UNIVERSITI TEKNOLOGI MARA

JABATAN BANGUNAN

FAKULTI SENIBINA, PERANCANGAN DAN UKUR

UNIVERSITI TEKNOLOGI MARA

PERAK

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It is understood that the Practical Training Report is prepared

By

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Titled

MICROPILING AND ITS FUNDAMENTALS

Accepted in partial fulfillment of the requirement for obtaining a Diploma in Building

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DECLARATION

With this, I took full responsibility for the work and writing of this Practical Training Report except stated through my practical training work that I endured for 5 months starting from 31st October 2011 until 31st March 2012 at Jabatan Pembangunan dan Penyenggaraan (Unit Awam), Universiti Utara Malaysia. It is also one of the conditions to pass for the course DBN 307 and accepted as one of the conditions to achieve the Diploma in Building.

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Date : **10 December 2011**

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Thank you

ABSTRACT

In general, this report explains briefly about the fundamentals and operation of a certain piling system; the micropile. It is based on the experience, knowledge and observance of the writer for 5 months on the construction site. This report is divided further into several parts which include the introduction on the topic chosen, the history and background of the company the writer was placed upon, the methods and sequence of work done based on the topic of choice and also the conclusion and opinion of the writer about the topic given. The introduction briefly explains the concepts of piling and how it gives support to any building. It also contains the methods used to ensure the completion of the report and also the objectives of the whole report. The second chapter involves the history, background and organizational chart of the company where the writer was placed upon. The methods and sequence of work consist of step by step measures that were taken to complete the work of piling at the construction site. As a whole, micropiling is a piling concept and system used based on the soil of a construction site. For this construction site, the soil was harder than any normal soil so a micropile was used to give the foundation needed for the soil. It is learned that micropiling is not the easiest or the cheapest concept of piling. Although it is the fastest, it needs a lot of skilled workers to handle the machines and all this is explained in the third chapter of this report. As a whole, the writer hopes the readers will understand more on the concept of micropiling and how it is used in the development of the nation's buildings in this new era.

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LIST OF SHORTFORMS

JPP : Jabatan Pembangunan dan Penyenggaraaan

UiTM : Universiti Teknologi Mara

API : American Petroleum Industry

JKR : Jabatan Kerja Raya

TBM : Temporary Benchmark

ODEX : Overburden Drilling Eccentric

EDM : Electronic Distance meter

UUM : Universiti Utara Malaysia

CHAPTER 1

INTRODUCTION

1.1 PREFACE

Piling is the early stages of work done for the process of constructing a new building. Piling is done to strengthen the ground and soil of the construction site so that the new building can be more stable and do not collapse due to soil movement. Piling is also known as deep foundation, where a foundation is where the main weight and load of building goes to. The foundation helps the building retain its structure and make sure it does not collapse. Usually, a deep foundation is chosen over shallow foundations because deep foundations are more consistent and reliable in future tense.

Piles used in the construction industry have different type of properties differentiating from the different types of building to be build, the number of storey the building will be, the properties of the soil and many other factors that relates back to the structure of the building. These piles are either made of timber, steel, or reinforced concrete.

Piles are beaten or driven into the ground using pile drivers. A pile driver is a large mechanical machine that beats or drives a pile into the ground to strengthen the building's foundation structure. Pile drivers will lift a weight to a certain height using hydraulics, steam, diesel or even manual labor. After the weight reached its certain limit

or point, it will be released and hit the pile and thus driving it into the soil. This process is continued until the pile cannot be further driven into the ground.

Piles are made of different materials because each material has its own properties when constructing a building. For example, wood piles are used for small storey buildings, and it saves costs. Though wood is degradable and can suffer from rotting through time. These wood materials are made from the trunk of a tree. The reinforced concretes are made in different shapes including round, squares and octagonal. Though they are quite expensive, the durability and long lastingness is very good in the construction industry. Steel on the other hand can be divided into two types. There are pipe piles and the "H" piles. "H" piles are rarely used where else pipe piles are used in 2 ways. Which is open end or closed end, where open end will let the soil get into the pile when driven into the ground where else close end would not.

1.2 SELECTION OF TOPIC

Throughout the practical training period, the writer has been assigned by the supervisor to aid the supervisor monitor the construction areas and sites that are under the supervisor's duty. There are several sites such as at the EDC building which is a project that involves constructing a small steel structured building for the plantation of trees and flowers. There is also a project located in the UUM area, where the writer was asked to help supervise a site where the contractor is renovating a golf academy lounge.

Even though there are not many sites to be supervised, the writer took this opportunity to ensure that every site is supervised each day so that the construction process finishes as given in the tender and work order documents.

The writer's topic of study was chosen from another construction site that is still in the clearing up stage when the writer was at JPP. Piling work will be done in the early of January at this site. This project is a 4 storey Faculty of International Studies and lecture hall.

Though this project is under JKR and not JPP or UUM, the writer has written a letter to JKR to be allowed inside the construction site and the letter has been approved. The JKR will be building a 4 storey Faculty of International Studies and lecture hall and it is still in the clearing up stage. The topic of study will be relevant because the piling process will be starting soon and the topic seems to be interesting to the writer.

The writer also learns that the type of pile used on the site was not a normal type of pile that is regularly used but a different type which is the micropile. The micropile is a different concept of piling system where it does not use a hammer to drive the pile into the ground. This type of pile uses a system where a drill is used to drive the pile in. The drill will be encased in a steel casing which helps prevents the collapsing of the soil around the borehole and a reinforcement API (American Petroleum Industry) pipe will be installed later on. Finally a grouting process will take place to harden the foundation. So the writer topic of choice will be "***Micropile and its fundamentals***" as this seems to be a relevant topic of choice considering the uniqueness of this very topic

This topic brought attention to the writer because micropiles are rarely used in Malaysia and it is only used in certain condition of soil and usually Malaysia has a soft composite soil for a normal type of piling which is using the pile driver hammer. The writer also hopes that this topic will be unique and hopefully different to the other writers in their practical training.

The writer's final topic of choice will be "***Micropile and its fundamentals***" and it will explain the general concept of a micropile, the machines used, number of workers involved and a step by step guide on how to install a micropile.

1.3 OBJECTIVES OF STUDY

The objectives of study are to know and learn more about micropile and micropiling work that is done on the construction site. Objectives of study are:

1. To identify the types of pile used on the construction site during the early period of the construction process
2. To identify the equipments used for each stages of the piling work on the construction site
3. To identify the stages of the piling work and how it is done correctly on the construction site

1.4 SCOPE OF STUDY

The scope of study includes piling work done on the construction site from the start of the project until the end of the first piling process. The writer will stop supervising the site until the first point of the pile is grouted at the construction site. It also includes giving details on the micropiling process, which includes step by step process of the piling system, the machinery used on the site, the amount of workers needed and the amount of time needed for the completion of the first piling point.

The scope of study also includes various aspects and other important measures to be taken into account during the micropiling process. This project will be taken place near the UUM area and the project is a 4 storey Faculty of International Studies and lecture hall, and is under a JKR project.

1.5 METHODOLOGY

There are various methods that are used during the completion of this report and these are:

1.5.1 PRIMARY DATA

1. **Observation**

This is the second most common method used in conducting an investigation. Observations are made at the construction or project site. Through this method also, it is also easy to see and understand the method of work done on the site and is very accurate, according to the work done by the contractor on site. The observation is done by the writer and taking photographs helps improve the originality of the observation's facts.

2. Interview

An interview is the third most important and useful way to get information about a project done. It is also effective in getting the right information with the right person. Using this method however, the writer has to consult the workers and the professionals on site such as the engineer or the architect that has much knowledge and experience on the information. The writer also confronts his supervisor and his practical training supervisor on advices to help with the choice of topic for the report.

1.5.2 SECONDARY DATA

1. Electronic Media

This is the most common method used in the new century. This method is much easier and faster compared to other types of methods because through this method, information about anything can be found fast and mostly accurate. An example of an electronic media used by the writer is the internet.

CHAPTER 2

COMPANY BACKGROUND

2.1 INTRODUCTION

Jabatan Pembangunan dan Penyenggaraan (JPP) plays an important role in the building and maintenance perspective in Universiti Utara Malaysia. This department is responsible in the building and maintenance work throughout the university. This includes academic buildings, hallways, exhibition halls, lecture room, colleges, student buildings, governing building and other infrastructures and facilities located in the university.

There are a total of 9 units working under this department. Which means JPP is further divided into another 9 bodies. These bodies are:-

1. Administration and financial unit
2. Architectural unit
3. Civil Engineering unit
4. Electrical Engineering unit
5. Electronic Engineering unit
6. Mechanical unit
7. Property and Facility unit
8. Agriculture, Landscape and Forestry unit
9. Contract Management and Quantity Surveying unit

2.2 HISTORY OF ESTABLISHMENT OF COMPANY

Jabatan Pembangunan dan Penyenggaraan (JPP), Universiti Utara Malaysia was first established at the end of the year 1983 as a result of the establishment of the plan while the Univesiti Utara Malaysia campus (Campus Darul Aman) was in Tanjung Pauh, Jitra. All management of the affairs of the development of Universiti Utara Malaysia at that time was housed in a temporary office opened at and UMNO Building, Jitra before moving to its temporary campus in June 1984.

