DEPARTMENT OF BUILDING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

METHOD CONSTRUCTION OF PRE-BORE SPUN PILE

Prepared by:

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DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

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(PERAK)

DECEMBER 2018

It is recommended that the report of this practical training provided

by

Nor Sharfieza Binti Nor Shamsul

2016618004

entitled

Method Construction of Pre-bore Spun Pile

be accepted in partial fulfillment of the requirement for obtaining the Diploma In Building.

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STUDENT'S DECLARATION

I hereby declare that this report is my own work, except for extract and summaries for which the original references are stated herein, prepared during a practical training session that I underwent at Nadi Cergas Sdn Bhd for a duration of 14 weeks starting from 3 September 2018 and ended on 7 December 2018. It is submitted as one of the prerequisite requirements of DBG307 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

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Date : 16/12/18

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I would also like to thank all the UiTM lecturers that have taught and nurtured me in becoming a better student and person. I would like to extend my deepest appreciation to the lecturers who are directly involved during my training stint. To En Mohamad Hamdan Bin Othman, supervising lecturer, En. Muhammad Naim Bin Mahyuddin, Practical Training Coordinator and Dr. Dzulkarnaen Bin Ismail as Programme Coordinator, I value the time, effort, encouragement and ideas that they have contributed towards the successful completion of my training, this report and the valuable knowledge that have been shared over the last few semesters.

Last but not least, my special thanks to my beloved parents for their sacrifices over the years.

Thank you so much.

ABSTRACT

Piling works is crucial element and structure that build underneath ground. Behind the glorious building, there is always have an element and structure underground that hold loads of the glorious building. People will mostly forgot on how important piling works are to a building or structure, therefore this report will discuss about piling in details. This report was conducted for the Practical Training report The objective of this report is to discover the construction method of pre-bore spun pile piling process and describe factor and causes using pre-bore spun pile piling method. It will focus on method construction of pre-bore spun pile based on the project proposed. To illustrate the pre-bore spun pile as an important aspect to focus on building, observation and research has been done to evaluate how far the pre-bore spun piles quality and effectiveness. This report will also look at the factors and effect on choosing pre-bore spun piles for this project. Piles are essential component for many construction projects because they can provide a strong, stiff foundation for a structure regardless of soil quality or harsh environment

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CHAPTER 1.0

INTRODUCTION

1.1 Background and Scope of Study

First and foremost, the study has been done at one of the Nadi Cergas Sdn Bhd's project which is *Pusat Kardiologi, Hospital Serdang*. They are now have been building a 8 storey of Cardiology Block and 9 storey car park block with M&E room. They build block since they need to cop all the Bangi and Serdang area with a great amount of patient and vehicle.

Since the project mostly use precast substructure, this study will be more concentrated on the method construction of pre-bore spun pile piling process using injection method based on area site which is located near hospital. This also explain about the factors influence the type of deep foundation as a chosen method in this project. In this case, this report will briefly explain about the piling method that is being used on the site including the machineries and materials involved.

Through this report, it will be stated a lot of machineries that is being used which only can be discovered on site. Other than that, it will also show a different amount of manpower required in certain job or task in construction method in Chapter 3.

1.2 Objectives

In the proposed study, the objectives are to gain more detail about pre-bore spun pile process and procedure. Therefore, the objectives of this study are:

1. To describe factor and causes using pre-bore spun pile piling method.
2. To discover the method of construction of pre-bore spun pile piling process.
3. To explain the types of testing involved to ensure the piles achieve its integrity, settlement and bearing capacity.

1.3 Method of study

In obtaining data required through out 3 months, there are several research method conducted on site of Pusat Kardiologi Hospital Serdang, Selangor.

1.3.1 Primary source

i. Interviews

Unstructured interviews has been done during practical which when on site by asking questions to resident engineer, surveyor, project engineer, site agent and supervisors on site. Structured interviews also has done in the resident engineer's site office, Pusat Kardiologi Hospital Serdang. He has helped in explaining regarding the method used, the process involved and how the construction started. Both interviews were recorded by writing short notes, pictures and video recorder.

ii. Observation

Observation was made during 3 months of practical specifically on method of construction of pre-bore spun pile piling process and the type of machineries and equipment used for pre-bore spun pile piling process on site. This observation was recorded by writing short notes, took pictures and video recording.

iii. Document reviews

Other methods that are used to collect data for this report are document reviews. This has been done with project engineer, QAQC engineer, surveyor and resident engineer such as layout plan, piling plan, pile cap details and column schedule on site.

1.3.2 Secondary source

i. Book

Book has been the major reference in completing this case study. It enable to find regarding the foundations, piling process and more. Book can be used to obtain more information about type of pile and installation of pile. All of the books are available at the website Google books and borrowed from engineers and seniors.

ii. Desk study

Several of the case study for the construction of pre-bore spun pile are from the piling layout plan and piling details of project at the site office.

iii. Internet

Other than that, internet also has been used to obtain more information about pre-bore spun pile. There are several websites that have been used as shown in references.

CHAPTER 2.0

COMPANY PROFILE

2.1 Introduction of Company

NADICERGAS
SENDIRIAN BERHAD (243249-U)

Nadi Cergas Sdn Bhd are an established construction company based in Petaling Jaya since 1999. The company has show their intergrity as evidenced by its extraordinary track record. By dint of professionalism and perseverance, its personnel have forged a reputation for excellence.

Nadi Cergas Sdn. Bhd. has been able to diversify its businesses aggressively. Presently, its spectrum of activities encompasses concessions and utilities. Its main source is construction but they are moving forward, construction and property development will go hand in hand.

Inspired by visionary leadership, Nadi Cergas Sdn. Bhd. has always search promising business opportunities. Its management team has enabled it to overcome the many challenges that have made it a more unified and resourceful organization. Guided by its corporate vision, Nadi Cergas Sdn. Bhd. continues to forge ahead in order to fulfill its true potential. (nadicergas.com, 2018)

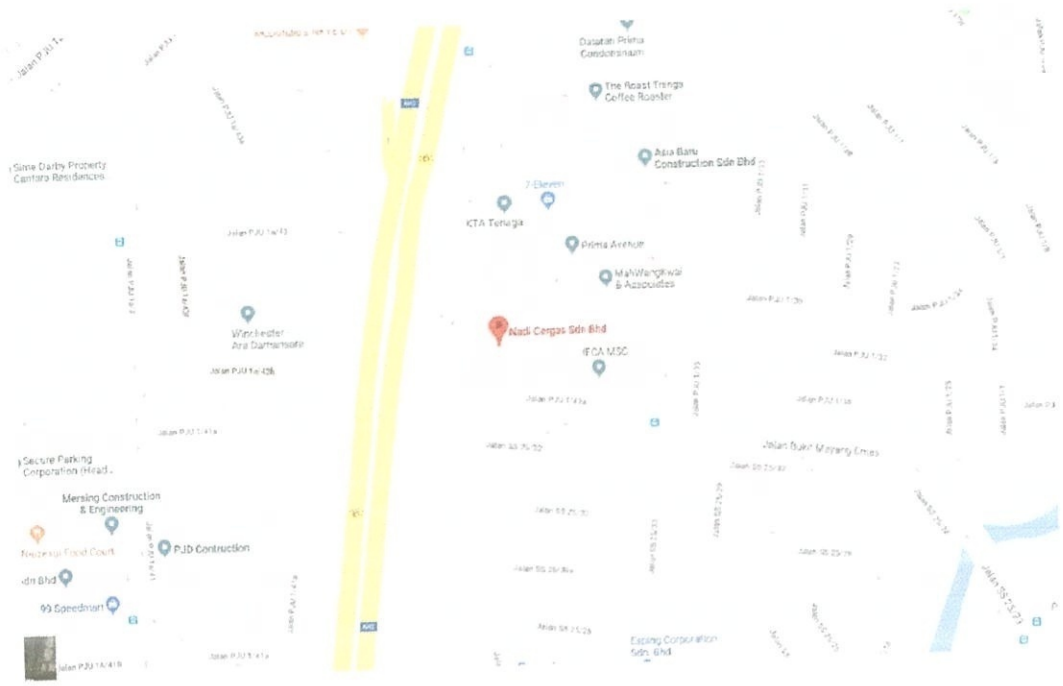

Figure 2.1 : Location of Nadi Cergas Sdn Bhd office

Source: Google Map

Figure 2.2 : Nadi Cergas Sdn Bhd building view

Source: Google Street

2.1.1 Vision & Mission of Company

a) Vision

To become a dynamic and progressive industry leader that is astutely managed in order to provide state of the art technology which benefits society. (nadicergas.com, 2018)

b) Mission

To achieve optimum returns for our stakeholders in the area of concession, construction, property development and utility. (nadicergas.com, 2018)

2.2 Company Profile

Board of directors

HAJI WAN AZMAN BIN WAN KAMAL

Hj Wan Azman Bin Wan Kamal, 56 years old is the Group Managing Director in Nadi Cergas Sdn Bhd. He was appointed on board in 2017. With Diploma in Quantity Surveying, he has been a Registered Quantity Surveyor of the Board of Quantity Surveyors Malaysia since 1990 and a Member of the Institute of Surveyors Malaysia since 1995. He has a great experience in property development and construction industry with approximately 35 years.

As Group Managing Director, he has been the role in the growth and development. He is responsible for the strategic direction of Nadi Cergas Sdn Bhd including the implementation of future plans and strategies, property development segment of business. (nadicergas.com, 2018)

DATO' SRI SUBAHAN BIN KAMAL

Dato' Sri Subahan Bin Kamal aged 52 is Executive Director. He was appointed to our Board on 15 September 2017. He graduated in 1989 from the Southern Illinois University at Carbondale, USA with a Bachelor of Science Honors Degree in Finance. He also holds a Certificate of Marine Cargo Technical Claims and a Certificate of Liability Insurance from the Malaysian Insurance Institute, both of which were obtained in 1989.

Dato' Sri Subahan actively contributes a lot to society in various capacities, in polics, economis especially sports and education. He was appointed as the Deputy President of the Football Association of Malaysia in 2017 and the President of the Malaysia Hockey Confederation in 2015, positions which he continues to hold till today. He has also been appointed as a member of the Advisory Board of Quest International University since 2014, and a member of the Curriculum Advisory Board of University Institute Technology, MARA since 2013. Dato' Sri Subahan also sits on the board of Can-One Berhad, and The New Straits Times Press (Malaysia) Bhd, and several other private companies. (nadicergas.com, 2018)

