% of the 0.1% characteristic proof strength of the steel or 80% of the characteristic strength (f_{pu}) of the tendon.

Instruments for measuring load shall be calibrated in accordance with BS 8081:1989, using a test machine with an absolute accuracy of 0.5%. The instruments shall have a relative accuracy of 0.5% and shall be insensitive to temperature change.

Instruments for measuring extension shall be accurate to ±0.1 mm and shall be insensitive to temperature change.

8.9 Making good after completion of trials

The *Contractor* shall make good the site after the completion of the trials.

Failed anchors shall be cut off below top of concrete level such that there are no exposed or protruding strands. Anchors that have reached 80% of f_{pu} without failing shall be de-stressed and then cut off below top of concrete level.

If the jacking beam has been constructed from reinforced concrete, the beam can be left in place provided all recesses for anchor heads have been infilled and there are no sections of concrete protruding either above top of cope level or protruding seaward beyond the existing cope line. No steps in the quay wall will be permitted.

If the jacking beam has been constructed from structural steel, the Contractor shall remove all steel work including fasteners/holding down bolts and shall make good the concrete at all attachment points with an approved epoxy.

All temporary works used to support the *Contractor's* Equipment shall be removed and attachment points shall be made good.

9.0 STORAGE AND HANDLING

The manufacture's recommendations for the storage and handling of tendons shall be submitted to the *Supervisor* prior to any tendons arriving on site.

Anchor tendons shall be protected against mechanical damage and corrosion whilst being handled and shall be stored clear of the ground in a clean dry location.

Immediately prior to homing, the tendon shall be carefully inspected for damage to components and corrosion. No damaged or corroded tendons or components will be accepted in the Works.

10.0 RECORDS

10.1 Exploratory Drilling

Drilling reports shall be forwarded to the Supervisor on a daily basis.

The reports shall detail the drill runs, method of drilling, core recovery, material type, length and type of casing, delays and occurrences such as water loss.

10.2 Drilling of Anchor Holes

During the drilling operation all changes in ground strata shall be recorded together with records of water levels encountered, drilling rates, flushing requirements and stoppages.

The reports shall detail the daily depths of the holes, material type, drilling method, delays and occurrences such as water loss.

Drilling reports shall be forwarded to the Supervisor on a daily basis.

10.3 Installation of Anchors

The following items shall be recorded by the *Contractor* and submitted to the *Supervisor* within one week of the installation of each anchor:

a) Anchorage number, free length, fixed length, ground types, date commenced, flushing losses or gains, stoppages.
b) Tendon type, E value of steel, characteristic strength, relaxation value.
c) Full records of all properties of the grout shall be kept including mix formulation, age of constituents, air temperature, type of mixing equipment, grouting pressure, quantity of grout injected, details of samples and tests as appropriate.

10.4 Stressing of Anchors

The following items shall be recorded by the *Contractor* and submitted to the *Supervisor* within one week of the stressing of each anchor:

a) Jack type, area of piston, capacity, and date of last calibration.
b) Pump type, pressure gauge range, accuracy, date of test certification.
c) Load cell type, range, accuracy, date of test certification.
d) Type of anchor head assembly, lock-off mechanism, initial seating pressure, shank pull-in.

e) Plots of load vs. displacement data
f) Failure load

Details of all forces, extension, seating and other losses observed during all stressing operations and the times at which the data were monitored shall be recorded in the appropriate form for each anchorage

Details of the ground anchorage shall be recorded by the *Contractor* on record sheets.

10.5 Completion Report

Following completion of the trial, a factual report collating and summarising all the information described in 10.1 to 10.4 above shall be compiled by the Contractor and submitted to the *Supervisor* for acceptance.

10.6 As Built data and drawings

In addition to the completion report detailed in 10.5, the *Contractor* shall provide a drawing in CAD and pdf format of the existing capping beam as modified by the *Contractor* for the jacking beam. The drawing shall show the final layout of the capping beam (i.e. after demolition / making good by the *Contractor*)

ANNEXURE 3 – EXPLORATORY DRILLING DETAILS

ZAA Engineering Projects & Naval Architecture (Pty) Ltd

Project

PORT OF DURBAN BERTH DEEPENING

Berths 203 to 205

Sandy Materials		Clayey Materials	
Descriptions	**SPT N**	**Descriptions**	**SPT N**
Very loose	<5	Very Soft	<2
Loose	5-10	Soft	2-4
Medium dense	10-30	Firm	4-8
Dense	30-50	Stiff	8-15
Very dense	>50	Very Stiff	15-30

Borehole No. 1370 BHL03

Start Date	2012/07/09	**End Date**	2012/07/12
Project No:	1370 - DCT	**Orientation:**	Vertical
Location:	Berth 205 extension	**Elevation:**	+3.482 CDP
Logged By:	MAS Baleta	**Coordinates:**	X: 3306770.90
Drilling -	Fairbrother		Y: -1303.90
Contractor:	Geotechnical Engineering CC		**Page 1 of 2**

Elev. (CDP)	Run Elev. (CDP)	Material / Core Recovery %	RQD %	FF (J/m)	Method & Sample	SPT Value 'N'	SPT 'N' Bar Graph (0 – 100)	Lithology	General Description	Remarks	Depth (mbgl)
		-	-	-	WB				(3.48, -2.52) Slightly moist, light brown grey, cohesionless, very dense to loose, layered, medium Fine SAND with shell fragments. Imported, SAND FILL.		
	1.720										
	1.270	60	-	-	SPT	N=51					
	0.720	-	-	-	WB						
	0.270	56	-	-	SPT	N=39				+0.720 to +0.270 CDP: Intermittent pebbles (5 to 20 mm)	
	-0.280	-	-	-	WB						
	-0.730	40	-	-	SPT	N=7					
	-1.280	-	-	-	WB						
	-1.730	51	-	-	SPT	N=6					
	-2.280	-	-	-	WB						
	-2.730	44	-	-	SPT	N=20			(-2.52, -6.97) Moist, light brown grey, cohesionless, dense to very dense, layered, medium Fine SAND with intermittent shell fragments and clay lenses. Transported, fluvial-lacustrine / estuarine-lagoonal deposits.	-2.280 CDP: Approximate FILL / IN SITU contact.	
	-3.280	-	-	-	WB						
	-3.730	56	-	-	SPT	N=53					
	-4.280	-	-	-	WB						
	-4.730	44	-	-	SPT	N=33					
	-5.280	-	-	-	WB						
	-5.730	67	-	-	SPT	N=38					
	-6.280	-	-	-	WB						
	-6.730	76	-	-	SPT	N=68					
	-7.280	-	-	-	WB				(-6.97, -10.52) Moist, grey & dark grey, slightly cohesive, very soft, layered, clayey Fine SAND with clayey silt. Transported, fluvial-lacustrine / estuarine-lagoonal deposits.		
	-7.730	82	-	-	SPT	N=0					
	-8.280	-	-	-	WB						
	-8.730	89	-	-	SPT	N=2					
	-9.280	-	-	-	WB						
	-9.880	67	-	-	Shelby S01						
	-10.280	-	-	-	WB						
	-10.730	89	-	-	SPT	N=23			(-10.52, -13.97) As for -2.28 to -6.73 CDP: Cohesionless, fine SAND.		
	-11.280	-	-	-	WB						
	-11.730	73	-	-	SPT	N=52					
	-12.280	-	-	-	WB						
	-12.730	56	-	-	SPT	N=36					
	-13.280	-	-	-	WB						
	-13.730	49	-	-	SPT	N=44					
	-14.280	-	-	-	WB				(-13.97, -15.52) As for -6.73 to -10.28 CDP: Slightly cohesive, clayey silty Fine SAND.		
	-14.730	111	-	-	SPT	N=1					
	-15.280	-	-	-	WB						
	-15.730	100	-	-	SPT	N=0			(-15.52, -22.52) Slightly moist, dark brown grey, cohesive, very soft, (pasty), silty CLAY with intermittent & isolated nodules and shell fragments. Transported, fluvial-lacustrine / estuarine-lagoonal deposits.		
	-16.280	-	-	-	WB						
	-16.880	100	-	-	Shelby S02						
	-17.280	-	-	-	WB						
	-17.730	100	-	-	SPT	N=0					
	-18.280	-	-	-	WB						
	-18.730	111	-	-	SPT	N=0					
	-19.280	-	-	-	WB						
	-19.730	93	-	-	SPT	N=0					
	-20.280	-	-	-	WB						
	-20.730	100	-	-	SPT	N=1					
	-21.280	-	-	-	WB						
	-21.730	93	-	-	SPT	N=7					
	-22.280	-	-	-	WB						
	-22.730	-	-	-	SPT	N=7			(-22.52, -26.52) Moist, green brown & turquoise & orange brown, cohesionless, loose (medium dense in places), layered, silty Fine SAND. Transported, fluvial-lacustrine / estuarine-lagoonal deposits.		
	-23.280	-	-	-	WB						
	-23.880	100	-	-	Shelby S03						
	-24.280	-	-	-	WB						
	-24.730	53	-	-	SPT	N=9					
	-25.280	-	-	-	WB						
	-25.730	73	-	-	SPT	N=23					
	-26.280	-	-	-	WB						
	-26.730	96	-	-	SPT	N=16			(-26.52, -27.97) Slightly moist, dark grey, cohesive, stiff to very stiff, friable, clayey SILT with clayey fine sand. Transported, fluvial-lacustrine / estuarine-lagoonal deposits.		
	-27.280	-	-	-	WB						
	-27.730	100	-	-	SPT	N=39					
	-28.280	-	-	-	WB				(-27.97, -30.52)		

Elevation scale: 3.00, 2.00, 1.00, 0.00, -1.00, -2.00, -3.00, -4.00, -5.00, -6.00, -7.00, -8.00, -9.00, -10.00, -11.00, -12.00, -13.00, -14.00, -15.00, -16.00, -17.00, -18.00, -19.00, -20.00, -21.00, -22.00, -23.00, -24.00, -25.00, -26.00, -27.00, -28.00

Depth scale: 0.00, 1.00, 2.00, 3.00, 4.00, 5.00, 6.00, 7.00, 8.00, 9.00, 10.00, 11.00, 12.00, 13.00, 14.00, 15.00, 16.00, 17.00, 18.00, 19.00, 20.00, 21.00, 22.00, 23.00, 24.00, 25.00, 26.00, 27.00, 28.00, 29.00, 30.00, 31.00, 32.00

ZAA Engineering Projects & Naval Architecture (Pty) Ltd
31 Melkhout Crescent
Hout Bay
Cape Town
7806
T: +27 (0) 21 791 9100

ZAA Project Number: 1370

Client Project Number: M-2122830-408

Client: Transnet
Project: PORT OF DURBAN BERTH DEEPENING
Berths 203 to 205

Borehole No.: 1370 BHL03

ZAA Engineering Projects & Naval Architecture (Pty) Ltd

Project

PORT OF DURBAN BERTH DEEPENING

Berths 203 to 205

Sandy Materials		Clayey Materials	
Descriptions	**SPT N**	**Descriptions**	**SPT N**
Very loose	<5	Very Soft	<2
Loose	5-10	Soft	2-4
Medium dense	10-30	Firm	4-8
Dense	30-50	Stiff	8-15
Very dense	>50	Very Stiff	15-30

Borehole No. 1370 BHL03

Start Date	2012/07/09	**End Date**	2012/07/12
Project No:	1370 - DCT	**Orientation:**	Vertical
Location:	Berth 205 extension	**Elevation:**	+3.482 CDP
Logged By:	MAS Baleta	**Coordinates:**	X: 3306770.90
Drilling -	Fairbrother		Y: -1303.90
Contractor:	Geotechnical Engineering CC		**Page 2 of 2**

Elev. (CDP)	Run Elev. (CDP)	Material / Core Recovery %	RQD %	FF (J/m)	Method & Sample	SPT Value 'N'	SPT 'N' Bar Graph 0 100	Lithology	General Description	Remarks	Depth (mbgl)
-29.00	-28.730	82	-	-	SPT	N=46			As for -22.28 to -26.28 CDP: Cohesionless, silty Fine SAND.		32.00
	-29.280	-	-	-	WB						
-30.00	-29.730	71	-	-	SPT	N=34					33.00
	-30.280	-	-	-	WB						
-31.00	-30.730	67	-	-	SPT	N=32			(-30.52, -32.82) Slightly moist, olive green brown, cohesionless, very dense, fine sandy SILT. Residual, St Lucia Fm.		34.00
	-31.280	-	-	-	WB					-31.280 to -31.680 CDP: Calcrete lens	35.00
-32.00	-32.280	40	-	-	NWD4						
	-32.580	80	-	-	SPT	N=R					36.00
-33.00	-33.780	93 / 87	59	13	NWD4				(-32.82, -40.02) Dark brownish Olive-Green, moderately to highly weathered, closely to widely fractured, VERY SOFT ROCK, interbedded SILTSTONE and MUDSTONE. Cretaceous St. Lucia Formation.	-33.380 to -33.610 CDP: Calcrete lens	37.00
-34.00	-35.280	60 / 53	7	12	NWD4				No definitive primary fabric with poorly defined bedding as coarser horizons grade into finer horizons.		38.00
-35.00	-36.780	31 / 25	11	5	NWD4				Joint surfaces are planar, smooth, no fill, sub-horizontal at irregular spacing (50-300mm), sub-vertical joints are conspicuous.		39.00
-36.00	-38.280	29 / 15	8	1	NWD4				Note the presence of fossil shells and imprints associated with, but not confined to, hard calcrete layers.	-36.480 to -36.650 CDP: Calcrete lens	40.00
-37.00	-39.780	88 / 57	51	6	NWD4						41.00
-38.00											42.00
-39.00										END OF BOREHOLE (-39.78 CDP / 43.50 mbgl)	43.00
-40.00											

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31 Melkhout Crescent
Hout Bay
Cape Town
7806
T: +27 (0) 21 791 9100

ZAA Project Number: 1370

Client Project Number: M-2122830-408

Client: Transnet
Project: PORT OF DURBAN BERTH DEEPENING
Berths 203 to 205

Borehole No.: **1370 BHL03**

ZAA Engineering Projects & Naval Architecture (Pty) Ltd

Project

Deepening of Berths 203 to 205

Trial Anchors

Sandy Materials		Clayey Materials	
Descriptions	**SPT N**	**Descriptions**	**SPT N**
Very loose	<5	Very Soft	<2
Loose	5-10	Soft	2-4
Medium dense	10-30	Firm	4-8
Dense	30-50	Stiff	8-15
Very dense	>50	Very Stiff	15-30

Borehole No. 1370-EAT02

Start Date	13/03/14	**End Date**	01/04/14
Project No:	1370	**Orientation:**	45 Degrees
Location:	205 Extension	**Elevation:**	+ 3.75 mCDP
Logged By:	M. Holmwood	**Coordinates:**	X: 1351.47
Drilling -	Esorfranki		Y: -3306743.18
Contractor:	Geotechnical		**Page 1 of 1**

Depth (CDP)	Run Depth (mbgl)	Material / Core Recovery %	RQD %	FF (J/m)	Method & Sample	SPT Value 'N'	SPT 'N' Bar Graph 0 100	Lithology	General Description	Remarks	Depth (mbgl)
	36.80	26/22	7	17	NXC	-			(-32.10, -33.34) Olive brown, slightly to moderately weathered, very fine grained, thinly bedded, one +-45 deg. fracture, medium hard CALCRETE. Note: Abundant fossil remnants.		36.00
-33.00	37.87	70/70	49	9	NXC	-			(-33.34, -40.23) Olive dark brown, moderatley weathered, thinly to medium bedded, slightly to moderately fractured with scattered +-45 to 85 deg. fractures with creamy infill on lower calcrete surfaces, very soft SILTSTONE with interbedded CALCRETE.		37.00
-34.00	38.57	90/85	60	7	NXC	-					38.00
-35.00	39.63	33/20	7	17	NXC	-					39.00
-36.00	40.34	100/70	70	9	NXC	-					40.00
-37.00	41.40	97/97	77	7	NXC	-					41.00
-38.00	42.11	100/50	50	12	NXC	-					42.00
-39.00	43.17	100/83	73	8	NXC UCS UCS	-					43.00
-40.00	44.23	100/73	53	8	 UCS NXC	-					44.00
	44.69	100/0	0	0	NXC	-			(-40.23, -40.94) Wet, olive dark brown, cohesive, very soft, intact, fine sandy clayey SILT, Residual Siltstone.		

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31 Melkhout Crescent
Hout Bay
Cape Town
7806
T: +27 (0) 21 791 9100

ZAA Project Number: 1370

Client Project Number: M-2122-830-571

Client Transnet SOC LTD
Project Deepening of Berths 203 to 205
Trial Anchors

ZAA Engineering Projects & Naval Architecture (Pty) Ltd

Project: Deepening of Berths 203 to 205
Trial Anchors

Sandy Materials		Clayey Materials	
Descriptions	**SPT N**	**Descriptions**	**SPT N**
Very loose	<5	Very Soft	<2
Loose	5-10	Soft	2-4
Medium dense	10-30	Firm	4-8
Dense	30-50	Stiff	8-15
Very dense	>50	Very Stiff	15-30

Borehole No. 1370-EAT05

Start Date	04/04/14	**End Date**	17/04/14
Project No:	1370	**Orientation:**	45 Degrees
Location:	205 Extension	**Elevation:**	+ 3.75 mCDP*
Logged By:	M. Holmwood	**Coordinates:**	X: 1348.28
Drilling -	Esorfranki		Y: -3306751.66
Contractor:	Geotechnical		**Page 1 of 1**

Depth (CDP)	Run Depth (mbgl)	Material / Core Recovery %	RQD %	FF (J/m)	Method & Sample	SPT Value 'N'	SPT 'N' Bar Graph (0 – 100)	Lithology	General Description	Remarks	Depth (mbgl)
-32.00	35.99	73/69	63	4	NXC	-			(-31.32, -32.24) Olive dark brown, moderately weathered, very fine grained, medium bedded, slightly fractured, very soft SILTSTONE.		36.00
-33.00	36.91	83/0	0	-	NXC	-			(-32.24, -33.16) Wet, light olive brown, slightly cohesive, very soft, intact, slightly clayey silty medium SAND.		37.00
-34.00	38.01	100/97	90	6	NXC	-			(-33.16, -41.19) Olive brown to dark olive brown, moderately to highly weathered in places, very fine, predominantly medium bedded with scattered thin beds in places, slightly fractured with fractures ranging from +-45 to +-80 deg., very soft and medium hard SILTSTONE with CALCRETE interbeds.		38.00
-35.00	39.07	100/80	70	5	NXC	-					39.00
-36.00	40.13	90/90	90	4	NXC	-					40.00
-37.00	41.01	47/27	0	0	NXC	-					41.00
-38.00	42.07	4727	17	35	NXC	-					42.00
-39.00	42.78	85/65	65	6	NXC UCS NXC	-					43.00
-40.00	43.84	70/70	60	7	NXC UCS NXC	-					44.00
-41.00	44.94	100/87	65	0	NXC UCS NXC	-					

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31 Melkhout Crescent
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Cape Town
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T: +27 (0) 21 791 9100

ZAA Project Number: 1370
Client Project Number: M-2122-830-571

Client Transnet SOC LTD
Project Deepening of Berths 203 to 205
Trial Anchors

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SOILTECH

DRILLING REPORT

DBN 00089

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203 - 205 TRIAL ANCHORS
Site: BERTH 203 - 205 DURBAN HARBOUR
DST: KZN 0072
BH Number: LEA1 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
Wingbit	0	28,0	28,0
HW Casings	0	7,5	7,5
Core Boxes			
Piezometer Installed (m)			

Date: 13-03-2014
Day: THURSDAY
Sheet: 1 of 16
Drill Rig: LONGYEAR 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
0	28,0					Washbore			

Remarks: Did a DST. Carried out a Daily Plant Checklist. Checked location, position marked and reference point for C.D level with ZAA. Drilling inclination was checked at 45° on drilling rig that was set up the previous day. Started washboring at 08h20. Washbored to 28,0m by 11h30. The operator stated pulling out the drill rods for the lunch break. Whilst pulling out the rods, the last 2 rods slipped off the pipe wrench and fell into the borehole. He tried fishing for the rods but was unsuccessful. The operator drilled down HW casings to isolate the drill rods in the borehole. 7,50m of HW casings were drilled down by the end of the day.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00090

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 02
Drilling Angle: 45° INCLINED.
Drilling Direction:
Water Level:

Type	From	To	Total
HW Casings	7,50	25,50	18,00
NX Corebarrel	13,50	13,70	0,20
Core Boxes			
Piezometer Installed (m)			

Date: 14-03-2014
Day: FRIDAY
Sheet: 2 of 16
Drill Rig: LONGYEAR 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
13,50	13,70			0,06		Boulder.			

Remarks: Did DS11, Carried out Plant Daily checklist. Filled rig with diesel and cleaned out sumps. Mixed bentonite drilling fluid and started drilling at 08h00. Drilled down HW casings from 7,50m - 13,50m. Casings would not go beyond 13,50m. Tried pushing by last rods without success. Cored through obstruction with NX corebarrel. Cored through boulder recovering 0,06m of core. Continued drilling down HW casing to 25,50m. Took slurry sample in a plastic sample bottle at 24,0m.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MAFOKA.

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DRILLING REPORT

DBN 00091

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: K2N 0072
BH Number: EAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NQ Corebarrel	25,50	25,70	0,20
NQ Corebarrel	28,00	28,20	0,20
Single Corebarrel	28,20	34,00	5,80
Core Boxes			
Piezometer Installed (m)			

Date: 15-03-2014
Day: SATURDAY
Sheet: 3 of 16
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
25,50	25,70			0,09		Boulder			
28,00	28,20			0,04		Boulder			
28,20	34,00					Washbore.			

Remarks: Did DSTI - Carried out Daily plant checklist. Started at 07h30. Tried fishing for missing drill rods at 25,50m but was unsuccessful. Cored with NQ corebarrel through another boulder at 25,50m. Washbored from 25,50m - 34,00m by the end of the day. Took slurry samples in plastic sample bottles at 28,0m, 31,0m and 34,0m.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00092

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203 - 205 TRIAL ANCHORS
Site: BERTH 203 - 205 DURBAN HARBOUR
DST: KZN 0072
BH Number: LAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
Single Cardband	34,00	50,10	16,10
Core Boxes			
Piezometer Installed (m)			

Date: 17-03-2014
Day: MONDAY
Sheet: 4 of 16
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
34,00	50,10					Washbore.			