At first, JPP only consists of only a few staff and these staff began to conduct operations in several units which are the civil engineering unit, electrical units, mechanical unit, environmental unit and the administrative unit. In September 1990, when Universiti Utara Malaysia began moving to a permanent campus in Sintok, the units in the JPP began to increase gradually as needed and up to nine units which still exists as of present time.

2.3 OBJECTIVES OF COMPANY

JPP has a total of 4 objectives which are used to achieve its goals. These are:

1. To create a safe campus, comfortable and beautiful that will help the development of the academic, administrative areas and make Universiti Utara Malaysia and interesting place to visit.
2. To provide effective and efficient services to the campus's citizens.
3. To optimize the use of workforce and implement money spending wisely.
4. Making it a department that has employees who have a high sense of belonging, productivity, creativity and multi skills.

Photo 2.2.1 : This is the old JPP building used from the year 1990 until the early year 2011

Photo credit: Mr. Affendi Askandar (Technician at JPP)

(17 November 2011)

Photo 2.2.2 : This is the new JPP building used from 2011 until present time

Photo credit: Mr. Affendi Askandar (Technician at JPP)

(17 November 2011)

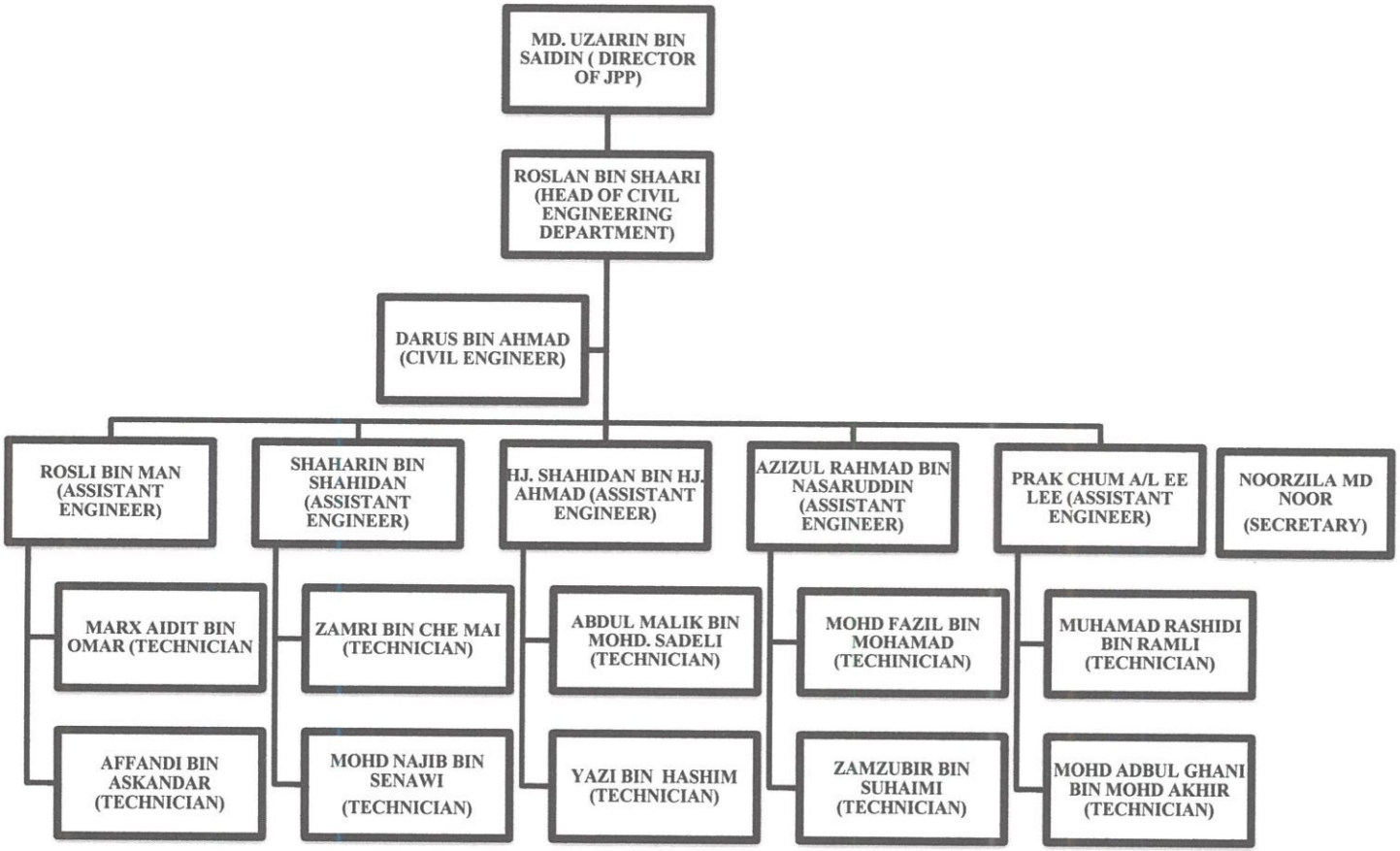
2.4 Staff members and Organizational Chart

Table 2.4.1 Staff and members list

No.	Name	Position
1	MD. Uzairin Bin Saidin	Director of JPP
2	Roslan Bin Shaari	Head of Civil Engineering unit
3	Darus Bin Ahmad	Civil Engineer
4	Rosli Bin Man	Assistant Engineer
5	Shaharin Bin Shahidan	Assistant Engineer
6	Hj. Shahidan Bin Hj. Ahmad	Assistant Engineer
7	Azizul Rahmad Bin Nasaruddin	Assistant Engineer
8	Prak Chum A/L Ee Lee	Assistant Engineer
9	Marx Aidit Bin Omar	Technician
10	Affandi Bin Askandar	Technician
11	Zamri Bin Che Mai	Technician
12	Mohd Najib Bin Senawi	Technician
13	Abdul Malek Bin Mohd Sadeli	Technician
14	Yazi Bin Hashim	Technician
15	Mohd Fazil Bin Mohd	Technician
16	Zamzubir Bin Suhaimi	Technician
17	Muhamad Rashidi Bin Ramli	Technician
18	Mohd Abdul Ghani Bin Mohd Akhir	Technician
19	Noorzila Binti Md. Noor	Secretary

2.4.2 ORGANISATIONAL CHART

Civil Engineering Unit



2.5 LISTS OF COMPLETED PROJECTS

Below are lists of big projects that are completed by the JPP unit over the past year:

Table 2.5 List of completed projects

No	Project/Building Name	Cost of Project	Time taken for completion of project	Contractor in charge	Architect in Charge
1	**Bangunan Perpustakaan Tambahan**	RM 1,648,900	2 years and 8 months	SERI TEMIN DEVELOPMENT CORPORATION SDN. BHD	MIR SHAHARIMAN
2	**Blok Bangunan Akademik Tambahan**	RM 152,600	8 months	SENGHOTI TECHNOLOGIES SDN. BHD.	AZMAN ZAINONABIDIN

3	**Dewan Kuliah Gugusan 6**	RM 138,500	11 months	PERTABINA TECHNICAL SERVICES SDN. BHD.	DESIGN NEXUS ARCHITECT
4	**Pusat Islam**	RM 1,267,000	1 year 7 months	BAKTIJAYA RESOURCES SDN. BHD.	ARKITEK NOR AZMAN
5	**Tambahan Kompleks Sukan Berserta Kemudahan**	RM 1,140,300	1 year 8 months	PERTABINA TECHNICAL SERVICES SDN. BHD.	ARKITEK MAJU REKA RUNDING SDN. BHD.
6	**Bangunan HEP dan Pusat Kegiatan Pelajar**	RM 1,502,500	1 year 3 months	ARRIZ ABADI SDN. BHD.	ARKITEK ICB SDN. BHD.
7	**Bangunan Jabatan Pembangunan dan Penyenggaraan**	RM 1,924,300	3 years 2 months	BUKIT TEMBAGA CORPORATION SDN. BHD.	SOBRI ARCHITECT SDN. BHD.

CHAPTER 3

MICROPILE

3.1 INTRODUCTION ON WORK DONE

Micropile is done using a drilling concept where a micropiling machine will drill a hole in the ground encased with a steel casing. The drill heads and rod will then be removed and API (American Petroleum Industry) pipes will be placed inside the casing. Grouting work will then be poured inside the casing. The temporary casings are then extracted from the holes when grouting work is completed.