2.3 Organization Chart

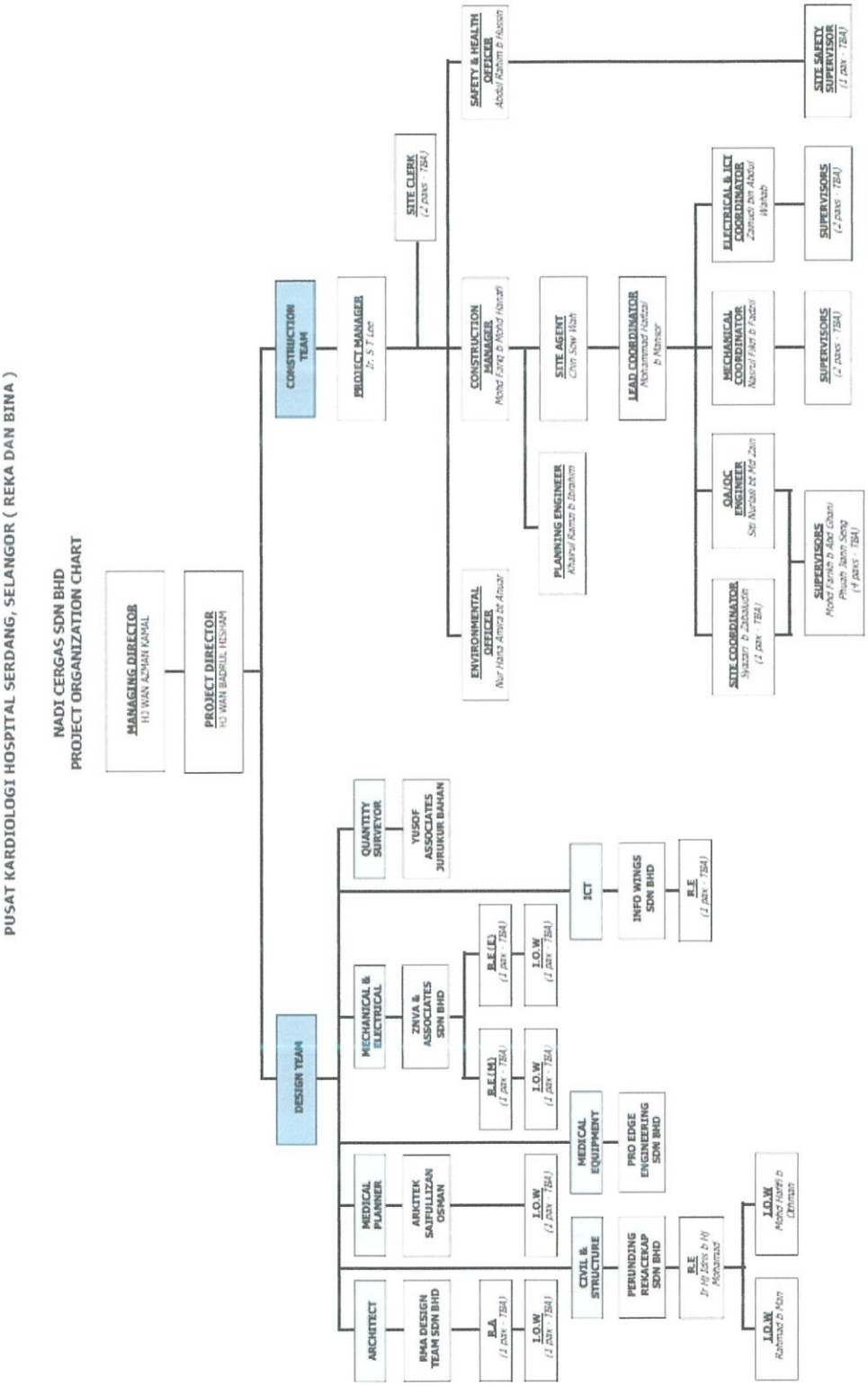

Figure 2.3 Organization Chart of Hospital Serdang project

Source: Pusat Kardiologi, Hospital Serdang

2.3.1 Company's Background

Table 2.1 Company background

Name	NADI CERGAS SDN BHD
Company registered	26 Jun 1992
Business address	F-1 @ 8 Suria, 33 Jalan PJU 1/42, 47301, Petaling Jaya, Selangor
Tel	
Fax	
Email	hq@nadicergas.com

2.4 List of project

2.4.1 Completed projects

Table 2.2 List of completed project

No	Project	Project title	Client	Date completed
1	UTEM	Design, Build and Maintain Student Hostels and Related Facilities and Infrastructure to Accommodate 5,000 Students through Private Finance Initiative (PFI).	UTEM	2016
2	Polytechnic project	Design, Construction and Completion of Student Hostels to Accommodate a Total of 10,000 Students in Seven Polytechnics in Various States of Peninsular Malaysia	MARA	2014
3	UIAM, Kuantan.	Design, Build and Maintain Student Hostels and Related Facilities and Infrastructure to Accommodate 5,000 Students through Private Finance Initiative (PFI)	UIAM	2015
4	GMI, Bangi.	Design, Construction and Completion of a New Campus for German-Malaysian Institute	GMI	2015
5	MIAT, Subang.	Construction and Completion of Aircraft Hangars and Academic Buildings for UniKL MIAT	MIAT	2016

2.4.2 Project in Progress

Table 2.3 List of on-going project

No	Project	Project title	Client	Expected year of completion
1	Antara Residence	Design, Construction and Completion of 1 block with 29 storeys residence	Putrajaya Holdings	2021
2	MRSM Bagan Datuk	Design, Construction and Completion of Student Hostels	MARA	2021
3	Pusat Kardiologi, Hospital Serdang	Design, Construction and Completion of Construction of cardiology centre	Kementerian Kesihatan Malaysia	2021

CHAPTER 3

CASE STUDY

3.1 Introduction of Project

The study has been done at one of the Nadi Cergas Sdn Bhd's project which is Cardiology Block, Hospital Serdang. The project is to design construct and built a building of 8 storey Cardiology Block and 9 storey car park block with M&E room. The Heart Center Project, Serdang Hospital will be implemented within the existing Serdang Hospital area. The Site Budget allocated for this project is 17,758 square meters. Located next to the South Klang Valley Expressway (SKVE).

The proposed project implementation of the Centre for Cardiology, Serdang Hospital was approved by the Economic Planning Unit, Prime Minister's Department under the 4th Malaysia Plan's 4th Rolling Plan. Serdang Hospital has been identified as the National Centre for Cardiology Reference where the hospital will receive referral cases from the Peninsular, Sabah and Sarawak. The mission of Ministry of Health (MOH) to provide a high quality health system, the construction of the Heart Centre (Cardiology Centre) will be the One Stop Centre for all heart treatment services to cater for the next 10 year's patient needs. The objective of this project is (a) To provide an adequate, effective and efficient one stop centre for Cardiology Service (b) To provide comfortable and well equipped equipment for the benefits of the patients. (c) To provide adequate accommodation for the staff (d) To reduce waiting time for Cardiology services. Other than that, is to cater all the Bangi and Serdang area with a great amount of patient and vehicles. Before this, Hospital Serdang faced a great problem with people park along the street causing a terrible jam.

Figure 3.1 The location of Pusat Kardiologi Hospital Serdang

Source: EMP Hospital Serdang

Roughly, this project is costed nearly RM300 Million. The duration of the construction contract and the completion of this project are 3 years starting from 6th March 2018 and expected to complete on 1st March 2021. There are several parties involved in this project which is Jabatan Kerja Raya as the Project Director, Kementerian Kesihatan Malaysia as their client and the contractor responsible to accomplish this project is Nadi Cergas Sdn Bhd along with others, RMA Design Team as Architect Consultant, Yusof Associates as QS Consultant, Perunding Reka Cekap as C&S Consultant, ZNVA Associates as M&E Consultant, and lastly, Pro Edge Engineering as Medical Arrangement Consultant. The construction mostly use precast item and IBS system starting from the substructure to superstructure including piling works, beams, slabs, wall and staircases. This is because the project need to complete in limited time, avoid great delay, failures and achieve pleasure aesthetic.

Pusat Kardiologi Hospital Serdang has started several activities such as preliminaries activities, hoarding, setting out, construct retaining wall and piling works. In this project, there several responsible person which need to handle the piling work specifacally. There are Mr Lee Say Tuang as Project Manager, Mr Mohd Fariq Mohd Hanafi as Construction Manager, Mr Chin Sow Wah as Site agent, Mr Syazari Zabaludin as Project Engineer in C&S, Mr Puah Jien Seng a C&S Supervisor and Mohd Hizir Ismail as Inspector of work. They are among responsible persons in the piling process of any problems on the site. In this case study, it will focus on the method construction of pre-bore spun pile due to achieve easy and fast completion, save cost and to avoid noise as it is near hospital.

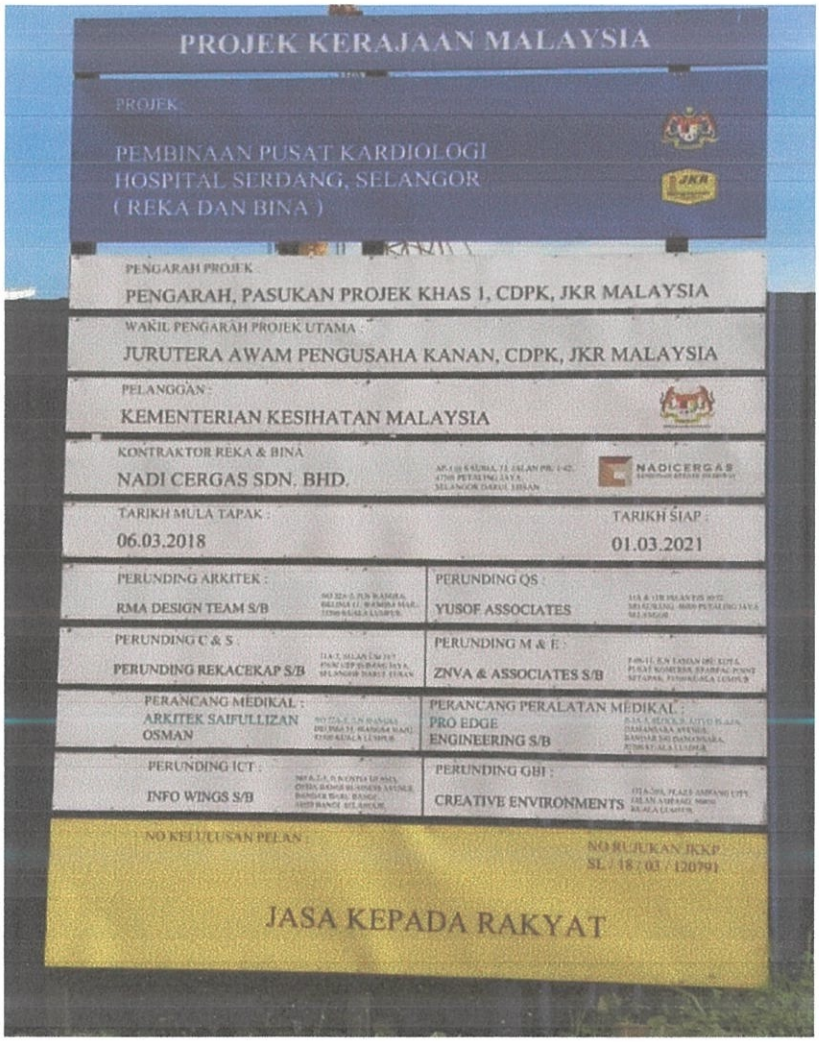

Figure 3.2 : The Project Signboard

Figure 3.3 The site environment and view

3.2 Introduction of Foundation

3.2.1 Introduction of foundation

Foundation is the lowest part of the building or sub- structure that is in direct contact with the soil which transfers loads from the structure to the soil safely. Basically, it is a structure that transfers its gravity loads to the earth, from the top of building flow through the structure and straight to the sub-structure and transfer it to the ground.

Based on theconstructor.org site, the purpose of foundations are provided for all load carrying structure for following purposes: (a) Foundation are the main reason behind the stability of any structure. The stronger is the foundation, more stable is the structure. (b) The proper design and construction of foundations provide a proper surface for the development of the substructure in a proper level and over a firm bed. (c) Specially designed foundation helps in avoiding the lateral movements of the supporting material. (d) A proper foundation distributes load on to the surface of the bed uniformly. This uniform transfer helps in avoiding unequal settlement of the building. Differential settlement is an undesirable building effect. e) The foundation serves the purpose of completely distributing the load from the structure over a large base area and then to the soil underneath. This load transferred to the soil should be within the allowable bearing capacity of the soil.

