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BY

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title

The Construction of Pile Foundation

accepted as a partial fulfillment of the requirements for obtaining a Diploma in Building.

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Thank you.

ABSTRACT

This report explained about pile foundations started from the type of piles used at the site until the ground beam. It is made based on five months experience at the site. This report is divided into few chapters which included company's background and project's background. From the observation, it is clearly shows that the construction of the pile foundations is not as easily as it seems. It took a lot of time, labours, and a complicated construction. In this report, it is explained about the type of piles used at the site for the construction of pile foundation for the double-storey terrace houses, the design of the pile caps existed at the site, the level of the column stump and the construction of the ground beam. During the construction, few problems had occurred especially during the pile driving and this report has mentioned the way to solve it. As a conclusion, this report has provided sufficient information about the construction of pile foundations.

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CIDB Construction Industry Development Board

PKK Pusat Khidmat Kontraktor

CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysia is one of the developed countries in South East Asia. Many high buildings can be seen now on the land. Because of that, the building needs to be designed correctly for them to be able to bear the load from the above. This is involving the construction of the foundation beneath the building.

Foundation is an important part of a building because it supports the load from the superstructure. The proper design will help the building from having cracks or even collapse. Many foundations are available in the construction field, such as raft, strip, pad, combined and piles foundations.

However, certain foundations are suit for a certain constructional area; therefore, the engineer needs to consider few important factors before deciding on which foundation to be used. There are shallow and deep foundations and each of them belongs to a certain kind of soil conditions. Engineer need to be sure of what they have chosen because they contribute to the safety of the user.

The usual limit of design life of foundation is around 50 years and the basic service of 10 years. After this period, an assessment of the building condition is necessary to ensure the continuing safe use of the building.

1.2 Research Objectives

There are several objectives need to be done namely:

i) To identify the type of piles used in the construction of pile foundation.

ii) To identify the components of pile foundation.

iii) To analyse the problems that occurs during the construction of pile foundation and ways to overcome it.

1.3 Scope of Research

The scope of this research is involving the construction of pile foundation on the site of terrace houses. The pile foundation is consists of:

i) Piles that are driven into the soil for 21m deep.

ii) Pile caps that have been clustered into three different groups.

iii) Column stump which is constructed on top of the pile caps.

iv) Ground beam to connect every one of the pile caps and stumps.

1.4 Method Of Research

Any information about the type of piles used on site, the construction of pile foundation and the problems that occurs can be gained by using two methods. The first one is known as primary method and the other is secondary method.

For the primary method, information was obtained via interview sessions that will be held by the researcher. The information is provided by the respondents who are professionals in their own fields and is considered reliable as they have years of working experiences. The researcher will conduct interviews with several site workers or staffs to obtain information regarding the construction of substructure of the terrace houses. The flexibility of changing questions also may help in doing the research as different people have different views and experiences. Information also can be gained through observations. Observations are made during the researcher's time at the site and are recorded directly from the first person view, which is the researcher itself.

For the secondary method, every knowledge and information is taken through various sources, which include collection data from books, magazine, reports and Internet. It consists of various findings and research from different resources related to the topic.

CHAPTER 2

COMPANY BACKGROUND

2.1 Introduction

Shahab Builders & Engineering Sdn Bhd was incorporated in Malaysia under The Companies Act 1965 on 8 November 1994 and its registered office is at 1465, Jalan Teratai, Taman Sultan Badlishah, 05050, Alor Setar, Kedah Darul Aman.

The principal activity of the company is Construction & Civil Engineering. Through the company was incorporated in 1994, the involvement of the Directors of the Company through Syarikat Sakan Sdn Bhd and Seng Hong Enterprise Sdn Bhd in the property development and construction sector is of more than 15 years.

The formation of SHAHAB Builders & Engineering Sdn Bhd was a direct step taken by the Director to diversify downstream in its construction sector. The company would benefit directly from the synergistic understanding between Syarikat Sakan Sdn Bhd and Seng Heong Enterprise Sdn Bhd.

From 1994-2005, the company has proven its capacity in delivering and completing all its contract obligation, as of 24th September 2000, the company finally achieved its target of being a 100% Bumiputera Status as a result of a Synergistic alliance with AIMA Development Sdn Bhd Directors. The synergy from its Directors as well as the management team will enhance the company potential future growth.

2.2 Company Profile

The Board of Directors of Shahab Builders & Engineering Sdn Bhd consist of five people. Tuan Haji Syed Zainal Abidin bin Syed Abdullah, the Managing Director, was appointed to the position on 20 December 1994. Dato Syed Zulkiflee bin Syed Abdullah, a Director, was one of the people who were instrumental towards the formation of the company and was appointed as a Managing Director of Syarikat Sakan Sdn Bhd in 1982. Tuan Syed Zaini Shahar Shahabudin bin Syed Abdullah, the Technical Director, was appointed to the position on 8 November 1994, whereas, Tuan Syed Anuar bin Syed Abdullah was also appointed as Project Director on 1994. Datin Hajjah Noor Mah binti Omar is the wife of Dato Haji Abdul Halim bin Che Din, the Director and Chief Executive of AIMA Development Sdn Bhd and she also sits on the Board Directors of AIMA Development Sdn Bhd. The last person on the Board of Directors is Encik Soffian bin Zainal, the Project Manager who joined Shahab Builder & Engineering in 1997.

The business is addressed at 120-A, Taman Nakishah, Jalan Datuk Kumbar, 05450, Alor Setar, Kedah Darul Aman. Capital structure of the company, which is authorized is RM 1,000,000.00 and the paid up is RM 750,000.00.

The registration number of the company in Construction Industry Development (CIDB) is 1970704-KD038826, the registration grades are G5 and G7, and the registered category and specialization are G5-CE CE21 and G7-B B04.

For Contractor Service Centre (PKK), the company is registered in Class A, Bumiputera status, and registered number is 0203 A 2001 0524.