3.1.2 Equipments and plants used during piling work

These are the various equipments used during the piling work:

1. Holy HDM-CD120 Micropiling machine
2. Mobile Crane/ Truck mounted crane
3. Steel temporary casing
4. API (American Petroleum Industry) pipes
5. Gas steel cutter
6. Grout Pump (Rockdrill TGP-120)
7. Air Compressor unit (Atlas Copco XRVS 345/Ingersoll-Rand XHP750)

3.2 LOCATION PLAN AND FLOOR PLAN

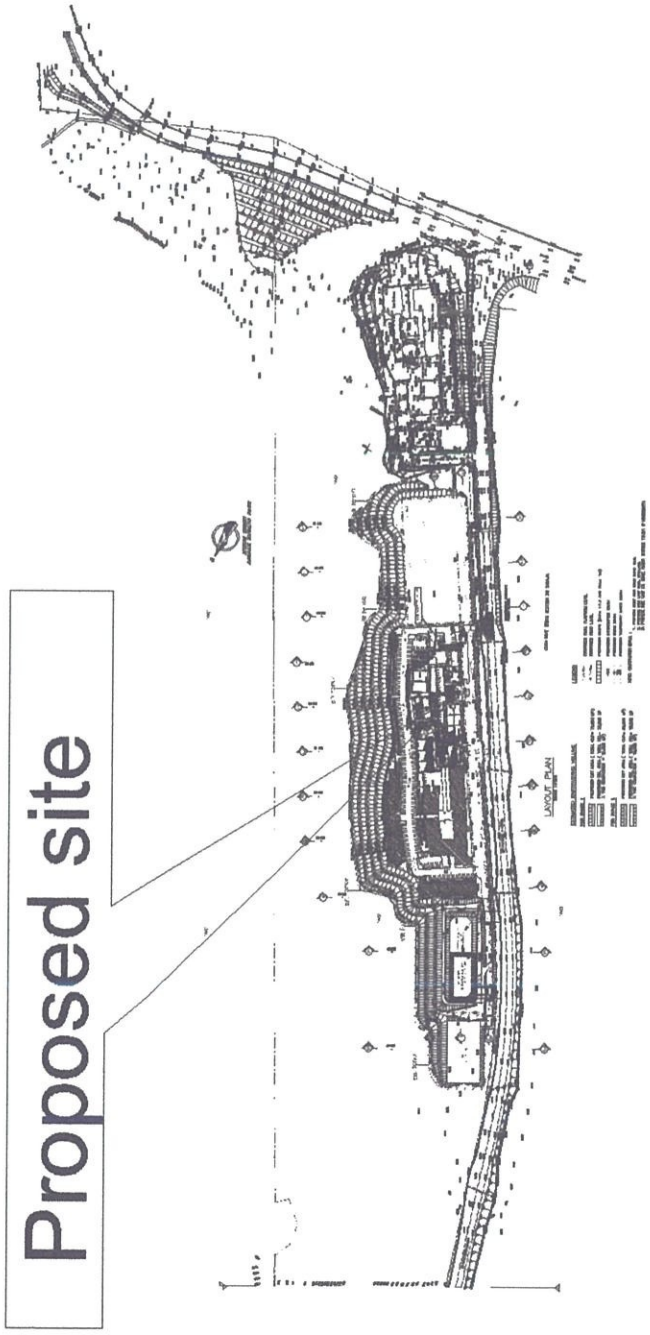


Figure 3.2.1 An overview diagram of the location plan

Source: Mr. Lim (contactor) (2012)

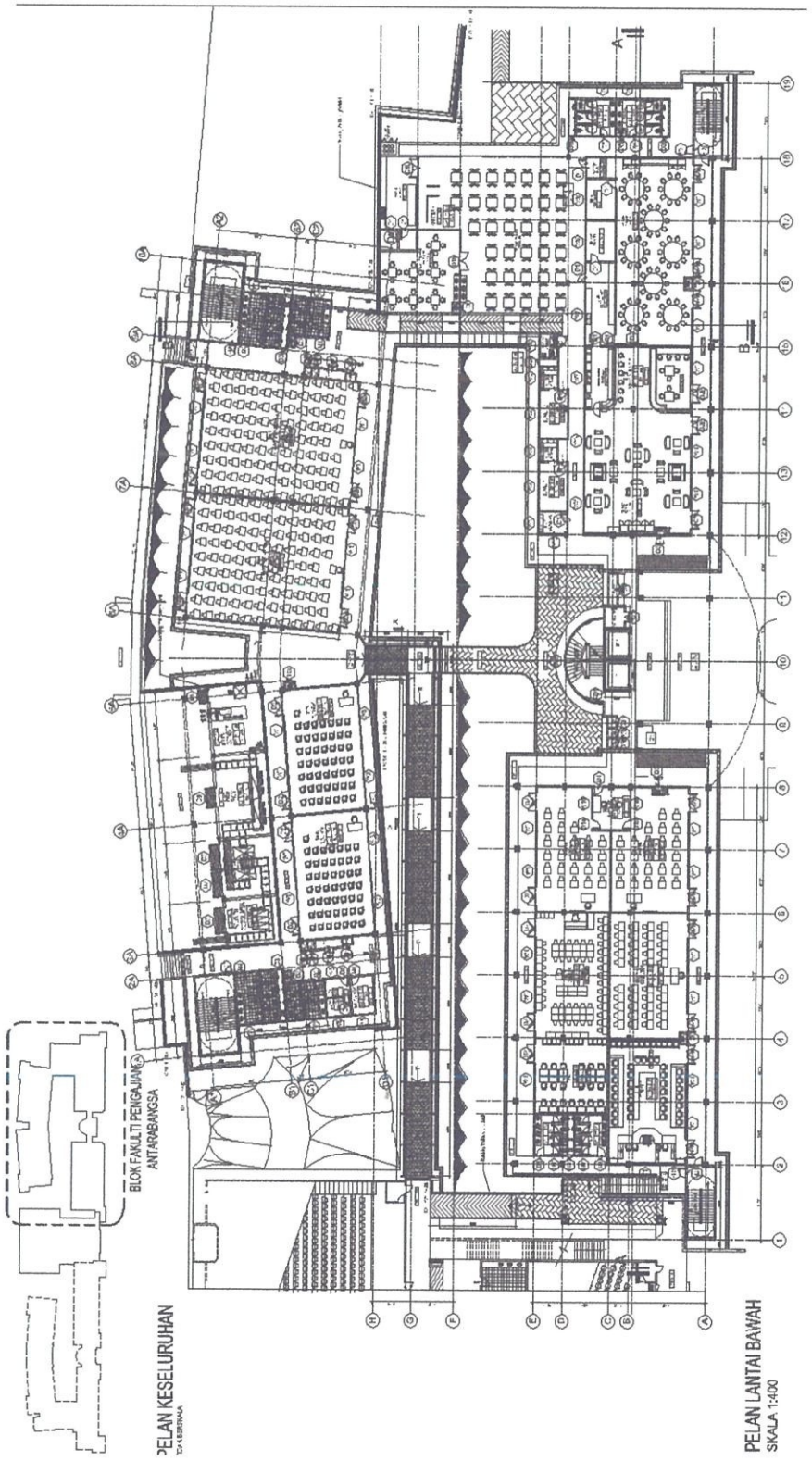


Figure 3.2.2 Ground Floor Plan

Source: Mr. Lim (contractor) (2012)

3.3 METHOD AND SEQUENCE OF WORK

3.3.1 Setting Piling Points

Setting out of the pile caps and piling points are carried out with an EDM accurate to 5 second, by a registered licensed surveyor. For the piling records and reference, the piling point shall be numbered. In general, the piling points sequence is from left to right and top to bottom as stated by the main contractor.

Photo 3.3.1

Piling points on site

Photo Credit: Najib

(15 February 2012)

