

Improvement of IBS Score Content in Construction Industry Standard (CIS) 18:2018

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Abstract

The Industrialised Building System (IBS) has been implemented by the government as an alternative effort in reducing foreign workers in Malaysia. IBS advantages can be seen in its higher product quality, reduced waste of building materials, cost-effective, and faster construction times than conventional construction methods. The Construction Industry Standard (CIS 18: 2010) has been introduced as a guideline manual to assist the industry on calculating the IBS score. The aims of this study is to identify the relevancy of the content used in the manual computation of existing IBS system in CIS 18:2010. Focus groups and interview sessions has been carried out for data collection. As a result from the industry feedback, there are several weightage changes in the usage of IBS components and the improvement of utilisation of standardized components based on MS 1064 for the IBS systems and also it has been suggested that these manuals need to be reviewed since it has been last updated in 2013. Overall, the finding from this study suggest that further improvement of the manual calculation in the existing IBS system content need to carry out to meet the needs of the construction industry in this country.

Keywords: Industrialized building system (IBS); Construction industry standard (CIS); IBS score.



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1. Introduction

In line with the current housing demands in the global market, the construction industry has shifted its focus to mass production assembly in standardizing product development. This strategy has prompted the Malaysian construction industry to study the value added of construction industry from various countries that have achieved the implementation of prefabricated technology such as the United Kingdom (UK), United States (US), Australia, Singapore and Hong Kong (Azman *et al.*, 2013; Blismas *et al.*, 2010; Lovell and Smith, 2010; Omar *et al.*, 2014; Tam *et al.*, 2007).

In Malaysia, the prefabrication technology is known as Industrialised Building System (IBS) which is defined as a complete process system of construction works where almost all the component structures is manufactured onsite or offsite, and the product is transported to the site and to be installed in the high precision coordinate joint as well as achieve high quality works, and accelerate the time of completion of the projects (Anuar *et al.*, 2011; CIDB, 2010; Majid *et al.*, 2010; Majid *et al.*, 2011; Nawi *et al.*, 2015). There are variety of terms used to describe the Industrialised Building System such as prefabrication, Modern Method of Construction (MMC), Offsite Manufacturing (OSM), Offsite Production (OSP) and OffsiteConstruction (OSC) are terms in common use at various times in the literatures. Those concepts are often useinterchangeably when describing the characteristics of industrialized construction.Modern Method ofConstruction (MMC) is a term adopted in the United Kingdom as a collectivedescription for both offsite based construction technologies and innovative onsite technologies (Goulding *et al.*, 2012).

Thus, appropriate technology is required and global standardization has changed the past practices of the construction industry. Sometimes the advanced technology do not suit with the local condition on factors pertaining to the environment; level of workers' skills. knowledge and competence; venerable resources and competent manufacturer to fabricate the mass production as well as high-quality products. Therefore, the construction industry

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have adapt the technology to suit to the local condition, as very simple example on the advantages of Malaysia tropical weather, the manufacturer are able to cure the concrete by natural curing instead of using the oven with high investment and high maintenance. On the other hand, the same action was also taken by the government of Singapore and Hong Kong to spread the use of prefabrication system widely in public housing (Dulaimi *et al.*, 2004; Tam *et al.*, 2007). Prefabrication enable to build up high rise building and able to send the prefabrication components to the limited access area and the component is directly erected from the crane. Therefore, IBS is suitable for cities and regions with the problems of dense population and with insufficient land for housing development.

The government has encouraged the construction industry to move towards IBS which can produce high volume of houses at affordable cost especially low-cost houses. Government agencies such as Jabatan Kerja Raya (JKR) and Construction Industry Development Board (CIDB); and researchers have played vital roles to educate the main players of the construction industry in the form of policies, financial incentives, strategy guidelines, workshops and seminars to increase the awareness among the end users and clients.

To further strengthen the use of IBS in the country, the IBS policy was issued in 2008 where the rules on the use of IBS in the construction of public buildings must be not less than 70 scores from IBS scores and in the sense that IBS should also be included as part of the document contract for tender (Hamid *et al.*, 2008).

Construction Industry Standard (CIS) is a reference and guide to construction industry players. Apart from that, the CIS has also become a reference source and the scientific materials used in the syllabus at universities involving the subject of construction. To ensure that the CIS has a positive impact on the industry, reviews and improvements are needed. According to the Stage Effectiveness Study Program Standards to Stakeholders that were conducted on 1 to 20 September 2013 by the Malaysian Qualifications Agency's Standard Division found that the duration and requirements of the program standard review were for five (5) years.

The Construction Industry Standard (CIS 18: 2010) was published in 2010 and has now reached its seven-year use. It is therefore necessary to make improvements and revisions of the standards to meet current industry requirements. A series of workshop has been done to suggest a recommendation towards the previous CIS. New elements have been added such as Building Information Modelling (BIM) and Prefinished Prefabrication Volumetric Construction (PPVC) while some scoring content has been changed to suit the productivity and number of workers usage.