2.3 Organisation Chart

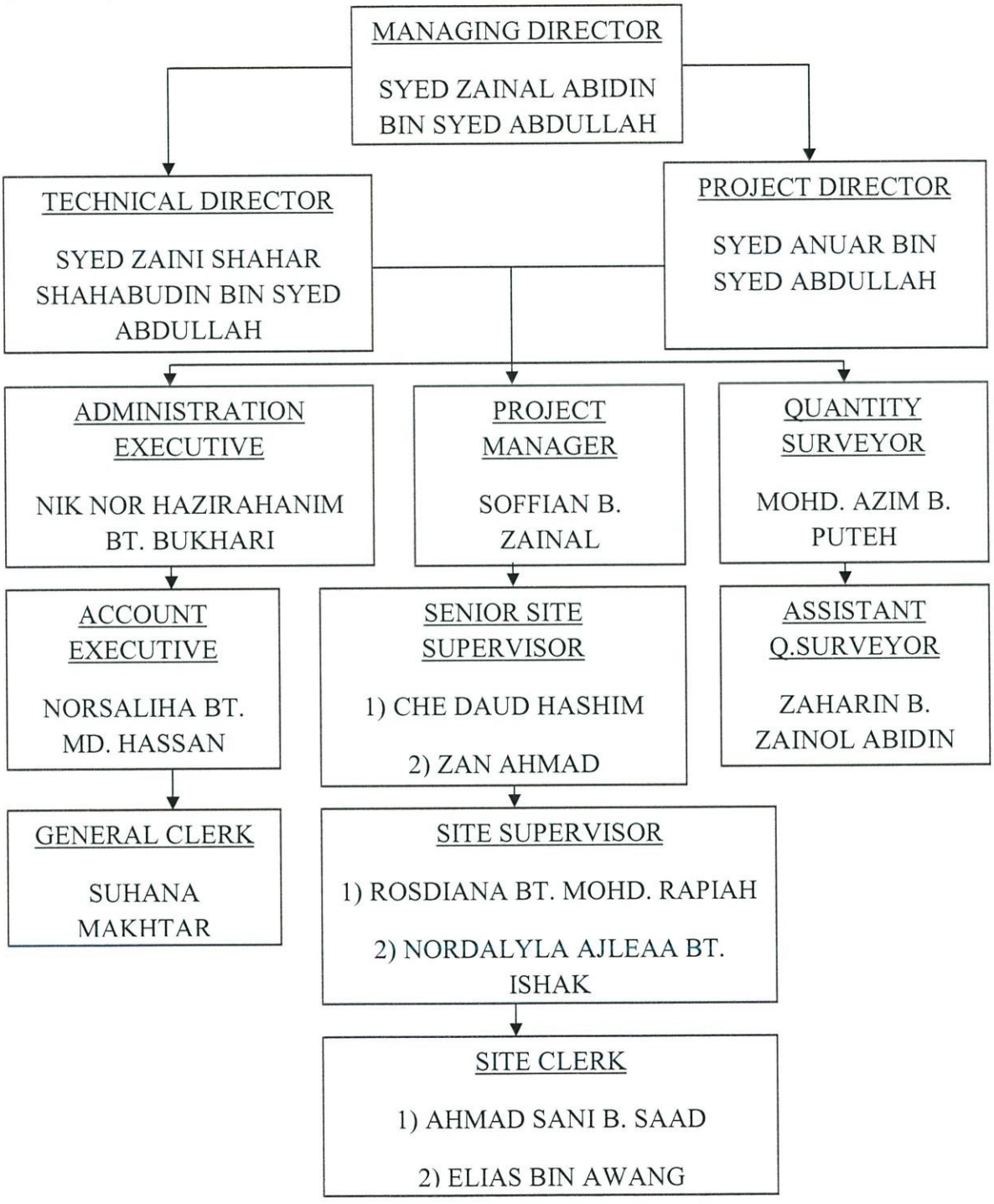


Figure 2.1 The organization chart.

2.4 List of Projects

2.4.1 Major Projects Completed

PROJECTS	DATES
Taman Desa Impiana : Cadangan Membina Dan Menyiapkan Perumahan Yang Mengandungi 74 Unit Rumah Teres 2 Tingkat, 29 Unit Kedai Pejabat & 18 Unit Rumah Kos Rendah Di Atas Lot 3420, Mukim Mergong, Daerah Kota Setar, Kedah Darul Aman.	Date of Commencement : 01-02-05 Date of Completion : 01-02-07
Taman Perlis (Phase 3) : Cadangan Projek Perumahan 96 Unit Yang Mengandungi 60 Unit Rumah Teres Kos Sederhana Jenis 'A' Setingkat, 8 Unit Rumah Teres Kos Sederhana Jenis 'B' 1 ½ Tingkat, 22 Unit Rumah Berkembar Setingkat dan 6 Unit Rumah Berasingan Setingkat Di Atas Lot 1468, Mukim Utan Aji, Kangar, Perlis.	Date of Commencement : 01-01-05 Date of Completion : 01-01-07
Cadangan Memperelok dan Menaiktaraf Persiaran Sultan Abdul Hamid (Jalan Pegawai), Kota Setar, Kedah (JV Agreement – Titian Arif Sdn Bhd)	Date of Commencement : 15-01-06 Date of Completion : 14-09-07
Taman Sri Bandar : Cadangan Projek Perumahan Di Atas Lot 2002 & 2003, Mukim Pengkalan Kundur, daerah Kota Setar, Kedah Darul Aman.	Date of Commencement : 15-11-05 Date of Completion : 15-11-07
Taman Tengku Maheran (Phase III) : Comprising of 69 Units Single Storey Terrace Type A & 35 Units Double Storey Terrace Type B, Mukim Naga, Jitra, Kedah Darul Aman.	Date of Commencement : 28-02-06 Date of Completion : 01-12-07

Cadangan Pembangunan Pusat Pentadbiran Kerajaan Persekutuan DI Bandar Muadzam Shah, Mukim Anak Bukit, Daerah Kota Setar, Kedah.	Date of Commencement : 29-12-06 Date of Completion : 14-03-09
Cadangan Pembangunan 72 Unit Kedai Pejabat Fasa 2 Yang Mengandungi 5 Unit Kedai Pejabat 3 ½ Tingkat, 52 Unit Kedai Pejabat 3 Tingkat, 15 Unit Kedai Pejabat 2 Tingkat, Di Jalan Pegawai, Mukim Kota Setar, Daerah Kota Setar, Kedah Darul Aman.	Date of Commencement : 15-05-07 Date of Completion : 14-05-09
Cadangan Membina dan Menyiapkan 23 Unit Rumah Teres 2 Tingkat & 4 Unit Rumah Kedai 2 Tingkat Di Atas Lot 2057, Mukim Naga, Daerah Kubang Pasu, Kedah Darul Aman.	Date of Commencement : 01-01-08 Date of Completion : 31-12-10
Taman Desa Impiana 2 : Cadangan Projek Perumahan 45 Unit Di Atas Lot 791, Mukim Mergong, Daerah Kota Setar, Kedah Darul Aman.	Date of Commencement : 15-08-08 Date of Completion : 15-04-10
Taman Serindit Fasa 3 : Cadangan Membina dan Menyiapkan 14 Unit Rumah Berkembar 2 Tingkat dan 14 Unit Rumah Berkembar Satu Tingkat Di Atas Lot 125, Mukim Alor Malai, Alor Setar, Kedah Darul Aman.	Date of Commencement : 01-01-09 Date of Completion : 31-12-10
Taman Hijrah Fasa 4A : Cadangan Projek Perumahan 104 Unit Di Atas Lot 1469 & 1470, Mukim Utan Aji, Kangar, Perlis Indera	Date of Commencement : 01-05-09 Date of Completion :

Kayangan	30-04-11
Taman Nusantara Fasa 2A : Cadangan Pindaan Kepada Pelan Yang Telah Diluluskan Bertarikh 27hb Ogos 2006, Rujukan MBAS/B/19/06/BA2 untuk 44 Unit Rumah Berkembar 2 Tingkat – Type A Dan 8 Unit Rumah Berkembar 2 Tingkat – Type B (Fasa 2) Di Atas Sebahagian Lot 1198, Mukim Kuala Kedah, daerah Kota Setar, Kedah Darul Aman.	Date of Commencement : 15-06-10 Date of Completion : 15-12-11

Table 2.1 The major projects completed.