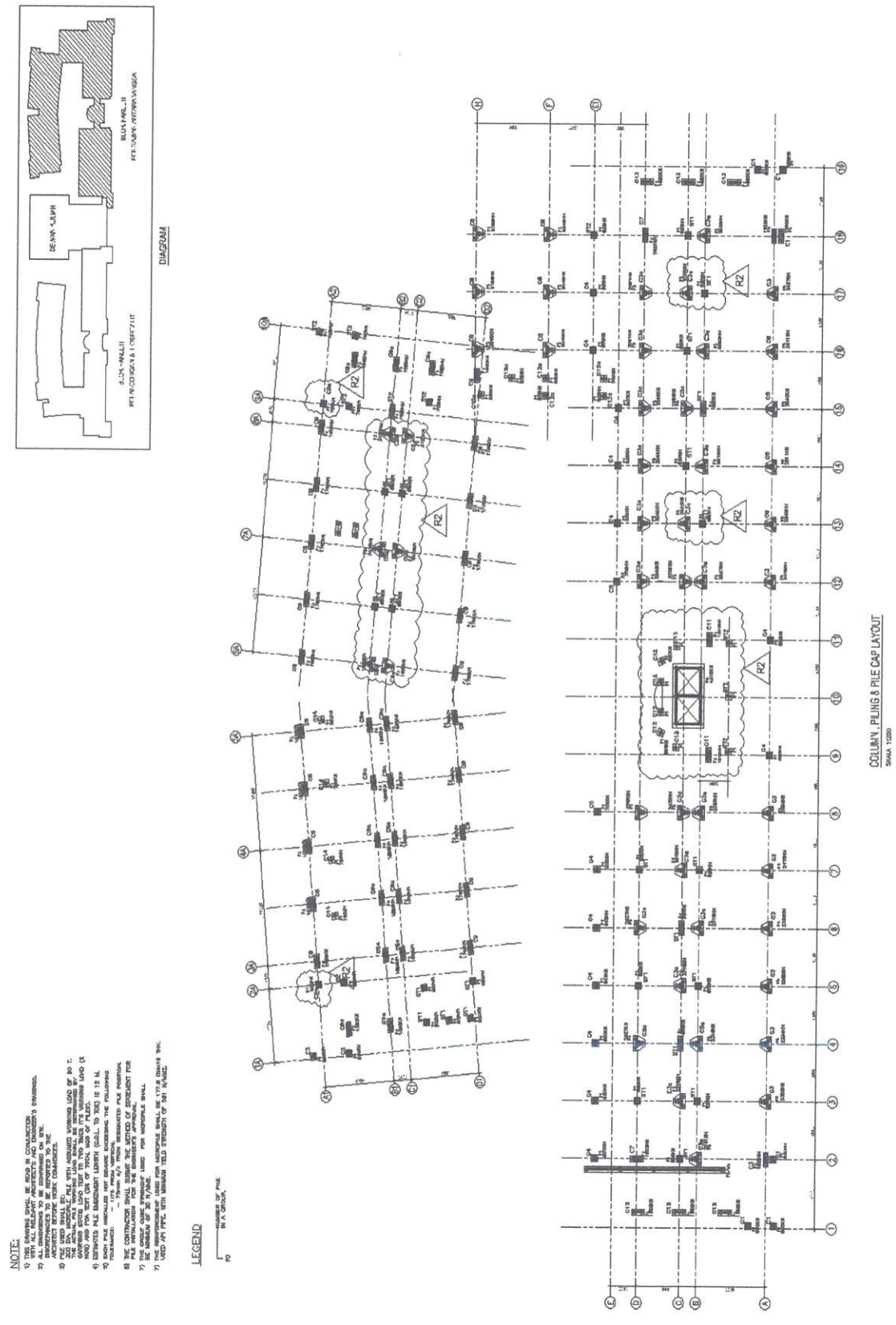


Figure 3.3.1 Layout Plan on piling points on the whole site

Photo Credit: Mr. Lim (contractor) (19 February 2012)

3.3.2 Boring

Boring is the drilling work done. The drilling method is selected on the basis causing minimal disturbance to the ground and nearby sensitive structures and able to achieve the required drilling performance. (Ir. L. S. Shong & F.C. Chung Gue ,2003)

Firstly, the boring will be carried out with a micropiling machine know as the "Holy HDM-CD120". This is a crawler mounted drilling rig with drilling capacity up to 400mm diameter. In this process, only 1 skilled worker will be running the drilling rig throughout the sequence of piling. This is to avoid miscalculation and improper installation of the piling work.

Secondly, when the boring is in certain underground condition such as limestone, or encounter high water table, underground water movement, cavity, weak slime or a sandy layer, drilling into these holes require the use of steel casing to stabilize the holes structure and does not collapse. The 2 main reasons for the installation of casing are that it stabilizes the boreholes and prevents the collapsing of boreholes and excessive loss of grout during the grouting process.

Photo 3.3.2.1 250 mm Steel Casing on site

Photo Credit: Najib

(15 January 2012)

For drilling with installation of temporary casing, a Topdrill of 8" Down-the-hole hammer with SD8 shank and TDEX 240 ODEX system, and Holy 5 1/2" drill rod and 250mm diameter temporary steel casing will be used. The ODEX system is also known as the rotary percussive Duplex (Down-the-Hole Hammer). ODEX stands for Overburden Drilling Eccentric (ODEX) system, this method involves the use of rotary percussive drilling combined with an eccentric un-reaming bit. The eccentric bit undercuts the drill casing, which then can be pushed into the oversized drill hole with much less rotational energy or thrust. In addition, the drill casing does not require an expensive cutting shoe and suffers less wear and abrasion. The larger diameter options, of more than 127mm in diameter, often involve the use of a down-the-hole hammer acting on a drive shoe at the toe of the casing, so that the casing effectively pulled into the borehole as opposed to being pushed by a top hammer. (Ir. L. S. Shong & F.C. Chung Gue, 2003)

Most recently, systems similar to ODEX, which is now known as TUBEX, have appeared from European and Japanese sources. some are merely mechanically simpler versions of TUBEX.
(Ir. L. S. Shong & F.C. Chung Gue, 2003)

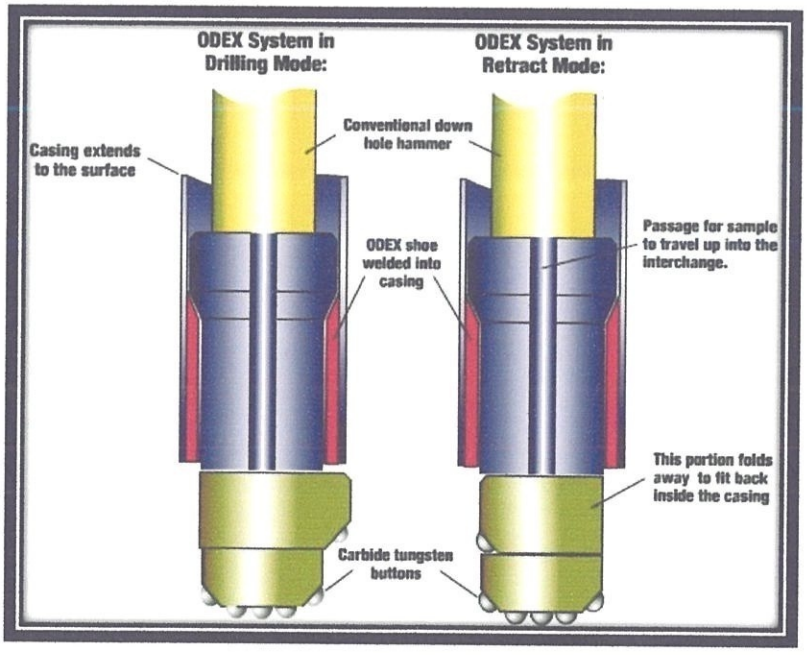


Photo 3.3.2.2 ODEX System Drilling and Retracting mode

Photo Credit: Mr. Lim(contracto

(19 February 2012)

During Drilling with ODEX, the steel casing is effectively pulled into the borehole during advancement of the hole. The first steel casing is cut to the required length before installation and subsequently the second casing is cut and welded to the first length casing and so on until the required depth is achieved. Raising all these heavy pipes acquire a large force, which is why a mobile crane or truck mounted crane is used to lift all the casings. The crane is also handled and driven by a skilled worker because it is important to achieve a specific point during the changing of casing and steel rods.

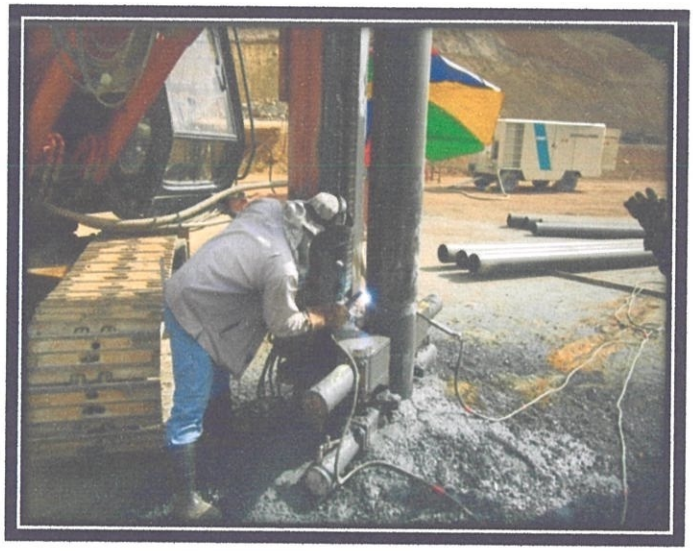


Photo 3.3.2.3 Skilled-Worker is welding steel casing

Photo Credit: Najib

(15 January 2012)

Photo 3.3.2.4 Mobile crane driven by a skilled worker

Photo Credit: Najib

(15 January 2012)

Vertically of the drill rod is first checked when rig is placed over the peg piling point. Boring is by applying hydraulic pressure and the high air-pressure driving the down-the-hole hammer. Drilling shall continue until the designed length is achieved or until the required socket length in the sound of continuous rock is obtained.

Photo 3.3.2.5 Drilling rig handled by a skilled worker

Photo credit: Najib

(15 January 2012)

Photo 3.3.2.6 Drilling Rig on "rest mode"

Photo Credit: Najib

(15 January 2012)

A total of 3 drill rods and 3 casings are used in the process of the piling work from a total of 12 meter deep of drill work needed. The casings are welded to each other each time it has reached a certain depth. The rods however are placed with tight sockets at each end to continue on with the drilling process. To add the drill rods, a hydraulic winch is used to lift the rod using a cable and it is then placed in a socket. Temporary casing will also be added after installing the new drill rods.

