UNIVERSITI TEKNOLOGI MARA

DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

SEPTEMBER 2015

It is recommended that the report of this practical training provided

By

Filzah Atikah Binti Yusop

2013434788

entitled

Aluminum Formwork System

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

Report Supervisor	:	Puan Azira Binti Ibrahim
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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 stated herein, prepared during a practical training session that I underwent at Syarikat Nyaman Sdn. Bhd. for duration of 5 months starting from 25 May 2015 and ended 09 October 2015. It is submitted as one of the prerequisite requirements of DBN307 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

.....

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UiTM ID No : 2013434788

Date : 12. OCTOBER. 2015

ACKNOWLEDGEMENT

Alhamdulillah, praise to Allah S.W.T.

I would like to extend my heartfelt gratitude for the guidance, advice and help rendered throughout the period of training by the following group of amazing individuals. First and foremost, I would like to thank Dato' Hj. Mat Shafie Awang for the opportunity given, to conduct my training in his esteem company. His team of professionals comprising of Tuan Haji Azhar Abd Gani, En. Mohd Azmi Abdul Rahman, En. Mohd Aziyan Abdul Rahman, En. Mohd. Hisyam Dato Shafie, En. Muhd Husni Suppian, and others in the company who have enabled me to learn and develop my understanding, knowledge and feel of real time projects. Not to mention to the sub- contractors that worked together with Syarikat Nyaman Sdn. Bhd., thank you very much for the continuous knowledge and guidance for me.

I would like to thanks the lecturers who are directly involved during my training stint. To Puan Azira Ibrahim; Supervising Lecturer, En Muhammad Naim Mahyuddin; Visiting Lecturer, Puan Noor Rizallinda Ishak; Practical Training Coordinator and Dr. Mohd Rofdzi Abdullah; Faculty Coordinator, thank you. I value the time, effort and encouragement that they have contributed towards the successful completion of this report.

Last but not least, my special thanks to my dearest and beloved parents;
and for their sacrifices over the years building me into a person I am today.

Thank you so much.

ABSTRACT

Formwork is an element that is very essentials in construction projects as they are the main element in all structural design in the building. There are many types of formwork system available in the construction industry; therefore, this report will discuss about aluminum formwork system. This report is conducted to study how the aluminum formwork system works. The objective of this report is to identify the construction method of aluminum formwork system, to determine the components used in the aluminum formwork system and to compare the aluminum formwork system with timber formwork system. The study has been done at a high rise building of 19 storey at Mukim 12, Sungai Nibong, Pulau Pinang. Through observation obtained by the author, the methodology of this system uses the same concept as recycle process, i.e. redo, reuse and recycle. By using this system, it is definitely gave a greater impact towards the completion of a project. The author believes that this system can ease the work progress to all the builders and to any parties involved in the construction process.

TABLE OF CONTENTS PAGE NO

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF APPENDIX

CHAPTER 1.0

PREFACE

1.1 Introduction

As years gone by, the technology has spread like a wildfire in our everyday lives. Technology has made our life much easier. This includes the technology in the construction industry. The important elements in constructing a building is the structural elements, such as; columns, beams, staircase, roof and others. In order to build these structural elements it needed a mould to create them. Thus, the usage of formwork is very essentials in making them a reality. According to Béton (2009), "*formwork: (according to BS 6100-6.5): the section of the temporary works used to give the required shape and to support the fresh concrete. It consists of sheathing materials (e.g. wood, plywood, metal sheet or plastic sheet) in direct contact with the concrete, and joists or stringers that directly support the sheathing*". There are many types of formwork available throughout the world in this 21st century. Therefore, this report will discuss the aluminum formwork system. Generally, aluminum formwork system is known as the Industrialized Building System (IBS) in Malaysia as it is prefabricated first at the factory, then later installed or fixed at construction site. Aluminum formwork system requires high precision in designing the formwork in order for it to function and assembled properly. This report will discuss how the aluminum formwork system is functioning and how the system can give greater impact in construction works compared to timber formwork system.

1.2 Objective

The objectives of this report are:

1.2.1 To identify the construction method of aluminum formwork system.

1.2.2 To determine the components used in the aluminum formwork system.

1.2.3 To compare the aluminum formwork system with timber formwork system.

1.3 Scope of Study

This report is conducted to study how the aluminum formwork system works in a construction project. The aspects looked into are the methodology of how the system functioning and works, the components in the system and as why the system is better than using timber formwork. Location of the study is at Mukim 12, Jalan Sultan Azlan Shah, Daerah Barat Daya, Penang. It is a construction project of a high rise building consists of two blocks of residential and a facility podium. Block A is a 900 square feet/unit, a total of 170 units of 19 storey, while Block B is a 800 square feet/unit, a total of 170 units of 19 storey. A one block podium of 2 ½ storey consists of parking lot, swimming pool, and other facilities for residents. (Refer Appendix A)

1.4 Method of Study

The methods of study in this report were done based on three aspects. Which is; through internet, interviews and observation.

1.4.1 The Internet

The World Wide Web has been a great help to find all the information that is needed which have not found in books. Mainly the search is about formwork systems and aluminum formwork system.

1.4.2 Interviews

Interviews were done in order to fully understand about how the system functioning. The people that have been interviewed are the people who work at the construction site and have been involved in the construction industry for over a decade.

1.4.3 Observation

Observation is the experience and knowledge that are gathered during the training stint of five months at Syarikat Nyaman Sdn Bhd.

CHAPTER 2.0

COMPANY BACKGROUND

2.1 Introduction of Company

The company was formed to undertake construction projects with the government and the private sector.

In May 1987, the Company was registered with PUSAKABUMI as a Class B contractor. In August 1993, the Company was registered with Pusat Khidmat Kontraktor (PKK) as a Class A Bumiputera Contractor.
In 1996, it was registered with the Construction Industry Development Board (CIDB), Malaysia under Grade G7.
In year 2001, the Company has achieved the ISO 9001: 2000 Quality Systems as a General Contractor in Civil and Building Industry and was later upgraded to ISO 9001: 2008.

Since year 2000, the Company has ventured in Property Development and has complete more than 500 units of Residential Landed properties and Light Industrial Building on Penang Island through its subsidiary company. Property Development includes Taman Tunas Muda Phase 2 in Sungai Ara, Taman Nyaman Indah in Balik Pulau, Taman Industri Nyaman Mutiara in Sungai Tiram and Metro Residences in Bukit Jambul. All the property development is located on Penang Island.

2.2 Company Profile

Table 2.1 : Company Profile

Board of Directors	Dato' Mat Shafie Bin Awang
	Azhar Bin Abd Ghani
Registers	KJ. Tan Sdn Bhd Pudu 55100 Kuala Lumpur
Auditors	Yeang & Co Unit A1 & A2, 18th Floor, 18, Persiaran Gurney, Gurney Tower, 10420 Pulau Pinang
Registered Office	199, Jalan Macalister, Georgetown, 10450 Pulau Pinang
Contact Number	Tel No : : :
	Fax No : 04- 228 2601
Email Address	info@nyaman.com.my
Banker's	Maybank Islamic Berhad
Financial Status as at 30th June 2014	Net Current Assets : RM 19, 112, 943. 00
	Company Net Worth : RM 21, 700, 095. 00
	Authorised Capital : RM 5, 000, 000. 00
	Paid Up Capital : RM 2, 000, 000. 00
List of Shareholder's	Dato' Mat Shafie Bin Awang (80%)
	Azhar Bin Abd Ghani (20%)

2.3 Organization Chart

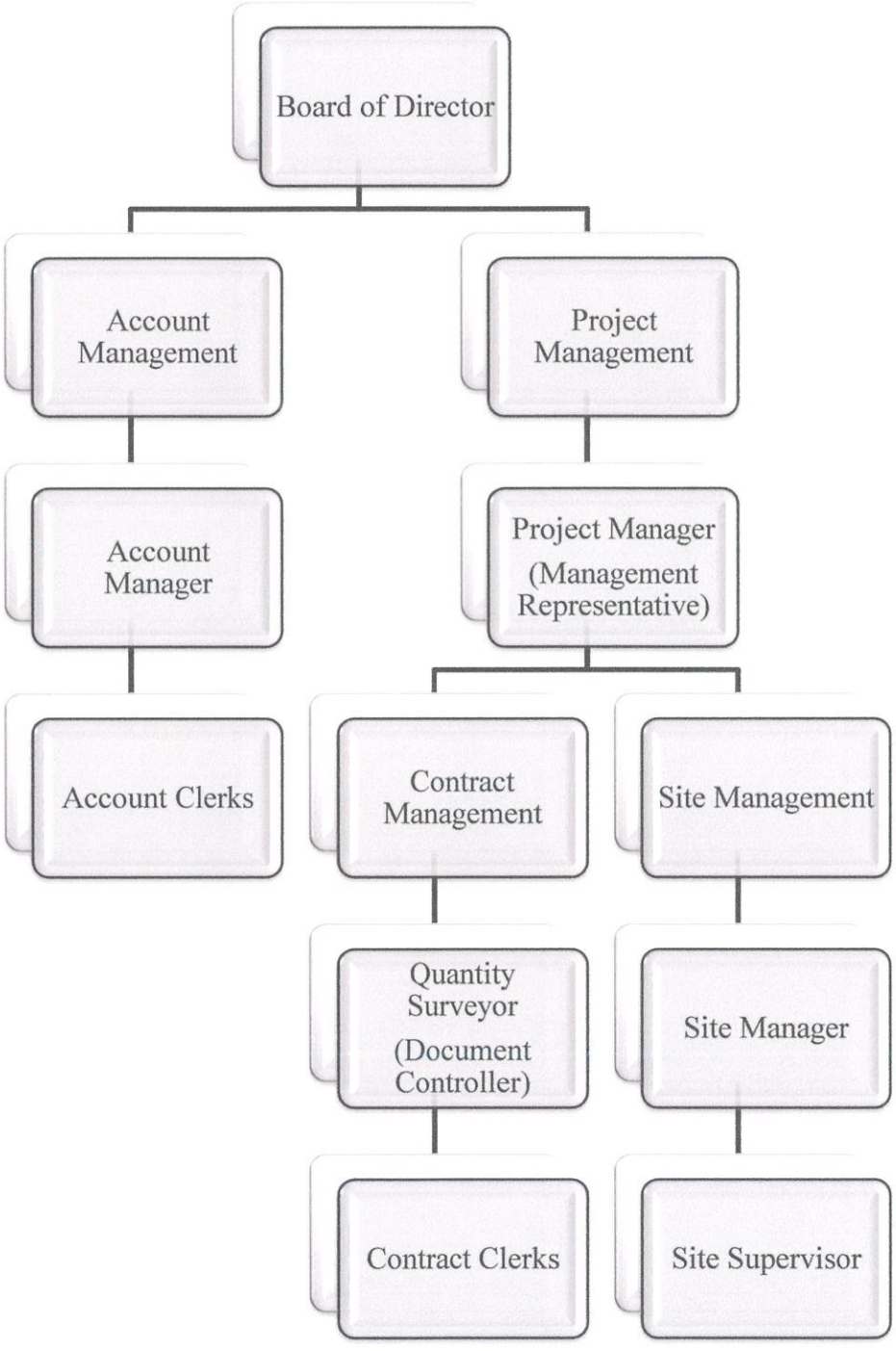


Figure 2.1 : Organization Chart

2.4 List of Projects

2.4.1 Completed Projects

Table 2.2 : Completed Projects

COMPLETED PROJECTS ON 2005 ONWARDS			
NO	**DESCRIPTION**	**CLIENT**	**CONTRACT SUM (RM)**
01	Proposed 59 Units @ Storey Terrace Houses on Lot 688, 689, 690, 691 & PT 319, Jalan Seri Genting, Mukim 6, Daerah Barat Daya, Pulau Pinang	Infra Land Development Sdn Bhd Date Awarded 2010	11, 054, 861. 24
02	Proposed Housing Scheme for 38 Units 3 Storey Terrace Houses, 2 Units 3 Storey D\Semi Detached Houses on Lot 681, 683 & 684, Jalan Pondok Upeh, MK 6, Daerah Barat Daya, Pulau Pinang	Utility Resources Sdn Bhd Date Awarded 2010	8, 438, 000. 00
03	Proposed to Construct 2 Storey Bungalow House (1 Unit) on Lot 9851 (Previous Lot is 7976), MK 13, Daerah Timur Laut, Pulau Pinang	TYT Tun Dato' Seri Utama Date Awarded 2011	3, 272, 807. 87
04	Proposed Development of 53 Housing Units 1 Floor Terrace (Type A) and 39 Housing Units 1 Floor Terrace (Type B) on Lot 132, 134, 748, 749, 185 and 786 MK 19, Seberang Perai Tengah, Pulau Pinang	JKP Sdn Bhd Date Awarded 2011	9, 051, 872. 03

