DEPARTMENT OF BUILDING

UNIVERSITI TEKNOLOGI MARA

(PERAK)

THE IBS CONSTRUCTION FOR PERUMAHAN RAKYAT TERMISKIN (PPRT) SINGLE STOREY HOUSES IN CHEMOR, PERAK DARUL RIDZUAN.

Prepared by:

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FEBRUARY 2022

It is recommended that the report of this practical training provided

By

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entitled

THE IBS CONSTRUCTION FOR PERUMAHAN RAKYAT TERMISKIN (PPRT) SINGLE STOREY HOUSES IN CHEMOR, PERAK DARUL RIDZUAN.

be accepted in partial fulfillment of requirement has for obtaining 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 stated herein, prepared during a practical training session that I underwent at Engrazh Services for duration of 20 weeks starting from 23 August 2021 and ended on 7 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 : 10 JANUARY 2022

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Last but not least, my deepest gratitude to my parents and friends for support me in everything I do, always understand my situation and for their wise counsel and sympathetic ear. The moral support that be given throughout the course of completing this practical training program.

ABSTRACT

The construction industry in Malaysia is experiencing a migration from conventional methods to a more systematic and mechanised method known as the Industrialised Building System (IBS). Each state in Malaysia is currently examining the developments of the IBS and its potential to overcome the shortages of housing accommodations in this country. This report was conducted for the building construction of a single storey house and installation of IBS precast panel system at Kg. Che Zainal Tambahan 1, Chemor, Perak Darul Ridzuan. The prime objective of building construction is to make sure that the performance of the Industrialised Building System (IBS) can be continues to the utmost throughout its construction field. The objectives of this report is to investigate the methods of IBS construction for PPRT houses, to identify the details equipment and jointing of building elements, and to identify the problems occurred during the construction works. The method of study used is by observation, interview, and document reviews to gain much knowledge in making this report. This report will state the overall installation method of IBS precast panel system and type of jointing elements used in this project which is a good quality and a good management system that will able to give a better impact for the buildings in the future.

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CHAPTER 1: INTRODUCTION

In the era of globalization, Malaysia is now participating in the use of modern construction technology that is consistent with the growth of other nations. Malaysia has taken an important step forward by creating an Industrialized Building System (IBS) to compete in infrastructure development (Muhamad, 2013). IBS is a construction process in which components are produced in a controlled environment either on or off site, transported, positioned, and assembled into a structure with minimal additional site labour (Kamar et al., 2009). The use of advanced technologies will enhance the quality and productivity of construction projects, allowing Malaysian infrastructure development to be equivalent to that of industrialised countries (Muhamad, 2013).

IBS commonly used in our country can be categorized into five types including the main frame and panel precast concrete systems, steel formwork systems, prefabricated timber framing systems, steel framing systems, and blockwork systems (CIDB, 2003). The most often utilised group in the IBS is precast concrete systems. Precast concrete beams, columns, slabs, lightweight precast concrete, permanent concrete formworks, walls, and “3-D” components likes balconies, staircases, toilets, elevator chambers, and waste chambers, are all included in this system. These components are often produced off-site utilising machinery and moulds (Muhamad, 2013). Besides, steel formwork system is one of the least prefabricated forms of IBS and typically includes concrete on the construction site and strict quality control. These products have high quality finish, are easier to build, and need less labour and materials. This comprises the "tunnel form," the "lilt-up" beam system, "moulding form" columns, and a permanent steel mould (Othuman Mydin et al., 2014).

Furthermore, steel framing system is a system that includes steel trusses, column and beams of a portal frame system. It is commonly utilised with precast concrete slabs, steel beams and columns, and portal frame systems. It is constantly favoured and frequently utilised in the construction of skyscrapers, as well as huge industries and exhibition halls that demand enormous spaces (Muhamad, 2013). Moreover, a block work system is IBS system that employs interlocking concrete masonry and lightweight concrete blocks. The arduous and time-consuming traditional brick-laying

duties are considerably reduced by adopting this excellent alternative technique. The invention and use of interlocking concrete masonry units and lightweight concrete blocks has changed the building process of applying conventional bricks (Muhamad, 2013).

The use of IBS in construction promises many benefits, including fewer workers on the construction site, fewer waste materials on-site construction, clean site construction, better quality control, a safer construction site, and a shorter construction time (Din et al., 2012). All these benefits have its own reasons such as, superior quality concrete is produced since it is feasible to have greater technical control over the production of concrete in the factory and it is not essential to supply joints in precast construction (Azman et al., 2010). Other than that, IBS construction sites have shown to be cleaner and much more organised than traditional construction sites, which are frequently wet and filthy. The use of IBS components can help to decrease wet work on construction sites (Othuman Mydin et al., 2014). Wastage of time and materials on temporary works like timber formworks and props, which are typical in conventional structures, is substantially minimised when the building emphasises IBS components. This encourages construction sites to be cleaner, lowers risks to health and well-being, and offers a safer working environment (Haron, 2009).

Furthermore, Malaysia's construction industry is heavily reliant on foreign labour from neighbouring nations such as Indonesia, and Bangladesh. This reliance may be greatly decreased by implementing the IBS system, which will help the local economy (Othuman Mydin et al., 2014). Concreters, carpenters, bar benders, and plasterers, for example, can be reduced in number by the IBS. This is because the task can be replaced by a group of IBS component installers, who can only consist of at most 5 people in each project (Warszawski, 1999). Besides, when precast components are used, the construction may be done quickly (Marsono et al., 2006). This is because precast element casting at the factory and foundation work at the site may proceed concurrently (Waleed et al., 2003). Lastly, there are many types of IBS system, however, the aim of this is to discover the IBS construction using pre-cast panel system at Chemor, Perak.

1.1 Objectives

The objectives of this study are:

1. to investigate the methods of IBS construction for PPRT houses.
2. to identify the details of equipment and jointing of building elements.
3. to identify problems occurred during the construction works.

1.2 Scope of Study

This study will provide applicable information of the beginning to final stages on the process of building construction of the IBS construction for Perumahan Rakyat Termiskin (PPRT) single storey houses using pre-cast panel system at Kg. Che Zainal, Chemor, Perak, Malaysia. The stages consist of substructure and superstructure activities related to building construction. All problems identified are only related to works of substructure and superstructure. Other problems and elements such as parties involve, planning, workers and plants are not within the scope of this study.

