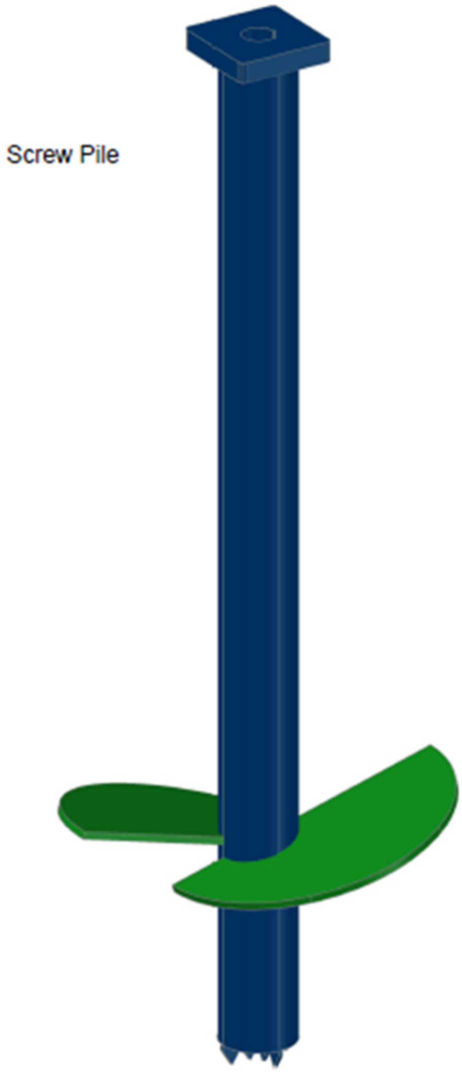
DETAILED

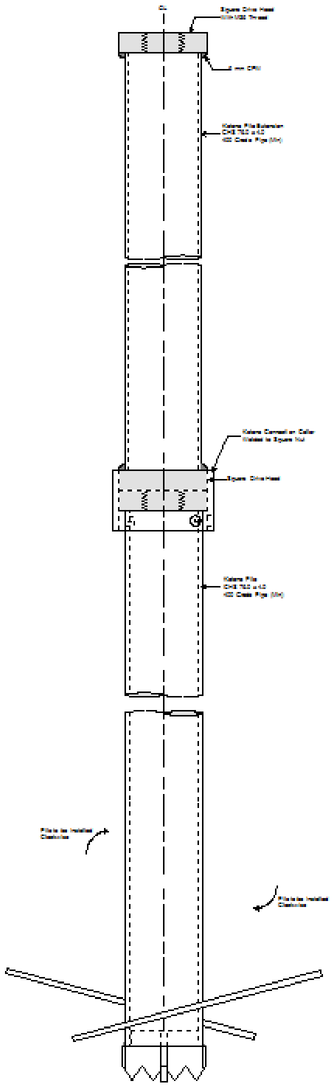
PRODUCT STATEMENT

Katana Twin-Fin Piles

80kN, 100kN & 150kN Series

TUBULAR STEEL – KATANA PILES





Prepared by Patented Foundations Pty Ltd

Please note this document has been prepared by Patented Foundations Pty Ltd. This specification outlines a minimum set of standards and procedures for the supply and installation of the Katana Twin-Fin Pile in accordance with the relevant Australian and New Zealand Standards.

ISSUE 5.3
DATE: 1/6/2019
Checked by JJW

CONTENTS

Clause Page

TUBULAR STEEL - KATANA PILE

GENERAL

1 SCOPE

The work to be executed under this Specification consists of:

- Supply of steel Katana piles
- Installation of steel Katana piles
- Design and certification of Katana piles.

2 REFERENCES

Australian Standards

AS 1579	Arc Welded Steel Pipes and Fittings for Water and Waste Water
AS 2159	Piling Design and Installation
AS 2177	Non-destructive Testing – Radiography of Welded Butt Joints in Metal
AS 2203.1	Cored Electrodes for Arc-Welding
AS 2207	Non-destructive Testing – Ultrasonic Testing of Fusion Welded Joints in Carbon & Low Alloy Steel
AS 1163	Structural steel hollow sections
AS 4100	Steel structures

Australian/New Zealand Standards

AS/NZS 1553.1	Low Carbon Steel Electrodes for Manual Metal-arc Welding of Carbon Steels & Carbon – Manganese Steels
AS/NZS 1554.1	Welding of Steel Structures
AS/NZS 3678	Structural Steel - Hot-rolled Plates, Floor plates and Slabs

Supporting Documentation

Appendix A	Weld Specifications
Appendix B	Corrosion
Appendix C	Geotechnical Test Results
Appendix D	Bracing Plate (Optional)

MATERIALS

3 STEEL KATANA PILES

STEEL TWIN-FIN PILES REQUIREMENTS for the 80kN KATANA TWIN-FIN PILE

a) The steel Katana pile shaft shall be manufactured using “BlueScope Steel” circular hollow section structural steel with a yield strength of greater than 460MPa and a tensile strength of 490MPa or better, to AS 1163 manufactured in accordance with AS/NZS 1554.1

b) The steel Katana Pile bearing plates shall be manufactured from structural steel Grade 450 or higher to AS 3678 and manufactured in accordance with AS/NZS 1554.1

c) Certification of materials - Test certificates shall be issued with the Katana piles for the steel used in the manufacture of the product in accordance with AS/NZS 3679.1 relating to tests performed by the manufacturer to establish compliance with the Standard.

d) Dimensions and Tolerances – The steel hollow sections shall conform to the manufacturing tolerances specified in AS 1163-2016.

e) Weld specifications are to comply with report by e3K Global *A division of Gilmore Engineers Pty Ltd, research and development. Attached (Appendix A)

f) The use of unidentified or second-hand steel is not to be used. All steel shall comply with AS 4100.

g) Once manufactured Katana piles are to be visually inspected and approved.

CORROSION PROTECTION TO KATANA PILES

Steel Katana piles to be designed in accordance with AS 2159 Section 6.3 with an allowance for sectional loss based on the site corrosion classification and design life. Refer “Katana Twin-Fin Pile” corrosion manual by e3k Global *A division of Gilmore Engineers Pty Ltd, research and development. Attached (Appendix B)

DESIGN

4. DESIGN OF STEEL KATANA TWIN-FIN PILES

a) The Katana pile when incorporated within a foundation system must be designed by a practising professional structural engineer with previous experience in the use and design of steel Twin-Fin piles.

b) The steel Katana piles shall be designed in accordance with AS 4100 and AS 2159 to carry either 80kN, 100kN or 150kN safe working load, along with any additional loads due to installation misalignment, soil movement or pile settlement if applicable. Suitable geotechnical information should be supplied and used for design purposes.

c) Katana pile design calculations shall include a load eccentricity of 25mm and a realistic allowance for effective length for the particular soil conditions

d) The maximum settlement of the Katana piles under design working load shall be as detailed in AS 2159 Table 8.2 unless noted otherwise on the engineered drawings.

e) The Katana pile connection to the footing or structure over shall be part of the design process undertaken by the design engineer.

INSTALLATION

5. KATANA PILE INSTALLATION

KATANA PILES INSTALLATION REQUIREMENTS

a) The Katana piles shall be installed using specialised equipment correctly calibrated to allow torque reading to be monitored and recorded during installation.

b) The Katana piles shall be installed by an experienced accredited "Katana Pile" contractor.

c) Details of the proposed Katana pile installation equipment and operator proficiency shall be submitted to the project engineers for approval.

d) During the storage, transportation, lifting and installation the Katana piles shall be correctly supported. Any steel Katana piles damaged or distorted in excess of the specified tolerances in AS 1163-2016 shall be replaced at the sole expense of the Contractor.

e) The piling contractor shall submit for approval a record of the initial "Rapid Load Test" verification with installation torques and pile depths achieved. The engineer is required to sign off on the install prior to the concrete foundation being completed.

Note: Installers are required to be accredited by "Stoddart Foundations". An install manual is available on request.

KATANA PILE INSTALLATION TOLERANCES

f) The maximum variation shall be no more than ± 25mm from the plan position as shown on the drawings.

g) The Katana pile shaft shall be installed vertically with a variation of not more than 4% from the vertical.

h) The maximum variation of the cut-off level shall be ± 25mm from that shown on the drawings.

CERTIFICATION

6 KATANA PILE CERTIFICATION

a) At the completion of the Katana piling works the piling contractor shall issue the following certification to the project engineer or principle contractor.

- ✓ Katana piles have been designed to carry the design loads as shown on the Drawings.
- ✓ Katana piles have been installed in accordance with the engineered design.
- ✓ Katana piles satisfy all the requirements of AS 4100 and AS 2159

b) Design certification is to be issued by a practising professional structural / geotechnical engineer as defined by the building code of Australia / New Zealand building Code and is competent and experienced in Katana pile design.

Appendix A

Weld Specifications

- Katana Pile Specification

engineering3000
new product design & development

Our Ref: RLH:P213304

Your Ref: JW

2nd April 2013

Mr Justin J Williamson
Patented Foundation Systems Pty Ltd ACN 156 530 497
c/- STA Consulting Engineers
241 Milton Road
Milton, QLD 4064

By Email: justin.williamson@staconsulting.com.au

Dear Mr Williamson,

RE: SCREW PILE WELD SPECIFICATION

e3k have performed Finite Element analysis (FEA) on the Stoddart Screw Pile and a review of the weld specification for the connection of the blades to the pipe. Three dimensional models were produced in Solidworks 2013 based on the two dimensional drawings supplied in the supplied document "Stoddarts Final Drawings 26-2-2013.pdf". The material for the CHS 76.0 x 4.0 pipe was assumed to be that specified on the supplied test certificate no. TC_138973 from Orrcon Steel. This shows a yield strength of 463 MPa, and tensile strength of 490 MPa.

Initial FEA was performed with a torque of 9,000 Nm applied to the blades of the screw pile. Figure 1 shows the predicted von Mises stress in the area around the welds. The peak stresses in the weld area are predicted to be well above the yield stress of the pipe (463 MPa). Thus it is not expected that the welds will handle a torque of 9,000 Nm applied to the blades. In practice, some of the torque produced when screwing the pile into the ground will be taken directly by the pipe, through friction between it and the surrounding material, thus the exact torque limit of the welds on the blades is difficult to predict.

It is recommended that the weld material be of equal or higher yield strength than the pipe material, i.e. 463 MPa or greater.

A review of the weld Interface, for the connection of the blades to the pipe, based on the supplied drawings, shows that the gap between the plate and the pipe is inconsistent around the pipe. The semicircular cut out in the blades, when placed on an angle against the pipe, results in the blade edge being angled to the pipe at the leading edge of the pipe, then transitioning to perpendicular to, but further away from, the pipe at the mid blade section, then transitioning to being angled the other way to the pipe at the trailing edge of the pipe. This creates a non-standard weld interface and is expected to make it difficult to create a consistent quality weld around the blades.

