DEPARTMENT OF BUILDING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

THE CONSTRUCTION PROCESS OF PRECAST REINFORCED CONCRETE OF FRAME STRUCTURE FOR INDUSTRIALISED BUILDING SYSTEM (IBS)

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DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

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It is recommended that the report of this practical training provided

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entitled

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

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STUDENT'S DECLARATION

I hereby declare that this report is my own work, except for extract and summaries for which the original references are stated herein, prepared during a practical training session that I underwent at Public Work Department (PWD) for a duration of 20 weeks starting from 5 August 2019 and ended on 20 December 2019. 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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ABSTRACTS

This report briefly described the construction process of precast reinforced concrete (PRC) frame structure focused on beam components. To achieve aimed of this report, two objectives were carried to determine the construction process of precast reinforced concrete of frame structure for IBS that focused on precast RC beams components. The construction work process was deliberated in production, transportation and installation aspects. On the other hand, problems and solution during the process of precast RC beams was also explained. The results revealed that the production, transportation and installation work process of precast reinforcement concrete beam for industrialised building system have been determined. Moreover, the problems and solutions occurred on site have been identify. In conclusion, by implement the IBS in construction nowadays, it can give better quality environment, rapid construction period and reduced waste in a large amount compared to the conventional construction method.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Industrialised Building System (IBS) is the term only being used in Malaysian construction industry. IBS can be defined "as a construction technique in which components are manufactured either on or off-site in a controlled environment, transported, placed and installed in a structure with minimal additional site work". Furthermore, IBS is a new process that has been applied in construction world (Din, 2007).

The IBS characteristics which different with conventional construction where all the structured are cast at the factory, transported and then assembly at the construction site. Meaning, less site work will be conducted at the site. Utilisation is reduced by minimising or eliminating non-value added compared to conventional construction. This supported by Esa and Nuruddin (1998) asserted that IBS is a construction creates from the ideas of manufacturing construction to reduce resource wastage and maximise end user quality.

The advantages derived from the implementation of IBS are accelerating the construction process, incorporating sustainability approaches, reducing waste during construction and mitigating risks and hazards (Nawi, 2011). Other benefits of IBS are, optimum material use, mould repetition and reuse, less materials waste.

Next, factory made quality products through fair and effective manufacturing processes, profesional jobs, routine practise and continuous performances assurance and tracking. Then, no adverse weather conditions impact construction operation because prefabricated components are manufactured in a factory-controlled environment. Also, prefabrication take place in hierarchical factories, thus reducing the demand for jobs on site. In addition, opportunities for innovative architecture as the system provide opportunities for designers and builders to explore creative design by using IBS. Lastly, environmentally friendly construction by enhancing the use of available building materials, production processes that adverse environmental impacts.

Thus, the barriers to implementation of the IBS in Malaysia are greater in cost and financial because many of them claim that building with IBS is usually cheaper than conventional building costs. Such perception, however, it tends to discourage stakeholders from using IBS because of this method need specialised equipment and machinery. In addition, the contractor prefer not to use IBS as they find it easier to stick to the conventional construction method. Next, poor skill and knowledge. This is crucial barriers that need to be solved as soon as possible because IBS requires high precision. Previous studies have shown that most local practitioners and contractors lack in IBS expertise and experience (Nawi, 2011). Other than that, problems related to the specification of the manufacturer have been described as one of the obstacles to IBS adoption in the Malaysian construction industry. Lastly, the terms of IBS is often misinterpreted with negative image due to past failures (Nawi, 2011). For instance, customer's perceptions of an IBS products are still perceived in terms of lack in flexibility, problem accommodation such as leaks and faults, low-quality finishing and the use of unfamiliar materials. In addition, some designers are not interested in IBS due to a possible lack of ecstatic value and limited design creativity.

There are five main categories of IBS, according to the Construction Industry Development Board (CIDB, 2003). This categorisation is based on the structural classification adopted in the construction industry in Malaysia. There are, pre-cast concrete framing, panel, and box systems such as pre-cast columns and beams. Steel formwork systems. For example, tunnels forms, columns and beams moulding forms and permanent steel formwork. Steel frame systems. Example, steel columns and beams, portal frames, roof trusses. Prefabricated timber framing systems. For instance, timber frames and roof trusses. Block work systems which is interlocking concrete masonry units and lightweight concrete blocks.

The IBS Content Scoring System (IBS Score) is a standardised and organised evaluation system that can be used reliably to evaluate the use of IBS (Ismail, 2019). The objective is to provide a well-structured evaluation system to measure the IBS score. From that, the formula is set out to calculate the IBS score with a few factors consist of each elements used in the building. A higher IBS score is a reflection of a reduction of site labour, lower wastage, less site materials and better quality. The IBS Score System is designed to be a simple but effective tool. Points are awarded depending on the structural and wall components used by the IBS criteria. The presence of high repeatability in the specification as well as other simpler design solutions also contribute to the overall score. Therefore, the IBS content scoring system consist of three parts which are structural system maximum score is 50 points, example used precast RC beam. Part two is wall system such as used precast concrete panel, maximum score is 30 points and last part is construction solution, maximum score is 20 points which means points awarded based on usage of other simplified construction solution as example standard components based on MS 1064.

