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**UTHM**  
Universiti Tun Hussein Onn Malaysia

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESI 2017/2018**

COURSE NAME : INDUSTRIALIZED BUILDING SYSTEM  
COURSE CODE : BFP40603  
PROGRAMME CODE : BFF  
EXAMINATION DATE : JUNE / JULY 2018  
DURATION : 3 HOURS  
INSTRUCTION : ANSWER ALL QUESTIONS.  
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THIS QUESTION PAPER CONSISTS OF ELEVEN (11) PAGES

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**SECTION A**

Answer all questions in the OMR form (total marks = 50).

**Q1** IBS should be deemed beyond product replacement exercise by understanding the degree of industrialization. Arrange the following degrees of industrialization for construction from low to high, as classified by Roger-Bruno Richard (1998).

- |                     |                   |
|---------------------|-------------------|
| I. Robotics         | IV. Mechanization |
| II. Reproduction    | V. Automation     |
| III. Prefabrication |                   |
- 
- |                          |                          |
|--------------------------|--------------------------|
| A. II → I → V → IV → II  | C. III → V → IV → I → II |
| B. III → IV → V → I → II | D. IV → III → V → II → I |

**Q2** Which of the following degrees of industrialization aim at substituting labour with machinery?

- |                     |                   |
|---------------------|-------------------|
| I. Robotics         | IV. Mechanization |
| II. Reproduction    | V. Automation     |
| III. Prefabrication |                   |
- 
- |                         |                     |
|-------------------------|---------------------|
| A. I, IV and V only     | C. I and V only     |
| B. I, II, IV and V only | D. All of the above |

**Q3** Company NHA has been asked by client to construct a 10-storey hotel in Hulu Langat using one of the IBS methods. The method should result in high quality finishes, fast construction with less site labour and material requirement; and involved onsite fabrication, in which the walls and complete building are cast onsite. Which of the followings best describes the IBS method above?

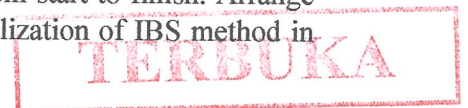
- |                                |                     |
|--------------------------------|---------------------|
| A. Precast concrete wall panel | C. Blockwork system |
| B. Precast concrete framing    | D. Formwork system  |

**Q4** A building needs to be constructed with the utilisation of CMU (bricks) for external wall. Which of the following methods of construction can be implemented?

- |                                |                                  |
|--------------------------------|----------------------------------|
| I. Precast concrete wall panel | III. Formwork system             |
| II. Precast concrete framing   | IV. Prefabricated timber framing |
- 
- |                       |                     |
|-----------------------|---------------------|
| A. I and III only     | C. II and IV only   |
| B. I, II and III only | D. All of the above |

**Q5** IBS construction phase is different from conventional systems from start to finish. Arrange the following stages of main construction process for product realization of IBS method in sequential order:

- |                                        |                                        |
|----------------------------------------|----------------------------------------|
| I. Ancillary site works                | III. Installation of IBS components    |
| II. Producing/manufacturing of product | IV. Delivery of IBS components to site |



- A. II → I → IV → III
- B. II → IV → III → I
- C. I → II → III → IV
- D. I → II → IV → III

**Q6** The IBS scoring system was developed to determine the percentage of IBS component/system usage in buildings or projects. The scoring can be applied in the following project categories:

- I. Residential
- II. Commercial
- III. Industrial
- IV. Infrastructure facilities
- V. Institutional

- A. I, II, III and IV only
- B. I, II, IV and V only
- C. I, II, III and V only
- D. All of the above

**Q7** IBS score was introduced in 2005 aiming for computing the total IBS component used in a building project as set out in the manual. Which of the followings are the strategies to increase the IBS score in a construction project:

- I. Use of standardised components according to MS1064
- II. Use of prefabricated components
- III. Repeating features of structural layout
- IV. Design using Modular Coordination concept

- A. I, II and III only
- B. I, II and IV only
- C. II, III and IV only
- D. All of the above

**Q8** Which of the followings is/are **TRUE** about IBS scoring system for wall system?

- I. Points are awarded based on various types of wall systems used
- II. Allocation of score is based on percentage of floor area that utilises the wall system
- III. Wall parapet and corridor is excluded in the calculation
- IV. The wall system includes precast concrete panel, dry partition, toilet cubicle partition wall and cavity wall

- A. I only
- B. I, II and III only
- C. I and IV only
- D. All of the above

**Q9** “A building can use two or more systems, allows selection of components supplier where everybody can bid to produce lower price of components. Manufacturer and installer will look for cooperation models that will create benefit for both.”