2.4.2 Current Projects

PROJECTS	DATES
Taman Pinggiran Seri Kota : Cadangan Mendirikan 24 Unit Rumah Berkembar 1 Tingkat Jenis A And 6 Unit Rumah Berkembar 1 Tingkat Jenis B Di Atas Lot PT 12800 Bandar Alor Setar, Daerah Kota Setar, Kedah Darul Aman.	Date of Commencement : 01-09-10 Date of Completion : 01-09-12
Taman Hijrah Fasa 4B : Cadangan Mendirikan Skim Perumahan 12 Unit Rumah Berkembar Type A, 8 Unit Rumah Berkembar Type B, Dan 12 Unit Rumah Dua Tingkat Di Atas Sebahagian Lot 1469 & 1470, Mukim Utan Aji, Kangar, Perlis Indera Kayangan	Date of Commencement : 01-11-10 Date of Completion : 01-12-12
Taman Tengku Maheran 6 : Cadangan Membina dan Menyiapkan Projek Perumahan 33 Unit Terdiri Daripada 6 Unit Rumah Banglo 2 Tingkat Jenis A, 1 Unit Rumah Banglo 2 Tingkat Jenis B, 26 Unit Rumah Berkembar 2 Tingkat, Di Atas Sebahagian Lot 1918, Mukim Naga, DaerahKubang Pasu, Kedah Darul Aman.	Date of Commencement : 01-12-11 Date of Completion : 01-12-13
Taman Kiara : Cadangan Membina Dan Menyiapkan Projek Perumahan Yang Terdiri Daripada 3 Unit Rumah Sebuah 1 Tingkat, 54 Unit Rumah Berkembar 1 Tingkat Jenis A, 6 Unit Rumah Berkembar 1 Tingkat Jenis B, 16 Unit Rumah Berkembar 2 Tingkat dan 19 Unit Rumah Teres 2 Tingkat Di Atas Lot 194, 195, 2765 & 2467, Mukim Derga, Daerah Kota Setar,	Date of Commencement : 15-11-12 Date of Completion : 14-12-13

Kedah Darul Aman.	
Taman Insaniah : Cadangan Membina dan Menyiapkan 63 Unit Perumahan Di Atas Sebahagian PT 6930 (Sebahagian Lot Asal 3979) Mukim Tawar, Daerah Baling, Kedah Darul Aman Yang Mengandungi Rumah Sesebuah 1 ½ Tingkat – 5 Unit, Rumah Berkembar 1 Tingkat – 58 Unit.	Date of Commencement : 22-11-11 Date of Completion : 22-05-13
Taman Putra Utama Fasa 1A : Cadangan Pembangunan Perumahan & Perniagaan Terdiri Daripada 8 Unit Rumah Kedai 3 Tingkat & 21 Unit Rumah Kedai Dua Tingkat Di Atas Lot 5337, Mukim Utan Aji, Kangar, Perlis Indera Kayangan.	Date of Commencement : 10-05-12 Date of Completion : 09-11-14

Table 2.2 The current projects.

CHAPTER 3

THE CONSTRUCTION OF PILE FOUNDATION

3.1 Introduction

There are two basic structural components of a residential building, which are substructure and superstructure. The substructure is that part of a building that is below natural or artificial ground level and which supports the superstructure (Emmit & Gorse, 2010). They also stated that the substructure is also known as foundation and defined the foundation of a building as, "that part of walls, piers and columns in direct contact with, and transmitting loads to, the ground".

Foundations support and anchor a structure. They resist lateral loads from soil pressure, seismic movement, and wind forces. They may enclose a crowd space as a habitable space. Many factors need to be required when designing the foundations. One of the most important factors is the characteristics of the soil upon which the foundation is to be constructed. These characteristics include self-bearing capacity, soil structure in presence of rocks and others, and groundwater conditions (Giglio, 2010). Apart from simple domestic foundations most foundation types are constructed in reinforced concrete and may be considered as being shallow or deep. Most shallow types of foundation are constructed within 2.000 of the ground level but in some circumstances it may be necessary to take the whole or part of the foundations down to a depth of 2.000 to 5.000 as in the case of a deep basement where the structural elements of the basement are to carry the superstructure loads. Generally foundations which need to be taken below 5.000 deep are cheaper when designed and constructed

as piled foundations and such foundations are classified as deep foundations (Chudley & Greeno, 2008).

According to Chudley and Greeno (2008), pile foundation can be defined as a series of columns constructed or inserted into the ground to transmit the loads of a structure to a lower level of subsoil. Pile foundations can be used when suitable foundation conditions are not present at or near ground level. The lack of suitable foundation conditions may be caused by natural low bearing capacity of subsoil, high water table which giving rise to high permanent dewatering costs, presence of layers of highly compressible subsoils such as peat and recently placed filling materials which have not sufficiently consolidated, and subsoils which may be subject to moisture movement or plastic failure.

3.2 Project's Background

Taman Kiara is a housing project consist of 3 units of bungalow, 54 units of semi-detached houses type A, 6 units of semi-detached houses type B, 16 units of double-storey semi-detached houses, and 19 units of double-storey terrace on lot 194, 195, 2765 and 2467, Mukim derga, Kota Setar, Kedah Darul Aman.

The owner of this project belongs to Syarikat Sakan Sdn. Bhd with a contract value of RM 10,763,100.00. The ones who are leading this project are Tuan Syed Zainal Abidin bin Syed Abdullah, the Managing Director, Tuan Syed Zaini Shahar Shahabudin bin Syed Abdullah, the Technical Director, and Tuan Syed Anuar bin Syed Abdullah, the Project Director. They are assisted by Encik Soffian bin Zainal, the Project Manager, Encik Che Daud Hashim, the Senior Site Supervisor, Encik Mohd. Azim bin Puteh, the Quantity Surveyor, and Encik Elias bin Awang, the Site Clerk.

3.3 Case Study

The case study consist information that the researcher obtain throughout the study.

3.3.1 Pile

3.3.1.1 Type of Piling Machine Used

Modular piling system (MCS) is innovative highly technological equipment, intended for construction of pile foundations with a flow-line production method. The piling system is equipped with the original piling machine and a modular coordinating skidding system. Environmentally friendly piling system operates with minimum noise, eliminates dynamic and vibration influence on the foundation bases and nearby existing buildings and structures (Santos, 2008).

Springman and Laue (2010) stated that the hydraulic piling machine, with a side wedge clamping system, is intended for the construction of different pile foundations and geotechnical structures using the press-in method. The piling machine is applied for the pressing-in of prefabricated concrete piles, sheet piles and other construction elements with a cross-section up to 500 mm, with an insertion force up to 2300 kN. The inclination of the pile is avoided due to the side wedge clamping system, and there is no limitation on the pile length.

The IPH Hydraulic Piling Hammer had been developed from the end of year 1993 and aimed to bring the most recent technology to pile driving techniques. IPH , in the enthusiasm over the level of demand for the hydraulic hammer, it is to meet the requirement for the installation of smaller sizes of driven square piles up to 250mm X 250mm, and driven spun piles up to diameter max of 300mm.

