DEPARTMENT OF BUILDING

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(PERAK)

PROJECT TITLE REPORT:
CONSTRUCTION OF SHEAR WALL
SIMPLE FORMWORK SYSTEM

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DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

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FEBRUARY 2022

It is recommended that the report of this practical training provided

By

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Diploma in Building

CONSTRUCTION OF SHEAR WALL

(SIMPLE FORMWORK SYSTEM)

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

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DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

10TH JANUARY 2022

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 Innah Makmur Builders Sdn Bhd for duration of 17 weeks starting from 18th September 2021 and ended on 10th January 2022. It is submitted as one of the prerequisite requirements of BGN310 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

…….

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Date : 10TH JANUARY 2022

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ABSTRACT

Walls are one of the most important structure elements of a building. A wall plays several functions in the performance of a building and these functions need to be fully understood in order to create suitable and comfortable building as well as providing privacy also as protection from weather. This report will discuss about simple formwork system for the load bearing wall (shear wall) of the building. This report was conducted for The Construction of public residential development consist of two blocks apartment 16 storey and 17 storey (463 units), 3 storey multilevel car park and common facilities block on PT 4284 (Zone 7C) and upgrading works at part of green area and buffer zone, Precinct 11, Putrajaya owned by Putrajaya Holdings. The objective of this report is to investigate the construction of shear wall and the way how it carried out. It will focus on the whole process shear wall construction using the simple formwork system. It also investigates the equipment and machinery in the methods simple formwork system for shear wall construction and to determine the time that have been used for the construction. This report will also look to at the problem and the solution in wall construction that would fulfill the criteria of shear wall. The methods that were used in order to gain information about the objective discussed were through observation, interviewing staff and document review. To conclude, the identification of shear wall construction method, machineries and tools, the time used for the shear wall construction and problem and solution during shear wall construction had been achieved effectively.

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CHAPTER 1.0

INTRODUCTION

1.1 Background of Study

In building construction, load bearing walls carries loads imposed on it from beams and slabs above including its own weight and transfer it to the foundation. These walls support structural members such as beams, slabs and walls on above floors above. It can be exterior wall or interior wall. It braces from the roof to the floor.(*Load Bearing Structure and Components vs. Framed Structural System - The Constructor*, n.d.) Majority of load bearing walls above grade required reinforcement to provide the flexural strength required, as these masonry walls expand and contract due to temperature changes, load imposed by strong winds, and the weight of the wall itself.(*Bearing Wall - an Overview | ScienceDirect Topics*, n.d.) Load bearing wall is a wall that is constructed to support the above slab or other building elements in structure and also supports the weight of the structure.(Ramiz,2020) The structure in the components of building will carries and transfers the load to the ground safely. The structure guarantee stability of building and its performance. (*Load Bearing Structure and Components vs. Framed Structural System,* 2018) By conducting its weight to a foundation structure, a load bearing wall bears the weight of the elements above the wall resting upon it. The main load bearing structural elements are beam, columns, walls, braces and trusses. (*Load Bearing Structure and Components vs. Framed Structural System*, 2018) Meanwhile, concrete, blocks, or bricks are the most often used materials to construct load bearing walls in large building. Load bearing walls theoretically consist of six types of walls such as precast concrete, retaining wall, masonry/brick wall, pre panelised load bearing metal stud wall, engineering brick wall and stone wall. For precast concrete walls, it constructed by casting in a reusable wall mould or form which is then cured in a controlled environment, transported to the construction site and lifted into place. It will speed up the construction process. In load bearing wall units resist and transfer loads from other element and cannot be removed without affecting the strength or stability of the building. Meanwhile, retaining walls

are vertical or near-vertical structures designed to retain material on one side, preventing it from collapsing, slipping or preventing erosion. (*Retaining Wall Design and Its Types Used on Construction*, n.d.) The lateral pressure could be also due to earth filling, liquid pressure, sand, and other granular materials behind the retaining wall structure.

While columns and load-bearing walls keep buildings standing up, carrying the compression load of the structure down to its foundation, the shear wall is what keeps structures from blowing over, resisting the lateral forces of wind and seismic activity. (*What Is a Shear Wall and Why Do Buildings Need Them?* 2020) Understanding all the physics of shear walls may require an education in structural engineering, but a simple way to grasp how they operate is to imagine a wooden square with four edges essentially two columns and two beams. This frame can support weight from above compression as any load put on the upper beam is transferred through the columns to the base of the square. But if you put too much pressure on its sides a lateral force and the square will twist and collapse on itself unless it is braced by supports. Shear walls have these braces and are designed so that they don't collapse on themselves. In turn, they assure that no wind will blow your house down. The support provided by shear walls does, however, create a design obstacle for architects. Whether the support against lateral forces is thanks to sheathing covering the frame or from other braces within it, any windows or doors must be limited in terms of the total area of the shear wall (and in some uses can't be used at all)(*What Is a Shear Wall and Why Do Buildings Need Them?*, 2020). Almost all houses have external shear walls, but internal shear walls are typically found only in larger houses and high-rise buildings subject to lateral winds and seismic forces. The taller the building, the greater the need for internal shear walls and a lateral force resisting system(*What Is a Shear Wall and Why Do Buildings Need Them?*, 2020). Placement of shear walls as a general rule, the ideal placement for shear walls in high-rise buildings and those houses that require them is in the center of each half of a building. Beyond that, shear walls must be built symmetrically around the building's central axis. In other words, if there is a shear wall on its north side, it has to have an identical one on its south side. If there is a shear wall in the southeast corner of a building, then an identical shear wall will be placed on the opposite side of the central axis, in the southwest corner(*What Is a Shear Wall and Why Do Buildings Need Them?*, 2020). Identifying shear walls on plans Shear

walls are typically identified on blueprints by a solid line with a thinner line indicating the sheathing that will cover it (and which is usually then specified in a separate sheathing schedule).(*What Is a Shear Wall and Why Do Buildings Need Them?*, 2020)

1.2 Objectives

There are several objectives have been developed from this construction as follow;

i. To identify the machineries and tools used during shear wall construction using simple formwork system

ii. To identify the methods of shear wall process using a simple formwork system (IBS)

iii. To determine the time of simple formwork system process

iv. To identify the problem and solution in wall construction

1.3 Scope of Study

The scope of study has been carried out at PT 4284 (Zone 7C) and upgrading works at part of green area and buffer zone, Precinct 11, Putrajaya. The project had started in 21st February 2019 and will be completed on 21st December 2021 (34 months). The construction is a public residential development consist of two blocks apartment 16 storey and 17 storey (463 units), 3 storey multilevel car park and common facilities block on PT 4284 (Zone 7C) and upgrading works at part of green area and buffer zone, Precinct 11, Putrajaya owned by Putrajaya Holdings and contract sum is One Hundred Nine Million Nine Hundred and Eighty-Eight Thousand Ringgit (RM109,988,000). The project is currently on going. Therefore, the focus of the study is to determine on how the wall construction process for load bearing wall is undertaken. Hence, the study will be explained not only about the method of wall simple formwork system process but including the advantages of simple formwork system in the construction, finishes for the wall, as well as machinery and tools. Furthermore, the problems and solution also included in this study. Even so, the study does not concentrate on the quantity of manpower or labours, the costs and the duration matters. In order to fulfil the data, there were three methods need to be carried out which is observation, interview, and document reviews. In conclusion, all further explanation relating the above method were explained as below.

1.4 Methods of Study

1. Observation The observation is a way of collecting data through observing. The observation is about how the wall construction process of load bearing wall starting from shear wall installation. The average time taken for this observation approximately around 2-3 hours but only for shear wall installation process and it depends on the length and quantity of the wall. The longer and more quantity of the wall, the longer it takes to complete the shear wall installation process. Overall, it took 2 to 3 days for the shear wall installation process at 1 zone which consists of 4 units. The observation of the wall construction process had been recorded by smartphone and some notes that lasted for 17 weeks.

2. Interview The interview is one of the methods to collect the construction data by doing the structured or semi structured interview with the trusted person for the project. The have been done while doing the observation and while doing the work at the site. The interview was conducted with the main contractor's C&S Site Supervisor, the contractor who is responsible for handling the project in civil and structure while at the construction site. This interview was also done to the workers who were at the construction site while shear wall installation works.

3. Document Review The documents review that have been used to collect all the data for the construction is company profile, construction drawing, standard operating procedures (SOP), progress report and the pictures that taken by me. Drawing plan will be used as the reference at the site that under monitoring for shear wall process. The pictures that belong to others also the best reference during the document reviews. The time for document reviews will usually take 30 minutes for one drawing plan in a week. This document reviews placed at the office.

CHAPTER 2.0

COMPANY BACKGROUND

2.1 Introduction of Company

Innah Makmur Builders Sdn Bhd is a company registered under the Malaysian Construction Industry Development Board (CIDB).. This company is registered in grade G4 in category B (building construction) for specialization B04, CE (civil engineering construction) for CE21 and ME (mechanical and electrical) for M15 specialization under CIDB. Apart from being registered under CIDB, this company has SSM Business Registration certificate (859944-P). Innah Makmur has collaborated with several professional panel companies to meet client demands as well as facilitate all construction matters. The professional panel involved consists of panel of architects, panel of surveyors, panel of engineers and panel of contractors. There are also some general workers and skilled workers who have skills and experience in the fields of construction. With specialized skills in the construction of shear wall, Innah Makmur has been entrusted to manage, plan and build shear wall for many types of building such as townhouses, terraces house and high-rise buildings.

2.2 Company Profile

Innah Makmur Builders Sdn. Bhd. was incorporated in 2009. The team of people has been in the construction industry for 20 years and specialising in various trades in the building industry such as system formwork for RC walls, table form, masonry works, carpentry, painting etc. The company continue to subcontract work and has worked for various main contractors. Today due to diligence and efficiency in management. Innah Makumur Builders Sdn Bhd has a reliable team of skilled site supervisors managing 150 workers in various sites. The company policy has always been to deliver its project on time and to deliver high quality workmanship for all jobs undertaken. This company based in Seremban located at No. 551, Block B1, Leisure Commerce Square (Pusat Dagang Setia Jaya), No. 9, Jalan PJS 8/9, 46150 Petaling Jaya Selangor Darul Ehsan.

Figure 2.1- Location of the company's office based on satellite

Source:

https://www.google.com/maps/@3.0819769,101.5785112,11627m/data=!3m1!1e3

With the company's mission to be one of the construction companies that are able to provide the best, high quality and transparent services to all customers, this company is ready to achieve the company's vision of being company that actively contributes to national and international development. The company has 6 employees and has collaborated with several construction-related companies. Innah Makmur Builders Sdn. Bhd. can be contacted via company email at innahmakmur@gmail.com or gohaigaik@yahoo.com (INNAH MAKMUR BUILDERS SDN. BHD.), or directly contact through company number (03-7866 0187).