Which of the followings best describes about the statement above?

- A. Modular coordination
- B. Open system
- C. Closed system
- D. Both B and C



**Q10** “This category refers to the various pre-fabricated materials that have entered the market, which include gypsum, wood wool, polymer, fibreglass, glass and aluminium-based IBS components.”

Which of the followings best describe the above statement?

- A. Precast concrete wall panel
- B. Blockwork system component
- C. Steel framing system component
- D. Innovative method

**Q11** What term is best described the following criteria?

- Interlocking or lightweight
- The component can be designed as a load bearing wall system
- Can be dry system (mortarless)
- Installed like ‘lego’ system

- A. Precast concrete wall panel
- B. Blockwork system component
- C. Steel framing system component
- D. Innovative method

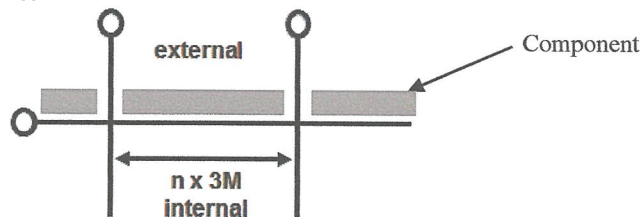
**Q12** Which of the followings is **FALSE** about Modular Coordination?

- A. To encourage the interchangeability of component in IBS
- B. To improve productivity through the reduction of wastages in the production & installation process
- C. If IBS system is modularly coordinated, it leads to a closed building system in contrast to an open building system
- D. Facilitate corporation between building designers, manufacturers, contractors and authorities

**Q13** You are required to design a building which uses precast concrete wall panel (internal and external) as a method of construction using Modular Coordination (MC) concept. Which of the horizontal coordination referencing systems below is the most suitable?

- A. Boundary reference
- B. Axial reference
- C. Flush reference
- D. None of the above

**Q14** Figure below shows a horizontal coordination for a component. Which of the followings best describes the component?



- A. Partition
- B. Façade/cladding
- C. Load bearing walls
- D. Beams

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**Q15** The followings are **TRUE** about precast hollow core slab, **EXCEPT**

- I. light in weight due to the hollows within the slabs
- II. less cost of steel as only tendons are used
- III. posses monolithic characteristic as good as conventional slab
- IV. suitable for the construction of office buildings that require spacious areas for flexible interior design

- A. I and II only
- B. I and IV only
- C. I, II and IV only
- D. None of the above

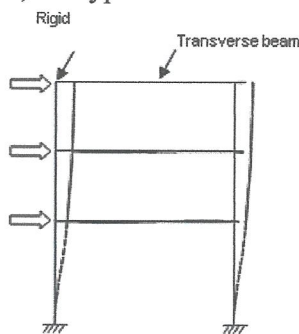
**Q16** The followings are **TRUE** about the use of precast concrete hollow core slabs constructed as 'topped', **EXCEPT**

- A. Enables the floor system to provide resistance to water leakage in between the hollow core slab joints
- B. The loose precast slab components are tied together using steel ties in order to form a monolithic slab
- C. Provide good level of floor surface
- D. Carry moving loads and heavy concentrated loads

**Q17** A residential apartment needs to be constructed using precast concrete framed structure. The spanning for floor system is not more than 5m. Which of the followings best describe the type of slab to be used?

- A. Precast planks
- B. Precast concrete hollow core 'untopped' slab
- C. Precast concrete hollow core 'topped' slab
- D. All of the above

**Q18** With regards to the figure below, the type of construction can be used for stability system is:



- A. Lift core
- B. Stair case core
- C. Wet joint beam-column connection
- D. Shear wall

**Q19** Which of the followings describe the diaphragm action for precast framed structure?

- I. Lateral loads acting on a building can be transferred safely to the lateral stability system through the bending action of the slab diaphragm.
- II. For untopped precast slabs, the rigid floor diaphragm of the precast floors can be achieved by connecting the precast slabs by means of welding, or tying.
- III. For topped precast slabs, the rigid diaphragm can be achieved by having reinforced structural topping consisting of cast insitu concrete with steel mesh.
- IV. The loose components of precast slabs should be connected together to enable the floor slabs to act as a rigid horizontal diaphragm.

