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Industrialized Building System (IBS): Challenges in Implementing Interlocking Mortarless Blocks (IMB) System for Housing Projects

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ABSTRACT: The Malaysian government strongly encourage the application of new techniques in building construction such as the Industrialized Building System (IBS). With this new IBS technology, numerous advantages will be obtained and will directly raise the performance of the building. However, the acceptance of IBS in Malaysia is still low. There are many components of IBS. The objective of this paper is to describe the Interlocking Mortarless Blocks System (IMB) and to identify the challenges in the utilization of the mortarless blocks system in housing construction. This research was carried out in Ipoh, Perak, with a focus on housing construction projects. Questionnaire was provided for the respondents to answer. The data was analyzed using the descriptive analysis from the SPSS software. The result revealed that one of the challenges is contractors who tend to use traditional construction method rather than the Interlocking Mortarless Blocks system method. The usage of Interlocking Mortarless Blocks in Malaysian is still low as there is no specific standard on Interlocking Mortarless Blocks system. Therefore, the findings of this research can hopefully assist Malaysian contractors in making a decision on the component to be used in their projects. Additionally, the findings ensure that the government can take appropriate action to encourage the use of IBS, especially the Interlocking Mortarless Blocks.

KEYWORDS: Industrialized Building System, Interlocking Mortarless Blocks, Challenges, Housing Projects

1. INTRODUCTION

The Industrialized Building System (IBS) is a key towards futuristic construction. IBS can be defined as a construction technique in which the components are manufactured in a controlled environment (or off site), transported, positioned and assembled into a structure with minimal additional site work (Din et al., 2012). According to Din et al. (2012), The Construction Industry Development Board (CIDB) stated that the IBS's construction components consist of precast component systems, fabricated steel structures, innovative mold systems, modular block systems and prefabricated timber structures. Hence, it is clear that block systems, which is also known as interlocking blocks system, is utilized in IBS.

Bricks are essential in completing a building structure. This is supported by A. Shakir and Ahmed Mohammed (2013), where they stated that brick is one of the most important materials for the construction industry. Nowadays, conventional bricks can generally be labeled as an outdated method for construction as the block systems available under the IBS module are better choices as replacement for conventional bricks. Block systems or interlocking mortarless blocks provide numerous benefits that conventional brick does not.

Block system is a construction with concrete or cement blocks, which are larger than standard clay bricks or concrete bricks (Bahari et al., 2017). In order to make them lighter and increase the ease of handling, there is a hollow core which can facilitate their insulation capacity. Therefore, this paper aims to describe the Interlocking Mortarless Blocks System and to identify the challenges in the utilization of mortarless blocks system in housing construction.

2. INTERLOCKING MORTARLESS BLOCKS SYSTEM

2.1 Development of Interlocking Mortarless Blocks

The interlocking mortarless blocks system is also known as the interlocking load bearing hollow blocks (ILHB) system. Sharath, Vikas and Kumar (2013) stated that the interlocking mortarless load bearing hollow blocks system differs from conventional mortared masonry system due to the elimination of mortar usage, where the bricks are connected through interlocking protrusions and grooves. Hence, the rate of construction significantly increases with the elimination of mortar (Bosro *et al.*, 2018).

In addition, Ahmad *et al.* (2011) highlighted that the introduction of interlocking mortarless blocks is to reduce the use of manpower in line with the fulfillment of the requirement of the Industrialized Building System (IBS). This will also lead to fast and cost-effective construction, hence offering a good solution in construction that brings great results in terms of the construction's output. Furthermore, Adedeji (2011) pointed out that various types of interlocking bricks and blocks have been produced commercially, which differ in the composition of material, shape and dimension, strength ability and purpose. The interlocking blocks include Putra block system, Meccano system, Sparlock system, Sparfil system, Haener system and Hydraform blocks or Solid Interlocking blocks (SIB), which can be considered as an upgraded system of the conventional bricks system (Al-Fakih *et al.*, 2018).