2.3 Company Organization Chart

The company consists of 7 people including the managing director which is Ms. Goh Ai Gaik. She is the boss of the company, any decision that were discussed in any aspects are all on her hands. She had been taking care of Innah Makmur Builders Sdn. Bhd. since the first day of this company were incorporated which was in 2009. She managed all construction project in Kuala Lumpur, Putrajaya and Selangor, where the office of the company is located. Mr. Ooi Keong Eng acted as the general manager of the company. He is based in Pulau Pinang, where the factory of the company is located. He is the one who take charge of the construction project at the Northern and East Side of Malaysia. Mr. Tan Chee Kong is the accountant of the company. He managed the the company's finance and account. Ms. Rosnida is the planner of the company, any process of the construction site, she managed. Puan Hafizah is the quantity surveyor and the engineer of the company, she managed all the estimating works and measurement works.

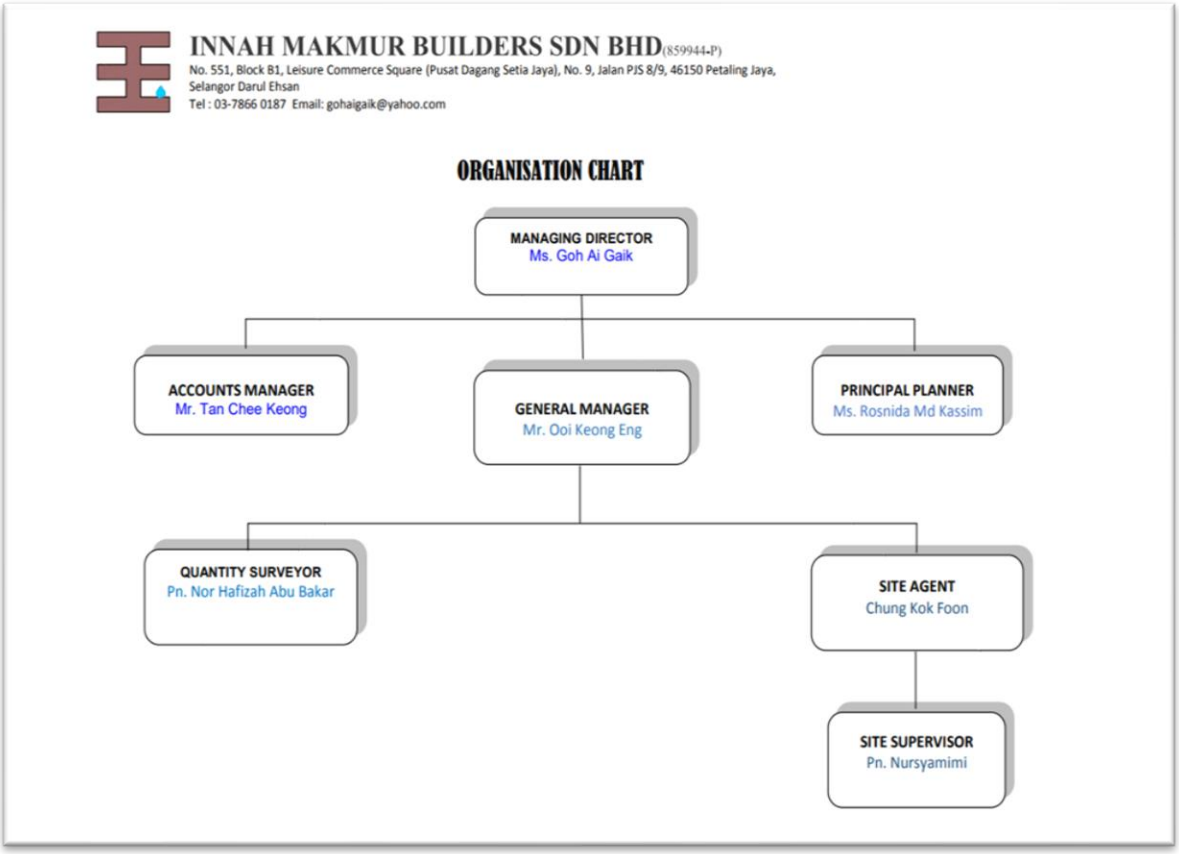

Figure 2.2: Company Organization Chart

Source: Innah Makmur Builders Sdn Bhd.

2.4 List of Project Undertaken

2.4.1 Completed Projects

Table 2.1: List of Completed Projects

No.	Project Title	Start Date	Completion Date	Project Duration	Client
1	Cadangan Membina Bangunan Pejabat 35 Tingkat Dan Hotel 33 Tingkat Yang Mengandungi: a) Podium 5 Tingkat Yang Mengandungi Ruang Letak Kereta Termasuk 1 Tingkat Kemudahan Rekreasi. b) Blok A : 29 Tingkat Kompleks Pejabat (Aras 7- Aras 35) c) Blok B : 27 Tingkat Hotel (378 Unit Hotel Suit) (Aras 9 - Aras 33) d) Ruang Tempat Letak Kereta Di Aras Sub-basement 1 Dan Basement 2. Di Atas Lot 582, Jalan Tun Sambathan Seksyen 55, Bandar Kuala Lumpur,	5th October 2009	20th December 2010	1 year	Magic Coast Sdn. Bhd.
2	Cadangan Membina Dan Menyiapkan Projek Perumahan	28th November 2010	8th March 2012	1.5 year	Pejabat Setiausaha Kerajaan

	Mampu Milik Di Atas Lot 007501, 1142, 1143, 1144, 1145, 9695, 9696, 9697, 9698, 9699, 9700 Dan 9701, Di Kampung Batu Hampar, Mukim Belara, Daerah Kuala Terengganu, Terengganu Darul Iman. Untuk Tetuan : Pejabat Setiausaha Kerajaan Terengganu (Perumahan				Terengganu (Perumahan)
3	Cadangan Membina Dan Menyiapkan 317 Unit Rumah Teres Dan Kerja-Kerja Berkaitan Dengannya Bagi Projeck Rumah Kos Rendah (RKR) Di Kampung Batu 22, Daerah Hulu Terengganu, Mukim Tanggul, Terengganu Darul Iman. Untuk Tetuan : Pejabat Setiausaha Kerajaan Terengganu (Perumahan)	10th January 2010	23rd February 2011	1 year	Pejabat Setiausaha Kerajaan Terengganu (Perumahan)
4	Cadangan Membina Dan Menyiapkan Sebuah Bangunan	6th June 2010	19th December 2012	2 years	Gazzriz Sdn Bhd

	Servis Apartment Yang Mengandungi : 251 Unit Servis Apartment, 4 Tingkat Tempat Letak Kereta, Bilik Seminar Dan 1 Unit Kedai Pejabat 2 Tingkat Di Atas Lot 2048 Dan 879, Mukim Kenali, Seksyen 54, Daerah Kubang Kerian, Kota Bharu, Kelantan Darul Naim				
5	Cadangan Membina Dan Menyiapkan: i) 1 Blok Pangsapuri 11 1/2 Tingkat ii) 1 Unit Janakuasa Elektrik iii) 1 Unit Kebuk Sampah Di Atas Lot 33003, Sebahagian Lot 33002, Lot PT8 Dan sebahagian Lot PT7, Persiaran Serimas, Kota Seriemas, Nilai, Negeri Sembilan Darul Khusus.	18th September 2010	30th November 2012	2 years	Puteri Nursing College Sdn Bhd
6	Politeknik Balik Pulau (PBU), Pulau Pinang. (Kerja Bangunan Dan Kerja-Kerja Berkaitan Reka & Bina)	18th December 2011	10th January 2013	1 year	PBU

7	Cadangan Pembangunan Perdagangan: i) 2 Tingkat Ruang Kedai / Pejabat (30 Unit) ii) 3 Tingkat Tempat Letak Kenderaan Bertingkat iii) 1 Tingkat Ruang Kemudahan iv) 14 Tingkat Ruang Pejabat (245 Unit) Dan 1 Unit Rumah Pungutan Sampah 1 Tingkat Di Atas No. 4 Lot P.T 19 (Precint 3.5) Persiaran Bandaraya, Seksyen 14, 40000 Shah Alam, Selangor Darul Ehsan	10th October 2011	29th November 2013	2 years	Lastik Pasti Sdn. Bhd.
8	Proposed Development Of Cadangan Membina Dan Menyiapkan 168 Unit Rumah Teres Yang Terdiri Dari : 56 Unit Jenis A (Ptd 174723 - Ptd 174750, Ptd 174889 - Ptd 174916), 56 Unit Jenis B (Ptd 174751 - Ptd 174778, Ptd 174917 - Ptd 174944), Dan 56 Unit Jenis C (Ptd 174779 - Ptd 174806, Ptd 174945 - Ptd	4th December 2011	13th August 2013	2 years	Nusajaya Heights Sdn. Bhd

	174972), Di Atas Sebahagian Lot Ptd 71040, Fasa 2c, Nusa Bayu, Nusajaya, Mukim Pulai, Daerah Johor Bahru, Johor Darul Takzim				
9	Permohonan Pelan Bangunan Bagi Pembangunan Bercampur Yang Mengandungi:- 1) 2 Blok Pangsapuri Servis 6 Tingkat (168 Unit) 2) 1 Tingkat Aras Tanah (9 Unit Lot Kedai), 3) 1 Tingkat Aras Bawah Tanah (4 Unit Lot Kedai Dan Tempat Letak Kereta), 4) 1 Tingkat Aras Basement (Tempat Letak Kereta), Beserta Kolam Renang Dan Kemudahan Rekreasi Di Atas Lot PTD 166949, Bandar Nusajaya, Mukim Pulai, Daerah Johor Bahru, Johor Darul Tak'zim	2nd April 2013	14th September 2014	1.5 year	Nusajaya Consolidated Sdn Bhd
10	Cadangan Membina 140 Unit Rumah Teres 2 Tingkat (20' x 70')	7th June 2013	6th July 2014	1 year	Nusajs Sdnaya Height Bhd

	Yang Terdiri Daripada 70 Unit Jenis A Dan 70 Unit Jenis B Di Atas Sebahagian PTD 71040, Fasa 2B, Nusabayu, Mukim Pulai, Daerah Johor Bahru, Johor Darul Takzim				

2.4.2 Ongoing Projects

Table 1.2: List of Ongoing Projects

No.	Project Title	Start Date	Completion Date	Project Duration	Client
1	Proposed Construction and Completion Of Public Residential Development Consist Of Two (2) Blocks Apartment 16 Storey And 17 Storey (463 Units). 3 Storey Multilevel Car Park and Common Facilities Block On Pt 4284 (Zone 7c) And Upgradings Works At Part Of Green Area And Buffer	19 February 2019	30 September 2022	Ongoing Target 3 years	Putrajaya Holdings (PJH)

	Zone, Precint 11, Putrajaya				

CHAPTER 3.0

CASE STUDY 3.1

Introduction to Case Study The case study is about shear wall construction (lBS) using simple formwork system. The scope of study has been carried out at PT 4284 (Zone 7C) and upgrading works at part of green area and buffer zone, Precinct 11, Putrajaya. The project had started in 21st February 2019 and will be completed on 21st December 2021 (34 months). The construction is a public residential development consist of two blocks apartment 16 storey and 17 storey (463 units), 3 storey multilevel car park and common facilities block on PT 4284 (Zone 7C) and upgrading works at part of green area and buffer zone, Precinct 11, Putrajaya owned by Putrajaya Holdings and contract sum is One Hundred Nine Million Nine Hundred and Eighty-Eight Thousand Ringgit (RM109,988,000). Currently, the project progress is still on going. Thus, the study will be explained not only regarding installation but including the machinery and tools, the time that have been carry out and the problem and solution of the construction. Nevertheless, the study does not concentrate on cost matters and manpower.