- A. II and III only
- B. I, II and III only
- C. II, III and IV only
- D. All of the above

**Q20** The details of an IBS score for a project are as follows:

- Structural system = 20%
- Wall system = 8%
- Other simplified construction solutions = 20%

Which of the followings is **TRUE** about the project?

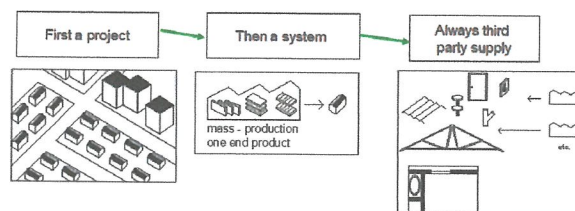
- A. Whether the project is government or private project, it can not be exempted for levi.
- B. If the project fully utilised standardised components and it is a government project, this project can be exempted for levi.
- C. The IBS score for this project can be increased if it uses common brickwall for wall.
- D. The IBS score for this project can be increased if 30% of the construction area uses precast concrete and column, precast concrete slab and prefabricated metal roof system.

**Q21** Which of the followings describes the below statement:

- Suitable for structures spanning in the range of 4m to 12m
- Lightweight
- Economical due to the used of tendons instead of steel

- A. Precast concrete hollow core slab ‘topped’
- B. Precast planks
- C. Precast concrete hollow core slab ‘untopped’
- D. Both A and C
- E. All of the above

**Q22** Which of the followings is/are **TRUE** about the figure below:



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- I. The system does not allow for the interchangeability of components from different factories.
- II. A system where all elements of industrial production of components to be used for specific designs for specific projects.
- III. Each component manufacturers have their own propriety building systems to be adopted in the project.
- IV. Allow openness to select components supplier where everybody can bid to produce lower price of components.

- A. I and II only
- B. I, II and III only
- C. IV only
- D. None of the above

**Q23** Which of the followings are classified under non-structural IBS component?

- I. Façade
- II. Cladding
- III. Non-load bearing wall
- IV. Balcony

- A. I and II only
- B. I and IV only
- C. All of the above
- D. None of the above

**Q24** Which of the followings is/are **FALSE** about IBS project procurement management?

- I. The resources for IBS project management are manpower, machinery, money, material and market.
- II. For IBS project executed through Design and Build (DB) contract, the installer for IBS components can be selected from either IBS supplier or the DB contractor.
- III. The types of contract tender for DB project are JKR2010 and PAM2006 only.

- A. II only
- B. II and III only
- C. All of the above
- D. None of the above

**Q25** Which of the followings is/are **TRUE** about organisation management for IBS project?

- I. The advantage of implementing IBS project is that safety aspect can be avoided since the factory operation is in controlled environment and creates no hazard.
- II. Apart from inspection team, one of the members in Quality Control (QC) team organization at IBS factory could be production manager.
- III. Since the IBS component has go through the QC inspection process at the factory before transported to site, the component must be installed immediately and does not need to be checked for damages when it has arrived at construction site.

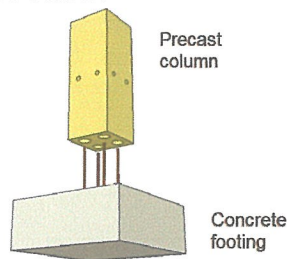
- A. II only
- B. II and III only
- C. All of the above
- D. None of the above

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**SECTION B**

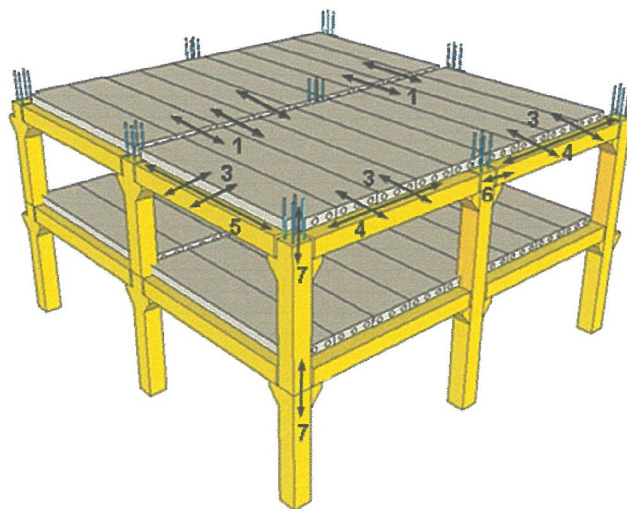
Answer all questions in the OMR form (total marks = 20). In the OMR form, select A for TRUE or B for FALSE statements.