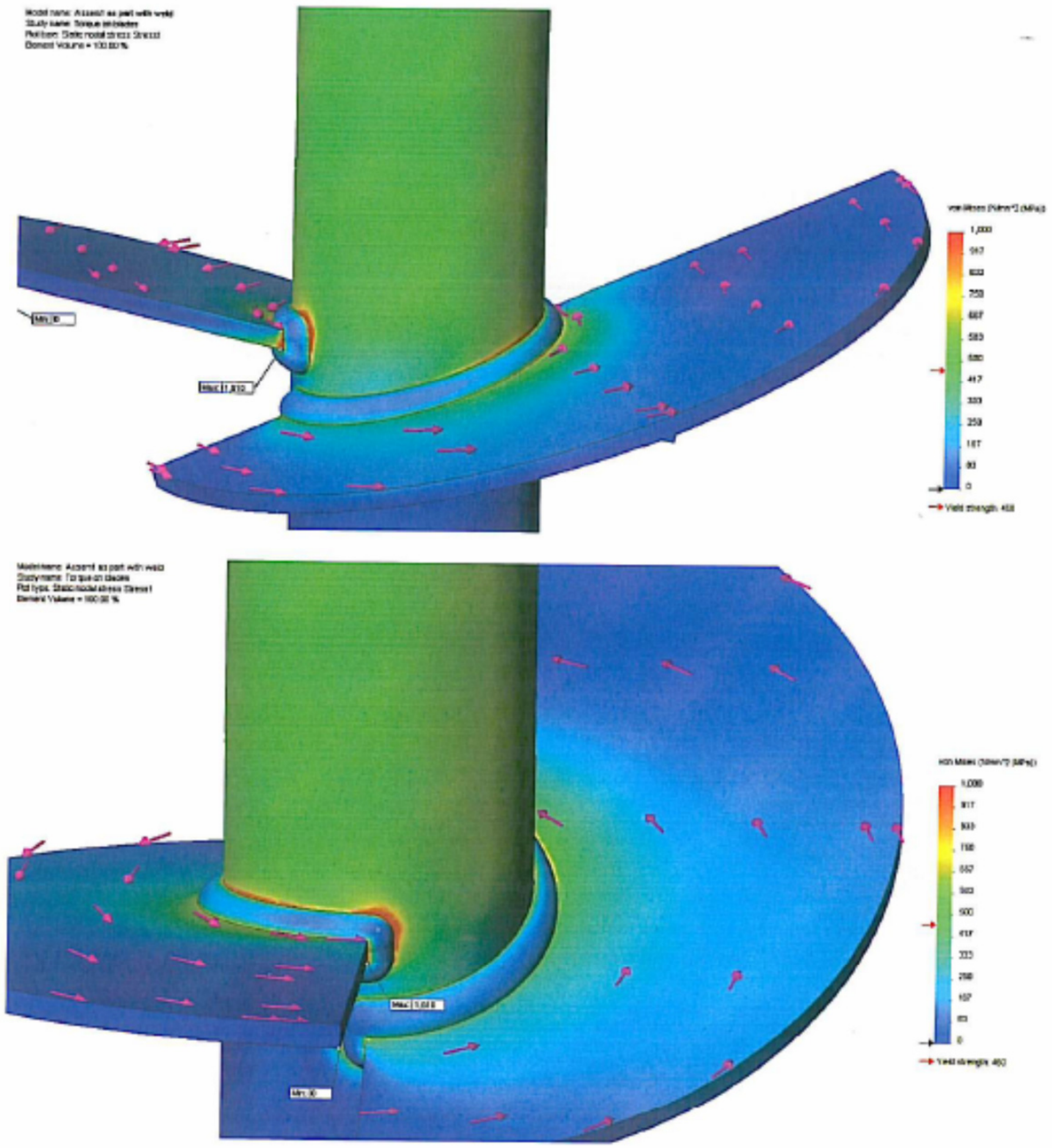


Figure 1. Predicted von Mises stress with a torque of 9000 Nm applied to the blades of the screw pile.

To maintain an equal distance between the blades and the pipe, it is recommended that the semicircular cut out in the blades be changed to an elliptical cut out, to match the angle the blade is to be placed on the pipe. Figure 2 shows dimensions for an elliptical cut to match a 15° angle on the pipe with a one millimetre clearance around the pipe.

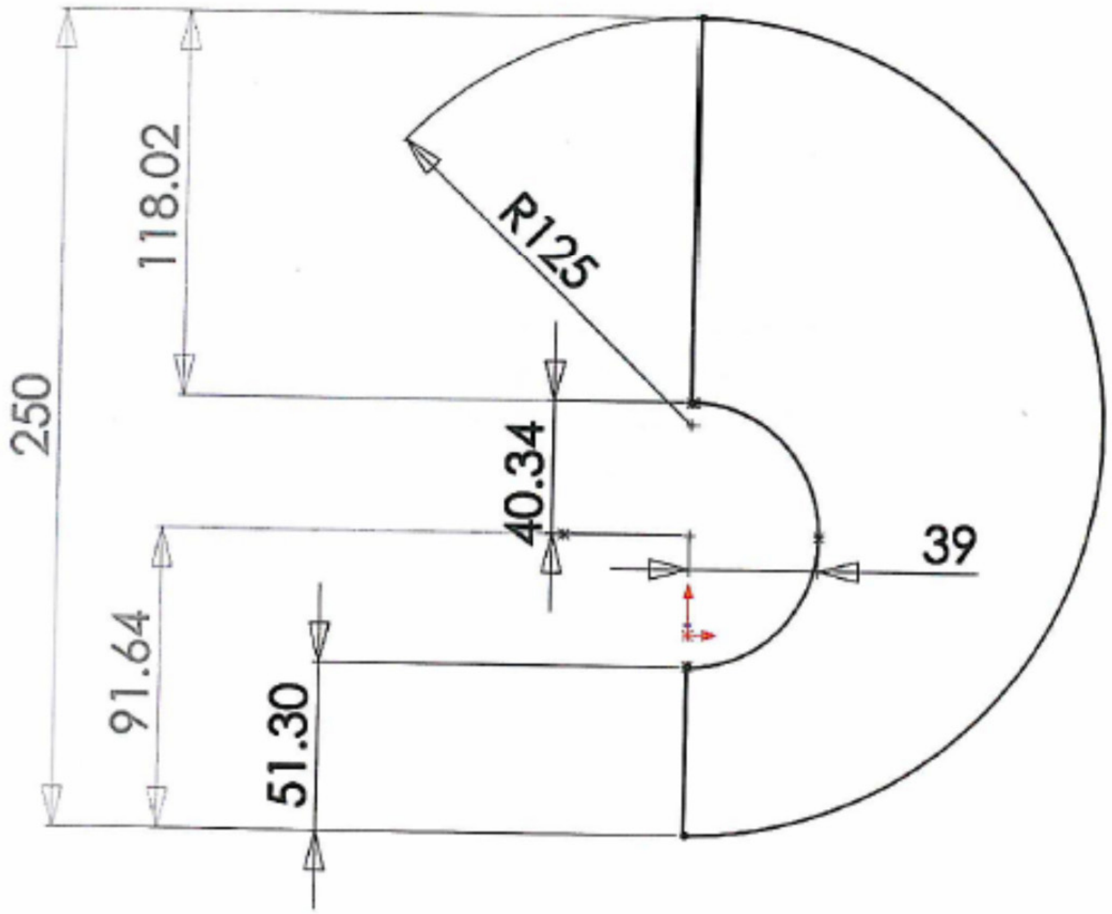


Figure 2. Dimensions for an elliptical cut to match a 15° angle on the pipe, with a one millimetre clearance around the pipe.

To provide a more consistent weld interface around the blade it is recommended that the edges of the elliptical cut out be ground back at 45° on each side (see Figure 3).

The recommended weld is "equal 6mm fillet welds superimposed on complete penetration bevel welds" as shown in Figure 3.

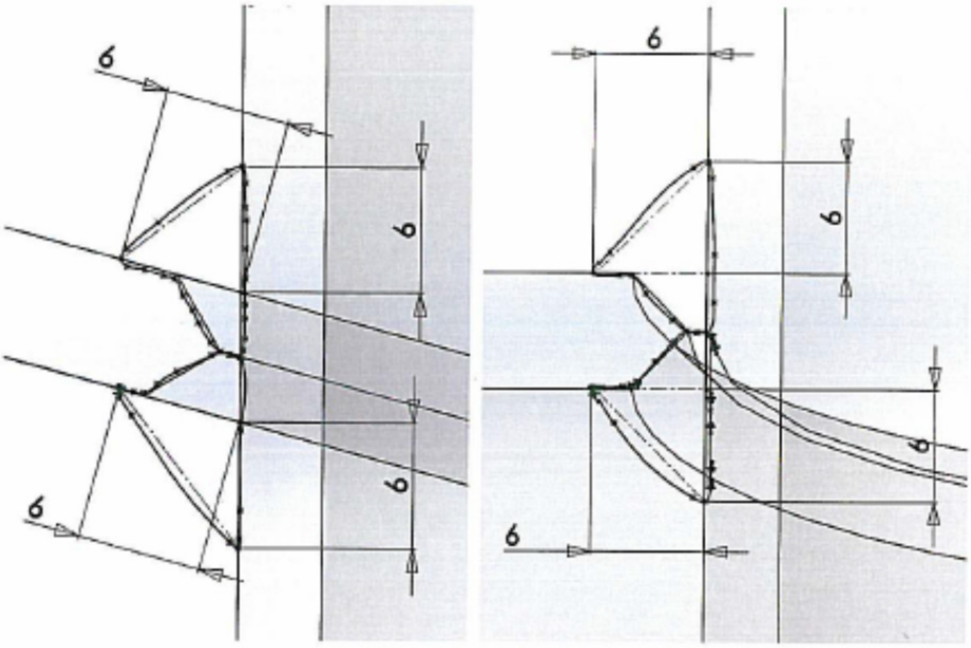


Figure 3. Equal 6mm fillet welds superimposed on complete penetration bevel welds.
The left figure shows the weld interface at the leading edge of the blades,
and the right figure shows the weld interface at the mid blade section.

Yours sincerely,
e3k

Dr Raymond L Hope
Vice President e3k Global

engineering3000
new product design & development

Appendix B

Corrosion

- Product Corrosion Report

engineering3000
new product design & development

*A division of Gilmore Engineers Pty Ltd
Research and Development

Our Ref: RLH:VLK:213306 Your Ref: JW

8 May 2013

REPORT

TO

Patented Foundation Systems Pty Ltd
ACN 156 530 497
c/- STA Consulting Engineers
241 Milton Road
Milton, QLD 4064

Attention: Mr Justin Williamson
Senior Geotechnical Engineer

RE: KATANA SCREW PILE CORROSION REVIEW

ON

VOID SLAB SYSTEM

Prepared by:

Dr Ray Hope
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1 INTRODUCTION

Patented Foundation Systems Pty Ltd have requested e3k review appropriate Australian Standards, or other Standards relevant to corrosion of steel screw piles, to determine the potential effects and limitations of use of the Katana pile in soils of varying pH, up to a depth of 500 mm, for an expected lifetime of 50 years. Patented Foundation Systems Pty Ltd have also requested e3k investigate measures to protect the Katana pile against corrosion in soils of varying pH, up to a depth of 500 mm, for an expected lifetime of 50 years.

I understand that the "Void slab system" is primarily intended for use in areas with expansive clay foundation soils.

In the preparation of this report, I have read and used the following information:

a) Katana Pile Product Guide, including drawings, from STA Consulting Engineers, dated 7th May (see Appendix 1).

b) Void Slab System, preliminary edition, from STA Consulting Engineers, dated 16th March 2013.

c) Australian Standard AS 2159-2009 Piling – Design and installation (incorporating amendment No.1).

d) Australian / New Zealand Standard AS/NZS 2312:2002 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings (incorporating amendment No.1).

e) Australian Standard AS 2832.2-2003 Cathodic protection of metals Part 2: Compact buried structures.

f) Australian Standard AS 2832.3-2005 Cathodic protection of metals Part 3: Fixed immersed structures.

g) Data sheet for Denso PVC SA tape (see Appendix 2).

h) Data sheet for Denso Rigspray Micro (see Appendix 3).

This report details our review of the relevant Standards and our recommendations.

2 AS 2159-2009 PILING – DESIGN AND INSTALLATION

Australian Standard AS 2159-2009 Piling – Design and installation, contains specific information on the durability design of piling. Section 6.5, of AS 2159-2009, "Design for durability of steel piles", contains exposure classifications for steel piles in different environments.

The exposure classification of the surface of a steel pile is to be determined from Tables 6.5.2 (A), (B) & (C) from AS 2159-2009. For the range of chemical conditions of piles in soil, the condition leading to the most severe aggressive conditions shall be allowed for and consideration shall be given to possible changes in groundwater levels.