Photo 3.3.2.7

The process of adding drilling r and casing

Photo Credit: Najib

(15 January 2012)

Photo 3.3.2.8

Skilled worker welding steel casings

Photo Credit: Najib

(15 January 2012)

These works requires a minimum of 3 semi-skilled workers. To prevent the rods from falling in the boreholes, a hydraulic clamp is used to clamp the rods from the previous depths before a skilled worker places the new rod in its socket from the previous rod. Rod's that are not clamped will fall in the boreholes and this is a total loss and cannot be retrievable anymore because of the depths of the boreholes.

Removal of drilled soil from the drill holes can be achieved by expelling the debris out of the hole with high pressure air pumped into the drill hole. For this purpose, air compressor such as Atlas Copco XRVS 345/ Ingersoll-Rand XHP750, high pressure air compressor will be provided.

Photo 3.3.2.9 Boreholes after finishing drilling with casing

Photo Credit: Najib

(15 January 2012)

3.3.3 Placing of API pipe reinforcement

When boring to the required depth or embedment in sound rock is achieved, the drill hole will be covered with a suitable bucket to avoid debris falling in. When a few boreholes are ready, API pipe is cut to the required length (12 meters for this piling work) will be prepared for placement in the boreholes. The API pipes are lowered and centered using a mobile crane. The API however will not be thoroughly centered so another method has to be developed which is to weld spacer blocks onto the API pipes so that it can achieve a maximum concrete cover.

Photo 3.3.3.1 API pipes on sit

Photo Credit: Najib

(15 January 2012)

Photo 3.3.3.2

"Spacer Blocks" being welded on API pipes

Photo Credit: Najib

(15 January 2012)

3.3.4 Grouting

For this project's piling work, a total of 4 to 5 boreholes were made from 8 a.m. to 2 p.m. and from 2 p.m. until 7 p.m. grouting work will be started to seal the boreholes with grout. Whilst the API reinforcement pipes are being put in place, cement grout will be prepared for pumping into the drill holes. Ordinary Portland Cement (OPC) will be used and to reduce shrinkage, Sika expanding grout admixture Intraplast-Z will be added at a dosage of 1 kg per 100 kg of cement. Measured quantity of water, for a water/cement ratio of 0.45- 0.5 shall be placed in a grout mixer tank; after the mixer is started, cement will then added and thoroughly mixed. The mixing sequence is Water - Cement - Sika.

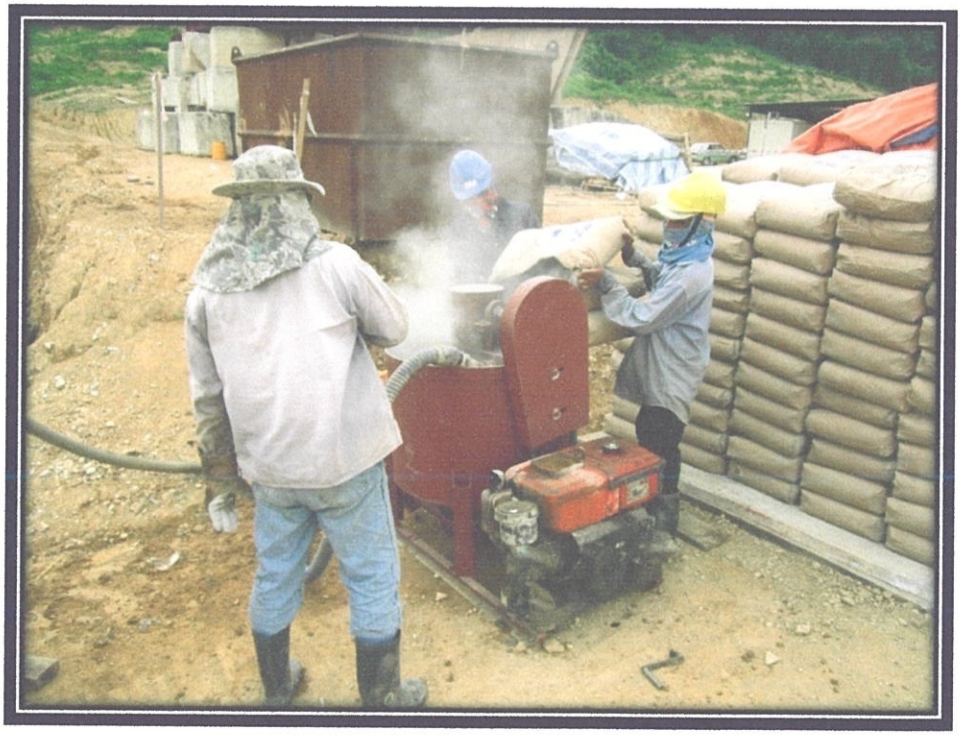


Photo 3.3.4.1 Grout is being mixed in the grout mixer

Photo Credit: Najib (15 January 2012)

After the cement grout is thoroughly mixed, the grout is then pumped by a grout pump *Rockdrill TGP-120 into the drill holes where it will egress from the bottom of the borehole in upward progression until it filled up to the required level, any drop in grout level will be filled until the grout level is stabilized. A suitable pipe is used to serve as a tremie pipe. The number of workers to do this job is two semi skilled workers.

Photo 3.3.4.2 Workers pumping grout into boreholes using pipe

Photo Credit: Najib

(15 January 2012)

Lastly, the temporary casings are then extracted from the boreholes when grouting works are completed.

Photo 3.3.4.3 Temporary steel casing being removed from boreholes

Photo Credit: Najib

(15 January 2012)

3.3.5 Records

Piling records are recorded as works of progress and duly signed and endorsed every day by the Site Officer Representative.

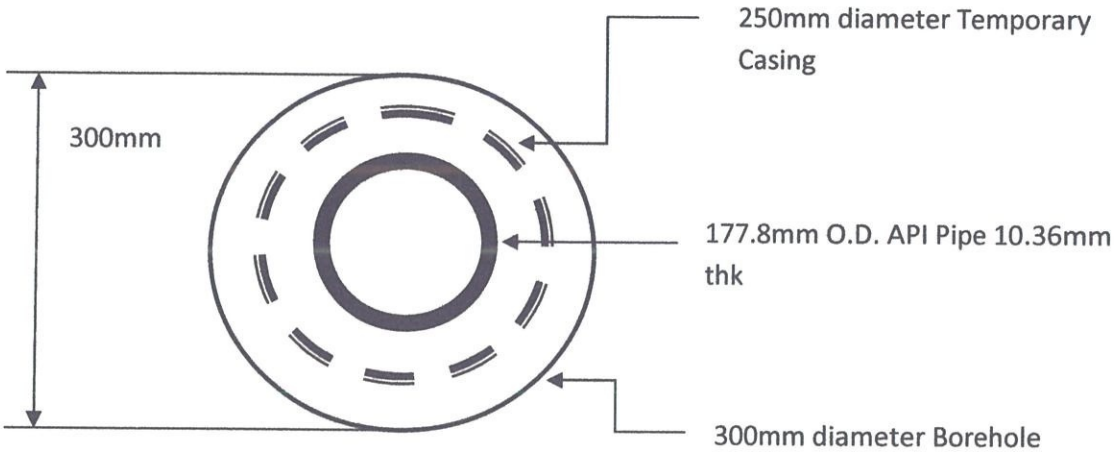


Figure 3.3.5 Section drawing of boreholes consisting of all elements

Photo Credit: Najib (19 February 2012)

3.3.6 Load Test

3.3.6.1 Preparation

The pile to be test loaded is built up to the necessary elevation and capped with epoxy resin or mortar to produce a smooth horizontal bearing surface. A thick steel plate is placed on the pile head to spread the load from the hydraulic jack to the pile.

Photo 3.3.6.1.1 Worker measuring whether metal plate is stable or not

Photo Credit: Najib

(16 January 2012)

Photo 3.3.6.1.2 Metal plate welded onto footing

Photo Credit: Najib

(16 January 2012)

3.3.6.2 Test Jack

The hydraulic jack covers a range in excess of the ultimate load of the pile (i.e. twice the pile working load). The load applied is determined by the Engineer. The test jack must be in order and no leakage shall be anticipated.

Photo 3.3.6.2.1 Hydraulic jacks being watched over for measurement

Photo Credit: Najib

(17 January 2012)

Photo 3.3.6.2.2 Hydraulics meters showing progress and change

Photo Credit: Najib

(17 January 2012)

3.3.6.3 Kentledge

The test load is applied by means of a jack, which obtains its reaction from kentledge in excess of twice the pile working load. Kentledge must be arranged in a manner to provide an effective load test without imposing any danger.