Construction Industry Standard (CIS) is the standard used in the construction industry issued by CIDB. To issue a standard, the CIDB will act as a moderator and facilitator for the working group throughout the development process of this standard. The CIDB is also responsible for providing a platform for private sector-wide discussions and the government including organising the workshops for the development and improvement of the standards (CIDB, 2015).

This study was conducted in order to assist and benefit the stakeholders such as CIDB Malaysia and construction industry players in general. Construction industry players, especially those directly involved in the IBS construction project, require the latest construction standards to assist them in full engagement. The results of this study will give input and further knowledge to be standardised in CIS 18 which will be used by CIDB Malaysia. The CIS 18 will be the official document and will be used by the construction industry as a reference document in the calculation of IBS content in a building.

2. Formula of IBS Scoring System

The formula of IBS score system involving structural system, wall system and other simplified construction solutions which are the weightage for structural system is 50, wall system is 20 and other simplified construction solutions is 30.

$$50 \sum \left[\frac{Q_s}{Q_{ST}} F_s \right] + 20 \sum \left[\frac{Q_w}{Q_{WT}} F_w \right] + S$$

Where:

\sum - Sum of

Q_s - Construction area of a structural system

Q_{ST} - Total construction area of building

F_s - IBS Factor for structural system (refer Table 1)

Q_w - Length of a wall system (external or internal wall)

Q_{WT} - Total wall length (external or internal wall)

F_w - IBS Factor for wall system (refer Table 3)

S - IBS Score for other simplified construction solutions (refer Table 4)

2.1. Structural System

The full points given under structural system are 50 points. Points are awarded based on the structural system used. Calculation is based on the floor area that utilises the structural system. Sub-structure works (elements) are not considered in the calculation. Example of sub-structure works are such as piling, ground beam, ground slab,

underground car park etc. The construction area includes car porch but excluding driveway, apron and landscaped areas.

$$50 \sum \left[\frac{Q_s}{Q_{ST}} F_s \right]$$

Where:

Q_s - Area of construction system is used

Q_{st} - Total construction area of the building

F_s - IBS Factor for structural system (refer Table 1)

Table-1. IBS Factor for Structural System

SYSTEM	FLOOR	Precast concrete slab ⁽¹⁾	In-situ concrete on permanent metal formwork	In-situ concrete using reusable ⁽³⁾ system formwork	In-situ concrete using timber ⁽⁴⁾ formwork	Steel flooring system	Timber frame flooring system	No Floor ⁽⁶⁾
	COLUMN / BEAM ⁽⁵⁾							
CONCRETE	Precast column and beam	1.0	0.9	0.7	0.6	1.0	1.0	1.0
	Precast column and In-situ beams using reusable ⁽³⁾ system formwork	0.9	0.8	0.6	0.5	0.9	0.9	0.8
	Precast column and in-situ beams using timber ⁽⁴⁾ formwork	0.8	0.7	0.5	0.4	0.8	0.8	0.7
	Precast beams and in-situ columns with reusable ⁽³⁾ system formwork	0.9	0.8	0.6	0.5	0.9	0.9	0.8
	Precast beams and in-situ columns using timber ⁽⁴⁾ formwork	0.8	0.7	0.5	0.4	0.8	0.8	0.7
	In-situ column and beams using reusable ⁽³⁾ system formwork	0.7	0.6	0.5	0.3	0.7	0.7	0.6
	In-situ column and beams using timber ⁽⁴⁾ formwork	0.6	0.5	0.3	0.0	0.6	0.6	0.0
LOAD BEARING BLOCKWORK ⁽⁷⁾	Vertical and horizontal member systems / structure	0.8	0.7	0.6	0.5	0.8	0.8	0.7
STEEL	Steel columns and beams	1.0	0.9	0.7	0.6	1.0	1.0	1.0

Structural system also including the roof structural system which the IBS factor as explained in Table 2.

Table-2. IBS Factor for Roof Structural System

No	Roof System	IBS Factor
1.	Prefab timber roof truss	1.0
2.	Prefab metal roof truss	1.0
3.	Precut metal roof truss	0.5
4.	Timber roof trusses	0.0

Source: Construction Industry Standard (CIS), 2010

2.2. Wall System

The full points for wall system is 20 points. Points are awarded based wall system used. Allocation based on length of the wall system used.

$$20 \sum \left[\frac{Q_w}{Q_{WT}} F_w \right]$$

Where:

Qw - Length of wall system is used

Qst - Total wall length of the building

Fw - Refer from Table 3

Table-3. IBS Factor for Wall System

No.	Wall System	IBS Factor
1.	Precast Concrete Panel	1.0
2.	Wall Cladding	1.0
3.	Prefabricated Timber Panel	1.0
4.	Full Height Glass Panel	1.0
5.	Dry Wall System	1.0
6.	In-situ Concrete with Reusable System Formwork	0.5
7.	In- situ Concrete with Timber Formwork	0.0
8.	Precision Blockworks	0.5
9.	Pre-assemble Brickwall / Blockwall	1.0
10.	Common Brickwall	0.0

Notes:

- 1) Precast concrete panels include sandwich panel, solid panel, hollow core panel and bay-window.
- 2) Wall cladding consists of panel acting as wall or façade and not as a skim to brickwall.
- 3) For full height windows, use the IBS factor for panel glass.
- 4) Precast dry wall includes cementitious panels and composite gypsum boards.
- 5) Reusable formworks include plastics, fiberglass, steel, aluminium and other metal formworks that can be used repeatedly.
- 6) Timber formwork (timber roof trusses) means the timber components are sized, cut and fabricated in-situ to form the formworks and the required temporary works. (stickbuilt).
- 7) Blockwork system either (loadbearing or non-loadbearing) includes hollow block, interlocking block, lightweight concrete block that can be laid on adhesive mortar.
- 8) Pre-assemble brickwall/ blockwall means brick that being laid in form of a panel and transported to site.
- 9) Wall constructed using tunnel formworks, use factor of 0.6.
- 10) For other structural systems not mentioned in the table please refer to CIDB for the IBS factor.

2.3. Other Simplified Solutions

The full points given under other simplified construction solutions is 30 points. Points are awarded based on utilisation of construction methods or solution that can contribute to the objectives of IBS as follows:

- i. Use of standardised components.
- ii. Repeating features – grids, floor height
- iii. Vertical repetitions, horizontal repetition

Table-4. IBS Score for Other Simplified Construction Solutions

No.	Description	Unit	IBS Score	
			Percentage of Usage	
			$50\% \leq x < 75\%$	$75\% \leq x < 100\%$
1	UTILISATION OF STANDARDISED COMPONENT BASED ON MS 1064			
	Beams	Nos	2	4
	Columns	Nos	2	4
	Walls	m ²	2	4
	Slabs	m ²	2	4
	Doors	Nos	2	4
	Windows	Nos	2	4
2	REPETITION OF STRUCTURAL LAYOUT			
	For building more than 2 storeys			
	Repetition of floor to floor height	Nos	1	2
	Vertical repetition of structural floor layout	Nos	1	2
	Horizontal repetition of structural floor layout	Nos	1	2
	For building 1 or 2 storeys			
Horizontal repetition of structural floor layout	m ²	3	6	

Notes:

- 1) Refer to MS 1064: Pt 10: 2001 (Coordinating sizes and Preferred sizes for reinforced concrete components)
- 2) Refer to MS 1064: Pt 4: 2001 (Coordinating sizes and Preferred sizes for doorsets)
- 3) Refer to MS 1064: Pt 5: 2001 (Coordinating sizes and Preferred sizes for windowsets)

3. Methodology

The research instrument involves interview and focus group. The interview questions used are semi-structured questions and conducted by face to face interview. Focus groups are group interviews that give the researcher the capability to capture deeper information more cautiously than individual interviews. Respondents for the focus group are the experts in the IBS construction industry. Respondents can be divided into two sectors, namely private and government including architects, consultant's engineers, contractors, IBS component installers, IBS component suppliers, CIDB's Technology & Innovation Division Officers and officers from Public Works Department Public Works Structure (JKR CKAS).

Table-5. Focus Group Profile

No	Position	Company	Experience (Year)
1	Senior General Manager	CIDB	32
2	General Manager	CIDB	35
3	Executive Vice Presiden	Setia Precast SdnBhd	33
4	Chief Executive Office	Teraju Precast Services SdnBhd	27
5	Chief Executive Office	Castwell Industries SdnBhd	33
6	Chief Executive Office	Portland Arena SdnBhd	27
7	Assistant Manager	Kumkang Industrial SdnBhd	27
8	Assistant Manager	Jet Formwork & Scaffold SdnBhd	30
9	Technical Manager	Starken AAC SdnBhd	22
10	Manager	MM2 Building Sys. SdnBhd	25
11	Chief Executive Office	InnovaciaSdnBhd	25
12	PAM Council Member	PertubuhanArkitek Malaysia (PAM)	32
13	PengarahKhidmatPakar dan Pengurusan,	Public Works Department (PWD)	35
14	Executive Director	Integrated Brickworks SdnBhd	35
15	Manager	Asia Roofing Industries SdnBhd	25
16	Deputy CEO	Kumpulan Sakata SdnBhd	30
17	Manager	PU Profile SdnBhd	28
18	Senior Manager	CIDB	31
19	Senior Manager	CIDB	25
20	Manager	CIDB	10
21	Manager	CIDB	8
22	Assistant Manager	CIDB	25
23	Assistant Manager	CIDB	25

4. Factors Influencing IBS Score Content

The factors influencing IBS content for three systems which are structural system, wall system and other simplified construction solutions are depending on the:

4.1. Usage of IBS Components

The usage of IBS components used in the projects will contribute to higher IBS score. Input from the focus group discussions; "IBS factors depend on the number of worker during the installation process." & "Permanent formwork involves three (3) step/work methods ie; 1.installation, 2.steel installation, 3.concreting work".