TABLE 6.5.2(A)

EXPOSURE CLASSIFICATION FOR STEEL PILES— PILES IN WATER

Exposure conditions	Exposure classification
Sea water—submerged	Severe
Sea water—tidal/splash zone— Cold water (south of 30°S)	Severe
Sea water—tidal splash zone— Tropical/Subtropical water (North of 30°S)	Very severe
Fresh water—soft running water	Moderate

TABLE 6.5.2(B)

EXPOSURE CLASSIFICATION FOR STEEL PILES— PILES IN REFUSE FILL

Exposure conditions	Exposure classification
Domestic waste	See Note 2
Industrial waste	See Note 2

TABLE 6.5.2(C)

EXPOSURE CLASSIFICATION FOR STEEL PILES—PILES IN SOIL

Exposure conditions				Exposure classification	
pH	Chlorides Cl		Resistivity ohm.cm	Soil condition A*	Soil condition B†
	In soil ppm	In groundwater ppm			
>5	<5000	<1 000	>5 000	Non-aggressive	Non-aggressive
4–5	5000–20,000	1 000–10 000	2 000–5 000	Mild	Non-aggressive
3–4	20,000–50,000	10 000–20 000	1 000–2 000	Moderate	Mild
<3	>50,000	>20 000	<1 000	Severe	Moderate

* Soil conditions A—high permeability soils (e.g., sands and gravels) that are in groundwater

† Soil conditions B—low permeability soils (e.g., silts and clays) or all soils above groundwater

NOTES TO TABLES 6.5.2 (A), 6.5.2 (B) AND 6.5.2 (C):

1 Where high levels of sulfates exist (>1000 ppm), sulfate-reducing bacteria may be present and active, sometimes leading to microbiologically induced corrosion. In such cases, classify as 'mild' for low permeability soils and 'moderate' for high permeability soils.

2 Contamination by the tipping of mineral and domestic waste or by spillage from mining, processing or manufacturing industries presents special durability risks due to the presence of certain aggressive acids (both organic and inorganic), salts and solvents, which can chemically attack steel. In the absence of site-specific chemical information, the exposure condition should be assessed as 'severe' for domestic refuse tips and 'very severe' for industrial/mining waste tips. Chemical and microbiological analysis of the latter may, however, lead to lower risk classification.

3 For piles in disturbed soil, consider the assumption of soil A conditions where accelerated corrosion is possible.

Based on table 6.5.2 (C) from AS 2159-2009, it is recommended to test the chloride level and resistivity at each installation site, as well as measuring the pH. Measuring of the sulphate level in clay is not required as even high levels above 1000 ppm will only result in a "mild" classification for low permeability soils.

Table 6.5.3, from AS 2159-2009, gives uniform corrosion allowances for loss of section under the five exposure classifications. Section 6.5.3 of AS 2159-2009 states "corrosion on the internal faces of a fully sealed closed-form pile may be assumed to be negligible".

TABLE 6.5.3

CORROSION ALLOWANCES FOR STEEL PILES

Exposure classification	Uniform corrosion allowance (mm/year)
Non-aggressive	<0.01
Mild	0.01–0.02
Moderate	0.02–0.04
Severe	0.04–0.1
Very severe[3]	>0.1

NOTES:

1 The allowances in Table 6.5.3 may be reduced, as appropriate, where adequate corrosion protection systems (coatings or cathodic protection) are to be used. Coatings will reduce corrosion allowance while they remain in good condition. Coating damage, deterioration and breakdown will result in the corrosion rate increasing and, in such circumstances, the corrosion allowances in Table 6.5.3 shall apply.

2 To allow the implementation of cathodic protection after construction it is good practice to provide electrical continuity throughout the piled system at the time of construction. In providing electrical continuity, consideration shall be given to the likelihood of stray current corrosion, especially if the completed structure is of significant length and adjacent to a cathodically protected system or within close proximity to direct current electrified traction or power supply systems.

3 For very severe conditions a site-specific assessment should be sought.

The Katana pile drawings are shown in Appendix 1 of this report. The main tube of the pile is a 350 Grade 76 x 4.0 Circular Hollow Section (CHS). I understand that the minimum required wall thickness for an 80 kN Safe Working Load (SWL) is 2.0 mm. Thus the 4.0 mm wall thickness CHS has a steel corrosion allowance of 2.0 mm.

It can be seen from the drawings in Appendix 1 of this report that the top of the piles can be sealed with the threaded edge beam connector. However, this will not provide an air tight seal. The bottom ends of the piles are open, and as the pile screws into the ground, the pile will fill with soil, which may seal the bottom end of the pile. However, this seal will most likely not be water tight. Thus in my opinion, the provided design would not be considered a fully sealed closed-form pile.

3 RECOMMENDATIONS

Table 1 of this report shows the estimated design life and recommendations for the Australian Standard exposure classifications.

I understand that the "Void slab system" is primarily intended for use in areas with expansive clay foundation soils. I note that Table 6.5.2 (C) from AS 2159-2009 indicates for use in clays, soil condition B is used, and that it has a maximum exposure classification of "Moderate". The only exception is if the site has been contaminated by domestic or industrial waste. Thus most sites where the "Void slab system" will be used will be classified as "Non-aggressive", "Mild" or "Moderate".

3.1 Non-Aggressive and Mild Environments

To be conservative, it is assumed that for the basic design the uniform corrosion allowance acts on both the inside and outside of the CHS. With this assumption, the basic design is expected to have a design life of 50 years or more in environments classified as "Non-aggressive" and "Mild".

3.2 Moderate Environments

To achieve a design life of 50 years or more in environments classified as "Moderate", it is recommended that the inside of the CHS be fully sealed air tight by welding, thus limiting corrosion to the outside surface.

3.3 Severe Environments

To achieve a design life of 50 years or more in environments classified as "Severe", it is recommended that the inside of the CHS be fully sealed air tight by welding. Additionally the wall thickness will need to be increased to at least 7.0 mm or extra corrosion protection will be required. AS 2159-2009 allows for either coating protection systems or cathodic protection.

3.3.1 Coating Protection Systems

Section 6.5.4 of AS 2159-2009 states "Coating systems should comply with the requirements of AS/NZS 2312". Appendix C of AS/NZS 2312:2002 deals with coating systems for non-atmospheric and hot environments. Table C1 in AS/NZS 2312:2002 recommends three different coating systems for soil environments. These are: ultra-high build two-pack epoxy, fusion bonded epoxy, or wrapping tapes.

Appendix 2 and 3 of this report show typical examples of coating protection systems available on the market. Other systems from other manufacturers are also available and may be more suitable.

Appendix 2 of this report contains a data sheet for Denso PVC SA tape. This is an example of a possible coating protection system.

Appendix 3 of this report contains a data sheet for Denso Rigspray Micro, a 2-component isophalic Polyester resin reinforced with micro glass flakes. This was recommended by Denso as a possible coating protection system for the screw piles.

For any coating protection system, it is recommended that the manufacturer's advice on suitability for the environment, surface preparation and application, be followed.

If a coating protection system is used, it is recommended that any coating protection system be tested to ensure it remains adhered to the piles after screwing into the ground. At least five tests are recommended where the piles are coated, screwed into the ground and then removed from the ground to check for damage to the coating protection system.

3.3.2 *Cathodic Protection*

Section 6.5.5 of AS 2159-2009 requires cathodic protection systems to conform with AS 2832.2 or AS 2832.3. After reviewing both AS 2832.2 and AS 2832.3 it is my opinion that cathodic protection systems will not be reliable in the clay environment and are not suitable for the "Void Slab System".

3.4 Very Severe Environments

For environments classified as "Very severe", it is not recommended that the metal Katana pile be used.

3.5 Recommendations Summary

Katana Twin Fin Screw Pile 80kN — 76x4.0 CHS Grade 400

Exposure Classification	Uniform corrosion allowance (mm)	Uniform corrosion over 50 Year life (mm.)	Recommendations	Estimated Life (Years)
Non Aggressive	<0.01	<0.5	Basic Design OK	100+ (Corrosion inside & outside)
Mild	0.01-0.02	0.5-1.0	Basic Design OK	50 - 100 (Corrosion inside & outside)
Moderate	0.02-0.04	1.0-2.0	Fully Sealed	50 - 100 (Corrosion outside Only)
Severe	0.04-0.1	2.0-5.0	Fully Sealed + increse wall thinkness to 7mm + coat	50-125 (7mm wall thickness) 20-50 (4mm wall thickness) + Coating allowance (Corrosion outside only)
Very Severe	>1.0	>5.0	Not Recommended	<20 (Corrosion outside only)

Table 1 Estinmated design life and recommendations for the Australian Standard exposure classification for a 350 Grade (2mm steel corrosion allowance)

Katana Twin Fin Screw Pile 100kN — 76x4.0 CHS Grade 400

Exposure Classification	Uniform corrosion allowance (mm)	Uniform corrosion over 50 Year life (mm.)	Recommendations	Estimated Life (Years)
Non Aggressive	<0.01	<0.5	Basic Design OK	50 - 100 (Corrosion inside & outside)
Mild	0.01-0.02	0.5-1.0	Fully Sealed	50 - 100 (Corrosion outside Only)
Moderate	0.02-0.04	1.0-2.0	Fully Sealed + increse wall thinkness to 7mm + coat	50-125 (7mm wall thickness) 20-50 (4mm wall thickness) + Coating allowance (Corrosion outside only)
Severe	0.04-0.1	2.0-5.0	Not Recommended	<20 (Corrosion outside only)
Very Severe	>1.0	>5.0	Not Recommended	<20 (Corrosion outside only)

Table 2 Estinmated design life and recommendations for the Australian Standard exposure classification for a 350 Grade (2mm steel corrosion allowance)

Katana Twin Fin Screw Pile 150kN — 86x5.5 CHS Grade 350

Exposure Classification	Uniform corrosion allowance (mm)	Uniform corrosion over 50 Year life (mm)	Recommendations	Estimated Life (Years)
Non Aggressive	<0.01	<0.5	Basic Design OK	100+ (Corrosion inside & outside)
Mild	0.01-0.02	0.5-1.0	Basic Design OK	50 - 100 (Corrosion inside & outside)
Moderate	0.02-0.04	1.0-2.0	Fully Sealed	50 - 100 (Corrosion outside Only)
Severe	0.04-0.1	2.0-5.0	Fully Sealed + increse wall thinkness to 7mm + coat	50-125 (7mm wall thickness) 20-50 (5.5m wall thickness) + Coating allowance (Corrosion outside only)
Very Severe	>1.0	>5.0	Not Recommended	<20 (Corrosion outside only)

Table 3 Estinmated design life and recommendations for the Australian Standard exposure classification for a 350 Grade (2mm steel corrosion allowance)

Conclusions

Based on review of documents and relevant Australian Standards;

A) It is recommended that the pH, chloride level, and resistivity at each installation site be measured to determine the exposure classification of the site as per Table 6.5.2 (C) from AS2159-2009

B) The basic Katana design is expected to have a design life of 50 years or more in environments classified “Non Aggressive”.

C) Where nominated in the above tables, it is recommended that that the inside of the CHS Katana Pile be fully sealed air tight by welding, thus limiting corrosion to the outside surface.

D) Where required as per tables, 7mm pipe needs to be sourced so as to obtain the required design life.

Appendix C

Pile Testing

- Product Geotechnical Testing Report

  a. Pile Static Load Test
  b. Pile Uplift Test
  c. Lateral Load Test

INTRODUCTION

A series of twenty six compressive tests, six lateral tests and ten pull out (tension) tests were undertaken to present a report of results in accordance with static pile load tests, AS 2159-2009 specifications requirements. These tests have three primary objectives:

- To establish load-deflection relationships in the pile-soil system,
- To determine capacity of the pile-soil system, and
- To determine load distribution in the pile-soil system.

These tests will confirm design assumptions or / and provide information to allow those assumptions and the pile design to be modified.

These tests relate, but are not limited to, a load capacity test for the footings of buildings, and more particularly, to the load capacity of screw piles supporting the footings.