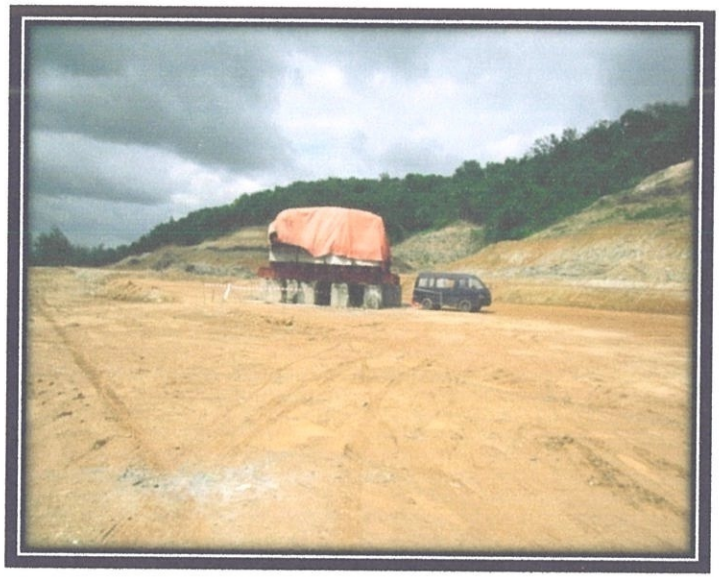


Photo 3.3.6.3

Kentledge system from a distance

Photo Credit: Najib

(17 January 2012)

3.3.6.4 Measurement of Settlement

Settlement is measured by using a reference beam, which are to be supported on two firm stakes placed sufficiently far from the pile under test and the reaction system, is to be unaffected by ground movements resulting from the tests.

The measurement of the settlement is made by four dial gauges or arranged diametrically on top of the steel plate. Vertical scale rules were fixed to pile top sighted by a survey level instrument (with the use of TBM reference for correction purposes).

Vertical scales were also provided on the reference beams to monitor any movement during load testing. Readings shall be taken to an accuracy of 0.025 mm (0.001") and the dial gauge must have a travel distance of not less than 50 mm (2").

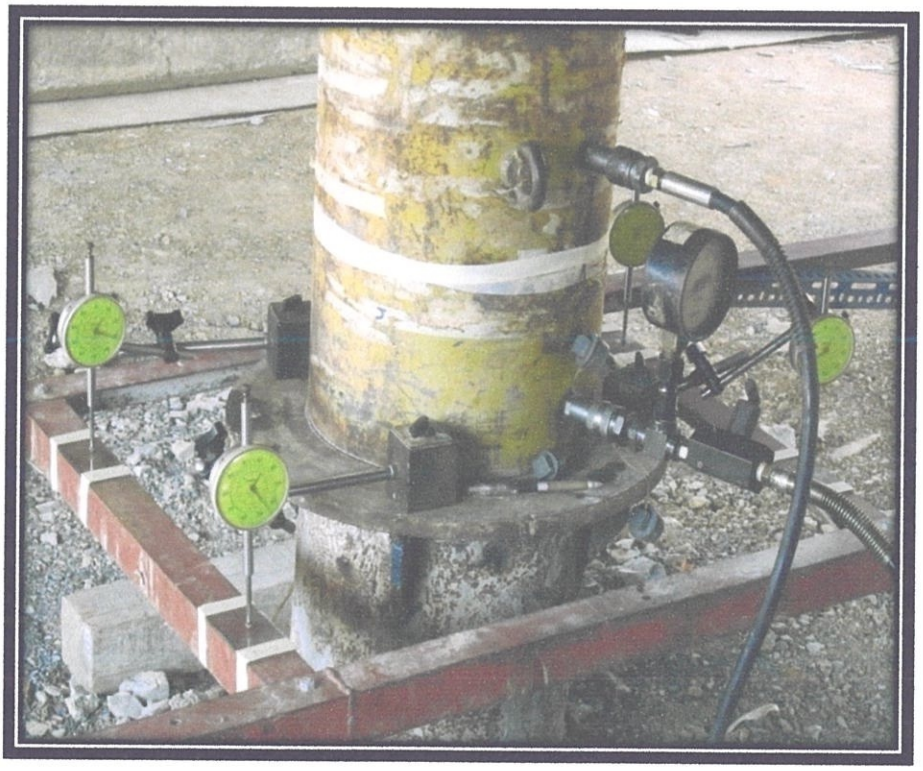


Photo 3.3.6.4. Dial gauges showing different readings in the process

Photo Credit: Najib (17 January 2012)

3.3.6.5 Maintained Load Test

The load test is conducted in two cycles. In the first cycle the pile shall be loaded to its designed working load whereas in the second cycle, the pile shall be loaded to twice its designed working load.

1. First Cycle

The load shall be increased in 4 equal intervals up to the designed working readings of settlement are to be taken at 15 minutes interval. At the working load, the applied load shall be maintained for 6 hours, during which readings of settlement are to be taken at 15 minutes intervals for the first hour and at hourly interval after that. The load shall then be reduced in a similar manner. At each reduction, the applied load shall be maintained for 30 minutes, during which readings of settlement are to be taken at 15 minutes interval.

2. Second Cycle

The load shall be increased in 8 equal intervals up to twice the designed working load. At each increment, the applied load shall be maintained for 1 hour, during which readings of settlement shall be taken at 15 minutes interval. At maximum load, the applied load shall be maintained for 24 hours, during which readings of settlement shall be taken at 15 minutes intervals for the first hour and at hourly interval after that. The load shall then be reduced in 4 equal intervals. At each reduction of load, the applied load shall be maintained for 30 minutes, during which readings of settlement are to be taken at 15 minutes interval.

3.3.6.5.1 Presentation of Load Test Results

Presentation of the load test results shall include plotting of graphs on :-

a) Load versus Settlement

b) Load versus Time

c) Settlement versus Tim

Table 3.3.6.5 Maximum Permissible Settlements

Criteria	**Test Pile 1**	**Test Pile 2**	**The pile is considered a failure if one of the following occurs**
Maximum settlement under working load	3.26 mm	2.35 mm	12.5 mm
Maximum settlement under twice the working load	7.36 mm	5.11 mm	38 mm
Maximum permanent/ residual settlement	1.49 mm	1.54 mm	6.5 mm

3.3.5.6.2 Results, conclusion and proposal

From the table shown are all the records in the pile load test under the criteria considered to have failed with a high margin. The following matters may be the major contributor:

1. The value assumptions ultimate bond stress (fbu) between grout and soil used in the design, which may be quite low which is 0.18N/mm2 soil condition on the site. The engineer suggests of an fbu N which is 4 times the value of the land (4x50 =200kPa or 0.20N/mm2) and Neoh CA recommends fbu =5N (0.25N/mm2)

2. 'End bearing' pile are ignored in the design contribute to overall bearing capacity (bearing capacity) of pile.

3. Factors of moving land slide in the hole, which add to the general side friction between pile and soil

It is proposed that the depth of the pile can reduce from 15.0 meters to 12.0 meters. The design of these piles will be tested of its effectiveness through the load tests. The pile built using a micropile is fulfilling the requirements design. However the design should be reviewed so that the cost of construction is kept at optimal.

3.4 MICROPILE, GROUTING AND DRILLING METHODS USED

3.4.1 Micropile Classification

Micropiles are mostly divided and classified according to the design application and secondly to the grouting method. The design application shows how the micropile work and its functions while the grouting method defines the grout/grout bond capacity during the grouting work.

The design application however can also be divided into two more types of application.

3.4.1.1 First design Application

The first type of design application is when the micropile is forcedly loaded either axially or laterally and the pile reinforcement resists most of the given load. This type is used to transfer structural load deeper, more competent or stable and may be used to restrict the movement of collapsing soil in slopes. The force of the load is mostly resisted by the steel reinforcement structurally and by the grout/grout bond geotechnical zone.

3.4.1.2 Second Design Application

The second type of design application is when the micropile stabilizes or reinforces the earth's soil to make a reinforced soil composite that resist the given load and known as reticulated pile network. This type of method is mostly to strengthen the reinforced soil composite.

3.4.1.3 Design application used on the construction site

In the construction site, the engineer and main contractor has chosen to use the second type of design application where the micropiles are used to stabilize or reinforce the earth's soil internally. The choice of this type of micropile is based on the soil matter around the construction site. It is legally chosen by the contractor and the engineer based on the data of the soil's composite.