In conclusion, there are many types of structural concept and components that be used in construction and have many benefits and also barriers of IBS. In addition, the rate of IBS adoption is still unsatisfactory however, the aim of this report is to determine on how the construction process of precast reinforced concrete (RC) of beam for IBS is undertaken. Thus, in order to achieve the aim of this report, there are two objectives are explaining below.

1.1 Objectives

The objective of this study are:

1. To identify construction work process of precast RC beam structure for IBS in term of production, transportation and installation.
2. To determine the problems occur and solution during the construction work process of precast RC beams are carried out.

1.2 Scope of study

The site location of this study is undertaken at Cardiology Centre, Hospital Serdang, Selangor Darul Ehsan. This project using Design and Build contract, with the construction cost of RM 289,765,000.00. The main focus of the study to identify the construction process of IBS mainly in precast RC frame structure of beam components for hospital project. Within 20 weeks of practical training, there are a lot of information able to collect and write in the report not only in terms of method, machinery use, manpower and materials, but including as the problem occur and its solution. However, this study not focus regarding cost in detail. Thus, a thoroughly review in regard to the study obtain using three research methods such as site observation, interview by having verbal discussion at the site and document review related to procedures, company profile and project progress reports are undertaken. Therefore, the researcher able to obtain a comprehensive understanding in a real setting on how the method of IBS construction work process of three aspects as mentioned in the objectives as well as the knowledge of current progress of the project.

1.3 Research method

The research method adopted for this study are:

1. Observation.

Observation was carried out at the manufacture's factory and site to obtain information regarding the construction work process of precast RC of beam. First thing first, the duration of observation with Resident Engineer (RE) and Quality Assurance and Quality Control (QAQC) on production at the manufacture's factory that located at Sungai Petani, Kedah two hours. Next, the transportation of the precast RC of beam by using a normal 40 foot (~ 12 meters) trailers for components not exceeding 12 meters in length, otherwise used pole trailers. It can be observed on site when the products arrived to be delivered. Other than that, the installation process being observed on site. The process to assemble the precast RC beam requires three assembler, two lifter, one crane operator and one signal man. Usually, the process to install precast RC beam approximately estimated two hours. Thus, in order to collect all these data, several pictures and video were undertaken using smartphone device. This is because, by collecting data through video recording and capture the pictures, it can be reviewed in multiple times where possibility of over looked some of the construction work process is occur.

2. Interview.

Unstructured interview was conducted with relevant IBS stakeholders such as Inspector of Work and Site Supervisor on how the work process of the precast RC beam done correctly on site. Moreover, the purpose of having interviews with relevant IBS stakeholders to obtain an explanation while observation is carried out. The interviews session was conducted within 10 minutes to 15 minutes. In addition, by using smartphone to the conversation between interviewee and interviewer were recorded as well as written notes in a notes book.

3. Document reviews.

The type of documents that has been refer are construction drawings and shop drawings. Next, another document is standard operating procedures such as Standard Specifications for Building Works 2014 that used as a guideline to the labour and all staff to accomplish the jobs. Other than that, progress report also been reviews once a month which are Project Progress Report, Environmental Monitoring Report, Quality Assurance and Quality Control Report and Safety and Health Report.

CHAPTER 2

COMPANY BACKGROUND

2.0 Company background

Public Work Department (PWD), Malaysia was established since 1872 till now. The function is as a technical agency to Malaysian Government. It is responsible to implementing infrastructure development and maintenance projects for various ministries, department, statutory bodies and state governments such as roads, buildings, airports, ports and jetty.

The vision are we will be a world class provider and centre of excellence in the areas of asset management, project management and engineering services for national infrastructure development through creative and innovative human capital and the latest technology.

The mission of PWD is contributing to national development by assisting clients in delivering policy and service outcomes through the cooperation of strategic partners. Next, standardisation of processes and systems for consistent delivery of results. Moreover, provide effective and innovative asset and project management. Strengthen existing engineering competencies. Therefore, develop human capital and new competencies. In addition, maintain integrity in delivering services. Establish a harmonious relationship with the community. Lastly, preserve the environment in service delivery.

As the Chief Consultant to the Government of Malaysia, the objective of the Public Works Department is to "Deliver products and implement timely maintenance, quality and cost services to achieve optimal asset benefits".

General-Director of PWD Malaysia was DATO' Ir. Dr. Meor Ab Aziz B. Hj. Osman. Under him have Deputy General-Director of Infrastructure, Building, Specialist, Portfolio Management Office and Public Work Department (State), Region, Special Unit and Project Management. Thus, for this project is under Deputy General-Director of Building which is 'Pasukan Projek Khas 1' that lead by DATO' Ir. Mohamad Sahimi B. Hj. Arshad as Project Director.

'Pasukan Projek Khas 1 (PPK1)' is a team that will regulating high impact government project which is worth more than RM100,000,000.00 value of project and will regulating supervise only on Peninsular of Malaysia. Moreover, this team handle 19 ongoing projects including 'Pusat Kardiologi, Hospital Serdang' that using Design and Build contract.