PILE TEST LOADS AND LOAD APPLICATION SYSTEMS

1) REACTION FRAME

Install two or more reaction piles for the reaction frame after the installation of the test pile. Locate these reaction piles not less than 3.0m from the test pile. These distances are measured between the axis of the test pile and reaction piles.
Apply the load to the pile by one or more hydraulic jack.
Design the reaction frame and reaction piles to resist four times the pile design load indicated in the contract documents without undergoing a magnitude of deflection exceeding 75 percent of maximum travel of the jack.

2) LOAD APPLICATION SYSTEM

Apply load with the jack(s), having a capacity of at least four times the pile design load indicated in the contract documents. Use jacks with a minimum travel of 150 mm, but not less than 25 percent of the test pile's maximum cross-section dimension. Equip the jack(s) with spherical bearing plates, to bear firmly and concentrically against the pile load transfer plate. Use an automatic load-maintaining pump with manual supplement to control load application. Use a pressure-gage for the jack so that the pressure reading corresponding to the pile design load indicated in the contract documents is between one-fourth and one-third of maximum gage pressure. Place a load cell (either electric or hydraulic, unless one or the other is specified in the contract documents) to measure strains for load monitoring during the load test. Load cell shall be accurate to within 2% of the indicated load and of stable construction.

Arrange and construct the elements of the load-application system as follows:

1. Provide a level load transfer plate perpendicular to the pile axis.
2. To distribute load over the pile's entire cross-section, place a solid steel plate of sufficient thickness (16 mm minimum) to prevent bending as a bearing plate between the capped pile and the jack base. The size of the solid steel plate shall be not less than the size of the pile butt or less than the area covered by the jack base.
3. Place the load application system (including hydraulic jack, spherical bearing and load cell) between the bearing plate on the pile and the centre of the underside of the load beam.
4. Construct the system so that all components are centred along the pile's longitudinal axis, to ensure application of a concentric axial load.

5. Immediately before starting a load test, verify that at least 25 mm of clear space exists between the load transfer plate and load beam. The details of the reaction

frame, test pile and apparatus for testing the load-bearing capacity of the test screw pile are illustrated in figure 1. below

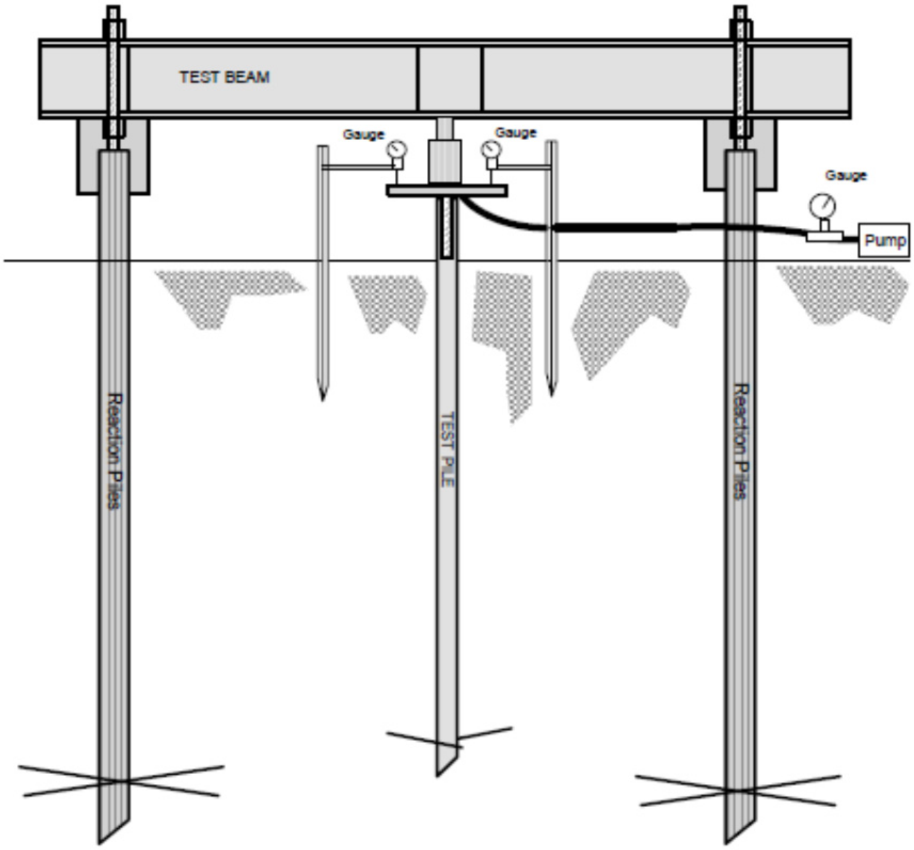


Figure 1.

PREPARATION AND MAINTENANCE OF TEST AREA

- Clear the area surrounding the test pile,
- Provide a properly designed level platform of sufficient plan dimensions to support the testing equipment safely and with suitable access for operatives,
- Construction plant that may be operating elsewhere on site must be excluded from
- the test area during the course of the pile test so that the test pile's performance can
- be accurately monitored in a safe environment,
- Any excavations within the exclusion zone are prohibited,
- Provide complete protection at all times for the pile supports and reference beam from wind, heavy rains, direct sunlight, frost action, and other disturbances. Also maintain a temperature of not less than 10° C and not more than 40° C throughout the duration of the test and provide a thermometer to monitor temperature,
- Provide adequate lighting for the duration of the test.

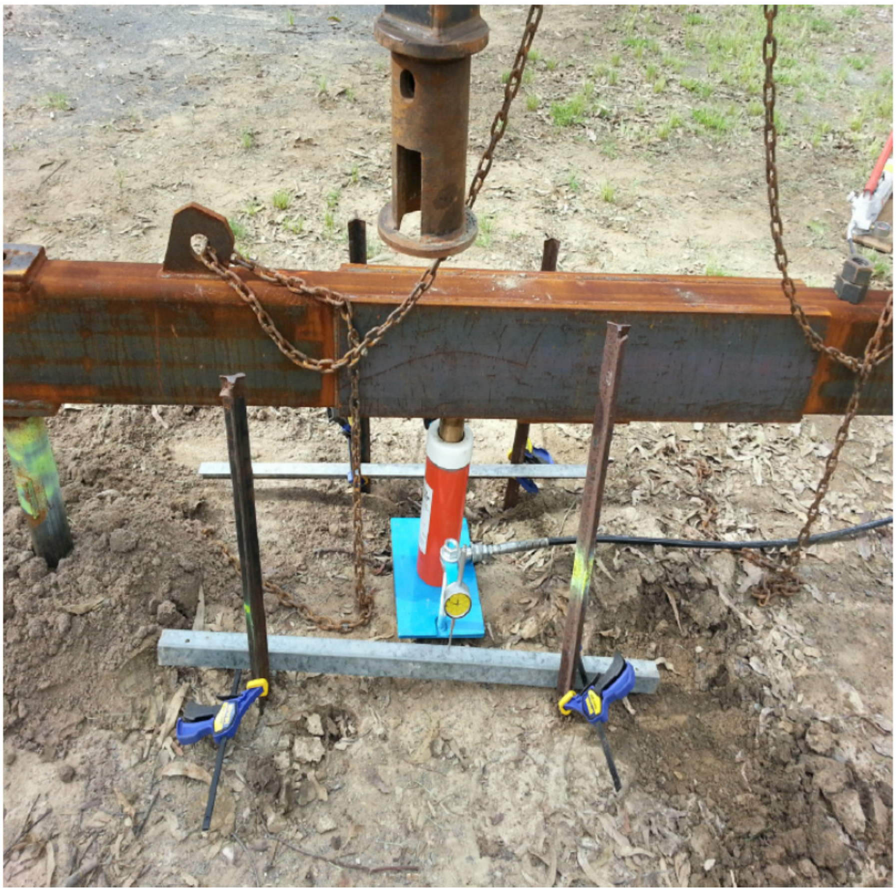
COMPRESSION TEST

Load and unload the test pile incrementally in two cycles, unless an alternative procedure is specified in the contract documents. Apply each load increment to the pile in as short a period as physically possible. The maximum load applied is at least 150% the pile design load indicated in the contract documents. The required load increments are expressed as a percentage of the pile design load. Magnitude and sequence of load increments for the two loading cycles are as follows:

Cycle	Percent of Maximum Design Load
1	10,20,30,40,50,60,70,80,90,100
2	10,20,30,40,50,60,70,80,90,100,110,120,130,140,150

Maintain each load increment until the deflection rate under the applied load, or rate of rebound from the previous load increment, is less than 0.05 mm in 10 minutes. The minimum period for maintaining a load increment, however, is 30 minutes and an increment may be removed after having been maintained for 2 hours, regardless of rate of deflection or rebound. When 150 percent of the design load has been applied during Cycle 2, provided the pile has not failed, leave this load in place for 24 hours. When the pile has rebounded to zero load at the end of Cycle 2, maintain zero load at least 1 hour.

If the pile fails before application of the 150-percent load, rebound it to zero load. The pile designer and the piling contractor should investigate the causes and undertake appropriate remedial action, if any.



TENSION LOAD TEST

This test has been developed to calibrate individual sites soil properties to actual performance load capacity tests. The Katana pile is installed to a set depth, with torque reading obtained. The Katana pile is then tested to determine whether it has maintained the nominated load bearing capacity, as specified by the engineer.

METHODOLOGY

The On-Site Rapid Load Test consisted of a test pile installed at a minimum depth of 2.0 metres below ground surface. The pile top was 100 mm clear of ground surface enabling Rapid Load Test Device to be positioned over the top of the test pile. The threaded pull rod was screwed into the top of the test pile ensuring full embedment of thread then locked off with an M36 locking nut. Load was then applied to the pile in increments using a 20 tonne hydraulic jack. Load was maintained at each loading increment for a minimum of 3 minutes ensuring pressure remained consistent for this period of time. The load was increased on each test until such time load/ pressure could no longer be maintained at which point is considered the failure point of the test.

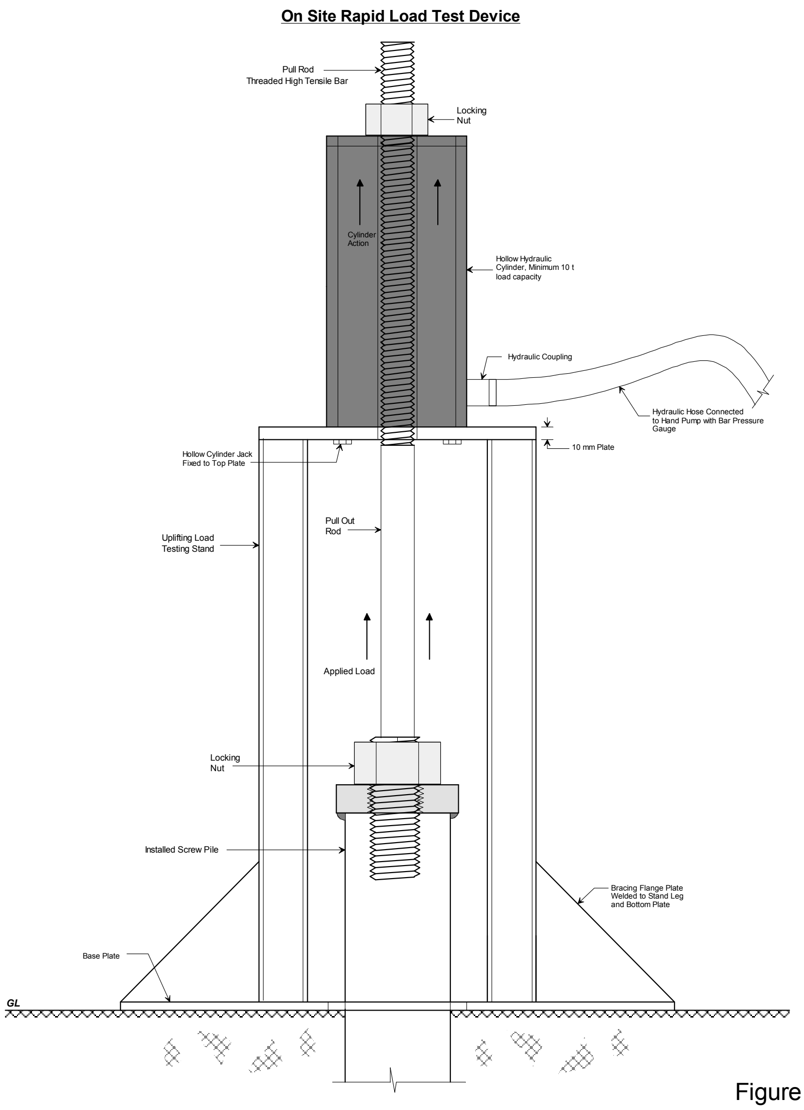


Figure 2.

