FOUNDTEST

METHOD STATEMENT
FOR
INSTALLATION AND MONITORING OF INCLINOMETER
IN BOREPILES

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1.0 Introduction

Foundtest Drilling Sdn. Bhd. was formed as an independent specialist contractor, which is a professional engineering firm in construction testing services. Our professional services include the **Installation and Monitoring of Inclinometer in Bore Piles** which is used to monitor the inclination of installed bore piles.

2.0 Inclinometer Monitoring Equipments

The reading of subsurface movement would be taken using a set of Portable Measurement System which consists of:

- Inclinometer Probe
- Cables
- Read Out Unit

For more details on the Inclinometer Equipments, please refer Appendix III: Inclinometer Equipment Manufacturer's Data Sheet.

3.0 Installation of Inclinometer Casing

During the pile casting works, bore pile contractor shall install an API pipe with minimum diameter of 90mm inside the bore pile where the inclinometer test is required. The depth of the pipe is according to the specifications issued by the consultant. The contractor shall also take necessary precaution and care to avoid any blockage of the pipe after the pile installation.

Our team would install the inclinometer access tube in the API pipe which is inside the bore pile. The inclinometer access tube comes in 3m length each and would be properly jointed by rivet or twist lock before it is lowered into the API pipe. The keyway shall be properly orientated according to the expected

movement direction of the soil. The gap between the access tube and the API pipe would be backfilled with granular material, such as sand or pea gravel. After the installation, the access tube would be properly capped as protection on top of the casing.

4.0 Monitoring of Inclinometer

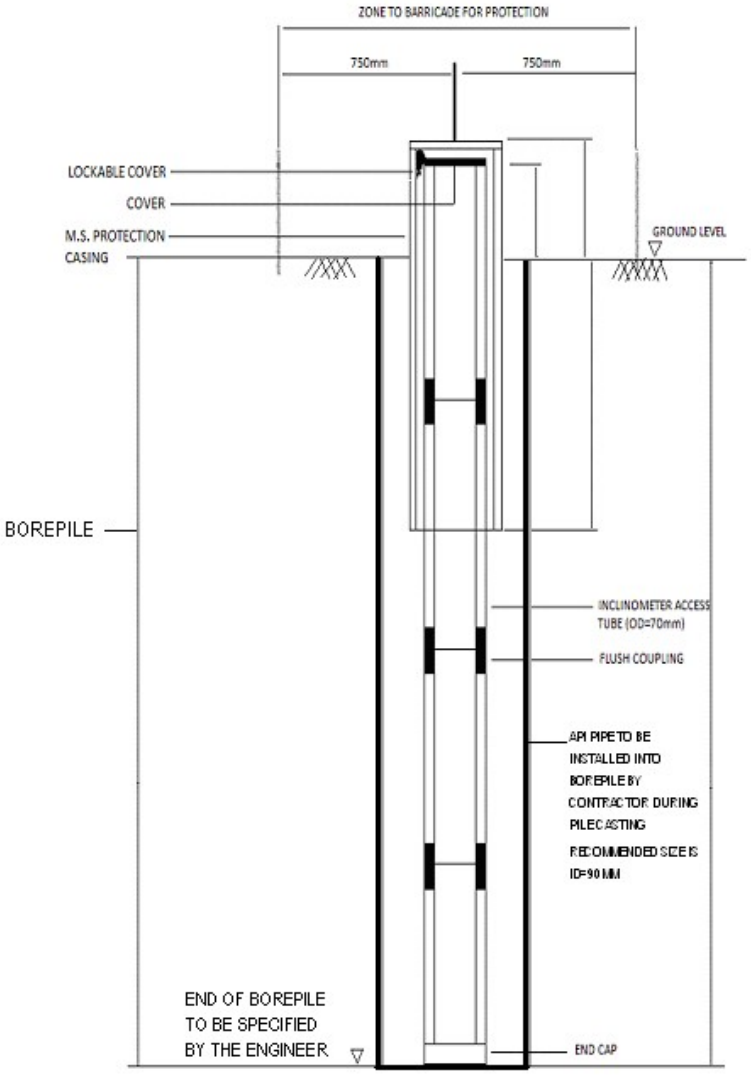
The monitoring of the inclinometer shall be carried out using a portable biaxial inclinometer probe. The probe is first lowered to the toe of the inclinometer tube and raised at every 0.5m interval for reading. The read-out system will store the recorded data in a data logger so that it can be retrieved for processing and plotting of lateral displacement profile later.

5.0 Reporting

All the data collected from the logger during monitoring would be processed and presented in proper reporting format which consist of plot and table of the lateral displacement profile, compiled and sorted for each trip according to date.