Moreover, this project is under Ministry of Health Malaysia (MOH). In details, the project has two blocks which are main block for cardiology block and multilevel carpark block. The cardiology block consists of nine level and multilevel carparks have nine level which is consist of 500 parking lots.

2.1 Completed projects

Public Work Department Malaysia has monitored many government projects that have been completed under main contractors as shown in Table 2.1.

Project's Name	Client	Price (RM)	Duration (Months)	Started	Finished
Cadangan Naik Taraf Hospital Kuala Lumpur (HKL)	Kementerian Kesihatan Malaysia (KKM)	216,831,063.45	1 Years 10 Months	06/03/2013	05/01/2015
Blok Wanita Kanak-Kanak dan Pusat Kardiologi, Hospital Raja Permaisuri Bainun, Ipoh, Perak	Kementerian Kesihatan Malaysia (KKM)	236,192,122.07	3 Years 5 Months	01/08/2013	31/01/2017
Kompleks Obstetrik Hospital Tengku Ampuan Rahimah (HTAR), Klang- Fasa 2	Kementerian Kesihatan Malaysia (KKM)	142,723,392.43	3 Years	06/09/2013	05/09/2016
Cadangan Hospital Rembau, Negeri Sembilan (76 Katil) Fasa 2 – Kerja Bangunan dan Lain-Lain Kerja Berkaitan	Kementerian Kesihatan Malaysia (KKM)	108,751,625.85	3 Years	09/09/2013	08/09/2016
Pembinaan Akademi dan Pusat Kecemerlangan Badminton Negara, Bukit Kiara, Kuala Lumpur (Reka dan Bina)	Kementerian Belia dan Sukan (KBS)	31,201,826.43	1 Year 4 Months	31/07/2014	08/11/2015
Penggantian Bumbung Polycarbonate di Pusat Sains Negara, Bukit Kiara	Kementerian Tenaga, Teknologi, Sains, Perubahan Iklim dan Alam Sekitar	20,162,481.09	1 Year 6 Months	27/04/2015	16/10/2016
Pembinaan Stadium Velodrom Nasional Malaysia	Kementerian Belia dan Sukan (KBS)	79,841,344.50	1 Year 2 Months	15/05/2015	13/07/2016
Kerja-Kerja Penukaran Bumbung Membrane dan Membaik pulih Struktur Bangunan di Pusat Akuatik Nasional, Kompleks Sukan Negara, Bukit Jalil, Kuala Lumpur (Reka dan Bina)	Kementerian Belia dan Sukan (KBS)	20,425,007.50	1 Year 3 Months	27/04/2016	22/07/2017

Table 2.1: Completed Projects (Sources: PWD Official website)

2.2 Ongoing projects

Public Work Department Malaysia has monitoring ongoing government projects under main contractors as shown in Table 2.2.

Project's Name	Client	Price (RM)	Duration (Month)	Started	Estimated to finish
Multi Storey Block, Hospital Seberang Jaya Pulau Pinang	Kementerian Kesihatan Malaysia (KKM)	368,897,112.97	3 Years 6 Months	16/05/2016	15/11/2019
Cadangan Pembinaan Hospital Pengajar di Universiti Sultan Zainal Abidin (UniSZA)	Kementerian Pedidikan (Sektor Pendidikan Tinggi)	281,124,216.25	3 Years 1 Month	30/08/2016	15/09/2019
Tambahan Blok Baru Hospital Putrajaya (Kompleks Endokrin), Putrajaya	Kementerian Kesihatan Malaysia (KKM)	345,956,974.00	3 Years 9 Months	30/03/2017	28/12/2020
Hospital Parit Buntar, Perak- Fasa 3- Bangunan	Kementerian Kesihatan Malaysia (KKM)	137,695,994.72	2 Years 11 Months	02/01/2018	28/12/2020
Cardiology Centre, Hospital Serdang, Selangor (Design and Build)	Kementerian Kesihatan Malaysia (KKM)	307,150,900.00	3 Years	06/03/2018	01/03/2021
Pembinaan Politeknik Bagan Datuk Perak (Reka dan Bina)	Kementerian Pendidikan (Sektor Pendidikan Tinggi)	175,006,000.00	2 Years 7 Months	10/09/2018	22/04/2021

Table 2.2: Ongoing Projects (Sources: PWD Official website)

2.3 Organisation chart

General-Director of PWD Malaysia was DATO' Ir. Dr. Meor Ab Aziz B. Hj. Osman. Under him have Deputy General-Director of Infrastructure, Building, Specialist, Portfolio Management Office and PWD (State), Region, Special Unit and Project Management. Thus, for this project is under Deputy General-Director of Building which is Construction Department. In this department have *'Pasukan Projek Khas 1'* (PPK) that led by DATO' Ir. Mohamad Sahimi B. Hj. Arshad as Project Director. Under him, have one Representative Project Director Main Work/Civil and Structure which is Puan Suzzana binti Punari. Basicly, 'Pasukan Projek Khas 1' is a team that will regulating high impact government project which is worth more than RM100,000,000.00 value of project and will regulating supervise only on Peninsular of Malaysia.