Location Plan

The location of the project was located at Zone 7-C Precent 11, Wilayah Persekutuan Putrajaya. The building was built for the use of public residential development owned by Putrajaya Holdings (PJH).

Figure 3.1: Location plan based on satellite map

Source:

https://www.google.com/maps/place/Site+Office+NCSB+(Gate+1+P11-7C)/@2.9511325,101.6747736,343m/data=!3m1!1e3!4m5!3m4!1s0x31cdb77723679321:0xac7bf1c085bcf9cc!8m2!3d2.9502505!4d101.6751894

Site Plan

A site plan is a set of construction drawings that a builder or contractor uses to make improvements to a property. The site plan can be used by counties to verify that development codes are being followed as well as a historical resource. Site plans are frequently prepared by a design consultant, who must be a professional engineer, architect, landscape architect or land surveyor. Here was the drawing of site plan of the project.

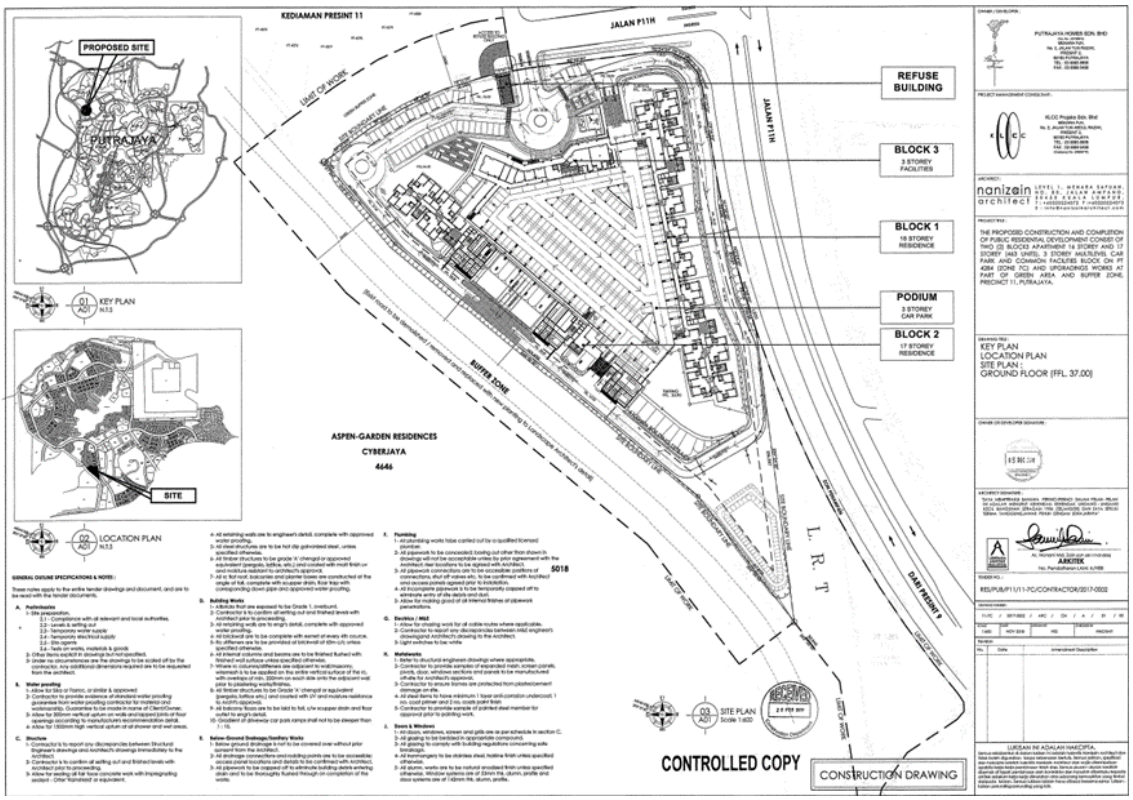

Figure 3.2: Construction Site Layout Plan & Key Plan

Source: Architect Supervisor Nadi Cergas Sdn. Bhd.

Project's view

The purpose of the project view is to describe the condition of the building from every side and view. Below was an image that includes project signboard, view from Tower Crane 1, Tower Crane 2 and Tower Crane 3

Figure 3.3: Project Signboard

Figure 3.4: Project's view from Tower Crane 1

Figure 3.5: Project's view from Tower Crane 2

Figure 3.6: Project's view from Tower Crane 3

Layout Plan

Referring to the layout plan, shear wall will be installed at level LG, level G, level 1, level 2 until Level 16. In this report, the writer focused on the installation of shear wall. The picture below refers to the shear wall plan of the project for the installation of shear walls.

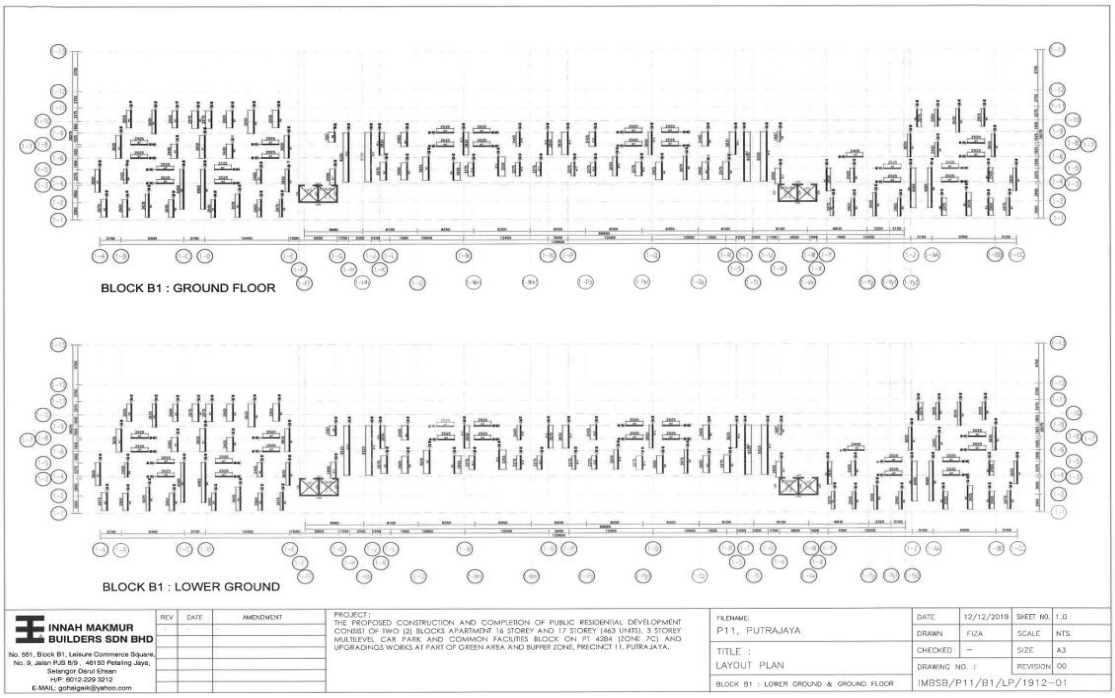

Figure 3.7: Shop drawing for shear wall Block 1 Level LG and Level G, Zone 6, Zone 7 and Zone 8

Source: Innah Makmur Builders Sdn. Bhd.

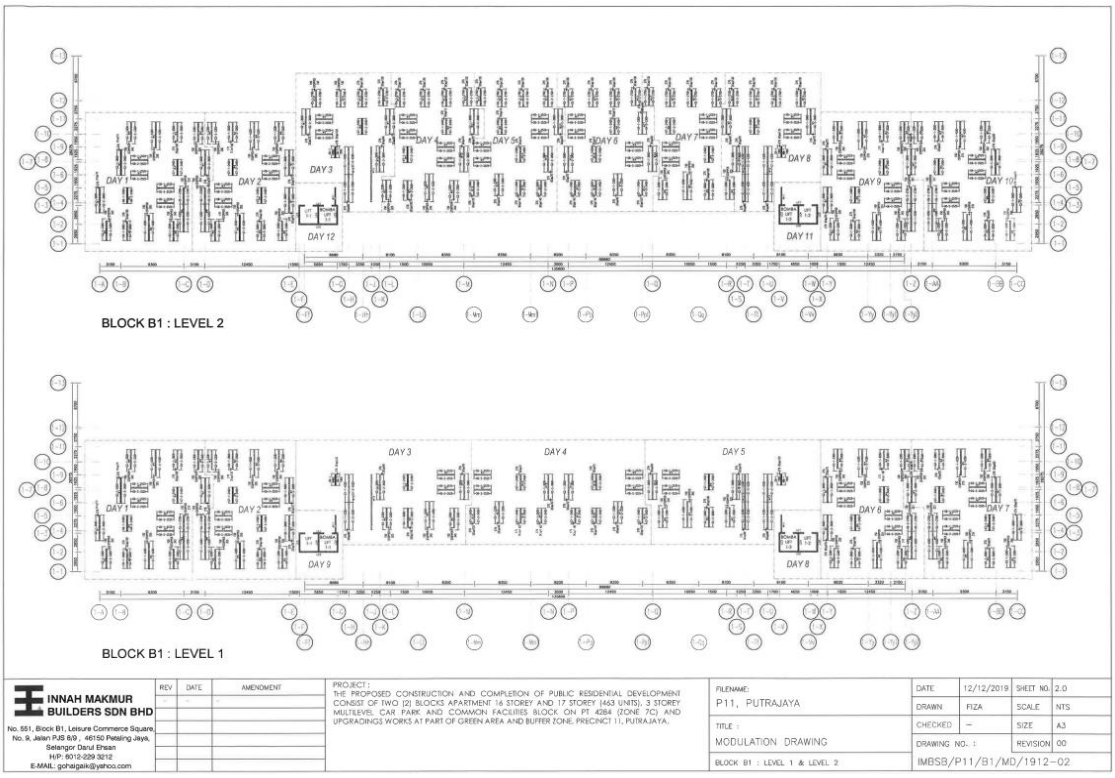

Figure 3.8: Shop drawing for shear wall Block 1 Level 1 and 2 Zone 6, Zone 7 & Zone 8

Source: Innah Makmur Builders Sdn. Bhd.