3.2.2 Functions of Foundation in Construction

The main functions of the foundation based on theconstructor.org site is as shown below:

1. Provide overall lateral stability for the structure
2. Foundation serve the function of providing a level surface for the construction of substructure
3. Load Distribution is carried out evenly
4. The load intensity is reduced to be within the safe bearing capacity of the soil
5. The soil movement effect is resisted and prevented

3.2.3 Types of foundation

There are 2 types of foundation which is shallow foundation and deep foundation. Shallow foundations has include pads ('isolated footings'), strip footings and rafts while deep foundations include piles, pile walls, diaphragm walls and caissons. Shallow foundations are those founded less than the width of the footing and less than 3m. Basically, if surface loading or other surface conditions will affect the bearing capacity of a foundation it is 'shallow'. Shallow foundations include pads ('isolated footings'), strip footings and rafts. Shallows foundations are used when surface soils are sufficiently strong and stiff to support the loads. Deep foundations are those founding too deeply below the finished ground surface for their base bearing capacity to be affected by surface conditions, this is usually at depths more than 3 m below finished ground level. They include piles, piers and caissons or compensated foundations using deep basements and also deep pad or strip foundations. Deep foundations can be used to transfer the loading to a deeper, more competent strata at depth if unsuitable soils are present near the surface.

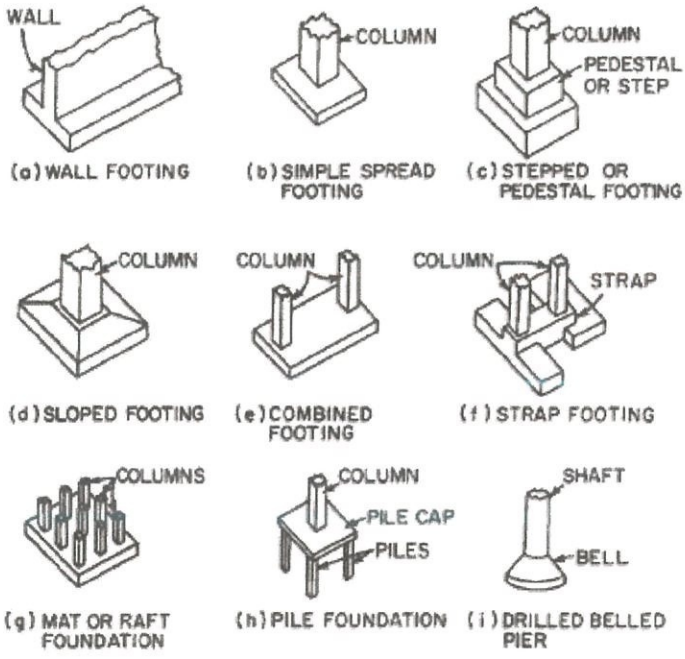

Figure 3.4 Common types of foundation

Source: Google

3.2.4 Requirements of a Good Foundation

The design and the construction of foundation must not be ignored. If they are not well taken, it might give a bad results on a building in a future. theconstructor.org site have brief some of the requirements that need to be taken they are:

1. The design and the construction of the foundation is done such that it can sustain as well as transmit the dead and the imposed loads to the soil. This transfer has to be carried out without resulting in any form of settlement that can result in any form of stability issues for the structure.
2. Differential settlements can be avoided by having a rigid base for the foundation. These issues are more pronounced in areas where the superimposed loads are not uniform in nature.
3. Based on the soil and area it is recommended to have a deeper foundation so that it can guard any form of damage or distress. These are mainly caused due to the problem of shrinkage and swelling because of temperature changes.
4. The location of the foundation chosen must be an area that is not affected or influenced by future works or factors.

3.3 Introduction of case study

3.3.1 Deep foundations – Piles and Drilled Shafts

Piles are structural members made of steel, concrete or timber. They are used to build pile foundations which are deep ad more costly than shallow foundations. Despite the cost, the use of piles is often to ensure structural safety. Drilled shafts are cast in place piles that generally have diameter greater than 750mm with or without steel reinforcement and with or without an enlarged bottom. (Braja M Das, 2000)

Pile foundation are deep foundation. The method construction of pile for this project is made entirely of pre-bore spun pile which is under deep foundation category. It use for Cardiology Block and Multilevel Car park for Hospital Serdang the reason of choosing this method will be explained in Chapter 3.5. All type of spun piles shall be manufactured by SIRIM's approved plant and manufacturer. The spun piles need to comply with specification note shown in the drawing provided. There are 3 size of spun pile used in this project which is 400mm, 500mm, & 600mm based on Soil Investigation proposed. All these 3 type of spun piles were manufactured and delivered by ICP Piles.

Figure 3.5 Jacked in machine

Figure 3.6 Photo of spun pile of various size at site

Figure 3.7 Photo of pointed pile shoe (starter) of spun pile

Figure 3.8 shows the specifications of spun pile

Figure 3.9 Crawler crane use to lift spun pile from the trailer truck delivered on site.

3.4 Factor and cause of using Pre-bore Spun Pile

3.4.1 Factor of using Pre-bore Spun Pile

Different circumstances need a different pile foundation. In this case, the are several reason on why *Pusat Kardiologi Hospital Serdang* use pre-bore spun pile:

i. The upper soil is highly compressible and weak to support load transmitted by superstructure. When there is no bed rock, the load will gradually transmitted to soil.

ii. The soils at the site of proposed structure may be expensive and collapsible. With 8 storey of Cardiology Block and 9 storey car park block , they need a great depth to transmit load to a stable soil.

iii. To avoid any extreme noise occur which might danger and disturb patients and public. Hammering method will produce extreme noise which is not suitable for hospital project. Instead of hammering method, *Pusat Kardiologi Hospital Serdang* chose pre-bore spun pile with injection method which are more environment friendly to patients and pubic.

iv. To save cost. Bored pile which cast in place is more expensive than pre-bore spun pile. Production of pre-bore spun pile are better in their quality and consistency. There is no need of labour cost needed in casting, concreting, bar bending, cutting bar and more. Indeed, only cost of machine operator and few piling workers need to be considered.

v. To save time. With pre-bore spun pile, time needed in casting, making pile and boring process will be cut. To compare between pre-bore spun pile and bore pile, pre-bore spun pile is much more easier and fast completion. Bore pile need time to drilling, insert casing, insert steel reinforcement, concrete pouring with tremie pipe and casing retraction. It is more complicated when the piling process is in rainy season.

3.4.2 Causes of using pre-bore spun pile

Based on the data taken, there are some causes of using pre-bore spun pile for this project, Pusat Kardiologi, Hospital Serdang:

i. Efficient installation and clean working area

The spun pile are manufactured and cast off-site which allows for efficient installation once the piles delivered on site and ensuring a clean working space without casing needed and steel reinforcement placement on site. The installation also usually produces little spoil for removal and disposal which really efficient in maintaining clean environment.

ii. Cost-effective

They are cost-effective as wide variety of materials, shapes, diameter ad length which can be easily fabricated to specified dimensions according to the client. In this case, parties can maintain quality control of piles which can result in the need for fewer piles used on site. Other than that, extension of time for one's project can be reduced with fast completion and effective.

iii. Higher bearing capacity of the pile

Pre-bore spun piles could receive great amount of bearing capacity of pile. The bearing capacity can be calculated from the maximum average contact pressure between the foundation and the soil that would not produce shear failure, which in this case, the spun pile will be driven into stiffer and deeper layer with higher bearing capacity.

iv. Quitter environment and working method. In this way, it will not effect the public and patients in the hospital.

3.5 Method of construction of Pre-bore Spun Pile

1. Setting out of pile locations

The pile position is set out by surveyor using digital theodolite on site. 2 reference pegs tie with barricade tape would be installed equidistant from the pile centre location pin (about 500mm away). The pile would then be pitched and positioned into the exact pile position by the chainman such that reference peg are equidistant from the pile face.

Figure 3.10 Surveyor conducted setting out of pile location for Main Block of Cardiology Block, Hospital Serdang.

2. Boring process

The pre-bore drive (auger) parked next to the pile point location which has been set up by surveyor. The crawler moved and pitched the auger on pile point by operator. The vertically is controlled by levelling ruler putting on the stem of auger. The auger is checked by operator and workers itself to ensure the right point. Then, the operator set in rotating. 50mm bigger than the size of pile was bored. The auger penetrate into the soil and remove the spoil to the surface using hoe. The spoil from the hole was removed immediately spontaneous when it is come out by the worker. This will prevent the auger from choking. Operation was terminate when required depth achieved. (Length was adjust and suit on site to achieve minimum length)

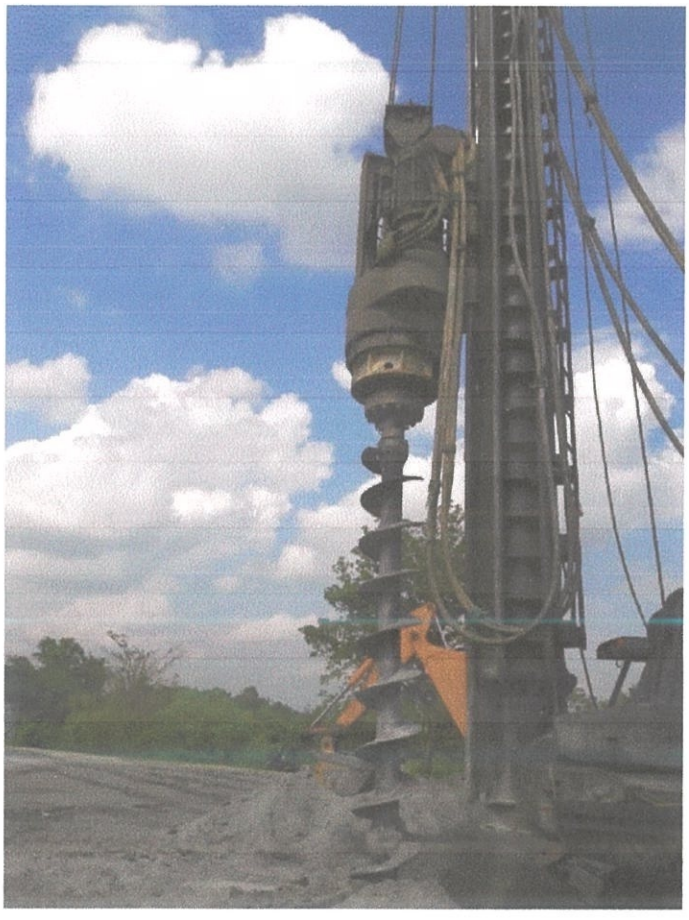

Figure 3.11 Pre-bore auger drive boring the pile location.

3. Handling and lifting pile

During installation the vertically of pile, will continuously monitored and plumbed to ensure the pile is centrally located to prevent pile whip, twist or rotate. Each has been marked by red ink or paint 1m along pile length to enable the jacked in pressure record at every 1m penetration.

Figure 3.12 Worker measuring and paint spun pile size 600mm with 1m each along the pile with red paint.

Figure 3.13 The result of painted 600mm spun pile.

4. Installation of pile

The vertically support structure of jacked-in machine was plumbed to ensure the vertical means. 600mm pile was lifted and inserted into the equipment as shown in 3.5. The pile was placed into the grip of jacked-in machine to grip the pile body and ensure the starter (pointed shoe) at the bottom. The hydraulic pressure of main jacks measured by the pressure gauge and corresponding pile penetration are recorded by staff. The 600mm pile may need extra pile by means of welding. Each pile is jacked in until required penetration reached. Extended pile portion above ground was cut by pile cutter to enable movement of rig.