05	Proposed to Erect 14 Units of 2 Storey Terrace House, 18 Units of 3 Storey Terrace House (Type 1), 12 Units of 2 Storey Terrace House (Type 2) & 2 Units of 2 Storey Semi Detached House on Lot 732, 728, 729, 977, 978, 1418, 10088 & Plot A, MK 6, Daerah Barat Daya, Pulau Pinang	Metro Penang Sdn Bhd Date Awarded 2011	14, 003, 600. 00
06	Proposed to Erect Light Factory and 2 Storey of Semi Detached Office Type A (1 Unit), Type B (5 Units), Type C (2 Units), Type D (2 Units), Type E (5 Units), Type F (1 Unit) and Light Factory and 2 Storey of Office Terraced Type A (2 Units) and Type B (25 Units) on Lot 15315, MK 12, Bayan Lepas, Pulau Pinang	Nyaman Mutiara Sdn Bhd Date Awarded 2012	18, 500, 500. 00
07	Proposed Development of 80 Housing Units of 2 Storey Cost Gouging Cluster (Phase 1D) on Lot 132, 134, 748, 749, 785 and 786 Seri Akasia, MK 19, Penanti, Seberang Perai Tengah, Pulau Pinang.	JKP Sdn Bhd Date Awarded 2012	6, 331, 895. 53
08	Proposed Erection of 24 Housing Units Terrace Block F & G (Plot 45- 68) on Lot 732, 729, 977, 978, 1418, 10088 and Plot A, MK 6, Daerah Barat Daya, Jalan Balik Pulau, Pulau Pinang	Metro Penang Sdn Bhd Date Awarded 2013	3, 849, 000. 00

2.4.2 Ongoing Projects

Table 2.3 : Ongoing Projects

ONGOING PROJECTS			
NO.	**DESCRIPTION**	**CLIENT**	**CONTRACT SUM (RM)**
01	Proposed to establish 1 Block of 5 Storey of Sekolah Agama Rakyat on Lot 8159, MK 12, Daerah Barat Daya, Lorong Kenari, Jalan Dato' Ismail Hashim, Pulau Pinang.	Lembaga Jawatankuasa & Qaryah Masjid Sungai Ara Date Awarded 2013	2, 300, 000. 00
02	Proposed Construction and Completion of 1 Block of 19- 20 Storey Middle Cost Apartment Type A (170 Units), 1 Block of 19- 20 Storey Middle Cost Apartment Type B (170 Units) and 1 Block of 2 ½ Storey of Car Park Podium together with Infrastructure Works that are related to Seri Anggun Phase 3 at Mukim 12, Jalan Sultan Azlan Shah, Daerah Barat Daya, Pulau Pinang.	JKP Sdn Bhd Date Awarded 2014	57, 653, 556. 67

CHAPTER 3.0

CASE STUDY

3.1 Introduction of Project

The title of the project is to Propose Construction and Completion of 1 Block of 19 - 20 Storey Middle Cost Apartment Type A (170 Units), 1 Block of 19 - 20 Storey Middle Cost Apartment Type B (170 Units) and 1 Block of 2 ½ Storey of Car Park Podium together with Infrastructure Works that are related to Seri Anggun Phase 3 at Mukim 12, Jalan Sultan Azlan Shah, Daerah Barat Daya, Pulau Pinang. This project is owned by JKP Sdn Bhd and the construction work started with construction of piling in the early of September 2014 for Block A. The case study of constructing aluminum formwork is done at Block A. (Refer Appendix B)

Below are the consultants involved in this project:

Table 3.1 : List of Consultants

Architect	**A.S.A.S Architects**
Engineer (Civil & Structure)	**IZINRIA Consulting Services**
Engineer (Mechanical & Electrical)	**ABA Jurutera Perunding**
Quantity Surveyor	**ZMS Associates**
Contractor	**Syarikat Nyaman Sdn. Bhd.**

Photo 3.1 : Project Signboard

The manufacturer of the aluminum formwork system is TAC System Formwork Sdn Bhd. This company has involved in the construction industry for over a decade. TAC System Formwork Sdn Bhd has been established since 2002 by Mr. Charlie Teh. Since then, the company has completed varieties of construction project all over Malaysia and has spread its wings to Thailand, the Philippines and Singapore. It has exported the formwork to all over Asia.

3.2 Aluminum Formwork System

Aluminum formwork system is known as Industrialized Building System (IBS) in Malaysia and it is quite similar to modular deck formwork. This system is designed by the manufacturer and later assembled at construction site.

This system is made in shapes of aluminum panels that can reach thousands of pieces. Since the house is design typically, all the units in the building is a mirrored image of the other. The design of aluminum panels in this project is based on architectural drawing since they didn't get permission to use the civil and structural drawing. The construction drawing supplied by TAC Formwork has included all the structural elements in the building. (Refer Appendix C)

The system is being calculated per meter square and not by per components. 1 m^2 of aluminum formwork can cost up to RM 500. Thus, making the main contractor spent approximately RM 1, 500, 000.00 for this formwork system. As stated in TAC official websites, this system can be used up to 250 repeats, thus can save cost and time for a long term period.

TAC System Formwork had issued one theory about how the system can creates one floor level in 4 - 5 days compared to timber formwork that took 10 - 15 days. Figuratively, in one month, the contractors can produce 4 - 5 floor levels in a high rise project. Thus, by using this formwork, the construction works can be done faster and efficiently.

Based on the theory issued by TAC, the author has a contrast opinion about it. Based on observation, it is quite impossible to create one floor level in 4 - 5 days, because there are few factors that need to be considered such as; weather condition, number of labors, labor's experience and the labor's working speed as well as the delaying delivery of formwork to construction site.

Weather plays an important factor in conducting the construction work smoothly. Living in Malaysia, the weather condition is either sunny clear or rain. Therefore, if heavy rain falls, all the construction work is delayed. By mid July till September, Penang has experience heavy rainfall throughout the months that makes the installation process is delayed. Thus affecting the progress of concrete work.

The contractor must budget the labors thoroughly. This means, the number of labors need not be less or more than it should be. If the number of labors is less, the speed efficiency of the project cannot be achieved. The worst situation would be that the number of labors is too many and there is no work to be done. This factor is crucial as it is directly connected to money. When talk about money, every cent is counted and is precious.

Besides that, the contractor also needs to think about the labors' experience on handling the formwork system. Even though this factor is not a major problem, but it is still need to be considered as it will affect the work progress. Sure enough, the system itself does not require skilled labor, but then, we need to count the time spent by teaching the labors about the aluminum panels. Besides that; the working speed also plays an important factor in speed and work efficiency.

One factor that is really essentials in achieving the speed efficiency is that the formwork needs to be delivered to site on time as agreed by both parties. (Refer Appendix D) From a contractor point of view; if the schedule cannot be fulfilled, the project is delayed thus creating great loss in the form of labor, energy, time and cost.

All of this problems can be solved if the parties involved worked together to fix it. Every problem has its own solutions. But the theory issued by TAC is still quite difficult; i.e. to achieve one floor level in 4 - 5 days. From the author's point of view, the system can achieved one floor level in 6 - 7 days. Comparative to that, it is still faster than using timber formwork.

3.3 Construction Method of Aluminum Formwork

Method statement on how to install aluminum formwork has been focused at Unit 9 and Unit 10 of Block A. This is because, for the first three floor of the units, the project uses timber formwork while waiting for the components to arrived on site. Aluminum formwork is started with third floor columns and for the fourth floor slab. The example of construction drawing by TAC Formwork is shown through Unit 9. (Refer Appendix E)

To summarize how the system works, aluminum formwork system is like putting up puzzle pieces together into becoming one big structure. To ease the installation of formwork on site, the manufacturer has labeled all the components at their body parts.

To ease understanding, figure below shows how the aluminum formwork system is functioning at site;

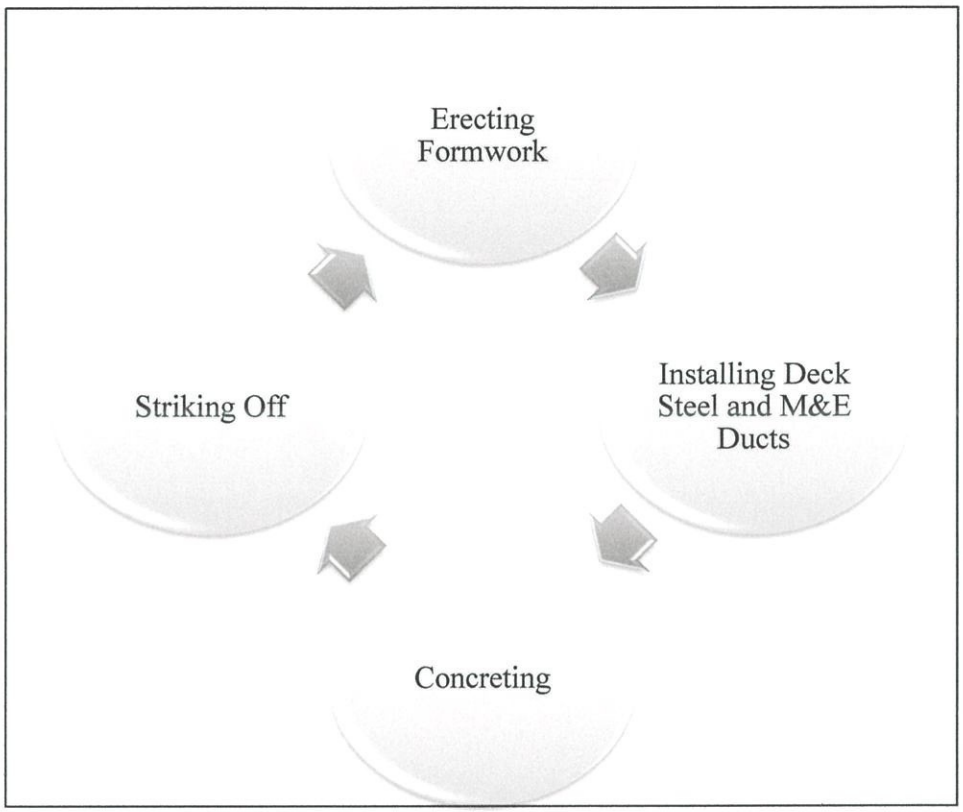


Figure 3.1: Cycle Process of Aluminum Formwork

3.3.1 Erecting of Formwork

The erecting process is done by referring the construction drawing supplied by TAC Formwork. This can be done easily as all the aluminum panels have its own sticker label attached to it. Thus making it easy for the labors to find the required panels.