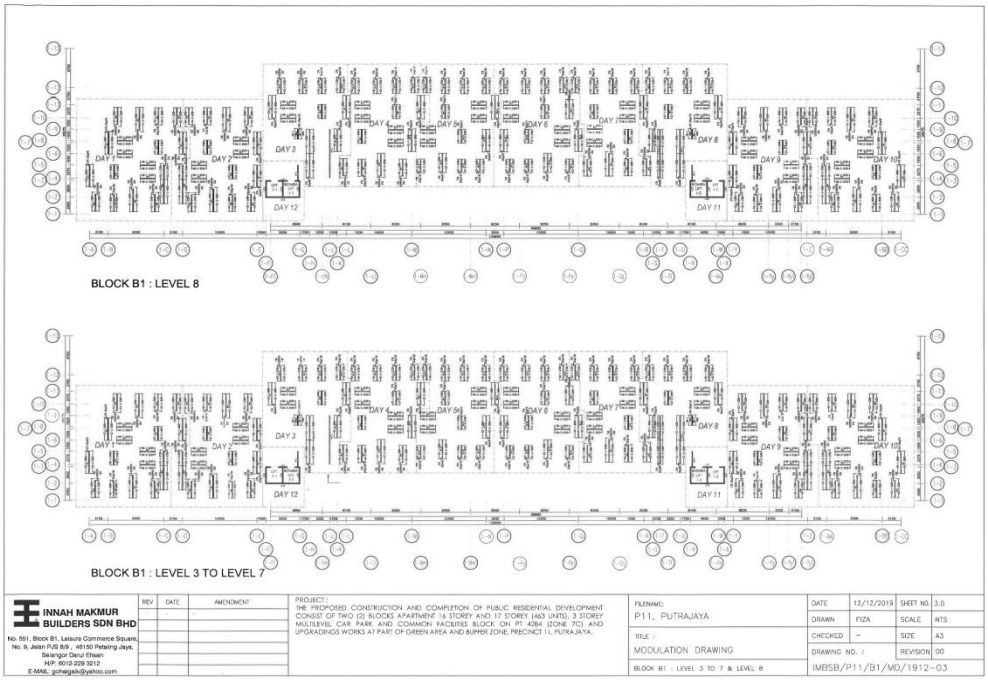

Figure 3.9: Shop drawing for shear wall Block 1 Level 3 to Level 7 and Level Zone 6, Zone 7 & Zone 8

Source: Innah Makmur Builders Sdn. Bhd.

Block 1 consists of 15 levels of units that have 6 types of units which are Type A, Type B, Type C, Type D, Type E and Type F. According to the shop drawing above, the left zone is counted as Zone 8, Zone 8 has 4 units per level. The middle zone is Zone 7 that consists of 8 units per level. The right side of zone is zone 6 which has 3 unit per level

but only from level LG to Level 1, starting from Level G there will be 4 units per level. 1 unit of all types consists of 8 shear walls excluding the stair walls and lift walls.

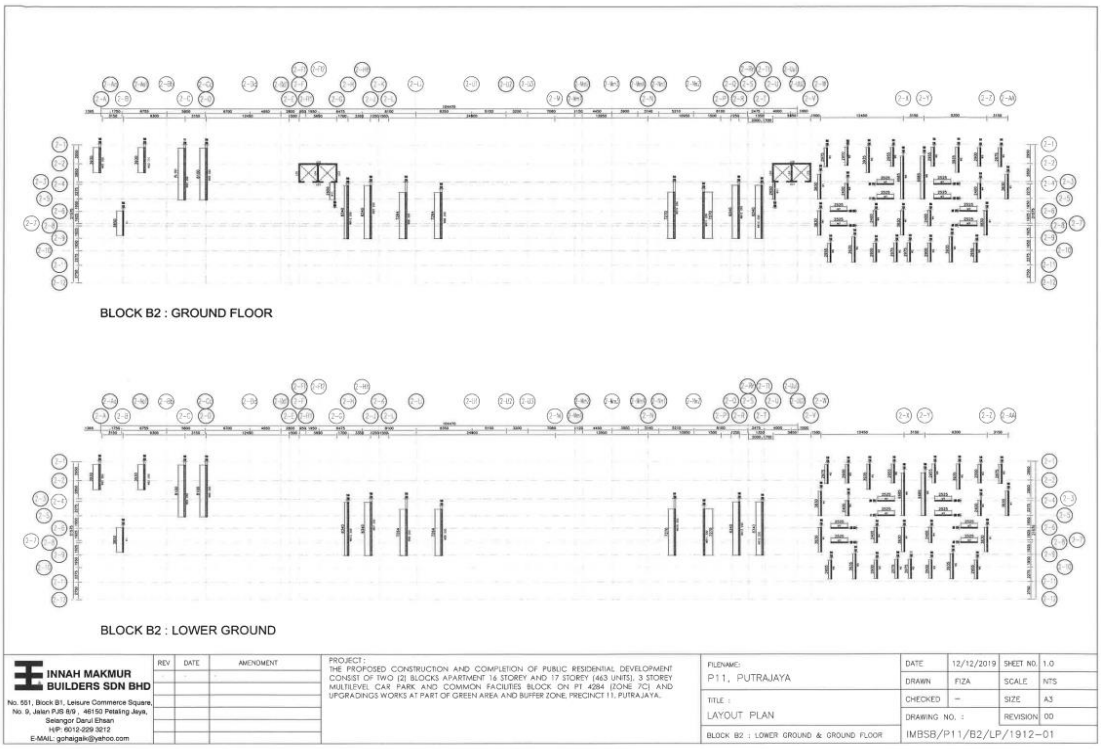

Figure 3.10: Shop drawing for shear wall Block 2 Level LG and G, Zone 1, Zone 2 and Zone 3

Source: Innah Makmur Builders Sdn. Bhd.

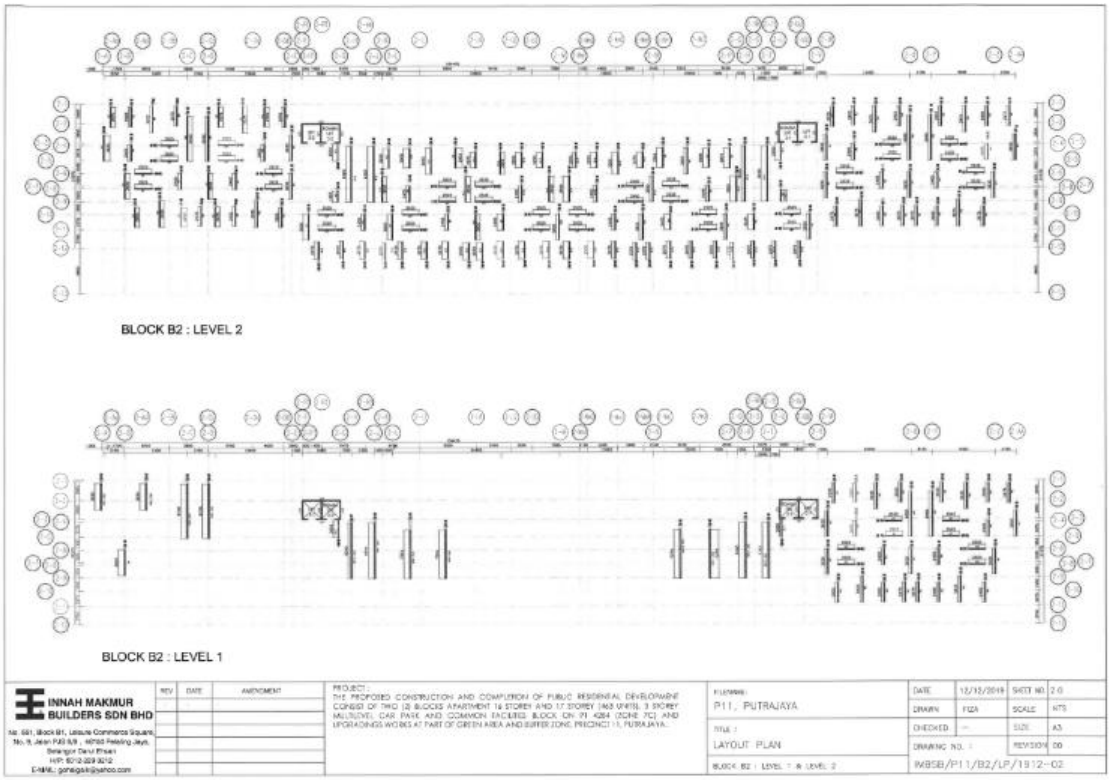

Figure 3.11: Shop drawing for shear wall Block 2 1 and Level 2, Zone 1, Zone 2 & Zone 3

Source: Innah Makmur Builders Sdn. Bhd.

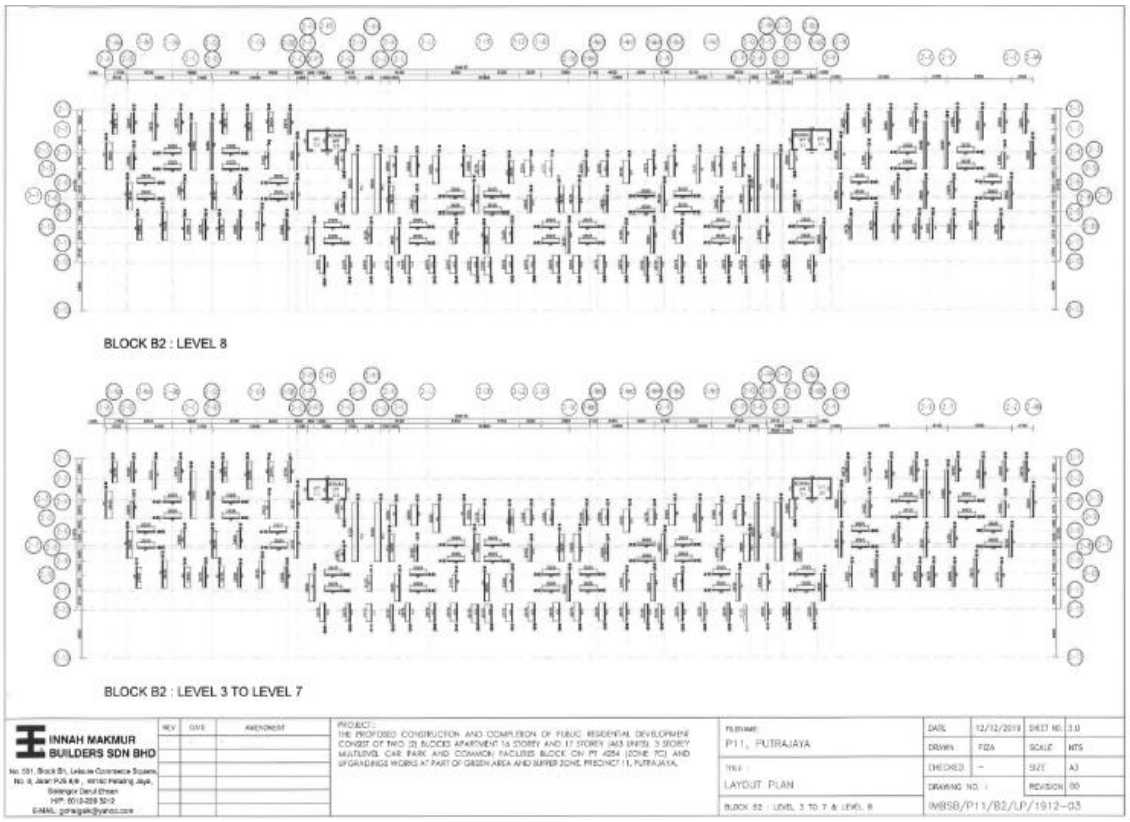

Figure 3.12: Shop Drawing for shear wall Block 2 Level 3 to Level 7 for Zone 1, Zone 2 & Zone 3

Source: Innah Makmur Builders Sdn. Bhd.