Appendix I

Typical Inclinometer Installation Diagram


ZONE TO BARRICADE FOR PROTECTION
750mm
750mm
LOCKABLE COVER
COVER
M.S. PROTECTION CASING
GROUND LEVEL
BOREPILE
INCLINOMETER ACCESS TUBE (OD=70mm)
FLUSH COUPLING
API PIPE TO BE INSTALLED INTO BOREPILE BY CONTRACTOR DURING PILE CASTING
RECOMMENDED SIZE IS ID=90 MM
END OF BOREPILE TO BE SPECIFIED BY THE ENGINEER
END CAP

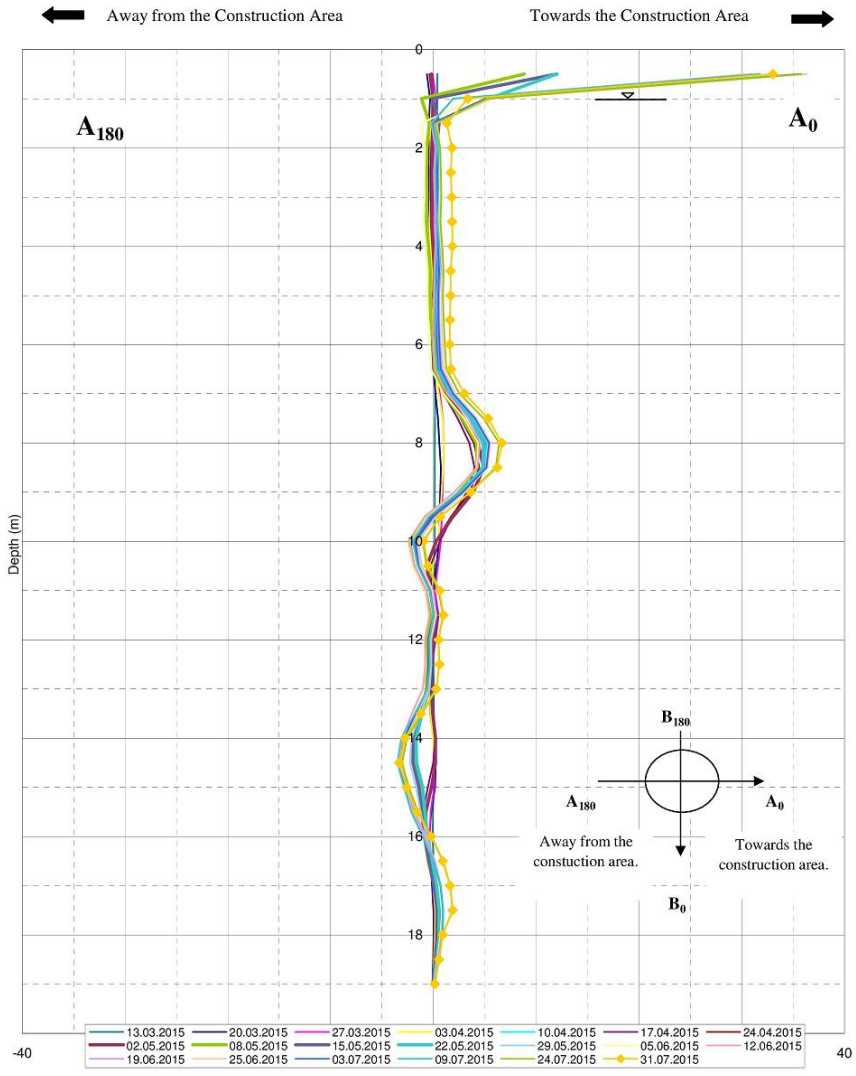
Appendix II

Sample Of Inclinometer Monitoring Result

MONITORING OF INCLINOMETER

AB Cumulative Displacement (mm) Against Depth (m)