1.3 Research Methods

The research method that being used for this study are:-

1. Observation.

   The construction methods of IBS construction using precast panel system was observed on site every three times a week for three months. In addition to that, site visits were carried out when there were specific jobs such as concreting work, and brickwork. The observation includes every single works carried out by the general worker. All data from observation were recorded by writing an observation diary. Other than that, the pictures and video were taken using Iphone 8 Plus. This is due to the fact that having photos and videos would make it simpler to recall, especially when it comes to construction methods. Normally, the observation took around two hours and thirty minutes.

2. Interview.

The unstructured interviews were conducted during site visits. Typically, unstructured inquiries will be directed to employees on the construction site, particularly during installations that need a high level of skill such as installation of IBS pre-cast panel system. Unstructured interviews will also be performed with the site supervisor about the structure discovered on the construction site. The data were recorded by jotting short notes in a notebook during unstructured interviews.

3. Document reviews.

The document referred to is a company profile, which was used to explain the company's background. Furthermore, architectural drawings and structural drawings are two other sorts of documents that have been referenced. Standard operating procedures also had been used to understand about the construction of IBS especially for pre-cast panel systems. Usually, document reviews were done in the office. All pertinent information from document reviews were recorded by jotted down in a notebook, while documents containing diagrams, such as an architectural plan and a structural plan, will be captured using Iphone 8 Plus. It is meant to be used in the future if the document is not accessible.

CHAPTER 2: COMPANY BACKGROUND

Engrazh Services is a Civil Engineering and Building Contractor firm registered in Malaysia to practice in all fields of engineering and construction. The firm is a private company owned by 100% Bumiputra. This firm was incorporated in October 2017 with registrar of company's registration IP-0487929 and registration under CIDB in April 2019. Engrazh Services has since marked its strong presence in the construction industry by offering stiff yet healthy competition and has delivered remarkable progress over these few years.

The well diversified services by the company have strengthened the company's financial credibility and standing with its vast project and contracts that have been awarded. The team in Engrazh Services maintain a strong foundation of trust and mutual respect generated through positive relationships with client, architect, engineers, subcontractors and suppliers. A company policy encouraging shared performance responsibility ensures the highest degree of professional service and results on all projects undertaken.

With its proven track record and dedication to excellence, Engrazh Services supports every project – from large, complex projects to smaller scale buildings – with outstanding leadership and commitment, building upon its reputation as one of the country's most dynamic and versatile contractors. As part of its seamless business, the company provides wide services in the areas of construction, preparation proposal for new development, addition and renovation, conservation, project feasibility studies, project management and project planning.

Engrazh Services has within it, a group of empowered teams that are selected via a thorough process of recruitment and selection. Being the best requires the company to be fitted with the strongest team of skilled human capital. Therefore, the company seeks only the most qualified and experienced employees for key appointment. The company is fully geared and ready to handle the most demanding challenges in the current construction arena.

2.1 Completed Projects

Engrazh Services has successfully completed many projects which have been awarded by the government as shown in Table 1.

Table 1: Completed Projects

Project's Name	Client	Price (RM)	Duration	Started	Finished
Proposal to upgrade the squash center at the Ipoh City Council Sports Complex, Ipoh, Perak	Ipoh City Council	2,830,000.00	52 weeks	7/2/2018	1/3/2019
Proposed construction of a new mosque in Kuala Sepetang, Perak.	Larut Matang and Selama Land and District Office	1,321,200.00	48 weeks	15/3/2018	20/3/2019
Building renovation and upgrading of Maimon Mosque in Kg Jana Baru Kamunting, Perak.	PWD Larut Matang and Selama	1,920,000.00	64 weeks	3/8/2018	10/12/2019
Ecotorism development project at mangrove forest eco-education center in Matang, Perak.	Taiping Municipal Council	1,837,010.00	95 weeks	25/1/2019	10/1/2021
Proposed road paving at Tanah Ayer Hitam, Chemor, Perak.	PWD Kinta	50,000.00	8 weeks	17/2/2019	30/4/2019
Proposed construction of a new single storey house at Batu Gajah, Perak.	Giatmara Gopeng, Perak	50,000.00	12 weeks	4/11/2020	29/1/2021
Building renovation and upgrading of SMK Anderson, Ipoh.	Kinta Utara District Education Office	30,000.00	8 weeks	2/12/2020	14/2/2021
Building renovation and upgrading of SMK Jalan Tasek, Ipoh.	Kinta Utara District Education Office	25,800.00	8 weeks	20/2/2021	27/4/2021
Proposed construction of 4 units handwash at SMK Tasek Damai, Ipoh	MERCY Malaysia	50,000.00	6 weeks	15/3/2021	16/4/2021

2.2 Ongoing Projects

Engrazh Services also manages the number of government projects that are still under construction as shown in Table 2.

Table 2: Ongoing Projects

Project's Name	Client	Price (RM)	Duration	Started	Estimated to Finish
Upgrading facilities at the solid waste landfill in Kuala Kangsar, Perak.	Kuala Kangsar Municipal Council	2,815,000.00	108 weeks	5/8/2019	27/9/2021
Construction and upgrading of the bridge on the Menora River on route A164 (Sayong-Tanjung Belanja)	PWD Kuala Kangsar	3,249,000.00	102 weeks	27/11/2019	13/1/2022
Proposal to build an Al-Muhajirin Mosque in Kg Ulu Chepor, Perak	MAIPK	4,999,000.00	112 weeks	14/7/2020	28/4/2022
Building renovation and upgrading of SMK Jalan Tasek, Ipoh.	Kinta Utara District Education Office	20,800.00	4 weeks	4/8/2021	6/9/2021
Proposed construction of a new single storey house at Kg. Che Zainal, Chemor.	Giatmara Tambun, Perak	50,000.00	12 weeks	9/8/2021	17/11/2021
Proposed construction of a new fence at the Batu Gajah Islamic cemetery	Kinta District Office	100,000.00	12 weeks	13/8/2021	15/11/2021
Building renovation and upgrading of at Kg. Lawan Kuda, Simpang Pulai, Perak	Giatmara Gopeng, Perak	19,800.00	4 weeks	24/8/2021	29/9/2021
Proposed road paving at Persiaran Tawas Permai 17, Ipoh Perak.	PWD Kinta	19,986.00	8 weeks	19/9/2021	25/11/2021
Proposed road paving at Hala Tasek Timur 2, Ipoh Perak.	PWD Kinta	19,986.00	8 weeks	19/9/2021	25/11/2021

2.3 Organisational Charts

The organisational chart is the general view for the position of each employee. This organisational chart as shown in Figure 1, help in illustrating data management for employees in workplace. It depicts the tasks that must be completed and helps people comprehend the organisational chart's design.