PROCEDURE

1. Install the first Katana Pile to the minimum target depth as nominated within the foundation design report.
2. Record the barometric pressure achieved on the machine used for installation when at the required target depth.
3. Place the Rapid Load Testing Device over the Katana Pile, ensuring a level firm base under the test unit.
   Note - Test is not suitable on piles installed at least 2.0 metres.
4. Screw in the connecting threaded rod to the full depth of the threaded slug in the top of the pile. Fix in place with locking nut as shown in fig.1 below.
5. Connect the hand pump unit with a calibrated barometric pressure gauge.
6. Hydraulic Ram Jack, pre-loading the test device allowing for potential settlement at base of the testing unit. This may vary depending on the extent of soils beneath test unit. All persons should be located a minimum of 3 metres clear of the testing unit prior to jacking.
7. Once pre-loading is completed, that is no further settlement can be observed within testing unit. Continue jacking ram until such time the required pier capacity as nominated by the engineer has been achieved. Typically, the measured uplifting load is ~ 100 % of the calculated load-bearing capacity of the pile.
8. Maintain minimum constant pressure on pile at load capacity requirement for a minimum of 5 minutes ensuring pile does not displace.
9. Record barometric pressures achieved on the supplied record sheets (refer appendix) and document using photographs and video evidence.
10. Where the tested pile continues to hold the required load capacity with no displacement for the minimum time specified, it can be confirmed the screw has passed the load requirements nominated.

ACCEPTANCE CRITERIA

The “Rapid Load Capacity Test” enables the engineer / installer to satisfy themselves, that the Katana piles load capacity has been met. It must also be noted that the pull-out test, under the “Piling Code” AS2159, has a 1.3 factor of safety. In other words, the pull-out capacity in the nominated soil strata, is 70% of the end bearing capacity.

LATERAL LOAD TEST

This test has been developed to determine the lateral capacity of the Katana Pile. The lateral capacity of vertical single piles has been determined from the least of the values calculated on the basis of soil failure, structural capacity of the pile and deflection of the pile head.

METHODOLOGY

The lateral load test setup seen in figure 3. below consisted of a test pile installed approximately 2.0 metres away from a reaction pile. The reaction pile was installed a minimum of 1.0 metre below the final depth of the test pile. Pile tops were maintained approximately 100 mm above ground level, where applied loads were imposed using a 5 tonne winch in line with a calibrated 5 tonne scale measuring the applied loads as the winch was retracted. The winch acted by pulling the test pile head towards the reaction pile. Lateral movements were monitored at two points at the test pile top at a distance of 100 mm above the ground surface to measure lateral deflections at the point of load application. The lateral movement was measured using dial gauges with 0.01 mm accuracy and 150 mm travel. All dial gauge readings were recorded at the same time at each point additional load was applied.

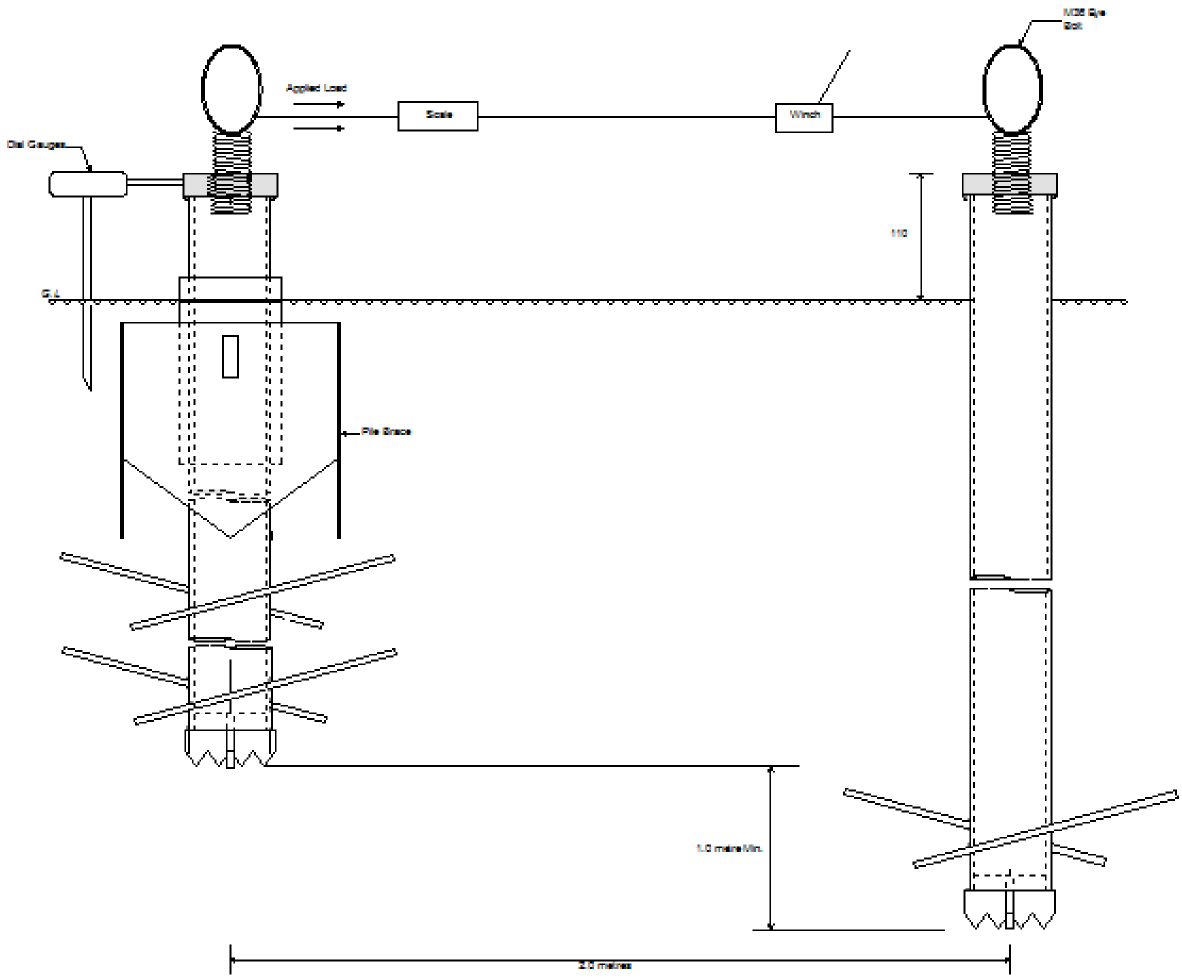


Figure 3

PROCEDURE

1. Install test pile to required target depth.
2. Record torque reading and document at final depth installed.
3. Install a single reaction pile after the installation of the test pile. Locate the reaction piles not less than 2.0m from the test pile. These distances are measured between the axis of the test pile and reaction piles.
4. Screw in high capacity eye bolts to top of test pile and reaction pile.
5. Mount in line scale and winch to pile tops between test pile and reaction pile.
6. Install dial gauges at base of test pile, with gauges measuring the deflection at the point of load application.
7. Begin to apply load by retracting winch, documenting the applied load on the in line scale. Maintain each applied load until stable, recording deflection on dial gauges throughout test duration.
8. Where required applied loads have been reached, release pressure from winch removing all applied load from test pile.
9. Record rebound of test pile on dial gauge after applied load removed.
10. Results of the lateral load test are to be presented in the form of a load deflection curve as presented in the following field test results.

ACCEPTANCE CRITERIA

The engineer must satisfy themselves, that the bracing requirements of the intended construction do not exceed the lateral loading capacity of the installed screw piles. Where this is the case a review of bracing measures must be undertaken.

SUMMARY OF TEST RESULTS

Test results for Compression and Tensile give a “Ultimate Geotechnical Load Capacity”. Lateral loads are nominated at a point where we had a 20mm deflection within the pipe. The 20mm mark was the point where we still achieve total rebound when load was released.

LIMITATIONS

STA Consulting Engineers (STA) has prepared this report in accordance with the usual care and thoroughness of the consulting professional for the use of the Stoddart Foundation Systems Pty Ltd screw pile. It is based on generally accepted practices and standards at the time it was prepared. No other warranty expresses or implied, is made as to the professional advice included in this report.

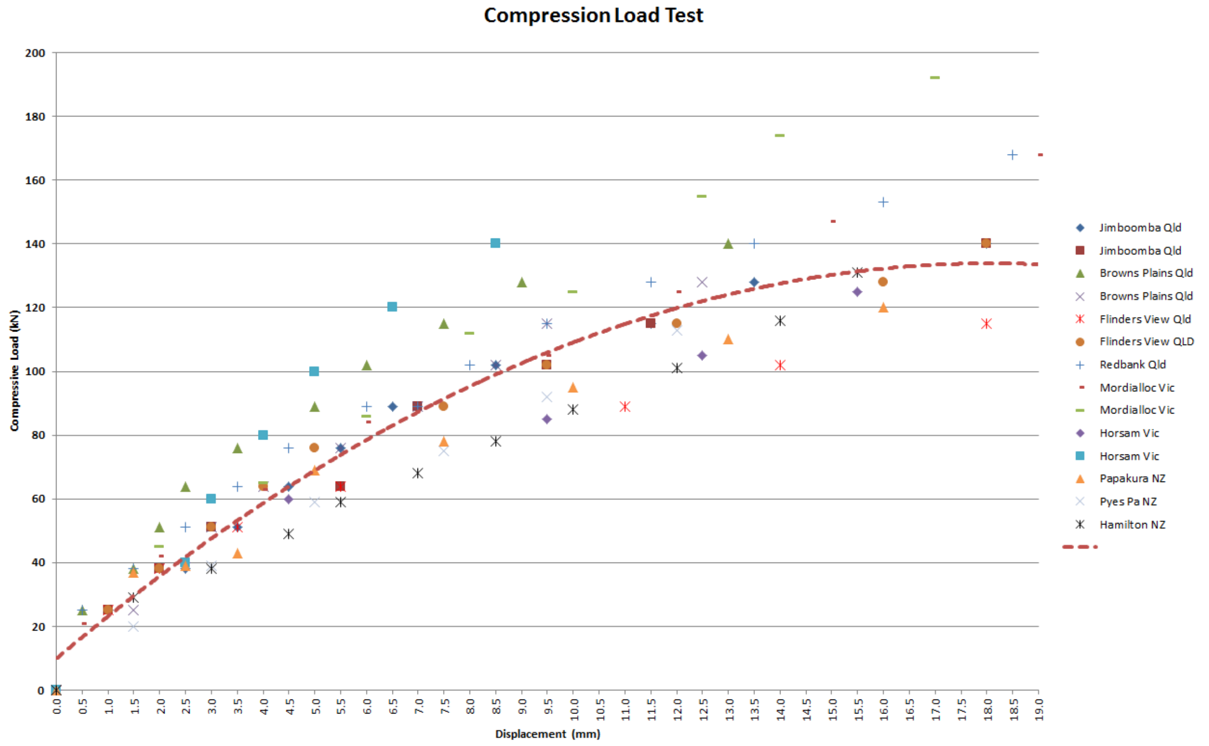
Table 1A

Test No.	Location	Region	Series	Pile Depth	Compression	Lateral	Tension
	Suburb			(m)	kN	kN	kN
1	Jimboomba	QLD	80	2	140	3.2	
2	Jimboomba	QLD	80	2	140		102
3	Browns Plains	QLD	80	2	140	3.3	
4	Browns Plains	QLD	80	2	128		89
5	Flinders View	QLD	80	2	76		51
6	Flinders View	QLD	80	3	153		115
9	Redbank	QLD	80	2	115	3.8	76
10	Mordialloc	VIC	80	3	168		
11	Mordialloc	VIC	80	3	224		
12	Jimboomba	QLD	100	3	176		155
13	Browns Plains	QLD	100	3	199		
14	Flinders View	QLD	100	3	198		163
15	Mordialloc	VIC	100	3	168		
16	Papakura	NZ	100	3	89		73
17	Jimboomba	QLD	150	3	280		
18	Browns Plains	QLD	150	3	278		
19	Flinders View	QLD	150	4	256		
20	Mordialloc	VIC	150	3	322		
21	Redbank	QLD	150	4	300		
22	Horsam	VIC	80	3	125		
23	Horsam	VIC	80	3	150		
24	Papakura	NZ	80	4	120		80
25	Pyes Pa	NZ	80	7	113		
26	Hamilton	NZ	80	4	116		80
27							
28							
29							
30							