Remarks: Did DSTI. Carried out Plant daily checklist. Cleaned out sump and mixed new batch of bentonite drilling fluid. Started drilling at 08h00. Washbored from 34,0m taking slurry samples at 37,0m, 40,0m, 43,0m, 46,0m, 49,0m and 50,10m. Stopped washboring at 50,10m recovering clay and siltstone pebbles. Decided to drill down HQ casings to 50,10m and start coring. Casing were stuck at 25,50m. Used jarring hammer to loosen casings.
Rain showers from 14h45 - 15h20.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00093

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAY 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
HW Casings	25,50	31,50	6,00
Core Boxes			
Piezometer Installed (m)			

Date: 18-03-2014
Day: TUESDAY
Sheet: 5 of 16
Drill Rig: LONGYEAR RIG - 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
25,50	31,50					Drilling down HW casings			

Remarks: Did DSTI. Carried out Daily plant checklist. Mixed bentonite drilling fluid and started drilling at 07h35. Continued using jarring hammer to loosen casings. Once loose started drilling HW casings through boulder at 25,50m. Drilled through boulder layer by 14h30 and continued drilling casings to 31,50m at the end of the day.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00094

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EA1 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
HW Casings	31,50	38,50	7,00
Core Boxes			
Piezometer Installed (m)			

Date: 19-03-2014
Day: WEDNESDAY
Sheet: 6 of 16
Drill Rig: LONGYEAR 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
						—			

Remarks: Did a JSA and carried out Plant daily checklist. Mixed bentonite drilling fluid and started drilling at 08h00. Drilled down HW casings from 31,50m - 38,50m. Obstruction at 38,50m and casing would not go further. Put down BWY drill rods with single corebarrel into casings and drilled down to 38,50m removing sand from inside the casings. Monopump was not pumping strongly to remove the sand.
BREAKDOWN: 16h00 - 17h00. Monopump not pumping sand out of casings. Phoned Franki yard for rotor and stator for monopump. Crew cleaning working area.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00095

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: LA1 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
Core Boxes			
Piezometer Installed (m)			

Date: 20-03-2014
Day: THURSDAY
Sheet: 7 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.

Remarks: Did a DSTI and carried out Plant daily checklist. Started at 07h30. Crew filling in trial Anchor holes where concrete slab was removed. Waited for spares for monopump. 07h00 - 12h00. Repaired monopump by 12h25 and started drilling at 12h30. Cleaned sand out of casings and washbored to 50,10m. Pulled out drill rods and tried drilling down casings. Casings were stuck. Used jarring hammer to loosen casings. Removed 3,0 m of casings before they started turning. Mixed 2 drums of bentonite drilling fluid and pumped into borehole while turning the casings. Casings down to 35,50 m.
BREAKDOWN: 07h00 - 12h30 - monopump repairs.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00096

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: FAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
Core Boxes			
Piezometer Installed (m)			

Date: 21-03-2014
Day: FRIDAY
Sheet: 8 of 06
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.

Remarks: Public Holiday.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MAKOKA

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SOILTECH

DRILLING REPORT

DBN 00097

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EA1 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
HW Casings	38,50	47,0	8,50
Core Boxes			
Piezometer Installed (m)			

Date: 24-03-2014
Day: MONDAY
Sheet: 9 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.

Remarks: Did DSTI and carried out Plant daily checklist. Started at 07h30. Turned casings with 48" pipe wrench to loosen them. Loosened and turned casings at 10h20. Mixed bentonite drilling fluid and pumped into borehole. Drilled down HW casings from 35,50m – 47,00m. Another obstruction at 47,0 m. Put down BQ rods with single core barrel to drill through 47,0m. Mixed more bentonite drilling fluid and pumped into borehole to keep the HW casings lubricated.

Site visited by:

Client: TRANSNET CAPITAL PROJECT

Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00098

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
HW Casings	47,00	50,10	3,10
Core Boxes			
Piezometer Installed (m)			

Date: 25-03-2014
Day: TUESDAY
Sheet: 10 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.

Remarks: Did DSTI and carried out Plant daily checklist. Filled drums with water and mixed bentonite drilling fluid. Started drilling at 07h40. Washbored through obstruction at 47.0m with NTC corebarrel. Pulled out drill rods and drilled down HW casings from 47,0m - 50,10m. Mixed bentonite drilling fluid and pumped into borehole.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MASOKA

WHITE = CLIENT • YELLOW = CONTRACT FILE • GREEN = BOOK COPY

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SOILTECH

DRILLING REPORT

DBN 00099

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: K2N 0072
BH Number: EA1 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NWD4 Corehardrill	50,70	54,55	3,85
Core Boxes			1
Piezometer Installed (m)			

Date: 26-03-2014
Day: WEDNESDAY
Sheet: 11 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
50,70	52,05	1,35		0,35	25,9				
52,05	53,55	1,50		1,05	70				
53,55	54,55	1,00		0,90	90				

Remarks: Did DSII and carried out Plant daily checklist. Started at 07h20. Removed 1,50m HW casing and replaced with 1,80m to lower height of casing for coring. Cleaned inside casing with bentonite drilling fluid using N+C corehardrill. Cleaned sumps and mixed Polyflip drilling fluid. Cleaned HW casing again with Polyflip drilling fluid. Started coring at 11h10. Corehardrill went down to 50,70m. St. Cored from 50,70m - 52,05 recovering 0,35m. Cored from 52,05m - 53,55m recovering 1,05m. Cored from 53,55m - 54,55m recovering 0,90m core.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00100

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: BAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
—	—	—	—
Core Boxes			
Piezometer Installed (m)			

Date: 27-03-2014
Day: THURSDAY
Sheet: 12 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DERUK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
						—			

Remarks: RAINDAY - No work carried out.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00602

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NWD4 Corebarrel	54,55	59,55	5,00
Core Boxes			1
Piezometer Installed (m)			

Date: 28-03-2014
Day: FRIDAY
Sheet: 13 of 16
Drill Rig: LONGYEAR RIG 1983
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
54,55	56,05	1,50				Siltstone rock. (Cretaceous)			
56,05	57,05	1,00		1,00	100	" " "			
57,05	58,55	1,50		1,46	97	" " "			
58,55	59,55	1,00		1,00	100	" " "			

Remarks: Did DSTI and carried out Plant daily checklist. Cleaned out sump and mixed a new batch of Polyflip drilling fluid. Started drilling at 08h10. Put down NWD4 corebarrel and cored from 54,55m - 56,05m recovering . Checked the drilling fluid consistantcy. On the second run, cored from 56,05m - 57,05m recovering 1,00m. Adjusted the drilling fluid flow whilst coring. Cored from 57,05m - 58,55 on the third run recovering 1,46m. Cored from 58,55m - 59,55m on the fourth run recovering 1,00m

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00603

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NW 4 Corebarrel	59,55	62,55	3,00
Core Boxes			
Piezometer Installed (m)			

Date: 29-03-2014
Day: SATURDAY
Sheet: 14 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
59,55	61,05	1,50		1,60	106,6	Siltstone - Cretaceous core.			
61,05	62,55	1,50		1,60	106,6	" " "			

Remarks: Did DSTI and carried out Plant daily checklist. Cleaned out sump and mixed Polyflip drilling fluid. Put down NW 4 corebarrel with drill rods and started drilling at 08h35. Cored from 59,55m - 61,05m recovering 1,60m core. Put down a second corebarrel and cored from 61,05 - 62,55m recovering 1,60m core.
One crew member did not turn up for work as he attended a family funeral. This slowed down the drilling process.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00604

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NQ3 4 Corehead	62,55	63,20	0,65
Core Boxes			
Piezometer Installed (m)			

Date: 31-03-2014
Day: MONDAY
Sheet: 15 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
62,55	63,20	0,65		0,65	100	Siltstone core - Cretaceous			

Remarks: Did DSM and Plant daily checklist. Cleaned out sump and mixed Polyflip drilling fluid. Put down NQ3 4 coreharrel and drill rods and started drilling at 08h10. Cored from 62,55m - 63,20m recovering 0,65m core. Mixed Bentonite drilling fluid and pumped into borehole turning the HW casings at the same time to keep it lubricated for removal. Crew cleaned working area. Grouting equipment being sent to site to grout EAT02.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00605

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 02
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
Core Boxes			
Piezometer Installed (m)			

Date: 01-04-2014
Day: TUESDAY
Sheet: 16 of 16
Drill Rig: LONGYEAR RIG 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
						Grouted EAT 02			

Remarks: Did DSR and Plant daily checklist. Grouting equipment arrived on site. Set up and tested grouting equipment. Mixed a 10 MPa grout and grouted borehole EAT 02 pulling up casings while grouting. Grouted down to 63.20m. Completed grouting hole, cleaned equipment and started cleaning cooking area. Pumped grout into 1000 litre tanks and backfilled bumps. Moved drill rig to clean concrete platform. Completed borehole EAT 02.

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Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00606

Client: TRANSNET CAPMAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
Core Boxes			
Piezometer Installed (m)			

Date: 04-04-2014
Day: FRIDAY
Sheet: 1 of 11
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
						No drilling.			

Remarks: 02-04-2014: Did JSA and Plant daily checklist. Moved drill rig and drilling equipment to position EAT 05 and set up. Excavated sumps and barricade drilling area with fencing. Filled drums with water and mixed bentonite drilling fluid. The final set up of the drill rig to 45° inclined could not be carried out as the rig would start and switch off immediately. Phoned Franki workshop to send out an electrician.
Breakdown: 03-04/04/2014 Electrician working on drill rig.

Site visited by:
Client: TRANSNET CAPMAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00607

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
Winghit	0	25,50	25,50.
HW Casings	0	18,00	18,00
Core Boxes			1
Piezometer Installed (m)			

Date: 07-04-2014
Day: MONDAY
Sheet: 2 of 11
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
0	25,5					Washbore.			

Remarks: Did a JSA and carried out Plant daily checklist. Drill rig would not start. Called out electrician who arrived at 09h30. The problem was electrical. He got the rig started at 09h40. Connect drill rod and winghit and started drilling at 09h45. Washbored with winghit down to 25,50m. Found obstruction at 25,50m. Pulled out drill rods and winghit and drilled down HW casings to 18,0m by the end of the day. Got water loss from 24,00m - 25,50m.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00608

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS.
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NXC Corebarrel	26,00m	33.00m	7,00
NX Corebarrel	25,20	26,00m	0,80
HW Casings	18,00	27,00m	9,00
Core Boxes			
Piezometer Installed (m)			

Date: 08-04-2014
Day: TUESDAY
Sheet: 3 of 11
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
25,20	26,00	0,80				Boulder			
26,00	33,00					Washbore.			

Remarks: Did a DSTI and carried out Plant daily checklist. Mixed bentonite drilling fluid and started drilling at 07h30. Drilled down HW casings from 18,00m - 25,50m. Put down NX corebarrel and cored from 25,20m - 26,0m through boulder recovering 0,70m of boulder. Pulled out corebarrel and put down NXC corebarrel to clean through casings to 27,00m. Drilled down more casings from 25,50m - 27,0m. Washbored through casings to 33,00m taking slurry samples at 30,0m and 33,0m.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MAFOKA.

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DRILLING REPORT

DBN 00609

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
N+C Corebarrel	33,00	44,00	11,00
HW Casings	27,00	42,00	15,00
Core Boxes			
Piezometer Installed (m)			

Date: 09-04-2014
Day: WEDNESDAY
Sheet: 4 of 11
Drill Rig: LONGYEAR 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
33,00	44,00					Washbore			

Remarks: Did DS11 and Plant daily checklist. Cleaned out sump and mixed bentonite drilling fluid. Started drilling at 07h40. Cleaned out casings with N+C corebarrel and continued washboring from 33,00m - 36,00m. Pulled out N+C corebarrel and drilled down HW casings from 27,00m - 36,00m. Got water loss from 35,00m - 36,00m. Filled drums with water and mixed new batch of bentonite drilling fluid. Continued washboring from 36,00m - 44,00m taking slurry samples every 3,00m. Pulled out N+C corebarrel and drilled down HW casings from 36,00m - 42,00m. Mixed a new batch of bentonite drilling fluid and pumped into borehole.
PROBLEMS: Had diesel leak on monopump. Replaced it with a big Lister monopump.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00610

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR.
DST: KZN 0072
BH Number: EA1 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NQ Corebarrel	44.00	49,60	5,60
HW Casings	42,00	49,60	7,60
NWJ4 Corebarrel	49,60	52,20	2,60
Core Boxes			
Piezometer Installed (m)			

Date: 10-04-2014
Day: THURSDAY
Sheet: 5 of 11
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
44,00	49,60					Washbore			
49,60	50,90					Siltstone Rock			
50,90	52,20					SAND + Siltstone			

Remarks: Did DS11 and Plant daily checklist. Mixed bentonite drilling fluid and started drilling at 07h40. Washbored from 44,00m - 49,60m onto Siltstone rock. Drilled down HW casings from 42,00m - 49,60m. Flushed inside casings with clean bentonite drilling fluid, Cleaned sumps and mixed Polyflip drilling fluid. Cored with NWJ4 corebarrel from 49,60m - 50,90m recovering 0,85m of Siltstone rock. Cored again from 50,90m - 52,20m recovering 1,08m of sample consisting of 1,04m of SAND and 0,04m of Siltstone. Mixed a batch of bentonite drilling fluid and pumped into borehole turning the casings at the same time.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00611

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EA1 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NWD4 Corebarrel	52,20	56,75	4,55
HW Casings	49,60	50,70	1,10
Core Boxes			1
Piezometer Installed (m)			

Date: 11-04-2014
Day: FRIDAY
Sheet: 6 of 11
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
52,20	53,75	1,55		1,55	100	Siltstone.			
53,75	55,25	1,50		1,50	100	"			
55,25	56,75	1,50		1,35	90	"			

Remarks: Did DST1 and Plant daily checklist. Filled drums with water and mixed Bentonite drilling fluid. Started drilling at 07h40. Drilled down HW casings from 49,60m - 50,70m. Cleaned out sump and mixed Polyflip drilling fluid. Put down NWD4 corebarrel and cored from 52,20m - 53,75m recovering 1,55m core. Put down another NWD4 corebarrel and cored from 53,75m - 55,25m recovering 1,50m core. Put down another NWD4 corebarrel and cored from 55,25m - 56,75m recovering 1,35m core.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00612

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NQ 4 Corebarrel	56,75	60,50	3,75
Core Boxes			
Piezometer Installed (m)			

Date: 12-04-2014
Day: SATURDAY
Sheet: 7 of 11
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: J LOUW
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M) From	To	Adv	Time	CORE RECOVERY (m)	%	DESCRIPTION	TEST DEPTH	SPT Number of Blows	OTHER TEST U4 Shelby etc.
56,75	58,00	1,25		0		No Sample.			
58,00	59,50	1,50		0,70	47	Siltstone			
59,50	60,50	1,00		0,85	85	"			

Remarks: Did DS11 and Plant daily checklist. Filled drums with water and mixed Polyflip drilling fluid. Started drilling at 07h40. Put down NQ4 Corebarrel and cored from 56,75m - 58,00m. Corebarrel got stuck at 58,00m. Got the corebarrel unstuck after 30minutes and pulled it out. There was no sample in the barrel. Changed the corebarrel bit and tried to retrieve the lost sample but was unsuccessful. Cored from 58,00m - 59,50m recovering 0,70m of core which included hard pebble sized siltstone with shell fragments. Did another run of coring from 59,50m - 60,50m recovering 0,85m core.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00613

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
NW34 Coreberrel	60,50	62,90	2,40
Core Boxes			
Piezometer Installed (m)			

Date: 14-04-2014
Day: MONDAY
Sheet: 8 of 11
Drill Rig: LONGYEAR - 1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
60.50	62,00	1,50		1,05	70	Siltstone			
62,00	62,90	0,90				No Sample			

Remarks: Did DSTI and Plant daily checklist. Cleaned sump, filled water and mixed Polyflip drilling fluid. Matthew came on site and looked at the core samples. He instructed us to core to 63,60m. Put down NW34 coreberrel and started drilling at 10h15. Cored from 60,50m - 62,00m recovering 1,05m core. Did a second drill run from 62,00m - 62,90m. At 62,90m a drilling fluid leak appeared from the water swivel and it gradually became worse. Stopped the drilling and phoned the Franki Workshop to send out a mechanic. Informed Matthew about the problem.
BREAKDOWN: 15h00 - 17h00. Drilling fluid leak from the water swivel.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MASOKA

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DRILLING REPORT

DBN 00614

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
–	–	–	–
Core Boxes			
Piezometer Installed (m)			

Date: 15-04-2014
Day: TUESDAY
Sheet: 9 of 11
Drill Rig: LONGYEAR -1933
Driller: LAWRENCE
Supervisor: DEREK.
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
						No Drilling.			

Remarks: BREAKDOWN: 07h00 - 17h00. Mechanic arrived on site to repair leaking water swivel. The water swivel shaft was removed where the "O" ring was found to be worn and the threads on the shaft stripped. The "O" ring was replaced. Nickel compound was put on the stripped threads and the shaft was replaced. This was to be a temporary solution until a new shaft was made available. There was movement on the shaft when fitted. This did not work so a new shaft was ordered.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MASOKA.

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DRILLING REPORT

DBN 00615

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: K2N 0072
BH Number: EA1 05
Drilling Angle: 45° INCLINED.
Drilling Direction:
Water Level:

Type	From	To	Total
NWP4 Corebarrel	62,00	63,50	1,50
Core Boxes			
Piezometer Installed (m)			

Date: 16-04-2014
Day: WEDNESDAY.
Sheet: 10 of 11
Drill Rig: LONGYEAR -1933
Driller: LAWRENCE
Supervisor: DEREK
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
62,00	63,55	1,50		1,55		Siltstone			

Remarks: Did DSI and Plant daily checklist
BREAKDOWN: 07h00 - 14h00. Mechanic removed water swivel shaft from gearbox, took to Franki workshop and got a replacement part. He drove back to site and fitted the water swivel shaft to the gearbox. The drill rig was reset to 45° inclined, the corebarrel and drill rods put down into the borehole and started coring at 14h50. Cored from 62,00m - 63,50m recovering 1,55m core. Completed drilling of EA1 05.

Site visited by:
Client: TRANSNET CAPITAL PROJECTS
Driller: LAWRENCE MASOKA.

WHITE = CLIENT • YELLOW = CONTRACT FILE • GREEN = BOOK COPY

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esorfranki GEOTECHNICAL

SOILTECH

DRILLING REPORT

DBN 00616

Client: TRANSNET CAPITAL PROJECTS
Project: BERTH 203-205 TRIAL ANCHORS
Site: BERTH 203-205 DURBAN HARBOUR
DST: KZN 0072
BH Number: EAT 05
Drilling Angle: 45° INCLINED
Drilling Direction:
Water Level:

Type	From	To	Total
-	-	-	-
Core Boxes			
Piezometer Installed (m)			

Date: 17-04-2014
Day: THURSDAY
Sheet: 11 of 11
Drill Rig: LONGYEAR 1933
Driller: LAWRENCE
Supervisor: DERER
Establish: Hours/Min
Drilling: Hours/Min

DRILL RUNS (M)				CORE RECOVERY		DESCRIPTION	TEST DEPTH	SPT	OTHER TEST
From	To	Adv	Time	(m)	%			Number of Blows	U4 Shelby etc.
						Grouted Borehole			

Remarks: Did JSA and Plant daily checklist. Started at 07h20. Mixed cement grout to 10 MPa. Pumped grout into borehole whilst pulling up HW casings. Grouted borehole and pulled out 51,00 m of HW casings. Cleaned grouting equipment. Cleaned out sumps and backfilled with sand. Washed drilling equipment and packed neatly on rod stands. Cleaned drilling area. Completed borehole EAT 05.

Site visited by:

Client: TRANSNET CAPITAL PROJECTS

Driller: LAWRENCE MASOKA

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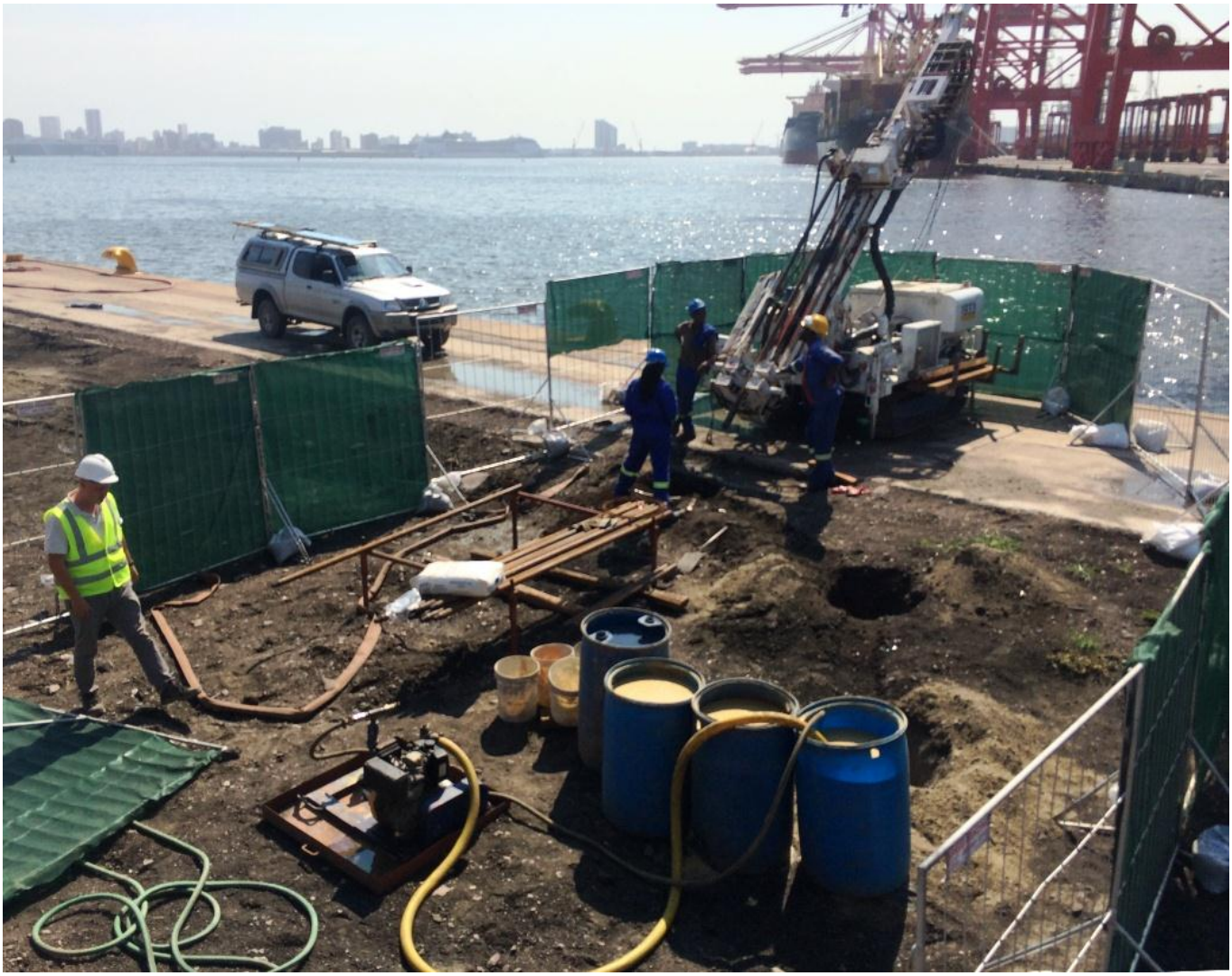
D&G Print 68722

Exploratory Drilling Rig and Associated Equipment



Boart Longyear DB520 – Site layout

Boart Longyear (DB520) rotary core drilling rig working at BH-EAT-02. Water pump and drilling mud mixing barrels visible in the foreground. Additional drilling rods and drilling tools on trestles in the mid-ground. A furrow and holes in the ground are visible above the blue mixing barrels. These serve to channel drilling fluid expelled from the borehole into a sump from where it is reused.