Next, under supervised of Puan Suzzana binti Punari as Representative Project Director Main Work/ Civil and Structure have Representative Project Director Architecture, Quantity Survey, General Manager of Construction, Mechanical and Electric. All of them will cooperate and supervised each other on the construction projects weather the project delay or keep on track with the control path method.

Last but not least, as a practical industry student will be directly under supervised of Assistant General Manager of Construction which is Encik Mohd Hafiz bin Mat Saaud. Lastly, as demonstrated in Figure 2.1, *'Pasukan Projek Khas 1'* (PPK1) will make sure the construction progress run continuously and smoothly finish it on time to reward this project to MOH.

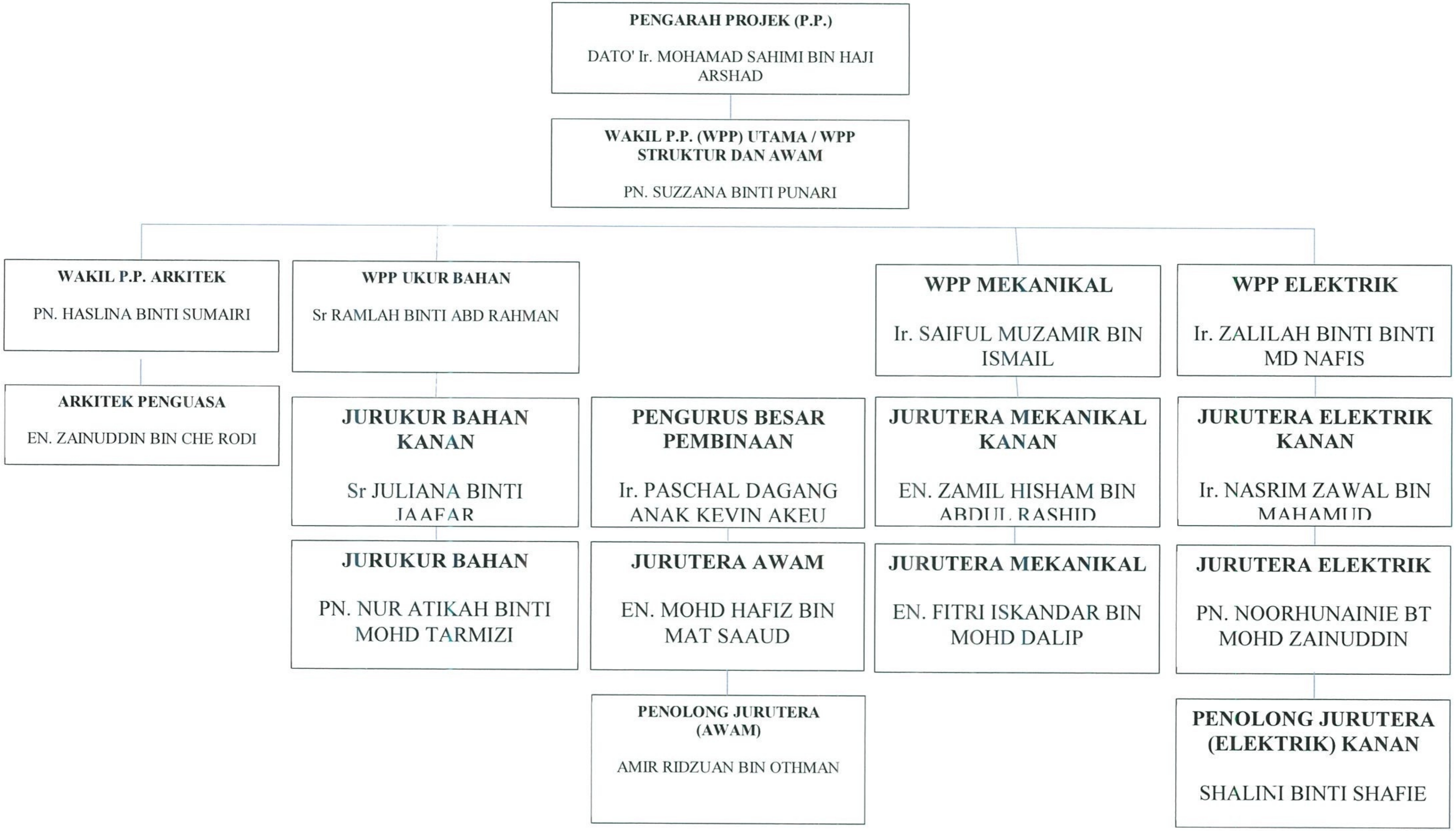

Figure 2.1: Organisation Chart

CHAPTER 3

CASE STUDY

3.0 Case study

The case study of this report focused on the project of 'Pusat Kardiologi, Hospiotal Serdang, Selangor'. Due to large project, the contract administration used Design and Build contract, and awarded to the Nadi Cergas Sdn Bhd as the main contractor The contractor accepted the tender, to commence the works on the date of possession stated in the Letter of Acceptance of Tender and to complete and deliver the whole of the work in conformity with the contract document within 156 weeks calculated from the said date of possession. The date of site possession is 6th March 2018. Thus, the estimated date of completion of this project is 1th March 2021. The project value worth RM 289,765,000.00 and the land size of the proposed site was 4.38 acre or 17725.23 Sqm.