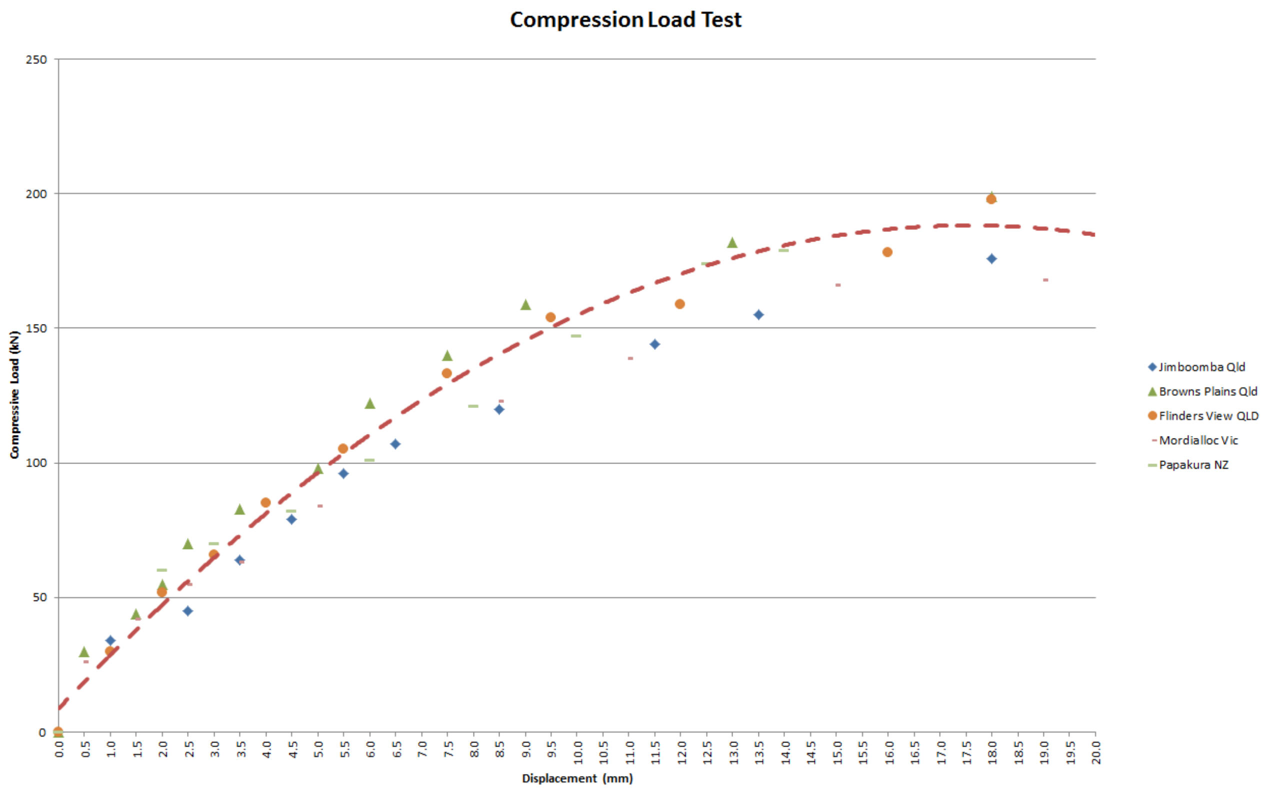
SUMMARY OF TEST RESULTS

Test results for Compression and Tensile give an "Ultimate Geotechnical Load Capacity". Lateral loads are nominated at a point where we had a 20mm deflection within the pipe. The 20mm mark was the point where we still achieve total rebound when load was released.

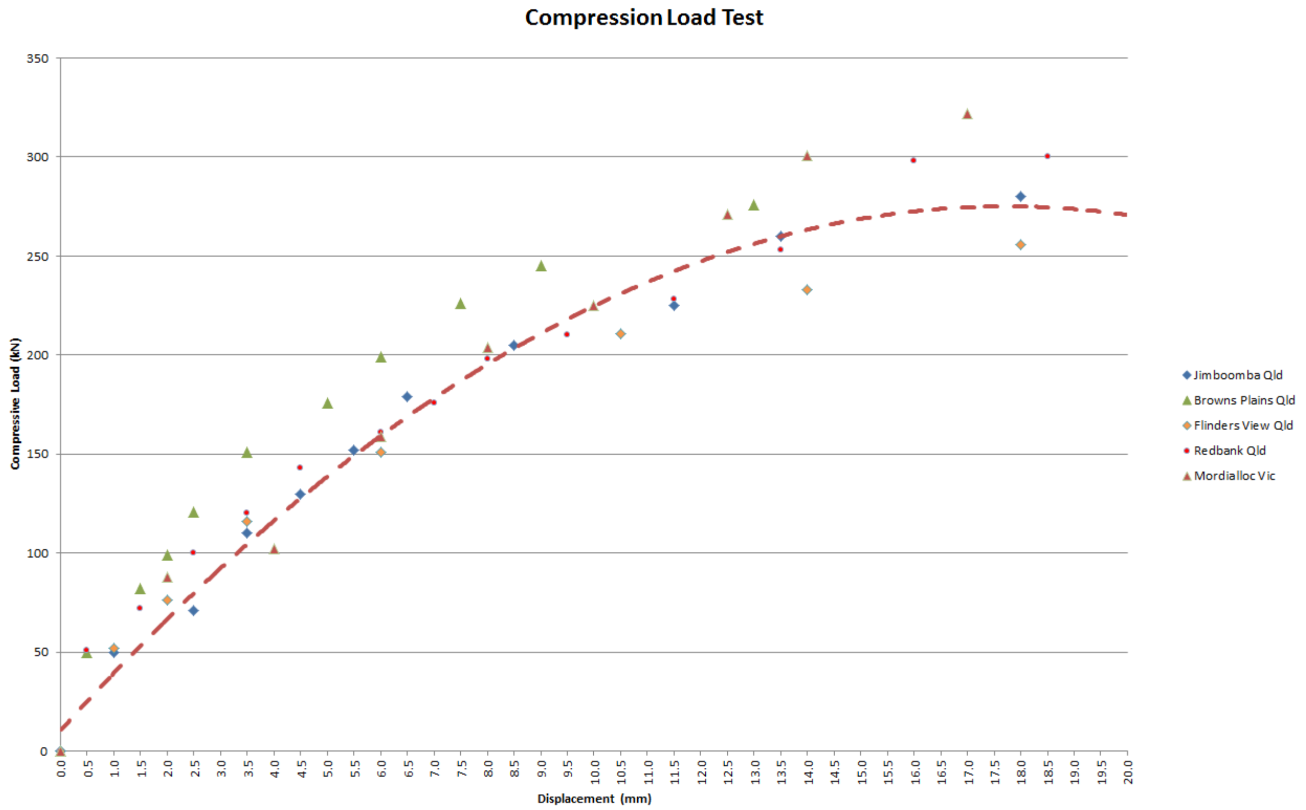
Katana – 80kN Series



Katana – 100kN Series



Katana – 150kN Series



Appendix D

Bracing Plate (Optional)

- Lateral Load Testing with Bracing Plate

INTRODUCTION

A series of two lateral tests were undertaken to present a report of results in accordance with, AS 2159-2009 specifications requirements. The test objectives were:

To determine capacity of the bracing pile.

These tests relate to the lateral load capacity of the bracing Katana pile supporting the footings.

LATERAL LOAD TEST

This test has been developed to determine the lateral capacity of the Katana Pile. The lateral capacity of vertical single pile has been determined from the least of the values calculated on the basis of soil failure, structural capacity of the pile and deflection of the pile head.

METHODOLOGY

The lateral load test setup seen in figure 3. below consisted of a test pile installed approximately 2.0 metres away from a reaction pile. The reaction pile was installed a minimum of 1.0 metre below the final depth of the test pile. Pile tops were maintained approximately 100 mm above ground level, where applied loads were imposed using a 5 tonne winch in line with a calibrated 5 tonne scale measuring the applied loads as the winch was retracted. The winch acted by pulling the test pile head towards the reaction pile. Lateral movements were monitored at two points at the test pile top at a distance of 100 mm above the ground surface to measure lateral deflections at the point of load application. The lateral movement was measured using dial gauges with 0.01 mm accuracy and 150 mm travel. All dial gauge readings were recorded at the same time at each point additional load was applied.

PROCEDURE

1. Install test pile to required target depth.
2. Record torque reading and document at final depth installed.
3. Install a single reaction pile after the installation of the test pile. Locate the reaction piles not less than 2.0m from the test pile. These distances are measured between the axis of the test pile and reaction piles.
4. Screw in high capacity eye bolts to top of test pile and reaction pile.
5. Mount in line scale and winch to pile tops between test pile and reaction pile.
6. Install dial gauges at base of test pile, with gauges measuring the deflection at the point of load application.
7. Begin to apply load by retracting winch, documenting the applied load on the in line scale. Maintain each applied load until stable, recording deflection on dial gauges throughout test duration.
8. Where required applied loads have been reached, release pressure from winch removing all applied load from test pile.
9. Record rebound of test pile on dial gauge after applied load removed.
10. Results of the lateral load test are to be presented in the form of a load deflection curve as presented in the following field test results.