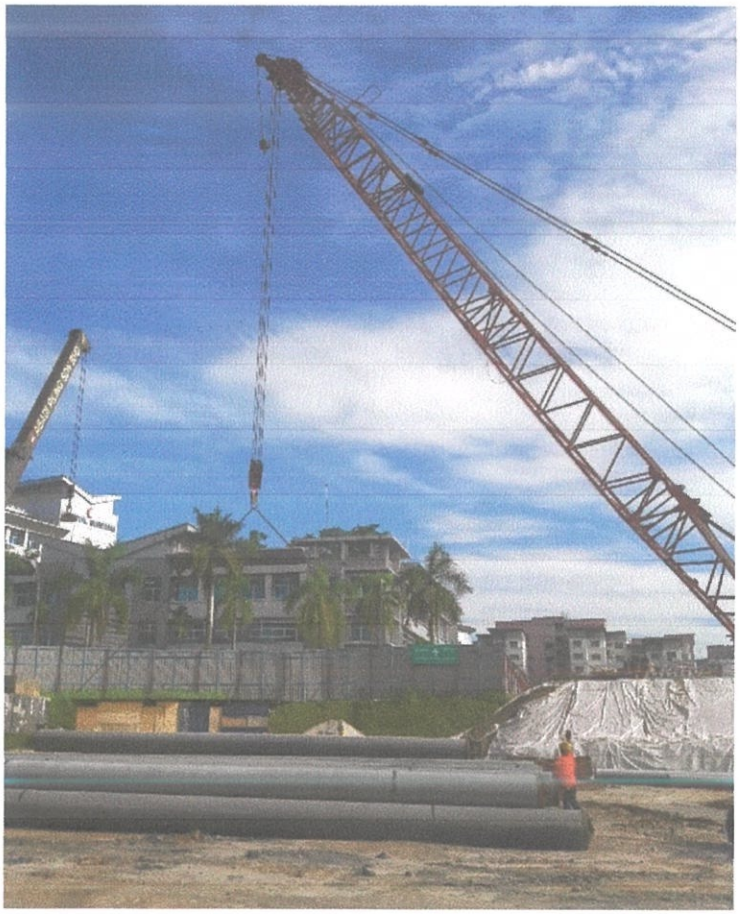

Figure 3.14 Spun piles are placed from another location to near pile location to ease the process.

Figure 3.15 The installation of 600mm diameter spun pile into jacked-in machine 10 using 6 cylinder.

Figure 3.16 Welding process of extended 600mm spun pile

5. **Set criteria**

Graph paper was paste on 'dolly' surface to take set record. When pile has achieved its bearing capacity, specified attention was done on recording the pile pressure set by holding the setting jacking for 30 seconds as set criteria. 3 set reading was taken. This process was checked by inspector of work and supervisor to ensure the set criteria achieved sincerely.

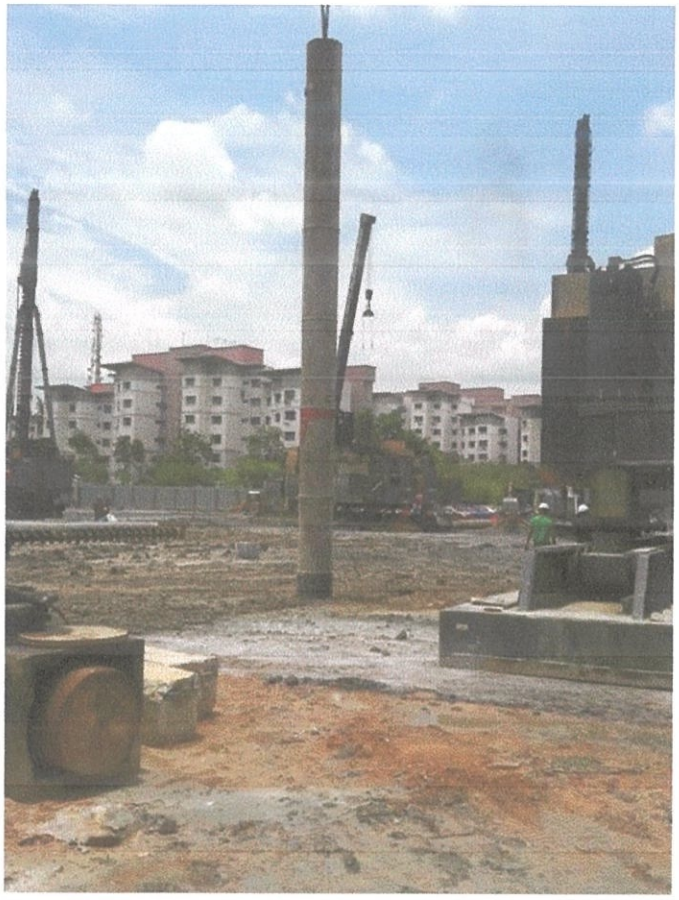

Figure 3.17 The jacked-in machine lifted 'dolly' into the grip to conduct set criteria.

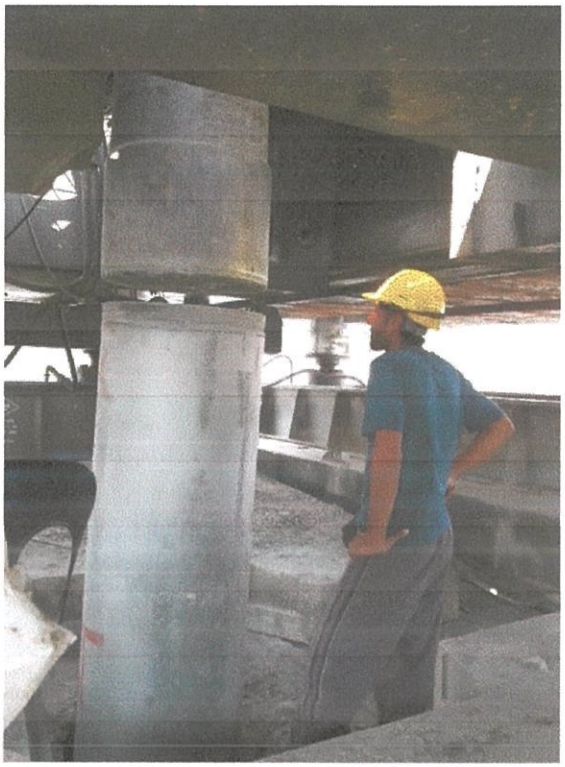

Figure 3.18 The 'dolly' was gripped by the jacked-in machine and ready to push the 600mm spun pile for set criteria process.

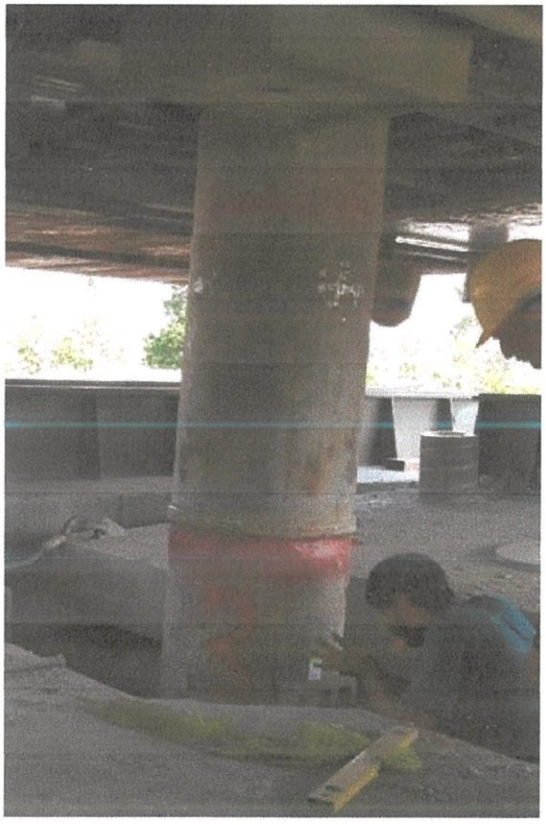

Figure 3.19 Set criteria was recorded by piling worker on graph paper.

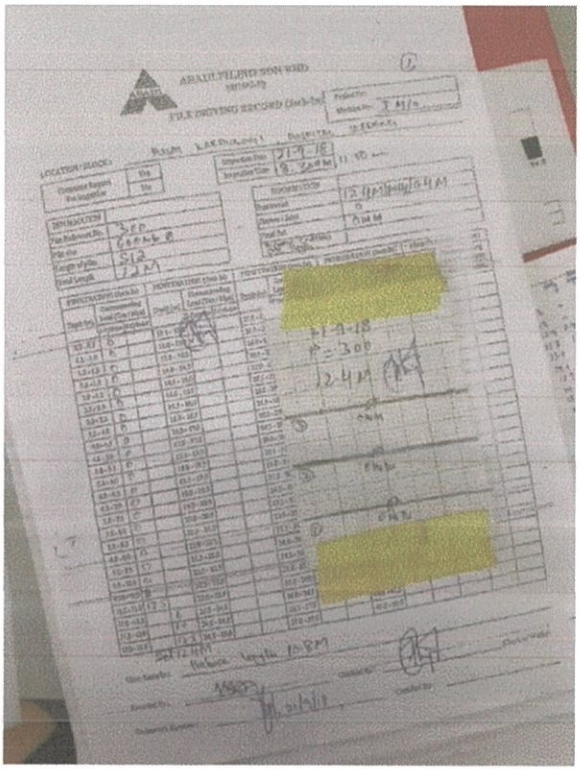

Figure 3.20 The example of pile driving record taken.

3.6 Type of pile testing

For this pre-bore spun pile method, 2 pile testing has been done which is Dynamic Load Test (PDA) and Static Load Test (SLT). Dynamic Load Test was done to detect any failure or defects on injected pile while Static Load Test was done to determine whether the settlement of injected pile achieved.

Based on Caltrans, Static Load Tests measure the response of a pile under an applied load and are the most accurate method for determining pile capacities. They can determine the ultimate failure load of a foundation pile and determine its capacity to support the load without excessive or continuous displacement. The purpose of such tests is to verify that the load capacity in the constructed pile is greater than the nominal resistance (Compression, Tension, Lateral, etc.) used in the design. The best results occur when pile load tests are performed in conjunction with Pile Dynamic Analysis (PDA). The tests give the Geoprofessional information needed to allow the use of a more "rational" foundation design. (Caltrans. 2018)

Static load tests may be recommended when piles are installed in soils with variable geologies or poor quality soils and can be used to validate design assumptions or to provide sufficient information to modify the design tip elevations. They provide more accurate information than can be obtained from pile driving formulas and may demonstrate that driven piles can be safely loaded beyond the capacities obtained from these formulas. (Caltrans. 2018)

For a safe foundation to perform as desired the ultimate strength of each pile must fulfill both structural and geotechnical limits present. A pile load test is a direct method of determining the ultimate geotechnical capacity of a pile. Dynamic load testing (PDA-measurement) is a fast and reliable way to evaluate the bearing capacity of a pile. In addition to pile capacity, the dynamic load test provides information about structural integrity, driving stresses and hammer efficiency. If a dynamic load test is out of the question then a static load test can be performed to identify the pile behavior under a static load. (Inspecta, 2018)

In challenging projects, a preliminary test pilling together with a dynamic load test can help you to pick the right pile type for the job, one which withstands the strains focused on the pile during driving. Guidelines usually give cautious end-of-driving requirements, which lead to unnecessarily long piles. With a PDA-measurement, it is possible to assign each pile rig with an individual end-of-driving requirement for a specific project and therefor cut the cost of overlong piles. (Inspecta. 2018)

3.6.1 Dynamic load testing (PDA)

This test was done on several pile which has odd result from piling record. Soil was excavated by using backhoe of 3 feet (1 meter) clear access for pile preparation. Pile head was levelled by surveyor and chainman by using dumpy level and staff. Then, tested pile was covered by timber cushion to protect by the impact of hammer drop first.