This project added new blocks which are main block as a cardiology centre and multilevel carpark from origin Hospital. Both building have nine level total. In addition, client to this project is MOH so, the function of PWD as a client representative to supervision the project.

Nowadays, implementation of IBS is mandatory for the government project which need to fulfil minimum 70 points of IBS score (Ismail, 2019). IBS score is assessment tool to determine either the project achieve the standard which has been circulated by CIDB since 2008 (Ismail, 2019). Due to that matter, this project had achieved 73 point in IBS score.

In addition, design and build contract are the contractor shall provide all design, services, labour, materials, contractor's equipment, temporary works, transports and everything whether of a temporary or permanent nature required in and for such planning, design, construction, completion, testing and commissioning so far as the necessity for providing the same is specified in or reasonably to be inferred from the contract.

Based on Figure 3.1, shown the location of project located at urban area which nearby to public transports such as MRT public bus, train station, IOI shopping mall, Hospital Serdang, clinics, public residents and educational area for instance University Putera Malaysia (UPM), National University of Malaysia (UKM), Infrastructure University Kuala Lumpur (IUKL) and primary and secondary schools. Based on Figure 3.2, the site for construction 'Pusat Kardiologi Hospital Serdang' was proposed at Serdang, Selangor under Sepang Municipal Council.