Boart Longyear DB520 – Guide for drilling rods

Boart Longyear DB520 – Measurement of drilling declination

Boart Longyear DB520 – Washbore drilling tool

Boart Longyear DB520 – Core barrel
PQ-size rotary core barrel being flushed clean.

Job Description: KZN 11710

THEKWINI SOILS LAB. CC
VAT REGISTRATION NO 4590210961
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Job no.:	7316
Lab no.:	06000
Source:	EAT02 - S01
Depth:	60.40 - 60.60

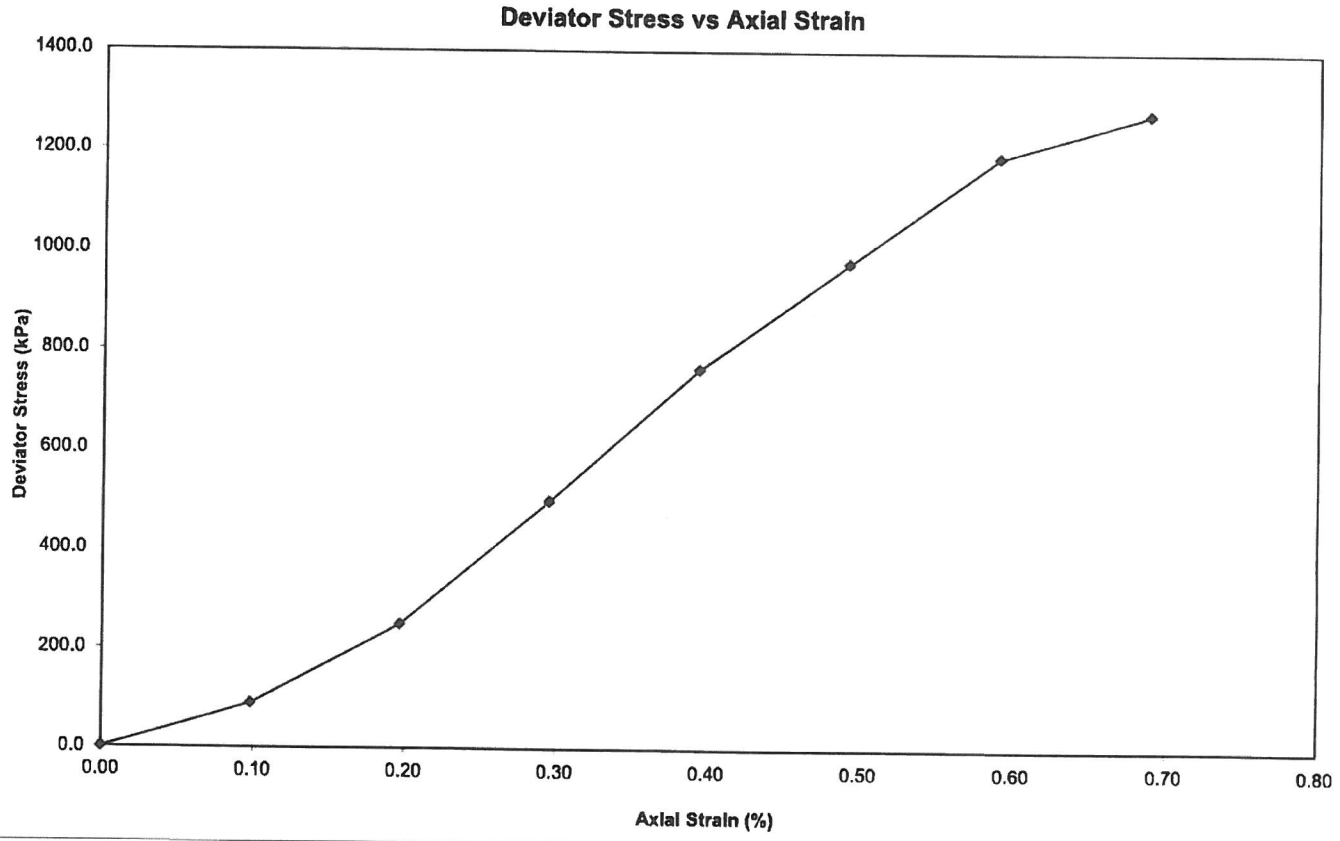
Length (cm)	10.17
Diameter (cm)	4.875
Area (cm2)	18.67
Volume (cm3)	189.83

Mass (g):	466.6
Bulk Density (kg/m3):	2458
Proving Ring Factor:	666

Strain Guage	Proving Rinng	%Strain	Deviator Stress
0	0	0.00	0.0
10	2.5	0.10	89.1
20	7	0.20	249.3
30	14	0.29	498.1
40	21.5	0.39	764.1
50	27.5	0.49	976.4
60	33.5	0.59	1188.3
70	36	0.69	1275.7

STRENGTH AND STRAIN PARAMETERS

Stress at Failure (kN/m^2): 1275.7
Strain at Failure (%): 0.69



Job Description: KZN 11710

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P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Job no.:	7316
Lab no.:	06001
Source:	EAT02 - S02
Depth:	60.60 - 60.81

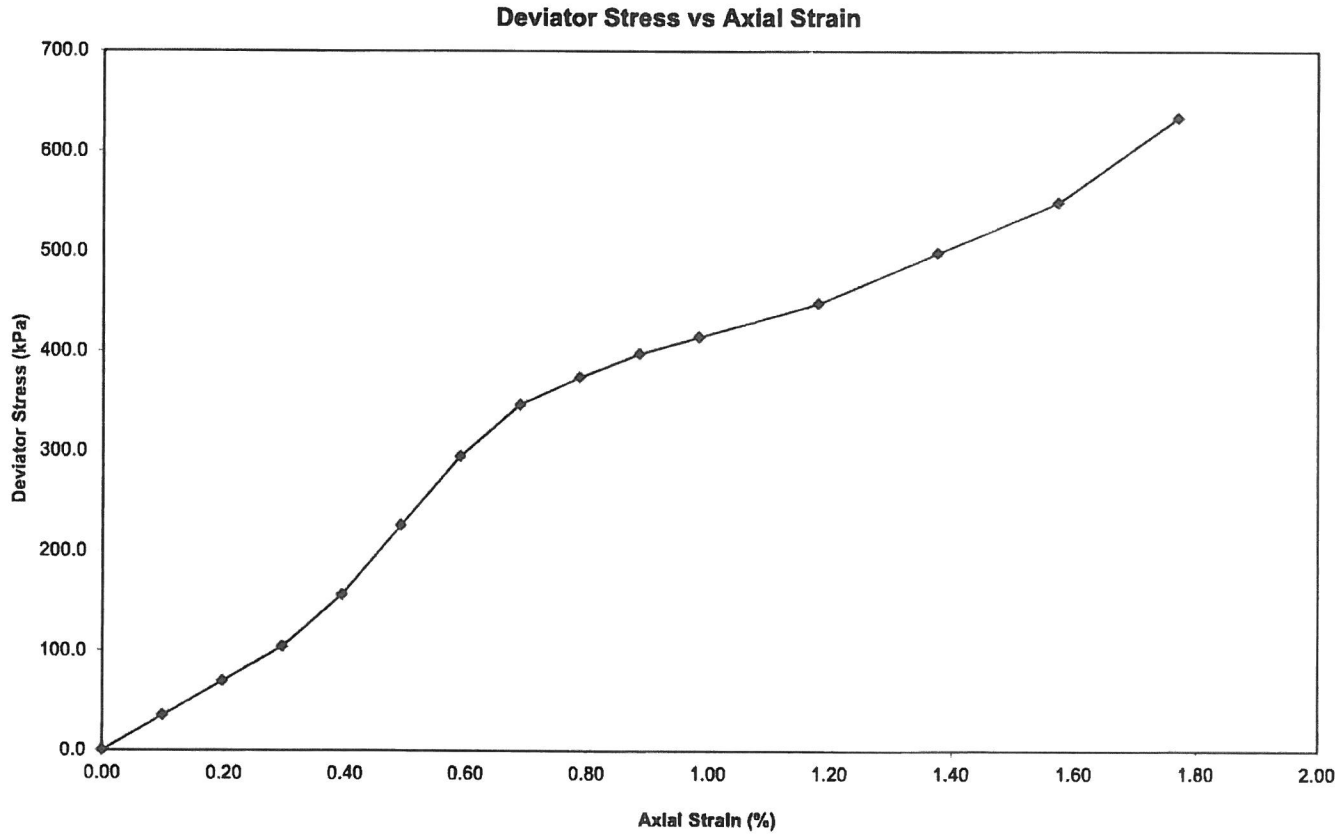
Length (cm)	10.165
Diameter (cm)	4.923
Area (cm2)	19.03
Volume (cm3)	193.49

Mass (g):	463.2
Bulk Density (kg/m3):	2394
Proving Ring Factor:	664

Strain Guage	Proving Rinng	%Strain	Deviator Stress
0	0	0.00	0.0
10	1	0.10	34.8
20	2	0.20	69.6
30	3	0.30	104.3
40	4.5	0.39	156.4
50	6.5	0.49	225.6
60	8.5	0.59	294.8
70	10	0.69	346.4
80	10.8	0.79	373.8
90	11.5	0.89	397.6
100	12	0.98	414.5
120	13	1.18	448.1
140	14.5	1.38	498.8
160	16	1.57	549.3
180	18.5	1.77	633.9

STRENGTH AND STRAIN PARAMETERS

Stress at Failure (kN/m^2): 633.9
Strain at Failure (%): 1.77



Job Description: KZN 11710

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Fax : (031) 201-7920

Job no.:	7316
Lab no.:	06002
Source:	EAT02 - S03
Depth:	61.25 - 61.50

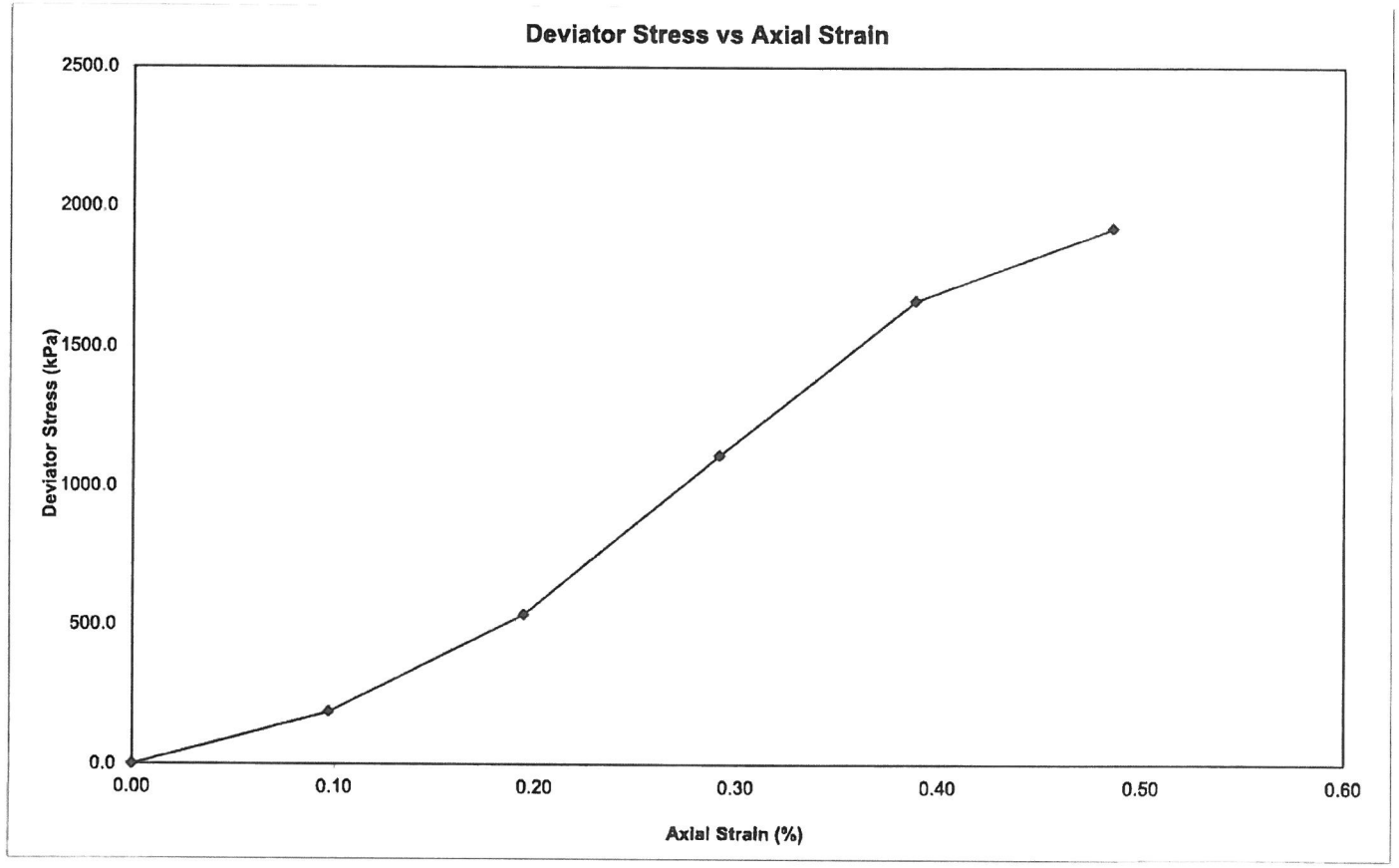
Length (cm)	10.29
Diameter (cm)	5.007
Area (cm2)	19.69
Volume (cm3)	202.61

Mass (g):	413.3
Bulk Density (kg/m3):	2040
Proving Ring Factor:	103

Strain Guage	Proving Rinng	%Strain	Deviator Stress
0	0	0.00	0.0
10	36	0.10	187.4
20	103	0.19	535.7
30	214	0.29	1111.9
40	321	0.39	1666.2
50	371	0.49	1923.8

STRENGTH AND STRAIN PARAMETERS

Stress at Failure (kN/m^2): 1923.8
Strain at Failure (%): 0.49



Job Description: KZN 11710

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P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Job no.:	7316
Lab no.:	06003
Source:	EAT05 - S04
Depth:	59.84 - 60.03

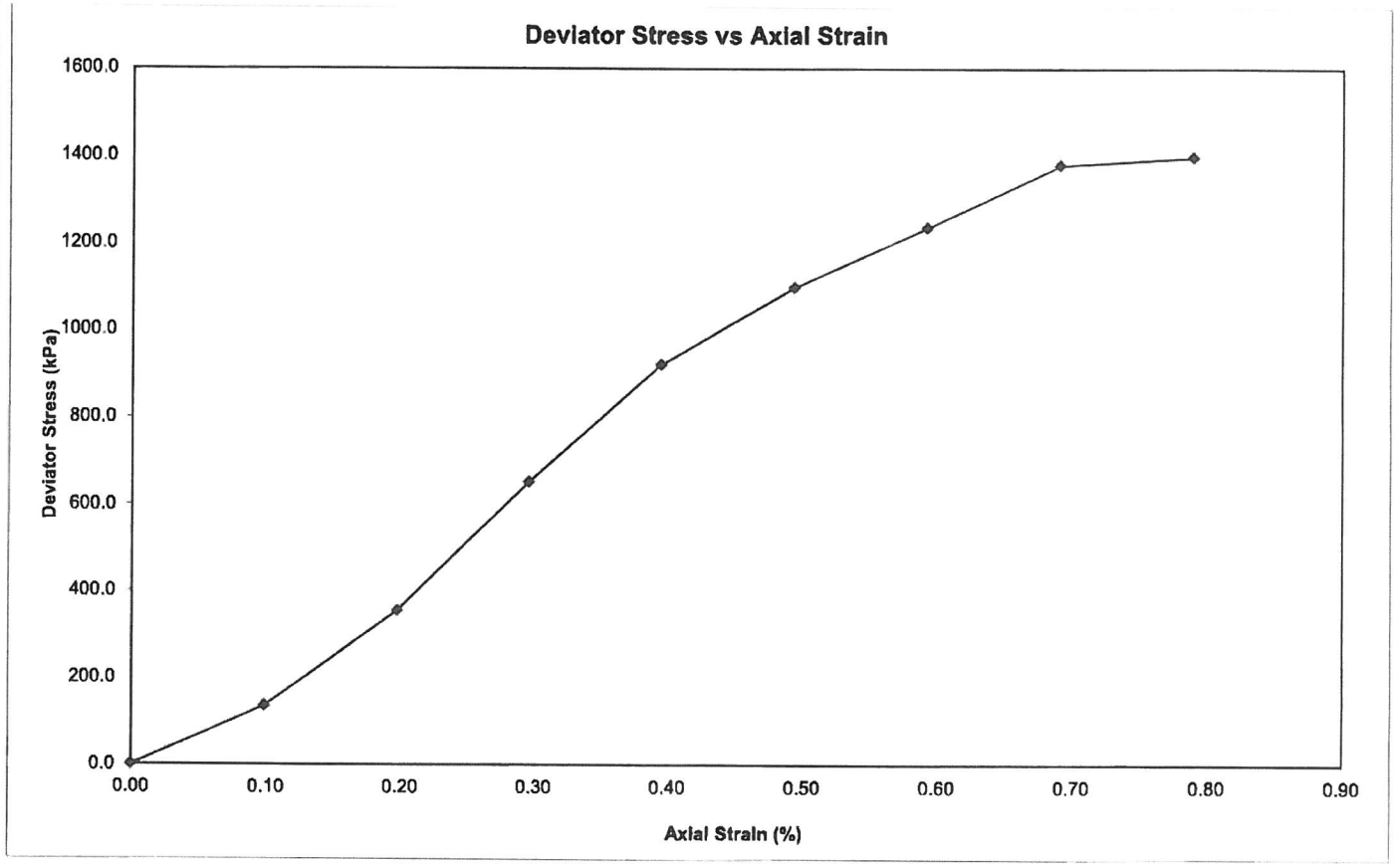
Length (cm)	10.135
Diameter (cm)	5.108
Area (cm2)	20.49
Volume (cm3)	207.69

Mass (g):	427.1
Bulk Density (kg/m3):	2056
Proving Ring Factor:	102

Strain Guage	Proving Rinng	%Strain	Deviator Stress
0	0	0.00	0.0
10	27	0.10	134.8
20	71	0.20	354.1
30	131	0.30	652.7
40	185	0.39	920.8
50	221	0.49	1098.9
60	249	0.59	1236.9
70	278	0.69	1379.6
80	282	0.79	1398.0

STRENGTH AND STRAIN PARAMETERS

Stress at Failure (kN/m^2): 1398
Strain at Failure (%): 0.79



Job Description: KZN 11710

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Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Job no.: 7316
Lab no.: 06004
Source: EAT05 - S05
Depth: 62.80 - 63.00

Length (cm) 10.135
Diameter (cm) 5.142
Area (cm2) 20.77
Volume (cm3) 210.46

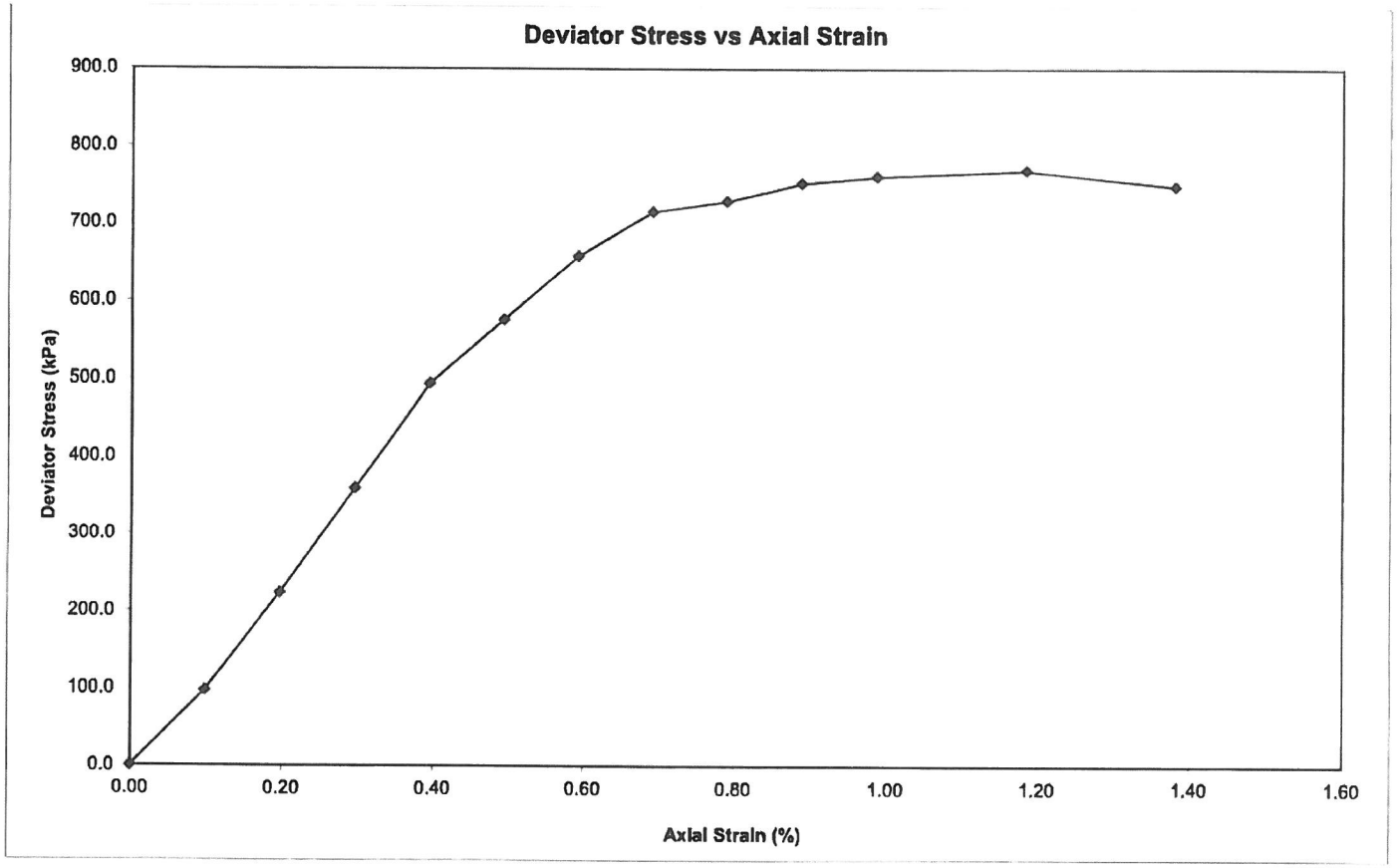
Mass (g): 445.4
Bulk Density (kg/m3): 2116

Proving Ring Factor: 101

Strain Guage	Proving Rinng	%Strain	Deviator Stress
0	0	0.00	0.0
10	20	0.10	97.2
20	46	0.20	223.2
30	74	0.30	358.8
40	102	0.39	494.0
50	119	0.49	575.8
60	136	0.59	657.4
70	148	0.69	714.7
80	151	0.79	728.5
90	156	0.89	751.9
100	158	0.99	760.7
120	160	1.18	768.8
140	156	1.38	748.1