2.1.1 Haener block

The Haener block (Figure 2.2) was invented by Juan Haener in 1997 and it has been in the industry market until now, which is longer than any other mortarless block units, due to its popularity and demand. It comes in a standard block size, which is 8 x 8 x 16 inch (Figure 2.1), and it weighs approximately 15 kilograms per block (Wani and Kumar, 2018). M. Fayez (2009) described that the block's webs have lifted lugs, which are formed with a special contoured shoe during the manufacturing process. Moreover, the webs are offset from their conventional locations so that the lugs lay, align and lock each block into the right position during stacking. According to Haener block's users, the general labors can stack the block up to more than 100 blocks per hour, regardless of whether they are skilled, semi-skilled or unskilled. This work rate for Haener blocks is recognized as 10 times faster than conventional bricks. Thus, it increases the work productivity per hour.

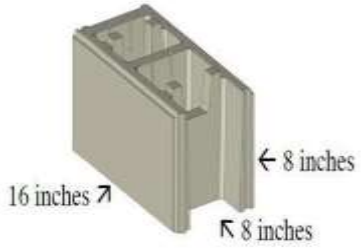

Figure 2.1: Standard size of Haener block
(Source: (Wani and Kumar, 2018))

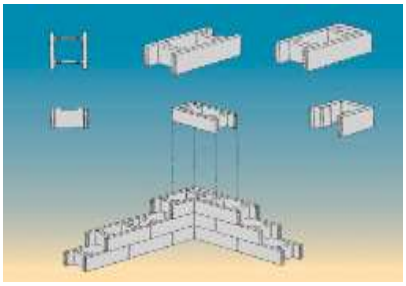

Figure 2.2: Haener block system
(Source: (M. Fayez, 2009))

2.1.2 Sparlock system

An upgraded system of the common dry-stacking system is widely known as the Sparlock system (Figure 2.3). The system was introduced to avoid the height problem in constructing high walls by using the interlocking mortarless blocks. In this system, the blocks are placed together in stack bond arrangement. This means that each block rests right on top of the block below, rather than being overlapped by two units (M. Fayez, 2009). In addition, this system is set in such a way to be more stable and stronger in terms of load taking compared to the previous system, Haener block. However, the overall construction cost involved is slightly higher. As a result, this arrangement of interlocking blocks increases the wall system's endurance entirely towards vertical bending and prevents fire and sound from penetrating through the wall.

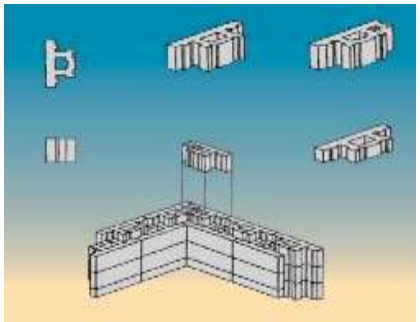

Figure 2.3: Sparlock system

2.2 Interlocking Mortarless Blocks in Malaysian Construction Industry

In Malaysia, there was a development on an interlocking loadbearing hollow blocks system that was called Putra Block (Al-Fakih *et al.*, 2018). It is an upgraded method of the conventional bricks system, where it was implemented to construct the wall of the Putra Blok building in University Putra Malaysia (UPM). The main objective of using Putra block is to eliminate the use of mortar jointing. Other than that, it also has a feature where the blocks are aligned and interconnected through the provision of protrusions and grooves. According to Thanoon *et al.* (2004), Putra block consists of three types of block, which are stretcher, corner and half block. Each of the block are distinct in terms of characteristics, particularly in terms of geometrical feature and the block's function in a wall system. Besides that, stretcher block is the most utilized unit in a wall system as it acts as the main part of the wall to resist loads. On the other hand, corner block is used in each corner or the wall junction, where it effectively acts as a linkage to connect between perpendicular walls. Half block functions as a complementary unit where it enhances wall alignment prior to wall course completion.

Figure 2.4: Stretcher block unit

Figure 2.5: Corner block unit

Figure 2.6: Half block unit

As a result, Bosro *et al.* (2018) asserted that this system offers numerous advantages in terms of design, construction cost and time, especially for a modern construction method. This assertion is supported by Al-Fakih *et al.* (2018), who concluded that the compressive strength of the blocks also met the Malaysian standards requirement.