An environmentally acceptable, low noise and non-polluting method with higher driving performance is offered by IPH Hydraulic Piling Machine. The hydraulic system had been modified from excavator. Without any power pack, it does not require heavy crane during mobilization & demobilization. More often, there is no dismantling of parts during transportation. No power pack is required for the above system. It is capable to work in rough terrain. It is able to handle up to 9 meter length of pile. If required longer leader could be arrange. It is able to drive raked section at the ratio of 1:3.

During the design development of this hammer particular attention was paid to easy operation and low maintenance problems. IPH Hydraulic Pile hammer are manufactured, using high quality materials, on the most modern machine tools and with utmost precision.

Photo 3.1 The pile machine used at the site, The IPH Hydraulic Piling Hammer.

3.3.1.2 Type of Pile Used

Piles are columnar elements in a foundation which have the function of transferring load from the superstructure through weak compressible strata or through water, onto stiffer or more compact and less compressible soils or onto rock. They may be required to carry uplift loads when used to support tall structures subjected to overturning forces from winds or waves (Tomlinson, 2007).

According to Schwartz (2000), piles can be made of treated or untreated wood, cast-in-place or precast concrete, steel, or a combination of these materials. There are two types of piles, which are end-bearing and friction. An end-bearing pile is a long column that extends to solid bedrock. It works like a leg on the table. A friction-type pile is more like a nail driven into wood. It uses the friction between the pile's surface and the soil to support the load on the pile.

Untreated wood pile is relatively cheap, but it has two disadvantages. First, an untreated wood pile must be cut off below the lowest water table; if the water table is subsequently lowered on account of a permanent change in groundwater conditions, the uppermost parts of the pile disintegrate within a relatively short time. Second, a wood pile may break if it is driven too hard. Because concrete or steel piles can be driven harder than wood piles without any risk of damage, the safe design load for such piles is considerably greater than that for wood piles.

Steel piles generally are either pipe piles or rolled steel H-section piles. Pipe piles can be driven into the ground with their ends open or closed. In many cases, the pipe piles are filled with concrete after they are driven. When necessary, steel piles are spliced by welding or by riveting.

Concrete piles may be divided into two basics types; precast piles and cast-in-situ piles. Precast piles can be prepared using ordinary reinforcement, and they can be

square or octagonal in cross section. Reinforcement is provided to enable the pile to resist the bending moment developed during pickup and transportation, the vertical load, and the bending moment caused by lateral force. The piles are cast to desired length and cured before transported to the work sites (Das, 2008).

The pile used at the site is 'MDC' STD E PILE (4T9MM), which is 150mm X 150mm X 3m and 150mm X 150mm X 3m in sizes. The piles are the products of MDC Precast Industries Sdn.Bhd. and produced by good quality Portland Pulverised-Fuel Ash Cement (PFA), which can perform much better in workability, durability and long term strength. It used an air-compressed vibrator to provide an equal efficient compacting process.

Photo 3.2 The 150mm X 150mm X 3m Piles.

Photo 3.3 The 'MDC' STD E PILES.

Advantages of square piles are that the longitudinal steel is better located to resist flexure, easy to form in banks or tiers, have more square area for volume of concrete and easier to place concrete.

3.3.1.3 Test Pile

	PILE - DRIVING RECORD	
Name of project :	Cadangan membina dan menyiapkan :- 3 Unit Rumah Sesebuah 1 Tingkat, 54 Unit Rumah Berkembar 1 Tingkat Jenis A, 6 Unit Rumah Berkembar 1 Tingkat Jenis B,16 Unit Rumah Berkembar 2 Tingkat,19 Unit Rumah Teres 2 Tingkat, Di atas Lot 194, 195, 2765 & 2767, Mukim Derga, Daerah Kota setar, Kedah Darul Aman	Date 6/6/12 Time start / end : Hammer Type : 2.5
Name of contractor :	Shahab Builders & Engineering Sdn. Bhd.	Existing grd. Level :
Pile Type	R.C Square Pile	Pile cut-off level :
Location : ~~ED9 E4 A~~ 12E-C2-A		Penetration :
Set (calculated) :		Set (actual) :

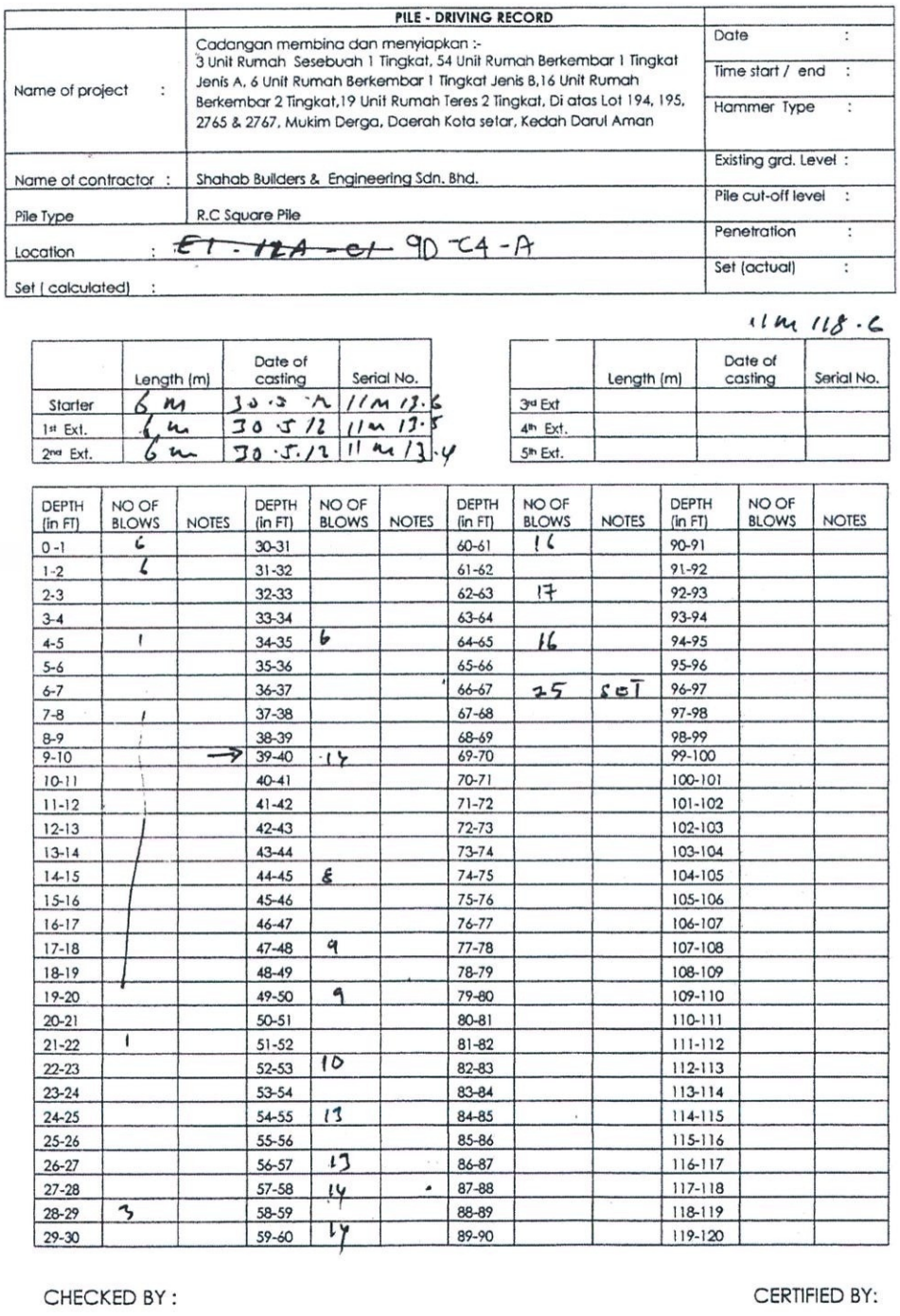
	Length (m)	Date of casting	Serial No.
Starter	6m	12.4.12	11M 9.10
1st Ext.	6m	12.4.12	11m 9.11
2nd Ext.	6m	12.4.12	11m 9.8

