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(CONSTRUCTION INDUSTRY STANDARD)

CIS 18 :

MANUAL FOR IBS CONTENT SCORING SYSTEM (IBS SCORE)

Description: scoring system, calculation guide

CONSTRUCTION INDUSTRY DEVELOPMENT BOARD

Construction Industry Development Board Malaysia

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COMMITTEE REPRESENTATION

This Construction Industry Standard (CIS) was managed and developed by the Construction Industry Development Board Malaysia with the assistance of the Technical Committee of Manual for IBS Content Scoring System (IBS Score), which comprises representatives from the following organisations:

Acre Works Sdn Bhd

AJIYA Berhad

CIDB IBS Sdn Bhd

Construction Research Institute of Malaysia (CREAM)

Green IBS Consult Sdn Bhd

IJM IBS Sdn Bhd

Innovacia Sdn Bhd

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Malaysian Timber Industry Board (MTIB)

Master Builders Association Malaysia (MBAM)

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PLYTEC Formwork System Industries Sdn Bhd

Real Estate and Housing Developers' Association (REHDA) Malaysia

Setia Precast Sdn Bhd

Tasblock (M) Sdn Bhd

The Institution of Engineers, Malaysia (IEM)

Universiti Kebangsaan Malaysia (UKM)

PREFACE

This Construction Industry Standard (CIS), hereby referred to as CIS 18: xxxx, was developed as a Manual for IBS Content Scoring System (IBS SCORE) by the Construction Industry Development Board (CIDB) Malaysia. This standard will serve as a guide in evaluating the IBS Score in a building project and conforming to the programme's related regulatory requirements.

This third edition cancels and replaces the second edition (CIS 18:2018), which has been technically revised.

The main changes in this edition compared to the previous edition are as follows:

1. A clause for normative reference has been added.
2. Detailed and comprehensive terms and definitions have been added.
3. The IBS Factors for structural and wall systems have been revised.
4. The term used for the structural systems was changed from material basis to construction method.
5. Term prefabricated has been used for construction method using offsite manufacturing (e.g., precast concrete, metal, advanced building material, etc.)
6. A formula for a building without wall systems has been added.
7. Additional factors for in-situ construction method have been revised and improved.
8. IBS Score for Other Simplified Construction Solutions has been improved and divided into three subcategories. Maximum point capping for each subcategory has been introduced. Adoption of technology from Construction 4.0 Strategic Plan and other simplified methods for productivity improvement have been added.
9. IBS scoring guides have been improved. New illustration and calculation examples have been added.
10. IBS Score calculation examples have been changed for improvement.
11. Annex A (Modular size for standardised component) has been added. A range of standardised components have been generated using coordinating size suitable for all construction methods.
12. All standardised components are no longer limited to preferred sizes only. By using coordinating sizes, all components are entitled to claim points.

Compliance with this Construction Industry Standard does not of itself confer immunity from legal obligations.

Any feedback or questions on this document should be directed to CIDB at www.cidb.gov.my.

MANUAL FOR IBS CONTENT SCORING SYSTEM (IBS SCORE)

SECTION 1: GENERAL

1.1 Introduction

The Manual for IBS Content Scoring System (IBS Score) was formulated in 2005 to standardise the measurement of IBS usage in buildings, followed by a revised edition in 2010. This document outlines a streamlined and efficient evaluation methodology for assessing the implementation of IBS and technological integration.

It sets out the IBS Score formula, the IBS Factors for each structural and wall systems used in the building, and methods of calculating the IBS Score, which include repetitive designs and other simplified construction solutions. In addition, this manual contains detailed calculation guides with examples. It serves as a main guidance to clients, consultants, contractors, manufacturers, and other related parties in calculating the IBS Score for any building project.

Taking into account the introduction of current technologies, policies, and business environment and based on input from the construction industry stakeholders, CIDB Malaysia publishes this latest edition of the IBS Score Manual, CIS 18: xxxx.

This xxxx edition of the Manual for IBS Content Scoring System (IBS Score) replaces CIS 18: 2018.

1.2 Objective

The purpose of this IBS Score Manual is to provide a well-structured assessment system for calculating the IBS Score of a building in both government and private projects. This is in line with the mandatory requirement for the IBS implementation in the building projects.

1.3 Scope

This IBS Score Manual sets out the formulas, tables, methods, and examples to calculate the IBS Score for building projects. The IBS Score calculation shall be applicable only for superstructures.

1.4 Normative References

The following normative references are indispensable for this CIS 18 application. The latest edition of the normative references (including any amendments) below shall apply:

1. Akta 520 – 1994, Perintah Lembaga Pembangunan Industri Pembinaan Malaysia.
2. Akta 133 – 1974, Undang-undang Kecil Bangunan Seragam.
3. CIS 24 - Industrialised Building System (IBS) Assessment & Certification.
4. MS 1064-4 - Guide to modular coordination in buildings – Part 4: Coordinating sizes and preferred sizes for doorsets.
5. MS 1064-5 - Guide to modular coordination in buildings – Part 5: Coordinating sizes and preferred sizes for windowsets.

1.5 Terms and Definitions

For the purpose of this IBS Score Manual, the following definitions shall apply:

1. “3D Printing & Additive Manufacturing”

A process to create or recreate a physical object that is modelled in digital version by depositing layers of materials.

2. "3D Scanning and Photogrammetry"

Data acquisition as point cloud data and mapping tool with the ability to interpolate photographs to become 3D models for monitoring of changes.

3. "Advanced Building Material"

Development of new materials for the industry by integrating new technologies and processes to create a better product.

4. "Artificial Intelligence"

Allowance for machines to imitate the human cognitive functions to enable machines to conduct tasks that are usually performed by humans via a set algorithm.

5. "Augmented Reality & Virtualisation"

Interaction between human and computer which would enable an individual to distinguish between virtual and real-world object(s).

6. "Autonomous Construction"

Automatic assembly method of construction by utilising a robot that is controlled using computer process and mechanisation.

7. "Basement"

One or more floors of a building that is/are completely or partly below ground.

8. "Big Data and Predictive Analytics"

Efficient handling of large amounts of project data by efficiently storing, managing, and processing the data using a commodity server.

9. "Blockchain"

Distributed ledger of database in which information, records of transactions, internet protocol, and others can be maintained across a network of computers.

10. "Blockwork System"

A construction method using blocks of concrete, cement, or any material for the main intended uses are common, facing or exposed blocks in load-bearing or non-load-bearing building and civil engineering applications. The units are suitable for all forms of walling, cavity walls, partitions, retaining, and basements with modular sizes in accordance with MS 1064- 8.

11. "Building Information Modelling (BIM)"

A central repository which requires integration of fragmented disciplines of architecture, engineering, and construction, to optimise the lifecycle performance of buildings.

12. "Cavity walls"

A wall consisting of two skins as a single wall. The space between the skins is filled or partially filled with other material or is left as a continuous cavity.

13. "Cloud and Realtime Collaboration"

Internet centric form of collaboration which enables the provision of free flow of information within the construction professionals and offering a huge amount of storage resources.

14. "Construction 4.0"

A process to implement modern technology in order to encourage the digitisation of the construction industry and its supply chain.