The director, Mr. Mohd Azham Bin Azmi, plays an important role in this organisational chart. Where he acts to monitor all works done by following specification. Meanwhile, the account clerk, Puan Rosma Binti Mohammad, acts as the accountant responsible for financial management such as recording all data related to company accounts or cash flows.

Furthermore, the project executive, Mrs. Nor Amirah Binti Mohamaddiah, is responsible for ensuring that everything on the construction site runs smoothly. Besides, the site quantity surveyor, Mr. Mohamad Aizad Bin Abd Halim, is responsible for ensuring that all building materials required at the construction site are adequate. Moreover, the project safety, Mr. Ramlan Shah Bin Feroz Ghandi, responsible as a safety officer who acts as the first person notified when an accident occurs at a construction site.

Lastly, there are 17 local workers and 13 people foreign workers in this company. All of these workers are responsible for doing labour work at the construction site which they are under the supervision of Mrs. Nor Amirah, the project executive, and Mr. Ramlan Shah, the project safety.

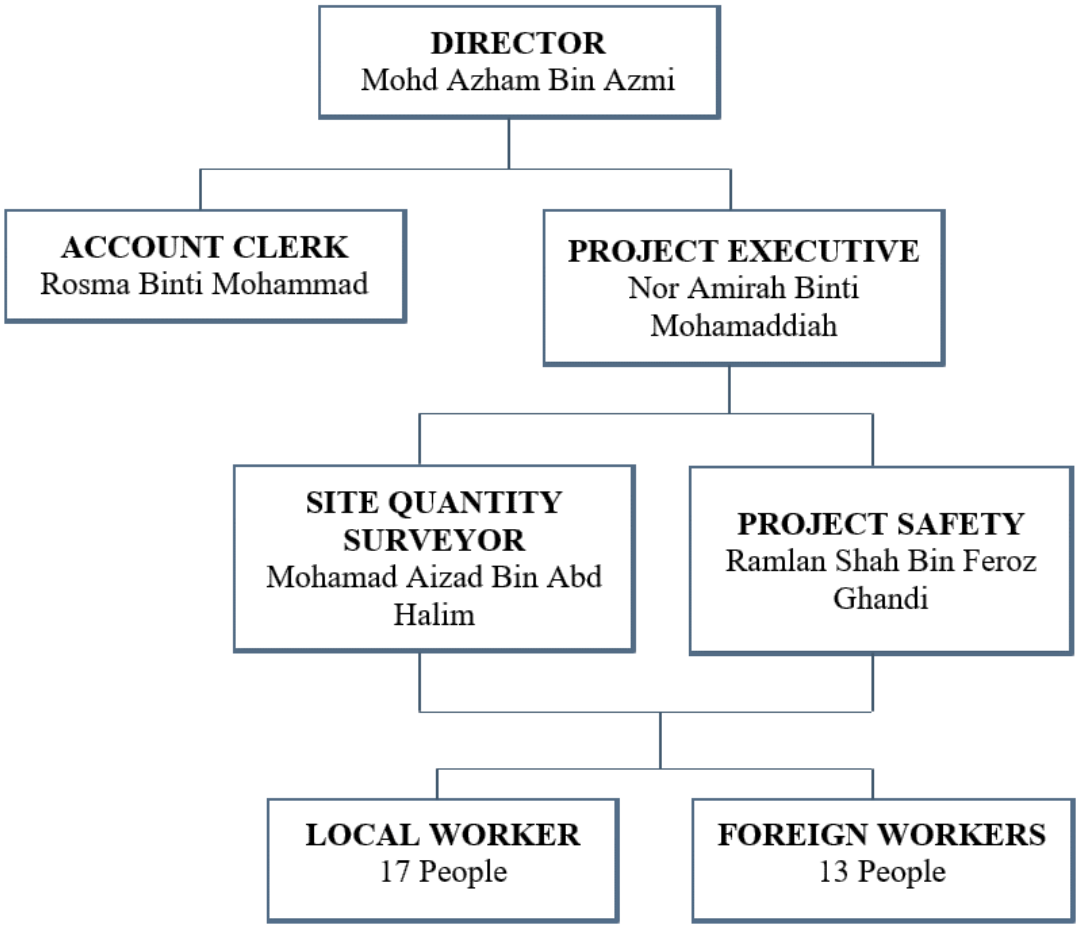

Figure 1: Organisational Chart

CHAPTER 3: CASE STUDY

Engrazh Services is the main-contractor of this project. This case study located at Kg. Che Zainal Tambahan 1, Chemor, Perak Darul Ridzuan. This area is located in the rural area. The area of case study building was surrounded by oil palm plantation areas as shown in Figure 2. Most of the houses in this area were squatter houses. This project was under Program Perumahan Rakyat Termiskin (PPRT). Program Perumahan Rakyat Termiskin (PPRT) was the government initiative in improving the quality of life of poor and hardcore poor families by building houses to provide a safer and more comfortable place to live as the basis for a family's growth.

Figure 2: The location plan of construction site

(Source: Google Map)

The actual duration for this project to complete was 3 months starting on 15th August 2021 and expected to complete on 30th November 2021. The total cost of this project was RM 50,000.00 (Fifty Thousand Only).

This project was an open tender project but several parties were also involved in this project. It was Giat Mara Tambun as the client, Arkitek Azman Ismail Sdn. Bhd as the architect, UCO Berhad as the IBS supplier, and Engrazh Services as the contractor. However, in this case study, Engrazh Services only performed substructure and superstructure construction work while the electrical work was sub to Mawar Elektrik Enterprise and the finishing work was sub to Razdon Enterprise.