	Length (m)	Date of casting	Serial No.
3rd Ext	6m	12.4.12	11m 9.7
4th Ext.			
5th Ext.			

DEPTH (in FT)	NO OF BLOWS	NOTES	DEPTH (in FT)	NO OF BLOWS	NOTES	DEPTH (in FT)	NO OF BLOWS	NOTES	DEPTH (in FT)	NO OF BLOWS	NOTES
0 -1	3		30-31			60-61	16		90-91		
1-2			31-32			61-62			91-92		
2-3	1		32-33			62-63	16		92-93		
3-4			33-34			63-64			93-94		
4-5	1		34-35			64-65	16		94-95		
5-6			35-36			65-66			95-96		
6-7			36-37	4		66-67			96-97		
7-8			37-38			67-68	24		97-98		
8-9			38-39	3		68-69			98-99		
9-10			39-40			69-70	25		99-100		
10-11			40-41	13		70-71			100-101		
11-12			41-42			71-72			101-102		
12-13			42-43	12		72-73			102-103		
13-14			43-44			73-74	29	SET	103-104		
14-15			44-45			74-75			104-105		
15-16			45-46			75-76			105-106		
16-17			46-47	11		76-77			106-107		
17-18			47-48			77-78			107-108		
18-19			48-49			78-79			108-109		
19-20	1		49-50	13		79-80			109-110		
20-21			50-51			80-81			110-111		
21-22	2		51-52			81-82			111-112		
22-23			52-53	12		82-83			112-113		
23-24			53-54			83-84			113-114		
24-25	2		54-55	12		84-85			114-115		
25-26			55-56			85-86			115-116		
26-27	1		56-57			86-87			116-117		
27-28			57-58	14		87-88			117-118		
28-29			58-59			88-89			118-119		
29-30			59-60	14		89-90			119-120		

CHECKED BY : CERTIFIED BY:

Figure 3.1 The first test pile.



PILE - DRIVING RECORD

Name of project :	Cadangan membina dan menyiapkan :- 3 Unit Rumah Sesebuah 1 Tingkat, 54 Unit Rumah Berkembar 1 Tingkat Jenis A, 6 Unit Rumah Berkembar 1 Tingkat Jenis B,16 Unit Rumah Berkembar 2 Tingkat,19 Unit Rumah Teres 2 Tingkat, Di atas Lot 194, 195, 2765 & 2767, Mukim Derga, Daerah Kota setar, Kedah Darul Aman	Date : Time start / end : Hammer Type :
Name of contractor :	Shahab Builders & Engineering Sdn. Bhd.	Existing grd. Level :
Pile Type	R.C Square Pile	Pile cut-off level :
Location : ~~ET-12A-01~~ 9D-C4-A		Penetration :
Set (calculated) :		Set (actual) :

11m 118.6

	Length (m)	Date of casting	Serial No.
Starter	6 m	30.3.12	11m 13.6
1st Ext.	6 m	30.3.12	11m 13.5
2nd Ext.	6 m	30.3.12	11 m 13.4

	Length (m)	Date of casting	Serial No.
3rd Ext			
4th Ext.			
5th Ext.			

DEPTH (in FT)	NO OF BLOWS	NOTES	DEPTH (in FT)	NO OF BLOWS	NOTES	DEPTH (in FT)	NO OF BLOWS	NOTES	DEPTH (in FT)	NO OF BLOWS	NOTES
0-1	6		30-31			60-61	16		90-91		
1-2	6		31-32			61-62			91-92		
2-3			32-33			62-63	17		92-93		
3-4			33-34			63-64			93-94		
4-5	1		34-35	6		64-65	16		94-95		
5-6			35-36			65-66			95-96		
6-7			36-37			66-67	25	SET	96-97		
7-8	1		37-38			67-68			97-98		
8-9			38-39			68-69			98-99		
9-10		→	39-40	14		69-70			99-100		
10-11			40-41			70-71			100-101		
11-12			41-42			71-72			101-102		
12-13			42-43			72-73			102-103		
13-14			43-44			73-74			103-104		
14-15			44-45	8		74-75			104-105		
15-16			45-46			75-76			105-106		
16-17			46-47			76-77			106-107		
17-18			47-48	9		77-78			107-108		
18-19			48-49			78-79			108-109		
19-20			49-50	9		79-80			109-110		
20-21			50-51			80-81			110-111		
21-22	1		51-52			81-82			111-112		
22-23			52-53	10		82-83			112-113		
23-24			53-54			83-84			113-114		
24-25			54-55	13		84-85			114-115		
25-26			55-56			85-86			115-116		
26-27			56-57	13		86-87			116-117		
27-28			57-58	14		87-88			117-118		
28-29	3		58-59			88-89			118-119		
29-30			59-60	14		89-90			119-120		

CHECKED BY : CERTIFIED BY:

Figure 3.2 The second test pile.

Based on these two test piles, it shows that there are two different soil conditions. The first test pile is set at 73-74 feet depth, showing that the soil beneath it is soft.

Whereas, the second test pile is set at 66-67 feet depth, showing that the soil beneath is hard compared to the first test.

For this test, four 6m piles have been used for one point. After knowing the limitation of the depth, it has been agreed that one of the four 6m piles is exchanged with a 3m pile.

3.3.2 Pile Cap

Varghese (2009) explained that pile caps are used to transmit the column load to the pile foundation. The plan dimension of the pile cap should be based on the assumption that the actual final position of piles in construction can be up to 10 cm out of line from the theoretical centre lines. Pile caps should, therefore, be made very large to accommodate these deviations. However, Tomlinson (2007) stated that the minimum number of diameter piles which is permitted in an isolated pile cap is three. Caps for single piles must be interconnected by ground beams in two directions, and for twin piles by ground beams in a line transverse to the common axis of the pair.