15. "Drywall"

Cementitious panels, gypsum boards, calcium silicate boards, and other types of composite panel products.

16. "Horizontal repetition of structural layout"

Repeating or mirroring identical structural layout in horizontal direction.

17. "IBS Factors"

A value given to a particular building system, which reflects the relative differences in site labour productivity.

18. "IBS Score"

The score for computing the total IBS usage in a building project, as set out in this IBS Score Manual.

19. "Industrialised Building System (IBS)"

The technique or method of building construction in which the product(s) that consist of components/elements/systems are produced by the manufacturer in a controlled environment, either on-site or offsite, and subsequently transported, positioned, and assembled into construction works.

20. "Internet of Things "

A system that enables the detection of a surrounding environmental conditions which are sensed by objects and devices and have unique identifiers (UIDs) or the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

21. "Load-bearing Wall"

In relation to any part of a building and its foundations, meaning that part of the building which bears a load other than due to its own weight and to wind pressure on its own surface.

22. "Other simplified construction solutions"

Utilisation of innovative construction methods or solutions that can contribute towards labour-saving as well as enhanced quality and productivity.

23. "Precut and prebend reinforcement bar/ steel fabric"

A reinforcement bar/ steel fabric that has been cut and/or bent into the required size or shape and produced by a certified manufacturer.

24. "Prefabricated"

Building components/elements/systems produced by the manufacturer in a controlled environment, either on-site or offsite, and subsequently transported, positioned, and assembled into construction works (e.g. precast concrete, metal, timber, glass, advanced materials, etc.).

25. "Prefabricated Volumetric Module (PVM)"

Construction method applying three-dimensional (3D) volumetric modules which involves the prefabrication of whole units under controlled conditions in factories, transported to the construction site, where they are installed and assembled to create functional building.

26. "Prefabrication and Modular Construction"

A completed manufacturing process for volumetric units of building construction systems that are generally made/assembled in factory to form a component prior to final installation on site.

27. "Repetition of floor-to-floor height"

Repeating the floor-to-floor height in a building.

28. "Reusable Formwork System"

The application of reusable prefabricated formwork system for the in-situ construction of concrete structures. The main function is to enable temporary work to be reused for a minimum count of 20 times.

(a) Reusable formwork used for columns, beams, walls, and slabs.
(b) Tunnel form is used for the monolithic construction of walls and slabs.
(c) The application of reusable formwork ensures high-quality finishing, shortens construction time, and requires less labour compared to the conventional formwork method.

29. "Self-climbing formwork system"

A special type of formwork that rises along with the progress of vertical concrete construction. It can move by using an electric or hydraulic jack or any other mechanical system.

30. "Self-climbing working platform"

A self-climbing working platform with protective screen, equipped with controlled, synchronised climbing mechanism, to prevent workers and objects from falling when working at a height. It is a more intensively designed system compared to scaffolding and other falsework system.

31. "Vertical repetition of structural layout"

Repeating the identical structural layout of a building in vertical direction.

1.6 Principles of IBS Score

IBS Score shall emphasise the following attributes:

a) Usage of IBS components for structural systems.
b) Usage of IBS components for wall systems.
c) Utilisation of standardised components.
d) Repetition of the floor height and structural layout.
e) Productivity-enhancing solutions and technology adoption.

A higher IBS Score reflects higher productivity, reduced site labour, lower wastage, less site materials, a cleaner environment, better quality, neater and safer construction sites, faster project completion, and lower total construction costs.

The method for calculating the IBS Score is designed to be simple but effective. Scores shall be awarded based on the IBS Factors of the structural and wall elements used. In addition, the high level of repetitiveness in the design and other simplified construction solutions shall also contribute to the total score. This manual also includes a guide on calculating the IBS Score for an entire project, consisting of a group of buildings in development.

1.7 Categories of Buildings

IBS Score shall be applied to all new residential, commercial, industrial, institutional, and other building projects, as categorised in Table 1.

Table 1. Categories of Buildings

CATEGORIES	TYPES OF BUILDING
Residential (landed housing)	1. Bungalows/ Detached houses 2. Clustered housing 3. Semi-detached houses 4. Terrace houses/ Link houses
Residential (non-landed/ stratified housing)	1. Apartments/ Serviced apartments/ Quarters 2. Condominiums 3. Flats 4. Hostels 5. Small office home office (SOHO) 6. Townhouses
Commercial	1. Banks 2. Departmental stores/ Shopping centres/ Supermarkets 3. Exhibition halls 4. Office buildings 5. Restaurants 6. Small office flexible office (SOFO) 7. Small office virtual office (SOVO)
Industrial	1. Factories 2. Sub-stations 3. Warehouses

CATEGORIES	TYPES OF BUILDING
Institutional and others	1. Camps 2. Child centres/ Nurseries/ Homes for the aged 3. Cinemas/ Theatres 4. Clubhouses 5. Crematoriums and columbaria 6. Embassies 7. Libraries 8. Medical centres/ Hospitals/ Clinics 9. Museums 10. Open halls/ Community halls 11. Places of worship/ Religious buildings 12. Police stations/ Fire stations 13. Schools/ Educational facilities/ Campuses 14. Sports/ Recreational facilities/ Stadiums 15. Stations for public transport/ Terminal buildings

SECTION 2: IBS CONTENT SCORING SYSTEM

2.1 IBS Score Requirements

The maximum IBS Score for a building is one hundred (100) points. The IBS Score is composed of the following elements:

a) Part 1: Structural systems (Maximum score is 50 points)

Points shall be calculated based on various construction methods as listed in Table 2. Additional IBS Factors shall be applied as per construction usage listed in Table 3. Table 4 shows the points calculated for Roof Structural Systems.

b) Part 2: Wall systems (Maximum score is 20 points)

Points shall be calculated based on various types of wall systems (load-bearing and non-load bearing) as listed in Table 5. Additional IBS Factors shall be applied as per construction usage listed in Table 6.

c) Part 3: Other simplified construction solutions (Maximum score is 30 points)

Points shall be calculated for the use of other simplified construction solutions as shown in Table 8.