Dynamic pile testing was performed using a Pile Driving Analyser (PDA) at site and pile wave analysis was carried out on the signal acquired by using Case Pile Wave Analysis Program (CAPWAP). The sensitivity sensor was drilled on 600mm diameter tested pile and was checked before test performed.

After all hardware were fully functioned, the test pile parameter was keyed into pile driving analyser. Few hammer drop of 8 tonnes were taken at 1.2 metre by release of crawler crane. The hammer blows were continue until good signal was obtained. The cage was secured by backhoe. All signal taken were recorded (refer in Appendix) in pile driving analyser for further analysis by expert pile tester.

Figure 3.21 The worker prepare the hammer drop by means of welding.

Figure 3.22 The cage of hammer was lifted by crawler crane from one place to tested pile location.

Figure 3.23 Hammer drop was placed on tested pile and ready to be tested.

Figure 3.24 hammer drop cage secured by backhoe

Figure 3.25 Tested pile need to be covered by timber cushion.

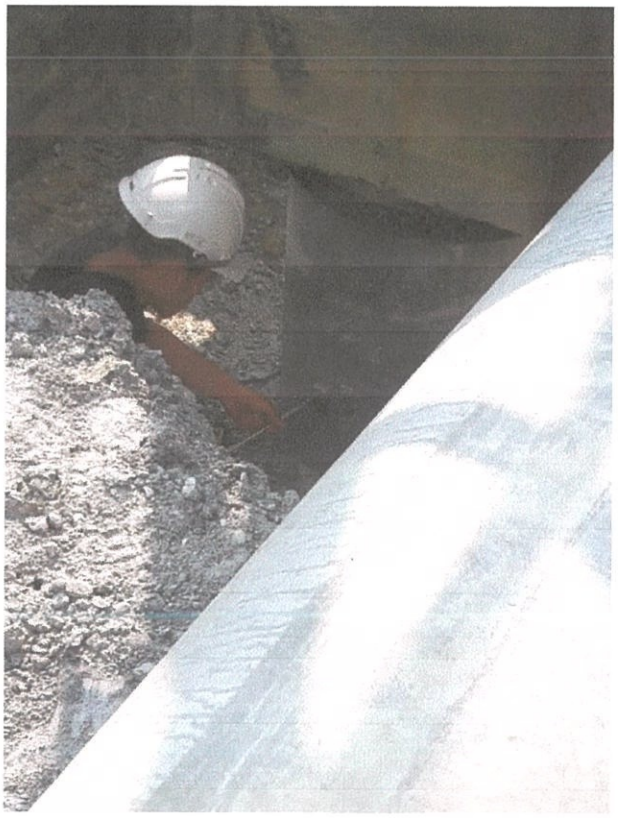

Figure 3.26 appropriate sizes of holes were drilled on the surface of tested pile of sensitivity sensor and connected to pile driving analyser.

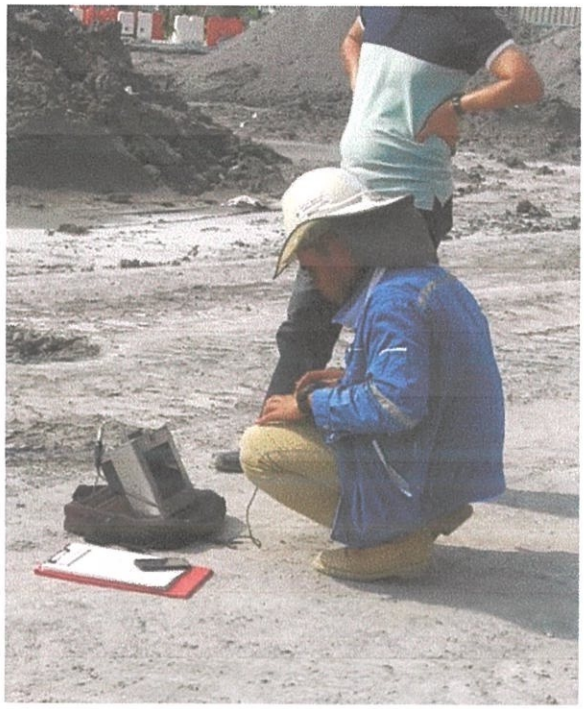

Figure 3.27 The field result was conducted by pile tester.

Figure 3.28 shows pile driving analyser.

6. Static Load Test

Load test was done on several pile which has odd result from piling record selected by S.O. Pile head was levelled by surveyor and chainman by using dumpy level and staff. The 600mm diameter pile head was cut to give a plane surface. A mild steel plate of sufficient thickness was mounted on top of the pile head to hold the load and settlement and to prevent due to concentrated of loaded equipment.

The test load was provided by heavy mass of dead load exceeding the maximum test load required. The distance from edge of tested pile to the nearest support to the kentledge stack in contact with ground was less than 1.3 meter.

Minimum reaction mass was taken and not less than 120%. The test was conducted for 3 days (66 hours) until the rate of settlement not exceeding 0.05mm (for result as shown Appendix)

Figure 3.29 SLT workers prepared welding equipment on tested pile

Figure 3.30 Hydraulic jack and loaded jack fitted with pressure gauge.

Figure 3.31 Pressure gauge

Figure 3.32 shows 2,220kN Maintained Load Test with loaded cells or block.

CHAPTER 4

CONCLUSION

At the end of this report, all of the objectives stated in Chapter 1 specifically in the Background and scope of study have been successfully achieved. All said objectives that had been achieved is based on the study and research on the site regarding on piling works which is the Method Construction of Pre-bore Spun Pile. Author clearly understand practically and detail regarding on piling process, material and machineries involved, the procedures taken, factor and causes using Pre-bore Spun Pile method which being carried out on the site of *Pusat Kardiologi, Hospital Serdang.*

Foundation is the major factor of good, strong and stiff structure or building. Specifically, in this case, Pre-bore Spun Pile is one of the element under deep foundation which is piling works will either gives positive or negative results. A proper and detail care to construct and install pile is a must to avoid any extra cost and time in installing additional pile if there is any defect of pile head, twisted or missed location when injecting pile. Besides, this method is ultimately significant as it will determine the overall strength of the building, especially the foundation itself. In addition, based on the study, author had the chance to learn about all the factors that have to be considered before choosing the types of piling that will be used on the site. This is due to the fact that the strength of soil differs from one another. Therefore, soil investigation is needed to be done ahead of time to ensure proper piling is correctly chosen.

A few pre-caution has been conducted from the beginning and the end of piling works. For example, all handling and lifting spun pile shall use uplifting sling which certified by SIRIM and ensure it hang on crane's hook properly and safe. All workers shall be far away from the crane 100m away to avoid any unwanted accident to workers. One of the main precautions that had taken at this project is the quality of spun pile delivered on site. Date cast of spun pile in factory must not more than 3 days within the delivery time. The spun pile need to be fresh

and not too set which will cause a long term problem, especially in a few years due to weakness of material used.

People don not often pay attention to its existence when it is transferring loads from a structure to the soil or bedrock safely and as planned. However, possible shortcomings in the pile design or implementation are easy to observe when settlement occurs. This project has done 2 method of pile testing which is Pile dynamic test (PDA) and Static Load Test (SLT). These 2 pile testing was done to ensure the integrity, bearing capacity, and settlement of pile. Unfortunately, at this point, if there is any defect occurs, correcting those shortcomings are already too late or at the very least, expensive.

It can be concluded that this case study has achieve all objectives stated in Chapter 1 which is (a) Discover the method construction of pre-bore spun pile piling process (b) Describe factor and causes using pre-bore spun pile piling method and (c) Explain the types of testing involved to ensure the piles achieve its integrity, settlement and bearing capacity.

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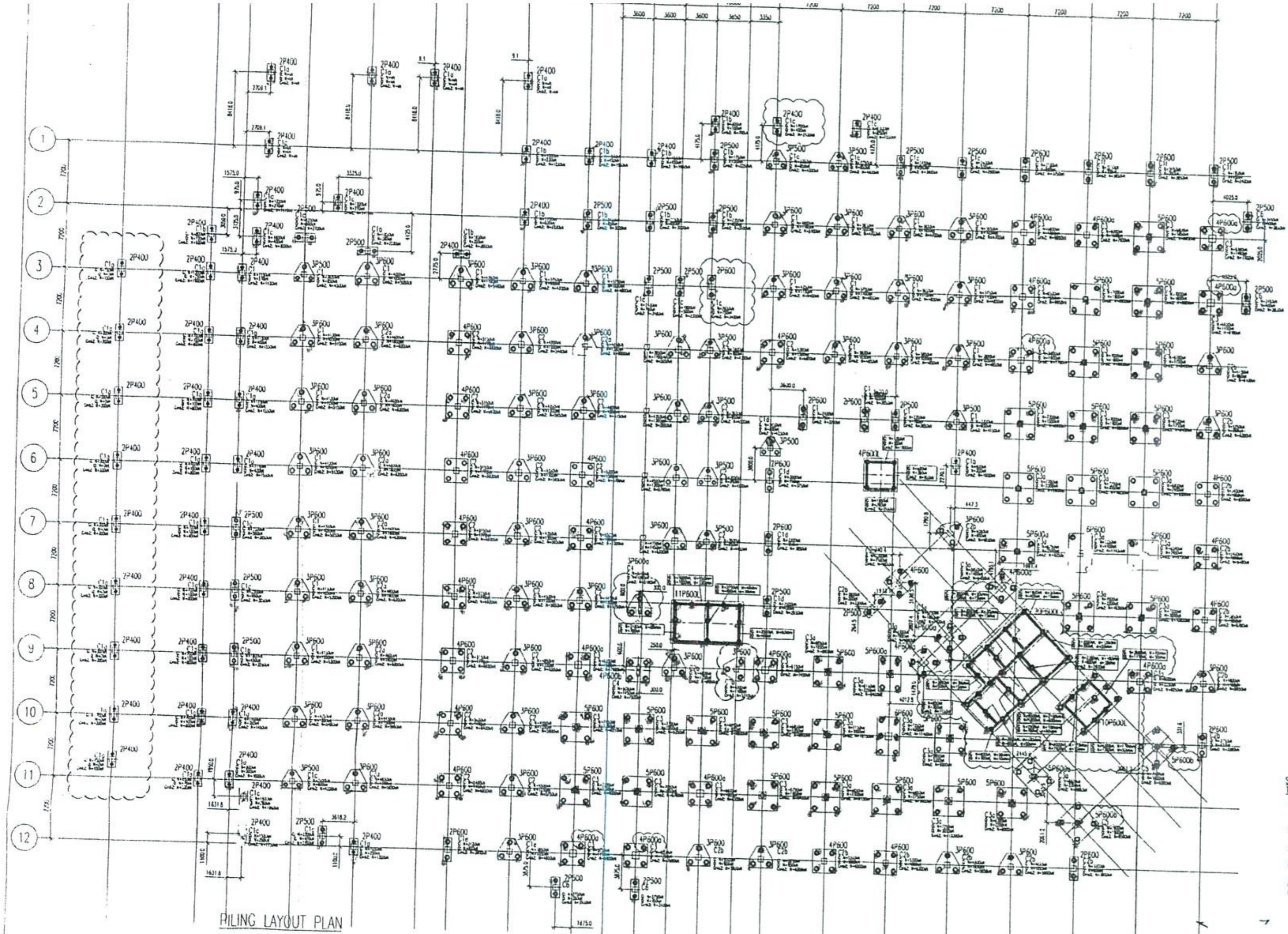
APPENDIX A

PILING LAYOUT



TYPE OF FOUNDATION	SIZE OF PILE (mm)	WORKING LOAD
SPUN PILE (P)	400mm ø (G80 Class B)	1,110 kN
SPUN PILE (P)	500mm ø (G80 Class B)	1,560 kN
SPUN PILE (P)	600mm ø (G80 Class B)	2,070 kN