The design objectives of pile caps are that they should be capable of safely carrying the bending moment and shear force and they should be deep enough to provide adequate bond length for the pile reinforcements and the column starter bars. The important parameters in the design of pile caps are as follows:

- Shape of the pile cap
- Depth of the pile cap
- Amount of steel to be provided
- Arrangement of reinforcement

The column or wall on the pile cap should be centered at the geometric center of the pile cap in order to transfer load evenly to each pile.

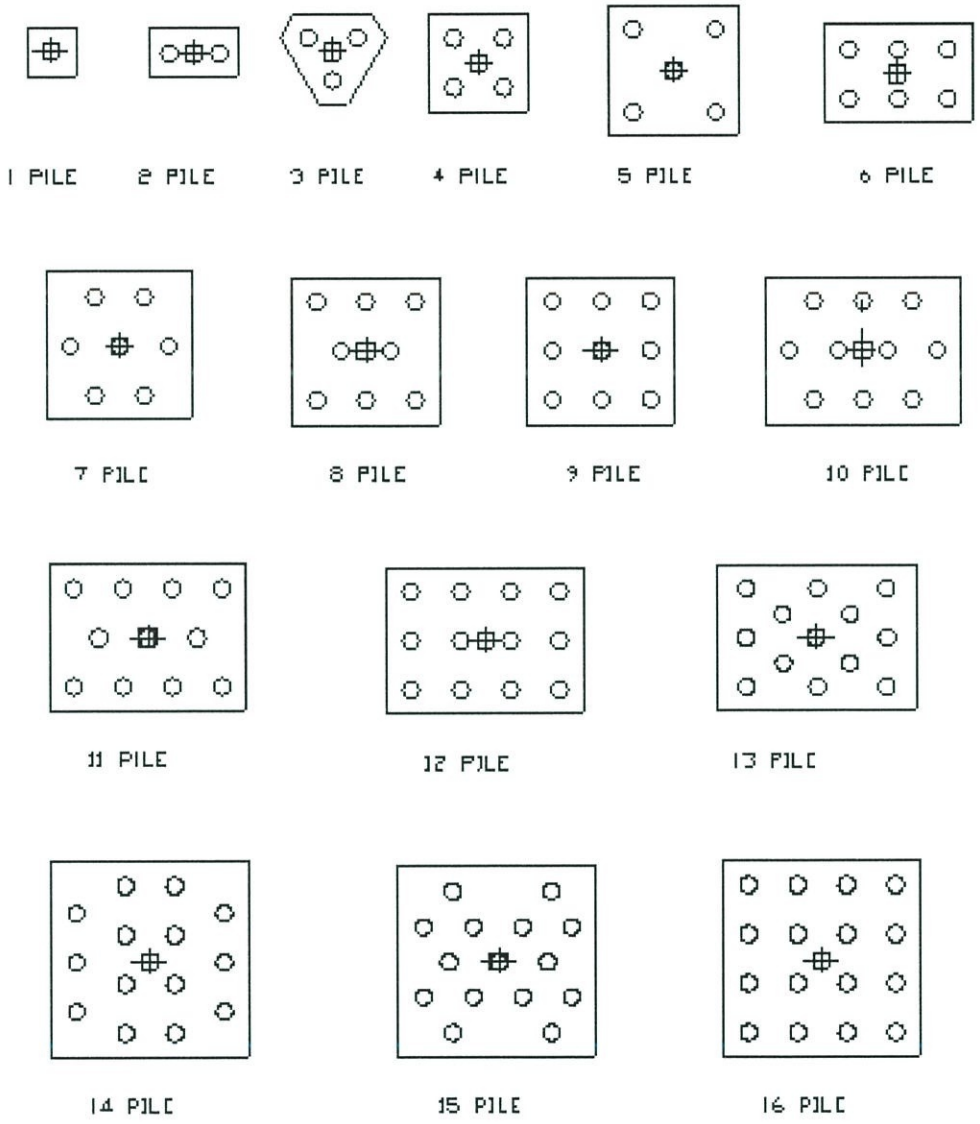


Photo 3.4 Example of the design of pile layout pattern.

Source: http://www.ce-ref.com/pile_cap.htm (7th September 2012)

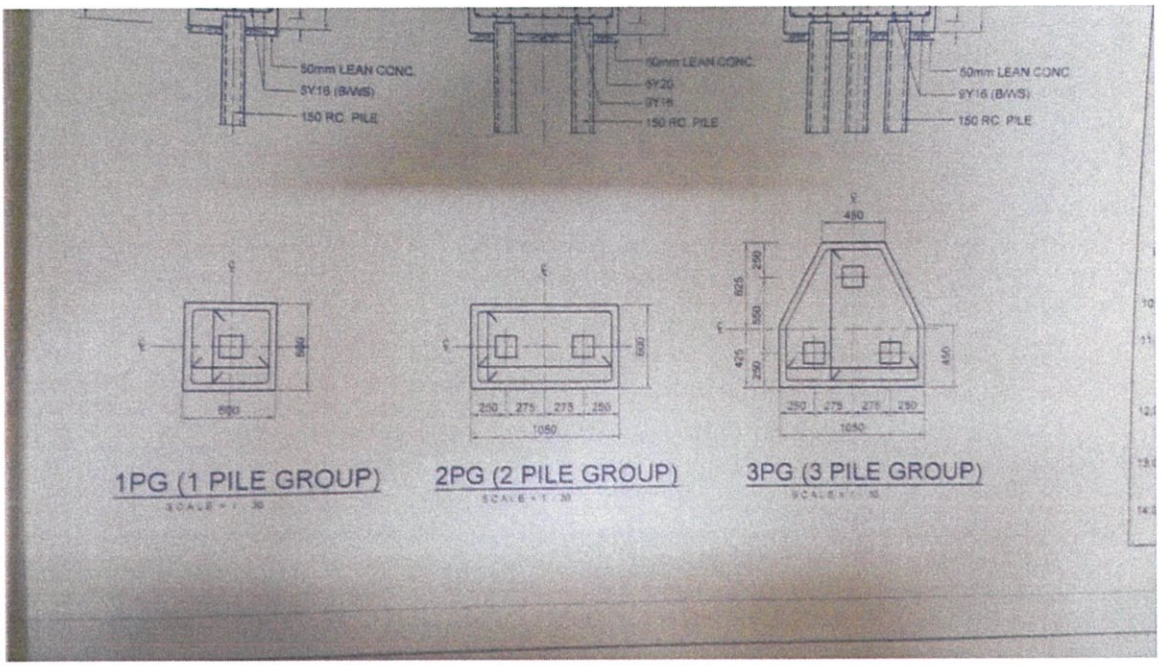


Photo 3.5 The design of pile cap used at the site.

The detailing of reinforcement in pile caps depends on their shape. According to Gambhir (2008), in order to prevent the outward splaying tendency of piles, reinforcement is provided at the bottom of the pile cap, running around longitudinal reinforcement projecting from the piles into the cap. This reinforcement should be so bent that there is change of its directions at head of every pile. The area of such reinforcement distributed across the depth is usually not less than 20 per cent of the tensile reinforcement.