2.2 Formula for IBS Scores

2.2.1 Buildings with Wall Systems

For buildings with wall systems, IBS Score calculation is based on Equation 1:

IBS Score for buildings with wall systems = $$50 \sum \left[\frac{Q_S}{Q_{ST}} F_S\right] + 20 \sum \left[\frac{Q_W}{Q_{WT}} F_W\right] + S$$ Equation 1

Where:

$\sum$ - Sum of
Q_S - Construction area of a structural system
Q_{ST} - Total construction area of building, including roof
F_S - IBS Factors for structural systems from Table 2, Table 3, and Table 4
Q_W - Length of a wall system (external and internal wall),
Q_{WT} - Total wall length (external and internal wall)
F_W - IBS Factor for wall systems from Table 5 and Table 6
S - IBS Score for other simplified construction solutions from Table 8

2.2.2 Buildings without Wall (No-wall System)

For buildings without wall systems, Part 2 shall be excluded, and IBS Score calculation is based on Equation 2:

IBS Score for buildings without wall systems = $\left(\frac{50\sum\left[\frac{Q_S}{Q_{ST}}F_S\right]+S}{80}\right)$ x 100 Equation 2

Where:

$\sum$ - Sum of
Q_S - Construction area of a structural system
Q_{ST} - Total construction area of building, including roof
F_S - IBS Factor for structural systems from Table 2, Table 3, and Table 4
S - IBS Score for other simplified construction solutions from Table 8

2.3 Part 1: IBS Score for Structural Systems

$$50\Sigma\left[\frac{Q_S}{Q_{ST}}F_S\right]$$

Where:

Q_S/Q_{ST}	-	The ratio of the construction area of which a particular structural system is used, out of the total construction area of the building, including roof
F_S	-	IBS Factor for the particular structural systems from Table 2, Table 3, and Table 4

a) The maximum IBS Score for Part 1: Structural Systems is fifty (50) points.

b) The IBS Score is calculated from the percentage of construction area covered by the structural systems and the corresponding IBS Factor from Table 2, Table 3, and Table 4, then multiplied by fifty (50).

c) When determining the IBS Factors from Table 2, the slabs or flooring system types shall refer to the combination of beams, columns, or load-bearing walls supporting the slabs or flooring system.

d) The area without any slab or flooring system shall be referred to as the void section.

e) The IBS Score calculation shall cover superstructure elements of the building, including porches and balconies.

f) The IBS Score calculation shall NOT consider substructure works, the basement, the driveway, or the apron.

g) For a multi-structural system building, the contribution of each system shall be calculated and summed up to arrive at the total IBS Score for the structural systems combination.

h) Table 2 provides the IBS Factors for common combinations of slabs with columns and beams or load-bearing walls.

i) Table 3 offers an additional factor to support the structural systems in Table 2 using cast in situ method. In a structural system, precut and prebend reinforcement bar/steel fabric and prefabricated reinforcement cage usage coverage is in numbers for beam and column, area for slab, and length for load-bearing wall. Self-compacting concrete usage coverage is measured in volume.

j) Table 4 lists the types of structural roof systems.

Table 2. IBS Factors for Structural Systems

No	CONSTRUCTION METHOD Slabs/ Flooring System Columns & Beams / Walls	A Prefabricated slabs/ flooring system	B In situ concrete on permanent formwork	C In situ concrete using reusable formwork system	D In situ concrete using conventional timber formwork	E Void
1	Prefabricated columns and beams/ load-bearing walls	1.0	0.8	0.7	0.4	1.0
2	Prefabricated columns and in situ beams using reusable formwork system	0.7	0.6	0.4	0.3	0.7
3	Prefabricated columns and in situ beams using conventional timber formwork	0.6	0.5	0.3	0.2	0.6
4	Prefabricated beams and in situ columns using reusable formwork system	0.7	0.6	0.4	0.3	0.7
5	Prefabricated beams and in situ columns using conventional timber formwork	0.6	0.5	0.3	0.2	0.6
6	In situ columns and beams / load-bearing walls using reusable formwork system	0.5	0.4	0.3	0.1	0.5
7	In situ columns and beams / load-bearing walls using conventional timber formwork	0.4	0.3	0.1	0.0	0.0
8	Load-bearing blockwork system	0.7	0.6	0.4	0.3	0.7
9	In situ columns and beams / load-bearing walls with permanent formwork	0.6	0.5	0.3	0.2	0.6

Table 3. Additional IBS Factors for Structural Systems

No.	Additional Factors (Structural System)*	Usage (in Percentage)	
		50% ≤ x < 75%	**75% ≤ x ≤ 100%**
1	Precut and prebend reinforcement bar/ steel fabric	0.02	0.05
2	Prefabricated reinforcement cage	0.05	0.10
3	Self-compacting concrete	0.05	0.10
4	Tunnel formwork / self-climbing formwork system	0.10	

Note:
*Additional factors shall be awarded only for in-situ construction based on component utilisation. The components are as follows:
(a) Beam and column – nos
(b) Wall – metre length
(c) Slab – metre square

Table 4. IBS Factors for Roof Structural Systems

No.	Roof Systems	IBS Factor
1	Prefabricated roof trusses	1.0
2	Conventional timber roof trusses	0.0

2.4 Part 2: IBS Score for Wall Systems

$$20\Sigma\left[\frac{Q_W}{Q_{WT}}F_W\right]$$

Where:

Q_W/Q_{WT} - The ratio of the length of a particular wall system (external or internal) used out of the total wall length of the building

F_W - IBS Factor for the particular wall system, from Table 4

a) The maximum IBS Score for Part 2: Wall Systems is twenty (20) points.

b) The IBS Score is calculated from the percentage of wall length covered by the wall systems and the corresponding IBS Factor from Table 5, and Table 6, then multiplied by twenty (20).

c) The IBS Score calculation shall NOT consider basement walls and toilet cubicle partitions.

d) For cavity walls, the two separate skins are considered as a single wall.

e) Half wall, parapets, and corridor/balcony walls shall be included in the IBS Score calculation.

f) Windows and doors shall NOT be considered in wall systems calculation.

g) Reference shall be made to Section 3 for combination of wall systems on a single wall.

h) For a building with multi-structural systems, the contribution of each system shall be calculated and summed up to arrive at the total IBS Score for the wall systems combination.

i) Table 5 provides the IBS Factors for common wall systems.

j) Table 6 offers an additional factor to support the wall systems from Table 5 using cast in situ method. In a wall system, precut and prebend reinforcement bar/steel fabric and prefabricated reinforcement cage usage coverage are in length. Self-compacting concrete usage coverage is measured in volume.

Table 5. IBS Factors for Wall Systems

No.	Wall Systems	IBS Factor
1	Prefabricated wall panels	1.0
2	Dry wall system	0.7
3	In situ concrete with permanent formwork	0.6
4	Blockwork system	0.5
5	In situ concrete with a reusable formwork system	0.3
6	Common brick walls	0.0
7	In situ concrete with conventional timber formwork	0.0

Table 6. Additional IBS Factors for Wall Systems

No.	Additional Factors (Wall Systems)*	Usage (in Percentage)	
		50% ≤ x < 75%	75% ≤ x ≤ 100%
1	Precut and prebend reinforcement bar/ steel fabric	0.02	0.05
2	Prefabricated reinforcement cage	0.05	0.10
3	Self-compacting concrete	0.05	0.10
4	Tunnel formwork / self-climbing formwork system	0.10	

Note:
*Additional factors shall be awarded only for in-situ construction. The wall shall be measured in metre length.