STRENGTH AND STRAIN PARAMETERS

Stress at Failure (kN/m^2): 768.8
Strain at Failure (%): 1.38



Job Description: KZN 11710

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Fax : (031) 201-7920

Job no.:	7316
Lab no.:	06005
Source:	61.11 - 61.34
Depth:	EAT05 - S06

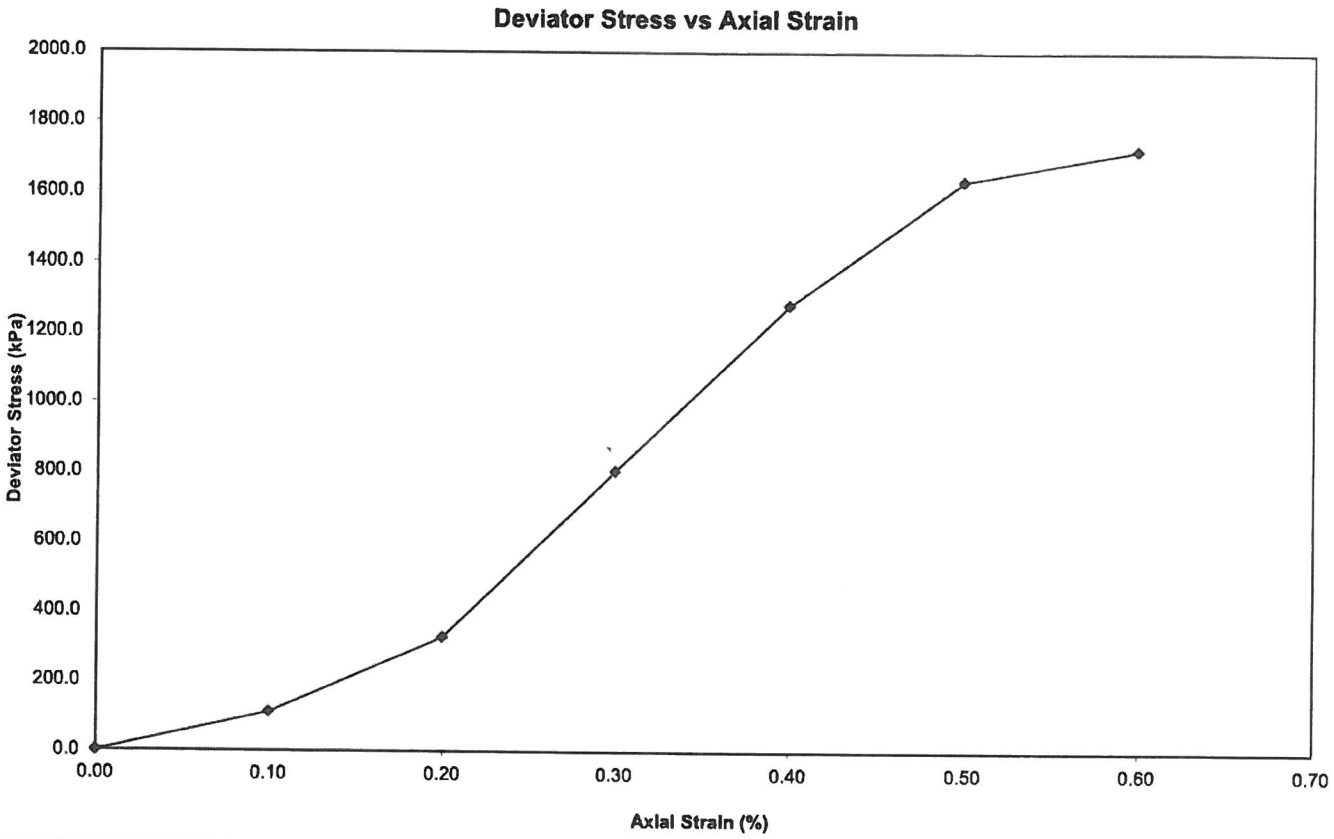
Length (cm)	10.015
Diameter (cm)	5.102
Area (cm2)	20.44
Volume (cm3)	204.75

Mass (g):	402.4
Bulk Density (kg/m3):	1965
Proving Ring Factor:	103

Strain Guage	Proving Rinng	%Strain	Deviator Stress
0	0	0.00	0.0
10	22	0.10	110.8
20	65	0.20	327.0
30	160	0.30	804.1
40	255	0.40	1280.3
50	326	0.50	1635.2
60	344	0.60	1723.7

STRENGTH AND STRAIN PARAMETERS

Stress at Failure (kN/m^2): 1723.7
Strain at Failure (%): 0.6



ANNEXURE 4 – ANCHOR HOLE FREE LENGTH

Anchor hole free length

Casagrande C8 – Site Layout

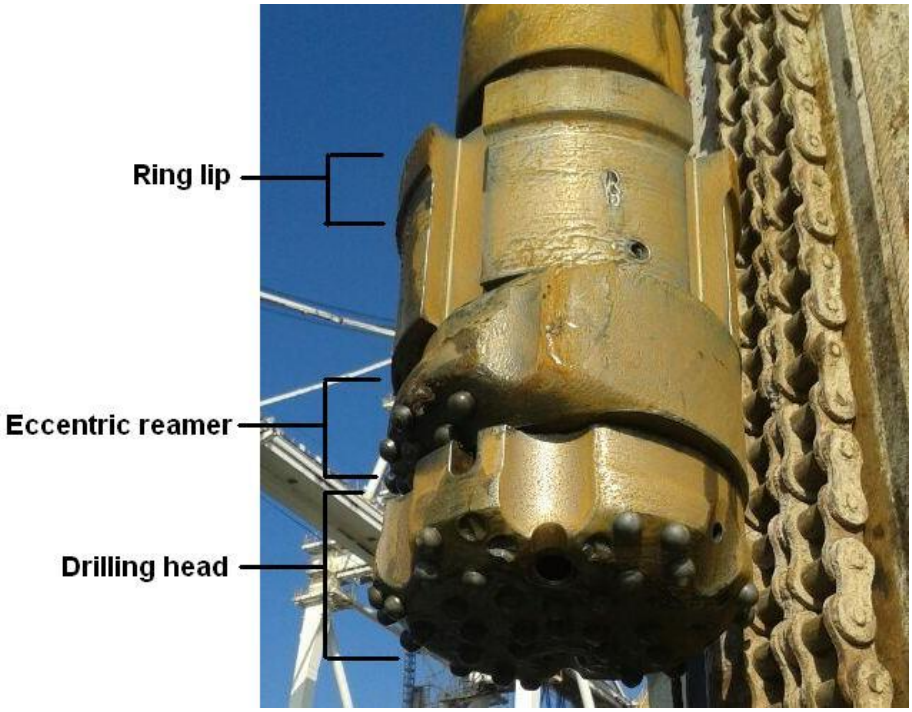
Casagrande C8 drilling rig working at anchor hole 3. An auxiliary air compressor (bottom left) is use to drive the pneumatic ODEX down-the-hole hammer (DTH), which pulls casings down as the hole is advanced.

Casagrande C8 – Drag bit

Where the casing shoe has failed the hole is advanced by drilling of unconsolidated soil and soft material (including soft rock and weak grout) with the drag bit. The drag bit is also used to inject grout into the anchor hole. Fins of the drag bit are shortened (by grinding off) of extended (by welding) to achieve the required hole diameter. The drag bit is advanced by rotation.

Casagrande C8 – 222 mm OD core barrel

Where the casing shoe has failed the hole is advanced by coring out competent material (soft to hard rock and grout) with the large diameter core barrel. The core barrel is advanced by rotation.

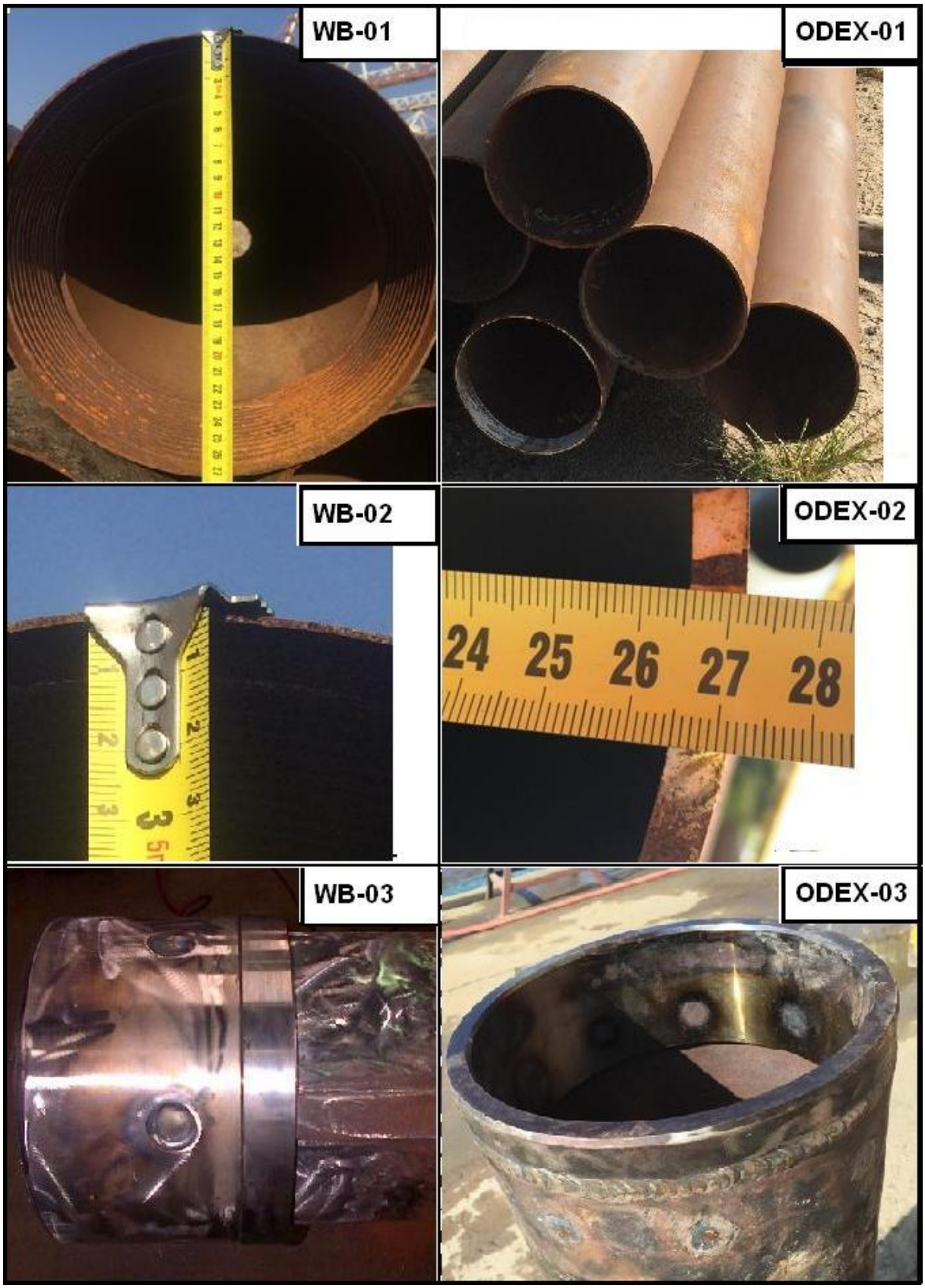


Casagrande C8 – ODEX DTH

ODEX DTH is used to advance the anchor hole while installing the casing. The ring lip of the ODEX DTH hammers against the casing shoe of the leader casing. Once casing are installed into competent material the ODEX drilling head can be advanced beyond the casing. The ODEX DTH is advance by rotation and hammering.

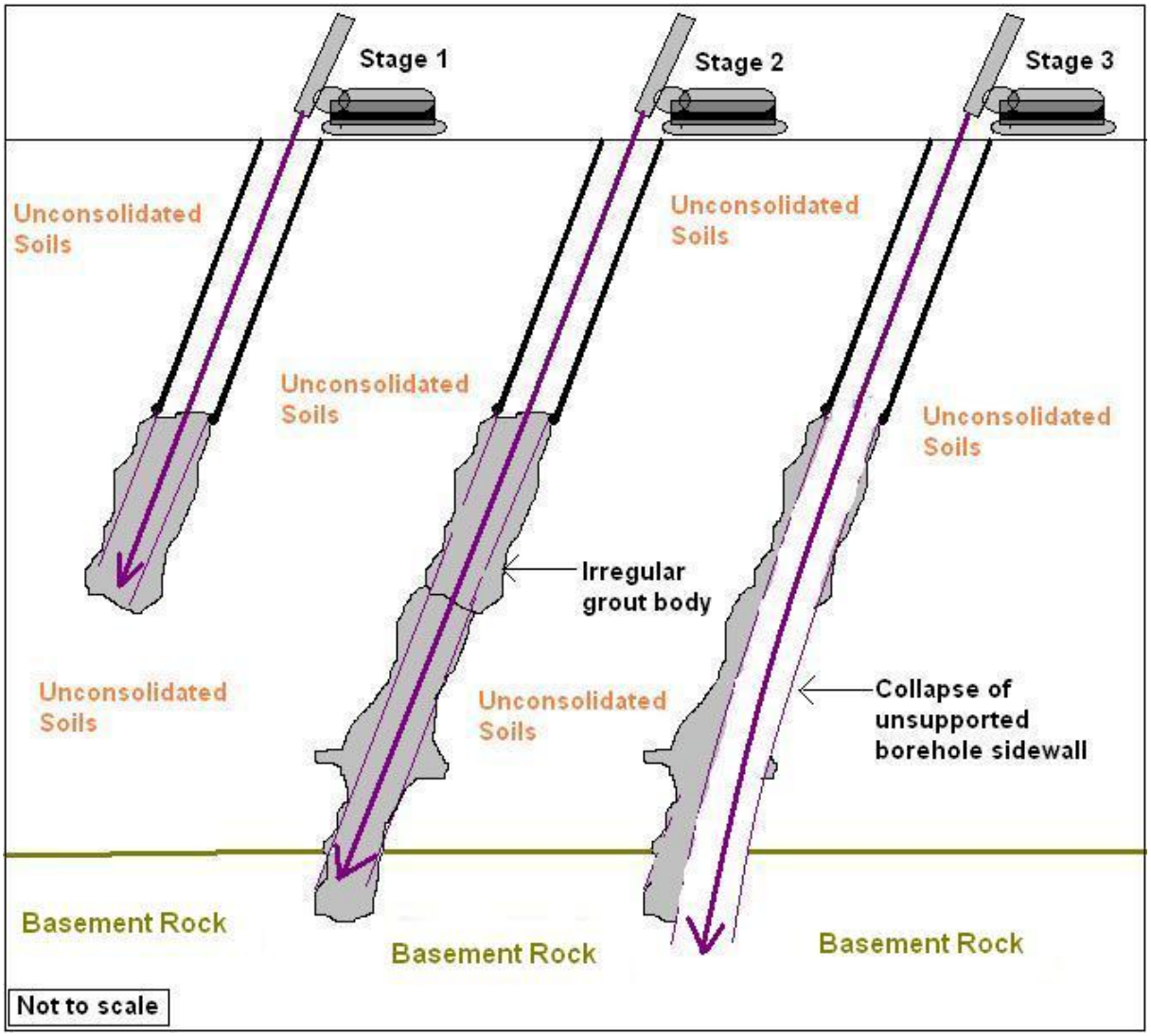
Casagrande C8 – ODEX DTH, wear of ring lip

Image A) shows normal wear on the ring lip of an ODEX DTH. Addition of casing braces would increase the skin friction as casing is advanced. It is believed that this additional friction has resulted in excessive wear of the ODEX DTH ring lip and casing shoe as seen in image B) and C).



Casing comparison – Washbore casing Vs ODEX casing

Washbore casing (WB) and ODEX casing are compared. Note the decrease wall thickness of the WB casing at the threaded joins (WB-02). WB-03 shows the improvised casing shoe fitted to the washbore leader casing to be used with the ODEX DTH. ODEX-03 shows a proprietary ODEX casing shoes displaying a significantly smoother profile.

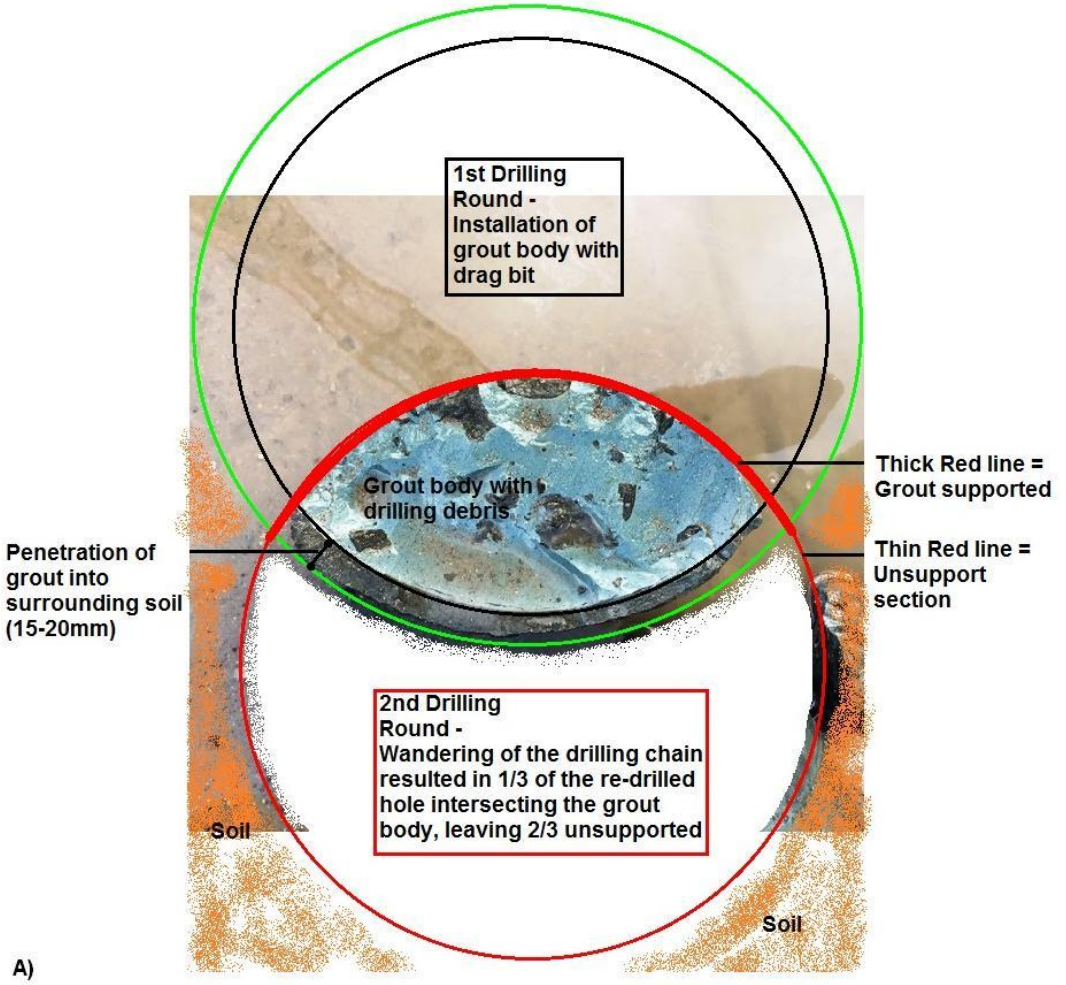


Drill-grout-drill method – Conceptual sketch

Where collapse occurred, repetitive iterations of the drill-grout-drill method were conducted with the intent of installing a sufficiently large grout body so that the re-drilled hole would be contained within the grout body.

Drill-grout-drill method – re-drilled grout body

Recovered core from anchor hole 1, depth increases from the right to the left. On the left, recovered core shows that the anchor hole has been drilled through the centre of the grout body. Progressive wandering of the drilling string as the hole is advanced observed to the left, with the final run of core showing partial intersection of the grout body (light grey material).



Drill-grout-drill method – Re-drilled grout body (cross section)

ANNEXURE 5 – ANCHOR INSTALLATION

Air Lift Cleaning

Air lift cleaning tool

The contractor fabricated an air lift cleaning tool by modification of an ODEX drilling rod. The air lift tool utilises the auxiliary compressor to input pressurised air into the drill string at about 1.5 m (inset B) from the air lift intake (inset C). The air escapes up the drilling string causing a venturi effect at the air lift intake. In this way drilling debris is lifted out of the anchor hole through the drilling string, with water or drilling fluid continual being supplied via the cased free length to maintain flow.

Air lift cleaning – initial flushing stage

Initial stages of cleaning, dark silty sandy fluid with rock and grout fragments are expelled from the anchor hole.

Air lift cleaning – intermediate flushing stage

Cleaning is continued to an intermediate stage when relative clean drilling fluids are expelled from the anchor hole. At this stage water testing was conducted.

Air lift cleaning – final flushing stage

Following successful water testing the anchor hole was flushed with clean water until all drilling fluids and debris were cleared and clean water was expelled. At this stage anchor installation and grout would commence.

Water Testing

Water testing – pneumatic packer

A pneumatic packer was lowered to a point directly above the intended anchor fixed length. The packer was inflated to about 1000 kPA, by mean of a nitrogen cylinder. Once the packer was inflated, a water pump was use to increase the water pressure below the packet to about 500 kPa (100 kPa over the estimated ambient water pressure). Water pressure was maintained and water loss was recorded on a flow gauge.