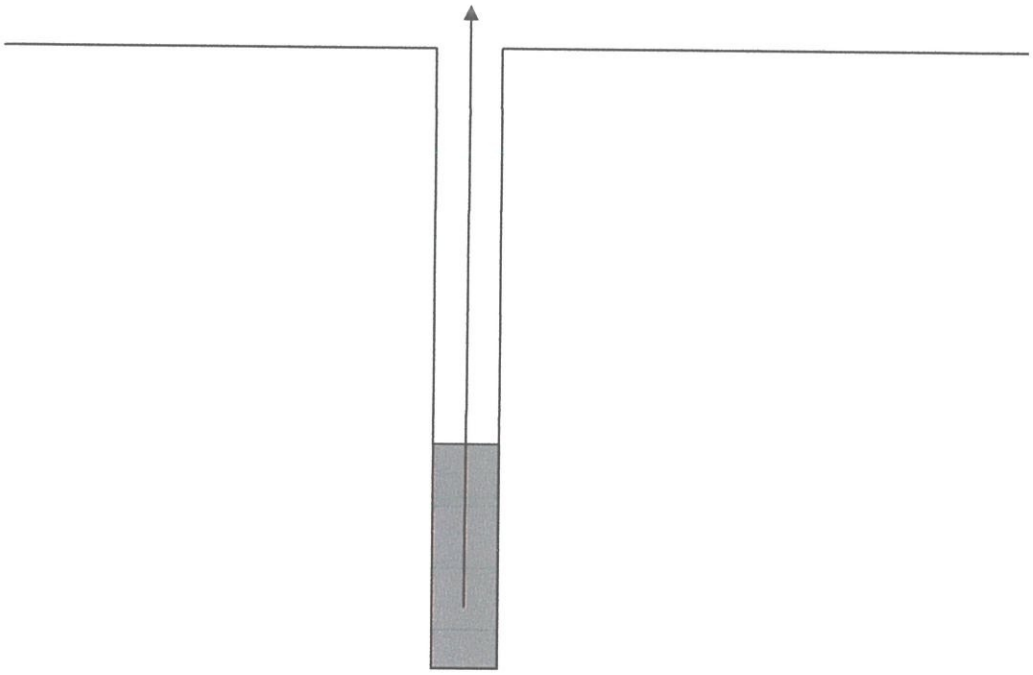
3.4.2 Method of Grouting

The method of grouting is generally the most effective and sensitive construction control over grout/ grout bond capacity and varies directly with the grouting method. In total there are four types of grouting method which are Type A, B, C, and D. Each of these types has its own form and specialty.

These types of grouting method are used mostly based on the soil condition and the height of the building that is to going to be built. The different types of grouting method will have its own pro's and cons and these are explained as below.

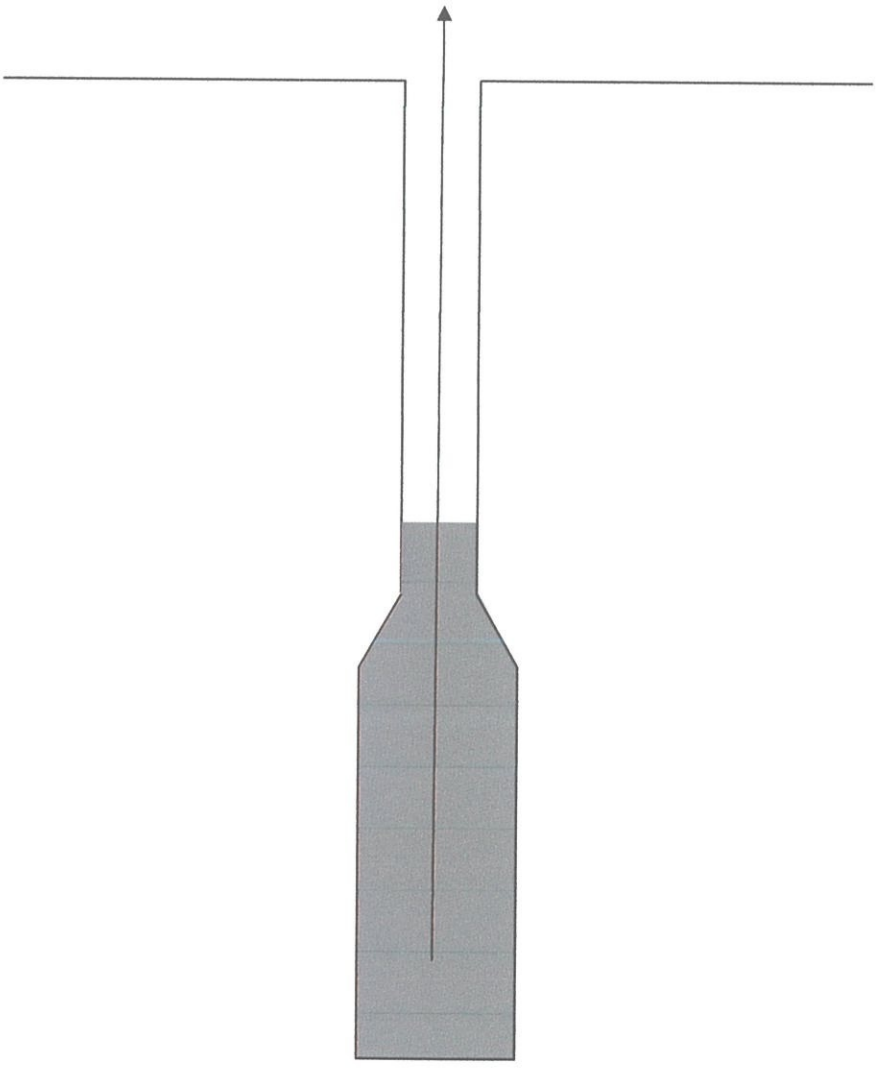
3.4.2.1 Type A

Type A classification indicates that grout is placed under gravity head only. Sand-cement mortars, as well as neat cement grouts, can be used because the grout column is not pressurized. This type of grouting is the most common type used in regular micropiling sites as it is the easiest to accomplish.



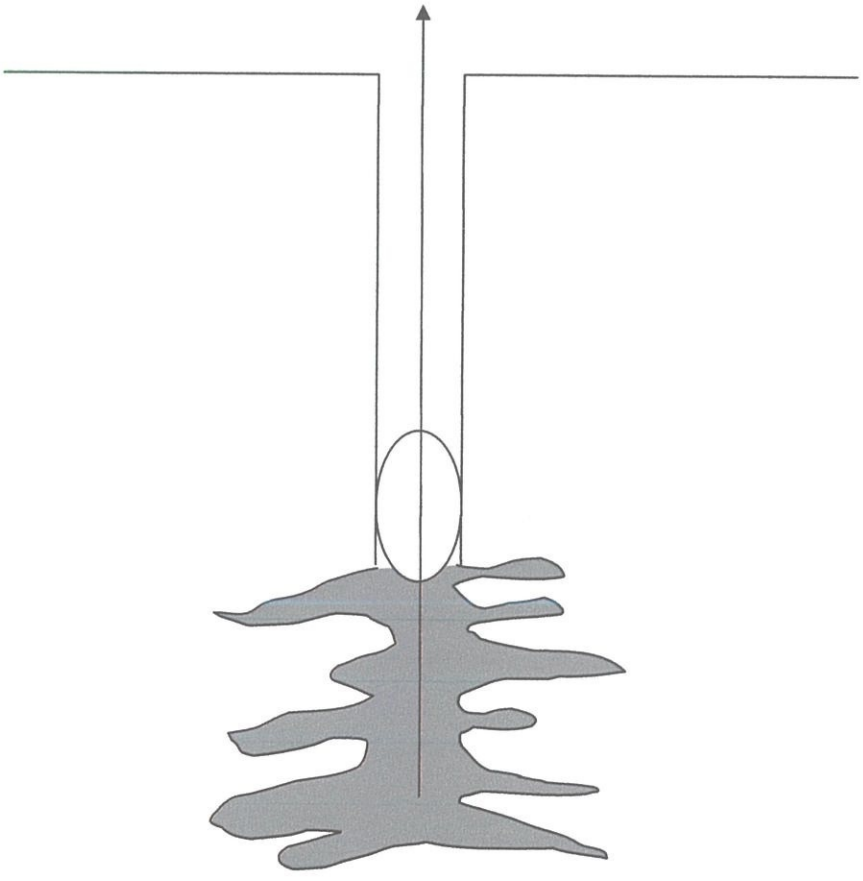
3.4.2.2 Type B

Type B indicates that neat cement grout is placed into the hole under pressure as the temporary steel drill casing is withdrawn. Injection pressures typically range from 0.5 to 1 MPa, and are limited to avoid hydro-fracturing the surrounding ground or causing excessive grout takes, and to maintain a seal around the casing during its withdrawal, where possible.