Q26 to Q30 are referring to the figure below.



- Q26 The connection type is considered semi-rigid. TRUE / FALSE
- Q27 The connection has the ability to provide moment resistance at the connection between column end to footing. TRUE / FALSE
- Q28 The connection method is grouted pocket. TRUE / FALSE
- Q29 The construction method involves the precast column with vertical sleeves at the end is inserted into the starter bars and fixed to the footing using steel plate. TRUE / FALSE
- Q30 The type of joint for this connection is wet joint. TRUE / FALSE

Q31 to Q35 are referring to the figure below.



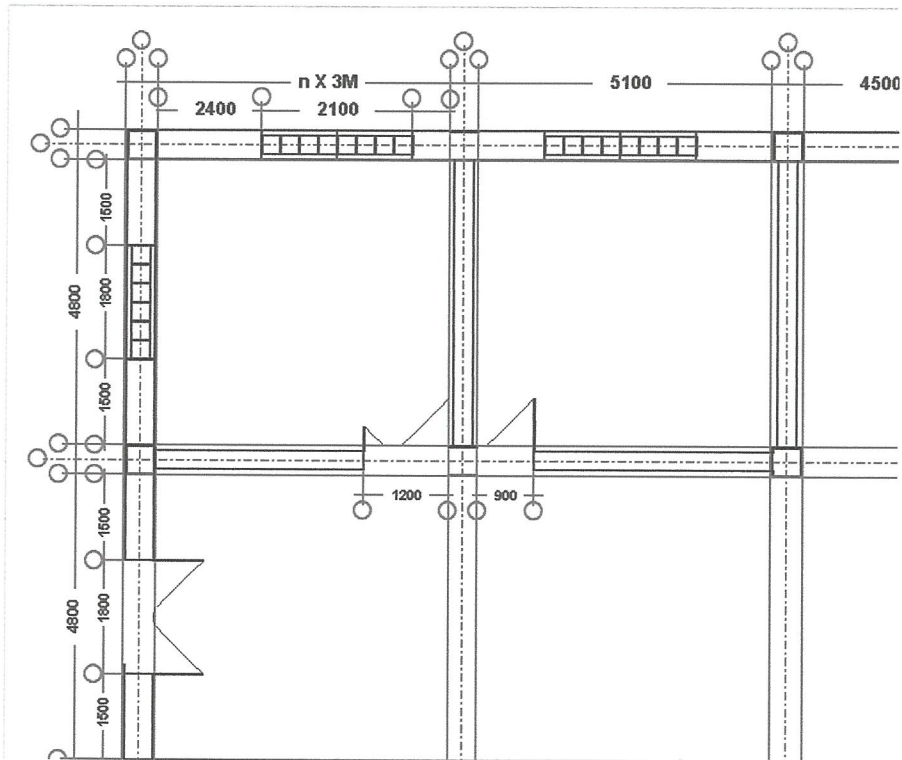
- Q31 Ties no. 1 require a bar to be placed between edges of precast units and insitu-fill to create a robust joint. TRUE / FALSE

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- Q32 Ties no. 6 represent connections between beam to column. TRUE / FALSE
- Q33 The importance of these ties to the structure is the ability to transfer loads to un-failed members through alternate load paths. TRUE / FALSE
- Q34 The structure represents precast concrete framed with 'topped' precast concrete slabs. TRUE / FALSE
- Q35 Ties no. 1 are used to connect the precast slabs to achieve rigid floor diaphragm. TRUE / FALSE

Q36 to Q40 are referring to the figure below.



- Q36 Axial reference system is used for dimensioning purpose. TRUE / FALSE
- Q37 All columns and perimeter beams are modular. TRUE / FALSE
- Q38 All doors and windows are in modular size. TRUE / FALSE
- Q39 Cross walls/internal walls are placed in technical zone or space. TRUE / FALSE
- Q40 The horizontal coordination is defined as  $M_v = n \times M$ , where  $M=100\text{mm}$ . TRUE / FALSE

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**Q41 to Q45** are referring to the table below which shows the IBS score calculation for two building construction projects. The projects are the development of 200 units of two-storey terrace houses, in which both projects use different construction method.