2.3 Types of Interlocking Mortarless Blocks

Regarding the current situation in the Malaysian construction industry, there are only 15 interlocking blocks manufacturers in the whole country as listed in the CIDBIBS portal, which makes it a tiny construction player compared to other common material manufacturers (CIDB, 2019). Furthermore, with reference to three manufacturers, CKYIBS (M) Sdn. Bhd., Proven Engineering Blocks Sdn. Bhd., and Zenbes Sdn. Bhd., there are some typical types of interlocking mortarless blocks that are popular in the current moment. Each of the types has its own function and characteristic, thus they are distinct in terms of shape and form. Besides, the interlocking blocks are also known as concrete masonry unit as they are majorly made of concrete. Consequently, the concrete itself has a strong compressive strength which causes the blocks to also possess a high compressive strength. Moreover, the alignment of the blocks is simple and easy, which can be perfectly carried out by a semi-skilled worker. The existence of long and narrow protrusions and grooves at the sides has made the blocks more convenient to be laid and connected together (Bosro *et al.*, 2018). The common block types are stretcher, corner, and half block (Figure 2.4, 2.5 and 2.6).

Figure 2.7: Protrusion side

Figure 2.8: Groove side

2.3.1 Stretcher unit

This type of block is generally known as the main unit in forming a wall system. This is due to its standard size of block where it is the best form to construct a wall course. In the Malaysian construction industry nowadays, there are various units offered by different manufacturers where the blocks are different in terms of specifications. Accordingly, the most common size used in the industry is 400mm in length, 200mm in height, and 142mm in thickness. However, there are also other sizes of block offered, depending on the client's request.

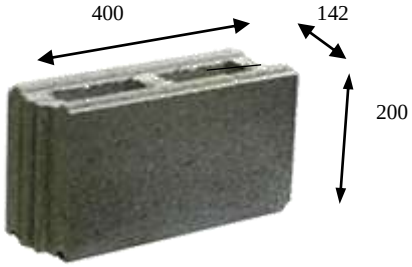

Figure 2.9: Stretcher unit of 400mm x 200mm x 142mm
(Source: (Proven Group, 2019))

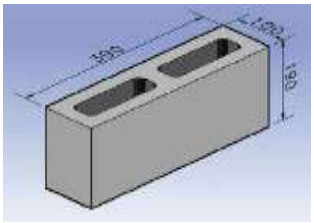

Figure 2.10: Stretcher unit of 390mm x 190mm x 100mm
(Source: (Zenbes, 2018))

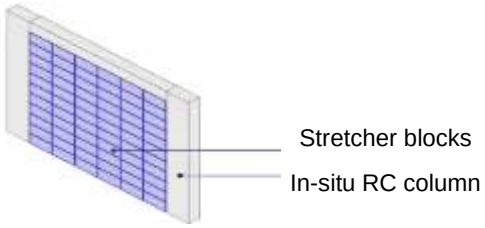

Figure 2.11: In-fill wall with stretcher units
(Source: (Zenbes, 2018))

2.3.2 Corner unit

The corner unit is one of the blocks that differ from the others in terms of design. The design is specially created for the block to be placed at a T-junction of a wall or on perpendicular wall type. Furthermore, what makes this block different from others is that it has extra grooves at both faces. It was designed to ensure that the junction or perpendicular wall is connected to the wall by inserting the protrusion of the stretcher units to the readily available groove. Apart from that, the size of the manufacturers' most commonly supplied corner unit block is approximately 300mm in length, 200mm in height, and 142mm in thickness (CKYIBS, 2019). This is due to the fact that the demands for corner unit from clients is not as high as the stretcher unit, where they did not request for other different-sized corner blocks.

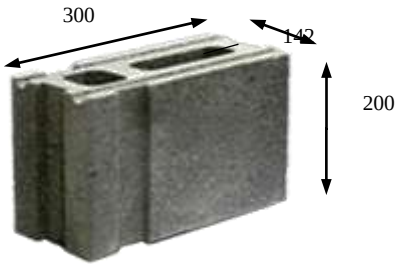

Figure 2.12: Corner block unit of 300mm x 200mm x 142mm
(Source: (CKYIBS, 2019))

2.3.3 Half block unit

A half block unit is typically made to be half the size of a stretcher unit, hence the name. It is utilized by placing the block in short length positions to complete the wall course. Hence, the usage of half block is also one of the methods to reduce the need of cutting the standard stretcher unit. This also leads to the reduce in wastage and time consumption.