2.5 Part 3: IBS Score for Other Simplified Construction Solutions

$$S$$

a) The total maximum IBS Score capped for Part 3: Other Simplified Construction Solutions is thirty (30) points.

b) Maximum points are capped in each subcategory. Total points shall be the sum of all subcategories listed in Table 8.

c) The first subcategory is the Utilisation of Standardised Components:

   i. All standardised components, including non-concrete elements, shall refer to Annex A.

   ii. Maximum points shall be provided under the beam and column section for structures using load-bearing wall systems (without beams and columns).

   iii. For walls, load-bearing and non-load-bearing components shall refer to the same standardised size as stated in Annex A.

   iv. For doors, the standardised components shall refer to MS1064-4 coordinating sizes.

   v. For windows, the standardised components shall refer to MS1064-5 coordinating sizes.

vi. The components of the basement structures, ground slabs, and ground beams shall NOT be considered in the calculation.

vii. The points shall be given based on the usage in percentage.

d) The second subcategory is the Repetition of the Structural Layout:

i. For a building of three (3) storeys and above (e.g., high-rise apartment, office, townhouse, etc.), reference shall be made to Table 8 item 2 (a) for the floor-to-floor height and vertical / horizontal repetition of the structural layout.

ii. For a building of one (1) or two (2) storeys (e.g., bungalow, terrace house, townhouse etc.), reference shall be made to Table 8 item 2(b) for the horizontal repetition of the structural layout.

iii. For horizontal repetition, mirror unit shall be included.

iv. The points shall be given based on the usage in percentage.

e) The third subcategory is Productivity Enhancing Solutions and Technology Adoption;

i. Simulation and modelling:

a) The points shall be given based on Building Information Modelling (BIM) level as stated in Table 7.

Table 7. BIM Level and BIM Maturity Level

BIM Level		Description
Manual	0	**No Collaboration with CAD drawings** Level 0 represents 2D drawings that contain relevant information using computer-aided design software. Project stakeholders share hardcopies of files, drawings, documents, etc. Therefore, the BIM level is considered as no or zero collaboration.
Modelling	1	**2D Drawings and 3D digital models** Utilising conceptual 2D drawings, 3-dimensional CAD models are prepared by multi-trade project teams at this level. Following the CAD standard 3D models are shared through Common Data Environment (CDE) which the contractors commonly manage. This BIM level is considered as partial collaboration because project stakeholders independently publish and manage their data.
Collaboration	2	**Multiple 3D models for different project teams on a digital platform** Architects, designers, structural engineers, MEP engineers, contractors, and other project stakeholders work on 3D BIM models and share data in CDE. The multi-disciplinary project teams may not necessarily work on a single file but use a common file format like IFC (Industry Foundation Class) in Level 2. Collaboration amongst different project teams takes place at this level.
Integration	3	**Single work-shared 3D model for different project teams** Level 3 of BIM represents maximum utilisation of a common data environment and full collaboration. Multi-trade project participants work on a single work-shared model in a central location where every project team member has the relevant access to update, review, and markup. The Level 3 approach of BIM is also considered as OpenBIM. This level adds value to the entire design-build process through constructability review and resolution, clash detection, BIM coordination, etc.

ii. Digitalisation and virtualisation:

a) The points shall be given based on the adoption of each item as mentioned in the Project Execution Plan.

iii. Smart construction:

a) For 3D Printing & Additive Manufacturing, 3D Scanning and Photogrammetry, and Autonomous Construction, the points shall be given based on the adoption of each item as mentioned in the Project Execution Plan.

b) For Advanced Building Materials, only major building components shall be considered (beam, column, floor slab, wall, roof structure, staircase etc.). The points shall be given based on the adoption as mentioned in the Project Execution Plan.

c) For Prefabrication & Modular Construction, Prefabricated Volumetric Module (PVM) shall be referred to as free-standing factory-produced volumetric modules that are either bare or completed with finishes such as Prefabricated Bathroom Units (PBU), or any volumetric modular units. The points shall be given based on the usage in percentage.

d) Prefabricated staircases shall be referred to as completed units made of precast, steel, engineered timber, or other prefabricated materials. The points shall be given based on usage in percentage.

e) Prefabricated mechanical, electrical, and plumbing (MEP) systems shall be referred to as prefabricated horizontal or vertical ceiling modules (with pipes, cable trays, trunking etc.), prefabricated plant modules (with pump, compressor etc.) or any prefabricated MEP services which involve sub-assemblies. The points shall be given based on usage in percentage.

iv. Other enhancing solutions:

a) Self-climbing working platform shall be used to improve construction site productivity. The points shall be given based on the adoption as mentioned in the Project Execution Plan.

b) Modular gridlines in drawing shall refer to major plan grids (x and y) that shall be at an increment of 3M. The points shall be given based on usage in percentage.

Table 8. IBS Score for Other Simplified Construction Solutions

NO.	DESCRIPTION	USAGE (IN PERCENTAGE)		
		Unit/ Adopt	50% ≤ x <75%	75% ≤ x ≤ 100%
1	**Utilisation of Standardised Components**			**Max 16 points**
	a) Beam	Nos	2	4
	b) Column	Nos	2	4
	c) Wall	m	2	4
	d) Slab	m^2	2	4
	e) Door	Nos	2	4
	f) Window	Nos	2	4
2	**Repetition of the Structural Layouts**			**Max 6 points**
	a) For a building of three (3) storeys and above			
	i. Repetition of floor-to-floor height	Nos	2	3
	ii. Vertical/ horizontal repetition of structural layout	Nos	2	3
	b) For a building of one (1) or two (2) storeys			
	i. Horizontal repetition of structural layout	Nos	3	6
3	**Productivity Enhancing Solutions and Technology Adoption**			**Max 14 points**
	a) Simulation and Modelling			
	i. Building Information Modelling (BIM)	Level 1	2	
		Level 2 and above	6	
	b) Digitalisation and Virtualisation			
	i. Augmented Reality & Virtualisation	Adopt	1	
	ii. Artificial Intelligence	Adopt	1	
	iii. Big Data and Predictive Analytics	Adopt	1	
	iv. Blockchain	Adopt	1	
	v. Cloud and Realtime Collaboration	Adopt	1	
	vi. Internet of Things	Adopt	1	
	c) Smart Construction			
	i. 3D Printing & Additive Manufacturing	Adopt	1	
	ii. 3D Scanning and Photogrammetry	Adopt	1	
	iii. Autonomous Construction	Adopt	1	
	iv. Advanced Building Material	Adopt	2	
	v. Prefabrication & Modular Construction			
	(a) Prefabricated Volumetric Module (PVM)	Nos	3	6
	(b) Prefabricated staircase	Nos	2	4
	(c) Usage of Prefabricated Mechanical, Electrical, Plumbing (MEP) systems	Nos	2	4
	d) Other Enhancing Solutions			
	i. Usage of self-climbing working platform	Adopt	2	
	ii. Usage of Modular Gridlines in drawings	Nos	3	6
			Total (max)	**30**

2.6 IBS Score for Project with a Group of Buildings

In the case of a group of buildings in one project, the IBS Score of the project shall be calculated by multiplying the percentage of construction area of the respective building (out of total construction area of project) with the IBS Score of the individual building as shown in Equation 3.

IBS Score for Group of Buildings = $$\sum \left[IBS\ Score\ for\ Building \times \frac{Q_{ST(building)}}{Q_{ST(project)}} \right]$$ Equation 3

Where:

$\sum$ - Sum of

$Q_{ST(building)}$ - Total construction area used in the IBS Score calculation of a building, including roof

$Q_{ST(project)}$ - Total construction area used in the IBS Score calculation of all buildings, including roof

a) All major structures in the project, including car park building, surau, etc. shall be considered when computing the area covered by the respective systems.

b) Minor structures, e.g. guardhouse, refuse chamber, and others shall be excluded from the calculation provided where they are not structurally linked to the main buildings.