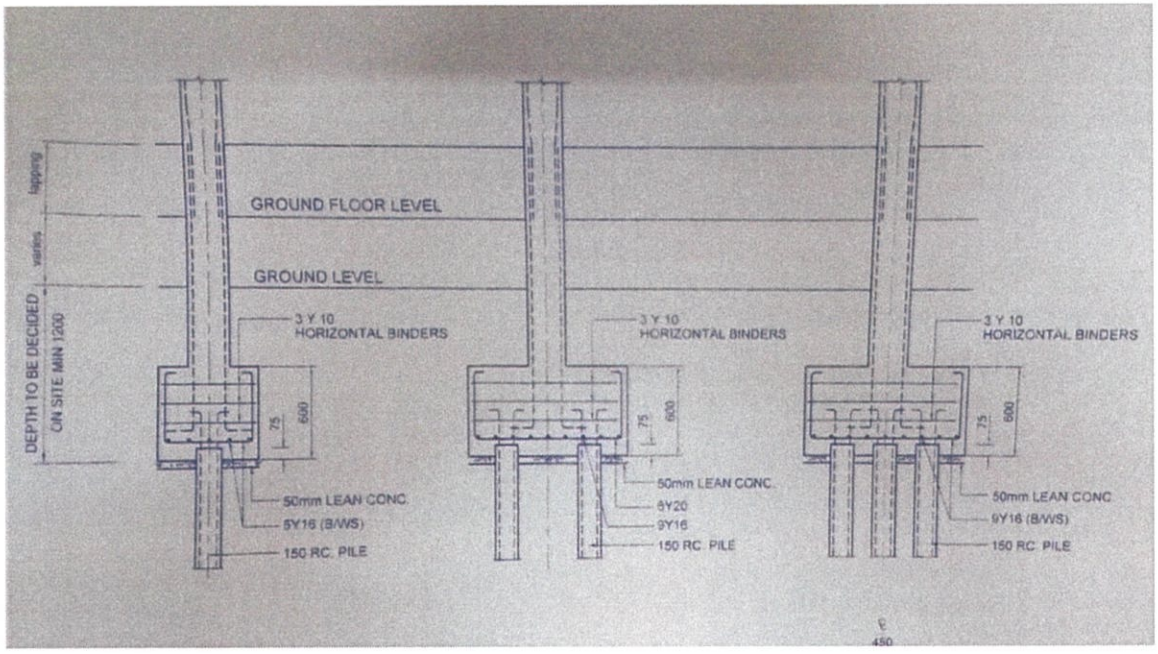


Photo 3.6 The arrangement of reinforcement in pile cap.

Photo 3.7 The pile cap reinforcement for 3 pile group.

Photo 3.8 The pile reinforcement for 2 pile group.

Photo 3.9 The pile cap reinforcement for 1 pile group.

The grade of concrete used for concreting the pile cap is Grade 25.

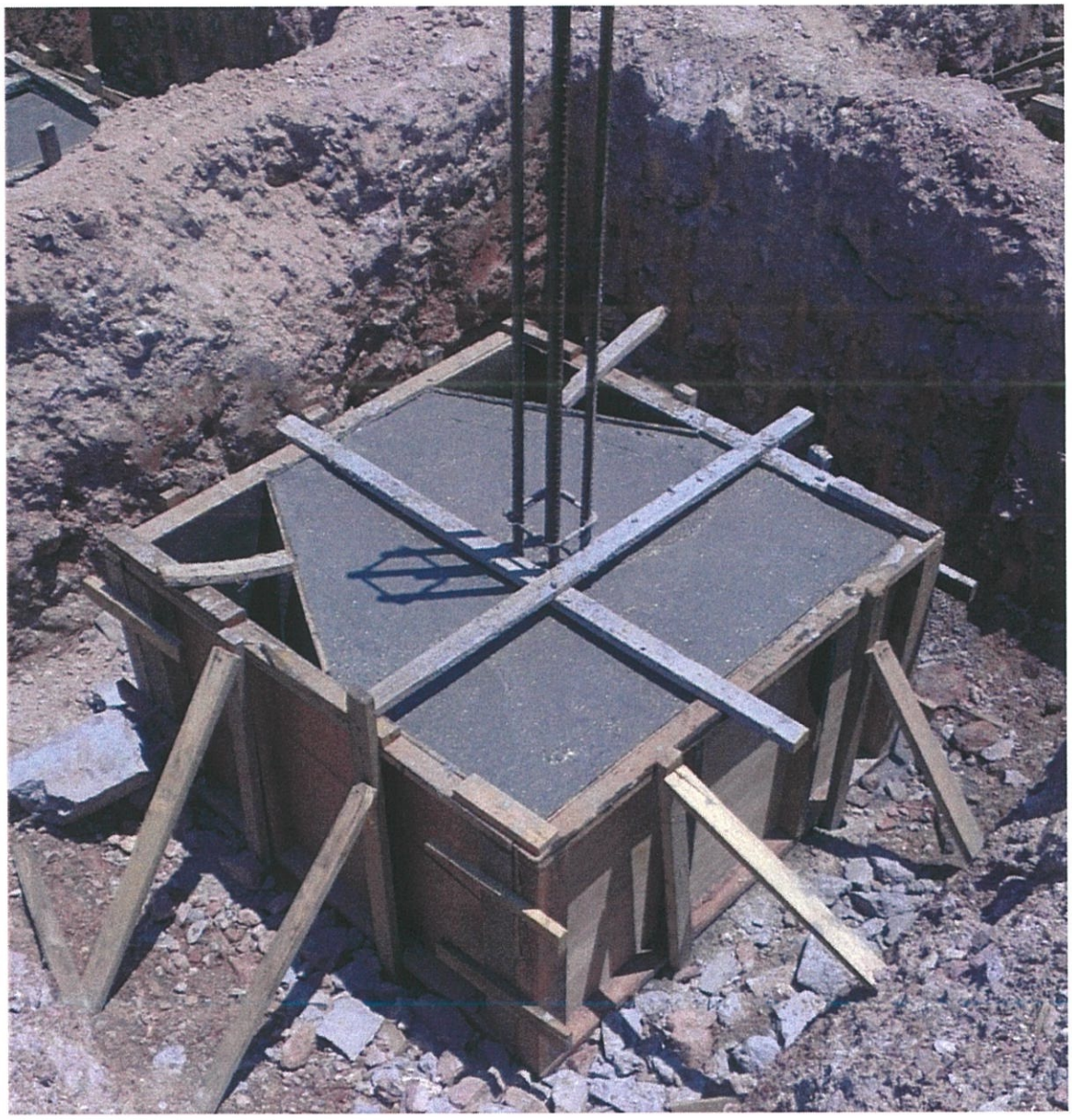


Photo 3.10 The concreted pile cap 3 pile group.

Photo 3.11 The pile cap for 1 pile group.

3.3.3 Column Stump

Column stump is a column that considered as lower structure because it is located in the ground below the waterproof layer at ground floor slab. The position is vertical above the foundation. The function of the column stump is to transfer load of building to the foundation. Column stump will receive load from ground beam and column and then will transfer the load to the foundation. The columns can be made from steel tube; pre cast concrete or treated timber these need to be designed by an engineer for correct sizing.