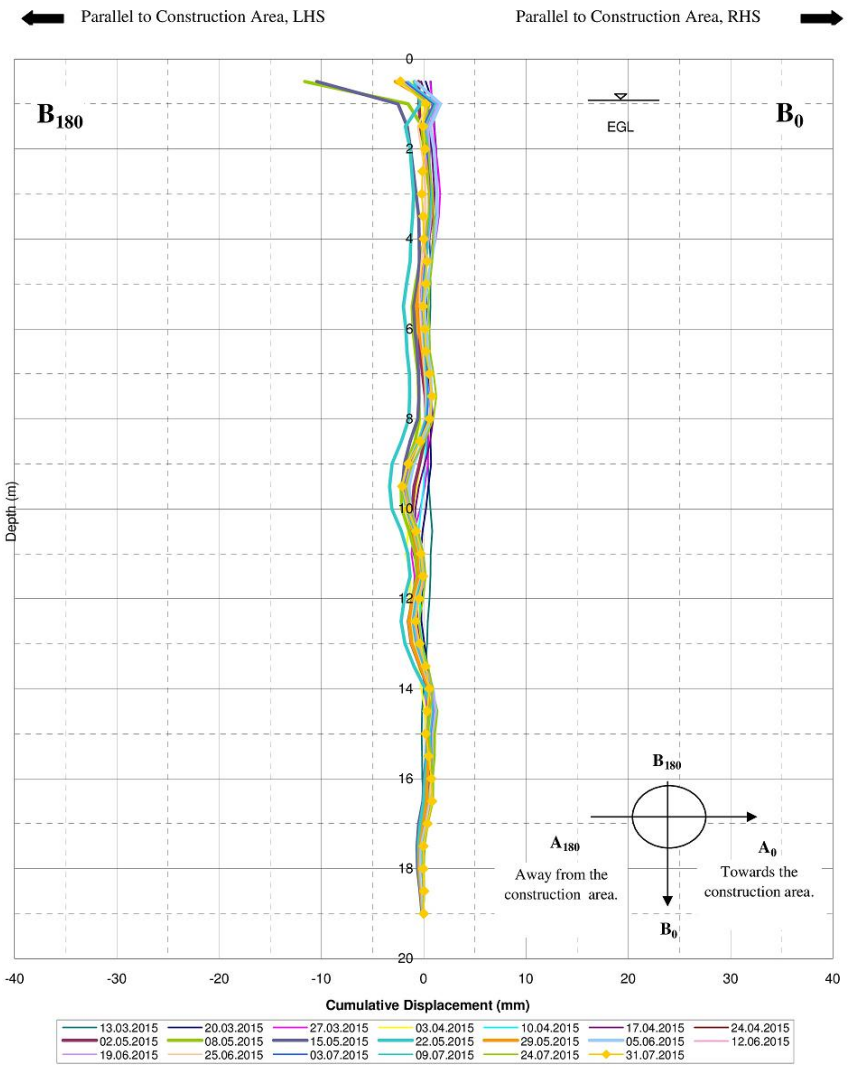
Inclinometer ID : **INC** **(A-axis)**



MONITORING OF INCLINOMETER

AB Cumulative Displacement (mm) Against Depth (m)

Inclinometer ID : **INC** **(B-axis)**



Appendix III

INCLINOMETER EQUIPMENT MANUFACTURER'S DATA SHEET

GT-INC-M Inclinometer System

Advantages

- Excellent Accuracy
- Repeatable Tracking
- Reliable Control Cable
- Consistent Depth Control
- Datamate is easy to operate
- Come with Software for Data storage and Management

Geotech GT-INC-M Inclinometer System (Package A) consists of: Inclinometer Probe, Control cable, Datamate with BlueTooth, a Reader (Geotech measurement APP), and a carrying case (cable reel is optional). Besides for inclinometer system, the Datamate can also be used for tiltmeter measurement. The inclinometer probe equipped with waterproof and durable steel casings, completed with wheel assembly and sealed wheel bearings to allow the probe move smoothly inside inclinometer casing. The control cable has a great resistance to tension force, scratch and cut. Its depth marked is fixed to the cable jacket, and cannot slip, which is suitable for long-term applications.

Applications

GT-INC-MEMS is used for monitoring slope stability of a landslide, displacement on a retaining wall due to deep excavations, embankment, tunneling and DAM monitoring, etc. Inclinometer casing is installed vertically to a stable rock used as reference point. Surveyor use inclinometer probe and control cable to survey Inclinometer casing. The first survey establishes the initial profile of the casing. Subsequent surveys show changes in the profile if ground movement occurs. The magnitude, direction, and rate of ground movement can be estimated and predicted by the plot of inclinometer readings along inclinometer casing.

Operation

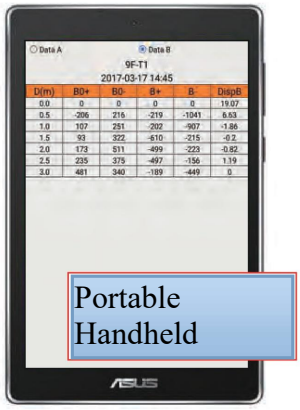
- To begin the measurement, connect control cable to the datamate. When datamate is turned on the Bluetooth can be linked to the tablet or phone APP.
- The surveyor input the inclinometer measurement parameter to the APP, and put the inclinometer probe to the bottom of the borehole, as the APP will display an indicator that indicating the reading signal is stable, and record the reading in that position.