Block 2 consists of 16 levels of units that have 6 types of units which are Type A, Type B, Type C, Type D, Type E and Type F. According to the shop drawing above, the left zone is counted as Zone 3, Zone 3 has 4 units per level. The middle zone is Zone 2 that consists of 8 units per level. The right side of zone is zone 1 which has 4 units per level. 1 unit of all types consists of 8 shear walls excluding the stair walls and lift walls. Block 2 is a special case because from level G to Level 1, Zone 2 and Zone 3 is a parking lot. Therefore, they would be shear walls that have the different length and thickness.

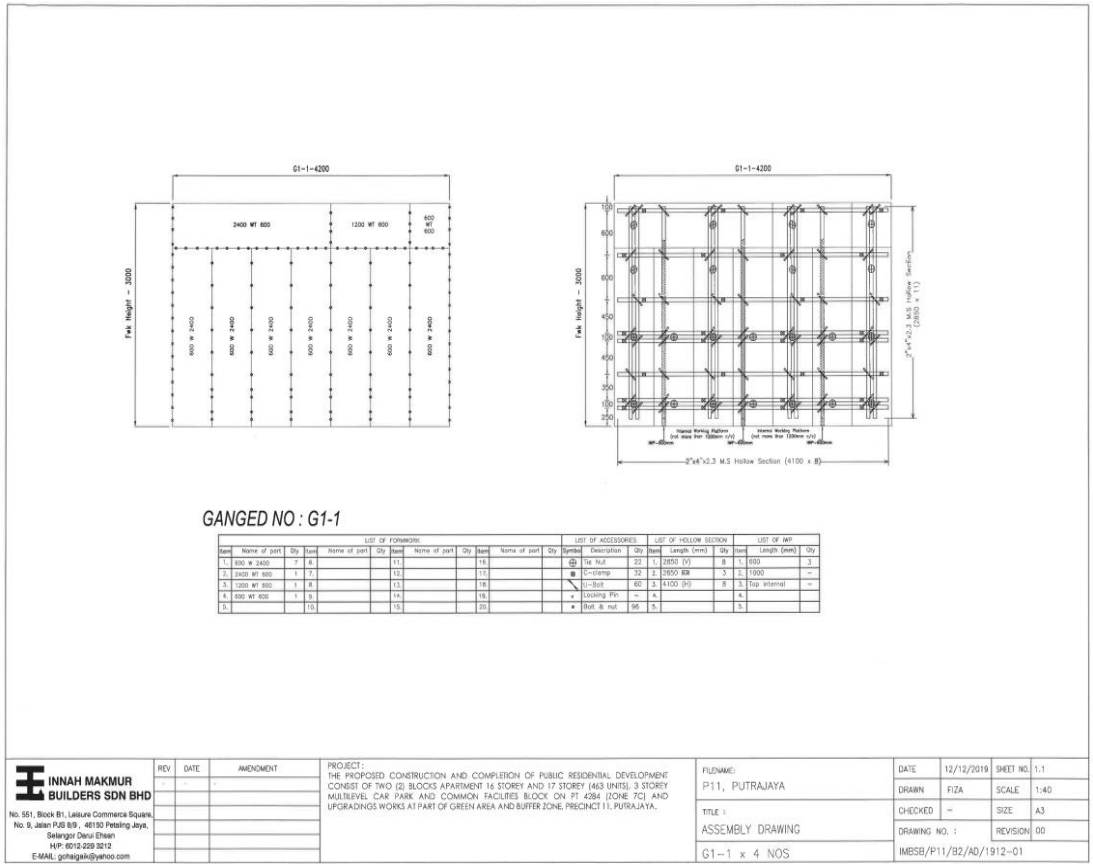

Figure 3.13 Assembly Drawing of the ganged Formwork

Source: Innah Makmur Builders Sdn. Bhd.

Table 3.1 – List of Accessories of Ganged Formwork

Source: Innah Makmur Builders Sdn. Bhd.

LIST OF FORMWORK												LIST OF ACCESSORIES			LIST OF HOLLOW SECTION			LIST OF IWP		
Item	Name of part	Qty	Item	Name of part	Qty	Item	Name of part	Qty	Item	Name of part	Qty	Symbol	Description	Qty	Item	Length (mm)	Qty	Item	Length (mm)	Qty
1.	600 W 2400	7	6.			11.			16.			⊕	Tie Nut	22	1.	2850 (V)	8	1.	600	3
2.	2400 WT 600	1	7.			12.			17.			◙	C-clamp	32	2.	2850 ◙	3	2.	1000	-
3.	1200 WT 600	1	8.			13.			18.			\	U-Bolt	60	3.	4100 (H)	8	3.	Top Internal	-
4.	600 WT 600	1	9.			14.			19.			x	Locking Pin	-	4.			4.		
5.			10.			15.			20.			•	Bolt & nut	96	5.			5.		

3.2 Identify the machineries and tools for shear wall installation using simple formwork system

Table 3.2 – List of Machineries and Tools with function

No.	Machineries and Tools	Function
1	Tower Crane 	• a rotatable cantilever jib on top of a steelwork tower used on building sites where the operator needs to command a good view of the site. • able to outperform the loading and lifting capacity of any other crane • To lift and shift the ganged formwork panel from one place to another
2	Measuring Tape 	• To measure the dimension of the walls in certain zone during setting out • To measure the length of the shear wall
3	Hammer 	• To tighten the lock pins during shear walls installation • To tighten the tie nuts during shear walls installation • To adjust the jack base during verticality adjusting
4	Lock pin 	• To connect the adjacent ganged formwork • To lock the other pair of the wall formwork panel

5	Jack Base 	• To adjust verticality of the wall formwork panel • To reduce the load bore from the formwork panel
6	Tie rods 	• To tighten the pair of the ganged formwork panel together with tie nuts • To ensure the alignment of the shear walls
7	Tie nuts 	• To tighten the pair of the ganged formwork panel together with tie rods • To ensure the alignment of the shear walls
8	UPVC Pipe 25mm x 150mm 	• To be inserted inside the formwork panel during shear wall installation to facilitate the dismantling process of the ganged formwork panel

9	Kicker Mould 150mmx150mm 	• To install kicker of shear wall before installation of shear wall commence • To make sure the alignment of the shear walls is accurate

3.3 Identify the method of shear wall installation using simple formwork system

Method Statement & Safety Guidelines – SIMPLE FORMWORK SYSTEM

Structure before shear wall to be ready before shear wall installation

The foundation, ground beams and ground floor slab and transfer floor (if any) are first formed by others. Steel reinforcement starter bars are placed (by others) in position along the reinforced concrete walls.

Modulation the loose formwork panels at a plain area

Figure 3.14: Shows the modulation of the formwork panels

The loose formwork panels were modulated which are sent to site according to the shop drawings provided. Each ganged formwork was identified by labelling them according to the shop drawings.

Safety Guidelines adopted by workers. The workers wore safety helmet and safety shoes when working at site.

Grid line established by the surveyor was and steel reinforcement bar for shear walls are installed by barbenders was checked according to the construction drawing

Figure 1.15: Shows the Grid Line point given by the Licensed Building Surveyor

Figure 3.16: Shows the steel reinforcement (BRC) for shear walls

After the wall line has been established by the surveyor, the steel reinforcement (by others) to the wall were installed followed by the electrical conduiting (by others), sanitary pipes (by others), plumbing pipes (by others) and kickers formwork. The reinforcement will always lead the formwork by one phase.

Safety Guidelines adopted by workers. The workers wore safety helmet and safety shoes when working at site.

Installation assembled ganged formwork of one side of shear wall rebar using tower crane

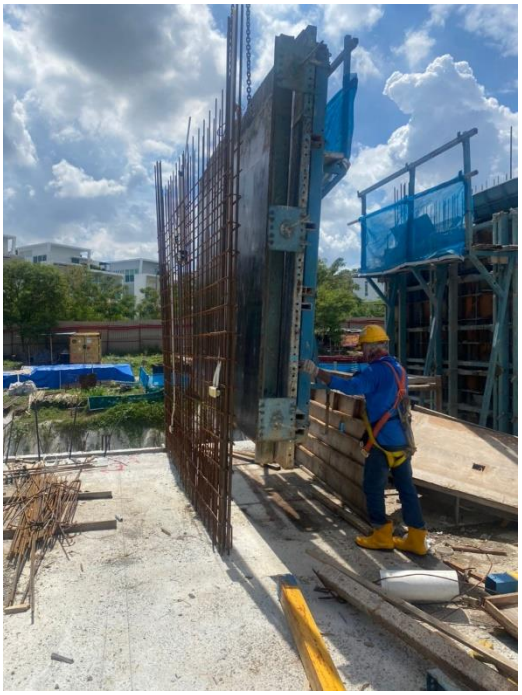

Figure 3.17: Shows the installation of shear wall using the simple form work system on one side

The formwork installer then followed closely behind. The assembled ganged formwork attached to the internal working platform was lifted by crane and placed in position, guided by the concrete kickers. The ganged formwork for one side of the wall will first be placed on the wall line. For an internal wall, either side of the ganged formwork could be fixed first but for an external wall always was fixed the internal side of the ganged formwork first to be followed immediately by an external ganged. Safety Guidelines adopted by workers. The workers wore safety helmet and safety shoes when working at site. The lifting chain or hooks are tied around hollow section at both ends of ganged formwork when hoisting/shifting by crane. Ensured do not have any loose parts on the formwork during shifting. Always installed one side of the wall and immediately followed by the opposite side by tightening the tie rod and wing nuts. Never leave one side of the formwork standing by itself and go for a break. Due to unforeseen circumstances such as. rain, lunch. etc if only one side of the ganged formwork has been installed at the edge, removed the said formwork away from the

edge of the building and placed it at a distance of at least twice the height of the formwork. If not, placed it lying on the ground.