SECTION 3: IBS SCORING GUIDES

3.1 General

This section sets out guidelines to illustrate the calculation methods for determining the components.

3.2 Guide for Structural System Components

a) The components shall be treated as performing in an "n-shape" structure starting from Ground to 1st Floor Column and above.

b) The following Figure 1 and Table 9 shall be used as guides for structural system components:

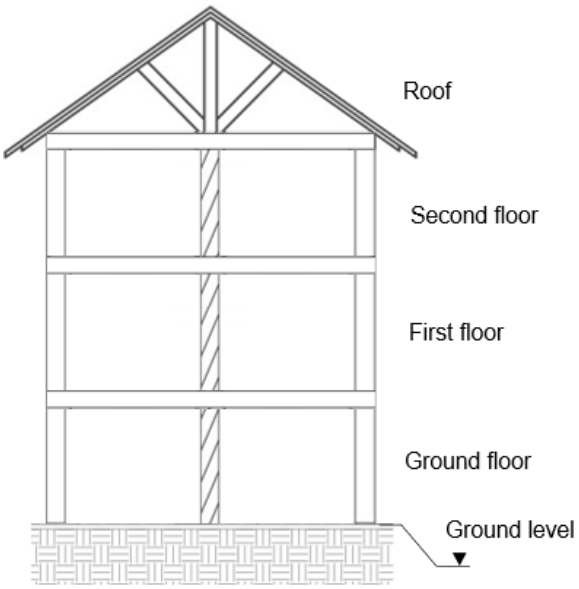
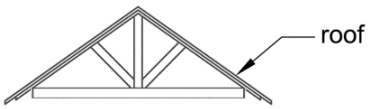
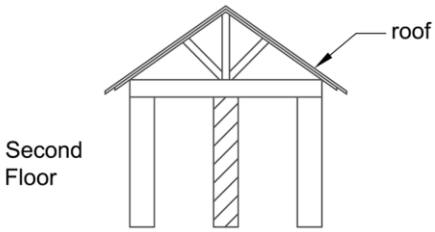
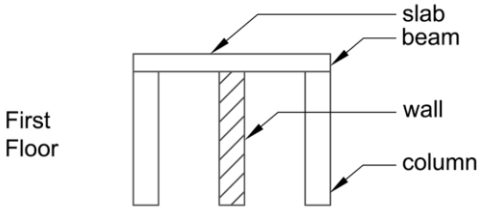
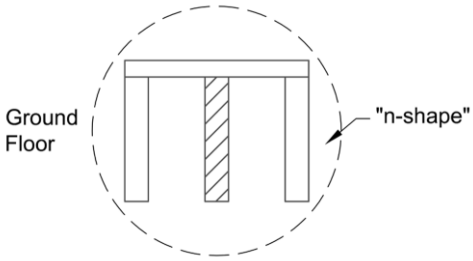


Figure 1. Example of Multi-storey Building

Table 9. Guide for Structural System Component

Description	Step for consideration
Roof Structural System 	i. Type of roof structural system ii. Select IBS Factor from Table 4.
Second Floor (Top most floor) 	i. Types of structure for roof floor beams ii. Types of structure for 2nd to roof floor columns iii. Types of structure for roof floor slab (if any) iv. Select IBS Factor from Table 2 and Table 3 v. Types of wall system for 2nd floor walls vi. Select IBS Factor from Table 5 and Table 6.
First Floor 	i. Types of structure for 2nd floor beams ii. Types of structure for 1st to 2nd floor columns iii. Types of structure for 2nd floor slab iv. Select IBS Factor from Table 2 and Table 3 v. Types of wall system for 1st floor walls vi. Select IBS Factor from Table 5 and Table 6
Ground Floor 	i. Types of structure for 1st floor beams ii. Types of structure for ground to 1st floor columns iii. Types of structure for 1st floor slab iv. Select IBS Factor from Table 2 and Table 3 v. Types of wall system for ground floor walls vi. Select IBS Factor from Table 5 and Table 6

3.3 Guide for Floor Heights/Beams and Columns

a) Floor height shall be measured from one finished level to another finished level.

b) A beam in between two supports shall be counted as one beam.

c) A column in between two floors shall be considered as one column.

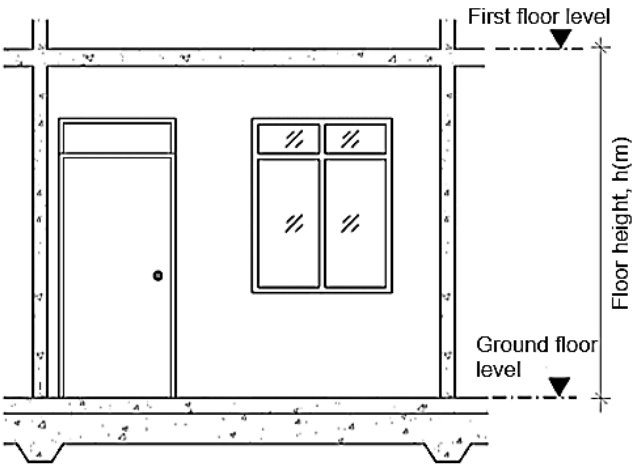


Figure 2. Example of Floor Heights Diagram

3.4 Guide for Wall Systems

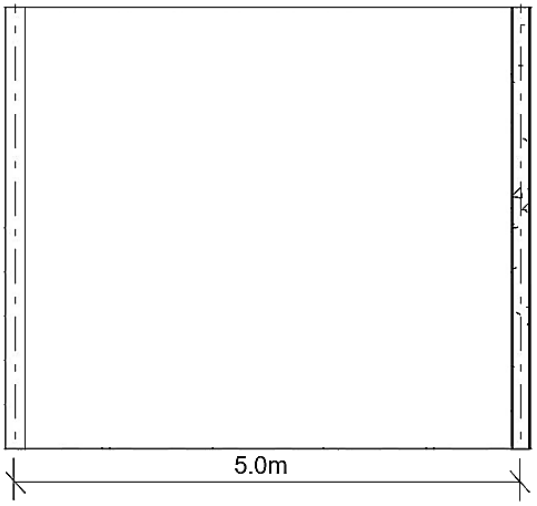
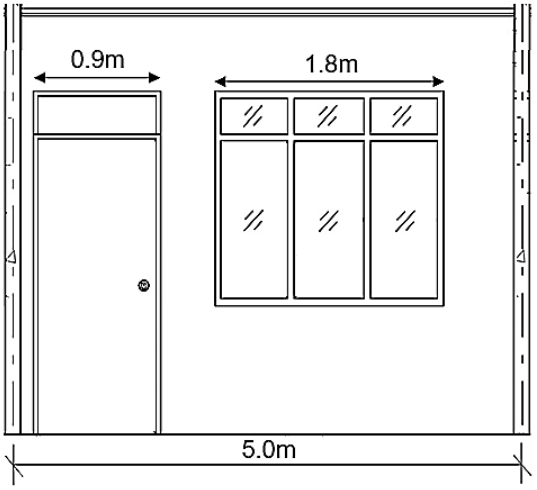
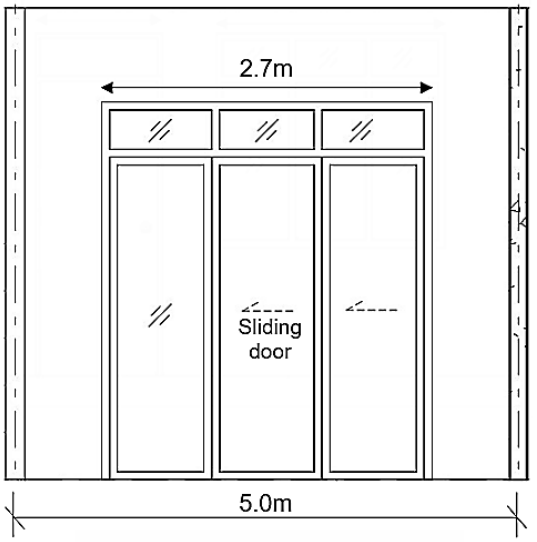
a) Wall length for external walls shall be measured from grid to grid (ignore column).