(a) (b)

(c) (d)

(e) (f)

Photo 3.2 (a-f) : Sequence of Erecting Aluminum Formwork

(3^{rd} Floor Column - 4^{th} Floor Slab/ Beam)

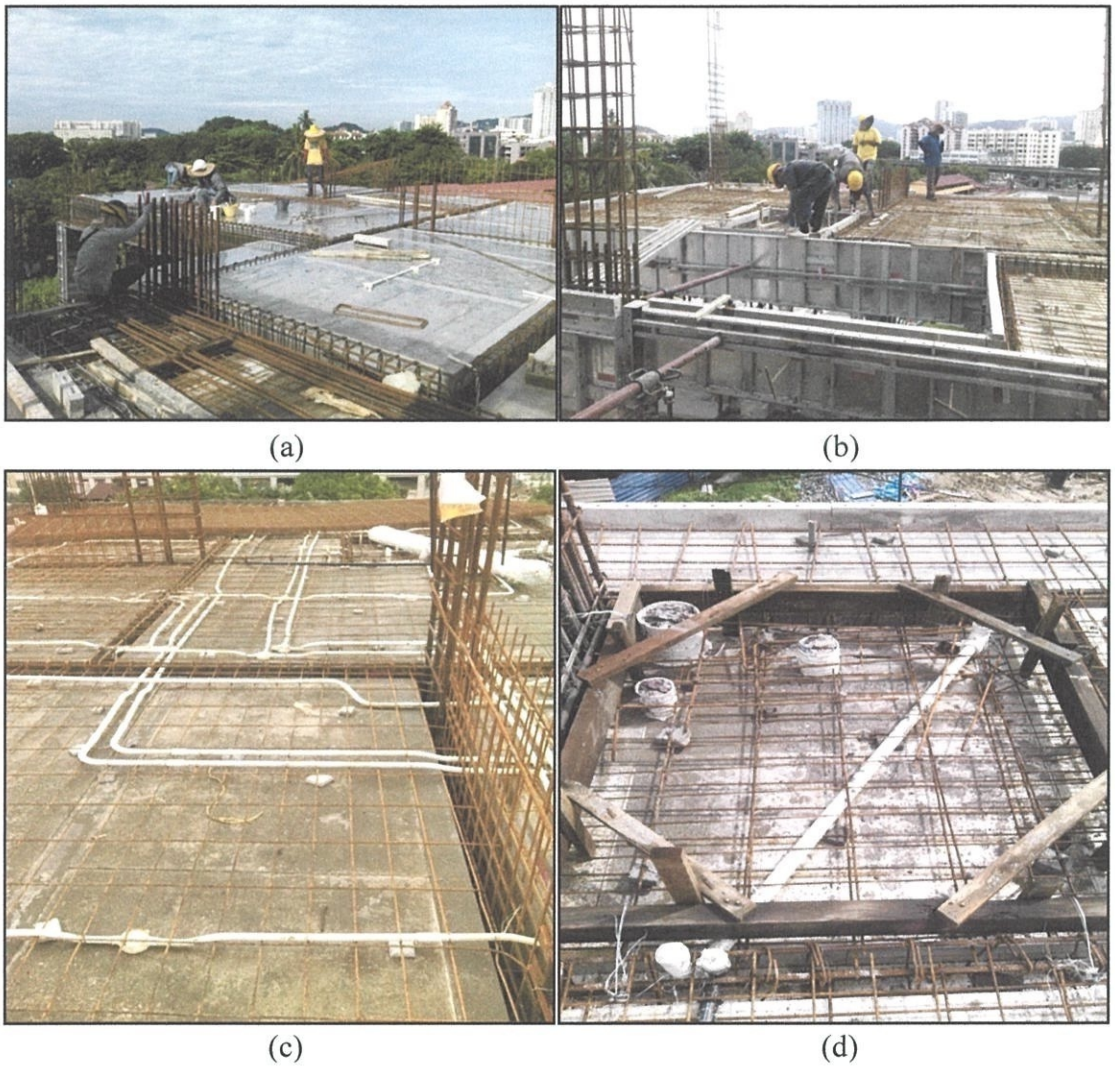
As shown in photo 3.2 (a), setting out need to be done first in order to ensure that the columns are in the right position. Based on photo 3.2 (b) and 3.2 (c), erection of formwork started with columns. The aluminum panels on columns are called Wall Panel. (Refer Appendix F – G). While erecting columns, the labors need to make sure that it is assemble carefully according to the gridlines. This is because; columns are the benchmark for every floor levels in the project.

Before assembling the columns, the labors need to put mould oil on the surface of Wall Panel as can be seen in photo 3.2 (d). Based on the same photo; after finished assembling the columns, the erection of beams will started with Beam Bottom followed by Beam Side. (Refer Appendix H – I) Installation of slab panels would be the last step in erecting the formwork. The working process would be done in bays as you can see in photo 3.2 (e) and (f). (Refer Appendix J)

After finished erecting all the formwork, again, the contractor will weigh the columns to make sure the verticality is precise. Mould oil is put on the surface of floor slab before the installation of steel structures, electrical wiring and plumbing works occurs.

3.3.2 Installing Deck Steel and M&E Duct

Installing deck steel and M&E duct will occur after erecting of formwork completed and before concreting work occurs. This stage is when all the reinforcement bars and M&E duct takes place on the floor slab. Reinforcement bars for beams, BRC, electrical conduit, air conditioning pipes and also cold water piping for drainage and sewer system. Rebar for columns had been done earlier before erecting stage due to the stage of fixing the aluminum panels for columns before fixing aluminum panels for beams.



(a) (b)

(c) (d)

Photo 3.3 (a-d): Installation of Deck Steel and M&E Duct

Based on photo 3.3 (a), it is the installation of beam reinforcement. Next to it, photo 3.3 (b) would be the installation of BRC reinforcement after the installation of mechanical and electrical duct as can be seen in photo 3.3 (c). Photo 3.3 (d) shows the layout section of cold water piping of a bathroom.

3.3.3 Concreting Work

Concreting work for this project begins with concreting the columns first, followed by floor slab and beams. In the early progress of concrete work, the concreting work is done when the construction of two units' houses completed. This happened due to delaying of formwork's components on site. In early July 2015, almost 80% of aluminum formwork's components arrived on site, therefore; the concreting area has widened into four units of houses. This type of concreting work is called the staging process. The concrete work has been divided into three zones, which is Zone A, Zone B and Zone C. Zone A includes Unit 3, Unit 4, Unit 5 and Unit 6. Zone B includes Unit 1, Unit 2, Unit7 and Unit 8. Zone C includes Unit 9 and Unit 10. One unit house needed approximately 18 m^3 of concrete Grade 25.

(a) (b)

Photo 3.4 (a-b): Concreting Work at 4^{th} Floor Slab/ Beam
(Unit 9 and Unit 10)

(c) (d)

(e) (f)

Photo 3.4 (c-f): Concreting Work at 4th Floor Slab/ Beam
(Unit 9 and Unit 10)

The concreting work is started by concreting the column first [photo 3.4 (b)], then followed by concreting the floor slab and beam (photo 3.4 (c) – (f)]. The stage of concreting the column and the slab does not occur at the same day, in fact the column is concreted one/ two days earlier before concreting the floor slab. This is to fasten the speed of construction work by not waiting the installation of steel deck and M&E duct.

3.3.4 Striking Off Formwork

Dismantling of formwork is done after concreting work is finished. The dismantling off formwork is faster due to its design that are able to hold concrete slab by using adjustable prop unlike timber formwork that needs to remove all the scaffolding.

(a) (b)

(c) (d)

Photo 3.5 (a-d): Sequence of Striking Off Aluminum Formwork

The procedure of striking off formwork is the same as erecting the formwork. Striking off stage started with dismantling the columns based on photo 3.5 (a), followed by beams based on photo 3.5 (b) and lastly slab panel based on photo 3.5 (c). As shown in photo 3.5 (d), all the formwork has been removed to the upper floor level for the next structural stage.

3.4 Components of Aluminum Formwork

3.4.1 Components of Aluminum Formwork

Photo 3.6: Wall Panel (WP), (WPF)

Wall Panel is one of the main components of aluminum formwork. Wall Panel is erected at columns. **varies in sizes*

Photo 3.7: Wall Heel (WH)

Wall heel is usually fixed at the bottom of wall panel at columns. It is to prevent the occurrence of honeycomb at columns.

Photo 3.8: Wall Top (WT), WX

Wall Top is fixing at the top of WP. It is a smaller size of wall panel. **varies in sizes*

WX is similar like WT, except for the coding, due to its special design specifically in this project. **varies in sizes*

Photo 3.9: Column Nick (NC)

NC is fixed in between column to Beam Bottom. **varies in length*

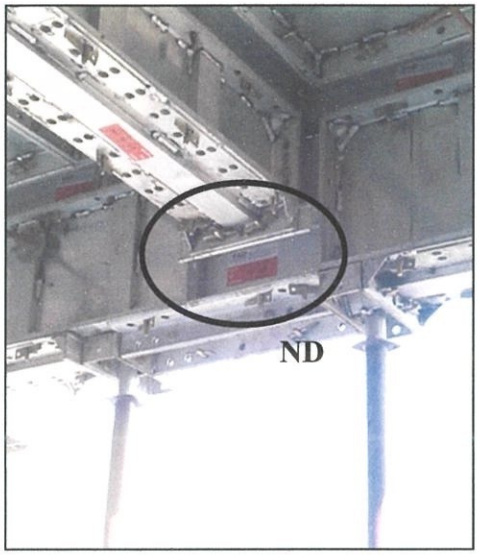


Photo 3.10: ND

ND is similar like NC; to connect BB – BP and BB – BB but differs in code name.

**varies in length*

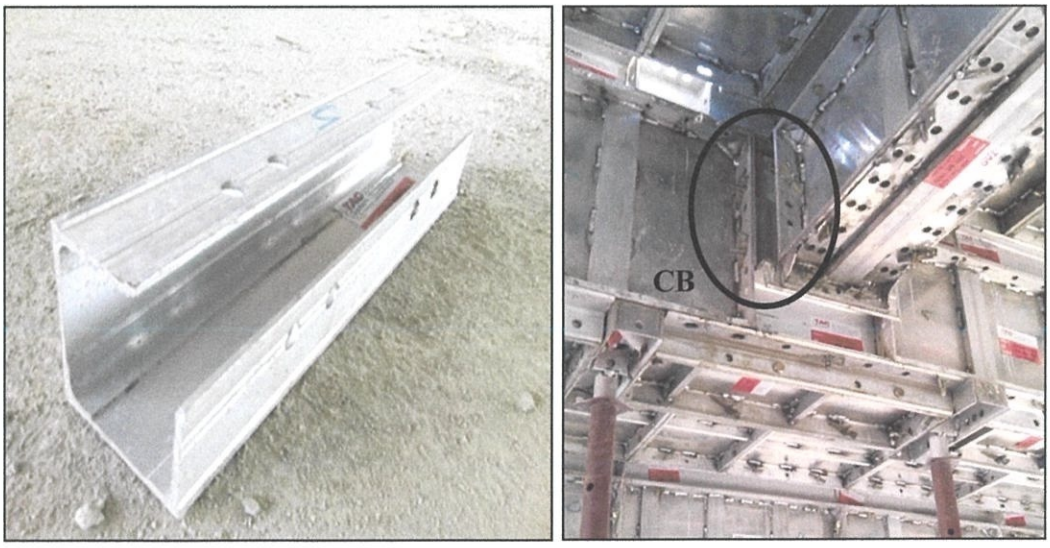


Photo 3.11: Beam Column (CB)

CB is fixed in between WT, BS. CB can also be fixed at lift shaft if the length is long.

**varies in length*

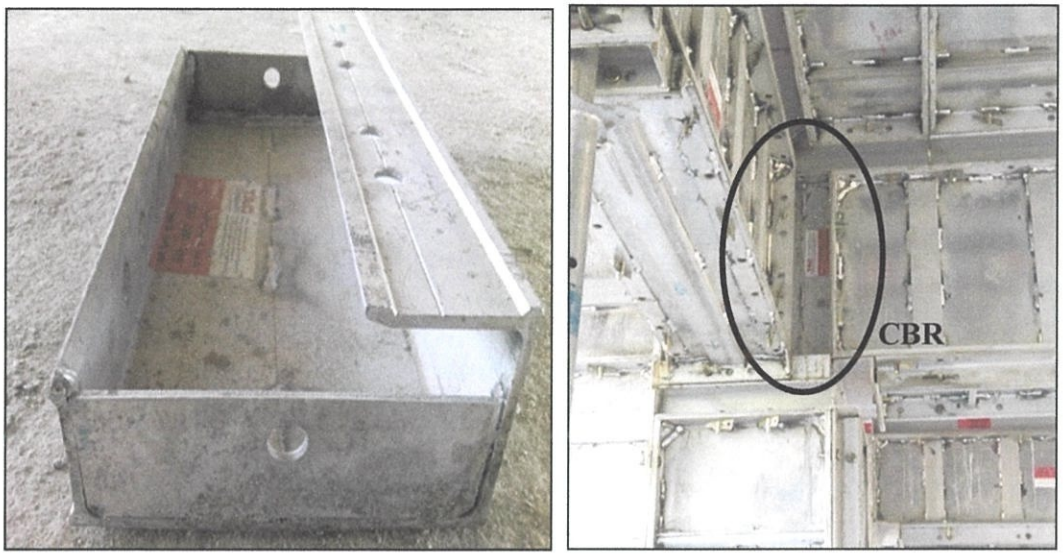


Photo 3.12: Beam Column Right (CBR)

CBR connected slab panel and beam at the right side. **varies in sizes*

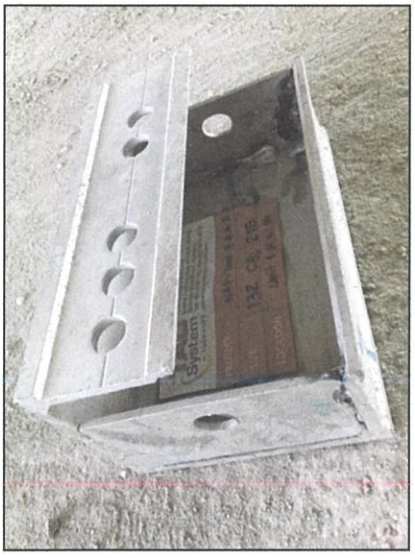


Photo 3.13: Beam Column Left (CBL)