Anchor Fabrication

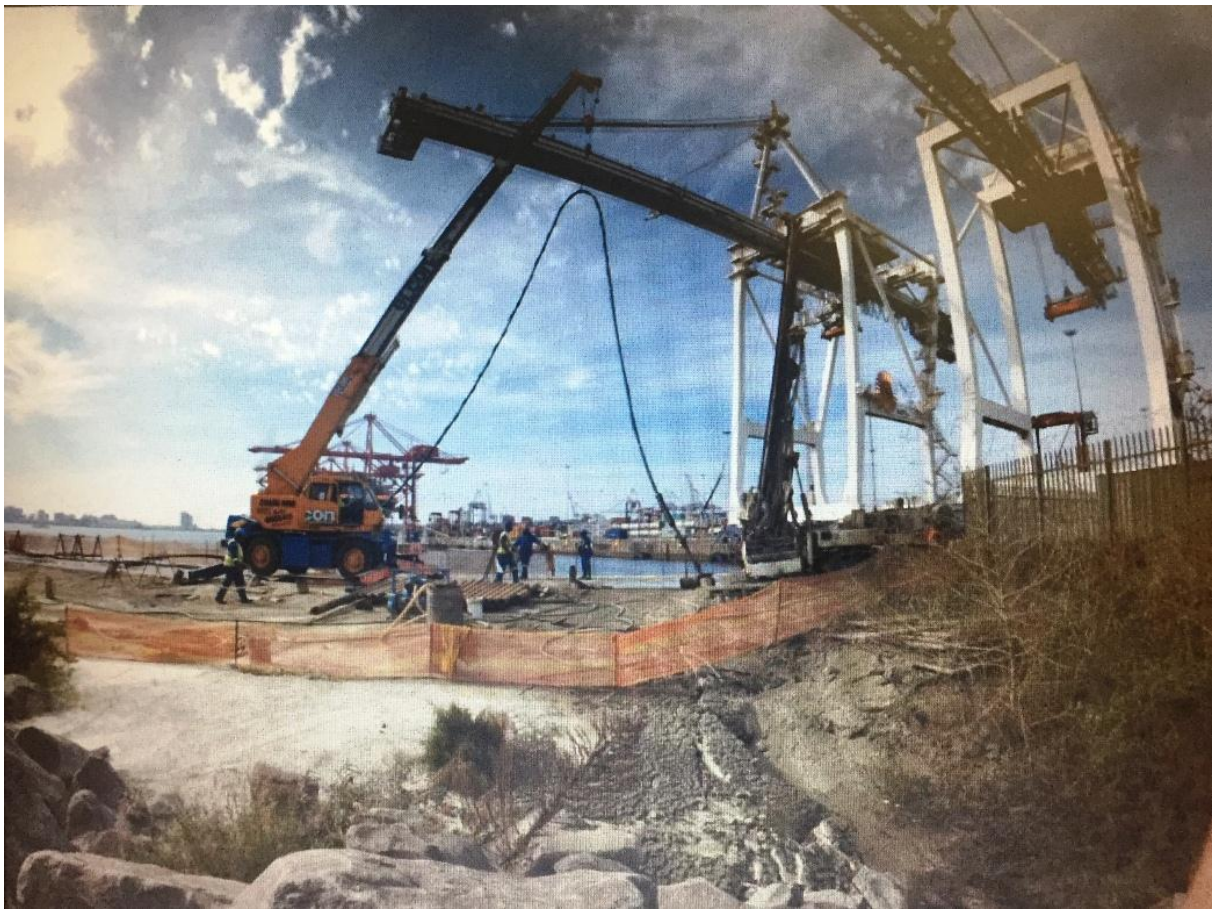
Anchor Fabrication – degreasing of anchor tendon cables

Anchor tendon cables were unravelled and degreased for the three metre fixed length, before being rebound with cable separators and lashed with wire.

Anchor Fabrication – Three metre fixed length

In this image the anchor is being suspended and moved into position to be lowered into Anchor Hole 5. The foam packer is about one metre long and comprised of expanded foam. This foam packer presents a collapsible to allow unobstructed displacement of the fixed length in the event of failure of the ground/grout anchor bond. Inset B) shows the plastic anchor centraliser and anchor head with protruding HDPE pipe, which was used to inject grout into the bottom of the fixed length.

Anchor Installation



Anchor Installation

Anchor 1a being installed utilising a mobile crane and the Casagrande C8 boom winch in tandem to lift and lower the anchor.

Calculation for Ground Anchors **TYPE 3 - REVISED**

Project: **DCT Berth 203 to 205 Trial Anchors**

Date: **Aug-14**

Ground anchor tendons

Cable strand diameter	**15.7**	**mm**
Ultimate strength	**279**	**kN**
X-sectional area cable	**193.59**	**mm2**
	1.936E-04	**m2**
Ultimate strength	**1 441.17**	**MPa**

Item	**Unit**	**Quantity**	
Setting up	No	6	
Drill holes	m	396	66.000 m/anchor
Free length		378	63.000 m
Fixed length		18	3.000 m

Working load reqd.	kN	1 400.00	Specified	1 400.00	
Ultimate capacity/anchor	kN	3 500.00	2.5 x specified	3 500.00	
No. of cables/anchor	No.	13		12	
Actual ultimate capacity	kN	3627		3348	
Allowable WL max (50% UL)	kN	1 813.50	OK	1 674.00	
Test load (80% UDL) Max	kN	2 800.00	Specified	2 800.00	
Allowable load (70% UL)	kN	2 538.90	OK	2 343.60	83.6%
Mass (1.18kg/m)	kg	6 151.34			

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Ref: CF14/04/405 3 June 2014

Client: Franki Africa

Project: Berth 203 Anchors

O/N: KZN8015

Mix Design for Cementitious Grout

CLIENT

Franki Geotechnical, P O Box 40096, RED HILL, 4071

SYNOPSIS

Proportions have been provided based on trial mixes carried out in our laboratory.

BRIEF FROM CLIENT

Contest was requested to provide proportions for a cement / water grout that would achieve a cube compressive strength of 40 MPa at 28 days.

SAMPLES

The following samples were received on 16.04.2014.

Material	Description	Client Marking	Laboratory Reference
Coarse Aggregate:	n/a	-	-
Fine Aggregate:	n/a	-	-
Cementitious Material:	NPC Plus CEM II/B-S 42.5N	-	405/1
Admixture:	Chrysoplast Optima 175 Chryso NS Grout	-	Laboratory Stock

SPECIFICATION

The specification was received

LABORATORY TRIAL MIXES

A trial mix was carried out to evaluate the performance characteristics of the materials and the plastic properties of the grout.

Tabulated below are the results of the trial mix carried out on 05.05.2014

Raw Materials	Units	Mix proportions kg/m^3 (dry)	
		CT392	
Cement NPC Original Black	kg	1452	
CEMII/B-S 42.5N			
Admixture: Chrysoplast Optima 175 (0.80%)	mL	3564	
Chryso NS Grout (0.675%)	mL	9799	
Water	litre	487	
Flow Cone	sec	25	
Wet density	kg/m^3	1942	
Total Bleed water	% (v/v)	2.0	
Total Bleed Water after 3 hrs	% (v/v)	1.9	
Initial Expansion	% (v/v)	4.0	
Final Expansion	% (v/v)	2.0	
Average compressive strength			
24 hrs	MPa	retarded	
3 days	MPa	24.5	
7 days	MPa	31.7	
28 days	MPa	40.5	
W/C	ratio	0.336	

NOTES ON LABORATORY MIXES

CT392: Good ability to flow, little bleeding and cohesive.

RECOMMENDATIONS

Based on the trial mix and the specified requirements the proportions given on the schedules in Appendix B are recommended.

Notes

1. No allowance has been made in the schedule for wastage.
2. Assumes the materials employed on site are from the same source and similar to those samples submitted.

3. For weigh batching a standard deviation of 5,5 MPa and a margin of 9 MPa are assumed. For volume batching a standard deviation of 7,0 MPa and a margin of 11,5 MPa are utilised.

4. THE PROPORTIONS ARE GIVEN FOR SITE TRIAL MIXES FOR EVALUATION. IF THE GROUT IS NOT COMPLETELY SATISFACTORY FOR THE SPECIFIC CONDITIONS ON SITE, CONTEST SHOULD BE APPROACHED FOR ADVICE.

5. It is very important to know the composition (ingredients) of the cement used in this mix design because many cements have different compositions which have different effects on concrete characteristics, such as strength among others.

   The cement used in a concrete mix should not be changed without a competent laboratory making any necessary changes to the mix design before the cement is changed.

   It should be borne in mind that some cements with the same trade name have different compositions and therefore concrete made with cements of different compositions may have different characteristics such as strength, among others.

R J L Raw
B Tech (Civil Eng)

CONTEST
Concrete Technology Services

APPENDIX B

SCHEDULE OF MIX PROPORTIONS

Date:	2014/06/02
Client :	Franki Africa
Project :	Berth 203 Anchors
Job No :	CF14/04/405

Material	Grade		Quantities						
	40MPa Grout		BY MASS					BY VOLUME	
			Per cubic metre		Per Sack			Per cubic metre	Per Sack
	Material Description	Unit	Dry	Damp	Dry	Damp	Unit	Damp	Damp
Cement	NPC Original Black CEM II B-S 42,5N	kg	1577	1577	50	50	kg	1688	50
		kg					kg		
Stone		kg					litres		
		kg					litres		
Sand		kg					litres		
		kg					litres		
Admixture	Chrysoplast Optima 175 (0.80%)	mls	12619	12619	400	400	mls	13503	400
Admixture	Chryso NS Grout (At 0.675%)	g	10648	10648	338	338	mls	11393	338
Water	Maximum	litres	489	489	16	16	litres	523	16
Flow	Maximum	seconds	23	23	23	23	mm	23	23
	YIELD	litres	1000	1000	32	32	litres	1000	30
		W/C	0.310						

NOTES:

1. Concrete for structural use should preferably be batched by weight.
2. When volume proportions have to be used then volumes should be measured as accurately as possible.
3. A standard builders barrow when struck off level contains 65litres.
4. Cement type should not be changed before any necessary changes are made to the mix proportions.
   Water : cement ratio used for the design is only applicable to the cement type specified above.

R J L Raw
B Tech (Civ Eng)

KZN0072
Eugene

CONTEST
Concrete Technology Services

P.O. Box 1675, HILLCREST, 3650
TEL: (031)700-9394 FAX: (031)700-9342

ATTENTION Blessing Mbatha
COMPANY: Franki Africa
REPORT No: 5794
PROJECT: KZN0072

TEL NO:
FAX NO:
CELL NO:
EMAIL: blessing.mbatha@franki.co.za
tiko.rajcoomar@franki.co.za

CONCRETE CUBE REPORT

Job number	Date cast	Specimen Data	Date Rec	Cube number	Customer marking	Test date	Test age days	Problem code	Dimensions mm x mm x mm			Mass (kg)	Compressive Strength	
													Load (kN)	MPa
14007156	22 Nov 14	Cust Ref: Berth 203	01 Dec 14	14038183	Anchor No. 4	01 Dec 14	9	11	100	100	100	1.875	374.9	37.5
	22 Nov 14		01 Dec 14	14038184	Anchor No. 4	01 Dec 14	9	11	100	100	100	1.895	389.9	39.0
	22 Nov 14		01 Dec 14	14038185	Anchor No. 4	01 Dec 14	9	11	100	100	100	1.875	398.5	40.0
	22 Nov 14		01 Dec 14	14038186	Anchor No. 4	06 Dec 14	14	9,11	100	100	100	1.790	419.5	42.0
	22 Nov 14		01 Dec 14	14038187	Anchor No. 4	06 Dec 14	14	9,11	100	100	100	1.880	507.2	50.5
	22 Nov 14		01 Dec 14	14038188	Anchor No. 4	06 Dec 14	14	9,11	100	100	100	1.801	508.3	51.0
	22 Nov 14		01 Dec 14	14038189	Anchor No. 4	13 Dec 14	21	7,11	100	100	100	1.885	388.9	39.0
	22 Nov 14		01 Dec 14	14038190	Anchor No. 4	13 Dec 14	21	7,11	100	100	100	1.899	521.7	52.0
	22 Nov 14		01 Dec 14	14038191	Anchor No. 4	13 Dec 14	21	7,11	100	100	100	1.945	514.1	51.5
	22 Nov 14		01 Dec 14	14038192	Anchor No. 4	20 Dec 14	28	7,11	100	100	100	1.910	491.4	49.0
	22 Nov 14		01 Dec 14	14038193	Anchor No. 4	20 Dec 14	28	7,11	100	100	100	1.900	482.1	48.0
	22 Nov 14		01 Dec 14	14038194	Anchor No. 4	20 Dec 14	28	7,11	100	100	100	1.900	383.6	38.5

Data reported here for job number 14007156 contains material amendments made after issue of report numbers 4693, 4941, 5284 and 5418
Data reported here for job number 14007156 replaces that in report numbers 4693, 4941, 5284 and 5418

14007293	28 Nov 14	Cust Ref: Berth 203	04 Dec 14	14038926	Anchor 5	06 Dec 14	8	11	100	100	100	1.900	400.8	40.0
	28 Nov 14		04 Dec 14	14038927	Anchor 5	06 Dec 14	8	11	100	100	100	1.930	416.6	41.5
	28 Nov 14		04 Dec 14	14038928	Anchor 5	06 Dec 14	8	11	100	100	100	1.895	418.8	42.0
	28 Nov 14		04 Dec 14	14038929	Anchor 5	12 Dec 14	14	11	100	100	100	1.985	434.2	43.5
	28 Nov 14		04 Dec 14	14038930	Anchor 5	12 Dec 14	14	11	100	100	100	1.980	436.4	43.5
	28 Nov 14		04 Dec 14	14038931	Anchor 5	12 Dec 14	14	11	100	100	100	1.988	435.5	43.5
	28 Nov 14		04 Dec 14	14038933	Anchor 5	19 Dec 14	21	11	100	100	100	1.875	471.6	47.0
	28 Nov 14		04 Dec 14	14038934	Anchor 5	19 Dec 14	21	11	100	100	100	1.865	464.8	46.5
	28 Nov 14		04 Dec 14	14038935	Anchor 5	19 Dec 14	21	11	100	100	100	1.888	453.6	45.5

PROBLEM CODES

1 Cube honeycombed/voided 2 Cube damaged 3 Cube mass low 4 Abnormal cube failure mode 5 Cube dimensionally non-standard 6 Test results low strength 7 Test results exceeds allowed variance 8 Cubes received and tested dry 9 Non-std test, SABS requires 3 cubes/ set/ test age 10 See attached photo's 11 No concrete specification given to Contest 12 High variance of test results

Contest cured cubes, where possible and conducted strength testing on cubes, however, Contest was not involved in any processes that were outside its scope of work, as defined by the customer. Such processes may have included sampling concrete, making, transporting and curing of cubes, as relevant. Cubes were cured by Contest from date received to date tested, as relevant

SABS 0100-2, clause 3.5.4, states: "valid test result: the average result obtained from three test cubes of concrete that have been tested in accordance with SABS method 863, with the additional reuirement that curing water must be maintained at a temperature between 22 deg C and 25 deg C".

SABS 0100-2, clause 14.3.1.4, states: "The cubes shall be tested in accordance with SABS method 863. Three cubes shall be tested for acceptance at the age specified, which is usually 28 days. For prestressed concrete, sets of three cubes shall be tested at 3 days. Sets of three cubes may be tested at other ages for information".

SABS method 863, clause 4, states: "Obtain samples of concrete and prepare and cure a set of three test specimens, as described in the relevant clauses of SABS method 862-3, respectively".

If the cube strengths given in this report are to be used for acceptance in accordance with SABS 0100-2 (or any other specification with similar requirements to those of SABS 0100-2) then the above requirements must be complied with otherwise, acceptance based on cube strengths using the results given in this report, cannot be made

ALL CUBES ARE TESTED IN ACCORDANCE WITH SABS STM 863
The results relate only to the items tested.
The test report shall not be reproduced except in full, without approval of Contest

CONTEST

Reported on: 22 January 2015 at 14:07

CONTEST
Concrete Technology Services

P.O. Box 1675, HILLCREST. 3650
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CONCRETE CUBE REPORT

Job number	Date cast	Specimen Data	Date Rec	Cube number	Customer marking	Test date	Test age days	Problem code	Dimensions mm x mm x mm			Mass (kg)	Compressive Strength	
													Load (kN)	MPa
Data reported here for job number 14007293 contains material amendments made after issue of report numbers 4941, 5201, 5418, 5711 and 5728 Data reported here for job number 14007293 replaces that in report numbers 4941, 5201, 5418, 5711 and 5728														
15000092	28 Nov 14	Cust Ref: None	15 Jan 15	15000459	Berth 203	15 Jan 15	48	9,11	100	100	100	1.930	459.0	46.0
Data reported here for job number 15000092 contains material amendments made after issue of report numbers 5711 and 5728. Data reported here for job number 15000092 replaces that in report numbers 5711 and 5728														
15000091	06 Dec 14	Cust Ref: Berth 203 DN DBN 1803	15 Jan 15	15000453	Dowel Grout Berth 203	15 Jan 15	40	9,11	100	100	100	2.060	674.9	67.5
	06 Dec 14		15 Jan 15	15000454	Dowel Grout Berth 203	15 Jan 15	40	9,11	100	100	100	2.085	668.8	67.0
	06 Dec 14		15 Jan 15	15000455	Dowel Grout Berth 203	15 Jan 15	40	9,11	100	100	100	2.060	545.1	54.5
	06 Dec 14		15 Jan 15	15000456	Dowel Grout Berth 203	15 Jan 15	40	9,11	100	100	100	2.095	628.9	63.0
	06 Dec 14		15 Jan 15	15000457	Dowel Grout Berth 203	15 Jan 15	40	9,11	100	100	100	2.065	646.7	64.5
	06 Dec 14		15 Jan 15	15000458	Dowel Grout Berth 203	15 Jan 15	40	9,11	100	100	100	2.055	640.8	64.0

Reason slump figures not required: Not Given

Data reported here for job number 15000091 contains material amendments made after issue of report numbers 5711 and 5728.
Data reported here for job number 15000091 replaces that in report numbers 5711 and 5728

PROBLEM CODES

1 Cube honeycombed/voided 2 Cube damaged 3 Cube mass low 4 Abnormal cube failure mode 5 Cube dimensionally non-standard 6 Test results low strength 7 Test results exceeds allowed variance 8 Cubes received and tested dry 9 Non-std test, SABS requires 3 cubes/ set/ test age 10 See attached photo's 11 No concrete specification given to Contest 12 High variance of test results

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SABS 0100-2, clause 3.5.4, states: "valid test result: the average result obtained from three test cubes of concrete that have been tested in accordance with SABS method 863, with the additional reuirement that curing water must be maintained at a temperature between 22 deg C and 25 deg C".

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SABS method 863, clause 4, states: "Obtain samples of concrete and prepare and cure a set of three test specimens, as described in the relevant clauses of SABS method 862-3, respectively".

If the cube strengths given in this report are to be used for acceptance in accordance with SABS 0100-2 (or any other specification with similar requirements to those of SABS 0100-2) then the above requirements must be complied with otherwise, acceptance based on cube strengths using the results given in this report, cannot be made

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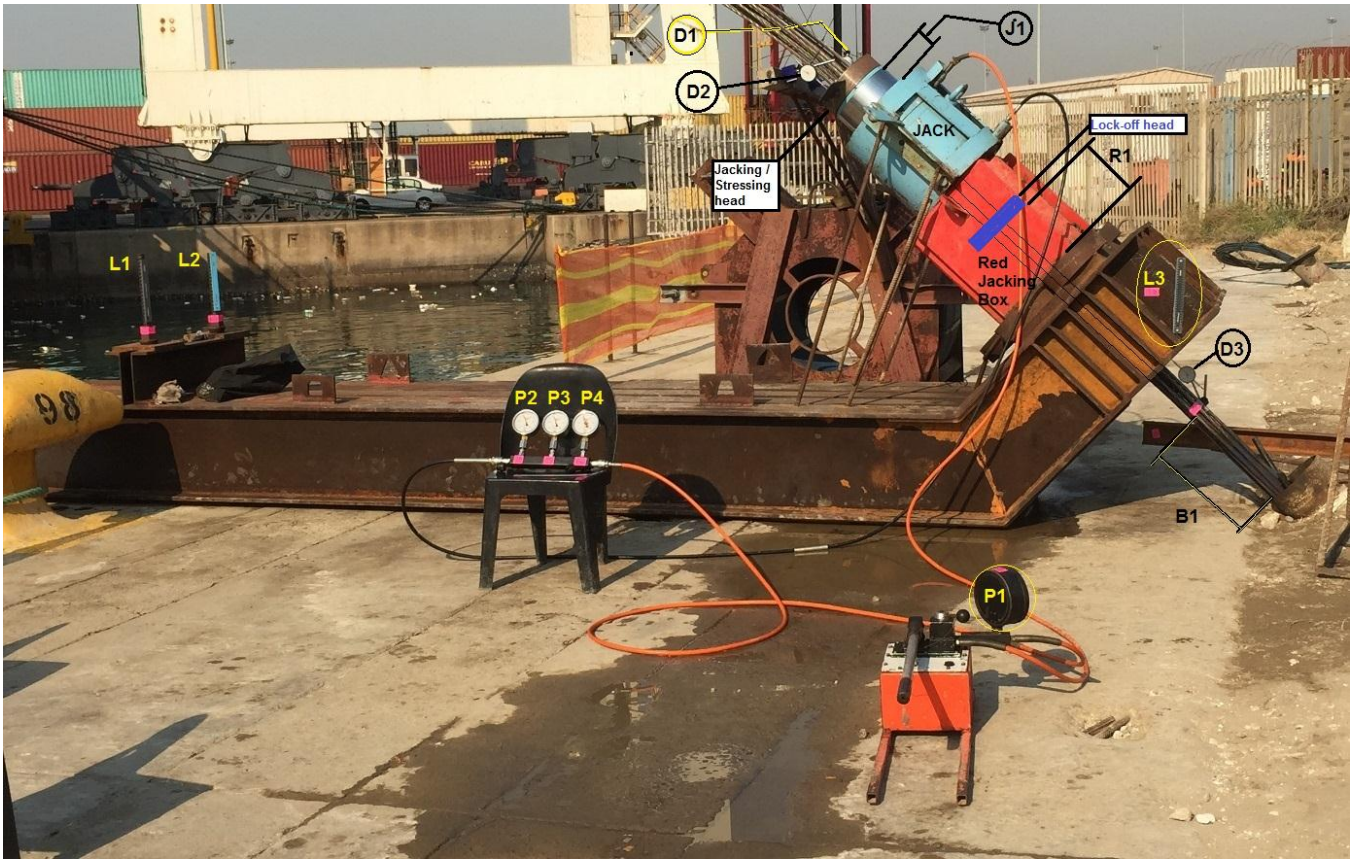
CONTEST