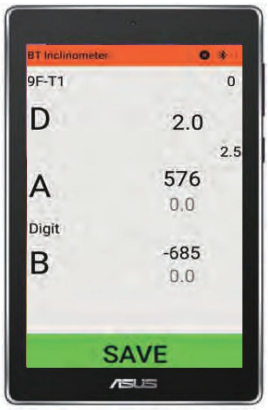
- Next, the surveyor repositions the probe to the next depth, while watching until the reading signal is stable, record the readings. Repeating these steps until the survey is completed (in both zero and 180 degrees modes)
- The readings can be repeated in case misreading is occurred. When all inclinometer readings have been taken by the surveyor. Surveyor can display check sum statistics to validate the survey.
- Measurement data is saved and can be seen directly inside the APP and can be sent or transferred by using email or cloud platform. The data can also be opened on PC using Geotech MRT Software.

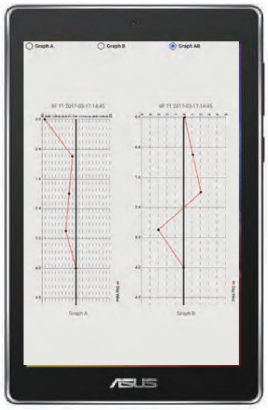
Mechanical and Technical Specifications

Model	GT-INC-M Digital Inclinometer System
Sensor Type	MEMS
Axes	Biaxial
Measuring range	±30°
Resolution	0.005 mm
Repeatability	±0.003°
Accuracy	±0.05 mm per reading
Operating temperature	-20 to +70 °C
Diameter	25.4 mm
Wheel carriage	Pair of wheels mounted on long-life sealed ball bearing race
Wheel diameter	32 mm
Distance between wheel axis	500 mm
Weight	1.8 kg
Cable Length	60m, 100m
Readout	Geotech GT-MR
Software	Geotech Measuring APP

Package A. Measuring APP (ASUS Tablet)







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GT-INCC Inclinometer Casing

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Inclinometer casing is a special tube that used in conjunction with inclinometer probe and characterized by cross shaped groove section along its length. It provides an easy and smooth access for inclinometer probe during subsurface data collection. Inclinometer casing is generally installed in boreholes, however it can also be directly cast inside concrete, embedded in fills or attached to structures. Typically, Inclinometer casing needs to be vertically installed at the center of the borehole.

Inclinometer casing is manufactured using ABS plastic which is capable of retains its shape over a high temperature. It is also easy to assemble and seal during the installation. Finally, it can sustain the ground displacement over long period of time and also suitable for long term contact with groundwater, grout and any types of soil. Because of its advantages, ABS casing is more preferable than PVC, fiberglass, or steel casing.

Casing grooves are precisely designed and manufactured with an excellent quality control of width, chamfer, depth, straightness and spiral. These criteria are very critical that can directly affect the accuracy of inclinometer probe. The groove holds the wheels of inclinometer probe tightly such as the probe can smoothly move up and down along its track without derailing

While measuring deflections inside borehole, Inclinometer probe is drawn from the bottom to the top of the casing and record is taken every interval of 0.5 or 1 meter. During the recording, sufficient time is needed for the probe to achieve stable readings which is determined by observing the readings on readout box.

Assembly

Inclinometer casing is designed with a standard length of 3 meters. Coupling section is used to connect together each section of Inclinometer casing such as they can stretch along borehole depth. In installation, joint connection between Inclinometer casing and joint section should be properly assembled by using ABS cement, blind rivets and also bound together with tape. In case if the connection is not adequately sealed, grout could seep through the casing and could prevent inclinometer probe from reaching measurement depth.

Casing Specifications

Inner groove type Casing	Outer groove type Casing
Coupling OD: 70 mm, 2.75 inches. Casing OD: 70 mm, 2.75 inches. Casing ID: 59 mm, 2.32 inches. Collapse Rating: 15 bar, 220 psi. Load Rating: 320 kg, 700 lb. Temp rating: -20 to 80 ºC. Spiral: ≤ 0.33º per 3 m or 10' section.	Coupling OD: 78 mm, 3.07 inches. Casing OD: 70 mm, 2.75 inches. Casing ID: 60 mm, 2.32 inches. Collapse Rating: 15 bar, 220 psi. Load Rating: 320 kg, 700 lb. Temp rating: -20 to 80 ºC Spiral: ≤ 0.5º per 3m or 10' section.