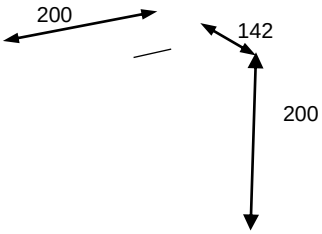

Figure 2.13: Half block unit of 200mm x 200mm x 142mm
(Source: (Proven Group, 2019))

2.4 Challenges in the Utilization of Interlocking Mortarless Blocks

The adoption of IBS has always been an issue in Malaysia since many years ago. According to Tahir *et al.* (2017), there were always negative perceptions among the construction players towards the adoption of IBS in the Malaysian Construction Industry (MCI), where they declared that MCI is not ready for the changes from the conventional system to a new concept of evolution. In addition, the construction players are also concerned on the lack of information regarding IBS construction and the lack of knowledge to understand how to implement IBS. Hence, in order to overcome these issues, on behalf of the government, the CIDB should step up the efforts, initiatives and approaches towards the implementation of IBS.

Traditional construction method was very common and well-known among the contractors, thus they prioritized the conventional method rather than the IBS method (Mohammad *et al.*, 2016). However, when IBS started to be used in MCI, the contractors tend to utilize the system in order to enhance the construction products and receive recognition from the government. Furthermore, interlocking mortarless blocks are also the topic of discussion among construction stakeholders, where they currently prefer to use the upgraded system of interlocking mortarless blocks rather than conventional bricks. Nevertheless, referring to the statistics from CIDB (2019), the number of manufacturers producing the interlocking mortarless block were still lacking and they could not effectively supply the interlocking mortarless block to the whole country. When there is a lack of supply, the contractors tend to face construction delay issue, which leads to great losses and the possibility of being imposed with damages. In addition, the statistics from CIDB (2018) also showed that the utilization of blockwork component is among the lowest compared to other IBS components.

Moreover, Idris (2019) emphasized that IBS in Malaysia is still not being implemented widely among the private sector, as reported by CIDB. As highlighted by Yunus and Yang (2011), the possible reason is the limited understanding among stakeholders on the IBS components and their potentials. Apart from that, Ahmad *et al.* (2011) highlighted that the utilization of interlocking mortarless blocks is not widely practicable in Malaysia due to there being no specific standard accordance for this system. Furthermore, the study on the standard requirement for the manufacturing or production and installation of the system is limited, hence this leads to difficulty in implementing the system. Besides, Zawawi (2009) also stated that there are needs for higher capital investment and also expert labor to deal with issues related to the IBS technology. Yunus and Yang (2011) further added that the lack of skilled labor for the IBS technology had been one of the main obstacles.

According to Din *et al.* (2012), there were some challenges that had been observed in the current Malaysian construction industry. One of the challenges is the incentives from government are not sufficient. Hence, the government should play as an important role to promote and push the players of the construction industry towards a manufacturing-based industry. Other than that, the availability of cheap foreign worker can also be the reason why the construction industry is slow in moving towards IBS construction. The ease of getting cheap labor discourage the stakeholders to pay more for IBS workers, who tend to command higher wages. Furthermore, to utilize the higher levels of IBS, the adopters need to take into account the large volume of works that is required to break even on the investment. Although it produces higher value to the construction industry, the cost will be very high because of the total capital and maintenance cost.

3.0 RESEARCH METHODOLOGY

The research was conducted by means of questionnaire survey. The questionnaire was distributed to housing developers that currently own housing projects in Ipoh district, whereby the housing projects adopted the blockwork system of IBS. There were 410 private housing projects as listed by KPKT, regardless of the construction technology used in the construction. However, out of the 410, there were 107 projects that adopted the IBS components in their housing construction project, where these projects were the population for the study. Next, out of the 107 projects, only 35 samples that utilized blockwork system under the IBS technology were chosen.

The questionnaire was designed to have two sections. The first section solicited the general information about the respondent and the organization. The second section required the respondents to answer questions on the ten (10) challenges in utilizing the Interlocking Mortarless Blocks, as listed in the Table 1. The scale provided ranged from 1 to 5: strongly disagree (1), disagree (2), uncertain (3), agree (4) and strongly agree (5). The statistical analysis method that was used for this study is a descriptive analysis from the Statistical Package for Social Sciences (SPSS) software, version 26. The result from the data was presented in the form of a table in section 4.