CBL connected slab panel and beam at the left side. **varies in sizes*

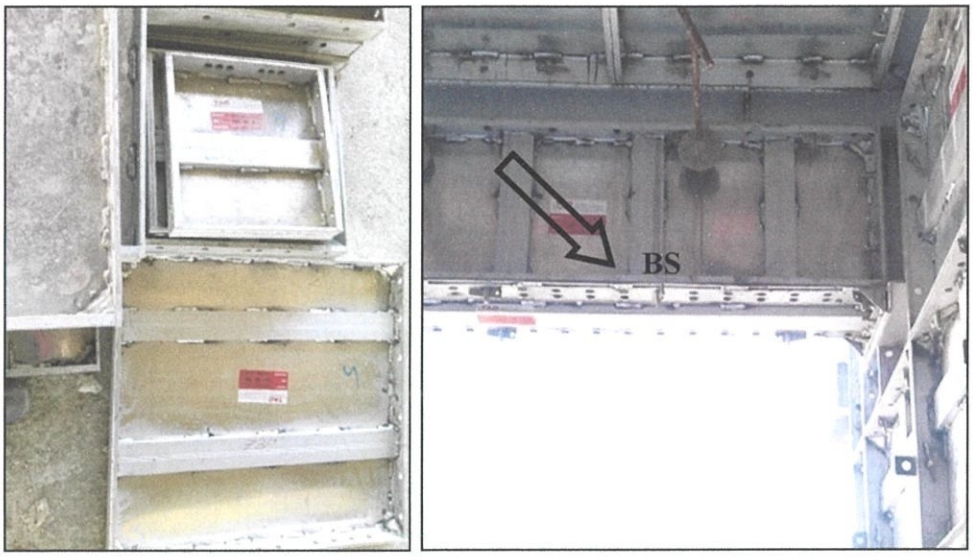


Photo 3.14: Beam Side (BS)

BS is installing at the side of beams. **varies according to beam sizes*

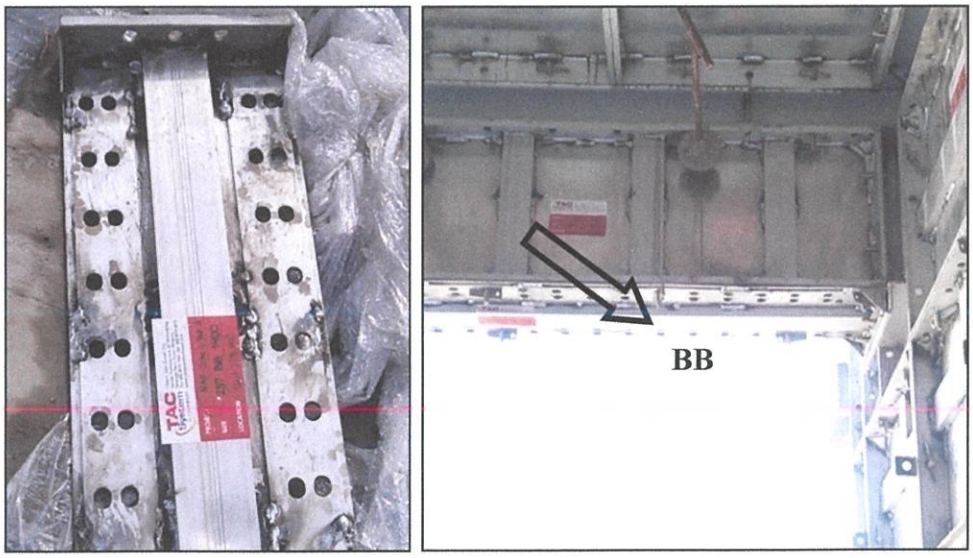


Photo 3.15: Beam Bottom (BB)

BB is the bottom of beams.**varies in sizes of beams*

Photo 3.16: Beam Panel (BP)

BP is installing for beam that is NOT more than 230mm width. Differences between BP than BB is that BP is full weld and is connected with AB. **varies in sizes*

Photo 3.17: Slab Panel (SP)

Slab Panel act as floor slab. **varies in sizes*

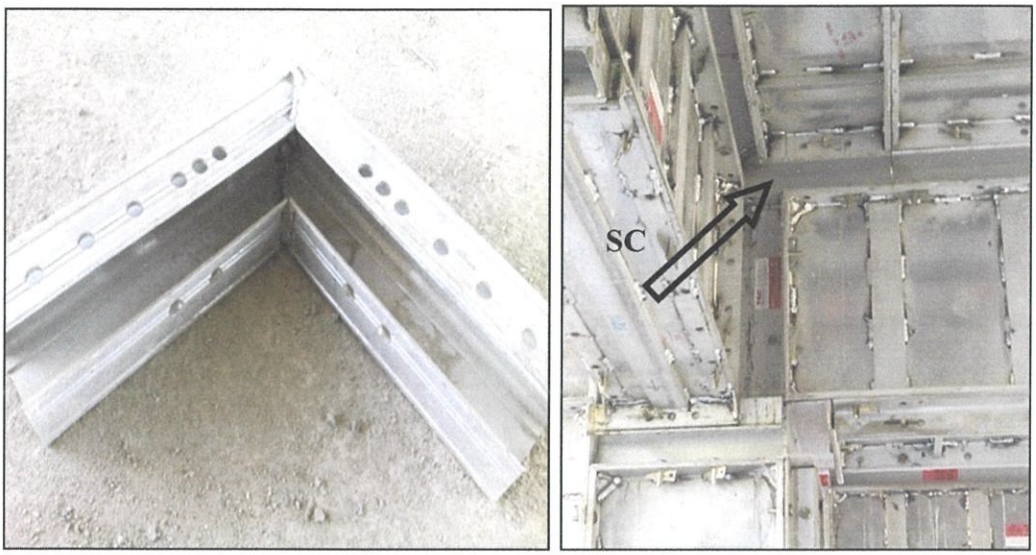


Photo 3.18: Slab Corner (SC)

SC is fixing at the corner of floor slab. **varies in length*

Photo 3.19: Slab Joint (SJ)

SJ is used as connection for slab that has the same floor level. **varies in length*

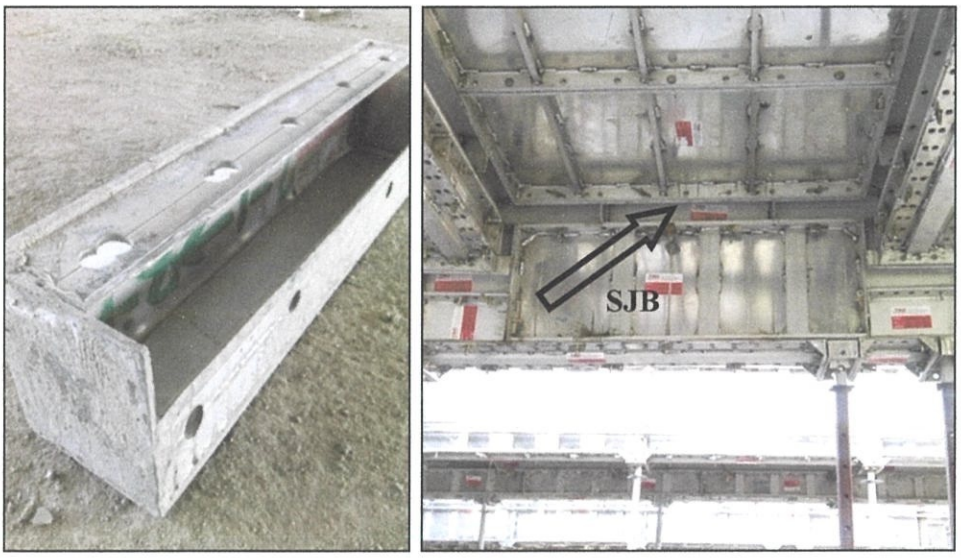


Photo 3.20: Slab Joint Both Side Plate Cover (SJB)

SJB is used as connection for floor slab that has different floor level especially in drops at bathroom. **varies in length*

Photo 3.21: Link Side/ End (LS), Link Medal (LM)

Function of LS and LM is similar, which is to connect slab panel together.

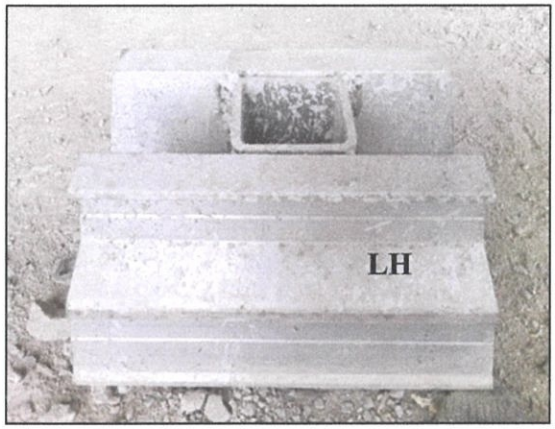


Photo 3.22: Link Head (LH)

LH used to connect LS and LM at their intersection. Link Bar (L- Bar); is fixed at the sides of LH to connect LS and LM.

Photo 3.23: Kicker (K)

Kicker is installed at the external side of the building. Usually being fixed at column. It is fixed by using wheel and nut. It also can be seen at copings of the buildings. **varies in sizes*

Photo 3.24: Channel Head (CH)

CH is part of beam bottom layout drawing as it is erected together/ side by side. Besides that, the circular hole at the centre of CH is to hold up adjustable prop. **varies in sizes*

Photo 3.25: Angle (AE), AB, AT

Angle is fixed at WP for the edges of columns. It differs in code name. **varies in length*

**(Refer Appendix K)*

3.4.2 Aluminum Formwork's Accessories

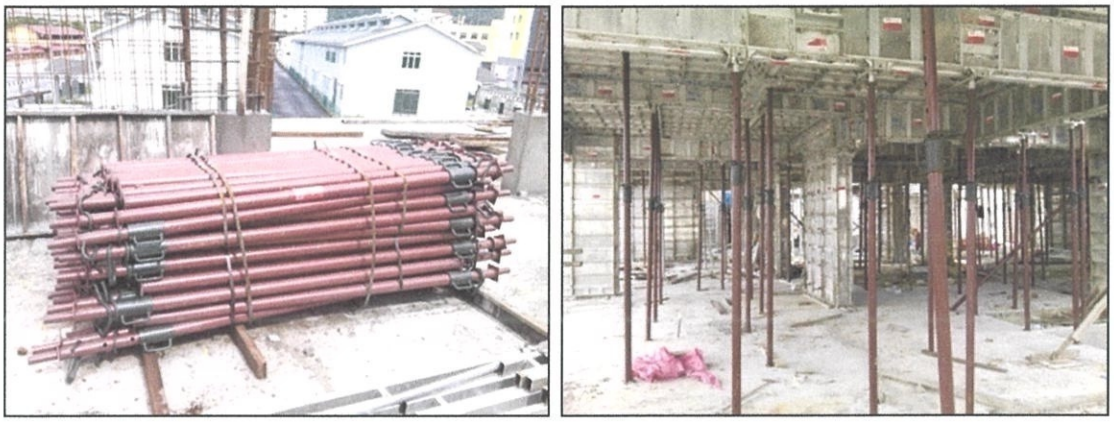


Photo 3.26: Adjustable Prop

Control slab and beam level. Props also help to support aluminum formwork.

Photo 3.27: Steel Pin and Wedges

Similar like timber structure, they have wedges to strengthen the formwork structures. In aluminum formwork, steel pins and wedges are used to tie all the components together.

*steel pins comes in two sizes (as stated in photos); the longer ones are used to connect LS and LM with LH

Photo 3.28: Wall Tie

Wall Tie is put in between wall panel at columns. It helps to prevent concrete wall from bulging.

Photo 3.29: LDPE Tubing for Sheathing Wall Steel Tie and P.P. Sheet

LDPE and P. P. Sheet are both plastic that is used to cover wall tie metal. Other function of LDPE tubing is to ease the movement of wall tie steel after concreting process.

Photo 3.30: Double Wall Waler, Wing Nut and Tie Puller

Double Wall Waler is used at the bottom of column to support the formwork's strength when the process of pouring the concrete inside column.