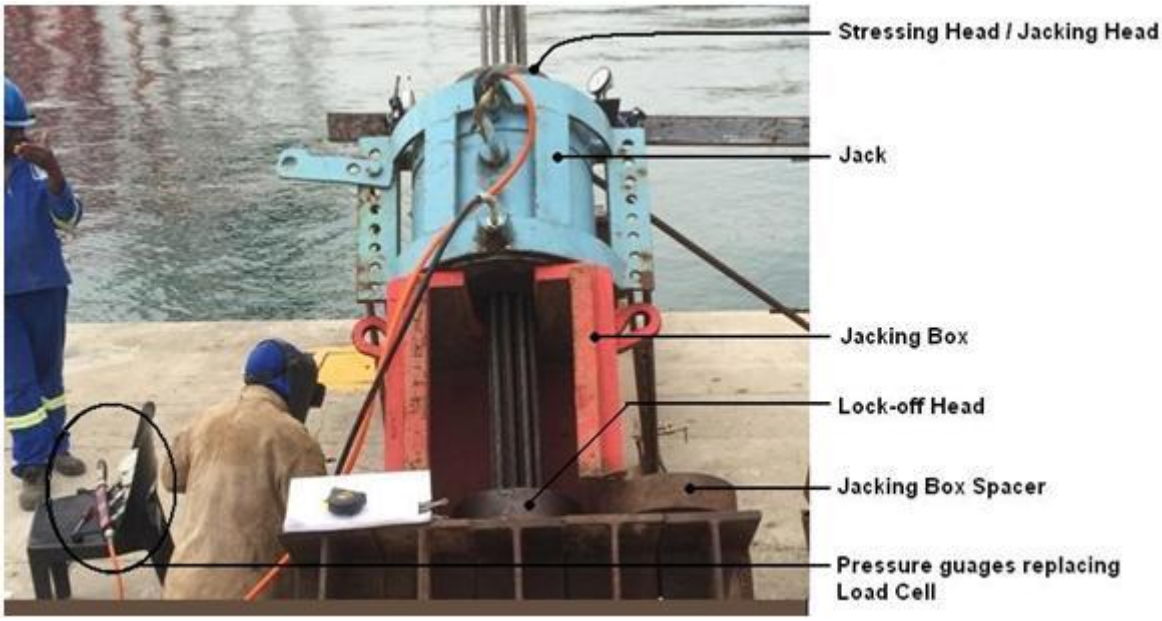
Reported on: 22 January 2015 at 14:07

ANNEXURE 6 – ANCHOR STRESSING APPARATUS

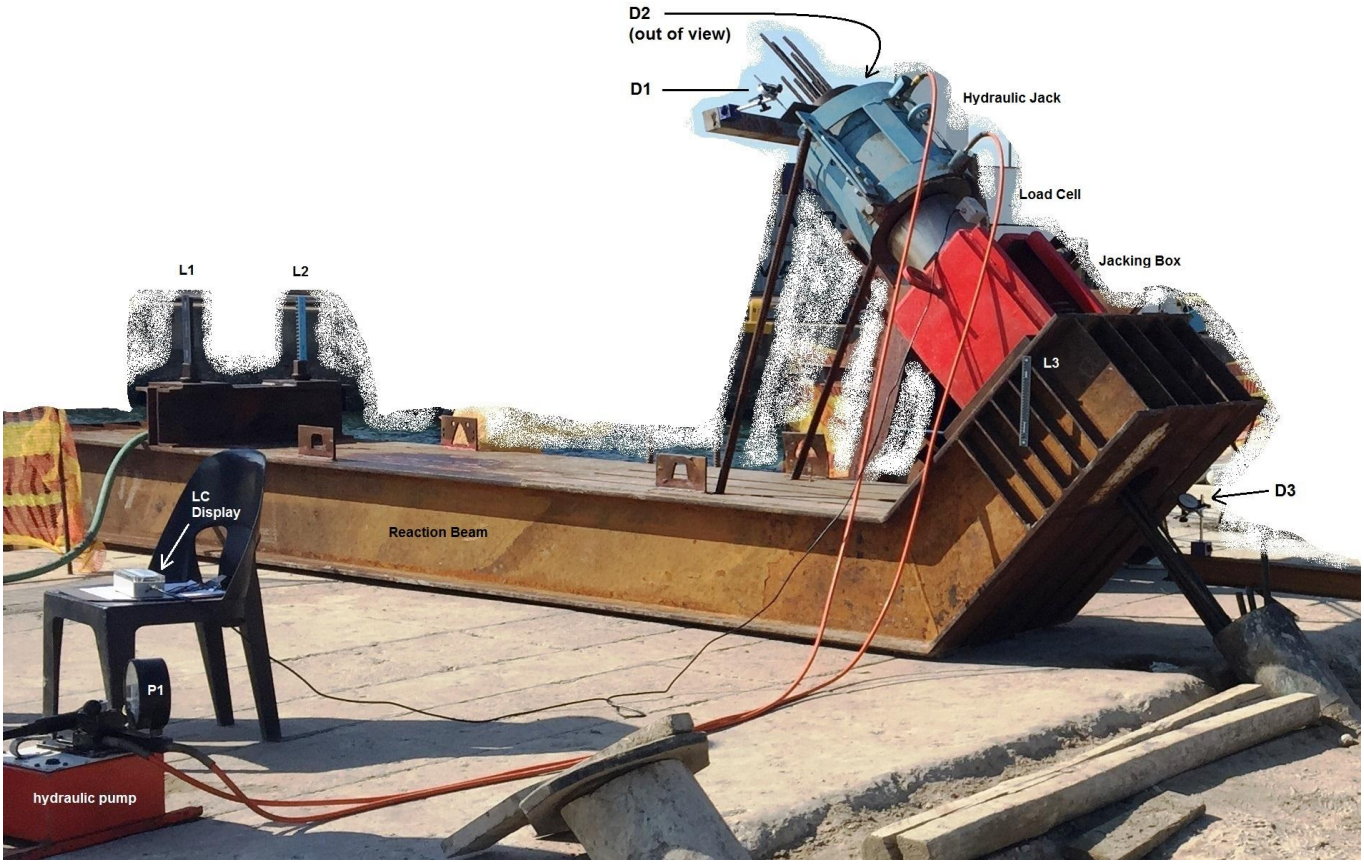
Anchor Stressing Equipment



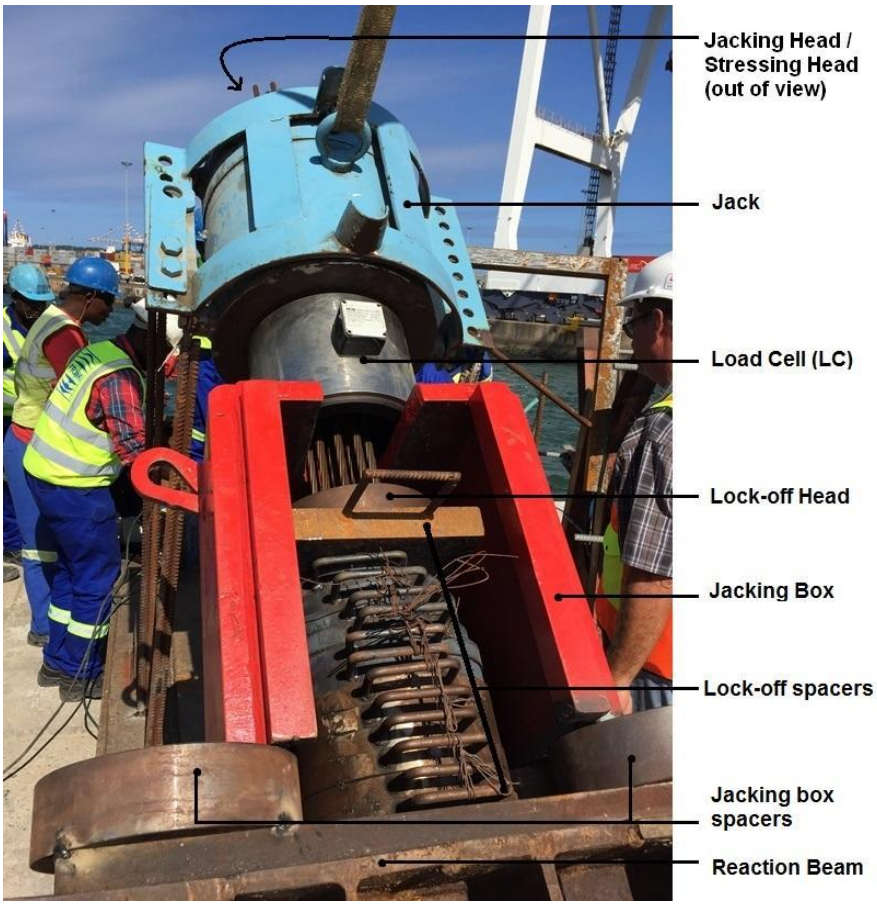
Anchor stressing equipment – Anchor 1a & 4, side view



Anchor stressing equipment – Anchor 1a & 4, head-on view



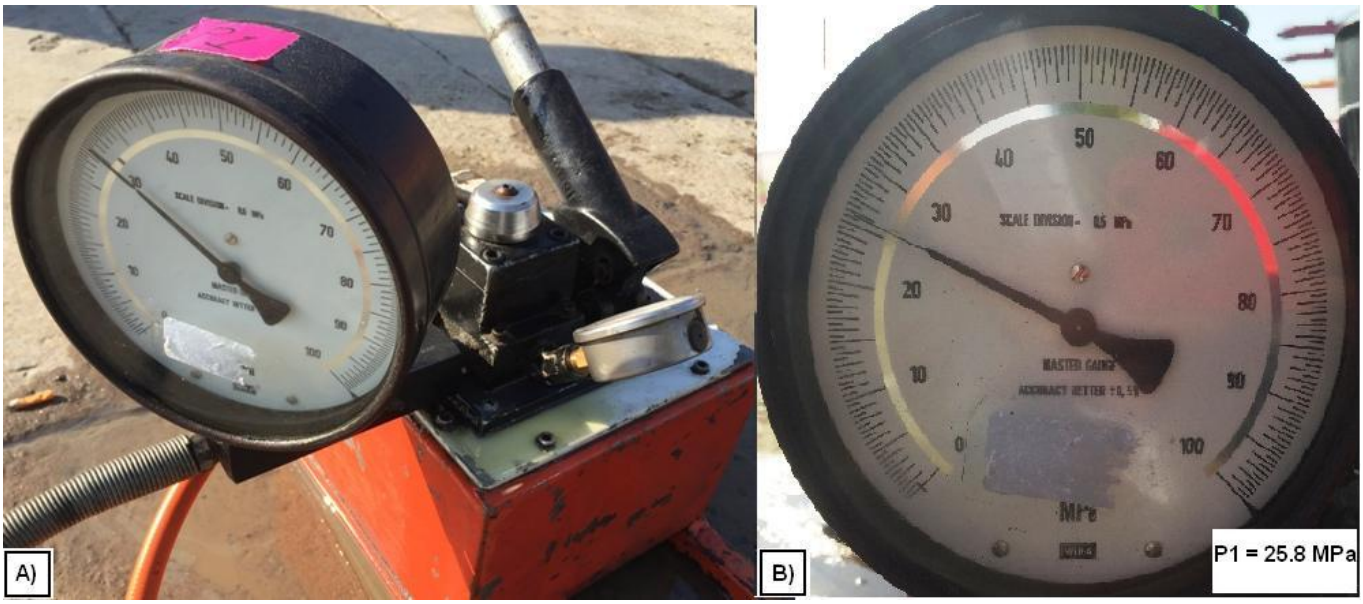
Anchor stressing equipment – Anchor 5, side view



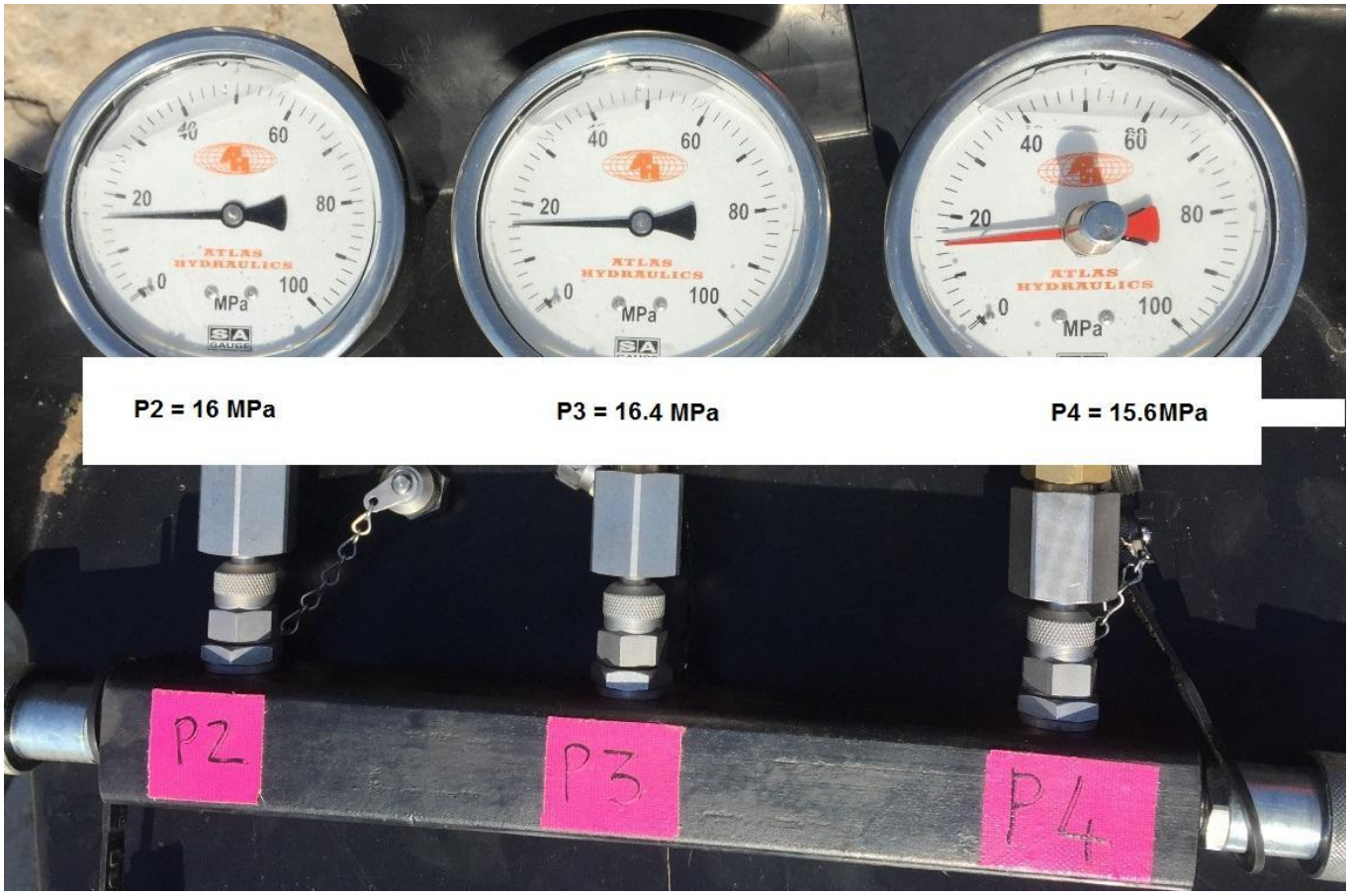
Anchor stressing equipment – Anchor 5, head-on view

Summary of anchor stressing measurement stations

	Measurement Station	Description	A01a	A04	A05
P1	Pressure gauge 1	Jacking pressure measured at 0.5 MPa demarcation	Y	Y	Y
P2-P3-P4	Pressure gauge 2, 3 and 4	Jacking pressure measured at 2.0 MPa demarcation	Y	Y	N
LC	Load cell	Direct measure of load, shown on digital display to 0.5 kN	N	N	Y
D1-D2	Dial gauge 1 and 2	Tendon displacement measured to 0.01 mm accuracy with dial gauge	Y	Y	Y
D3	Dial gauge 3	Displacement of reaction beam at jacking end. Measured with dial gauge to 0.01 mm accuracy.	Y	Y	Y
L1-L2	Dumpy level 1 and 2	Vertical displacement of reaction beam dywidag stays at quay wall end. Measured with dumpy level to 1.0 mm accuracy	Y	Y	Y
L3	Dumpy level 3	Vertical displacement of reaction beam at jacking end. Measured with dumpy level to 1.0 mm accuracy.	Y	Y	Y
B1	Below beam tendon marker displacement	Extension of tendon measured from casing to duct tape marker with tape measure. 1.0 mm accuracy	Y	Y	N
R1	Lock-off head displacement	Displacement of lock-off head from reaction beam. Measure with vernier to 0.1 mm accuracy	Y	Y	N
J1	Jack stroke	Displacement of hydraulic jack measured with vernier to 1.0 mm accuracy	Y	Y	N



P1 – Pressure gauge 1



P2-P3-P4 – Pressure gauges 2, 3 and 4

LC – Load cell and digital display

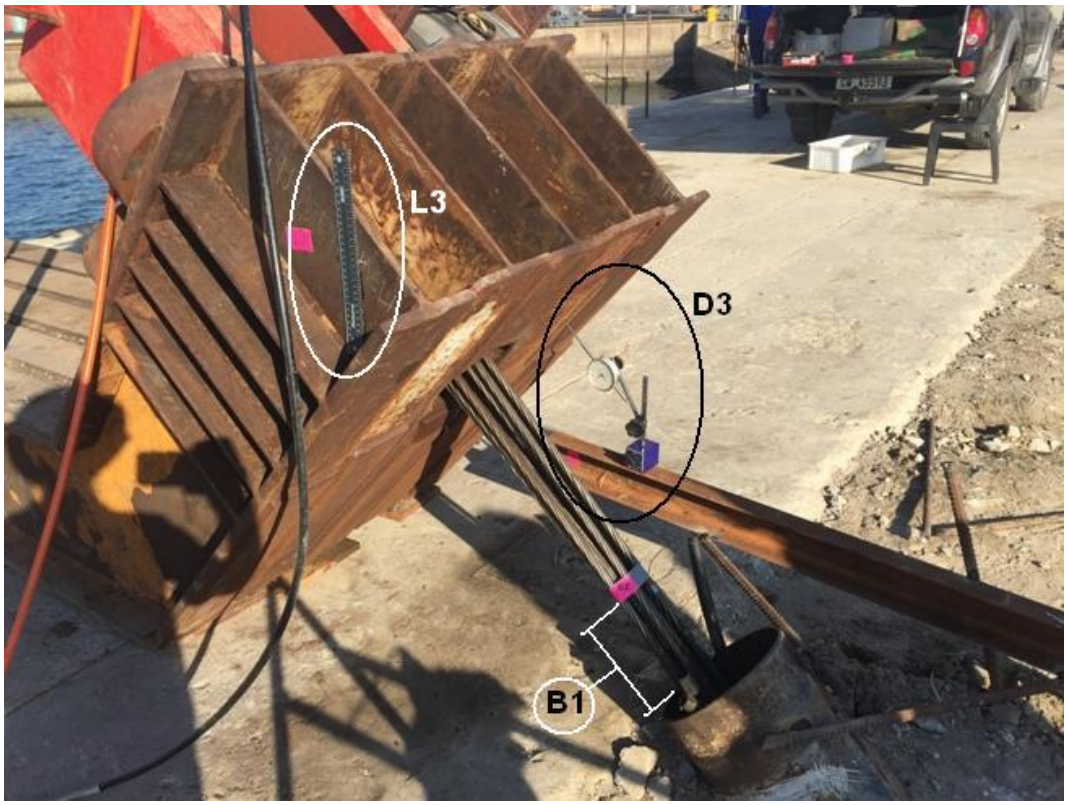
The load cell was faulty and so was excluded during stressing of Anchor 1a and 4.

D1-D2 – Dial gauges 1 and 2

The dial gauges are positioned on an independent stand. D1 and D2 measure tendon extension at the stressing head. The dial gauges used had a travel of 50 mm. This necessitated resetting every 50mm. Rotation of the stressing head is seen in image B). This is the result of elastic unwinding of the tendon cables under load.

L1-L2 – Dumpy level station L1 and L2

Displacement of the dywidag bars was measure using a dumpy level.

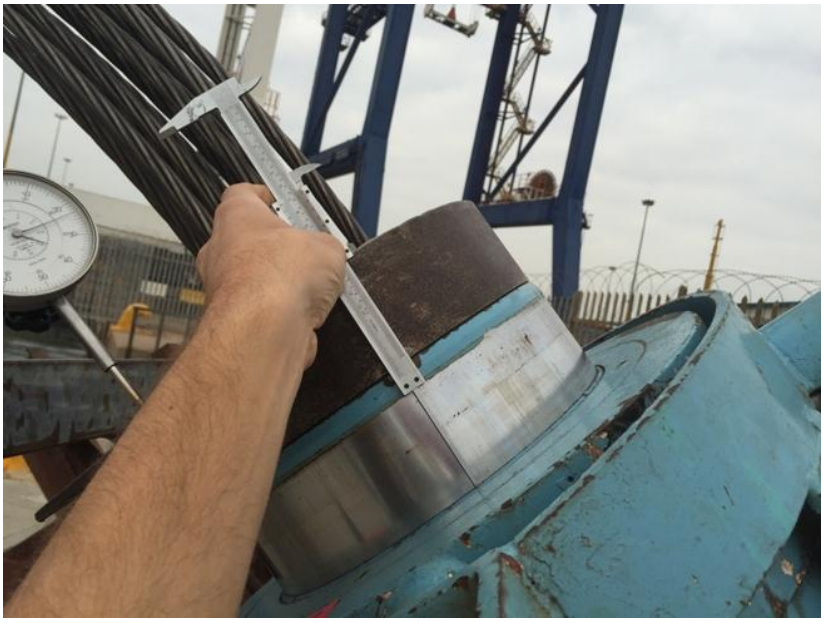


L3, D3 and B1

L3 – dumpy level station L3
D3 – dial gauge D3, measuring reaction beam deflection
B1 – Duct tape marker on anchor tendons.

R1 – Lock-off head displacement

Lift off pressure of the lock-off head was recorded when displacement was sufficient to allow a business card to be slid into the gap.



J1 – Jack stroke measurement

Extension of the hydraulic jack was recorded using a vernier.