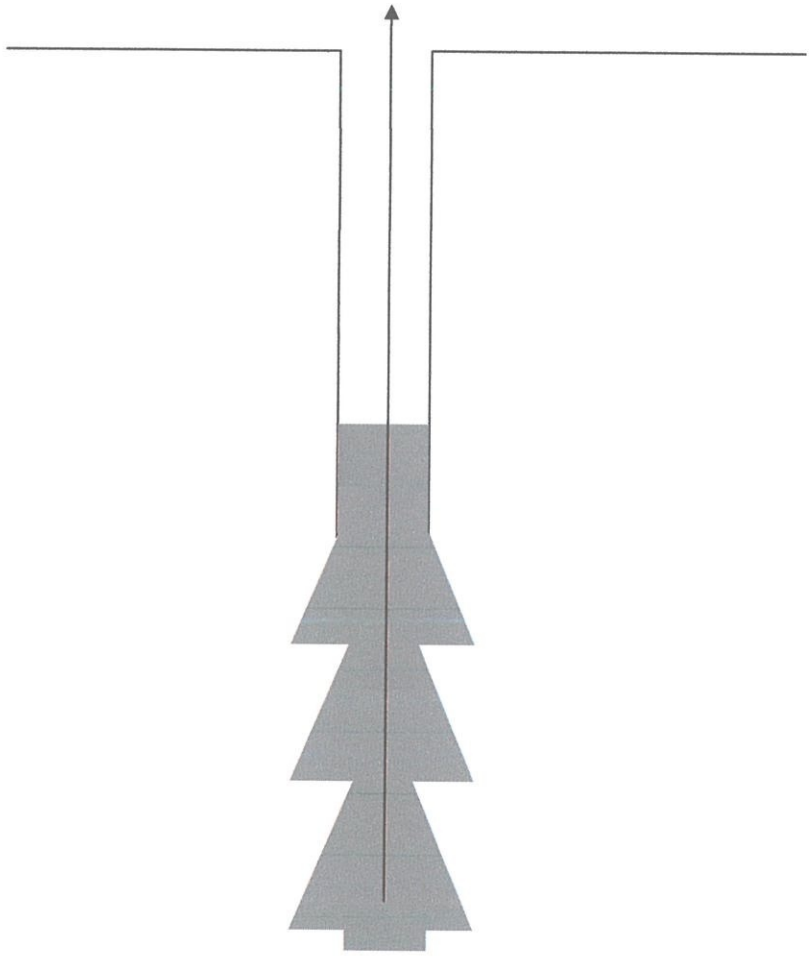
3.4.2.3 Type C

Type C indicates a two-step process of grouting: Primary grout is placed under pressure of 1.0 - 2.0 MPa, causing hydro fracturing of surrounding ground. Prior to the hardening of the primary grout (technically 15 to 25 minutes); secondary grout is injected usually via a tube. This method is sometimes referred to as IGU (Injection Globale et Unitaire).



3.4.2.4 Type D

Type D indicates a two-step process of grouting similar to Type C with modifications to the secondary grouting. Primary grout is placed under pressure and after hardening of the initially placed grout, additional grout is injected via a tube at a pressure of 2 to 8 MPa. A packer may be placed so that specific levels can be treated several times, if required. This type of grouting is mostly used in buildings with higher number of storeys as it needs more load to be carried down to the foundation.



3.4.2.5 Type of grouting method used

The type of grouting method used on the construction site is Type A. This type of method is used because it is the easiest and fastest method comparing to the other methods. This method simply takes a short time to accomplish and wasting time is never an option in the construction industry.

3.4.3 Drilling Methods

The drilling method is selected on one main reason which is to reduce damage and minimal disturbance to the ground and nearby structures. It is also important to achieve the required drilling performance. In all drilling methods, drilling fluid is used as a coolant for the drill bit and as a flushing medium to remove the drill cuttings. Water is the most common drilling fluid compared to other drilling fluid such as drill slurries, polymer, foam and bentonite. Another type of flushing medium is using compressed air which is used on this construction site. There are generally 6 drilling methods and these are:

1. Single-tube Advancement-external flush (wash boring)
2. Rotary Duplex
3. Rotary Percussive Duplex (concentric)
4. Rotary Percussive Duplex (down-the-hole-hammer)
5. Double Head Duplex
6. Hollow-Stem Auger

3.4.3.1 Type of drill method used on the construction site

The type of drill method use on the construction site's micropiling work is the Rotary Percussive Duplex (Down-the-Hole Hammer). This method is originally known as the Overburden Drilling Eccentric (ODEX) system, this method involves the use of rotary percussive drilling combined with an eccentric under-reaming bit. The eccentric bit undercuts the drill casing, which then can be pushed into the oversized drill hole with much less rotational energy or thrust than is required with the concentric method. In addition, the drill casing does not require an expensive cutting shoe and suffers less wear and abrasion.

This type of drill method is used and picked because cutting shoes are very expensive so this type of method is to save cost and also time.

CHAPTER 4

METHOD STATEMENT FOR MICROPILING WORK

4.1 Method Statement

Step No.	Work Done	Picture or Diagram	Workers	Equipments and plants	Description
1	Setting Piling Points		1-2 skilled workers 3-5 unskilled workers	Electronic Distance Measurement (EDM)	The piling point sequence is from le right and top to bott as stated by the mai contractor

2	Boring/ drilling work	 	4-5 skilled workers	Micropiling Boring (Holy HDM-CD120) Mobile Crane Air compressor Unit (Atlas Copco XRVS 345) Welding equipments and Gas metal Cutter	The boring work has to follow an important step by step sequence of work: 1. Installation of steel casing on drill rod 2. Drill to a certain depths 3. Adding of drill rod and steel casing by the method of welding 4. Repeat step 2 and step 3 until it reaches a certain required depths

3	Placing of API pipe reinforcement	 	3 skilled workers	Mobile Crane Welding Equipments and Gas metal Cutter	Steps included : 1. API pipe is cut to the required length 2. API pipe is lowered using mobile crane 3. To centralize the API pipe, a 'Spacer Block' is welded onto the pipe so that it achieves maximum concrete cover later in the grouting process

4	Grouting	 	2- 3 skilled workers	Grout Mixer Grout pump *Rockdrill TGP-120	The grout is mixed using the grout mixer during the placing of the API pipes. The grout is then pumped into the boreholes using the grout pump

5	Removal of steel Casing		2-3 semi-skilled workers	Mobile Crane	The steel Casings a finally extracted 1 b until no more are le the boreholes so tha grout mixture can c a firmer ground foundation.
6	Records for piling work		1 semi-skilled worker		Piling work are recorded as works c progress and duly signed and endorse every day by the Si Officer representati

7	Load test	 	3 skilled workers	Mobile Crane Hydraulic Jack with reading meters	Readings shall be taken to an accuracy of 0.025 mm (0.001") and the dial gauge must have a travel distance of not less than 50 mm (2")

CHAPTER 5

CONCLUSION AND RECOMENDATION

5.1 CONCLUSION

Micropiles has been used throughout the world as a means of a more stable and better foundations to many buildings. It can be used as both normal foundation piles and compensation piles for remedial or improvement works, especially in area with soil problems and site constraints. Micropiles have very unique features that allow it to be chosen as the piling system that is used on this site.

Micropiles can drill through hard surfaced rocks and soil to achieve a desired hole for reinforcements and grout that is why it was chosen for the piling work at the site. The ground surface is very hard and has a lot of friction and normal piling method will not work and even might damage the normal pile driver.

Choosing the right drilling method is very important in using the micropile. The right choice of drilling method connects back to the type of soil on the construction site. Percussion drilling technique can be applied in most micropile construction except in sensitive ground, particularly in a cohensionless soil such as the one on the site that is why rotary percussive drilling was recommended with temporary casings on this site. This method is very useful because it helps prevents the downfall and collapsing of the surrounding soil and reduce ground movement.

All in all, micropile is the best solution for piling although it is not the cheapest type of piling. Micropile saves a lot of time for drilling which 1 piling point only takes a maximum of 1 hour 45 minutes to complete, thus saving more time for future works.

5.2 RECOMMENDATION

There are various recommendations that the writer considered useful for future micropiling work to achieve the best outcome, the 2 best examples are the API pipes and the drilling rig that the writer explains on how it can achieve better results.

5.2.1 API (American Petroleum Industry) pipes

The API pipe is used for the reinforcement for the pile work. The API pipes used for this site are in total of 12 meters. However the API pipes that were used on the site only come in 9 meter for 1 piece of API pipe. Whereas the extra 3 meters will have to be cut from the other pipes and welded onto the original 9 meter pipe. This method is very time wasting and my recommendation is that it can be changed in the future where a full 12 meter of API pipes can be used. By doing this, it will save a lot of time from the cutting of the pipe and the welding work that is needed to be done. A full 12 meter pipe can be used spacer blocks can be welded and it can just slide into the borehole without any problem.

Photo 4.1.1

Shows the section of the API pipe which was cut to achieve a 12 meter pipe

Photo credit : Najib

(16 January 2012)

If a 9 meter pipe was used, apart from the time consuming, it can also be a problem if for example an accident occur and the pipe suddenly falls down the hole without the extra 3 meters. It cannot be retrievable anymore. This can also result in failure of the piling work and also money costing.

5.2.2 The drilling rig

The drilling rig is the rig used to drill the holes to install the API pipes. The main problem of the type of the drilling rig used on this site is the size of it. The size of the rig is fairly small which is only 10 meters high and the amount of time to drill using the casing takes fairly longer. If a bigger drilling rig is used on the site, the amount of time can be saved can be reduced to even half the time originally used. Bigger rig means it can carry bigger steel casing and thus reducing the time needed to weld the casings. Bigger drilling rig also helps reduce the cost from the oil used to run the machine. Bigger machines saves time thus saving cost for the whole piling work.

Also the amount of drill rigs can also be raised to save more time on the site. For this piling work, only a total of 3 rigs were used for the piling work. More rigs can be used to save time and money for the future. Maybe 2 or 3 more rigs could help improve the timing of the project. 1 rig can drill an amount of 4 to 5 boreholes per day and 3 can drill a total of 12 to 15.However if 5 were used, it might be possible to drill up to 20 to 25 holes per day and saving a huge amount of time for the whole project.

Reference

1. Ir. Liew Shaw Shong & Fong Chew Chung Gue & Partners Sdn. Bhd, 2003, Design Construction of Micropiles, Kuala Lumpur, Malaysia.