There were few officers in charge on this project to ensure the smooth running like Project Manager, Inspector of Work (IOW), and site supervisor. They were among the responsible person in any problems on site.

This project actually was the construction of a single storey house that used IBS precast panel system for superstructure and raft foundation as the substructure. The size of this house was 20 feet width and 30 feet length with three units bedroom, two units bathroom, kitchen, and living area as shown in Figure 3.

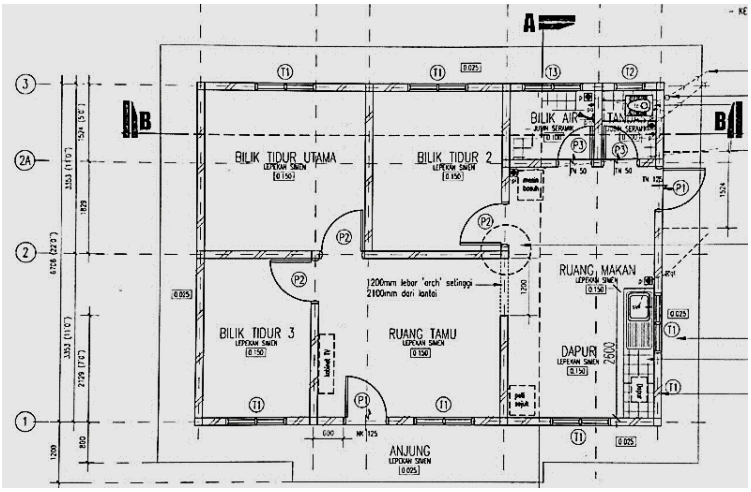

Figure 3: The drawing plan of IBS house

(Source: Courtesy of Engrazh Services)

For this case study, the focus will be on construction of single storey houses using IBS pre-cast panel system. This case study described the whole method, details equipment used, jointing elements, and problem occurred during construction work. The IBS precast panel system, one of the latest construction systems for the purpose of providing a shorter construction time. Most IBS systems have their own jointing elements. For IBS precast panel systems, its required expertise in the panel connection part. Therefore, this case study will describe in details about the jointing elements of IBS precast panel systems.

3.1 The Methods of IBS Construction for PPRT Houses

Figure 4 shows the whole process of the construction for single storey houses starting from site clearance, setting out, foundation, IBS setting out, IBS installation, and lastly roofing. The main focus of this study is the IBS installation.

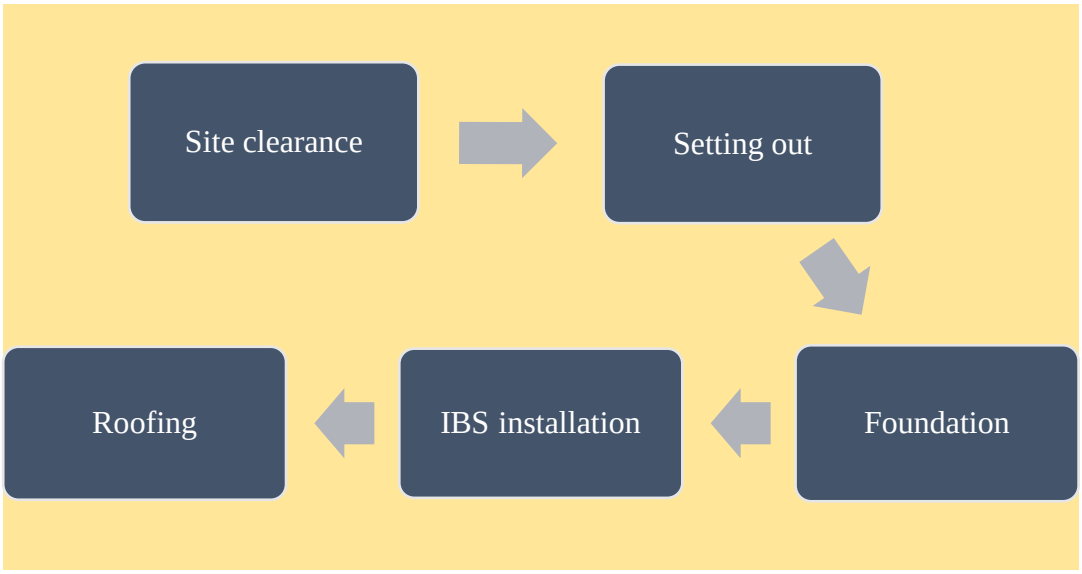

Figure 4: The stages of construction single storey house

1. Site clearance

The first method to do before any construction and structural work is site clearance. In this case study building, the site clearance was done by using the backhoe as shown in Figure 5. Backhoe is a common machinery that is used for site clearance. Site clearance is the process to clear all the vegetation, and remove the surface of the topsoil layer. Therefore, backhoe was used for cutting brush, moving debris, digging out rocks and removing the surface of topsoil layer.

Figure 5: Site clearance using backhoe

(Source: Courtesy of Site Supervisor)

2. Setting out

Setting out was the process in order to clearly define and mark the outline of the excavation and the centre line of the walls, so that construction can be carried out exactly according to the plan. The centre line method of setting out was generally preferred and adopted. Setting out was done by marking the outline by using pegs that was made by the wood size 1" x 2" as shown in Figure 6.

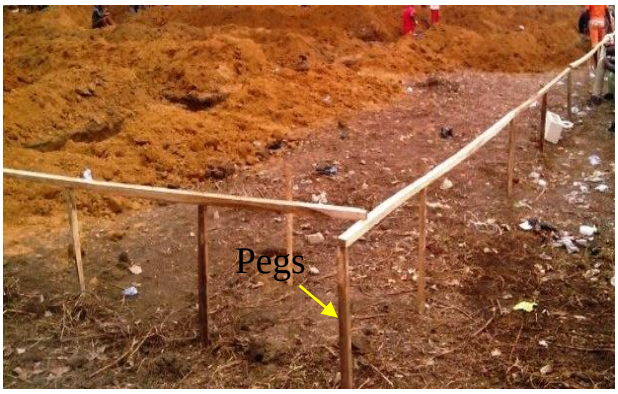

Figure 6: Setting out

(Source: Courtesy of Site Supervisor)

3. Foundation

This case study building was used raft foundation. Firstly, formwork has been installed according to the drawing plan. A string was pulled between two marked pegs so that the formwork can be installed in a straight line. The formwork was made from the plywood and timber as shown in Figure 7. The second step, the crusher run was poured using a wheelbarrow in the formwork area and the crusher run was levelled using a hoe as shown in the Figure 8.