Photo 3.31: Working Platform

Platform used for the workers to stand for assembling and dismantling of aluminum formwork outside building structure.

Photo 3.32: Temporary Formwork Opening

To ease the movement/ shifting of aluminum panels from lower floor to upper floor. Usually every house has one hole to move panels faster. These holes will be cover up later when all the shifting work is finished.

3.4.3 Aluminum Formwork Additives

Photo 3.33: Mould/ Form Oil

Use before the work of concreting for slab formwork and before fixing wall panels for column. It is to prevent the concrete from sticking on the surface of formwork.

Photo 3.34: Grease

The usage of grease has the same function as mould oil except that it is put at the edge of formwork to ease the striking off of formwork easily.

3.5 Comparison between Aluminum Formwork and Timber Formwork

Table 3.2: Comparison between Aluminum Formwork and Timber Formwork

	Aluminum Formwork	**Timber Formwork**
Labors	1. Does not required skilled labor 2. Two unit houses (Unit 9 & Unit 10) only requires 8 number of labors	1. Required skilled and unskilled labor 2. Two unit houses (Unit 9 & Unit 10) requires 15-17 number of labors
Time	Time to erect and striking off formwork is shorter (4-5 days) for two units.	Time to install and remove formwork is longer (14-15 days) for two units.
Tools and Machineries	1. Hammer and metal chisel to fix and remove formwork 2. Connection of formwork are only steel pin and wedges 3. Formwork does not require heavy machinery, i.e. tower crane to lift formwork floor by floor (use temporary formwork opening)	1. Requires hammer, seesaw, nails, measuring tape and other tools necessaries for carpentry. 2. Requires a lot of scaffolding in order to hold up concrete slab 3. Require heavy machineries, i.e. mobile crane, tower crane, to lift scaffoldings, wooden planks and other materials required (due to materials comes in bundle

Materials Wastage	Does not have any major wastage. Possible wastage comes from steel pins and wedges (8%) and the PPE and LDPE tubing (10%) 	Wastages comes from wooden plank, wooden board, rafters, nails, and many more etc. (type of wood used: mixed wood) 
Architectural Finish	1. Better and nicer architectural finish. 2. Provide sharp edges and nicer cuts of columns and beams. 	Poor architectural finish • Depends on the quality of timber formwork (too many repeats would degrade the aesthetic value) 
Repeats of Formwork	Up to 250 repeats. (This project can use the formwork until all structural elements completed)	According to JKR, timber formwork can use up to 3 times repeat; differs to timber quality.

Cleanliness	1. Greater site cleanliness as it has no wastage. 2. Require approximately 1 day and 1-2 number of labors to clean it	1. Poor site cleanliness. 2. Require approximately 2- 3 days and 4-5 number of labors to clean it
Price	1 m^2 of aluminum formwork is approximately priced RM 500. 00 Total cost of aluminum formwork is RM 1, 500, 000. 00 • Save a lot of money for a long term period due to its repeats of performance.	1 ton of mix wood is approximately cost up to RM 300. 00. Plywood is more expensive as it measured by feet long. Plywood (4'×8'×12") is cost RM 44. 00 for 76 pieces. • More money needs to spend on buying more raw materials due to limited usage.
Scrap Value	Aluminum formwork can be sold back to the manufacturer after finish the project. Prices are negotiated accordance with formwork's condition.	No scrap value as all the materials; such as timber will be burnt up or is disposed at dump site.

CHAPTER 4.0

CONCLUSION

4.1 Conclusion

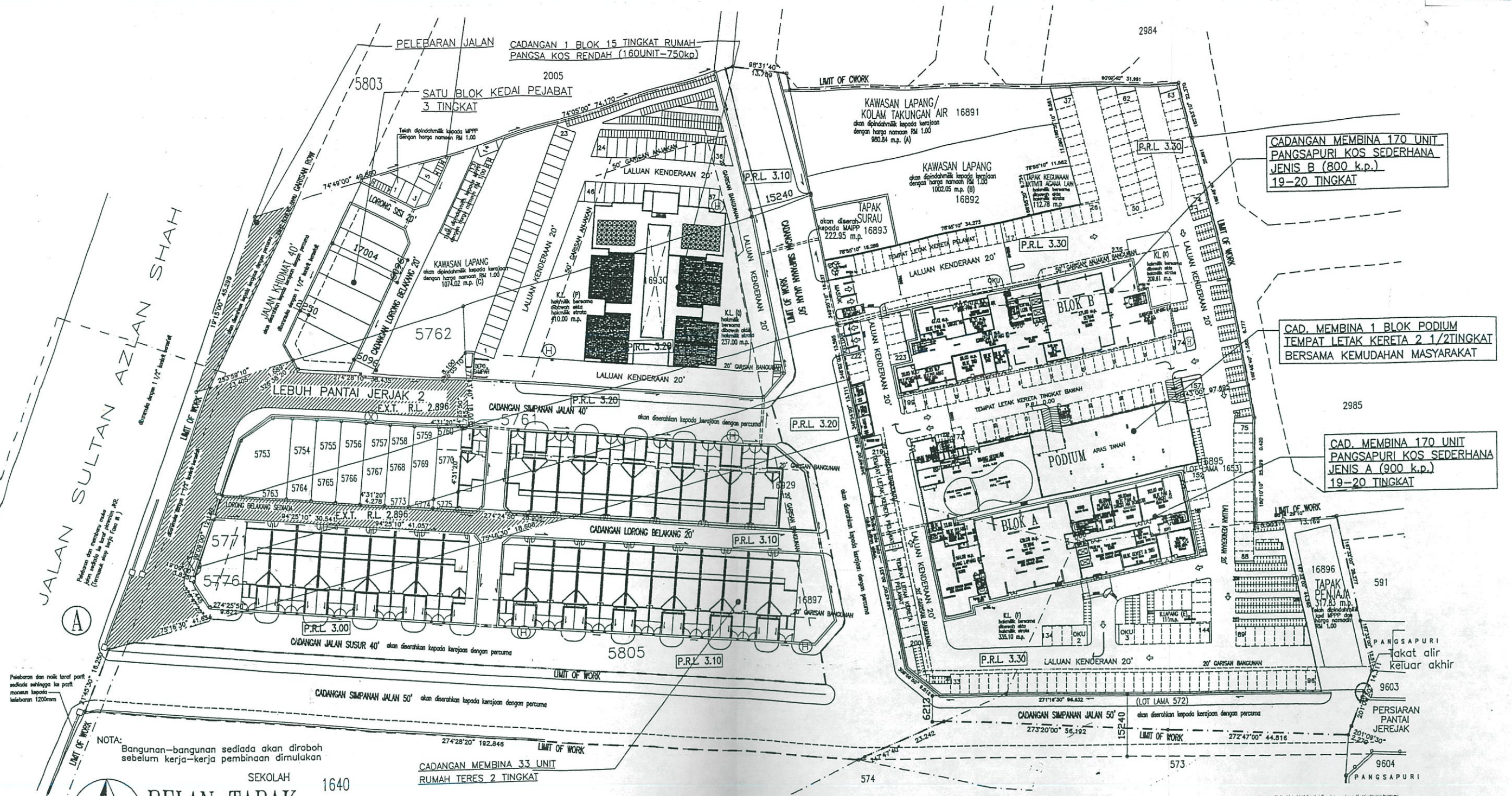
Time and money is precious in handling a construction project. By using the aluminum formwork system, it can shorten the time frame of the construction process and save cost for the builders and the contractors involved in the project. Compared to timber formwork system; which took approximately 106 hours (for two unit houses) to construct it, the aluminum formwork system only took 72 hours (for two unit houses) to finish it. Thus, it gives greater impact towards the efficiency and the speed of the construction works. Although the initial cost of purchasing the aluminum formwork system is quite expensive compared to timber formwork; but for a long term range, the aluminum formwork system is more worthy due to its ability to withstand up to 250 repeats of usage compared to timber quality which can only withstand up to 3 times of usage, according to Jabatan Kerja Raya (JKR) Malaysia construction manual. In a nutshell, by using this system, it can ease the work progress towards the completion of the project.

REFERENCES

1. Beton, F. -F. (2009). *Formwork and Falsework for Heavy Construction: Guide to Good Practice.* Lausanne, Switzerland: International Federation for Structural Concrete (fib).

2. Bhd, T. S. (n.d.). *TAC System Formwork.* Retrieved July 30, 2015, from www.tacsystemformwork.com: http://www.tacsystemformwork.com/index.html

APPENDIX A



NOTA:
Bangunan-bangunan sediada akan diroboh sebelum kerja-kerja pembinaan dimulakan

SEKOLAH 1640

PELAN TAPAK
Skala 1: 500

LEMBAR PIAWAI 11-D-1

ARKITEK

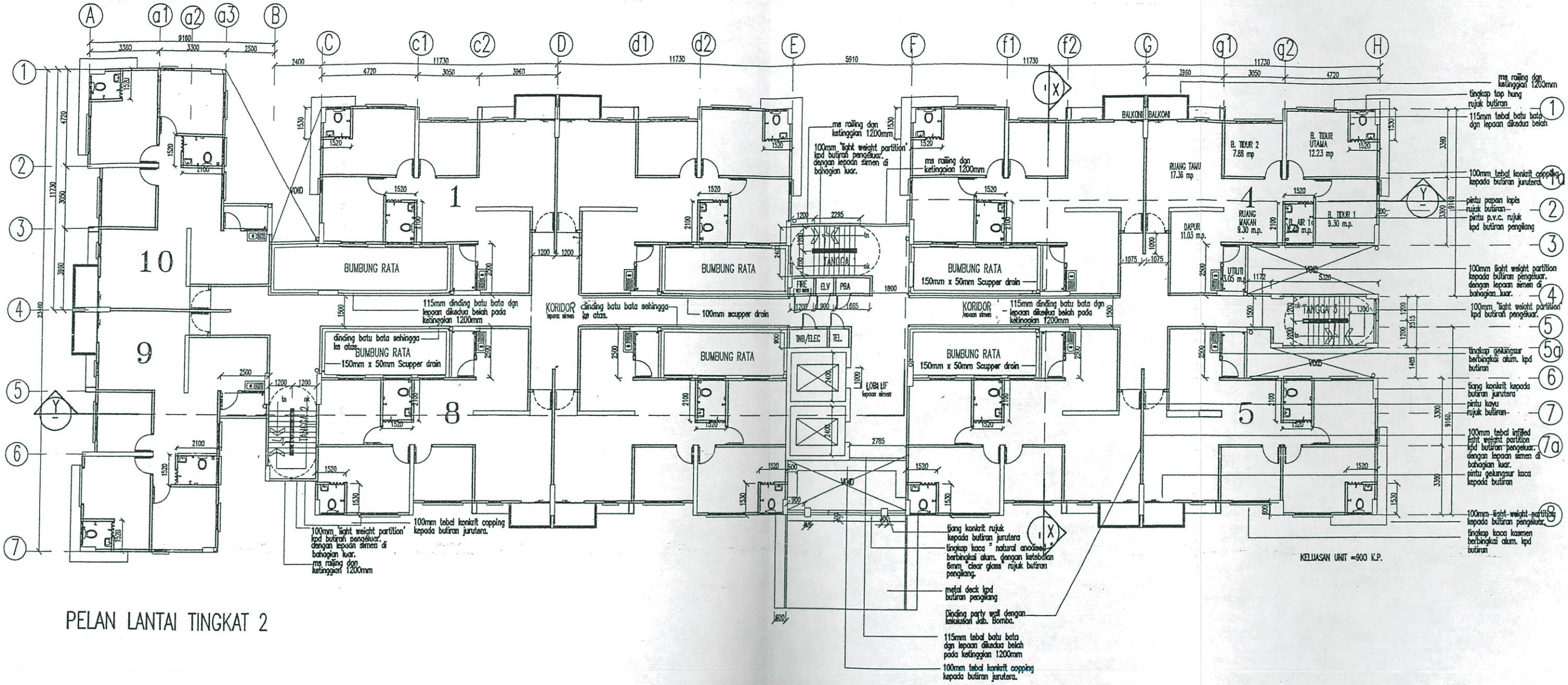
A . S . A . S
architects
sendirian berhad
9-1, lorong Pauh Jaya1/2, Taman Pauh Jaya,
13500 Butterworth Pulau Pinang.