LEGEND:-

3 P600
- NO. OF PILES IN PILECAP
- TYPE OF FOUNDATION:- P - SPUN PILE
- SIZE OF PILE

NOTES FOR PILING WORK

1. CONTRACTOR HAS ALLOWED PROVISIONAL X-POINTED PILE SHOE FOR ALL PILES.
2. PILE INSTALLATION METHOD :-
   PILES SHALL BE INSTALLED BY HYDRAULIC INJECTION METHOD
   THE CONTRACTOR TO SUBMIT TO THE ENGINEER METHOD STATEMENT OF HYDRAULIC INJECTION PILE BEFORE COMMENCEMENT OF WORK.
   TERMINATION CRITERIA - THE PILES SHALL BE JACKED TO 2.3 x WORKING STRUCTURAL LOAD CAPACITY AND HELD FOR 30 SECONDS FOR THREE CYCLES, SET LESS THAN 2mm.
3. ALLOW FOR LOAD TEST :-
   i) 1% OF TOTAL PILE NUMBERS FOR NOS WORKING LOAD TEST (2x WORKING LOAD) ON RC PILE
   ii) 3% OF TOTAL PILE NUMBERS FOR NOS OF PDA TEST C/W CAPWAP ANALYSIS ON RC PILE
   ANY PILE WHICH FAILS THE WORKING LOAD TEST, IT SHALL BE REPLACED WITH 2 NOS OF ADDITIONAL PILES.
4. ALL NECESSARY BOUNDARY LINES/SETTING OUT SHALL BE ESTABLISHED BY APPROVED REGISTERED SURVEYOR.
5. ALL DIMENSION SHALL BE WORKED OUT AND CONFIRMED WITH RELEVANT ARCHITECTURAL, M/E AND STRUCTURAL DRAWING. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE S.O. BEFORE WORK COMMENCES.
6. THE POSITION OF LOAD-TEST SHALL BE AS DETERMINED AND DIRECTED BY THE ENGINEER. INSTALLATION OF FIRST PILE MUST BE WITNESSED BY REPRESENTATIVE FROM CONSULTING ENGINEER. CONTRACTOR SHALL NOT PROCEED FURTHER IF WRITTEN APPROVAL AND CONFIRMATION ON THE RESULT OF THE FIRST PILE INSTALLED IS NOT GIVEN BY THE ENGINEER.
7. THE CONTRACTOR SHALL EXERCISE HIS CARE TO MINIMIZE DISTURBANCE TO ADJACENT PROPERTIES. ANY DAMAGES CAUSED BY HIS WORK SHALL BE RECTIFIED BY CONTRACTOR.
8. THE CONTRACTOR TO SUBMIT AS-BUILT PILING PLAN ENDORSED BY REGISTERED SURVEYOR PRIOR TO PILECAP CONSTRUCTION.
   THE CONTRACTOR TO SUBMIT COLUMN STARTER BAR AS-BUILT PLAN ENDORSED BY REGISTERED SURVEYOR BEFORE HANDOVER.
9. PILE DEVIATION TOLERANCES SHALL NOT MORE THAN 50mm FOR SINGLE LINE PILE, 75mm FOR 3 PILE GROUP AND ABOVE.
   CONTRACTOR TO PROPOSE REMEDIAL PROPOSAL FOR ENGINEER APPROVAL SHOULD THE PILE INSTALL EXCEED THE TOLERANCE WHICH EVENTUALLY WILL CAUSE THE PILE TO BE OVERSTRESSED.
10. BROKEN PILE SHALL BE REPLACED WITH 2 NOS. OF ADDITIONAL PILES.
11. EXACT DIMENSION OF LIFT PIT TO RECONFIRM WITH ARCHITECT & M&E PRIOR TO PILE INSTALLATION.
12. PILOT PILES TO BE INSTALLED FOR LOAD TEST SELECTION PRIOR TO
13. DOLLY IS USED BUT LIMITED TO 2.0m (MAX DEPTH) FROM PLATFORM LEVEL.
14. MIN. OF 9.0 METER PILE LENGTH (MEASURED BELOW CUT OFF LEVEL) WILL BE INSTALLED AT SITE.

NOTES ON LOAD TEST :-(SUBJECT TO LOAD TEST RESULTS)

1. PILE LOAD TEST SHALL BE MAINTAINED LOAD TEST U.O.S.
2. INJECTION MACHINE USED AS STATIC LOAD TEST INSTEAD OF STATNAMIC TEST.
3. THE CONTRACTOR SHALL SUBMIT TO THE ENGINEER FOR APPROVAL 1 WEEK PRIOR TO LOAD TEST OF THE FOLLOWING :-
   i) PLAN OF TEST RIG SHOWING RELEVANT POSITION AND DISTANCES OF THE KENTLEDGE ARRANGEMENT.
   ii) PROCEDURE OF PILE LOAD TEST
   iii) CALIBRATION CERTIFICATE (ISSUED NOT MORE THAN 2 MONTHS) FOR DIAL GAUGE AND PRESSURE GAUGE OF THE HYDRAULIC JACK
   iv) UPON COMPLETION OF LOAD TEST A SUMMARY OF TEST DATA SHALL BE SUBMITTED TO THE ENGINEER WITHIN 24 HOURS OF COMPLETION OF TEST. COMPREHENSIVE REPORT SHALL BE SUBMITTED WITHIN 7 DAYS.
   v) ALL ULTIMATE LOAD TEST SHALL BE COMPLETED PRIOR TO COMMENCEMENT OF WORKING PILE INSTALLATION.

SHOULD THERE BE ANY COUNTER PROPOSAL FOR THE DESIGN THE FOLLOWING NEEDS TO BE COMPLIED :-

a. ALL DOCUMENTS AND DRAWINGS TO BE ENDORSED BY THE PROFESSIONAL ENGINEER WITH PRACTICING CERTIFICATE, PEPC WHOM IS WELL-VERSED IN FOUNDATION DESIGN.
b. ALL CCC FORMS RELATED TO THE WORKS SHALL BE ENDORSED BY THE SAME PROFESSIONAL ENGINEER.
c. ALL GEOTECHNICAL PILING DESIGN CALCULATION TO BE SUBMITTED FOR APPROVAL.
d. MAXIMUM PUNCHING SHEAR FOR PILECAP SHALL BE LIMIT TO BELOW 4 N/mm²
e. NO SINGLE PILE (DRIVEN PILE) IS ALLOWED.
f. THE SOIL INVESTIGATION REPORT AS PROVIDED FOR YOUR REFERENCE ONLY. YOU SHALL CARRY OUT YOU OWN SOIL INVESTIGATION TO VERIFY THE SOIL STRATA FOR THE SITE. NO CLAIMS WILL BE ENTERTAINED FOR ADDITIONAL PAYMENT AND EXTENSION OF TIME ON THE GROUND THAT THE SOIL INVESTIGATION REPORT AS PROVIDED IS INCORRECT.

No	Tarikh	Catatan	Diluluskan oleh

Pemilik: KEMENTERIAN KESIHATAN MALAYSIA (Bahagian Perancangan dan Pembangunan)

Pengurus Projek: JABATAN KERJA RAYA MALAYSIA

Kontraktor Reka & Bina: NADI CERGAS SDN. BHD.

Arkitek: RMA DESIGN TEAM SDN BHD

Perunding Medical: ARKITEK SAIFULLIZAN OSMAN

Perunding C & S

Perunding Mekanikal & Elektrikal: ZNVA ASSOCIATES SDN. BHD. Mechanical & Electrical Consulting Engineers

Perunding Peralatan Medikal: PRO EDGE ENGINEERING SDN BHD

Perunding QS: YUSOF ASSOCIATES JURUKUR BAHAN

Perunding ICT: INFO WINGS SDN BHD

Perunding CB: CREATIVE ENVIRONMENTS

PROJECT: CADANGAN PEMBINAAN PUSAT KARDIOLOGI HOSPITAL SERDANG, SELANGOR (262 KATIL) (REKA DAN BINA)

SUBJECT: (HOSPITAL) PILING PLAN

TANDATANGAN JURUTERA

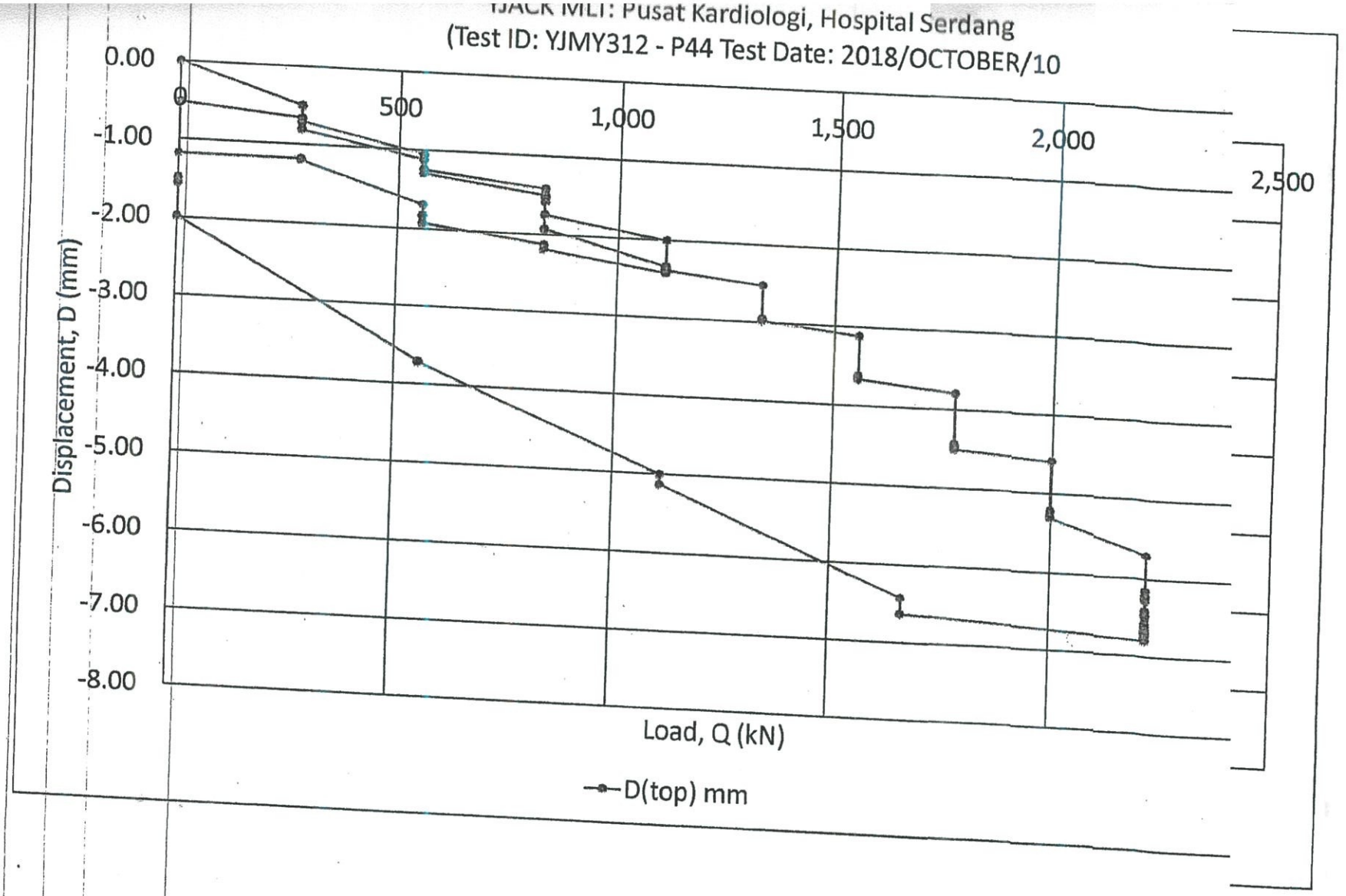
I hereby certify that these works have been designed by me in accordance with sound engineering practice and that I take full responsibility for the design and proper performance of the same.