Figure 8: Formwork installation

Figure 7: Formwork filled with crusher run

The third step, the crusher run was excavated one feet width from the marking line to make a gap between each section as shown in Figure 9. The crusher run was excavated using hoe. The fourth step, the crusher run was compacted using compactor machine as shown in Figure 10. The function of compaction was to make the crusher run level be in uniform.

Figure 9: Crusher run was excavated

Figure 10: Crusher run was compacted

The fifth step, the surface of the crusher run was covered with the bed sheet plastic cover as shown in Figure 11. The purpose of the bed sheet plastic cover was to avoid water moisture from the soil absorbing the concrete. Bed sheet plastic cover was important as a layer to prevent water moisture so that termites from the soil will not come to attack the building structure. The sixth step, the rebar was placed at the spacing area and the BRC were placed on the rebar as shown in Figure 12. The brick is placed on the bed sheet plastic cover as the spacing component to provide a gap between the bed sheet plastic cover and the BRC. The rebar in made from steel reinforcement grade Y10 while the BRC used grade A10.

Figure 11: Bed sheet installation

Figure 12: Rebar and BRC installation

The last step of raft foundation was concrete and curing. The formwork area was poured with the concrete from the concrete mixer truck as shown in Figure 13. Then, the surface of the concrete was curing to smooth the surface as shown in Figure 14.

Figure 14: Concreting work

Figure 13: Curing

4. IBS installation

There were a few steps in installing the IBS precast wall panel system. Firstly, line markings were made to determine the position of the wall. The position of the wall was marked using string according to the approved drawing plan as shown in Figure 15. The floor was levelled uniformly to facilitate the work of raising the panel to the correct position. The second step, the bottom track was installed according to the thread position as shown in Figure 16. The bottom track was nailed to the floor using concrete nails.

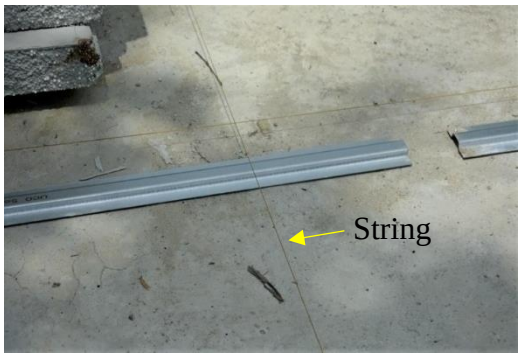

Figure 15: IBS setting out

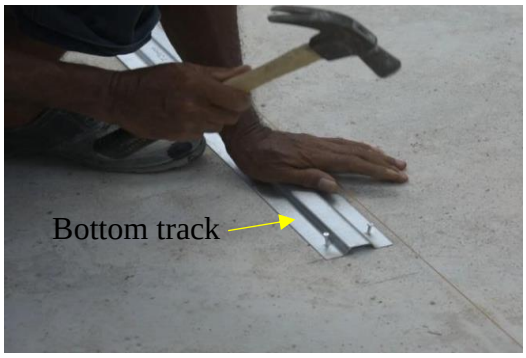

Figure 16: Bottom track installation

The third step, Sika Ceram 288 cement was placed on the side of the panel as shown in Figure 17. In this process, the whisk was used to achieve a perfect combination between Sika Ceram 288 and a water mixture. Only one side of the panel is plastered with Sika Ceram 288 cement. A moist sponge was used to flatten excess Sika Ceram 288.

Figure 17: The placement of Sika Ceram 288 cement

The fourth step, the panel on which Sika Ceram 288 had been placed, was lifted and placed vertically on the bottom track. The 1" x 2" wood was used to support the panels that had been placed on the bottom track as shown in Figure 18. The fifth step, water levels were used vertically and horizontally to check and ensure each panel placed on the bottom track is in the proper position as shown in Figure 19. This process seems simple but it was very important to keep the panels in balance.

Figure 19: IBS panel support by temporary support

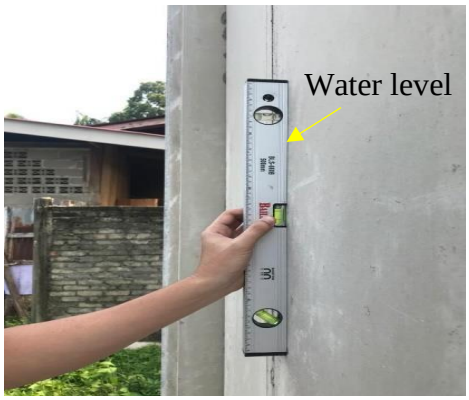

Figure 18: IBS panel position inspection

The sixth step, connecting devices were mounted on each bottom of the panel for the purpose of panel rigidity. In this step, the bottom track was drilled and fitted with a Y10 grade “7-shape” dowel bar as shown in Figure 20. A hammer was used to install the Y10 “7-shape” dowel bar on each side of the bottom corner of the panel as shown in Figure 21.

Figure 20: Bottom track is drilled

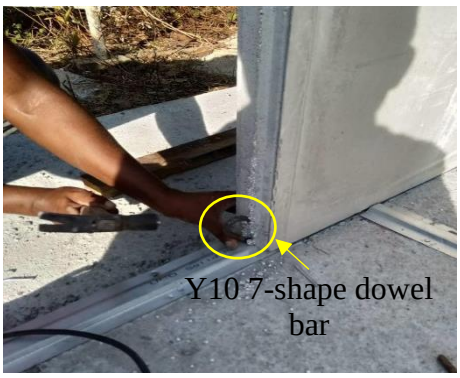

Figure 21: The dowel bar is fitted

The seventh step, marking and cutting panels for door and window openings. In this step, the panels were marked and cut according to the approved drawing measurements for the purpose of door and window openings as shown in Figure 22. The marked measurements were checked by the supervisor to ensure the measurements were accurate before the cutting process was carried out. The surface of the panel to be cut was moistened with water to facilitate the cutting process using a circular saw machine. Then, the door and window frames were installed on panel openings using fully filled cement mortar inside the door and window frames.