4.0 ANALYSIS AND RESULT

The respondents that participated in this survey consisted of 75% male and 25% female. The age of the majority of the respondents are in the range from 21 until 30 years old (53%). Another 47% are aged between 31 and 50 years. 41% of the respondents had not more than two years of experience in the construction industry while 59% had more than two years of experience in the construction industry. Thus, these respondents are eligible to be involved in this survey.

Table 1: Ranking Scale of the Challenges in Utilizing Interlocking Mortarless Blocks

No.	Challenges in Utilizing Interlocking Mortarless Blocks	Frequency Analysis					Average Index	Ranking Scale
		1	2	3	4	5		
1	Contractors tend to use traditional construction method rather than IMB system method.	0	0	2	12	18	4.50	1
2	Usage of Interlocking Mortarless Blocks (IMB) in Malaysian Construction Industry (MCI) is still low.	0	0	3	12	17	4.44	2
3	There is no specific standard on IMB system in MCI.	0	1	3	14	14	4.28	3
4	Manufacturers of IMB are inadequate to cover the entire Malaysia.	0	0	6	12	14	4.25	4
5	Information related to the IMB system are not widely spread in Malaysia.	0	0	3	20	9	4.19	5
6	There is a need of high capital cost to implement the IMB system.	0	0	6	17	9	4.09	6
7	IMB system is less popular in MCI.	0	0	6	18	8	4.06	7
8	Lack of understanding on IMB system among construction stakeholders in Malaysia.	1	1	3	18	9	4.03	8
9	There is no encouragement from the government to implement the IMB system.	0	3	2	18	9	4.03	9
10	The skilled labors for the IMB system are still lacking.	1	1	5	18	7	3.91	10

Referring to Table 1 above, the ranking scale of each factor is evaluated by using the average index analysis. The closer the average index is towards 5.00, the higher the ranking scale is. The tendency of contractors to use traditional construction method rather than interlocking mortarless blocks system takes the first place in the ranking scale with an average index of 4.50, where a total of 18 respondents chose to strongly agree, 12 respondents chose to agree, and 2 respondents chose uncertain. Then, it is followed by the low usage of interlocking mortarless blocks in Malaysian construction industry, where it has an average index of 4.44, which is not too different from the first ranking scale factor. In addition, the third ranking scale factor is the lack of specific standard on interlocking mortarless blocks system in Malaysian construction industry, where it has an average index of 4.28.

CONCLUSIONS

This research explored the interlocking mortarless blocks system in detail. As explained, the system eliminates the usage of mortar which speeds up the construction pace, subsequently decreases manpower requirements and leads to cost-effective construction projects. Commercially, interlocking mortarless blocks are characterized according to the composition of material, shape and dimension, strength ability and purpose. This produced different types of interlocking mortarless blocks system that are being used in the construction of housing projects including Putra Block System, Meccano System, Sparlock System, Sparfil System, Haener System and Hydraform Blocks or Solid Interlocking Blocks (SIB).

Though it is said to have various benefits in the construction industry, there are many challenges that must be confronted by the industry players in the implementation of this interlocking mortarless blocks system especially in housing projects. In fact, the major issue is many still opt for conventional construction method rather than the interlocking mortarless block system because of various concerns, thus, contributes to the lower rate of the IMB implementation in local construction sites. One of the most current concerns in utilizing the system in housing projects is due to the absence of specific standard on IMB system in MCI. They lack information of various aspects and descriptions of the system making it risky to be implemented especially for multi-million projects. Though IMB system has lots of benefits, ironically, suppliers for IMB system are scarce which make it impossible to fulfill the demand for the whole country. As a matter of fact, the information about IMB is not well communicated throughout the country and not all construction players or even the public are well aware about this system.

Although changes are necessary, it is hard for those who are using traditional methods to change to the new technology, and this is a process that will take time. Consequently, contractors will continue to perform their work as usual using the traditional

method. The usage of interlocking mortarless blocks is still low, especially in the housing projects. Contractors prefer to use ordinary bricks to build the house rather than to adopt a new technology, even though the contractors know that using the common bricks will take a longer period and use a lot of labor.

Therefore, it is recommended that the related bodies, such as the government to act on this matter. Courses and promotions on the current technologies must be conducted, especially on IBS and IMB. In addition, further formal study needs to be conducted in the future to investigate the utilization of interlocking mortarless blocks system in different building projects in Malaysia.

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