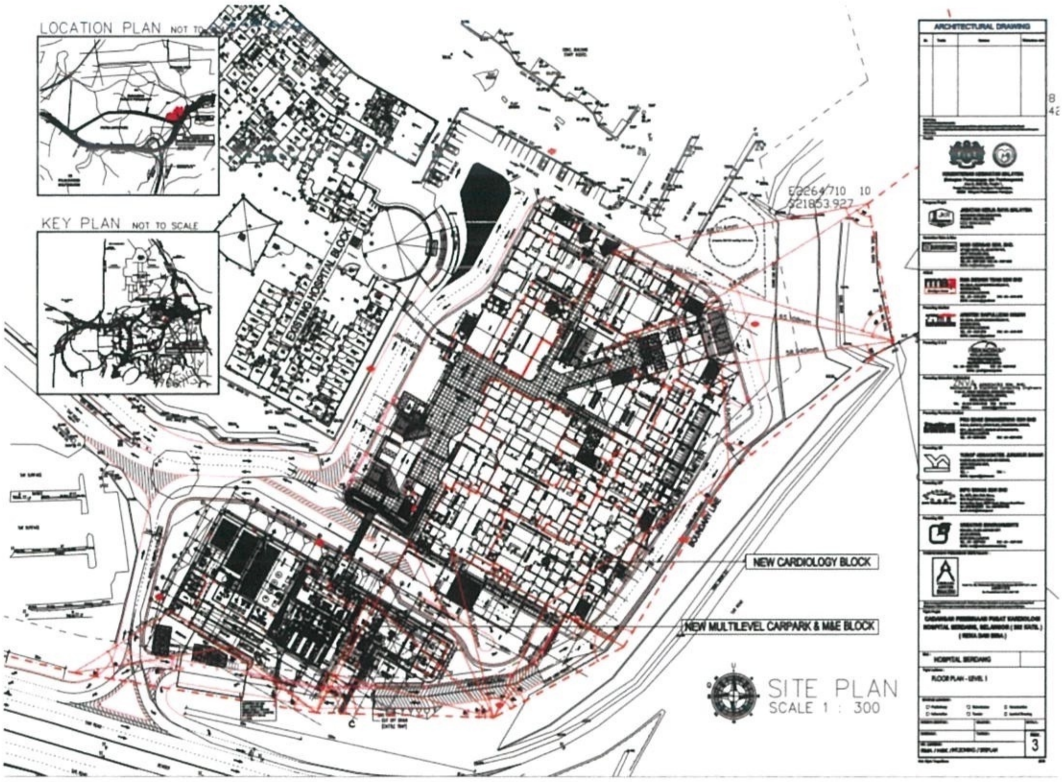

Figure 3.1: Site Plan Drawing

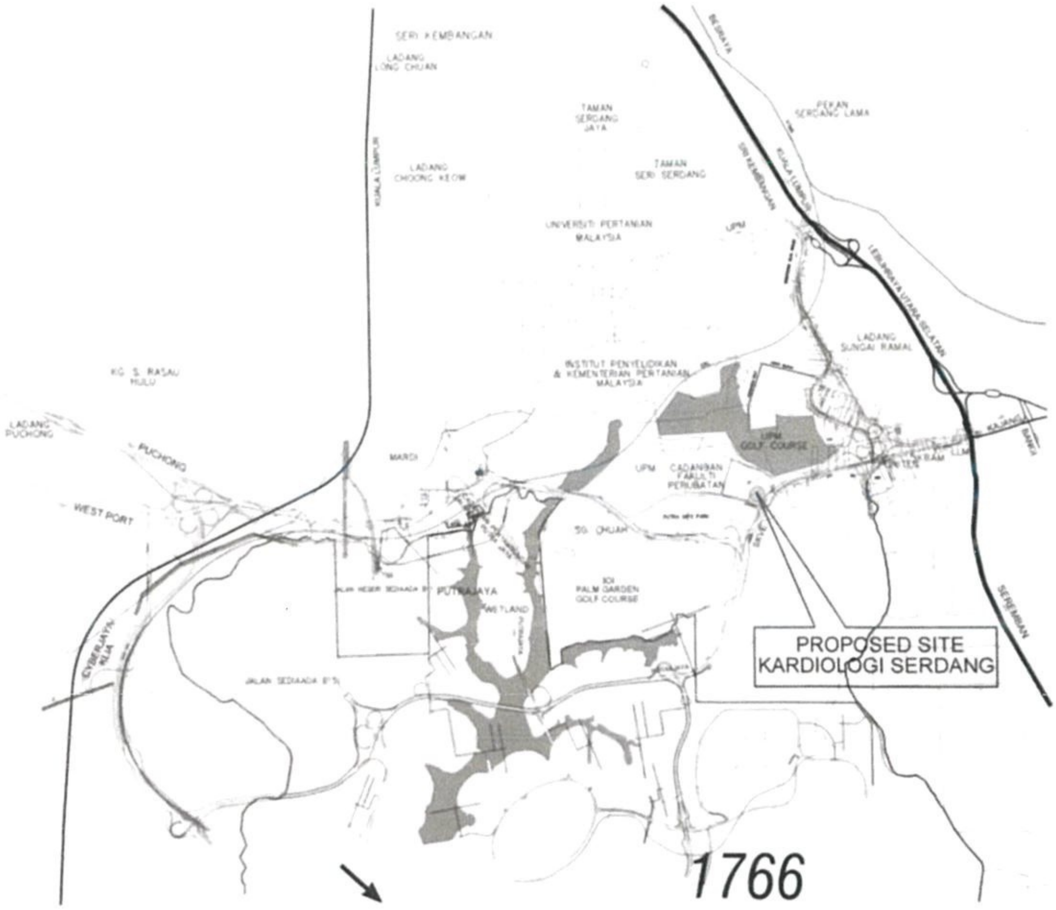

Figure 3.2: Key Plan Drawing

3.1 To identify the production, transportation and installation of precast reinforced beam.

On 5th October 2019 the site visit was undertaken at the NSL Eastern Pretech, Sungai Petani, Kedah. The purposed of this site visit, to observe and interview person in charge on how the production of precast RC beams as well as loading and unloading during transportation activity. NSL Eastern Pretech, is the IBS manufacturer supplier who will casting the precast RC beam components for level seven up to level nine for project 'Pusat Kardiologi, Hospital Serdang, Selangor'. In addition, NSL Eastern Pretech is certified as IBS manufacturers who registered under CIDB. Based on the observation at the NFL Eastern Pretech manufacture's factory, it provided the workers itself and the management decide to divide into a few teams. For example, at production line, it have two teams.

3.1.1 Prepared the precast RC beam mould.

First of all, the precast mould must be prepared based on finalised drawings and its specification. The precast mould was made from the stainless steel. It is because to prevent the steel from rust and have higher in strength, as well as reusability compared to the plywood or timber formwork in the conventioan construction . The dimension of the precast RC beam mould panel was in 6600mm length, 475mm thickness and 300mm width.

As demonstrated as shown in Figure 3.4, the left side of the mould panel was supported with bar in triangular shape to sustain the panel when concreting work process is carried out. Additionaly, Figure 3.3 the each of precast mould panel were connected using bolts and nuts to ensure that each panel was jointed together. In fact, at the precast mould panel consist of horizontal bar that placed on top of the mould, with the function to hold and stabilise left and side panel

Support

Figure 3.3: Precast RC beam mould support

Horizontal

Bar

Figure 3.4: Precast RC beam mould horizontal bar

3.1.2 Install the reinforcement bar

Fabricate the reinforcement bar at yard. The aim to fabricate was to increase the tensile strength of the precast RC beam. Thus, the arrangement of the reinforcement bar in the mould from site elevation were four tensile of reinforcement bar, 16mm diameter size from the bottom as a tendon. Then, on top used two tensile of reinforcement bar, 12mm diameter. After that, the links used tensile reinforcement bar, 10mm of diameter to connect the bottom and top of reinforcement bar together.

Next, from the right and left side of the beam, there is five tensile of reinforcement bar, 10mm diameter install horizontally with 150mm length and also will be joints with the links. And then, on top of the beam used tensile reinforcement bar, 10mm of diameter as hooks and the length of hook is 150mm each. Furthermore, for reinforcement beam steel was extend out from the bottom of the mould is 225mm and bend upright 225mm as per drawing details. Tying wire was twisted sufficiently and ready to be lifted. After that, the reinforcement cage being lift by the lifting equipment horizontally and lift into the position.