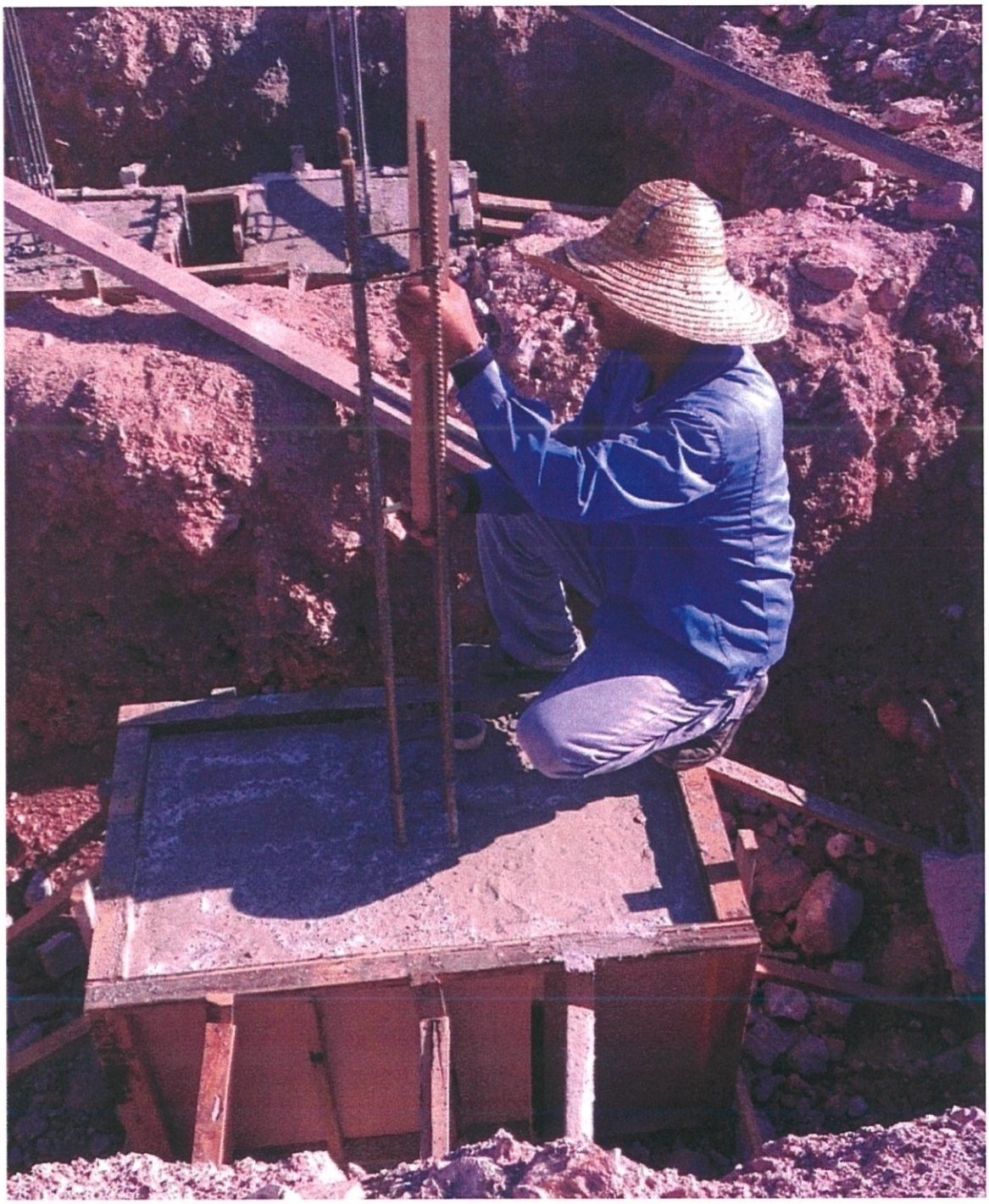


Photo 3.12 A worker marked the level of the column stump and ground beam.

Photo 3.13 The formwork for column stump.

Photo 3.14 The column stump on the pile cap.

3.3.4 Ground Beam

Ground beams are provided to act as ties or compressions members between adjacent pile caps, so providing the required against sideways or buckling of the piles under lateral or eccentric loading. Ground beams and pile capping beams may have to withstand horizontal loading from the soil due to the tendency to movement of vertical piles upon lateral loading. They may also be subjected to bending in a vertical direction due to differential settlement between adjacent group of piles (Tomlinson, 2007). The superimposed loading on the ground beams is transferred to the piles by bonding the longitudinal reinforcing steel to the beams into the pile caps.

To facilitate construction, ground beams should be arranged, where possible, to pass across the tops of the pile caps and not to frame into the sides of the caps, the connection between the cap and the ground beam provided by column starter bars and by the friction and bond between the cap and beam. If the beams must frame into the cap sides, an alternative to providing pockets is to place the concrete in the caps in two operations, a horizontal construction joint being formed in each cap at the level of the underside of the ground beams.

Photo 3.15 The formwork for ground beam.

Photo 3.16 Lean concrete is poured before concreting.

Photo 3.17 The reinforcement for ground beam.

Photo 3.18 The ground beam.

3.4 Problems and Ways to Overcome It

There are three problems that occurred at the site of pile foundation. First, the piles are driving out of alignment. Piles may be moving out of alignment tolerance due to hammer-pile alignment control or due to soil conditions. Soil conditions such as near surface obstructions or steeply sloping bedrock having minimal overburden material may prevent tolerance from being met. If due to poor hammer-pile alignment control, a pile gate, template or fixed lead system may improve the ability to maintain alignment tolerance. If due to soil conditions, then additional piles can be added to the correct alignment.

Photo 3.19 Piles on the left was out of alignment. Piles on the right were added to stay in the correct alignment.

The second problem is when the piles are slightly bending and deviate from vertically or intended direction. This may happened because of hammer was not parallel with the pile. It can be prevented by using straight pile segments, having splices equally

strong with the pile, or by ensuring that the hammer strikes concentrically and parallel with the length of the piles.

Photo 3.20 The bending of the pile.

The third problem is when the piles were developing complete horizontal cracks-easy driving. To solve this problem, first, determine the tension stresses along the pile for observed blow counts. If high calculated tension stresses, add some cushioning or reduce the strokes. If low calculated tension stresses, check the hammer performance.

CHAPTER 4

CONCLUSION AND RECOMMENDATION

Pile foundation is one of many foundations of a building and it is classified as a deep foundation. Deep foundation means it goes more than just 2.000 depths into the soil. In this site, precast concrete piles were used for the foundation as it is suits the soil condition. One more reason on why pile foundation has been chosen is because it can bear the load from the double-storey terrace houses that will be built on it. The load will be transferred from the column to the ground beam and to the pile cap beneath the ground before it is been transmitted to the soil. Four components have been identified as a part of pile foundation, which are piles, pile caps, column stump and ground beam. Even though there are few problems happened, they were managed to be solved.

However, it is recommended:

- That the piles chosen are really suitable for the soil condition and buildings built on it.
- The piling machine using strokes that suitable with the strength of the pile.
- The hammer is located parallel with the pile.

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