ANNEXURE 7 – ANCHOR STRESSING RAW DATA

ANCHOR A01a RAW DATA

Cycle	Description	Date	Time	P1	P2	P3	P4	D1	D2	D3	L1	L2	L3	B1	R1	J1
				MPa	MPa	MPa	MPa	mm	mm	mm	mm	mm	mm	mm	mm	mm
1	5% Seating Load - 4MPa	2015/07/17		3.7	3.7	3.7	3.7	x	x	x	x	x	x	139.00	x	x
1	Zero Reading	2015/07/20	09:30	0.5	0.0	0.0	0.0	1.02	1.32	15.78	141	143	201	147.00	0.00	2.50
1	Lift Off	2015/07/20		3.5	3.5	3.5	3.5	2.34	2.58	15.85	141	143	201	148.00	0.35	x
1	5% 1 min	2015/07/20		4.3	4.4	4.4	4.4	4.70	4.98	16.13	141	143	201	150.00	4.00	11.50
1	10% 0 min	2015/07/20		8.5	8.4	8.4	7.6	35.36	35.18	18.83	141	143	205	178.00	37.40	43.00
1	10% 1 min	2015/07/20		8.4	8.2	8.4	7.6	35.35	35.15	18.83	141	143	205	178.00	37.40	43.00
1	Up Reset	2015/07/20						0.05	1.15							
1	15% 0 min	2015/07/20		13.0	13.0	13.0	11.8	27.81	28.75	20.63	141	143	208	205.00	66.00	72.50
1	15% 1 min	2015/07/20		12.8	12.8	13.0	11.8	27.79	28.73	20.63	141	143	208	205.00	66.00	72.50
1	Up Reset	2015/07/20						1.99	0.41							
1	20% 0 min	2015/07/20		17.4	16.6	17.4	16.0	29.30	27.93	22.02	141	142	209	231.00	93.80	10.80
1	20% 1 min	2015/07/20		17.4	16.6	17.4	16.0	29.29	27.93	22.02	141	142	209	231.00	93.80	10.80
1	20% 5 min	2015/07/20		16.8	16.2	17.0	16.0	29.31	27.93	22.03	141	142	209	231.00	93.80	10.80
1	20% 10 min	2015/07/20		16.6	16.0	16.8	15.8	29.34	27.98	22.03	141	142	209	231.00	93.80	10.80
1	20% 15 min	2015/07/20		16.5	16.0	16.8	15.8	29.39	28.05	22.03	141	142	209	231.00	93.80	10.80
1	15% 0 min	2015/07/20		12.8	12.4	12.8	11.8	11.16	9.78	21.34	141	142	209	214.00	75.00	81.50
1	15% 1 min	2015/07/20		12.8	12.4	12.8	11.8	11.20	9.80	21.34	141	142	209	214.00	75.00	81.50
1	Down Reset	2015/07/20						48.69	49.81							
1	10% 0 min	2015/07/20		9.0	8.6	8.8	8.8	21.30	22.82	20.05	141	142	205	187.00	47.50	53.00
1	10% 1 min	2015/07/20		9.0	8.6	8.8	8.8	21.34	22.85	20.50	141	142	205	187.00	47.50	53.00
2	5% 0 min	2015/07/20		5.5	6.0	6.0	5.8	h	h	18.22	141	142	205	165.00	22.50	28.00
2	5% 1 min	2015/07/20		5.5	6.0	6.0	5.8	h	h	18.22	141	142	205	165.00	22.50	28.00
2	Down Reset	2015/07/20						1.10	0.51	18.22						
2	15% 0 min	2015/07/20		13.0	13.0	12.8	11.8	44.34	43.53	20.85	141	142	205	206.00	67.00	74.00
2	15% 1 min	2015/07/20		12.8	12.8	13.0	11.8	44.40	43.55	20.86	141	142	205	206.00	67.00	74.00
2	Up Reset	2015/07/20						1.62	1.17							
2	20% 0 min	2015/07/20		17.5	17.2	17.8	16.2	29.92	29.78	22.00	141	142	210	233.00	96.00	104.00
2	20% 1 min	2015/07/20		17.5	17.0	17.8	16.2	29.93	29.81	22.01	141	142	210	233.00	96.00	104.00
2	Up Reset	2015/07/20						1.77	1.50							
2	25% 0 min	2015/07/20		21.0	20.8	21.2	20.0	24.12	24.06	23.79	143	143	210	256.00	118.00	127.00
2	25% 1 min	2015/07/20		20.5	20.6	21.0	20.0	24.20	24.16	23.81	143	143	210	256.00	118.00	127.00
2	Stop Up 0 min	2015/07/20		25.0	24.6	25.4	24.0	48.26	48.57	23.65	143	143	210	278.00	142.80	152.00
2	Stop Up 1 min	2015/07/20		24.5	24.4	25.0	24.0	48.27	48.58	23.65	143	143	210	278.00	142.80	152.00
2	Up Reset	2015/07/20						0.05	1.53							
2	35% 0 min	2015/07/20		31.0	30.4	30.6	30.0	35.00	37.14	24.88	143	144	213	313.00	177.00	190.00
2	35% 1 min	2015/07/20		31.0	30.4	30.6	30.0	35.02	37.15	24.88	143	144	213	313.00	177.00	190.00
2	35% 5 min	2015/07/20		30.5	30.0	30.2	30.0	35.01	37.15	24.89	143	144	213	313.00	177.00	190.00
2	35% 10 min	2015/07/20		30.5	30.0	30.2	30.0	35.02	37.18	24.89	143	144	213	313.00	177.00	190.00
2	35% 15 min	2015/07/20		30.5	30.0	30.0	30.0	35.04	37.19	24.90	143	144	213	313.00	177.00	190.00
2	Stop down 0 min	2015/07/20		21.5	21.2	21.8	21.0	0.95	2.80	21.14	143	143	210	280.00	143.00	154.00
2	Stop down 1 min	2015/07/20		22.0	21.6	22.0	21.0	0.95	2.80	21.14	143	143	210	280.00	143.00	154.00
2	Down Reset	2015/07/20						48.66	48.10							
2	Stop down 0 min	2015/07/20		15.0	14.4	14.8	14.0	0.63	0.70	22.80	96	98	165	233.00	95.00	103.00
2	Stop down 1 min	2015/07/20		15.0	14.4	14.8	14.0	0.62	0.71	22.80	96	98	165	233.00	95.00	103.00
2	Down Reset	2015/07/20						48.60	49.70							
2	Stop down 0 min	2015/07/20		8.0	8.0	8.0	7.0	0.26	1.68	20.30	96	98	163	186.00	46.00	55.00
2	Stop down 1 min	2015/07/20		8.0	8.0	8.0	7.0	0.26	1.65	20.30	96	98	163	186.00	46.00	55.00
2	Down Reset	2015/07/20						48.46	49.65							
3	5% 0 min	2015/07/20		4.8	5.0	5.0	3.8	24.80	27.00	18.37	96	98	160	165.00	23.00	29.40
3	5% 1 min	2015/07/20	17:22	4.8	5.0	5.0	3.8	24.86	27.00	18.37	96	98	160	165.00	23.00	29.40
3	Next day start (5% 920 min)	2015/07/21	08:44	5.0	5.0	5.2	4.2	25.64	26.75	18.21	138	138	124	165.00	22.70	29.00
3	Stop Up 0 min	2015/07/21		9.0	8.8	9.0	7.8	47.30	48.45	20.05	138	138	124	184.00	45.00	52.00
3	Stop Up 1 min	2015/07/21		9.0	8.8	9.0	7.8	47.30	48.45	20.05	138	138	124	184.00	45.00	52.00
3	Up Reset	2015/07/21						1.20	2.35							
3	Stop Up 0 min	2015/07/21		16.5	16.0	16.4	15.4	46.35	48.72	22.35	137	137	128	229.00	92.00	100.50
3	Stop Up 1 min	2015/07/21		16.0	15.8	16.2	15.0	46.35	48.72	22.38	137	137	128	229.00	92.00	100.50
3	Up Reset	2015/07/21						1.62	0.86							
3	Stop Up 0 min	2015/07/21		19.5	19.4	19.8	19.0	22.21	21.57	22.99	136	136	129	250.00	113.00	121.80
3	Up Reset	2015/07/21						1.88	2.20							
3	Stop Up 0 min	2015/07/21		27.5	26.8	27.4	26.2	47.82	48.26	24.21	136	136	129	294.00	158.00	170.00
3	Stop Up 1 min	2015/07/21		27.0	26.8	27.4	26.2	47.86	48.28	24.21	136	136	129	294.00	158.00	170.00
3	Up Reset	2015/07/21						1.25	1.63							
3	Pressure Spike	2015/07/21		40.0				26.41								
3	35% 0 min (Release P)	2015/07/21		32.5	31.8	32.2	31.0	30.35	29.36	25.04	136	136	130	321.00	187.00	197.00
3	35% 1 min	2015/07/21		32.5	31.8	32.2	31.0	30.35	29.36	25.04	136	136	130	321.00	187.00	197.00
3	35% 5 min	2015/07/21		32.5	31.8	32.2	31.0	30.30	29.32	25.04	136	136	130	321.00	187.00	197.00
3	35% 10 min	2015/07/21		32.5	31.8	32.2	31.0	30.28	29.32	25.04	136	136	130	321.00	187.00	197.00
3	35% 15 min -> lower onto spacers	2015/07/21		32.5	31.8	32.2	31.0	30.26	29.31	25.04	136	136	130	321.00	187.00	197.00
3	Lift Off	2015/07/21	11:09	30.0	29.6	29.8	29.0	26.05	26.88	24.94	136	136	130	318.00	183.00	196.00
3	Reset stressing head	2015/07/21		0.0	0.0	0.0	0.0	x	x	24.93	136	136	130	315.00	181.00	0.00
4	Lift Off	2015/07/21		29.5	28.8	29.2	28.2	x	x	25.11	136	136	130	318.00	183.00	14.00
4	Re-install D Gauges	2015/07/21	12:40	29.0	28.6	29.0	28.0	0.45	1.02	25.14	136	136	130	318.00	183.00	14.00
4	Stop Up 0 min	2015/07/21		36.5	36.0	36.2	36.5	46.38	46.40	26.38	136	136	130	360.00	228.00	61.00
4	Stop Up 1 min	2015/07/21		36.5	36.0	36.2	36.5	46.42	46.41	26.39	136	136	130	360.00	228.00	61.00
4	Up Reset	2015/07/21	13:27					1.42	0.78							
4	50% 0 min	2015/07/21		42.5	41.6	42.0	41.6	43.38	43.33	27.52	135	135	130	401.00	272.00	105.00
4	50% 1 min	2015/07/21		42.5	41.6	42.0	41.6	43.38	43.31	27.54	135	135	130	401.00	272.00	105.00
4	50% 5 min	2015/07/21		42.0	41.2	42.0	41.4	43.38	43.27	27.54	135	135	130	401.00	272.00	105.00
4	50% 10 min	2015/07/21		42.0	40.6	41.8	40.8	43.44	43.35	27.54	135	135	130	402.00	271.00	105.00
4	50% 15 min	2015/07/21		41.5	40.4	41.4	40.6	43.53	43.46	27.53	135	135	130	402.00	271.00	105.00
4	Stop down 0 min	2015/07/21		33.0	32.2	32.8	32.4	1.72	1.37	26.85	135	135	130	363.00	230.00	62.00
4	Stop down 1 min	2015/07/21		33.0	32.2	33.0	32.4	1.68	1.34		135	135	130	363.00	230.00	62.00
4	Down Reset	2015/07/21						48.68	48.27							
5	Stop down 0 min	2015/07/21		26.0	25.0	25.8	24.8	1.73	1.42	26.21	135	135	129	316.00	184.00	14.50
5	Stop down 1 min	2015/07/21		26.0	25.0	25.8	24.8	1.74	1.43	26.20	135	135	129	316.00	184.00	14.50
5	Stop Up 0 min	2015/07/21		35.5	34.6	35.2	34.6	47.73	47.80	26.83	136	136	130	360.00	229.00	61.00
5	Stop Up 1 min	2015/07/21		35.0	34.2	35.0	34.4	47.75	47.80	26.84	136	136	130	360.00	229.00	61.00
5	Up Reset	2015/07/21	14:55					0.92	0.20							
5	Stop Up 0 min	2015/07/21		42.0	41.0	42.0	41.6	45.28	44.96	27.60	136	136	131	403.00	274.00	107.50
5	Stop Up 1 min	2015/07/21		42.5	41.0	42.0	41.6	45.30	44.90	27.62	136	136	131	403.00	274.00	107.50
5	Up Reset	2015/07/21						0.25	0.78							
5	Stop Up 0 min	2015/07/21		49.5	48.0	49.0	48.6	46.82	47.82	28.61	136	136	132	449.00	319.00	154.00
5	Stop Up 1 min	2015/07/21		49.0	48.0	48.6	48.0	46.84	47.82	28.62	136	136	132	449.00	319.00	154.00
5	Up Reset	2015/07/21						0.24	2.95							
5	65% 0 min	2015/07/21		54.5	53.6	54.2	54.0	39.13	42.48	29.47	136	136	133	487.00	360.00	197.00
5	65% 1 min	2015/07/21		54.5	53.4	54.2	53.8	39.11	42.46	29.52	136	136	133	487.00	360.00	197.00
5	65% 5 min	2015/07/21		54.5	53.4	54.0	53.8	39.13	42.46	29.52	136	136	133	487.00	360.00	197.00
5	65% 10 min	2015/07/21		54.5	53.4	54.0	53.8	39.13	42.59	29.53	136	136	133	487.00	360.00	197.00
5	65% 15 min	2015/07/21	16:50	54.2	53.2	54.0	53.8	39.13	42.61	29.54	136	136	133	486.00	360.00	197.00
5	Next day start (65% 1140 min)	2015/07/22	11:44	48.8	47.8	48.4	48.0	39.07	42.57	29.60	174	173	170	485.00	360.00	197.00
5	Stop down 0 min	2015/07/22		44.0	42.8	43.6	43.0	11.45	14.88	29.01	174	173	170	460.00	331.00	166.00
5	Stop down 1 min	2015/07/22		44.0	42.8	43.6	43.0	11.45	14.88	29.01	174	173	170	460.00	331.00	166.00
5	Down Reset	2015/07/22						48.44	47.70							
5	Stop down 0 min	2015/07/22		37.5	36.8	37.4	36.8	6.75	6.35	28.28	174	173	169	420.00	291.00	124.00
5	Stop down 1 min	2015/07/22		38.0	37.0	37.6	37.0	0.73	6.35	28.28	174	173	169	420.00	291.00	124.00
5	Down Reset	2015/07/22						34.16	34.82							
6	Stop down 0 min	2015/07/22		35.0	34.0	34.6	34.0	13.88	14.69	27.94	174	174	168	400.00	271.00	105.00
6	Stop down 1 min	2015/07/22		35.0	34.0	34.6	34.2	13.86	14.68	27.94	174	174	168	400.00	271.00	105.00
6	Lift off - 3 more spacers	2015/07/22		37.5	36.6	37.0	36.6	17.30	18.26	27.97	174	174	168	404.00	274.00	109.00
6	Jack down	2015/07/22	13:33	0.0	0.0	0.0	0.0	8.17	7.80	26.80	174	174	168	402.00	273.00	98.00
6	Reset stressing head	2015/07/22		0.0	0.0	0.0	0.0	0.58	0.40	27.79	174	174	168	402.00	273.00	0.00
6	lift off	2015/07/22		37.5	36.6	27.0	36.6	11.25	11.25	28.14	174	174	168	403.00	276.00	18.00
6	Lower to 20MPa for the day	2015/07/22		20.0		20.0		remove dial gauges								
6	next day	2015/07/23	07:51								100	100	94	403.00	275.00	15.00
6	lift off	2015/07/23		37.5	36.6	37.0	36.6	1.08	0.42	25.91	100	100	94	403.00	275.00	18.00
6	Stop Up 0 min	2015/07/23		45.5	44.0	44.6	44.2	47.36	47.19	26.48	100	100	94	448.00	323.00	66.00
6	Stop Up 1 min	2015/07/23		45.0	44.0	44.6	44.2	47.44	47.20	26.48	100	100	94	448.00	323.00	66.00
6	Up Reset	2015/07/23	08:38					0.88	0.86							
6	Stop Up 0 min	2015/07/23		52.5	51.4	52.0	51.8	46.85	47.02	27.30	99	99	95	492.00	369.00	114.00
6	Stop Up 1 min	2015/07/23		52.5	51.4	52.0	51.8	46.83	47.05	27.34	99	99	95	492.00	369.00	114.00
6	Up Reset	2015/07/23	09:14					1.11	0.96							
6	65% 0 min	2015/07/23		56.5	55.4	56.0	55.8	25.63	26.22	27.91	98	98	95	516.00	394.00	138.00
6	65% 1 min	2015/07/23		56.5	55.4	56.0	55.8	25.64	26.22	27.93	98	98	95	516.00	394.00	138.00
6	Stop Up 0 min	2015/07/23		59.0	57.8	58.4	58.2	46.22	45.55	28.44	98	98	95	537.00	415.00	162.00
6	Stop Up 1 min	2015/07/23		58.5	57.8	58.2	58.0	46.45	47.51	28.48	98	98	95	537.00	415.00	162.00
6	Up Reset	2015/07/23						0.46	1.11							
6	Tendon FAILURE!!!	2015/07/23		60.0	x	60.0	x	x	x	x	x	100	98	451.00	x	x
6	at Zero load	2015/07/23		0.0	0.0	0.0	0.0	x	x	x	x	x	x	415.00	x	x