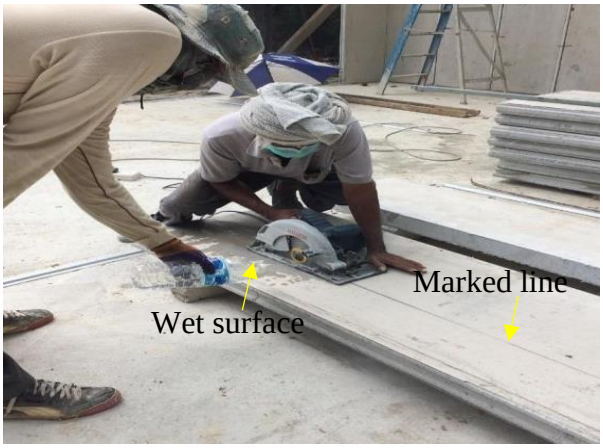

Figure 22: IBS panel cutting activity for door and window opening

The eighth step was installation of 'locks' on each side of the panel surface and on the top of the panel. In this step, as in Figure 23, a "stapler-shape" steel reinforcement link of grade R6 was installed as a 'lock' at the connection between the two surfaces of the panel that was at the bottom, middle and top of the wall, while a one feet length Y10 dowel bar was installed using a hammer at the top of the connector between the two panels as shown in Figure 24.

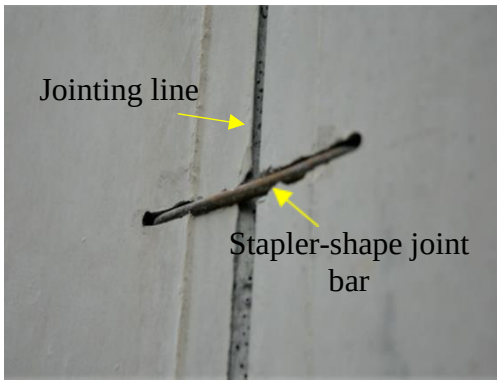

Figure 23: Stapler-shape joint bar is installed at the jointing line

Figure 24: Y10 dowel bar is installed on top of the IBS panel

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The last step is known as the final touch up process of the connection. In this process, Sika 288 cement was applied entirely at a width of 50mm between two panel connection surfaces. In Figure 25, a wet sponge was used to smooth and level the Sika 288 cement. Then, Figure 26 shows the skim coat was also used on the connection part between the panels to prevent cracking and cover the effect of the connection.

Figure 25: Sika 288 cement is applied

Figure 26: Skim coat is applied

(Source: Courtesy of site supervisor)

4 outer corners of walls and uncovered panel with door and window frames were installed PVC corner beads as in Figure 27. The purpose of PVC corner beads was to cover the edges of the panel.

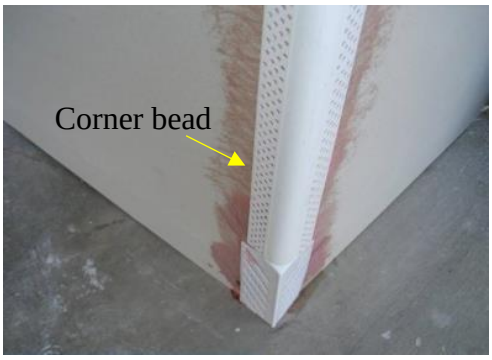

Figure 27: Corner bead

In Figure 28, the sealant was applied between the panel connector surface and the floor on the outer wall to seal the gap between the panel and floor. Sealants are used to keep air, water, and other environmental elements from entering or exiting a structure while allowing limited movement of the substrates.

Figure 28: The sealant was applied

5. Roofing

This case study building was used gable roof design and lightweight steel truss system. There were a few steps in roof trusses process. Firstly, roof trusses consisting of struts and rafters were constructed according to the drawing plan. In Figure 29, all strut and rafter installation work were done on the floor before the roof trusses were lifted and placed on top of the building structure.

Figure 29: Installation of roof truss component

(Source: Courtesy of site supervisor)

The second step, roof trusses that had been installed with struts and rafters were lifted and placed on top of the building structure as shown in Figure 30. The components of the roof trusses were all built of C channel steel. Nowadays, most of the contractor used a lightweight steel truss system due to the fact that it was lightweight and durable. So, the workers were easy to lift and place the roof truss. Furthermore, C channel steel had the advantages of being termite-proof, rust-resistant, and non-combustible.

Figure 30: Roof trusses are placed on the building structure

(Source: Courtesy of site supervisor)

The third step, Figure 31 shows temporary supports were used to erect roof trusses according to the drawing plan.

Figure 31: Roof truss support by temporary support

(Source: Courtesy of site supervisor)

The fourth step, in Figure 32 the batten was mounted on the roof truss horizontally using fasteners to lock the position of the roof truss from falling.

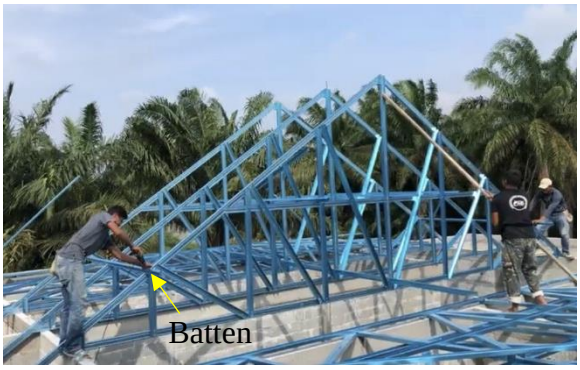

Figure 32: Installation of batten

(Source: Courtesy of site supervisor)

The fifth step, L-brackets were used to fasten the roof truss to the beam so that the roof truss remains in position as shown in Figure 33. The L-bracket was mounted on the roof truss using fasteners while the sleeve anchor was used to mount the L-bracket to the beam. The next step, 14 pieces of metal deck with the size of 2.5 feet wide and 14 feet length was placed on top of the roof truss and screwed on the batten using fasteners as shown in Figure 34. A metal deck with a 25° slope was mounted on the roof truss.