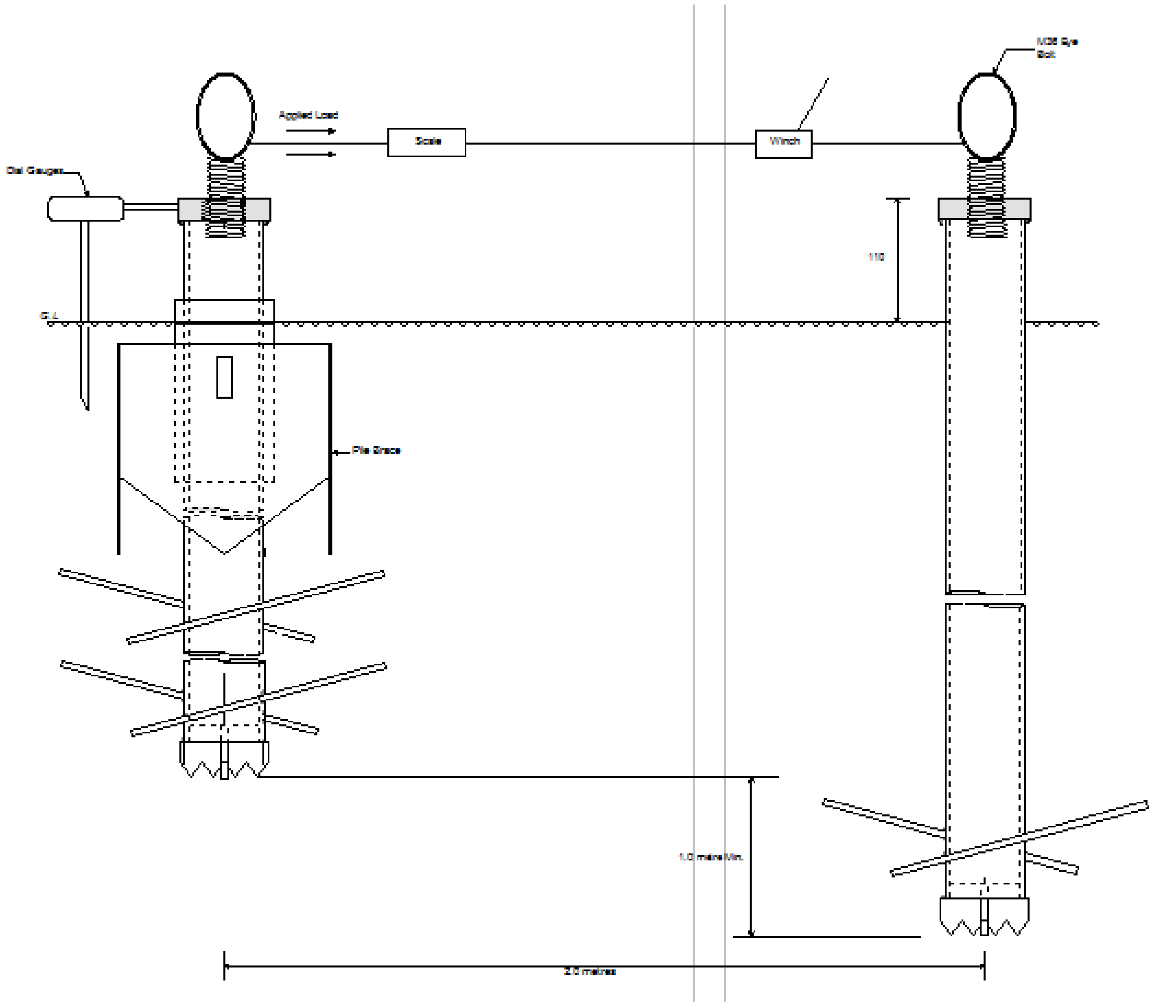


Figure 3

ACCEPTANCE CRITERIA

The engineer must satisfy themselves, that the bracing requirements of the intended construction do not exceed the lateral loading capacity of the installed screw piles. Where this is the case a review of bracing measures must be undertaken or additional portals must be created to improve the lateral stability of the system.

SUMMARY OF TEST RESULTS

Test results for Compression and Tensile give an “Ultimate Geotechnical Load Capacity”. Lateral loads are nominated at a point where we had a 20mm deflection within the pipe. The 20mm mark was the point where we still achieve total rebound when load was released.

Table 1A

Test No.	Location	Pile Depth	Lateral
	Suburb	(m)	kN
1	Browns Plains	2	8.35
2	“	2	8.61

LIMITATIONS

STA Consulting Engineers (STA) has prepared this report in accordance with the usual care and thoroughness of the consulting professional for the use of the Stoddart Foundation Systems Pty Ltd and Katana Pile. It is based on generally accepted practices and standards at the time it was prepared. No other warranty expresses or implied, is made as to the professional advice included in this report.

Section 3 - Bore Logs

Bore Log Sheet

Test Location # 1 - Test Piles # 1 & # 2

Project Job No. Testing **Client: Stoddart Screw Pile**	**Date Drilled: 13th November, 2012** **Drill Method: Power Auger**

Depth (m)	Sample Location	Groundwater	Graphic Log	Extent of Fill	Symbols	SOIL DESCRIPTION	PP Value	D.C.P blows/ 100 mm	N'q (kPa)
0						**SILTY CLAY** **(Brown)** **Dry to Moist & Stiff**		2 3 3 3 3 3 2 2 3 3 4 3 4	70 80 60 90
1.0						**Friable** **Silt & Sand Increase** **Friable**			
2.0						**EXTREMELY WEATHERED ROCK** **(Brown)** **Moist & Weak**			
3.0						**END**			
5.0									

Bore Hole Terminated - 3.0m

Terms :-

D.C.P.:- Dynamic Cone Penetrometer
N'q:- Allowable Bearing Capacity (kPa)
PP:- Pocket Penetrometer Strength (kPa)
U.T.P:- Unable to Penetrate
⟶ Slope Direction

Note : kPa value is allowable bearing pressure caculated in accordance with paper 'Determination of allowable bearing pressure under small structures' by M.J Stockwell (June 1977)

Test Results

Lateral Loading - Test Location # 1 - Test Piles # 1 & # 2

Load (kN)	Displacement (mm) WITH BRACING PLATE	Load (kN)	Displacement (mm) WITH BRACING PLATE
0.82	-	0.34	-
1.46	1.96	1.02	0.00
2.08	4.07	1.3	0.00
2.66	6.44	1.6	1.18
3.76	9.2	1.92	2.40
4.82	11.84	2.24	3.63
6.06	14.81	2.66	4.91
7.12	17.55	3.04	6.25
8.35	20.18	3.54	7.60
-	-	3.98	8.98
-	-	4.62	10.38
-	-	5.14	11.77
-	-	5.68	13.22
-	-	6.36	14.64
-	-	6.88	16.00
-	-	7.42	17.28
-	-	7.91	18.52
		8.61	19.57
Total Displacement	20.18	**Total Displacement**	19.57
Total Rebound	No Rebound observed	**Total Rebound**	No Rebound observed

Appendix E

Lateral Capacities

- Product Lateral Capacities

  a) Clay
  b) Sand

Note: Lateral Capacity for the 100kN Katana Pile is to be calculated from the 80kN Katana Pile design chart.

Katana Pile - 80kN

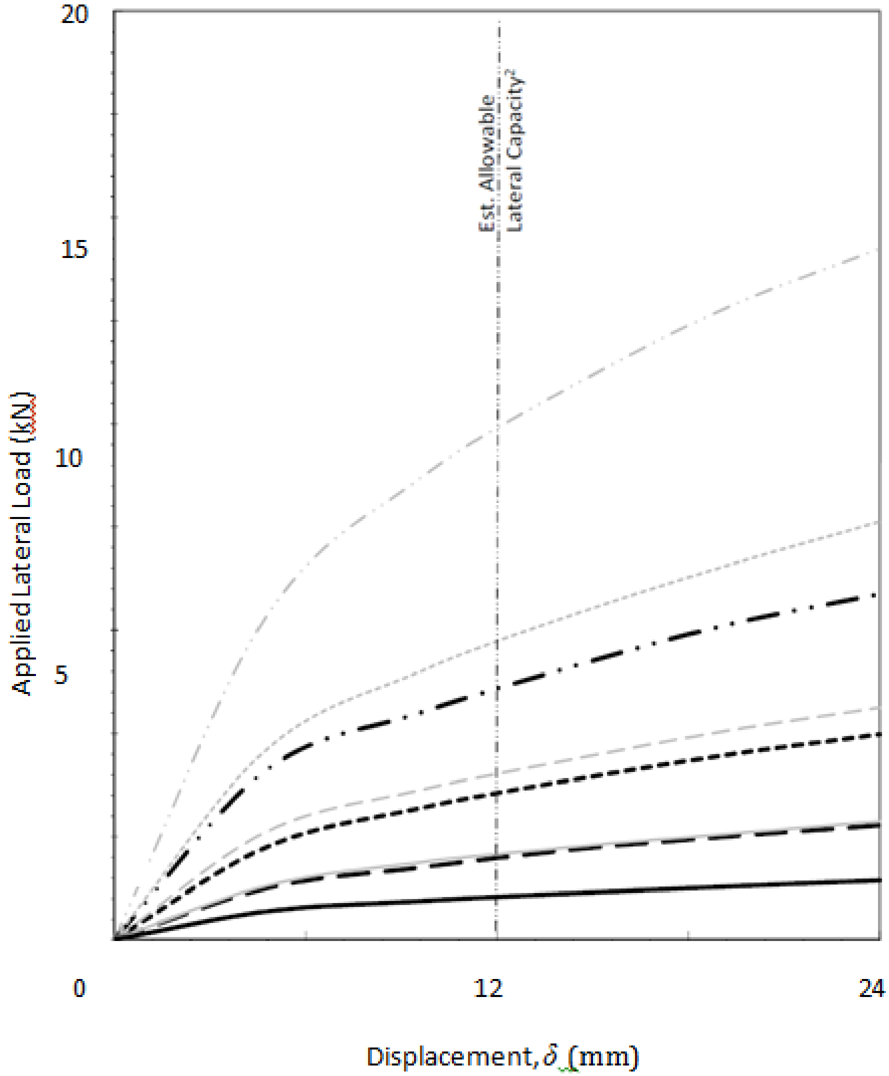
Lateral Performance in Clay

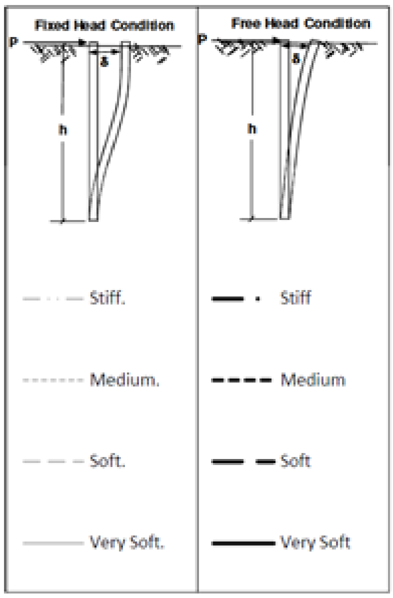
KATANA™ FOUNDATIONS

Pile Properties		
Pipe Diameter	(mm)	76
Wall Thickness	(mm)	4.0
Steel Grade	(f's)	400
Pile Base Dia.	(mm)	250

Soil Properties		
Soil Type	Angle of Friction (deg)	Cohesion Cu
Stiff	0	100
Medium	0	60
Soft	0	30

Minimum Pile Depth, h		
Soil Type	Fixed Head	Free Head
Stiff	40d	34d
Medium	30d	28d
Soft	28d	24d





These charts are for Katana Piles only as lateral performance is highly dependent on the connections rigidity and shaft properties. It is Katana's opinion that these graphs represent a reasonable approximation of the average performance of the Katana Pile in the indexed soils. Using the average performance is reasonable for multiple redundant structures (e.g. buildings, bridges, marina piers, etc.)