4.2. Utilisation of Standardized Components Based on MS 1064

This Malaysian Standard was developed by the Working Group on Preferred Sizes and Coordinating Sizes for Masonry Bricks and Blocks supervised by the Technical Committee on Modular Coordination under the authority of the Building and Civil Engineering Industry Standards Committee. The parties involved in the development of this standard are Construction Industry Development Board Malaysia (CIDB) which is the Standards-Writing Organisation (SWO) selected by SIRIM Berhad to develop standards for the construction industry.

The content of MS 1064 involved ten (10) parts. The parts that related to IBS is part 4, 5 and 10. Part 4 is Coordinating sizes and preferred sizes for doorsets, Part 5 is Coordinating sizes and preferred sizes for windowsets and Part 10 is Coordinating sizes and preferred sizes for Reinforced Concrete components.

- Repetition of structural layout
- Usage of other productivity enhancing solutions such as volumetric modular units, Building Information Modelling (BIM) and Modular gridlines.

5. IBS Score System Improvement

In 2010, the CIDB has made improvements from the first version of the IBS Score ie by changing the Part 2 The Wall System from 30 scores to 20 scores and for Part 3 Other Buildings Methods from 20 scores to 30 scores. This change can help in encouraging the use of Modular Coordination (MC) in building construction. Table 5 shows the IBS score assessment with maximum IBS score for a building is 100%.

Table-6. IBS ScoreAssessment

System	Elements	Score
Structural System	contributes most wet trade; 75% labour	50%
Wall System	widely available in the market	20%
Other Simplified Construction Solutions	standardized components MS1064; repetition; 3D components	30%

5.1. Findings from the Focus Group Discussion

Table-7. Findings

System	Issue
StructuralSystem	The numbering for columns and beams and coding. IBS factors depend on the number of worker during the installation process. Any system using reusable formwork to be consider reduced by 0.1 (factor). Permanent formwork involves three (3) step/work methods ie; 1.installation, 2.steel installation, 3.concreting work. Precut metal roof trusses in the IBS factors for roof structural system must be removed because it is a conventional construction method.
WallSystem	pre-assemble brick wall / blockwall need to be discarded because it is not practical and not used in this country.
OtherSimplifiedConstructionSolutions	To consider Building Information Modelling (BIM) and prefab bathroom units (PBU). BIM Level 1 and BIM Level 2 must be considered to added. To added in the other productivity enhancing solutions for Prefab bathroom units (PBU), prefab staircases include completed staircase units made of precast, steel, engineered timber, or any other prefab materials.

6. Conclusion

Added new items which are Timber and Innovative because they are in six (6) types of IBS. BIM is included in the manual because of the implementation in the construction project in Malaysia. The significance of higher IBS score implementation shown the level of productivity, reduction of site labour, lower wastages, less site materials, cleaner environment, better quality, neater and safer construction sites, faster project completion as well as lower total construction cost in the Malaysian construction industry.

The purpose of the review IBS score is to update the document based on the current situation which involves the new technology in the construction sector such as Prefabricated Prefinished Volumetric Construction (PPVC) and Building Information Modelling (BIM). The comparison between the previous one and the suggested recommendation is to add the elements of Building Information Modelling (BIM) and Prefabricated Prefinished Volumetric Construction (PPVC) in the standard.

Besides that, in the structural system, a few items are added such as metal and blockwork. Most of the items in the structural system is reduced by 0.1 because taken into consideration that involved more process, longer installation period and more workers required, thus will lead to the less productivity in the construction project. However, two items were increases in the no slab description because it was considered as conventional way of construction.

In the wall system the pre-assemble brickwall / blockwall is removed because the system is not available in Malaysia. The new wall system added is In-situ concrete with permanent formwork because of the innovation in the IBS construction. The IBS factor of in-situ concrete with reusable system formwork is reduced by 0.1 because of the level of productivity in the construction process.

In other simplified solutions under Other Productivity Enhancing Solutions, the PPVC and BIM is suggested to be added in the standard. The definition of BIM Level 1 and BIM Level 2 is also explained in the standard. The

PPVC involves the development of the Prefab Bathroom Unit (PBU). These two elements are added because there is a shift in technology in the Malaysian construction industry.

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