Figure 34: The L-bracket is mounted with roof truss and beam

(Source: Courtesy of site supervisor)

Figure 33: Metal deck is screwed on batten

(Source: Courtesy of site supervisor)

Lastly, in Figure 35, a flashing cover was installed on top of the roof to cover up the connection, or space, where the two sides of the roof meet. By installing this flashing cover, it can prevent the roof connection from leaking especially during rain.

Figure 35: Installation of capping

(Source: Courtesy of site supervisor)

3.2 The Details Equipment and Jointing of Building Elements

3.2.1 Equipment

1. Scaffolding

Figure 36 shows the scaffolding. Scaffolding was a temporary structure that was commonly used at construction sites. Scaffolds were widely used on site to get access to heights and areas that would be otherwise hard to get to because its function seems like a ladder. In this case study, scaffolding was used to transport the roof trusses to the top of the building.

Figure 36: Scaffolding

2. Power drill impact

Impact drills, also known as impact drivers, were handheld tools designed to drive screws fast and can also be used to drill holes. It had a variety of types and also offered a variety of functions. Impact drill was very useful for construction work. For this case study, it was used to drill holes and drill screws. Figure 37 shows the power drill impact.

Figure 37: Power drill

3. Circular saw machine

A circular saw was a type of power-saw that used a toothed or abrasive disc or blade to cut various materials in a rotational motion that revolved around an arbour. A circular saw was a tool for cutting a variety of materials such as wood, stone, plastic, or metal. It can be hand-held, as shown in Figure 38, or machine-mounted. The most common circle saw was a hand-held circular saw. In this case study, a hand-held circular saw was used to cut the IBS precast panel for the purpose of door and window opening.

Figure 38: Circular saw machine

4. Compactor

A compactor was a type of construction machine that applies pressure on soil, reducing air trapped and allowing the soil to support higher weights on flat surfaces. Roller compactors and flat plate compactors were the two main types of compactors. One of the most obvious advantages was their ability to boost a surface's load-bearing capability. In this case study, a flat plate compactor was used during construction of raft foundation as shown in Figure 39.

Figure 39: Compactor machine

5. Hammer

Figure 40 shows a hammer. A hammer is a hand tool that consists of a weighted "head" attached to a long handle and swung to produce an impact to a limited area of an item. In this case study, a hammer was used to install a dower bar and joint bar into IBS precast panel.

Figure 40: Hammer

3.2.2 Machineries

1. Backhoe

In this case study, a backhoe was used for site clearance activity as shown in Figure 41. A backhoe was an excavating equipment that had a digging bucket attached to the end of a two-part articulated arm. Backhoe loaders were normally loader or tractor units with a loader-style bucket on the front and a backhoe digging bucket on the end of a two-part articulated arm on the back.

Figure 41: Backhoe

(Source: Courtesy of Site Supervisor)

2. Concrete Mixer Truck

Concrete mixer was a machine that combines cement, aggregate such as sand or gravel, and water to form concrete. A typical concrete mixer used a revolving drum to mix the components. Usually, a mixer concrete truck can hold 9m3 of concrete. The concrete in the truck usually can hold for 2 hours after the batching concrete time. In this case study, a concrete mixer truck was used for concreting raft foundation as shown in Figure 42.

Figure 42: Concrete Mixer Truck

3. Forklift

A forklift was a compact industrial vehicle with a power-operated forked platform connected at the front that can be raised and lowered for insertion beneath a load to lift or transport it. They were used for short-distance lifting and moving of various materials. In this case study, a forklift was used to unload the IBS precast panel as shown in Figure 43.

Figure 43: Forklift

3.2.3 Jointing of Building Elements

1. Panel to Panel

The IBS precast panel system consisted of interlocking in every side of the panel as shown in Figure 44. In this case study building, jointing for panel to panel were used Sika Ceram 288. Sika Ceram 288 were laying on one side of the interlocking surfaces as shown in Figure 45. Sika Ceram 288 was a specialist cement that used to join each panel. Due to it high performance, thin layer, and flexible cementitious adhesive, Sika Ceram 288 was the best adhesive for the jointing of IBS precast panel wall.

Figure 45: Interlocking of panel

Figure 44: Sika Ceram 288 cement on interlocking surface

In addition, a jointing bar called a stapler-shape, was also used as a jointing element. After the Sika Ceram 288 cement had hardened, a stapler-shaped jointing bar was installed in the centre of the interlocking line as shown in Figure 46. This stapler-shape jointing bar was made from steel reinforcing link grade R6 with the size of 4 inches length and 1.5 inches wide as described in Figure 47. This stapler-shape jointing bar was installed in three areas namely the top, middle and bottom of the interlocking line. The function of the stapler-shape jointing bar was to provide more support and strengthening of the jointing element. Moreover, the function of this stapler-shape jointing bar was also used as a fastener of each panel simultaneously.

Figure 46: Stapler-shape jointing bar

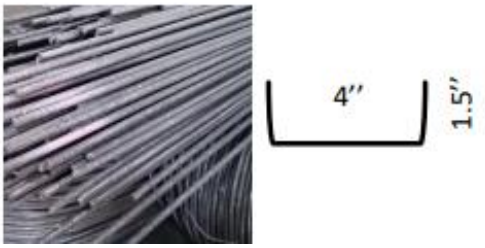

Figure 47: Details size of stapler-shape jointing bar

Furthermore, in this case study building, a dowel bar was also used as a jointing element. A dowel bar was only installed in the top side of the panel as shown in Figure 48. This dowel bar was made from steel reinforcement bar grade Y10 with the size of 1 feet length. These dowel bars were placed diagonally between the two panels as shown in Figure 49. The purpose of the dowel bar was to offer additional support and strength to the jointing elements, especially at the top of the panel.