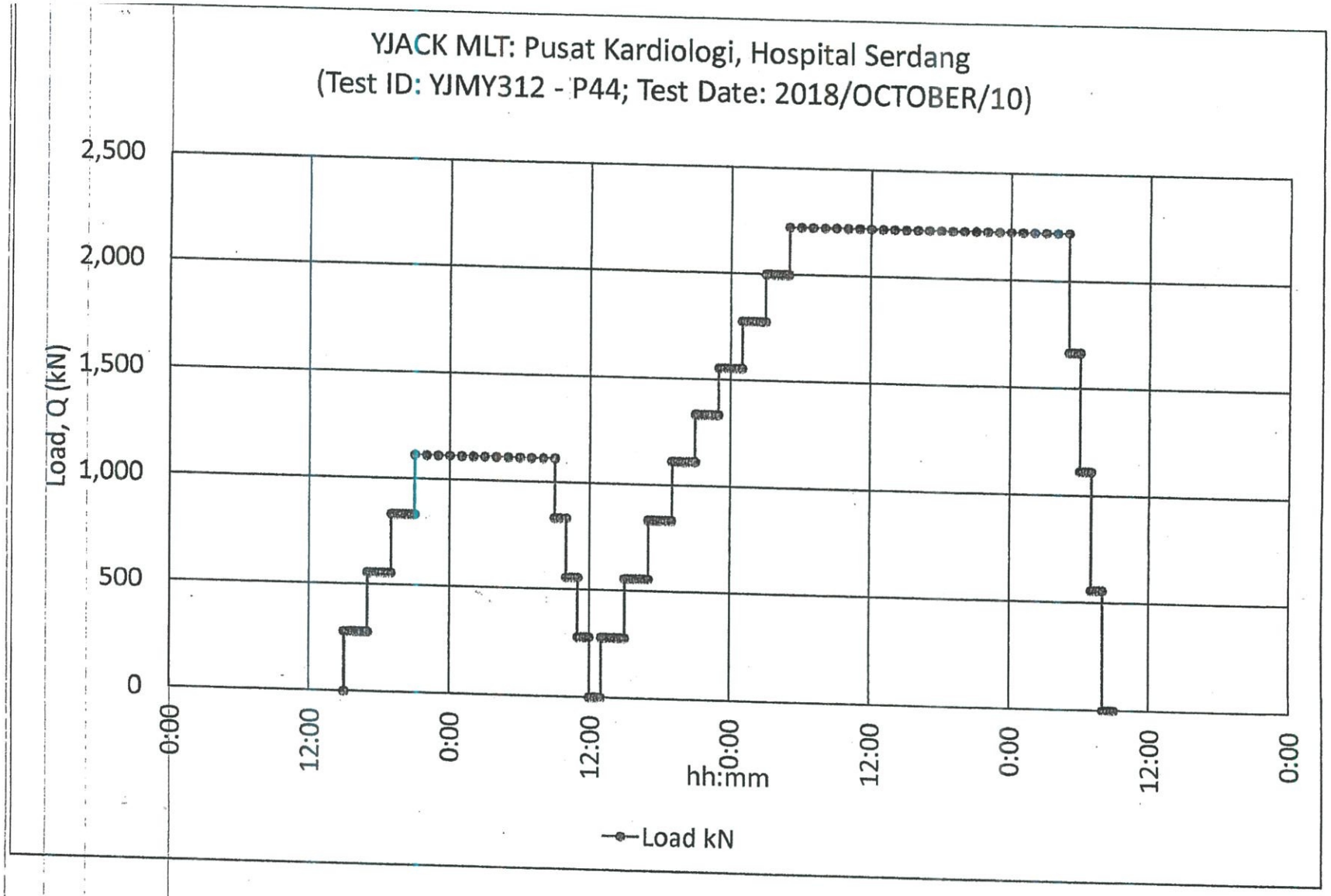
SCALE	1 : 250	DRAWING NO
DESIGNED	KKK	PRC/21801/HO/PL/1
DRAWN	HAFIZ	
CHECKED	SYN	REVISION
DATE	JAN 2018	FILE REFERENCE

☐ PRELIMINARY ☐ INFORMATION ☐ TENDER
☐ SUBMISSION ☐ CONSTRUCTION ☐ AS-BUILT

APPENDIX B

SLT TEST RESULT


YJACK MLT: Pusat Kardiologi, Hospital Serdang
(Test ID: YJMY312 - P44 Test Date: 2018/OCTOBER/10
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
Displacement, D (mm)
0
500
1,000
1,500
2,000
2,500
Load, Q (kN)
D(top) mm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(Test ID: YJMY312 - P44; Test Date: 2018/OCTOBER/10)
Load, Q (kN)
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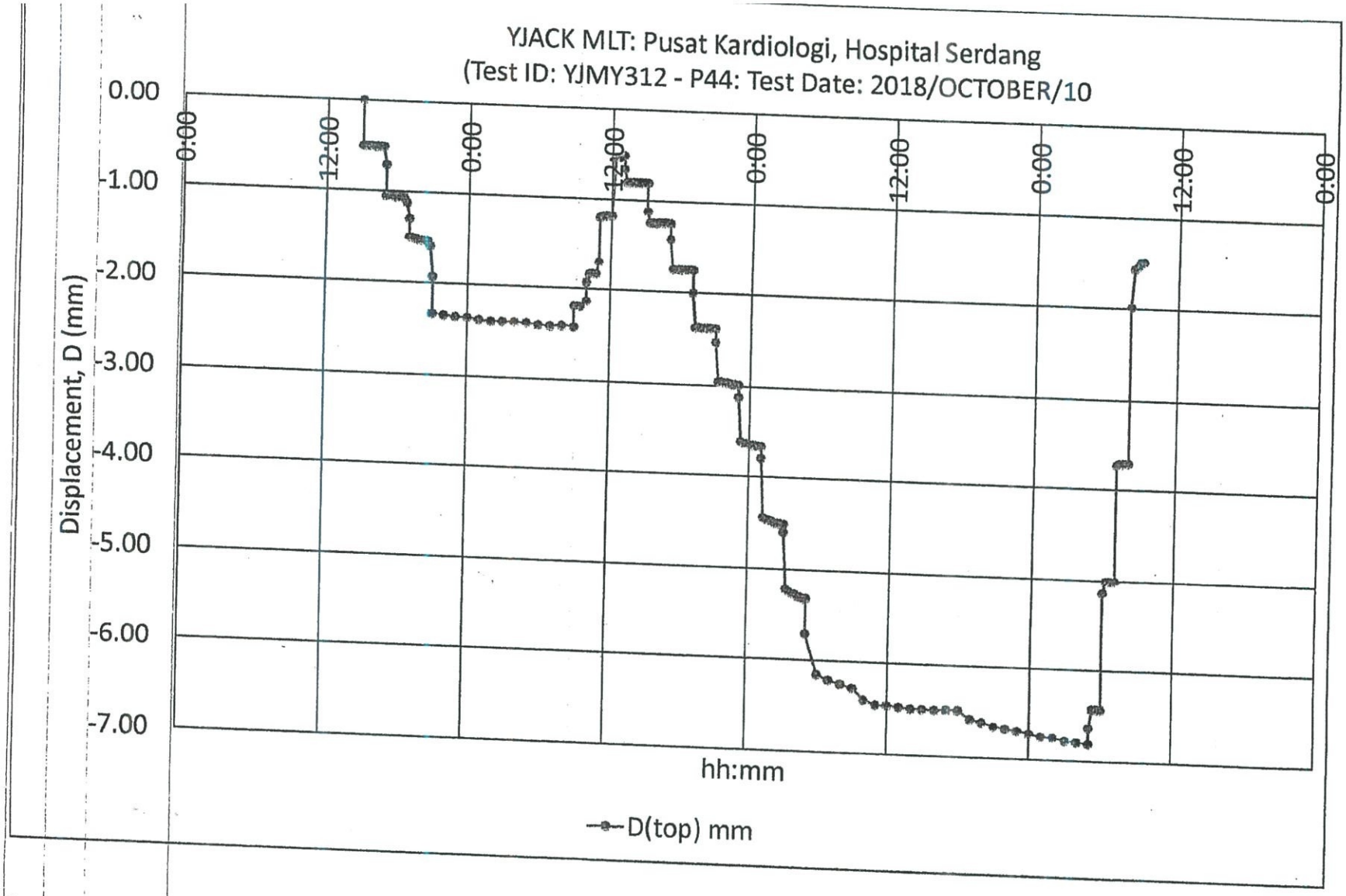
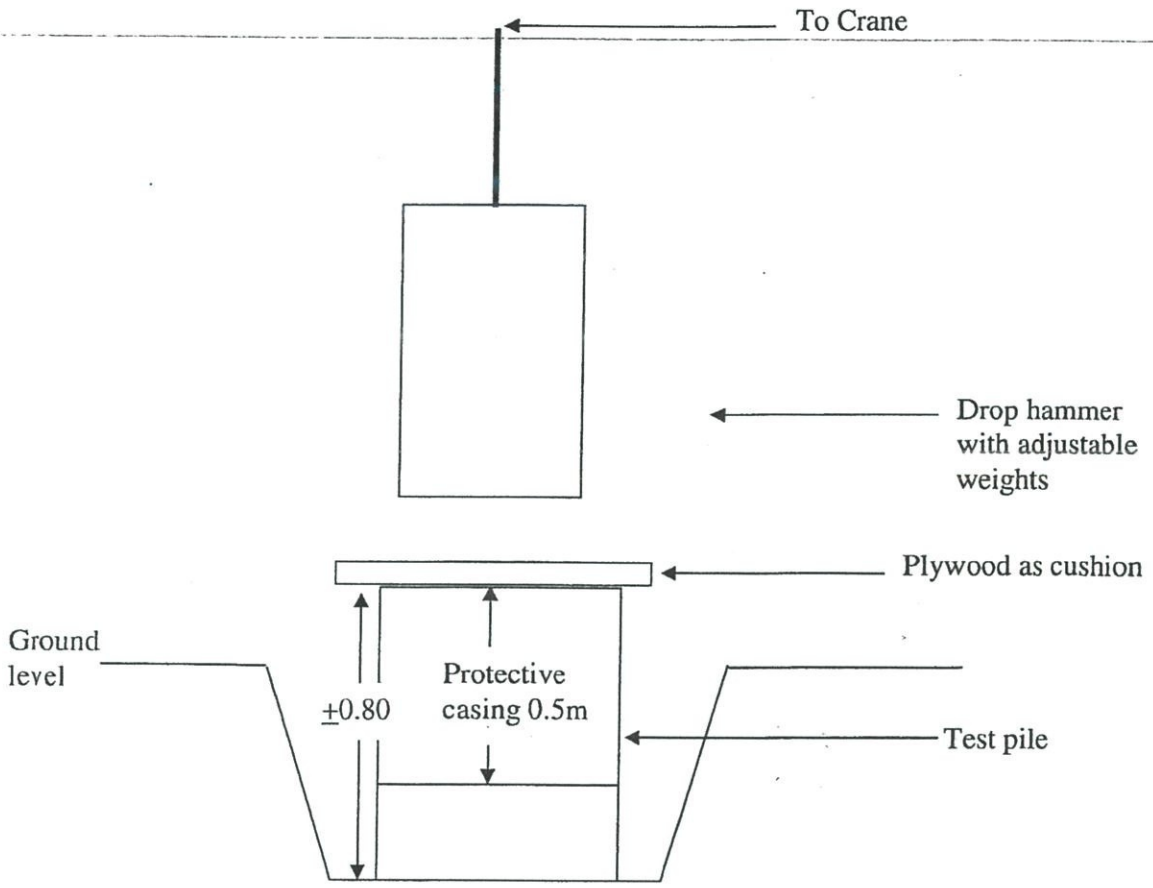
2,000
1,500
1,000
500
0
0:00
12:00
0:00
12:00
0:00
12:00
0:00
12:00
0:00
hh:mm
Load kN