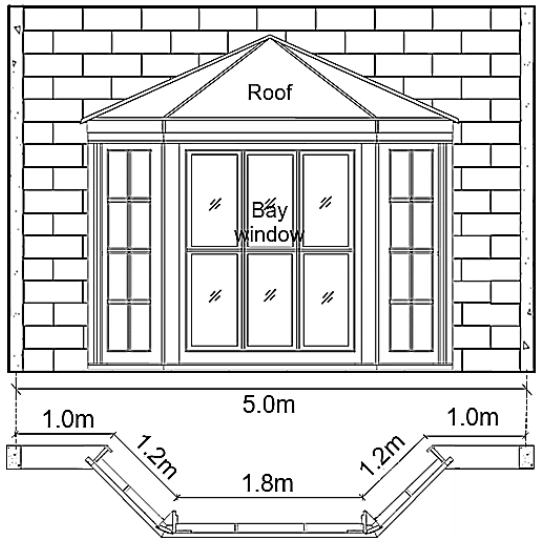
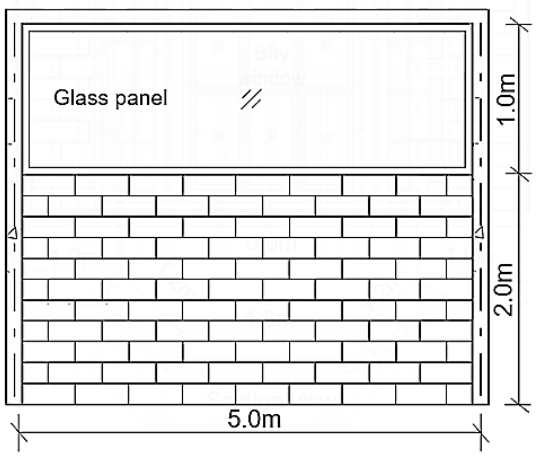
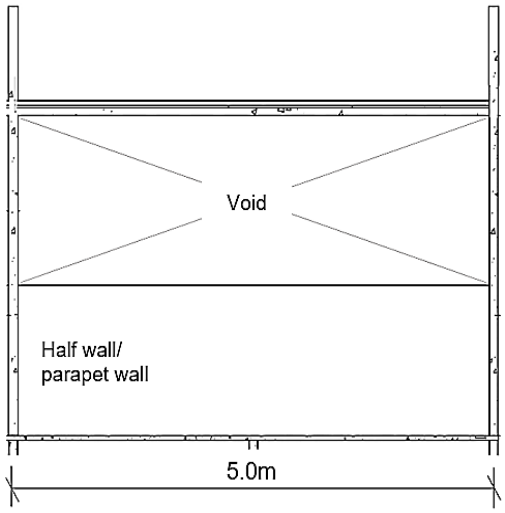
b) Wall length for internal walls shall be taken from wall dimension.

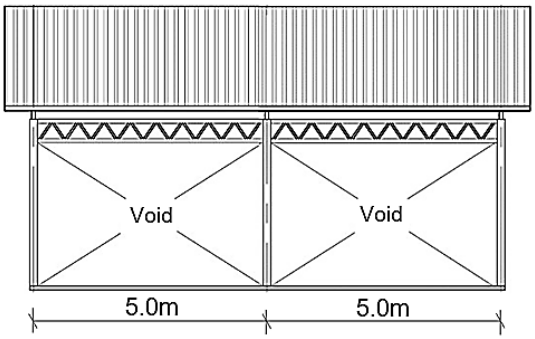
c) For curved wall or bay window, the wall shall be assumed to be a straight wall.

d) Table 10 below shall be used as a guide for wall systems:

Table 10. Guide for Wall Systems

Example	Description
	Case 1 : Full height wall Wall length : 5.0m Wall system : In situ concrete with reusable formwork system IBS Factor : 0.3
	Case 2 : Wall with opening (timber door and glass window) Wall length : 5.0m Wall system : In situ concrete with permanent formwork IBS Factor : 0.6
	Case 3 : Wall with opening (glass door on wall) Wall length : 5.0m Wall system : Prefabricated wall panels (Precast concrete) IBS Factor : 1.0

Example	Description
 Section view	Case 4 : Wall with bay window Wall length : 5.0m Wall system : Blockwork systems IBS Factor : 0.5
	Case 5 : Combination wall systems Wall length : 5.0m Wall system : Blockwork systems (predominant system) IBS Factor : 0.5 **Note**: IBS Factor for this combination of wall systems on a single wall shall be calculated based on predominant system used.
	Case 6 : Half wall/ parapet wall Wall length : 5.0m Wall system : Prefabricated wall panels (precast concrete) IBS Factor : 1.0

Example	Description
	Case 7 : No wall systems Wall length : None Wall system : None IBS Factor : None

3.5 Guide for Construction Area Calculation

a) The construction area shall be measured from grid to grid (ignore offsets of beams/walls to gridlines).

b) For elements that are not horizontal (e.g. roof, staircases, and all other sloped surfaces), plan areas shall be used for the calculation.