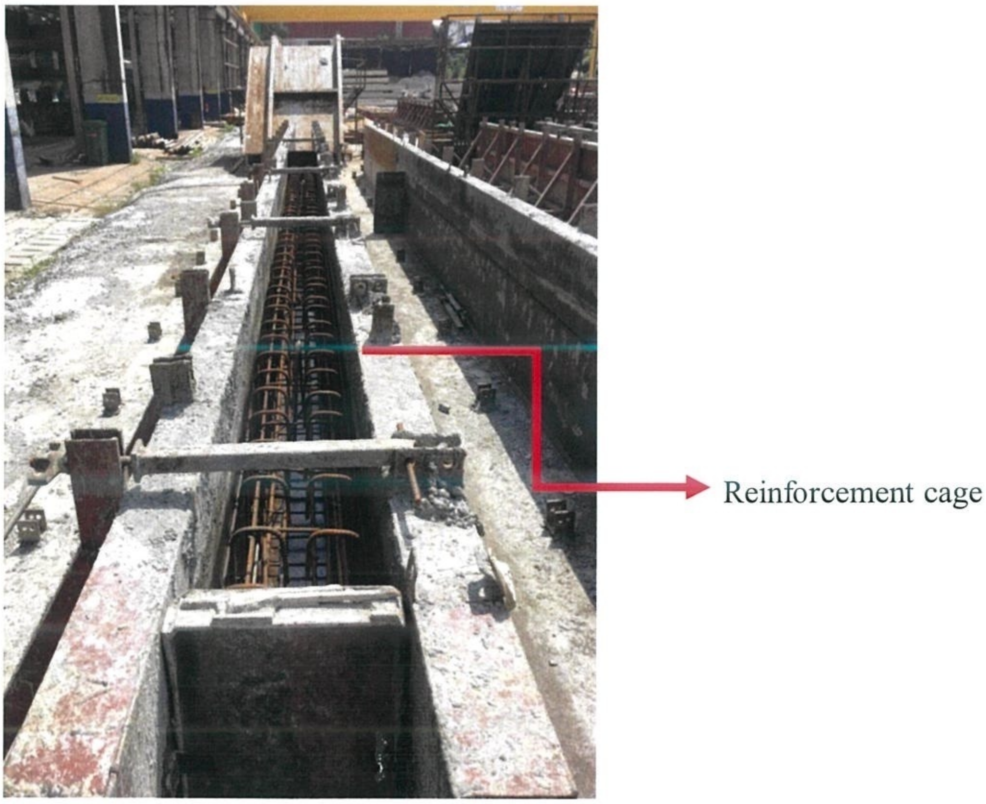

Figure 3.5: Reinforcement cage design

3.1.3 Concreting work process.

Third, for concreting work process, the IBS manufacturer used on-site mix where the flow test is required before concreting work process carried out. This test will measure the workability of the concrete. Therefore, the concrete grade was used for casting precast RC beam is 40 N/mm2. To achieve the concrete grade, trial mix test which is flow test was carried out on factory site. For this work, two labours required.

Before flow test begins, the preparation of the tools and equipment needed such as flow table, metal cone, rectangular trowel, scoop, wheelbarrow, measuring tape, steel rod and clean wet clothed.

Then, concrete mixture consists of river sand, 20mm of aggregates, cements and water. After that, placed the flow table on a horizontal surface and wiped to clean up the surface from debris and to make sure have wet surface.

Figure 3.6: Clean the flow table with wet clothe

Now, placed the metal cone at the middle portion of the flow table and stand on it. Then, pour the fresh concrete in the mould and comprising two layers, each layer must be tamped using tamping rod for 25 times. After tamping the last layer, the overflowed concrete on the cone was struck off using a trowel.

Figure 3.7: Fill the slump

Next, lift the mould vertically up slowly and let concrete stand-alone without any support.

Figure 3.8: Lift the mould vertically

The flow table was raised and lowered at 12.5 mm height. The same thing is repeated in 15secs for 15 times.

Figure 3.9: Pull up and released the flow table

Measure the diameter of horizontal and vertical distribution of concrete, the tolerance that acceptable of the flow test was in range less or more of 5mm only.

Figure 3.10: Measuring the diameter of concrete

Then, the cube mould was cleaned and applied with oil. Next, fill the concrete into cube moulds with approximately 5cm depth. After that, compact each layer with not less than 35 times using a steel bar sizing in 16mm diameter and 60cm length, bullet point at lower end. Last but not least, level the top surface and smoothen it with trowel. Lastly, all specimens were being tagged with a piece of paper before stored in moist air for 24 hours.

Figure 3.11: Tagging the Cube

In addition, during the cube test and flow test being run, the concreting pouring into the mould is done in the same time.

After cube was marked with permanent marker and removed from the mould and kept submerged in clear fresh water until achieve the required strength. In addition, the water for curing should be tested seven days and maintain the water to room temperature.

Figure 3.12: Curing in clear fresh water

3.1.4 Transportation of the precast RC beam.

Generally, precast RC beams will be transported by with trailer sizing of 40 foot or 12 meters long for component not exceeding more than 12 meters in length. For this situation, pole trailers and low loaders are used if precast elements are too high.

Figure 3.13: The precast beam was load on trailer

Therefore, there is a few items needs to be checked before the transportation begins such as avoiding possible obstruction route for transportation. Next, road condition as example roads surface, width, radius and circulation, including, parking space for loading and unloading activities. In other words, site accessibility and roads condition are significant important for the IBS construction work process. For instance, for unloading process required two workers to loading the products and one signal man on the building and two unloader and one signal man on the trailer.