<b>IBS score calculation</b>	<b>Project M</b>	<b>Project N</b>
Structural system	50%	35%
Wall system	20%	0%
Other simplified construction solutions	10%	18%

- Q41** Project M could probably use precast concrete load bearing wall panel. TRUE / FALSE
- Q42** If both are projects are private project, they can be exempted from paying levi. TRUE / FALSE
- Q43** Project N could use non-loadbearing lightweight blocks for wall. TRUE / FALSE
- Q44** Both projects may use any IBS structural components. TRUE / FALSE
- Q45** If the percentage of horizontal layout repetition for Project N is 100%, at least 5 components are moajoritily standardised components. TRUE / FALSE

**SECTION C**

*Answer all questions in the answer booklet (total mark = 30 marks).*

- Q46** (a) You are a design-and-build contractor for an upcoming project of ‘Construction of 2-blocks 30-storey apartment’ using IBS method instead of traditional method, and also request the project team to propose the best type of IBS to be used. The vertical layout of the building is similar from first floor up to 30<sup>th</sup> floor, and the method should eliminate the bricklaying and plastering activities. Discuss your proposal of the most suitable method in the following aspects:
- (i) State your choice of IBS construction method. (1 mark)
  - (ii) Justify your selection of IBS construction method based on the information given above. (4 marks)
  - (iii) Discuss **FOUR (4)** advantages of the selected method as compared to other types of IBS. (8 marks)
- (b) The precast slabs normally used for the floor system are either precast hollow core slabs or precast planks. With sketches, discuss how the monolithic characteristic can be achieved in the precast planks. (7 marks)



- (c) With the aid of a diagram, discuss the different phases in IBS and conventional cast in-situ construction timeline. Explain the impact of IBS on construction period timeline with regards to the different phases from conventional method.

(10 marks)

– END OF QUESTIONS –

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# REFERENCE FOR IBS FACTOR

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**Table 1. IBS Score For Structural Systems**

SYSTEM	FLOOR	Precast concrete slab <sup>(1)</sup>	In-situ concrete on permanent metal formwork	In-situ concrete using reusable <sup>(2)</sup> system formwork	In-situ concrete using timber <sup>(4)</sup> formwork	Steel flooring system	Timber frame flooring system	No Floor <sup>(9)</sup>
	COLUMN/BEAM <sup>(6)</sup>							
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 <sup>(2)</sup> system formwork	0.9	0.8	0.6	0.5	0.9	0.9	0.8
	Precast column and in-situ beams using timber <sup>(4)</sup> formwork	0.8	0.7	0.5	0.4	0.8	0.8	0.7
	Precast beams and in-situ columns with reusable <sup>(2)</sup> system formwork	0.9	0.8	0.6	0.5	0.9	0.9	0.8
	Precast beams and in-situ columns using timber <sup>(4)</sup> formwork	0.8	0.7	0.5	0.4	0.8	0.8	0.7
	In-situ column and beams using reusable <sup>(2)</sup> system formwork	0.7	0.6	0.5	0.3	0.7	0.7	0.6
	In-situ column and beams using timber <sup>(4)</sup> formwork	0.6	0.5	0.3	0.0	0.6	0.6	0.0
LOAD BEARING BLOCKWORK <sup>(7)</sup>	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

**Notes :**

1. Precast concrete slab include half slab, hollow core slab, and precast prestressed planks.
2. Precast concrete include products of factory precasting, site precasting or the use of lift-up systems.
3. Reusable formworks include plastic, fibreglass, steel, aluminium and other metal formworks that can be used not less than 20 cycles.
4. Timber formwork means the timber components are sized, cut and fabricated in-situ to form the formworks and the required temporary works.
5. For structural system using Load Bearing Wall, whether precast or in-situ, the factor can be determined from the table by treating the wall as a wide column.
6. The IBS factor for tunnel formwork system is 0.6.
7. Load-bearing blockwork include interlocking block, concrete masonry unit, hollow block and lightweight block.
8. This is for structures without floor. Refer examples in Section 6
9. For other structural systems not mentioned in the table please refer to IBS Centre, CIDB for the IBS Factor.