Assembled ganged formwork of opposite side of shear wall rebar, locking pin, tie rods with tie nuts were installed followed with verticality adjustment

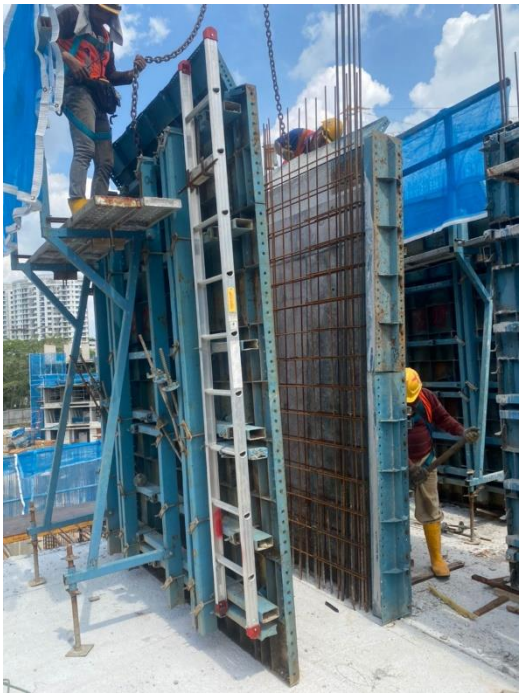

Figure 3.18: Shows the installation of shear wall using the simple formwork system on the opposite side

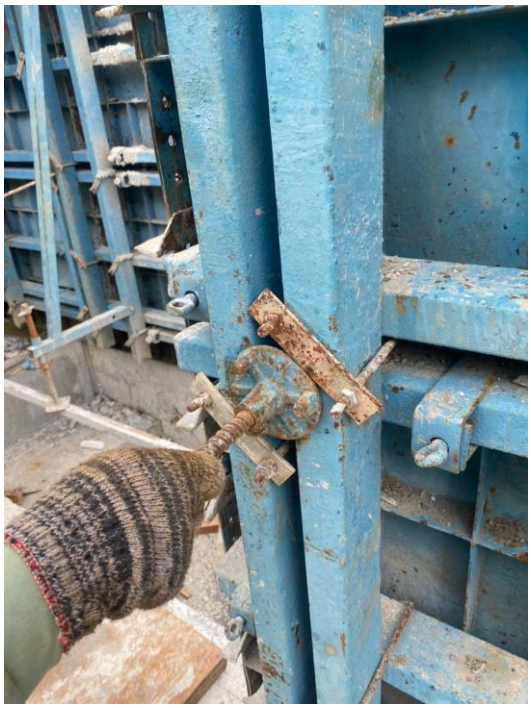

Figure 3.19: Shows the installation of tie rods & tie nuts on the ganged formwork panels

Figure 3.20: Shows the installation of lock pin to tighten the pair of ganged formwork panels

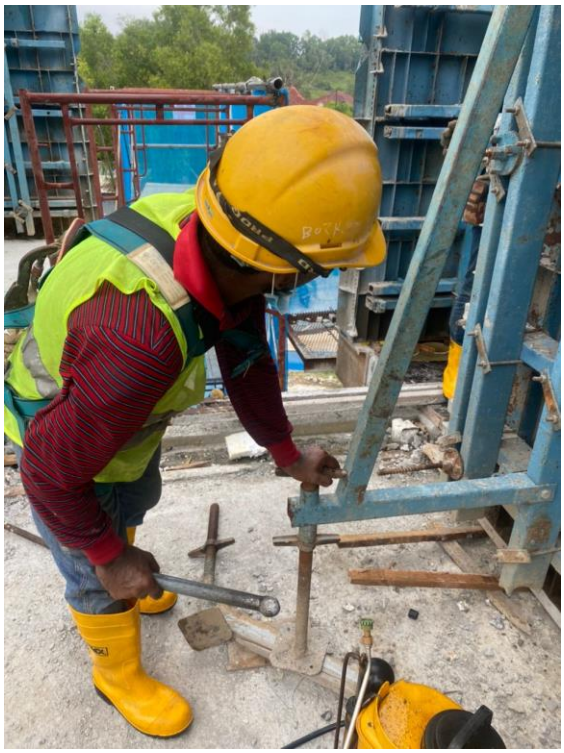

Figure 3.21: Shows the adjusting verticality work by adjusting the jack base

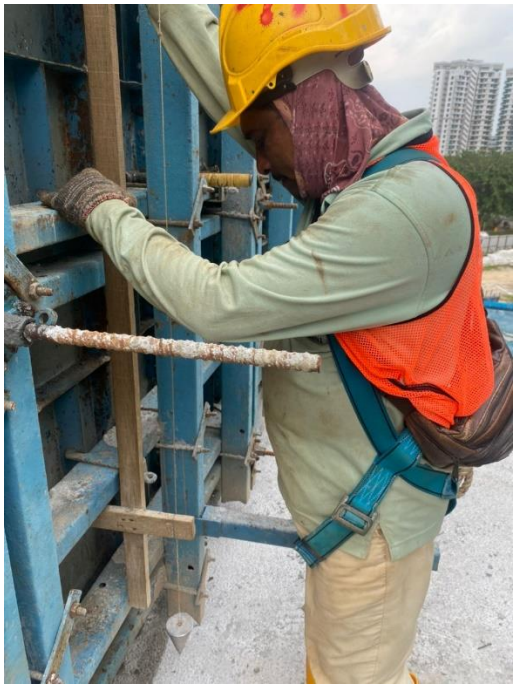

Figure 3.22: Shows the verticality checking of the ganged formwork panels

Once one side of the ganged formwork had been accurately placed, tie rods were be inserted at its proper location followed by upvc pipe. This was followed immediately by the opposite gang to form a wall. Once the pair of form work has been accurately placed, they were locked together by tightened the tie nuts. The tie rod and

upvc pipes acted as a control to maintain the required thickness throughout the entire length of the wall. After all the tie rods and tie nuts had been fixed the verticality of the formwork was adjusted by jacking the jack base. Once it is confirmed vertical, the jack base wing nut was tightened.

Safety Guidelines are adopted by worker. The workers wore safety helmet and safety shoes when working at site. The lifting chain or hooks are tied around hollow section at both ends of ganged formwork when hoisting/shifting by crane. Ensured do not have any loose parts on the formwork during shifting. Always installed one side of the wall and immediately followed by the opposite side by tightening the tie rods and wing nuts. Never leave one side of the formwork standing by itself and go for a break. Due to unforeseen circumstances e.g. rain, lunch. etc if only one side of the ganged formwork has been installed at the edge, removed the said formwork away from the edge of the building and placed it at a distance of at least twice the height of the formwork. If not, placed it lying on the ground. All accessories such as tie rods, wing nuts, lock pins, jack base, jack stems and others are kept in good condition and periodically checked after each casting. If quality of the accessories has deteriorated, they are replaced.

Installation of adjacent assembled ganged formwork (if required)

Figure 3.23: Shows the adjacent ganged formwork

Figure 3.24: Shows the adjacent ganged formwork installation ongoing

The adjacent gang (if required) was fixed to the existing ganged formwork to form to the required length of the wall. The ganged formworks were connected

together by lock pins. The lock pin was fastened every 150mm along the connecting panels.

Safety Guidelines are adopted by worker. The workers wore safety belt and safety shoes when working at site. The lifting chain or hooks were tied around hollow section at both ends of ganged formwork when hoisting/shifting by crane. Ensured do not have any loose parts on the formwork during shifting. The workers always installed one side of the wall and immediately followed by the opposite side by tightening the tie rods and wing nuts. Never leave one side of the formwork standing by itself and go for a break. Due to unforeseen circumstances e.g., rain, lunch. etc if only one side of the ganged formwork has been installed at the edge, removed the said formwork away from the edge of the building and placed it at a distance of at least twice the height of the formwork. If not, placed it lying on the ground. All accessories such as tie rods, wing nuts, lock pins, jack base, jack stems and others are kept in good condition and periodically checked after each casting. If quality of the accessories has deteriorated, they are replaced.

Installation of External working platform for external shear walls at ground level

Figure 3.25: Shows the External Working Platform for external shear walls

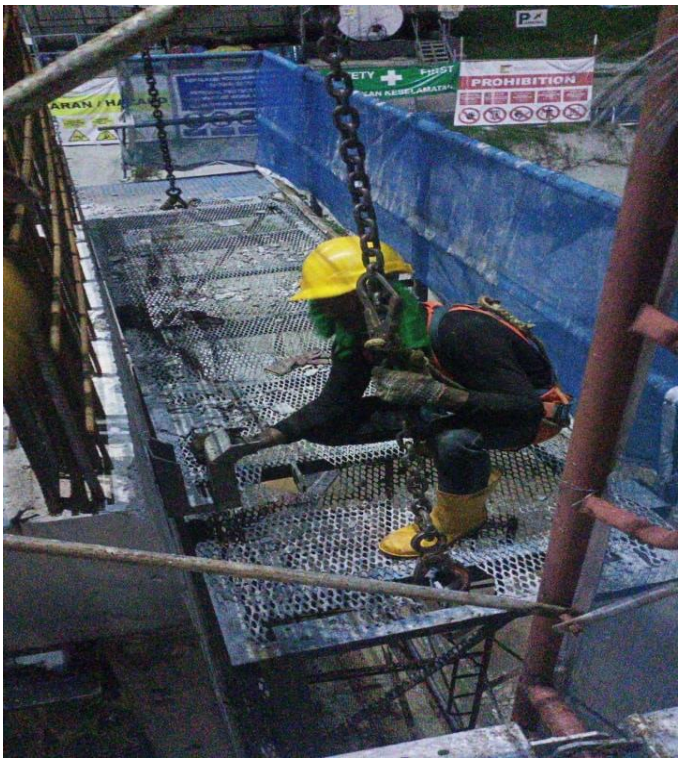

Figure 3.26: Shows the installation of external working platform

For external walls above ground floor, the installers had fixed the external working platforms first in order to install the ganged formwork. The installer would have to install the jack stems first by inserting the jack stem into the predetermined position in the concrete wall. The maximum distance between jack stems is 1.5 meter. His partner had tightened the jack stems from the inside of the building by using jack base tie nuts. Once the jack stems have been fixed, the external working platform would be slotted into the jack stem.