LUKISAN PELAN TAPAK (LIMIT OF KONTRACT)

PERIHAL CADANGAN MEMBINA DAN MENYIAPKAN SATU BLOK 19-20 TINGKAT PANGSAPURI KOS SEDERHANA JENIS A (170 UNIT) , SATU BLOK 19-20 TINGKAT PANGSAPURI KOS SEDERHANA JENIS B (170 UNIT) & 1 BLOK PODIUM TEMPAT LETAK KERETA 2 1/2 TINGKAT DI ATAS LOT 5761, 5762, 1656, 1658, 572, 5777, 5771, 5772, 5776, 5805, 1653 & 1654, MUKIM 12, JALAN SULTAN AZLAN SHAH, DAERAH BARAT DAYA, PULAU PINANG.

UNTUK: Tetuan JKP SDN. BHD

DILUKIS	MALIE
TARIKH	MEI 2014
SEKIL	1 : 1000
RUJUKAN	JKP / SG NIBONG / SITE PLAN



PELAN LANTAI TINGKAT 2

CONSTRUCTION DRAWING

ARKITEK	LUKISAN	PANGSAPURI JENIS A
A . S . A . S architects sendirian berhad 9-1, lorong Pauh Jaya1/2, Taman Pauh Jaya, 13500 Butterworth Pulau Pinang.	PERIHAL	CADANGAN MEMBINA DAN MENYIAPKAN SATU BLOK 19-20 TINGKAT PANGSAPURI KOS SEDERHANA JENIS A (170 UNIT) , SATU BLOK 19-20 TINGKAT PANGSAPURI KOS SEDERHANA JENIS B (170 UNIT) & 1 BLOK PODIUM TEMPAT LETAK KERETA 2 1/2 TINGKAT DI ATAS LOT 5761, 5762, 1656, 1658, 572, 5777, 5771, 5772, 5776, 5805, 1653 & 1654, MUKIM 12, JALAN SULTAN AZLAN SHAH, DAERAH BARAT DAYA, PULAU PINANG. UNTUK: Tetuan JKP SDN. BHD
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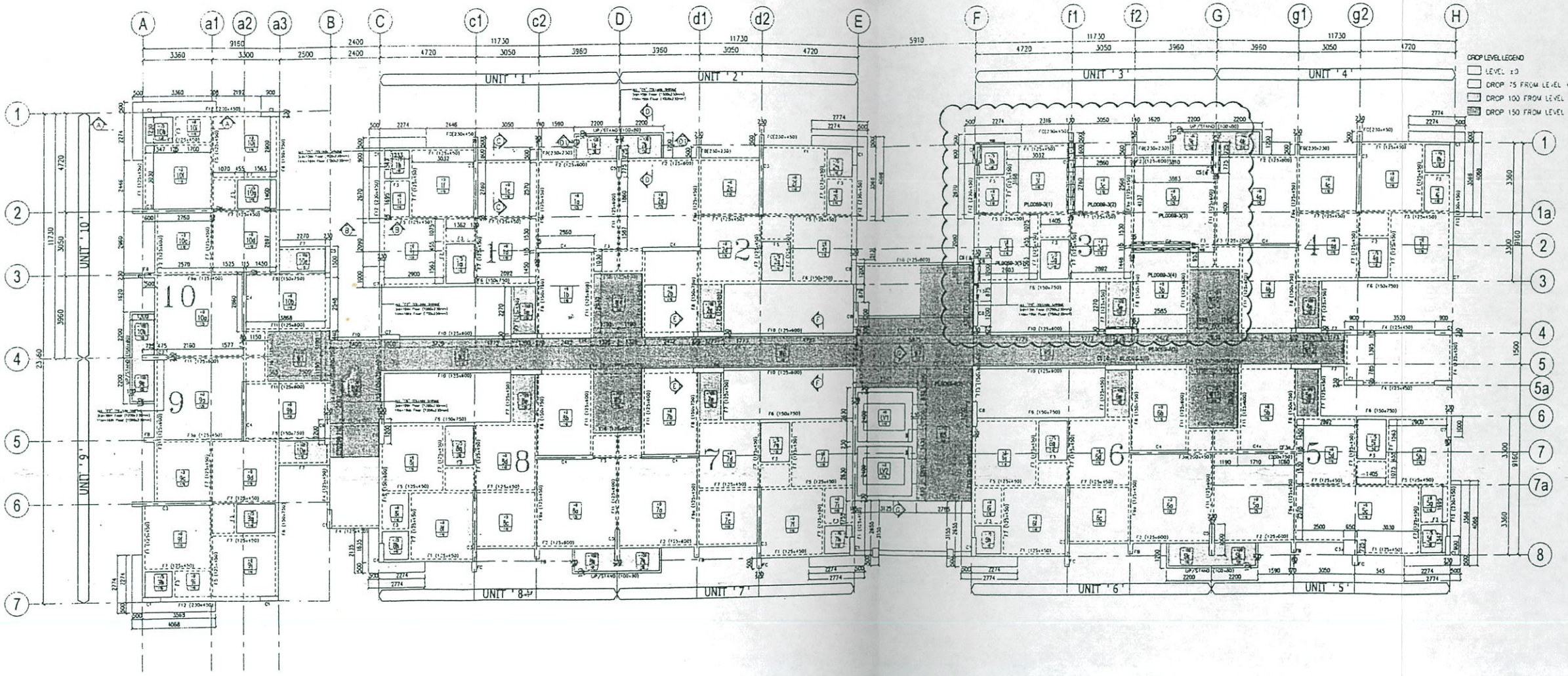
	TARIKH	MEI 2014
	SEKIL	1 : 200
	RUJUKAN	JKP / SG NIBONG / D - LMC (A) - 3

APPENDIX C



TYPICAL FLOOR LAYOUT PLAN
(LEVEL 3 - 16)

NOTE/INFORMATION / REVISE

SHELL DRAWING LEGEND :

AREA CODE

Area code 'B1' finished structural level at +0, with 200 thickness at 100mm

VIEW DIRECTOR FOR MODULATION

DOOR AND WINDOW TOLERANCE

a) All Door Opening at both side tolerances 10mm, tolerance for Top 10mm

b) All Window Opening at Top, Bottom and Both Side for window should give tolerance 10mm.

Beam Size Indication in Plan View

CROSS SECTION 125+125+125+100s/s

CROSS SECTION 225+450+100+50s/s

ELEVATION 125x300/350/350

's/s' Denotes 'up-stand' Beam

'LW' Denotes 'LOW WALL'

150x700
Slab Opening For Hoisting

TETUAN JKP SDN. BHD.

SYARIKAT NYAMAN SDN BHD

A.S.A.S architects

IZNARIA CONSULTING SERVICES

CADANGAN MEMBINA DAN MENYIAPKAN
a) 1 BLOK 19-20 TINGKAT PANGSAPURI KOS SEDERHANA JENIS A (170 UNIT),
b) 1 BLOK 19-20 TINGKAT PANGSAPURI KOS SEDERHANA JENIS B (170 UNIT) &
c) 1 BLOK PODIUM TEMPAT LETAK KERETA 2 1/2 TINGKAT BERSAMA KEMUDAHAN MASYARAKAT
MASYARAKAT DI ATAS LOT 16894 & 16895 (SEBAHAGIAN LOT LAMA 572,580,1653 &1654)
MUKIM 12, JALAN SULTAN AZLAN SHAH,
DAERAH BARAT DAYA, PULAU PINANG.

I/WE HEREBY CONFIRM ACCEPTANCE OF THIS DRAWING AS THE LAYOUT OF FINAL DIMENSIONS SHOWING APPROVED FOR CONSTRUCTION AND I/WE UNDERSTAND THAT ANY FURTHER CHANGES REQUESTED WILL INCUR ADDITIONAL COSTS AND DELAYS

RECEIVED
BY:

AUTHORISED SIGNATORY & COMPANY'S STAMP

TAC System Formwork Sdn. Bhd.
The Aluminium Formwork Manufacturer

TYPICAL FLOOR LAYOUT PLAN
3rd - 16th STOREY PLAN
(WALL PANEL LAYOUT)

DATE : 10.03.2015 | DWG NO. 0089-N3P-1/4

TAC System Formwork Sdn. Bhd (400588-P)
The Aluminum Formwork Manufacturer

SCHEDULE ,ZONING & DELIVERY

Company Name : NYAMAN SDN. BHD.
Project : 0069 - NAP - PENANG
Unit / Block : BLOCK A

ZONE	AREA	PEL-ORDER DATE	PRODUCTION DATE	MOCK-UP DATE	DELIVERY DATE
ZONE 1	LIFT LV1,LV2	4/10/2015	12/4/2015 - 15/4/2015	16/4/2015 - 20/4/2015	4/5/2015
	LIFT LOBBY				
	CORRIDOR (Grid line E-H)				
ZONE 2	UNIT 3	COMPLETED	COMPLETED	COMPLETED	4/5/2015
ZONE 3	UNIT 6	4/11/2015	16/4/2015 - 19/4/2015	22/4/2015 - 25/4/2015	7/5/2015
ZONE 4	UNIT 4	13/4/2015	20/4/2015 - 24/4/2015	28/4/2015 - 2/5/2015	12/5/2015
ZONE 5	UNIT 5	14/4/2015	25/4/2015 - 30/4/2015	4/5/2015 - 7/5/2015	15/5/2015
ZONE 6	UNIT 7	15/4/2015	1/5/2015 - 4/5/2015	-	18/5/2015
	CORRIDOR (Grid line A-D)			-	
ZONE 7	UNIT 2	15/4/2015	5/5/2015 - 9/5/2015	-	20/5/2015
ZONE 8	UNIT 8	16/4/2015	10/5/2015 - 14/5/2015	-	23/5/2015
ZONE 9	UNIT 1	16/4/2015	15/5/2015 - 19/5/2015	-	25/5/2015
ZONE 10	UNIT 9	17/4/2015	20/5/2015 - 24/5/2015	-	28/5/2015
ZONE 11	UNIT 10	17/4/2015	25/5/2015 - 30/5/2015	-	4/6/2015

Prepared By:
Name :SHAHRIL
Date :10-4-2015

Acknowledge By:

Date:

APPENDIX D

A a1 a2 a3 B

4 5 6 7

PL0069-13(5)
PL0069-13(4)
PL0069-13(3)
PL0069-13(1)
PL0069-13(2)

C2 (a)
C2
C3a
C3
C4
C1b
C1a

F1 (125x450)
F2 (125x600)
F3
F4
F5 (125x450)
F6 (150x750)
F7 (125x450)
F8 (150x750)
F9a (125x450)
F11 (125x600)
F12 (230x450)
F14 (230x750x600x750)
F16 (125x600

UP/STAND (100x80)
COLUMN SHRINK
Floor (1200x230mm)
Floor (1000x230mm)

9k 150
9a 125
9b 110
9c 110
9d 110
9e 110
9f 110
9g 110
9h 110
9i 110
9j 110
W1 110

725 475 2160 1577 1150 563 2500 1190 2062 710 620 290 2274 3568 4068

ZONE 11 - UNIT 9

16 JUN 2015

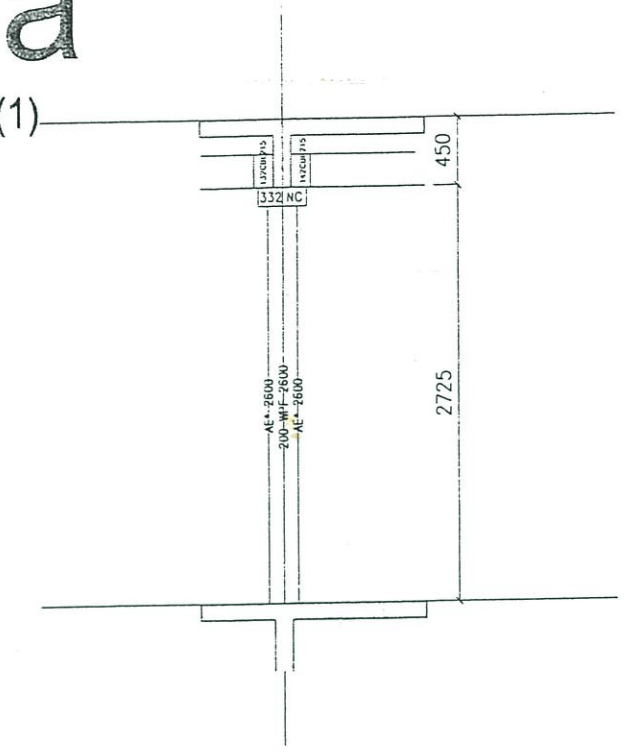
Title: 0069: NAP – PENANG – (WALL PANEL LAYOUT)
scale 1:50 unit mm date 12-6-2015
chkd STEFF drawn SHRL0069 dwg no. SHRL0069-NAP-Z11-WP01