3.6 Guide for Structural Systems Calculation

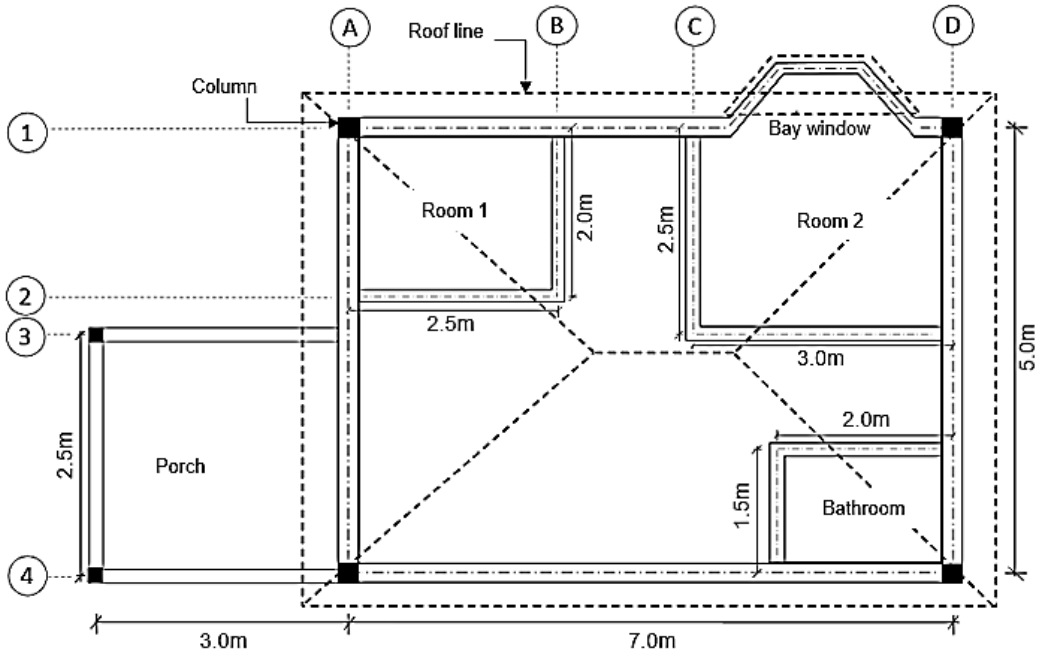


Figure 3. Example of Single-Storey Building Layout

a) Example of IBS Score Calculation for Structural Systems.

For this example, reference shall be made to Figure 3. The IBS Score calculation for the structural systems is shown in Table 11.

Table 11. IBS Score Calculation for the Structural Systems

No.	Structural Component	Construction Area	IBS Factor	Coverage	IBS Score
a)	Main building structure: - Prefabricated column and in situ beams using reusable formwork system	= 7.0 x 5.0 = 35m^2	0.7	= 35/ 77.5 = 0.452	= 0.452 x 0.7 x 50 = 15.82
b)	Main building slab: - Void				
c)	Porch structure: - Prefabricated column and in situ beams using reusable formwork system	= 2.5 x 3.0 = 7.5m^2	0.4	= 7.5/ 77.5 = 0.096	= 0.096 x 0.4 x 50 = 1.92
d)	Porch roof slab: - In situ slab using reusable formwork system				
e)	Roof system - Prefabricated roof trusses (metal)	= 7.0 x 5.0 = 35m^2	1.0	= 35/ 77.5 = 0.452	= 0.452 x 1.0 x 50 = 22.6
	Total	**77.5m^2**		**1.00**	**40.34**

The total IBS Score for the structural systems is 40.34.

b) Example of Calculation with Additional Factors

For this example, reference shall be made to Figure 3. The IBS Score calculation for the structural systems with additional factors is shown in Table 12.

Table 12. IBS Score Calculation for the Structural Systems with Additional Factors

No.	Structural Component	Construction Area/ Utilisation	IBS Factor	Coverage	IBS Score
a)	Main building structure: - Prefabricated column and in situ beams using reusable formwork system	= 7.0 x 5.0 = 35m^2	0.7	= 35/ 77.5 = 0.452	= 0.452 x 0.75 x 50 = 16.95
b)	Main building slab: - Void				
c)	Additional factors: - Precut and prebend reinforcement bar/ steel fabric	80%	0.05		
d)	Porch structure: - Prefabricated column and in situ beams using reusable formwork system	= 2.5 x 3.0 = 7.5m^2	0.4	= 7.5/ 77.5 = 0.096	= 0.096 x 0.45 x 50 = 2.16
e)	Porch roof slab: - In situ slab using reusable formwork system				
f)	Additional factors: - Precut and prebend reinforcement bar/ steel fabric	80%	0.05		
g)	Roof system - Prefabricated roof trusses (metal)	= 7.0 x 5.0 = 35m^2	1.0	= 35/ 77.5 = 0.452	= 0.452 x 1.0 x 50 = 22.6
	Total	**77.5m^2**		**1.00**	**41.71**

The total IBS Score for the structural systems with additional factors is 41.71.

3.7 Guide for Wall Systems Calculation

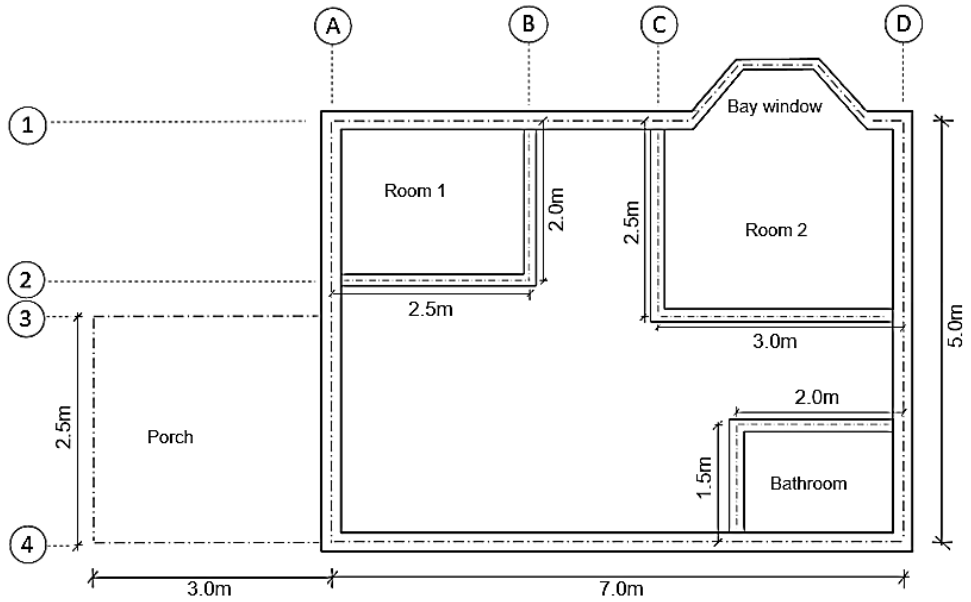


Figure 4. Example of Wall Layout for Single-Storey Building

a) Example of Calculation for the Wall Systems

For this example, reference shall be made to Figure 4. The IBS Score calculation for the wall systems is shown in Table 13.

Table 13. IBS Score Calculation for the Wall Systems

No.	Wall Component	Length	IBS Factor	Coverage	IBS Score
a)	External wall: - Blockwork system	= 7.0 + 5.0 + 7.0 + 5.0 = 24m	0.5	= 24/ 37.5 = 0.64	= 0.64 x 0.5 x 20 = 6.4
b)	Internal wall - Dry wall system • Room 1 • Room 2 • Bathroom	 = 2.0 + 2.5 = 4.5m = 2.5 + 3.0 = 5.5m = 2.0 + 1.5 = 3.5m	0.7	= 13.5/ 37.5 = 0.36	= 0.36 x 0.7 x 20 = 5.04
Total		**37.5m**		**1.00**	**11.44**

The total IBS Score for the wall systems is 11.44.

b) Example of Calculation with Additional Factors

For this example, reference shall be made to Figure 4. The IBS Score calculation for the wall systems is shown in Table 14.