Safety Guideline adopted by workers. The workers wore wear safety helmet and safety shoes when working at site. The workers always wore a safety belt when working on external working platform. Ensured that the barricade of the external working platform is properly fixed. Cleaned the external working platforms after each concreting to prevent any dried concrete/debris from falling during shifting Always ensured that the external working platforms are adequately placed. Ensured there were not be a gap of more than 300mm between two external working platforms. All accessories such as tie rods, wing nuts, lock pins, jack base, jack stems and others are kept in good condition and periodically checked after each casting. If quality of the accessories has deteriorated, they are replaced.

Installation of external working platform at upper level

For the subsequent external walls, the installer had shifted the external working platform (which is one floor below) to the next floor. The formwork installer first fastened the safety belt to the barricade of the working on external working platform. The crane lifted the external working platform to the above floor and the formwork installer inserted the second set of jack stems into the predetermined position in the concrete wall. His partner tightened the jack stem from the inside of the building by using jack base wing nut. Once the jack stem had been fixed the external working platform will be slotted into the jack stem.

Safety Guidelines adopted by workers. The workers always wore safety helmet and safety shoes when working at site. The workers always wore safety belt when working on external working platform. Ensured that the barricade of the external working platform is properly fixed. Cleaned the external working platforms after each concreting to prevent any dried concrete/debris from falling during shifting Always ensured that the external working platforms are adequately placed. Ensured there were not be a gap of more than 300mm between two external working platforms. All accessories such as tie rods, wing nuts, lock pins, jack base, jack stems and others are kept in good condition and periodically checked after each casting. If quality of the accessories has deteriorated, they are replaced.

Installation of external shear walls

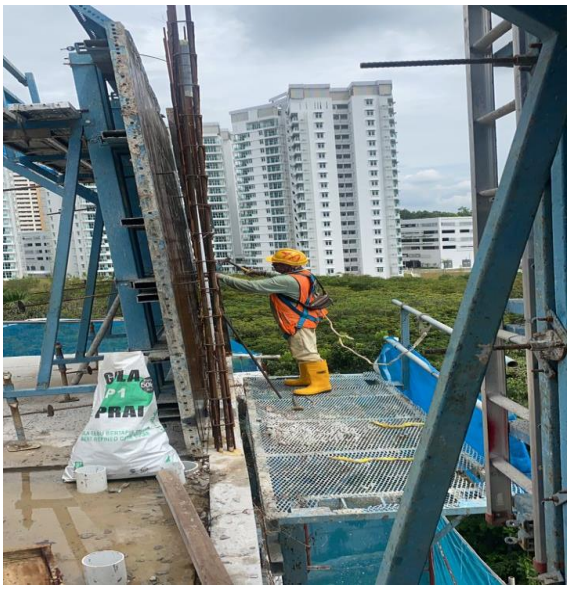

Figure 3.27: Shows the installation of external shear wall one side

Figure 3.28: Shows the installation of external shear wall opposite side

For external walls, the workers installed the internal side of the ganged formwork first. Once it is placed in position it was to tied with a cable to the next nearest RC wall (if it has been concreted) or to the next nearest ganged formwork which has been installed. The opposite external ganged formwork lifted and fixed to form a pair. The leg/internal working platform was sited on the external working

platform. The external ganged form was adjusted followed by tightening of the tie rods and tie nuts.

Safety Guidelines to be adopted by workers. Always wear safety belt and safety shoes when working at site. The lifting chain or hooks are to be tied around hollow section at both ends of ganged formwork when hoisting/shifting by crane. Do not have any loose parts on the formwork during shifting. Always install one side of the wall and immediately followed by the opposite side by tightening the tie rods and tie nuts. Never leave one side of the formwork standing by itself and go for a break. Due to unforeseen circumstances e.g., rain, lunch. etc if only one side of the ganged formwork has been installed at the edge, remove the said formwork away from the edge of the building and placed it at a distance of at least twice the height of the formwork. If not, placed it lying on the ground.

The same method is applied for the remaining walls.

Verticality inspection by Inspector of Work and Supervisor of Main Contractor

Figure 3.29: Shows the verticality inspection process by main contractors and consultant

There was a final inspection to ensure that all accessories are placed according to the shop drawings and securely tightened. The structure were ready for concreting (by others).

Safety Guidelines to be adopted by worker(s)

All accessories such as tie rods, tie nuts, lock pins, jack base, jack stems and others should be kept in good condition and periodically checked after each casting. If quality of the accessories has deteriorated, they should be replaced.

Dismantling of shear walls ganged formwork after casted

The next day after concreting, the ganged formwork was dismantled by loosening the tie nuts and removing the tie rods followed by the lock pins. The formwork was opened by tilting it backwards at 80-degree angle. As an indicator, the worker knew that the 80-degree angle has been achieved when one of the vertical hollow sections attached to the ganged formwork touched the ground. The crane lifted the ganged formwork and shifted it to the next location. The formwork was cleaned by scrapping the surface and mould oil will be applied on the surface of the panels before fixing it to form the next wall. For external walls, it was necessary and important to first securely attach the tower crane chain to the ganged formwork. Only after this could the process of loosened of the tie nuts to remove the tie rods and lock pins be carried out. Once completed, the jack bases of the ganged formwork were loosened until it reached the marking that indicates the resting angle of 80 degree has been achieved. The crane lifted the ganged formwork and shifted it to the next location. For certain panels which will not be in service during anytime of the construction process, always placed it at a safe distance from the edge of the building distance shall be at least twice the height of the formwork. If possible, placed it on ground.

Safety Guidelines to be adopted by workers. They always wore safety belt and safety shoes when working at site. The lifting chain or hooks were tied around hollow section at both ends of ganged formwork when hoisting/shifting by crane. Ensured that do not have any loose parts on the formwork during shifting. Always installed one side of the wall and immediately followed by the opposite side by tightening the tie rods and wing nuts. Never leave one side of the formwork standing by itself and go for a break. Due to unforeseen circumstances e.g., rain, lunch. etc if only one side of the ganged formwork has been installed at the edge, removed the said formwork away from the edge of the building and placed it at a distance of at least twice the height of the formwork. If not, placed it lying on the ground. When dismantling of an internal wall after concreting, they leaned the ganged formwork at 80 degree and tightened the jack

base to the ground. When dismantling formwork for an external wall after concreting, it was necessary and important to first securely attach the tower crane chain to the formwork follow by loosening the tie rods, wing nuts and lock pins. Immediately lifted the ganged formwork to the next location. Never leave a loosen external ganged formwork unattended standing /leaning by itself. Remove any loose parts sitting on the ganged formwork (timber, tie rod, wing nut…etc) in order to prevent them from falling during shifting. All accessories such as tie rods, wing nuts, lock pins, jack base, jack stems and others were kept in good condition and periodically checked after each casting. If quality of the accessories are deteriorated they were replaced.

Safety Guidelines for Simple Formwork System

At all times, please observe safety regulations at the site and exercise care when using the formwork and observe our safety guidelines mentioned below.

Hoisting/Shifting of Formwork at Site

The lifting chain or hooks are to be tied around hollow section at both ends of ganged formwork when hoisting/shifting by crane. Do not have any loose parts on the formwork during shifting.

Storage Of Gang Formwork When Not in Service

When there is just one side of ganged formwork standing by itself, lean it at 80 degree and tightened the jack base to the ground. Formwork is to be placed away from the edge of the building distance shall be at least twice the height of the formwork. If not, placed it lying on the ground.

Installation/ Dismantling of Formwork in Progress

Always install one side of the wall and immediately followed by the opposite side by tightening the tie rods and wing nuts.

For external wall always install the internal side of the formwork and immediately followed by the opposite side by tightening the tie rods and wing nuts. Never leave one side of the formwork standing by itself and go for a break. Due to unforeseen circumstances e.g., rain, lunch. etc if only one side of the formwork is installed at the edge of the building, remove the said formwork away from the edge of the building and go to

When dismantling of an internal wall after concreting, lean the ganged formwork at 80 degree and tightened the jack base to the ground. When dismantling formwork for an external wall after concreting, it is necessary and important to first securely attach the tower crane chain to the formwork follow by loosening the tie rods, wing nuts and lock pins. Immediately lift the ganged formwork to the next location. Never leave a loosen external gang formwork unattended standing /leaning by itself. v) Remove any loose parts sitting on the formwork (e.g., timber, tie rod, wing nut…etc) in order to prevent them from falling during shifting.

Installation/ Dismantling of External Working Platform

Always wear a safety belt when working on external working platform. Ensure that the barricade of the external working platform is properly fixed. ii) Clean the external working platforms after each concreting to prevent any dried concrete/debris from falling during shifting iii) Always ensure that the external working platforms are adequately placed. There should not be a gap of more than 300mm between two external working platforms.

Maintenance Of Accessories

All accessories such as tie rods, wing nuts, lock pins, jack base, jack stems and others should be kept in good condition and periodically checked after each casting. If quality of the accessories has deteriorated, they should be replaced.