TAG System

APPENDIX E

C3a

PL0069-13(1)



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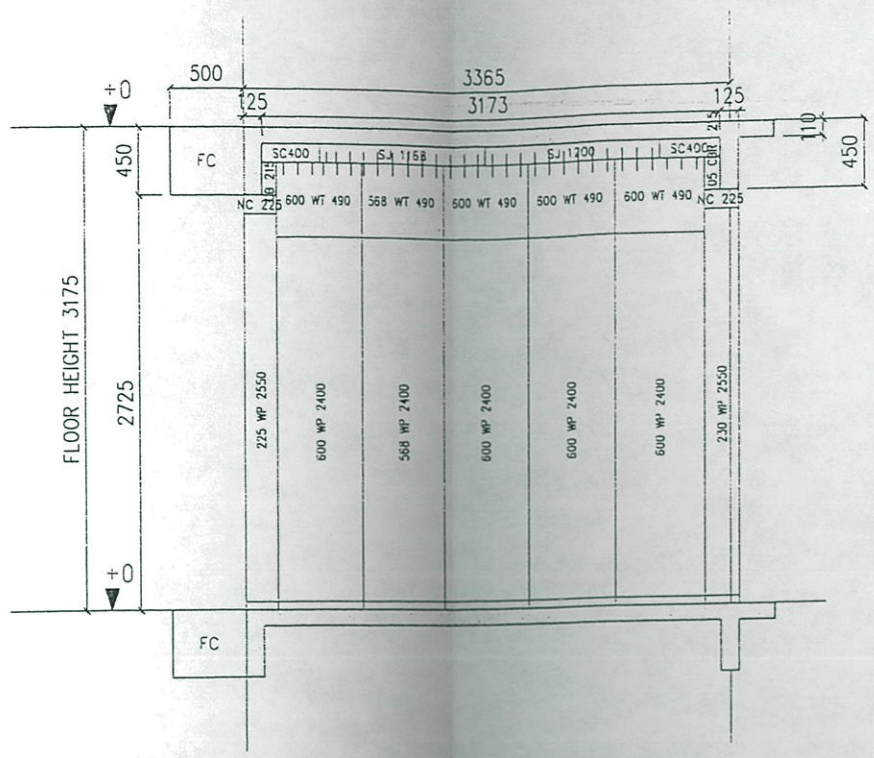

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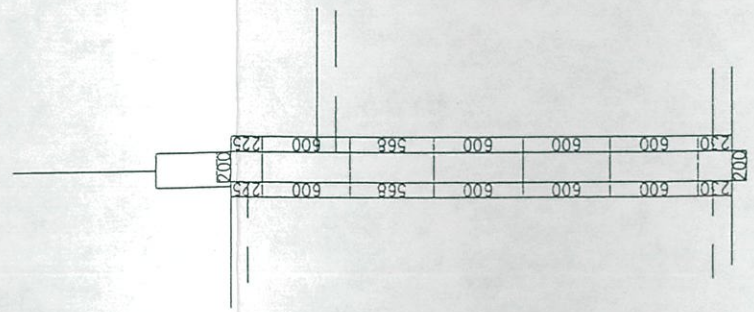

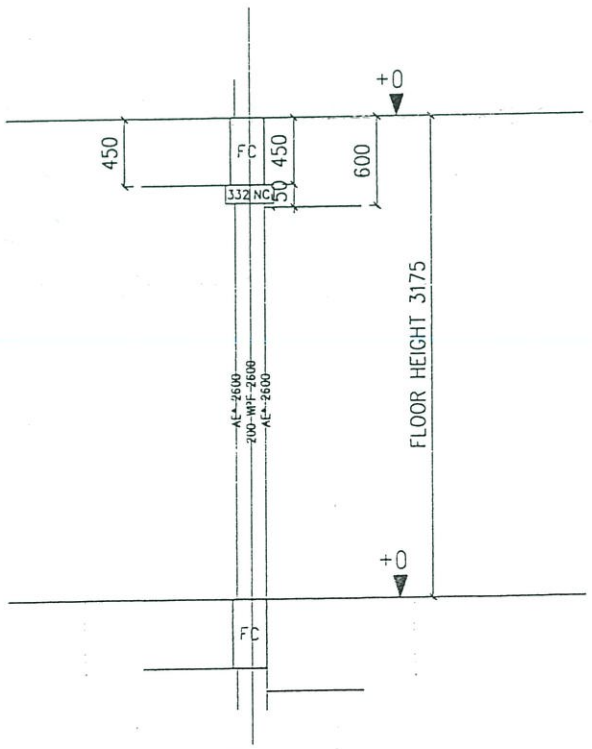

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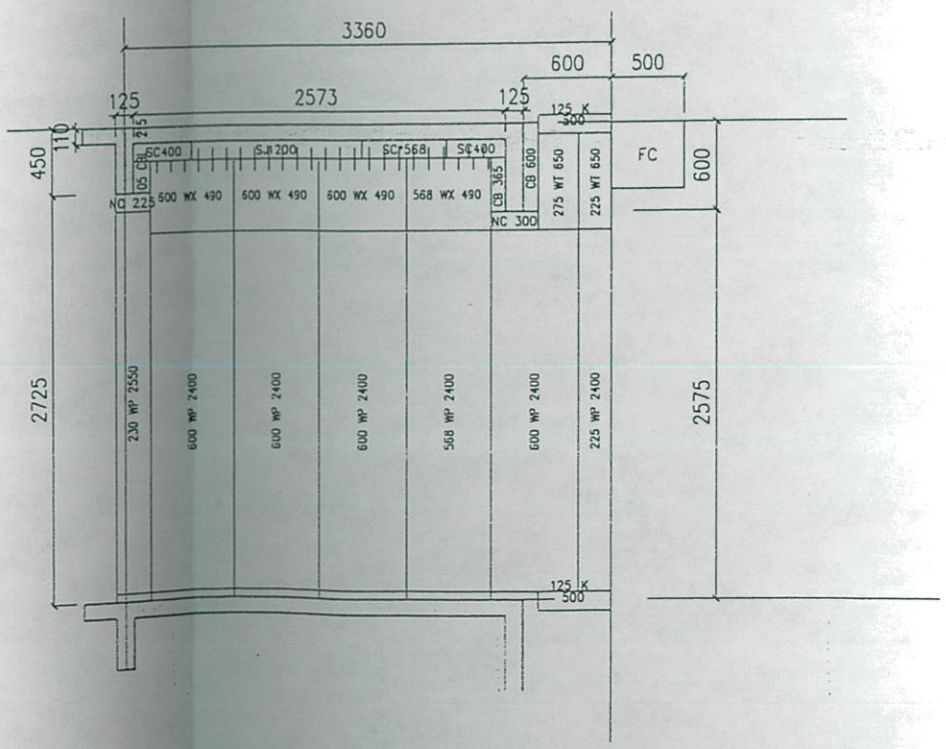

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MASTER COPY

16 JUN 2015

ICAR Ref.

TAC System FORMWORK

ZONE 11-UNIT 9

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unit	mm
date	05.03.2015
drawn	SHRI
chkd	RYAN
drawing no.	0069-NAP-ELE01

C4

PL0069-13(5)

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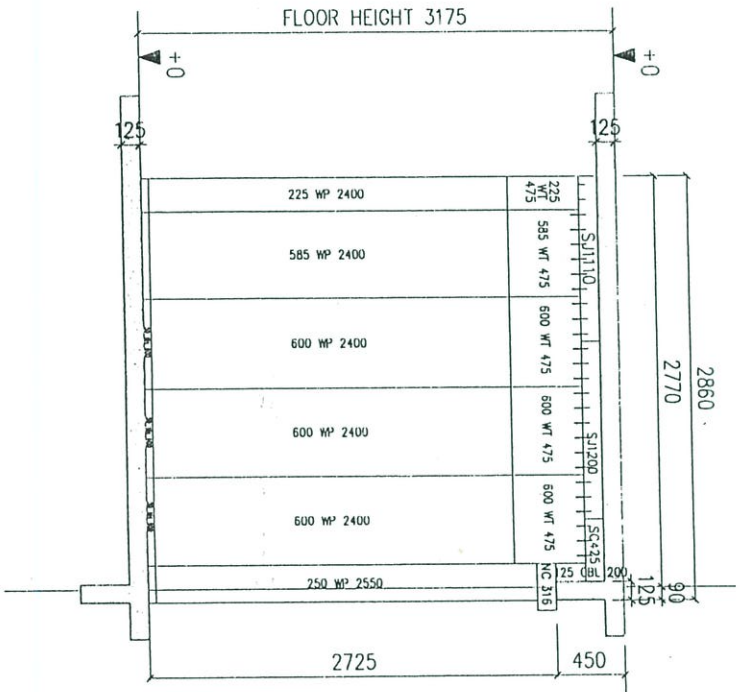

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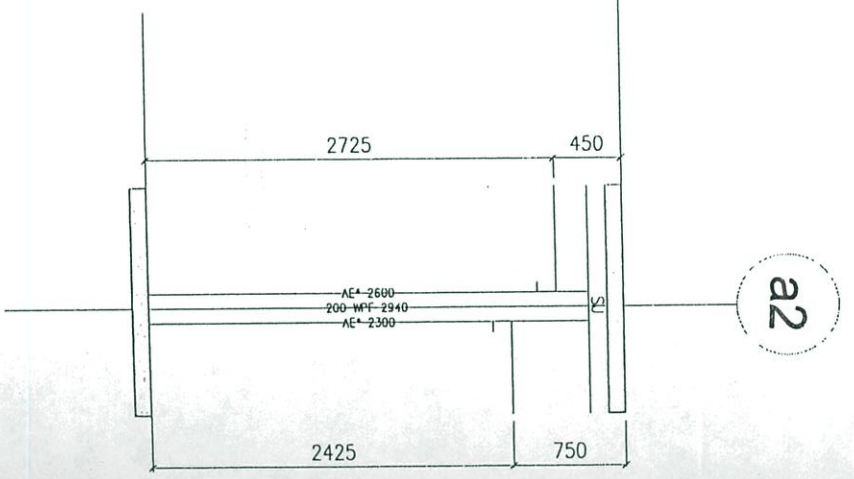

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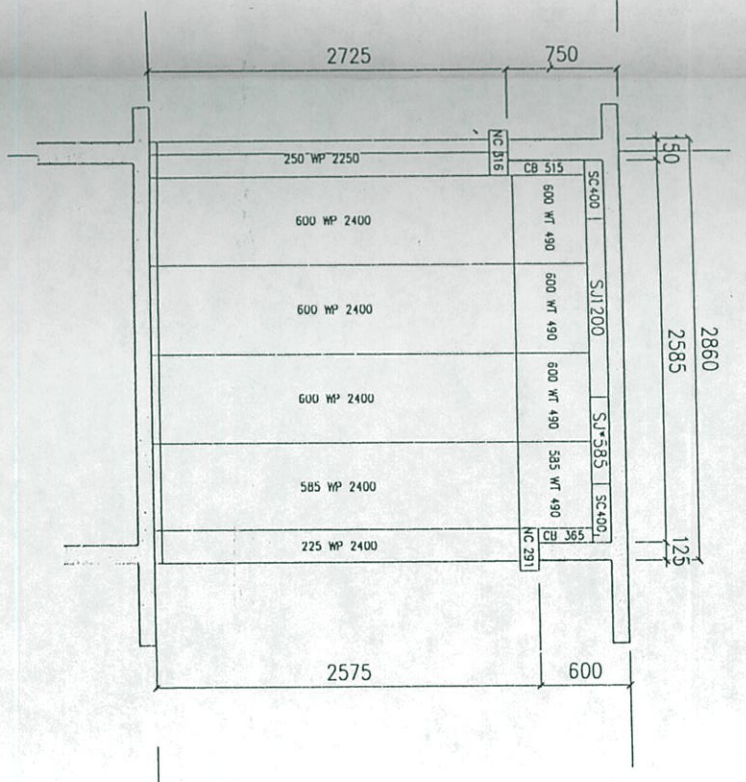

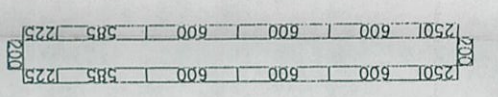

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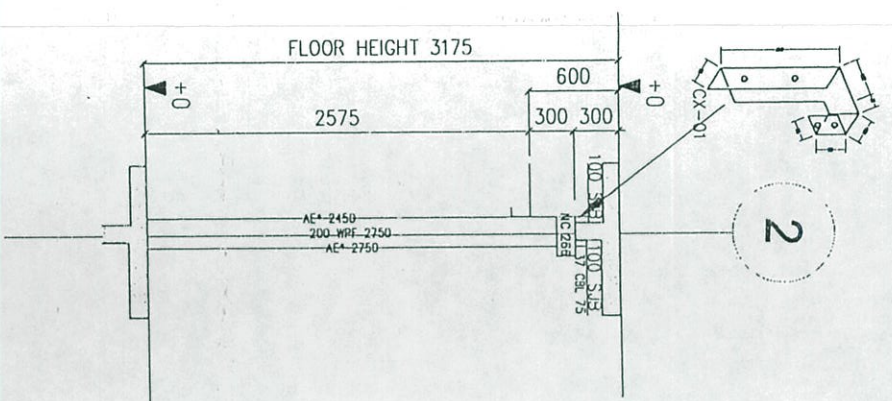

ICAR Ref.