Figure 48: Dowel bar

Figure 49: Details of dower bar location

2. Panel to Slab

Jointing elements for the panel to slab section used a dowel bar that was called J-shape. A J-shape dowel bar was installed in the bottom edge of the panel as shown in Figure 50. These J-shape dowel bars were made from steel reinforcement bar grade Y10 with the size of 4 inches length. These J-shaped dowel bars were diagonally placed between the panels and the slab. The J-shape dowel bar's purpose was to tighten the panel to the slab, and thus providing further support and strength to the jointing parts.

Figure 50: Y10 J-shape dowel bar is installed diagonally

Furthermore, sealant was also used as a jointing element in this case study building. Sealants were used to seal joints and openings or gaps between the panel and the beam. For this case study building, sealant was only applied on the surface between panel and beam as shown in Figure 51. The main purpose of sealants was to prevent water, air, and other environmental elements from entering or exiting the house while permitting limited movement of the structure.

Figure 51: Sealant is applied to the surface of the connection gap

3.3 Problem Occurred During the Construction Works

3.3.1 Limited and Isolated Construction Areas

The case study building is located in a rural area, and the distance from the main road to the construction site is around 4 kilometres. Furthermore, the road width in this location is insufficient for heavy vehicles such as trailers and lorries. As a result, due to small road factors, the IBS precast panel cannot be delivered directly to the construction site. During the delivery of IBS precast panel, the contractor had to rent two forklifts and a one-tonne lorry since only these vehicles were allowed to access the construction site area. The first forklift transfers the IBS precast panel from a trailer to a one-tonne lorry as shown in Figure 52, while the second forklift unloads the IBS precast panel at the construction site. This delivery period takes a long time since the one-tonne lorry cannot carry a large quantity of IBS precast panel due to the size of the one-tonne lorry being too small to transport large quantities of IBS precast panel.

Figure 52: Forklift transfers the IBS precast panel

3.3.2 Limited Production of IBS Precast Panel

The manufacture of IBS precast panel in this pandemic Covid-19 was quite restricted. Furthermore, the organisations that provided the service of manufacturing these IBS precast panels were quite limited. The customers had to wait for a month to get the IBS precast panel ordered. As a result, the construction period had to be rescheduled from the due date of completion.

3.3.3 Lack of Knowledge of IBS Technology

Lack of knowledge in handling the IBS precast panel system among workers was also one of the problems that occurred during construction works. Most of the workers were reluctant to adopt the IBS system and prefer to continue using the conventional method of construction. This was due to the fact that most of these workers often do construction work from small contractors, so they were already familiar with the conventional system and for them the technology suited well with small scale projects and therefore not willing to switch to a mechanized based system. There was one case, where one of the workers mixed the specialist cement with another type of cement, and as a result the cement did not adhere strongly during the process of laying the cement on the interlocking section.

CHAPTER 4: CONCLUSIONS

The conclusion that can make for this report is about construction of single storey houses that study located at Kg. Che Zainal Tambahan 1, Chemor, Perak Darul Ridzuan. This project was under Program Perumahan Rakyat Termiskin (PPRT) by Giat Mara Tambun. The objective of this report is to identify the methods of IBS construction for PPRT houses, the details equipment and jointing of building elements, and the problems occurred during the construction works. From this report, the construction of single storey houses using IBS precast panel system is starting with site clearance, setting out, foundation, IBS precast panel system installation, and lastly roofing. Other than that, this report also describes about the equipment and jointing used for construction of single storey houses using IBS precast panel system. The machinery that used for this construction is concrete mixer truck, backhoe and forklift. While the tools used is scaffolding, power drill impact, circular saw machine, compactor, and hammer. The material used for jointing elements of this IBS precast panel system is Sika Ceram 288 cement, stapler-shape jointing bar, reinforcement bar, J-shape dowel bar, and sealant. The problem occurred during the construction works is limited and isolated construction areas, limited production of IBS precast panel, and lack of knowledge of IBS technology. Through the construction of a single storey house on site, it can be seen more clearly how the construction process for IBS precast panel system and what machinery and equipment also material that should be used to construct a single storey house using this type of IBS system, and then problems occur during the construction work.

REFERENCES

Azman, M. N. A., Ahamad, M. S. S., & Hanafi, M. H. (2010). The common approach in off-site construction industry. Australian Journal of Basic and Applied Sciences,4(9), 4478-4482.

CIDB. (2003). IBS Roadmap 2003-2010. Construction Industry Development Board (CIDB)

Din, M. I., Bahri, N., Dzulkifly, M. A., Norman, M. R., Kamar, K. A. M., & Abd Hamid, Z. (2012). The adoption of Industrialised Building System (IBS) construction in Malaysia: The history, policies, experiences and lesson learned. *ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction*, *29*, 1.

Haron, Nuzul. (2009). A LITERATURE REVIEW OF THE ADVANTAGES AND BARRIERS TO THE IMPLEMENTATION OF INDUSTRIALISED BUILDING SYSTEM (IBS) IN CONSTRUCTION INDUSTRY. Malaysian Construction Research Journal. 4. 10-14.

Kamar, K. M., Alshawi, M., & Hamid, Z. (2009). Barriers to industrialized building system (IBS): The case of Malaysia. *BuHu 9th International Postgraduate Research Conference (IPGRC)*, 45–55.

Marsono, A. K., Tap, M. M., Ching, N. S., & Makhtar, A. M. (2006). Simulation of industrialized building system components production. In Proceedings of the 6th APSEC pp.87-96

MUHAMAD, Z. B. (2013). *ADAPTABLE EFFECTIVENESS OF INDUSTRIALISED BUILDING SYSTEM (IBS) IN CONSTRUCTION PROJECT* [PhD Thesis]. Universiti Malaysia Pahang.

Othuman Mydin, M. A., Sani, N. M., & Taib, M. (2014). Industrialised Building System in Malaysia: A Review. MATEC Web of Conferences, 10, 01002. https://doi.org/10.1051/matecconf/20141001002

Waleed, A.M.T., Lee Wah Peng, M.R.A. Kadir, Mohd. Saleh Jaafar and Mohd. Sapuan Salit (2003) The essential characteristics of industrialized building system, International Conference on Industrialised Building Systems, pp.283-295

Warszawski, A. (1999) Industrialised Building System. Prospect in Malaysia, Proceedings of World Engineering Congress.