YJACK MLT: Pusat Kardiologi, Hospital Serdang
(Test ID: YJMY312 - P44: Test Date: 2018/OCTOBER/10
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
Displacement, D (mm)
0:00
12:00
0:00
12:00
0:00
12:00
0:00
12:00
0:00
hh:mm
D(top) mm

APPENDIX C

PDA TEST RESULT


To Crane
Drop hammer
with adjustable
weights
Plywood as cushion
Ground
level
±0.80
Protective
casing 0.5m
Test pile

4.0 RESULTS SUMMARY

TEST PILE REFERENCE : 278

PILE DETAILS

Date Tested	:	29/09/18
Date Installed	:	16/09/18
Pile Type	:	SPUN
Pile Size (mm)	:	Ø600
Cross Section Area(cm^2)	:	1570.79
Wave Speed (m/s)	:	4400
Total Length (m)	:	12.0
Length Below Gauges (m)	:	11.7
Pile Penetration (m)	:	11.5(D)
Working Load (tons)	:	207
Test Load (tons)	:	414

HAMMER DETAILS

Hammer Type	:	Drop
Ram Weight (tons)	:	8.0
Observed Stroke (m)	:	1.2
Energy Transfer Ratio(%)	:	89

FIELD RESULT SUMMARY		CAPWAP RESULT SUMMARY	
RMX (tons)	430.0	Mobilised Capacity (tons)	429.6
FMX (tons)	421.2	Skin Friction (tons)	320.8
EMX (tons.m)	8.56	End Bearing (tons)	108.9
CSX (MPa)	27.7	Settlement at WL (mm)	6.23
Pile Integrity	Acceptable / 100	Settlement at TL (mm)	14.89

DEFINITIONS

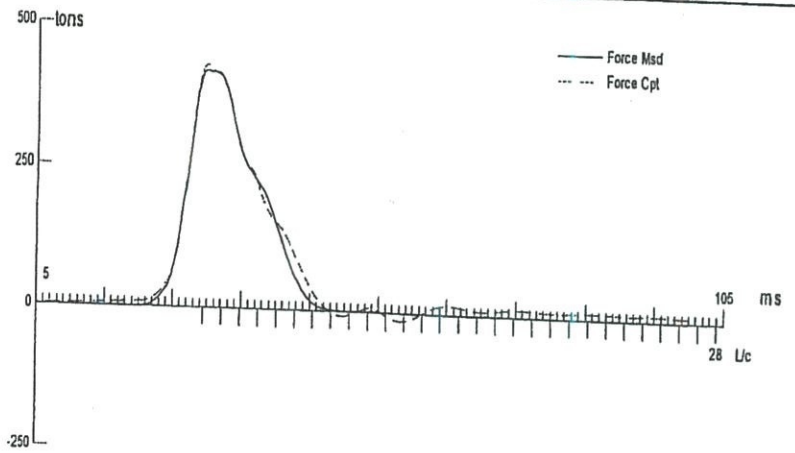
RMX	Case Static Capacity (J=0.5)
FMX	Maximum measured force at pile top
EMX	Maximum energy transmitted at gauges
CSX	Maximum compressive stress at pile top
WL	Working Load
TL	Test Load

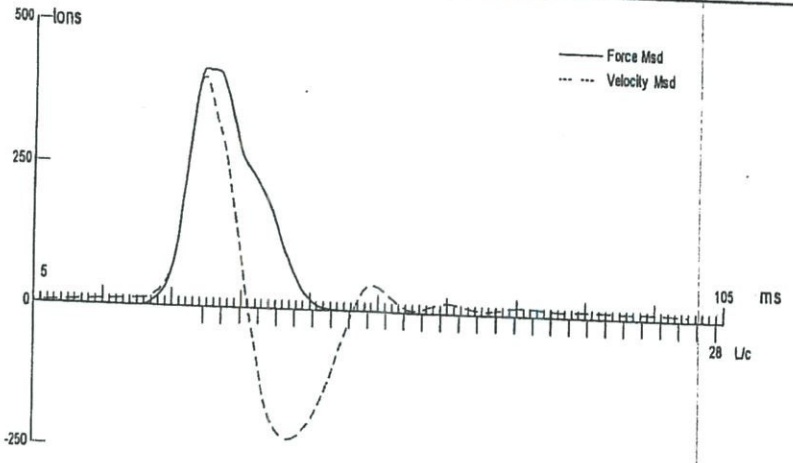
PUSAT KARDIOLOGI HOSPITAL; Pile: 278; SERDANG; BLOW: 4 (Test: 29-Sep-2018)

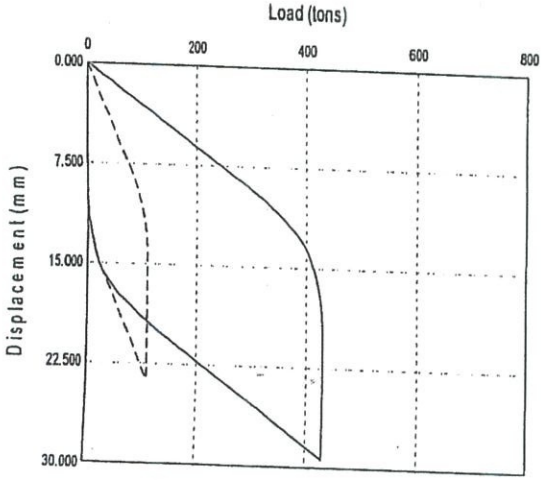
Foundtest (M) Sdn Bhd

09-Oct-2018

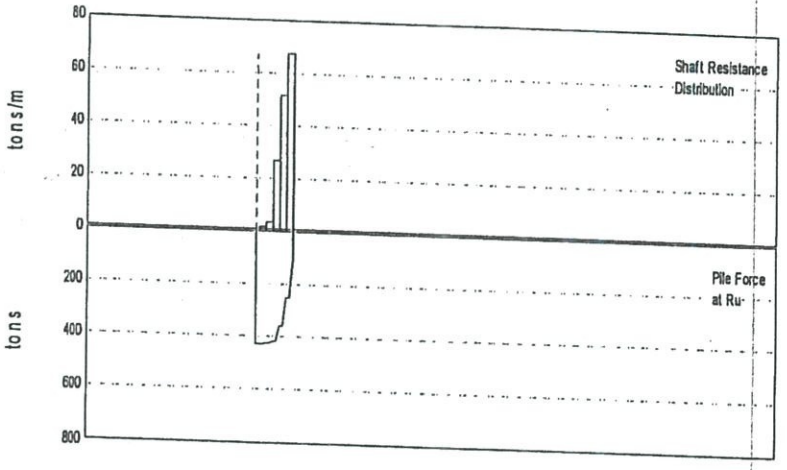
CAPWAP(R) 2006-2







Ru =	429.6 tons
Rs =	320.8 tons
Rb =	108.9 tons
Dy =	19.8 mm
Dx =	29.2 mm



~~S12~~ S12 = 180 530 – 071 P1

ABADI PILING SDN BHD
(611643-D)

(5)

PILE DRIVING RECORD (Jack-In)

Project No :
Machine No : J.M.10

LOCATION / BLOCK : PUSAT KARDIOLOGI, HOSPITAL SERDANG

Contractor Request For Inspection	Yes
	No

Inspection Date	16-9-18
Inspection Time	11:20PM 1:50 PM

INFORMATION	
Pile Reference No.	278 /
Pile size	600mmØ
Length of piles	S12
Total Length	12M

INFORMATION	
Penetration	13M (Daily) 1M
Sleeves / Joint	0
Final Set	0mm
Balance exposed pile length	0

PENETRATION (Jack In)			PENETRATION (Jack In)			PENETRATION (Jack In)			PENETRATION (Jack In)			PENETRATION (Jack In)	
Depth (m)	Corresponding Load (Ton / Mpa)		Depth (m)	Corresponding Load (Ton / Mpa)		Depth (m)	Corresponding Load (Ton / Mpa)		Depth (m)	Corresponding Load (Ton / Mpa)		Depth (m)	Corresponding Load (Ton / Mpa)
	2 Cylinder	4 Cylinder		2 Cylinder	4 Cylinder		2 Cylinder	4 Cylinder		2 Cylinder	4 Cylinder		2 Cylinder
0.0 - 0.5	0		12.5 - 13.0	12.5		25.0 - 25.5			37.5 - 38.0				
0.5 - 1.0	0		13.0 - 13.5	Set 13M		25.5 - 26.0			38.0 - 38.5				
1.0 - 1.5	0		13.5 - 14.0			26.0 - 26.5			38.5 - 39.0				
1.5 - 2.0	0		14.0 - 14.5			26.5 - 27.0			39.0 - 39.5				
2.0 - 2.5	0		14.5 - 15.0			27.0 - 27.5			39.5 - 40.0				
2.5 - 3.0	0		15.0 - 15.5			27.5 - 28.0			40.0 - 40.5				
3.0 - 3.5	0		15.5 - 16.0			28.0 - 28.5			40.5 - 41.0				
3.5 - 4.0	0		16.0 - 16.5			28.5 - 29.0			41.0 - 41.5				
4.0 - 4.5	0		16.5 - 17.0			29.0 - 29.5			41.5 - 42.0				
4.5 - 5.0	0		17.0 - 17.5			29.5 - 30.0			42.0 - 42.5				
5.0 - 5.5	0		17.5 - 18.0			30.0 - 30.5			42.5 - 43.0				
5.5 - 6.0	0		18.0 - 18.5			30.5 - 31.0			43.0 - 43.5				
6.0 - 6.5	0		18.5 - 19.0			31.0 - 31.5			43.5 - 44.0				
6.5 - 7.0	0		19.0 - 19.5			31.5 - 32.0			44.0 - 44.5				
7.0 - 7.5	0		19.5 - 20.0			32.0 - 32.5			44.5 - 45.0				
7.5 - 8.0	0		20.0 - 20.5			32.5 - 33.0			45.0 - 45.5				
8.0 - 8.5	0		20.5 - 21.0			33.0 - 33.5			45.5 - 46.0				
8.5 - 9.0	0		21.0 - 21.5			33.5 - 34.0			46.0 - 46.5				
9.0 - 9.5	0		21.5 - 22.0			34.0 - 34.5			46.5 - 47.0				
9.5 - 10.0	4		22.0 - 22.5			34.5 - 35.0			47.0 - 47.5				
10.0 - 10.5	8		22.5 - 23.0			35.0 - 35.5			47.5 - 48.0				
10.5 - 11.0	12.5		23.0 - 23.5			35.5 - 36.0			48.0 - 48.5				
11.0 - 11.5		5	23.5 - 24.0			36.0 - 36.5			48.5 - 49.0				
11.5 - 12.0		8	24.0 - 24.5			36.5 - 37.0			49.0 - 49.5				
12.0 - 12.5		10	24.5 - 25.0			37.0 - 37.5			49.5 - 50				

P = 278
13M
7/16

(3) 0mm
(2) 0mm
(1) 0mm

Remarks : Prebore length : 10.6M

Checked By : _____ (Clerk of Works)