ANCHOR A04 RAW DATA

Cycle	Description	Date	Time	P1	P2	P3	P4	D1	D2	D3	L1	L2	L3	B1	R1	J1
				MPa	MPa	MPa	MPa	mm	mm	mm	mm	mm	mm	mm	mm	mm
1	Beam in place - no load	2015/06/09	14:40	0.00	0.00	0.00	0.00	0.99	2.29	1.12	79.00	70.00	111.00	205.00	na	na
1	First LIFT OFF	2015/06/09	14:45	3.80	x	3.80	x	x	x	x	x	x	x	x	na	na
1	5% Seating Load - 4MPa	2015/06/09	14:51	4.40	4.30	4.30	3.80	10.18	11.60	1.74	79.00	71.00	118.00	213.00	na	na
1	10% 0 min	2015/06/09		8.70	8.10	8.10	7.40	36.42	37.32	3.32	79.00	71.00	120.00	236.00	na	na
1	10% 1 min	2015/06/09		8.40	8.10	8.10	7.40	36.42	37.32	3.32	79.00	71.00	120.00	236.00	na	na
1	Up Reset	2015/06/09		8.40				1.65	0.76	3.30					na	na
1	15% 0 min	2015/06/09		13.00	12.80	12.80	11.90	31.69	30.32	5.96	79.00	71.00	122.00	263.00	na	na
1	15% 1 min	2015/06/09	15:36	12.50	12.40	12.40	11.80	31.69	30.32	5.96	79.00	71.00	122.00	263.00	na	na
1	Up Reset	2015/06/09	15:22	12.50				1.42	1.75							
1	20% 0 min	2015/06/09		17.40	16.80	17.20	16.00	30.06	30.10	6.42	79.00	71.00	124.00	290.00	na	na
1	20% 1 min	2015/06/09	15:36	17.40	16.80	17.20	16.00	30.08	30.12	6.42	79.00	71.00	124.00	290.00	na	na
1	20% 5 min	2015/06/09		17.00	16.40	17.00	16.00	30.07	30.12	6.41	79.00	71.00	124.00	290.00	na	na
1	20% 10 min	2015/06/09		17.00	16.20	17.00	16.00	30.11	30.17	6.39	79.00	71.00	124.00	290.00	na	na
1	20% 15 min	2015/06/09		16.60	16.10	16.80	16.00	30.17	30.20	6.38	79.00	71.00	124.00	291.00	90.20	na
1	15% 0 min	2015/06/09		13.00	12.80	12.80	12.40	12.30	12.42	6.28	79.00	71.00	124.00	273.00	70.70	na
1	15% 1 min	2015/06/09		13.00	12.80	12.80	12.40	12.30	12.42	6.28	79.00	71.00	124.00	273.00	70.70	na
1	Down Reset	2015/06/09		13.20				49.04	48.53							
1	10% 0 min	2015/06/09		8.70	9.60	9.60	9.00	25.40	25.45	6.28	79.00	71.00	119.00	250.00	x	na
1	10% 1 min	2015/06/09		9.70	9.60	9.60	9.00	25.40	25.45	6.28	79.00	71.00	119.00	x	x	na
2	5% 0 min	2015/06/09		5.40	5.00	5.00	4.40	1.68	1.65	6.28	79.00	71.00	119.00	215.00	19.00	na
2	5% 1 min	2015/06/09	16:15	5.50	5.00	5.00	4.40	1.68	1.65	6.28	79.00	71.00	119.00	220.00	18.60	na
2	New Day Reset all D & L gauges	2015/06/10	08:10	5.50	5.50	5.60	4.60	1.67	0.80	0.80	62.00	54.00	102.00	220.00	18.20	na
2	15% 0 min	2015/06/10		13.20	13.00	13.00	12.00	49.75	47.65	3.04	62.00	54.00	104.00	267.00	68.00	na
2	15% 1 min	2015/06/10		13.00	12.80	12.80	11.80	49.75	47.65	3.04	62.00	54.00	104.00	267.00	68.00	na
2	Up Reset	2015/06/10						0.21	1.06							
2	20% 0 min	2015/06/10		18.00	17.80	18.00	16.60	32.04	32.68	4.71	60.00	51.00	105.00	296.00	100.40	na
2	20% 1 min	2015/06/10		18.00	17.80	18.00	16.60	32.04	32.68	4.71	60.00	51.00	105.00	296.00	100.40	na
2	Up Reset	2015/06/10						1.18	1.00							
2	25% 0 min	2015/06/10	09:20	22.00	21.80	21.80	20.80	25.42	24.74	5.90	60.00	51.00	102.00	317.00	124.00	na
2	25% 1 min	2015/06/10		21.60	21.80	21.80	20.80	25.40	24.72	5.90	60.00	51.00	102.00	317.00	124.00	135.00
2	30% 0 min	2015/06/10	09:31	26.10	25.40	25.60	24.80	49.12	48.12	7.09	60.00	51.00	108.00	340.00	147.60	158.00
2	30% 1 min	2015/06/10		26.00	25.40	25.60	24.80	49.12	48.10	7.09	60.00	51.00	108.00	340.00	147.60	158.00
2	30% 5 min	2015/06/10		25.80	25.40	25.60	24.60	49.06	48.04	7.09	60.00	51.00	108.00	340.00	147.60	158.00
2	30% 10 min	2015/06/10		26.00	25.20	25.60	24.60	49.01	47.96	7.17	60.00	51.00	108.00	340.00	147.60	158.00
2	30% 15 min	2015/06/10		26.00	25.20	25.60	24.60	48.98	47.92	7.22	60.00	51.00	108.00	340.00	147.50	158.00
2	20% 0 min	2015/06/10		17.50	17.60	17.80	17.00	12.23	11.39	6.94	60.00	51.00	108.00	304.00	110.65	120.00
2	20% 1 min	2015/06/10		18.00	17.80	18.00	17.20	12.23	11.40	6.94	60.00	51.00	106.00	304.00	110.65	120.00
2	Down Reset	2015/06/10						49.00	48.59							
2	10% 0 min	2015/06/10		9.00	9.50	9.50	9.00	0.00	0.00	2.61	60.00	51.00	103.00	245.00	47.20	55.00
2	10% 0 min	2015/06/10		9.00	9.50	9.50	9.00	10.50	9.00	2.61	60.00	51.00	103.00	245.00	47.20	55.00
2	10% 1 min	2015/06/10		9.50	9.50	9.50	9.00	10.50	9.00	2.61	60.00	51.00	103.00	245.00	47.20	55.00
2	Down Reset	2015/06/10						49.90	48.45							
3	5% 0 min	2015/06/10		4.50	4.20	4.20	3.80	16.20	15.32	0.81	60.00	51.00	100.00	212.00	12.00	19.00
3	5% 1 min	2015/06/10		4.50	4.20	4.20	3.80	16.20	15.32	0.81	60.00	51.00	100.00	212.00	12.00	19.00
3	10% 0 min	2015/06/10		10.00	9.60	9.40	8.40	49.25	47.91	2.64	60.00	51.00	102.00	246.00	41.40	53.65
3	10% 0 min	2015/06/10		9.60	9.60	9.40	8.40	49.25	47.88	2.64	60.00	51.00	102.00	246.00	41.40	53.65
3	Up Reset	2015/06/10						1.64	1.34							
3	20% 0 min	2015/06/10		17.00	16.50	16.40	15.80	48.26	47.64	5.25	60.00	51.00	105.00	289.00	94.00	102.80
3	20% 1 min	2015/06/10		16.80	16.20	16.40	15.80	48.26	47.64	5.25	60.00	51.00	105.00	289.00	94.00	102.80
3	Up Reset	2015/06/10						0.10	0.10							
3	30% 0 min	2015/06/10		25.00	24.60	25.00	23.80	48.62	47.90	7.33	60.00	51.00	108.00	335.00	142.50	153.00
3	30% 1 min	2015/06/10		25.00	24.40	24.60	24.00	48.60	47.88	7.33	60.00	51.00	108.00	335.00	142.50	153.00
3	Up Reset	2015/06/10						0.60	1.60	7.33						
3	35% 0 min	2015/06/10		30.00	29.40	29.40	28.80	29.40	30.41	8.63	60.00	51.00	110.00	363.00	170.00	182.00
3	35% 1 min	2015/06/10		30.00	29.00	29.20	28.60	29.40	30.38	8.64	60.00	51.00	110.00	363.00	170.00	182.00
3	Up Reset	2015/06/10	12:03					2.64	1.95							
3	40% 0 min	2015/06/10		34.00	34.00	34.60	34.00	15.95	15.25	9.20	60.00	51.00	110.00	375.00	182.00	195.00
3	40% 1 min	2015/06/10		35.00	34.00	34.60	34.00	15.95	15.25	9.20	60.00	51.00	110.00	375.00	182.00	195.00
3	40% 5 min	2015/06/10		35.00	34.00	34.40	34.00	15.91	15.18	9.21	60.00	51.00	110.00	375.00	182.00	195.00
3	40% 10 min	2015/06/10		35.00	34.00	34.40	34.00	15.86	15.10	9.21	60.00	51.00	110.00	375.00	182.00	195.00
3	40% 15 min	2015/06/10	12:35	35.00	34.00	34.40	34.00	15.85	15.05	9.21	60.00	51.00	110.00	375.00	183.00	195.00
3	Lunch Break	2015/06/10	13:36	30.00	28.60	28.60	29.00	0.62	14.00	8.05	60.00	51.00	110.00	375.00	182.00	195.00
3	Lower to 30%	2015/06/10		26.00	26.00	26.00	26.00	7.09	6.28	7.78	60.00	51.00	110.00	368.00	174.00	188.00
3	Raise to about 40%	2015/06/10	13:50	34.00	x	x	x	0.65	0.64	9.10	60.00	51.00	110.00	375.00	182.00	196.00
3	Lower onto spacers and LIFT OFF	2015/06/10	14:15	30.50	x	x	x	x	x	x	x	x	x	367.00	x	x
3	Stressing head re-seated	2015/06/10	15:42	0.00	0.00	0.00	0.00	2.06	0.11	8.03	x	x	x	x	x	x
4	LIFT OFF	2015/06/10		27.50	27.80	28.00	27.60	7.22	6.48	8.26	55.00	51.00	110.00	370.00	180.00	11.00
4	40% 0 min	2015/06/10		34.50	33.80	34.00	33.60	46.85	45.85	9.63	55.00	51.00	110.00	406.00	219.00	50.00
4	40% 1 min	2015/06/10		34.50	33.60	33.90	33.80	46.85	45.85	9.64	55.00	51.00	110.00	406.00	219.00	50.00
4	Up Reset	2015/06/10						1.05	0.60							
4	45% 0 min	2015/06/10		39.50	38.40	39.00	38.20	35.38	34.73	10.79	60.00	51.00	113.00	438.00	253.00	85.00
4	45% 1 min	2015/06/10		39.00	38.40	39.00	38.20	35.38	34.73	10.79	60.00	51.00	113.00	438.00	253.00	85.00
4	Up Reset	2015/06/10	16:33					1.59	0.80							
4	50% 0 min	2015/06/10		43.80	42.20	43.00	42.40	30.00	28.66	11.65	60.00	51.00	114.00	465.00	282.00	114.00
4	50% 1 min	2015/06/10		43.80	42.20	43.00	42.40	30.05	28.66	11.67	60.00	51.00	114.00	465.00	282.00	114.00
4	50% 5 min	2015/06/10		43.80	42.20	43.00	42.40	30.08	28.66	11.68	60.00	51.00	114.00	465.00	282.00	114.00
4	50% 10 min	2015/06/10		43.20	41.60	42.40	41.80	30.08	28.64	11.68	60.00	51.00	114.00	465.00	282.00	114.00
4	50% 15 min D Gauges on for night	2015/06/10		43.20	41.60	42.40	41.80	30.08	28.64	11.68	60.00	51.00	114.00	465.00	282.00	114.00
4	50% many min Reset L guages	2015/06/11	10:12	43.20	40.80	41.20	41.00	29.30	28.97	12.01	na	na	na	465.00	282.00	1145.00
4	50% many min	2015/06/11	12:23	43.50	42.00	42.40	42.00	29.09	28.54	12.31	na	na	na	465.00	282.00	1145.00
4	50% many min	2015/06/11	12:59	43.50	42.00	42.40	42.00	28.99	28.37	12.32	125.00	150.00	180.00	465.00	282.00	1145.00
4	40% 0 min	2015/06/11		35.50	34.60	35.00	35.00	6.23	2.40	11.69	125.00	150.00	180.00	440.00	255.00	88.00
4	40% 1 min	2015/06/11		35.90	34.60	35.00	35.00	6.23	2.40	11.69	125.00	150.00	180.00	440.00	255.00	88.00
4	Down Reset	2015/06/11						47.61	45.22							
5	35% 0 min	2015/06/11		29.50	29.00	29.60	29.60	7.11	5.75	10.49	120.00	116.00	178.00	401.00	214.00	46.00
5	35% 1 min	2015/06/11		30.00	29.00	29.60	29.60	7.11	5.75	10.48	120.00	116.00	178.00	401.00	214.00	46.00
5	40% 0 min	2015/06/11		35.50	34.80	35.60	35.00	27.99	24.45	11.18	120.00	116.00	178.00	420.00	235.00	67.00
5	40% 1 min	2015/06/11		35.10	34.80	35.60	35.00	27.99	24.45	11.18	120.00	116.00	178.00	420.00	235.00	67.00
5	45% 0 min	2015/06/11		38.90	38.00	38.90	38.20	50.23	47.55	11.69	120.00	116.00	178.00	442.00	257.00	90.00
5	45% 1 min	2015/06/11		38.90	38.00	38.90	38.20	50.23	47.55	11.66	120.00	116.00	178.00	442.00	257.00	90.00
5	Up Reset	2015/06/11						3.33	1.77							
5	50% 0 min	2015/06/11		44.50	43.20	43.80	43.60	38.24	36.59	12.40	120.00	116.00	180.00	475.00	292.00	126.00
5	50% 1 min	2015/06/11		44.10	43.20	43.80	43.60	38.29	36.66	12.41	120.00	116.00	180.00	475.00	292.00	126.00
5	53% 0 min	2015/06/11		46.80	45.60	46.00	45.80	49.70	44.49	12.65	120.00	116.00	180.00	486.00	302.00	137.00
5	53% 1 min	2015/06/11		46.60	45.60	46.00	45.80	49.80	47.52	12.65	120.00	116.00	180.00	486.00	302.00	137.00
5	Up Reset	2015/06/11						3.01	0.11							
5	55% 0 min	2015/06/11		49.00	48.60	48.00	48.80	15.77	12.91	12.91	120.00	115.00	180.00	497.00	315.00	149.00
5	55% 1 min	2015/06/11		48.90	48.60	48.00	48.80	15.78	12.92	12.92	120.00	116.00	180.00	497.00	315.00	149.00
5	60% 0 min	2015/06/11		52.50	51.00	51.80	52.20	39.52	36.45	13.53	120.00	115.00	180.00	521.00	340.00	174.00
5	60% 1 min	2015/06/11		52.50	51.00	51.80	52.20	39.59	36.47	13.53	120.00	115.00	180.00	521.00	340.00	174.00
5	60% 5 min	2015/06/11	15:02	52.20	50.80	51.60	51.80	39.61	36.49	13.53	120.00	115.00	180.00	521.00	340.00	174.00
5	60% 10 min	2015/06/11		52.10	50.60	51.40	51.60	39.62	36.50	13.53	120.00	115.00	180.00	521.00	340.00	174.00
5	60% 15 min	2015/06/11		52.00	50.60	51.40	51.60	39.60	36.53	13.53	120.00	115.00	180.00	520.00	339.00	174.00
5	46% Down Stop	2015/06/11		40.50	39.80	40.20	40.00	55.23	51.96	12.70	120.00	115.00	181.00	480.00	291.00	132.00
5	Down Reset	2015/06/11						48.36	47.84							
5	40% 0 min	2015/06/11		35.00	34.00	34.20	34.20	5.50	3.44	11.68	120.00	115.00	179.00	439.00	255.00	86.50
5	40% 1 min	2015/06/11		35.00	34.00	34.20	34.20	5.50	3.44	11.66	120.00	115.00	179.00	439.00	255.00	86.50
5	Down Reset	2015/06/11						48.36	40.29							
6	35% 0 min	2015/06/11		30.40	29.40	30.00	29.60	17.15	8.39	10.38	120.00	115.00	178.00	408.00	222.00	54.00
6	35% 1 min	2015/06/11		30.40	29.40	30.00	29.60	17.15	8.39	10.38	120.00	115.00	178.00	408.00	222.00	54.00
6	43% Up Stop	2015/06/11		37.50	36.70	37.00	37.40	49.71	41.41	11.69	x	x	x	440.00	254.00	85.00
6	Up Reset	2015/06/11	16:04					0.66	1.87							
6	52% Up Stop	2015/06/11		45.20	44.20	44.60	45.00	46.50	47.86	12.78	120.00	115.00	180.00	483.00	302.00	135.00
6	Up Reset	2015/06/11						0.18	0.75							
6	55% 0 min	2015/06/11	16:28	47.50	46.00	46.40	47.00	10.23	10.80	12.93	120.00	115.00	180.00	493.00	313.00	146.00
6	55% 10 min D Gauges on for night	2015/06/11	16:40	46.80	45.20	45.80	46.40	10.28	10.83	12.92	120.00	115.00	180.00	493.00	312.00	146.00
6		2015/06/12	08:15	43.20	41.80	42.20	42.40	10.13	10.77	12.86	94.00	90.00	154.00	494.00	312.00	145.50
6	61% 0 min	2015/06/12		53.50	51.80	52.20	53.00	49.72	48.18	13.65	94.00	90.00	154.00	494.00	312.00	145.50
6	61% 1 min	2015/06/12	09:03	53.20	51.80	52.20	52.60	49.74	48.21	13.66	94.00	90.00	154.00	532.00	352.00	187.00
6	61% 25 min	2015/06/12	09:30	53.00	51.60	52.10	52.20	49.74	48.45	13.78	94.00	90.00	154.00	532.00	352.00	187.00
6	Lower to Spacers - Card contact	2015/06/12		43.20	41.80	42.00	42.00	29.44	28.67	13.78	94.00	90.00	154.00	513.00	333.00	165.00
6	LIFT OFF	2015/06/12		47.40	47.80	47.80	48.20	30.43	29.47	13.78	x	x	x	x	x	x
6	Pressure of - LOUD Noise	2015/06/12		0.00	x	x	x	11.85	x	x	x	x	x	510.00	x	x
7	LIFT OFF	2015/06/12		46.50	x	45.00	x	x	x	x	x	x	x	513.00	x	x
7	1 more spacer - Release onto spacer	2015/06/12		51.50	x	51.00	x	x	x	x	x	x	x	545.00	x	x
7	Jack-up to snap - two more snapped	2015/06/12		x	x	x	x	x	x	x	x	x	x	x	x	x
7	Lowering to remove	2015/06/15		27.00	x	x	x	x	x	x	x	x	x	447.00	x	x
7	Lowering to remove	2015/06/15		18.50	x	x	x	x	x	x	x	x	x	357.00	x	x
7	Lowering to remove	2015/06/15		7.50	x	x	x	x	x	x	x	x	x	272.00	x	x
7	All LOAD off	2015/06/15		0.00	x	x	x	x	x	x	x	x	x	190.00	x	x

ANCHOR 05 RAW DATA

Cycle	Description	Date	Time	P1	LC	D1	D2	D3	L1	L2	L3	B1 R 1 J1
				MPa	kN	mm	mm	mm	mm	mm	mm	not recorded for Anchor 5
1	Take Base line	2015/02/18		0.00	0.00	0.00	0.00	0.00	182	189	185	
1	5p 0	2015/02/18		7.20	181.50	2.62	2.62	1.05	182	189	185	
1	5p 1m	2015/02/18		7.20	177.50	2.62	2.62	1.05	182	189	185	
1	10p 0m	2015/02/18		13.00	362.50	35.88	35.51	3.74	184	189	186	
1	10p 1m	2015/02/18		13.00	360.50	35.92	35.58	3.74	184	189	186	
1	Up reset	2015/02/18		13.00	360.50	1.25	1.41	3.74	184	189	186	
1	15p 0m	2015/02/18		19.00	544.50	41.07	39.84	5.52	182	189	189	
1	15p 1m	2015/02/18		19.00	541.50	41.07	39.85	5.53	182	189	189	
1	Up reset	2015/02/18		16.00	541.50	0.23	0.23	5.53	182	189	189	
1	20p 0	2015/02/18		25.00	725.00	39.73	39.40	5.96	182	190	189	
1	20p 5	2015/02/18		25.00	718.50	39.72	39.42	6.00	182	190	190	
1	20p 15	2015/02/18		24.50	715.50	39.72	39.42	6.05	182	192	190	
1	15p 0m	2015/02/18		18.50	546.00	8.65	8.13	5.13	182	190	190	
1	15p 1m	2015/02/18		19.00	547.50	8.65	8.17	5.14	182	190	188	
1	Reset down	2015/02/18		19.00	547.50	48.18	49.95	5.14	182	190	188	
1	10p 0m	2015/02/18		12.50	362.50	9.00	10.44	4.52	182	190	188	
1	10p 1m	2015/02/18		12.50	362.50	9.00	10.44	4.52	182	190	188	
1	Reset down	2015/02/18		12.50	362.50	48.15	49.33	4.52	182	190	188	
1	5p 0m	2015/02/18		7.00	172.00	9.57	10.20	2.58	182	189	185	
2	5p 1m	2015/02/18		7.00	175.00	9.57	10.24	2.59	182	189	185	
2	Pump up stop	2015/02/18		12.00	360.00	46.60	44.39	3.47	182	189	185	
2	Up reset	2015/02/18		12.00	360.00	0.53	0.56	3.47	x	x	x	
2	Pump up stop	2015/02/18		20.50	585.00	47.65	48.50	5.43	x	x	x	
2	Up reset	2015/02/18		20.50	585.00	1.48	1.68	5.43	x	x	x	
2	20p 0m	2015/02/18		25.00	725.00	31.45	31.58	6.31	182	190	189	
2	20p 1 m	2015/02/18		25.00	720.50	31.45	31.56	6.31	182	190	189	
2	Up reset	2015/02/18		25.00	720.50	2.38	3.00	6.31	182	190	189	
2	25p 0m	2015/02/18		31.50	906.00	41.32	42.02	7.50	182	189	190	
2	25p 1m	2015/02/18		31.50	900.00	41.41	42.02	7.51	182	189	190	
2	Up reset	2015/02/18		31.50	900.00	1.80	1.24	7.51	182	189	190	
2	30p 0m	2015/02/18		44.00	1047.00	32.53	31.14	8.41	182	189	190	
2	30P 5m	2015/02/18		43.50	1037.50	32.53	31.13	8.43	182	189	190	
2	30p 15m	2015/02/18		43.00	1036.00	32.50	31.10	8.45	182	191	191	
2	Down Stop	2015/02/18		30.00	890.00	9.21	8.60	7.95	x	x	x	
2	Reset down	2015/02/18		30.00	890.00	50.00	49.10	7.95	x	x	x	
2	20p 0m	2015/02/18		25.00	726.00	15.30	13.82	7.19	182	191	191	
2	20p 1m	2015/02/18		25.00	728.50	15.28	13.78	7.19	182	191	191	
2	Reset down	2015/02/18		25.00	728.50	49.50	49.22	7.19	182	189	190	
2	Down Stop	2015/02/18		18.50	525.00	7.00	7.90	5.83	x	x	x	
2	Reset down	2015/02/18		18.50	525.00	49.59	49.54					
2	10p 0m	2015/02/18		13.00	361.50	14.60	13.98	4.22	182	189	188	
2	10p 1m	2015/02/18		13.50	363.00	14.60	13.98	4.22	182	189	188	
2	Reset down	2015/02/18		13.50	363.00	48.70	50.00					
2	5p 0m	2015/02/18		7.50	181.00	11.74	11.39	2.29	182	192	186	
2	5p 1m	2015/02/18		8.00	185.50	11.74	11.39	2.29	182	192	186	
3	END OF DAY LOCK OFF	2015/02/18		8.00	186.00	11.74	11.39	2.29	182	192	186	
3	Base	2015/02/19		7.00	181.50	0.40	0.20	4.61	211	217	156	
3	Stop UP	2015/02/19		15.00	439.50	48.34	49.22	6.55	211	219	159	
3	Up reset	2015/02/19		15.00	436.00	1.96	0.60	6.55	211	219	159	
3	Stop UP	2015/02/19		22.50	667.00	49.61	48.05	8.80	211	219	160	
3	28 mins Up reset	2015/02/19		20.00	659.00	1.51	0.28	8.87	x	x	x	
3	Stop UP	2015/02/19		30.50	890.00	48.59	47.58	10.49	212	219	161	
3	Up reset	2015/02/19		30.50	886.00	0.40	0.75	10.49	212	219	161	
3	30p 0m	2015/02/19		35.50	1047.00	34.65	33.37	11.40	212	219	161	
3	30p 5m	2015/02/19		35.50	1047.00	34.64	33.37	11.42	212	219	161	
3	30p 10m	2015/02/19		35.00	1047.00	34.64	33.41	11.43	212	219	161	
3	30p 15m	2015/02/19		35.00	1037.50	34.64	33.52	11.46	212	219	161	
3	Lock OFF	2015/02/19			849.00							
4	Base 2	2015/02/23		1.00	51.50	1.65	1.74	7.74	194	201	105	
4	LIFT OFF TEST	2015/02/23		27.00	877.00	7.18	8.17	7.77	199	201	104	
4	30p 0m	2015/02/23		34.00	1088.00	46.78	46.78	8.92	200	201	104	
4	Up reset	2015/02/23		34.00	1088.00	1.52	0.14	8.92	200	201	104	
4	35p 0m	2015/02/23		40.00	1269.00	38.72	38.15	9.44	200	201	104	
4	35p 1m	2015/02/23		40.00	1263.50	38.72	38.15	9.44	200	201	104	
4	Up reset	2015/02/23		40.00	1263.50	1.25	1.16	9.44	200	201	104	
4	40p 0m	2015/02/23		45.50	1450.50	34.48	34.15	10.24	200	201	104	
4	40p 5m	2015/02/23		45.00	1437.50	34.64	34.18	10.27	200	201	104	
4	40p 15m	2015/02/23		45.00	1433.00	34.64	34.15	10.30	200	201	104	
4	Down Stop	2015/02/23		38.10	1233.00	6.35	5.70	x	200	201	104	
4	Reset down	2015/02/23		38.10	1233.00	49.11	49.81	x	200	201	104	
4	30p 0m	2015/02/23		33.50	1089.00	19.05	19.46	x	195	201	104	
4	30p 1m	2015/02/23		33.50	1092.00	19.05	19.44	x	195	201	104	
4	Reset down	2015/02/23		33.50	1092.00	49.35	45.28	x	195	201	104	
4	"Lift off" - 24p 0m	2015/02/23		22.50	879.50	5.22	0.87	8.29	194	201	104	
5	"Lift off" - 24p 1m	2015/02/23		22.50	880.50	5.22	0.87	8.29	194	201	104	
5	Stop UP	2015/02/23		30.50	1136.50	49.41	45.94	9.21	x	x	x	
5	Up reset	2015/02/23		30.50	1136.50	1.53	1.53	9.21	x	x	x	
5	Stop UP	2015/02/23		43.50	1373.50	48.57	48.55	10.05	x	x	x	
5	Lock OFF	2015/02/23		40.00	1290.00	43.01	43.02	10.06	x	x	x	
5	Base 3	2015/02/24		1.50	13.00	0.87	1.87	3.56	201	201	104	
6	LIFT OFF TEST	2015/02/24		41.00	1261.00	12.10	12.49	3.50	201	201	104	
6		2015/02/24		47.00	1450.00	47.32	47.52	4.13	201	201	103	
6	Up reset	2015/02/24		47.00	1444.00	2.22	0.00	4.13	201	201	103	
6	45p 0m	2015/02/24		53.00	1634.00	41.10	38.96	5.90	201	201	104	
6	45p 1m	2015/02/24		53.00	1629.50	41.20	38.94	5.90	201	201	103	
6	Up reset	2015/02/24		53.00	1629.50	2.12	1.86	5.90	201	201	103	
6	p50 0m	2015/02/24		60.00	1869.00	29.37	29.05	5.53	201	201	102	
6	p50 5m	2015/02/24		59.00	1845.50	29.45	29.45	5.57	201	201	102	
6	p50 15m	2015/02/24		59.00	1842.50	29.37	28.91	5.60	201	201	102	
6	Down Stop	2015/02/24		48.50	1559.50	1.67	1.22	5.08	x	x	x	
6	Reset down	2015/02/24		48.50	1561.50	49.92	48.51	5.08	x	x	x	
6	Down Stop	2015/02/24		41.50	1329.00	1.92	0.90	4.91	x	x	x	
6	Reset down	2015/02/24		41.50	1329.00	48.23	46.43	4.91	x	x	x	
6	Lock OFF	2015/02/24		39.50	1261.00	34.46	32.30	4.77	x	x	x	
7	Base 4	2015/02/25		39.00	1262.50	0.08	0.80	1.22	161	168	70	
7	Stop UP	2015/02/25		49.50	1556.50	48.05	49.10	2.18	161	167	69	
7	Up reset	2015/02/25		49.50	1555.50	0.80	1.83	2.18	161	167	69	
7	49.5p 0m	2015/02/25		57.50	1802.00	45.62	47.60	2.86	161	161	68	
7	49.5p 10m	2015/02/25		57.00	1793.00	45.58	47.00	2.88	161	161	68	
7	49.5p 130m	2015/02/25		57.00	1783.00	45.58	46.88	2.94	161	161	68	
7	49.5p 250m	2015/02/25		57.00	1785.00	45.80	46.89	2.71	161	161	68	
7	49.5p 310m	2015/02/25		56.50	1782.00	45.16	46.22	2.87	x	x	x	
7	Lock OFF	2015/02/25		48.50	1565.00	29.00	30.07	2.48	x	x	x	
7	xDead - 43p	2015/02/25		1.50	30.00	4.79	5.15	2.50	x	x	x	
7	xDead - 43p	2015/02/25		0.00	12.00	1.02	0.28	0.28	168	169	71	
8	Base	2015/02/25		43.00	1326.00	12.07	11.07	8.35	168	169	71	
8	LIFT OFF TEST	2015/02/25		46.50	1478.00	13.39	13.45	8.39	168	169	71	
8	Stop UP	2015/02/25		53.50	1689.50	49.00	47.50	9.08	x	x	x	
8	Up reset	2015/02/25		53.50	1689.50	4.60	3.79	9.04	x	x	x	
8	Stop UP	2015/02/25		55.50	1760.00	21.56	19.42	9.21	x	x	x	
8	Up reset	2015/02/25		55.50	1752.00	1.48	1.36	9.21	x	x	x	
8	50p 0m	2015/02/25		57.00	1813.00	12.05	12.00	9.38	168	170	70	
8	50p 1m	2015/02/25		57.00	1806.00	12.40	12.02	9.38	168	170	70	
8	54p 0m	2015/02/25		62.00	1966.00	49.10	48.37	10.02	168	170	70	
8	54p 1m	2015/02/25		62.00	1958.50	49.12	48.37	10.02	168	170	70	
8	Up reset	2015/02/25		62.00	1956.50	2.35	1.45	10.02	168	170	70	
8	55p 0m	2015/02/25		63.00	1994.00	8.37	7.43	10.10	168	170	70	
8	55p 1m	2015/02/25		63.00	1987.50	8.38	7.44	10.10	168	170	70	
8	Stop UP	2015/02/25		67.00	2117.50	39.57	38.50	10.58	168	170	70	
8	Up reset	2015/02/25		67.00	2109.50	0.92	1.25	10.58	168	170	70	