TAC System FORMWORK

ZONE 11 -UNIT 9

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scale	unit	date
1:50	mm	05.03.2015
chkd. RYAN	drawn SHRI	dwg.no. 0069-NAP-ELE02 Nil

APPENDIX G

A a1 a2 a3 B

4 5 6 7

COLUMN SHRINK
Floor (1200x230mm)
h Floor (1000x230mm)

PL0069-13(5)
PL0069-13(4)
PL0069-13(3)
PL0069-13(2)
PL0069-13(1)

F11 (125x600)
F9a (125x450)
F7 (125x450)
F1 (125x450)
F12 (230x450)
F8 (150x750)
F4 (150x750)
F4 (125x450)

C1 C1a C1b C2 C3 C4

9k 9a 9b 9c 9d 9e 9f 9g 9h 9i W1

2200 2774 2274 500 3568 4068

ZONE 11 - UNIT 9

Title: 0069: NAP – PENANG – (BEAM BOTTOM LAYOUT)

scale 1:50 unit mm date 12--6--2015

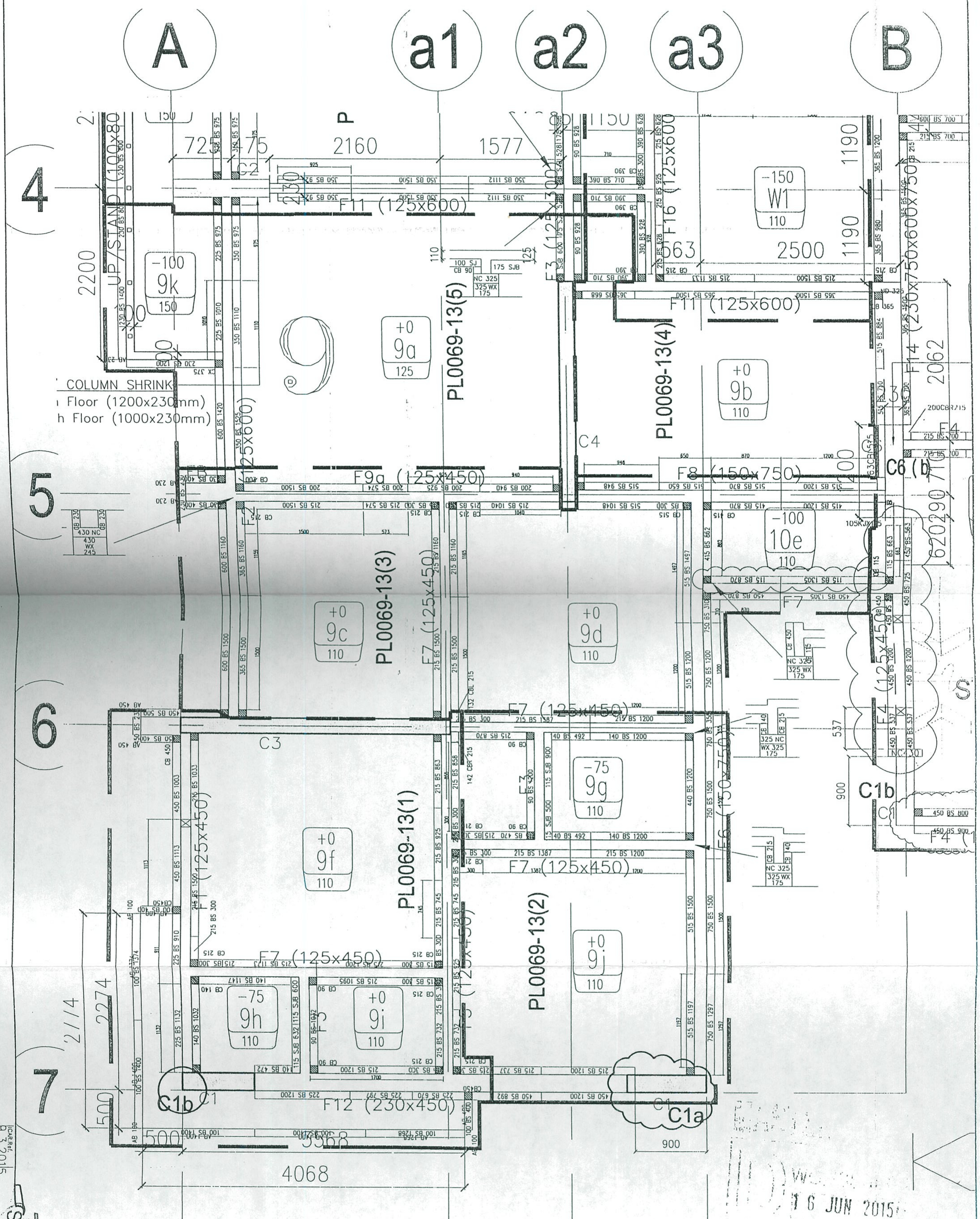
chkd STEFF drawn SHR dwg.no. L0069-NAP-Z11-BB01

ICAR Ref. 9.3.2015

TAG System FORMWORK

16 JUN 2015

APPENDIX H



ZONE 11 - UNIT 9

title 0069: NAP – PENANG – (BEAM SIDE LAYOUT)

scale	unit	date
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chkd: STEFF	drawn: SHRL	dwg.no: 0069-NAP-Z11-BS01

TAC System FORMWORK

16 JUN 2015

APPENDIX I

COLUMN SHRINK
Floor (1200x230mm)
h Floor (1000x230mm)

PL0069-13(5)
PL0069-13(4)
PL0069-13(3)
PL0069-13(1)
PL0069-13(2)

ZONE 11 - UNIT 9

16 JUN 2015

Title: 0069: NAP – PENANG – (SLAB PANEL LAYOUT)

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chkd	drawn	dwg.no
STEFF		SHRL0069-NAP-Z10-SP01

TAG System FORMWORK

APPENDIX J

01-11-99

After Multiplier
AFTER MULTIPLE

DATE 27 MAY 2015

Description :
0069 NAP PENANG
UNIT 9 - AREA CODE - 9f , 9i , 9h - ZONE 11 - BLOCK A
27MAY2015 - PL. 0069 - 13 - 1/5

		Code	Qty	Contact Mirror Area (m2)
Normal Equipment				
1	AB	100	3	0.039
2	AB	230	1	0.030
3	AB	300	2	0.080
4	AB	400	5	0.265
5	AB	450	2	0.118
6	AB	568	1	0.075
7	AB	697	2	0.184
8	AB	1074	1	0.142
9	AB	1100	2	0.290
10	AB	1268	1	0.167
11	AB	1374	1	0.181
12	AB	1400	6	1.110
			27	2.681
13	AE*	2450	2	0.646
14	AE*	2600	5	1.715
15	AE*	2950	1	0.389
			8	2.750
16	257 BB	432	1	0.111
17	257 BB	733	1	0.188
18	257 BB	745	1	0.191
19	257 BB	863	1	0.222
20	257 BB	1032	1	0.265
21	257 BB	1033	1	0.265
22	257 BB	1100	1	0.283
23	257 BB	1172	1	0.301
24	257 BB	1400	1	0.360
			9	2.186
25	230 BP	300	1	0.069
26	230 BP	697	1	0.160
27	230 BP	1100	1	0.253
			3	0.482
28	90 BS	1032	1	0.093
29	100 BS	400	2	0.080
30	100 BS	1268	1	0.127
31	100 BS	1374	1	0.137
32	100 BS	1400	3	0.420
33	140 BS	472	1	0.066
34	140 BS	1032	1	0.144
35	140 BS	1147	1	0.161
36	215 BS	300	10	0.650
37	215 BS	732	2	0.314
38	215 BS	745	2	0.320
39	215 BS	858	1	0.184
40	215 BS	863	1	0.186
41	215 BS	925	2	0.398
42	215 BS	1033	1	0.222
43	215 BS	1095	1	0.235
44	215 BS	1173	1	0.252
45	215 BS	1200	2	0.516
46	215 BS	1500	1	0.323
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49	225 BS	910	1	0.205
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55	450 BS	1003	1	0.451
56	450 BS	1113	1	0.501
			45	7.349
57	CB	90	2	0.036
58	CB	140	2	0.056
59	CB	215	8	0.344
60	CB	365	1	0.073
61	CB	450	3	0.270
62	CB	600	1	0.120
			17	0.899
63	105 CBL	215	1	0.044
64	132 CBL	215	1	0.050
			2	0.094
65	105 CBR	215	1	0.044
66	142 CBR	215	1	0.052
			2	0.096
67	CH	257	24	0.624
68	CH	362	6	0.216
69	CH	400	12	0.480
			42	1.320
70	125 K	500	2	0.126
			2	0.126
71	LB	350	2	0.052
			2	0.052
72	LH	200	2	0.040
			2	0.040
73	LS	1300	1	0.130
74	LS	1332	1	0.133
			2	0.263
75	NC	225	3	0.153
76	NC	300	1	0.068
77	NC	325	1	0.073
78	NC	332	2	0.090
79	NC	430	1	0.097
			8	0.481
80	ND	325	2	0.162
			2	0.162
81	PL	2925	2	0.000
			2	0.000
82	PLJ	0	44	0.000
			44	0.000
83	400 SC	400	8	1.360
			8	1.360
84	SJ	732	1	0.165
85	SJ	1172	2	0.528
86	SJ	1200	4	1.080
87	SJ	1500	3	1.014
			10	2.787
88	SJ*	732	1	0.165
			1	0.165
89	SJB	433	2	0.194
90	SJB	668	1	0.150
91	SJB	847	1	0.191
92	SJB	1100	1	0.248
93	SJB	1174	1	0.264
94	SJB	1500	1	0.338
95	100 SJB	600	1	0.135
96	100 SJB	632	1	0.142
97	115 SJB	600	1	0.129
			10	1.791
98	SJB*	847	1	0.191
99	115 SJB*	633	1	0.136
			2	0.327
100	400 SP	1074	1	0.430
101	400 SP	1400	3	1.680
102	432 SP	1400	1	0.605
103	432 SP	1472	1	0.636
104	432 SP	1500	1	0.648
105	547 SP	1033	1	0.565
106	600 SP	1033	1	0.620
107	600 SP	1400	4	3.360
108	600 SP	1472	4	3.532
109	600 SP	1500	1	0.900
			18	12.976
110	50 WH	125	1	0.006
111	50 WH	225	1	0.011
112	50 WH	230	2	0.024
113	50 WH	325	1	0.016
114	50 WH	375	1	0.019
115	50 WH	525	1	0.026
116	50 WH	568	2	0.056
117	50 WH	600	7	0.210
118	125 WH	375	1	0.047
119	125 WH	400	1	0.050
			18	0.465
120	225 WP	2400	1	0.540
121	225 WP	2550	1	0.574
122	230 WP	2550	2	1.174
123	375 WP	2400	2	1.800
124	525 WP	2400	2	2.520
125	568 WP	2400	2	2.726
126	600 WP	2400	8	11.520
			18	20.854
127	200 WPF	2600	2	1.040
128	230 WPF	2450	1	0.564
129	230 WPF	2950	1	0.679
			4	2.283
130	225 WT	650	1	0.146
131	275 WT	650	1	0.179
132	375 WT	415	1	0.156
133	375 WT	500	1	0.188
134	525 WT	500	1	0.263
135	568 WT	490	1	0.278
136	600 WT	490	4	1.176
			10	2.386
137	225 WX	150	1	0.034
138	300 WX	415	1	0.125
139	568 WX	490	1	0.278
140	600 WX	490	3	0.882
			6	1.319
Total :	N		324	65.694

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