3.3 To determine the time of shear wall installation process using the simple formwork system

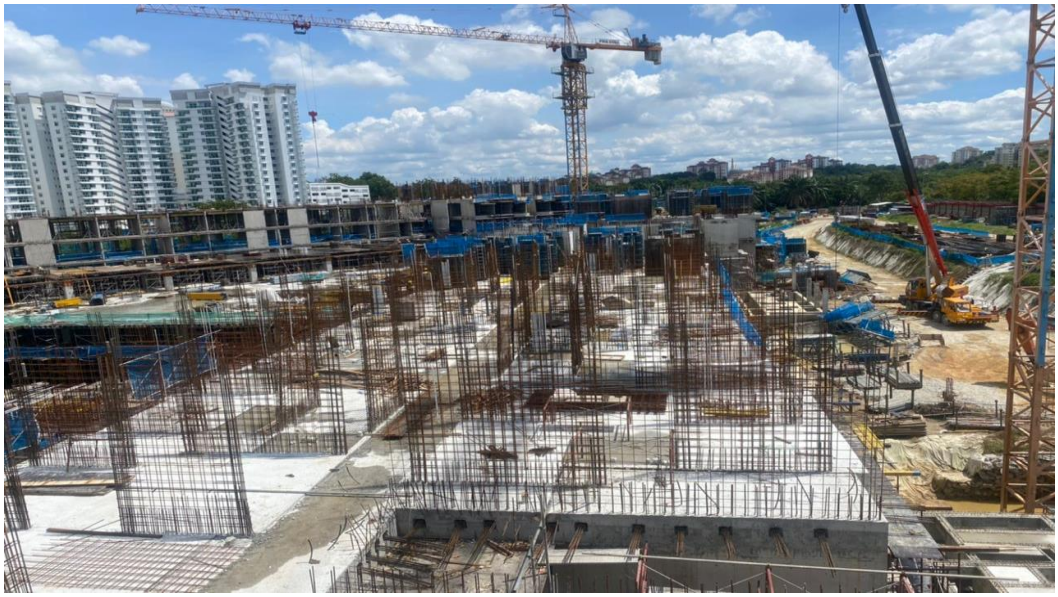

Figure 3.30: Block 2 Zone 2 Level 2 before cast

Before start installing shear walls 8 units – 01/11/2021

Figure 3.31: Block 2 Zone 2 Level 2 after finish cast

Finish casting shear wall 8 units – 18/11/2021

Figure 3.32: Block 2 Zone 1 Level 4 before cast

Before start install shear walls 4 units – 25/11/2021

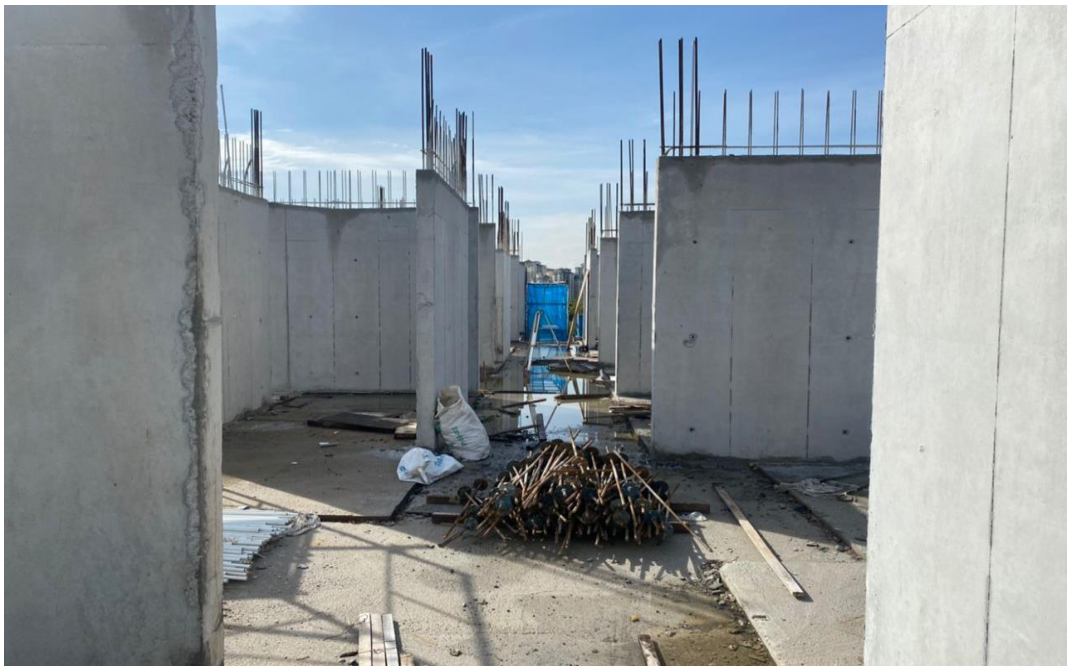

Figure 3.33: Block 2 Zone 1 Level 4 after finish cast

Finish casting shear wall 4 units – 27/11/2021

Figure 3.34: Block 2 Zone 3 Level 4 before cast

Before start install shear walls 4 units – 07/12/2021

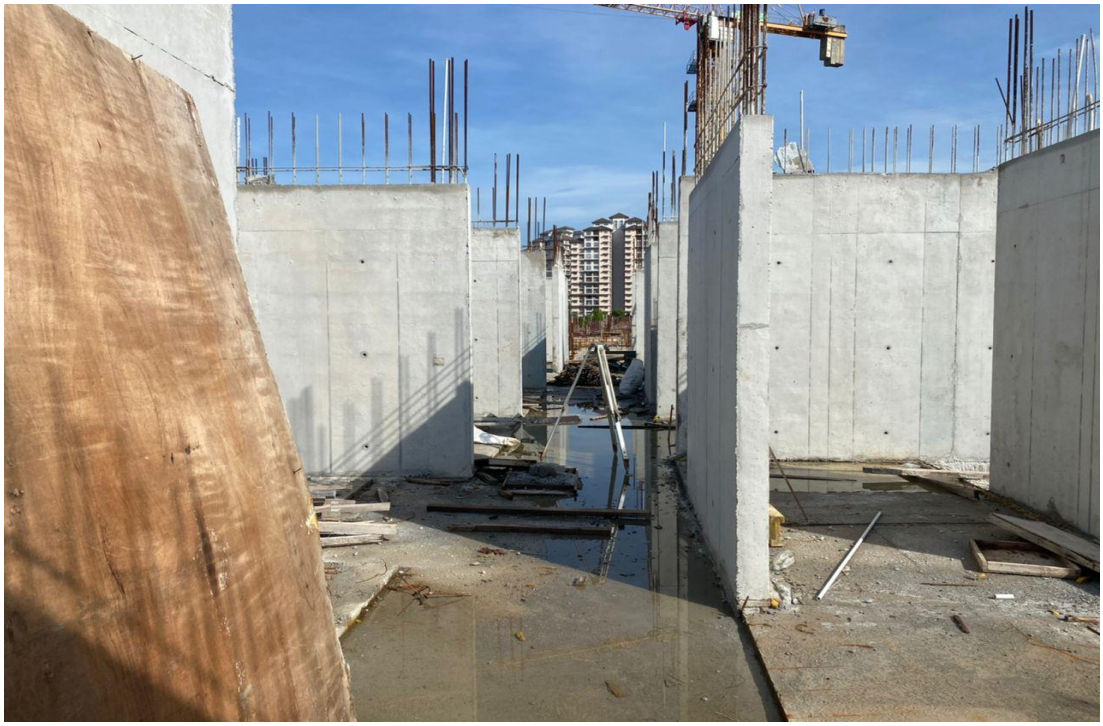

Figure 3.35: Block 2 Zone 3 Level 4 after finish cast

Finish casting shear walls 4 units – 09/12/2021

To sum it up, the construction process of shear wall using the simple formwork system supplied by Innah Makmur Builders Sdn. Bhd., two units per zone can be done within only 1 day. 1 zone can be finished within around 2 or 3 days. As a result, period of construction progress on site can be effectively reduced and the time estimated by the contractors can be efficiently achieved. The construction site consists of two blocks, one block consists of three zones that have 16 units. To be precise, 2 levels of units of the apartment of 2 block can be achieved within only 1 months.

3.4 To identify the problem and solution during shear wall construction

1. Holes on the surfaces of shear wall

Figure 3.36: Holes left by tie rods on the surface of shear walls

Causes

During the shear walls installation by using the simple ganged formwork system, a lot of tie rods were utilized in order to maintain the alignment and the verticality of the shear walls during casting process. As a result, tie rods holes will be left on the surface of the shear wall. This may cause a problem when sub-contractors who do architectural works enter the unit. They cannot skim coat the shear wall if there is a hole on the surfaces because it may cause defects afterwards.

Solution

Main contractors must sub a new work for the sub-contractors who install the shear wall or hire another sub-contractor to close the holes on the surfaces on the shear walls left by the tie rods by using the silica cement because the characteristics of silica is it fills all gaps in the particle it was situated.

2. The weight of the ganged panel formwork is very heavy

Figure 3.37: Shear walls carried using Tower Crane

Causes

The weight of one set of ganged panel formwork is around 2 ton. Therefore, it cannot be carried by hands or workers and cannot simply shift the ganged formwork spontaneously. This is because the formwork is made of steel and all the part of the ganged formwork are all made of steel including the bracing of the formwork, the concrete chute and panels.

Solution

The ganged panel formwork can only be carried during shear wall installation by using a super heavy duty carrying machine which are tower crane and mobile crane. This is due to the high-power output of the cranes can be used to withstand the weight of the steel formwork panels and shift the panels to the required places.

3. Bended Hollow & Rusted Tie Nut

Figure 3.38: Rusted Tie Nuts and Bended Hollow (Bracing)

Causes

Due to exposed rain water and high humidity of air, the hollow that were used as the bracing of the shear wall formwork panels and the tie nuts will get rusted and in worst case, it will cause wreckage and bending. This is because those accessories are made of steel and chances of the accessories will get rust is very high.

Continuous usage of the shear walls can be one of the causes the hollow and the tie nuts can be bended and rusted. This is because the material which is the steel is not strong enough to withstand the heavy duty during the shear wall installation consequently. Bended hollow and rusted tie nuts could cause concrete leakage because the defect accessories could not resist the tension given during the concrete pouring process.

Solution

Sub-contractor supervisor must keep a good monitoring of the condition of the accessories of the ganged formwork panels in order to maintain the quality of the shear walls and to avoid accident due to materials defects. To avoid rusting tie nuts and hollow, they must paint the accessories because the paint act as a protective barrier between the metal and corrosive elements and it is also a low-cost option. Oil-based paints is the best choice to prevent water and oxygen from penetrating the metal that could cause corrosion

4. Excess concrete water leakage

Figure 3.39: Concrete water leakage due to uneven surface level of slab

Causes

Due to continuous usage of the ganged formwork panels, it will leave small gaps between panels and DC's, this is because the panels were originally in flat shape, if it is being used consequently, the flat-shaped panels will get bended a small degree because of the tension given during the shifting works and casting shear wall works. As a result, during the casting process, concrete water leakage could occur and this could cause concrete defects such as honey combs and cracks.

Uneven level of slab can also be one of the factors of concrete water leakage. This is due to lack of monitoring of supervisor during casting slab process. As a result, the installation of shear wall could be difficult especially during adjusting verticality, bigger gaps will exist and could cause a lot of concrete water leakage.

Solution

Sponges to be used by the sub-contractors who install the shear wall in order close the gaps between panels and DC's. This could avoid or minimize concrete water leakage, avoid concrete defects, back charge by other sub-contractors due to rectifying works while maintaining the quality of the work projects

CHAPTER 4.0

CONCLUSION

To sum it up, Industrialised Building System (IBS) especially simple formwork system came up with a lot of benefits in the construction project. The cost for machineries and tools could be greatly reduced because the simple formwork system did not require a lot of machineries. As a result, this also could reduce the time taken for shipment of ordering process of tools and machineries. The method of the shear wall construction using the simple formwork system seems quite uncomplicated. This is because the working style of simple formwork system is assembling and dismantling work. For that reason, the construction process to finish is very efficient in term of time taken and the cost taken. Although there were some problems occurred during the shear wall construction using simple formwork system, it could be solved by the main contractor or sub-contractor effortlessly.

. There are many processes that need to be gone through in the operation and installation of the shear wall. The main contractor needs to monitor over the workers who install shear walls so that they care and do it carefully in order to avoid encountering problems mentioned in the report. In addition, the dimensions and shape of the shear wall must follow the specifications that have been set in the drawing because otherwise it can give a great effect to employees and even to contractors and supervisors when the installation of shear wall is carried out. Furthermore, the problems that arise during the installation of these shear wall have been overcome well and successfully to produce shear wall according to the standard specifications of building works. All objectives of this report have been successfully completed.

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