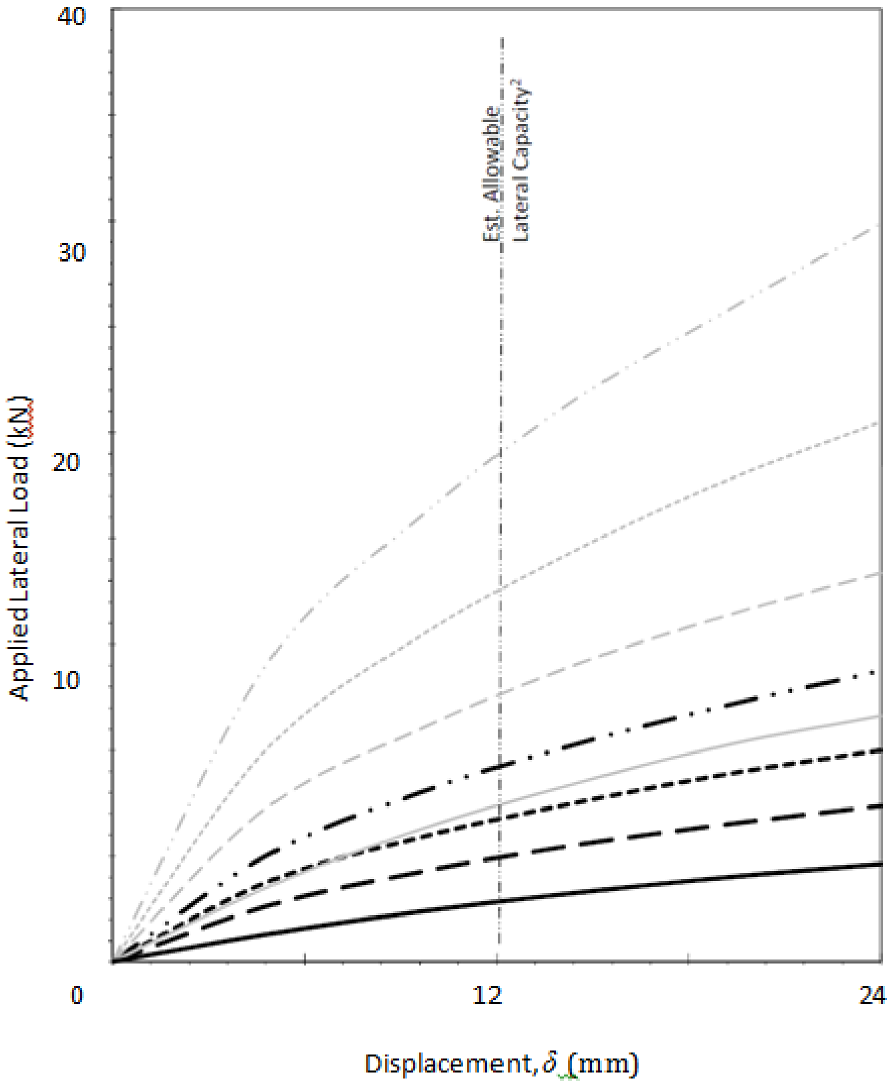
AS2159 - 2009, states that the allowable lateral capacity of a pile is half load causing a 25mm of displacement. Many practitioners take this to be nearly the same as the lateral load predicated at 12mm displacement. The graph presented here can be used to evaluate capacity for either condition as well as to judge lateral performance under other displacement criteria and codes. The design allowable displacement is the responsibility of the design engineer.

Katana Pile - 80kN

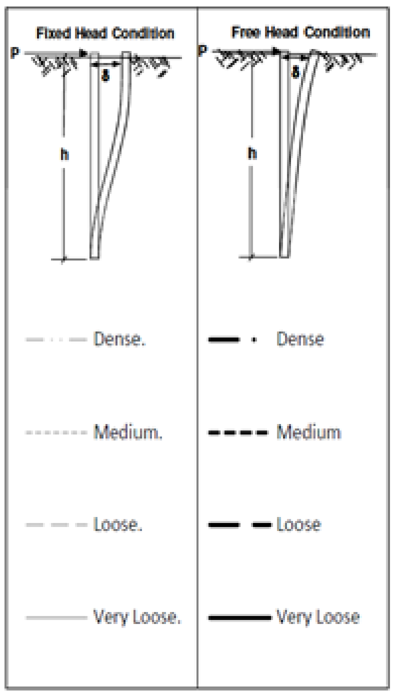
Lateral Performance in Sand

Pile Properties	
Pipe Diameter (mm)	76
Wall Thickness (mm)	4.0
Steel Grade (f's)	400
Pile Base Dia. (mm)	250

Soil Properties		
Soil Type	Angle of Friction (deg)	Cohesion Cu
Dense	25	0
Medium	29	0
Loose	33	0



Minimum Pile Depth, h		
Soil Type	Fixed Head	Free Head
Dense	40d	34d
Medium	30d	28d
Loose	28d	24d



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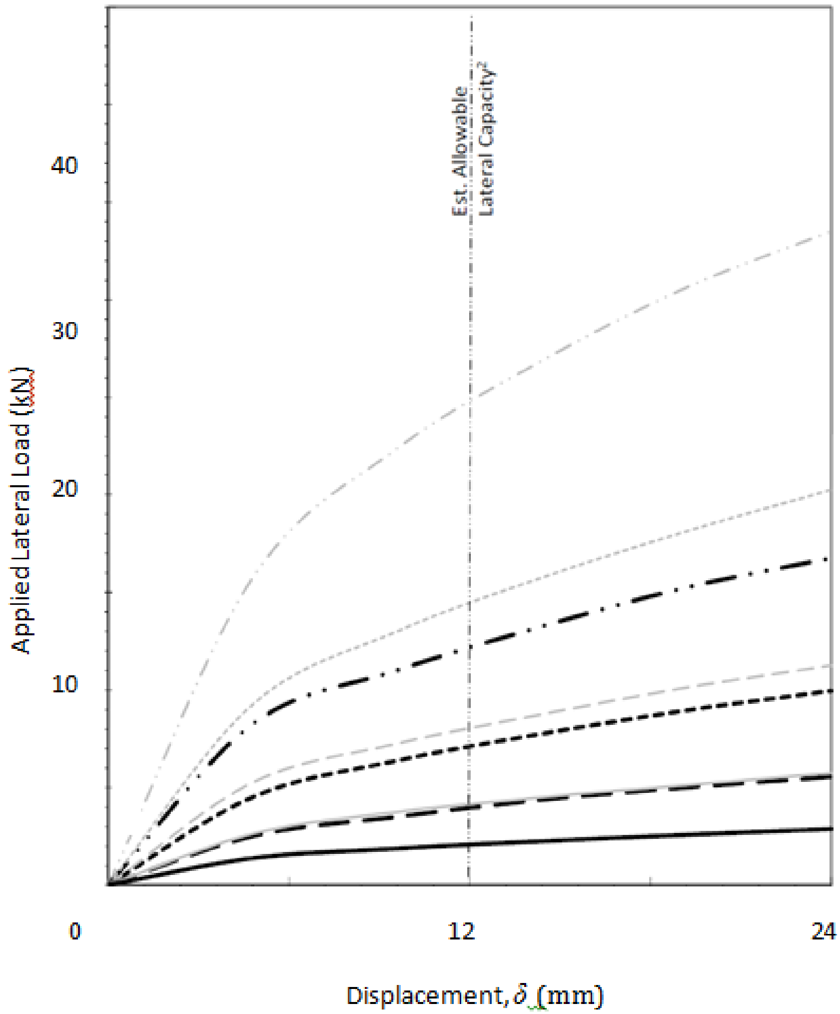
AS2159 - 2009, states that the allowable lateral capacity of a pile is half load causing a 25mm of displacement. Many practitioners take this to be nearly the same as the lateral load predicated at 12mm displacement. The graph presented here can be used to evaluate capacity for either condition as well as to judge lateral performance under other displacement criteria and codes. The design allowable displacement is the responsibility of the design engineer.

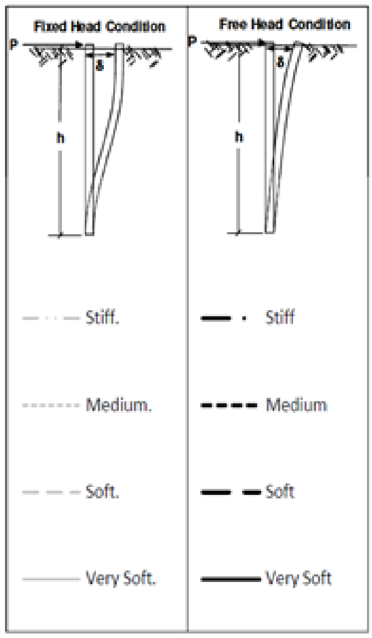
Katana Pile - 150kN
Lateral Performance in Clay

Pile Properties	
Pipe Diameter (mm)	89
Wall Thickness (mm)	4.0
Steel Grade (f's)	400
Pile Base Dia. (mm)	350

Soil Properties		
Soil Type	Angle of Friction (deg)	Cohesion Cu
Stiff	0	100
Medium	0	60
Soft	0	30

Minimum Pile Depth, h		
Soil Type	Fixed Head	Free Head
Stiff	40d	34d
Medium	30d	28d
Soft	28d	24d





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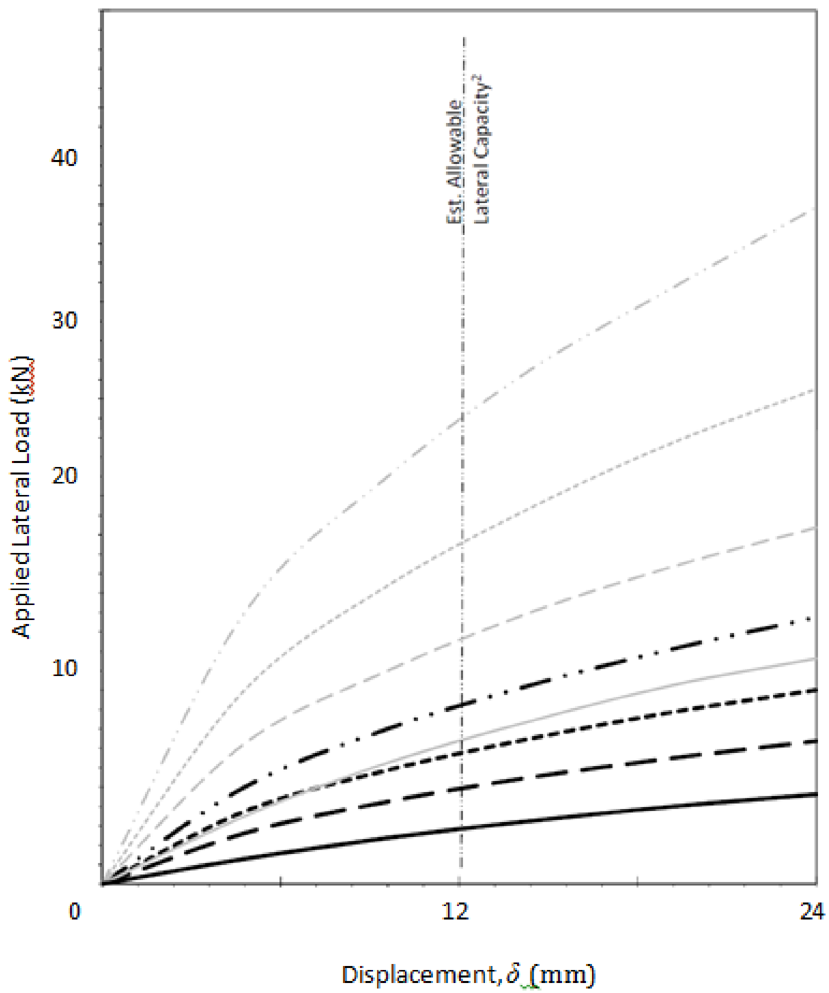
AS2159 - 2009, states that the allowable lateral capacity of a pile is half load causing a 25mm of displacement. Many practitioners take this to be nearly the same as the lateral load predicated at 12mm displacement. The graph presented here can be used to evaluate capacity for either condition as well as to judge lateral performance under other displacement criteria and codes. The design allowable displacement is the responsibility of the design engineer.

Katana Pile - 150kN

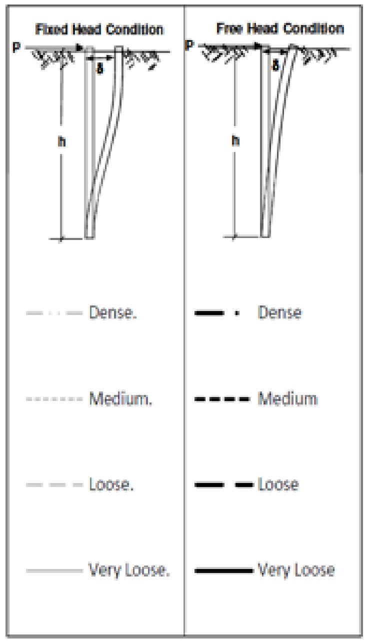
Lateral Performance in Sand

Pile Properties	
Pipe Diameter (mm)	89
Wall Thickness (mm)	4.0
Steel Grade (f's)	400
Pile Base Dia. (mm)	350

Soil Properties		
Soil Type	Angle of Friction (deg)	Cohesion Cu
Dense	25	0
Medium	29	0
Loose	33	0



Minimum Pile Depth, h		
Soil Type	Fixed Head	Free Head
Dense	40d	34d
Medium	30d	28d
Loose	28d	24d



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