Table 1A provides the IBS factor,  $F_s$  for various types of roof system.

**Table 1A. IBS Factor for Roof Structural Systems –  $F_s$**

NO	ROOF SYSTEM	IBS FACTOR
a.	Prefab timber roof truss	1.0
b.	Prefab metal roof truss	1.0
c.	Precut <sup>(1)</sup> metal roof truss	0.5
d.	Timber roof trusses <sup>(2)</sup>	0.0

Notes :

1. Precut means the metal section are cut and sized in factory but assembled in-situ.
2. Timber roof trusses means the timber components are cut, sized and fabricated in-situ to form the formworks and the required temporary works

**Table 2. IBS Factor for Wall Systems**

NO	WALL SYSTEM	IBS FACTOR
1	Precast concrete panel <sup>(1)</sup>	1.0
2	Wall cladding <sup>(2)</sup>	1.0
3	Prefabricated timber panel	1.0
4	Full height glass panel <sup>(3)</sup>	1.0
5	Dry wall system <sup>(4)</sup>	1.0
6	In-situ concrete with reusable <sup>(5)</sup> system formwork	0.5
7	In-situ concrete with timber <sup>(6)</sup> formwork	0.0
8	Blockwork system <sup>(7)</sup>	0.5
9	Pre-assemble brickwall / blockwall <sup>(8)</sup>	1.0
10	Common brickwall	0.0

Notes :

1. Precast concrete panels include sandwich panel, solid panel and bay-window. Precast concrete includes products of factory precasting, site precasting or the use of tilt-up systems.
2. Wall cladding consists of panel acting as wall or facade and not as a skin to brickwall.
3. For full height windows, use the IBS Factor for panel glass. For wall with non-full height windows, take the highest or widest material e.g. brickwall, precast wall, glass, etc.
4. Precast dry wall include cementitious panels and composite gypsum boards.
5. Reusable formworks include plastic, breglass, steel, aluminium and other metal formworks that can be used repeatedly.
6. Timber formwork means the timber components are sized, cut and fabricated in-situ to form the formworks and the required temporary works. This is commonly referred to as stickbuilt formwork. Timber includes plywood.
7. Blockwork System either (loadbearing or non-loadbearing) includes hollow block, interlocking blocks, lightweight concrete blocks 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 wall system not mentioned in the table please refer to IBS Centre, CIDB for IBS Factor.

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**Table 3. IBS Score for Other Simplified Construction Solutions**

No	DESCRIPTION	UNIT	IBS SCORE	
			PERCENTAGE OF USAGE	
			50% ≤ x <75%	75% ≤ x ≤100%
<b>UTILISATION OF STANDARDISED COMPONENTS BASED ON MS 1064</b>				
1	i) Beams <sup>(1)</sup>	Nos	2	4
	ii) Columns <sup>(1)</sup>	Nos	2	4
	iii) Walls <sup>(1)</sup>	m	2	4
	iv) Slabs <sup>(1)</sup>	m <sup>2</sup>	2	4
	v) Doors <sup>(2)</sup>	Nos	2	4
	vi) Windows <sup>(3)</sup>	Nos	2	4
<b>REPETITION OF STRUCTURAL LAYOUT</b>				
<b>a) For building more than 2 storeys</b>				
2	i) Repetition of floor to floor height	Nos	1	2
	ii) Vertical repetition of structural floor layout	Nos	1	2
	iii) Horizontal repetition of structural floor layout	Nos	1	2
<b>b) For building 1 or 2 storeys</b>				
	Horizontal repetition of structural floor layout	Nos	3	6

**Notes :**

1. Refer to MS 1064 : Pt 10 : 2001 Coordinating sizes and preferred sizes for reinforced concrete components. Values to use from the tables : beams and columns - width & depth, walls - width(thickness), slab-thickness.
2. Refer to MS 1064 : Pt 4 : 2001 Coordinating sizes and preferred sizes for door sets.
3. Refer to MS 1064 : Pt 5 : 2001 Coordinating sizes and preferred sizes for window sets.
4. Precast finished component/product means component that does not needs any finishes after installation on site such as plaster, skim coating and painting.
5. For structure using load bearing wall system, (without beams & columns) 8 marks is given automatically.
6. For non-concrete beams, columns, and slabs, 4 marks is given automatically for each component.
7. Other labour reducing products. Please provide details in the submission.