Figure 3.14: Unloading IBS

Lastly, wash pit as shown in Figure 3.15 is required to clean the tire of trailer either for exit and enter to or out of the site. One labour needed to wash the vehicles that want to out from the construction site.

Figure 3.15: Wash pit

3.1.5 The installation process of Precast RC beam components.

When precast RC beams arrived at the site, the assemble work begins the next day. The installation of the precast RC beams will be carried out after precast RC columns has been installed as portrayed in Figure 3.16. Beforehand, Inspector of Work checked the drawings to clarify whether propped is needed after the precast RC beams was installed.

Inspector of Work ensure that the on top of the surfaces corbels are clean, and must have neoprene pad on top of the corbel, as well as double checked the distance from column to column was accurate and precise as indicate in the drawing. If there was no neoprene pad on top of the corbel column, this matter need to be solved by project engineer or coordinator of this project as shown in Figure 3.17 is neoprene pad which needed to be placed at the top of the corbel for column. Next, referring to Figure 3.18, there were two assembler and one installer guider to guide the assembler to do work. It is prevent from the precast RC beam misallocated.

Figure 3.16: The installation of precast RC beam

Precast RC
Beam

Figure 3.17: Neoprene pad

Installer
guider

Figure 3.18: Installer guide the beam placed into position

3.2 To determine the problems occurred during the works process and also solutions to the problems.

3.2.1 Limited of machinery utilisation.

First, inefficiency management in utilisation of machineries such as tower crane, mobile cranes and backhoe. This is because, when the structure of the building become higher time by time, every elements such as mechanical, electrical and structures need to bring up their own materials and others, they need to queue. For example, the precast RC beam required to be install at current level, it will delay others to use the machinery whether to use tower cranes or crawler crane to bring their own materials and equipment to the next level such as level one to level two. So, in this case, it will reduce the productivity on site and delay the progress approximately estimated one to two days. Sometimes, due to lack of coordination and communication between Sub-Nominated Contractor (NSC) and main contractor which especially involve of machinery.

The best solution is every NSC need to well plan of their schedule for each work to be done to prevent from concurrent work occurred. It is because, by do a well plan for each work to be done, the progress project will synchronise with the control path method.

3.2.2 Coordination and communication between site personnel and IBS production.

Another problem occurred when there is misunderstanding between the site personnel example site agent and the IBS production team. Lack of coordination and communication give a massive impact towards project progress performance. As example, unsynchronised between IBS production and site personnel regarding installation schedule can cause delay to the work as well as other work, waiting time and high potential of the defect to the component might be occurred. So, this problem will increase the construction cost as well as time consuming to complete the installation work within the schedule.

The best solution whereby the site personnel always follow up and keep updating on-site progress and schedule by having a direct contact with the IBS production team as well as requesting ahead order or on hold for certain production due to change of the schedule. Then, make sure frequently inspection by double checking with the IBS production team that they supplied the correct and accurate of components to be installed Thus, with transparent communication and synchronised coordination of both parties (site personal and IBS production team), it will reduce or eliminate any misunderstanding or miscommunication of both parties.

3.2.3 Checking of components on site/ Quality assurance and quality control checks.

Sometimes, there are several defects can be detected to the precast RC beams components when it was arrived on site. One of the common defects occurred was component cracked. Thus, require rework for repairing work of that particular component. This defect can be rectified either at the site or send it back to the IBS production for rectification work.

To prevent of this problem occurred, inspection by quality control supervisor to check thoroughly of the components before loading for the transportation and approved to be delivered to the site. Upon arrival of precast RC beams component at site construction, the precast installer representative must do inspection as well also make a cross check with the list given to the IBS production which is known as pre-installation process. The purpose of having pre-installation, to ensure the precast RC beam components are correctly according to drawings, specifications and scheduling.

CHAPTER 4

CONCLUSION

Based on the first objective, the production process of precast RC beam have various advantages to the construction in quality products through fair and effective manufacturing process. With stainless steel as precast moulds, it can be used repetition and reuse and also can keep the cleanliness of environment because of less materials waste such as plywood and nails. Therefore, the team that involved in IBS project were divided into three teams for production at yard and two teams for installation works on site. Moreover, in production line required one teams to cast the reinforcement cage, another one team assemble the stainless steel mould and last team do concreting works. Each teams consist of two labours. In addition, installation works consist of two teams which are unloading the precast RC beam from trailer as one team and assemble the precast RC beam on site as one team. For unloading team required two unloaders and one signal man and assemble team needed two assemblers and one installer guider.

Next, the second objective, all the barriers and solution have been determined by teamwork and good communication skills that prevent from misunderstanding occurred between NSC and main contractor. For example, based on the good planning and good in communication, the machinery can be fully utilised on site without any concurrent works.

To sum up, all objectives successfully achieved in this report. The IBS is a construction innovation method as a transformation from conventional construction. Although several problems occur during IBS implementation. However, with comprehensive understanding of its definition, characteristics as well as work process. IBS stakeholders could gain a substantial benefits due to IBS implementation. Therefore, the methods similar with the theory as stated in the introduction which increase project productivity performance.

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