Table 14. IBS Score Calculation for the Wall Systems with Additional Factors

No.	Wall Component	Length/ Utilisation	IBS Factor	Coverage	IBS Score
a)	External wall: - Blockwork system	= 7.0 + 5.0 + 7.0 + 5.0 = 24m	0.5	= 24/ 37.5 = 0.64	= 0.64 x 0.55 x 20 = 7.04
b)	Additional factors: - Precut and prebend reinforcement bar/ steel fabric	80%	0.05		
c)	Internal wall - Dry wall system • Room 1 • Room 2 • Bathroom	= 2.0 + 2.5 = 4.5 m = 2.5 + 3.0 = 5.5m = 2.0 + 1.5 = 3.5m	0.7	= 13.5/ 37.5 = 0.36	= 0.36 x 0.7 x 20 = 5.04
	Total	**37.5m**		**1.00**	**12.08**

The total IBS Score for the wall systems with additional factors is 12.08.

3.8 Guide for Utilisation of Standardised Components Calculation

Points are awarded based on the percentage of components as follows:

a) Reference shall be made to Annex A for the standardised size for beams, columns, walls, and slabs.

b) Reference shall be made to MS 1064 for the standardised size for doors and windows.

Example: Two-storey commercial building.

The points calculation for standardised components are shown in Table 15. Reference shall be made to Table 8 for the points given for each standardised component.

Table 15. Points Calculation for Standardised Components

No.	Component	Dimension (mm)	Unit	% Usage	Points
a)	Beam	**a. 200 x 300** **b. 250 x 350** c. 350 x 430	**a. 70** **b. 40** c. 20 Total = 130nos	= (70 + 40)/ 130 = 0.85 x 100 = 85%	4
b)	Column	**a. 200 x 200** **b. 250 x 250** c. 350 x 360	**a. 60** **b. 40** c. 30 Total = 130nos	= (60 + 40)/ 130 = 0.77 x 100 = 77%	4
c)	Wall	**a. 100** b. 130	**a. 60** b. 40 Total = 100m	= 60 / 100 = 0.6 x 100 = 60%	2
d)	Slab	**a. 150** b. 170 **c. 200**	**a. 6** b. 24 **c. 30** Total = 60m^2	= (6 + 30) / 60 = 0.6 x 100 = 60%	2
e)	Door	**a. 2100 x 2100** **b. 1500 x 2100** **c. 1000 x 2100** d. 615 x 2000	**a. 1** **b. 2** **c. 10** d. 4 Total = 17nos	= (1 + 2 + 10) / 17 = 0.76 x 100 = 76%	4
f)	Window	**a. 1800 x 1500** **b. 1200 x 1500** **c. 1000 x 1500** d. 600 x 1100 **e. 600 x 700**	**a. 2** **b. 2** **c. 12** d. 4 **e. 4** Total = 24nos	= (2 + 2 + 12 + 4) / 24 = 0.83 x 100 = 83%	4
				Total points calculated	**20**
Maximum points for this subcategory = 16 points				**Points awarded**	**16**

3.9 Guide for Repetition of Structural Layouts Calculation

a) Case 1: For a building of three (3) storeys and above

Example: Five-storey apartment building (excluding basement and flat roof slab).

The points calculation for repetition of structural layouts are shown in Table 16. Reference shall be made to Table 8 for the points given for each subcategory.

Table 16. Points Calculation for Repetition of Structural Layouts (Apartment building)

No.	Item	Description	% Usage	Points
a)	Repetition of floor-to-floor height			
	a. Ground Floor to 1st Floor **b. 1st Floor to 2nd Floor** **c. 2nd Floor to 3rd Floor** **d. 3rd Floor to 4th Floor** e. 4th Floor to Roof	3600 **3200** **3200** **3200** 3000	The height with the most repetition is 3200mm. = 3 / 5 = 0.6 x 100 = 60%	2
b)	Vertical repetition of structural floor layout			
	a. Ground Floor **b. 1st Floor** **c. 2nd Floor** **d. 3rd Floor** **e. 4th Floor**	Structural layout type A **Structural layout type B** **Structural layout type B** **Structural layout type B** **Structural layout type B**	The most repeated layout which is layout type B. = 4 / 5 = 0.8 x 100 = 80%	3
			Total points calculated	**5**
Maximum points for this subcategory = 6 points			**Points awarded**	**5**

b) Case 2: For a building of three (3) storeys and above

Example: Fifteen (15) units of three-storey townhouse block.

The points calculation for repetition of structural layouts is shown in Table 17. Reference shall be made to Table 8 for the points given for each subcategory. The townhouse block consists of five sets of three-storey buildings.

Table 17. Points Calculation for Repetition of Structural Layouts (Townhouse block)

No.	Item	Description	% Usage	Points
a)	Repetition of floor-to-floor height			
	a. Ground Floor to 1st Floor **b. 1st Floor to 2nd Floor** c. **2nd Floor to Roof**	3600 **3200** **3200**	The height with the most repetition is 3200mm. = 2 / 3 = 0.67 x 100 = 67%	2
b)	Horizontal repetition of structural layout			
	a. Set 1 (corner) **b. Set 2 (intermediate)** **c. Set 3 (intermediate)** **d. Set 4 (intermediate)** e. Set 5 (end)	Structural layout type A **Structural layout type B** **Structural layout type B (mirror)** **Structural layout type B** Structural layout type C	The most repeated layout is layout type B. = 3 / 5 = 0.6 x 100 = 60%	2
			Total points calculated	**4**
Maximum points for this subcategory = 6 points			**Points awarded**	**4**

c) Case 3: For a building of one (1) storey or two (2) storeys

Example: Six (6) units of a one-storey terrace house block.

The points calculation for repetition of structural layouts is shown in Table 18. Reference shall be made to Table 8 for the points given for each subcategory.

Table 18. Points Calculation for Repetition of Structural Layouts (Terrace house)

No.	Item	Description	% Usage	Points
a)	Horizontal repetition of structural layouts			
	a. Unit 1 (corner) **b. Unit 2 (intermediate)** **c. Unit 3 (intermediate)** **d. Unit 4 (intermediate)** **e. Unit 5 (end)**	Structural layout type A **Structural layout type B** **Structural layout type B (mirror)** **Structural layout type B** **Structural layout type B (mirror)**	The most repeated layout is layout type B. = 4 / 5 = 0.8 x 100 = 80%	6
			Total points calculated	**6**
Maximum points for this subcategory = 6 points			**Points awarded**	**6**

3.10 Guide for Productivity Enhancing Solutions and Technology Adoption

Example: Three-storey commercial building.

The points calculation for standardised components are shown in Table 19. Reference shall be made to Table 8 for the points given for each standardised component.

Table 19. Points Calculation for Productivity Enhancing Solutions and Technology Adoption

No.	Item	% Usage / Description	Points
a)	Simulation and Modelling		
	i. Building Information Modelling (BIM)	**Apply BIM Level 2 between project team.**	**6**
b)	Digitalisation and Virtualisation		
	i. Augmented Reality & Virtualisation	**Apply VR technology with build-up 3D models containing information about the building during project planning.**	**1**
	ii. Artificial Intelligence	- None	0
	iii. Big Data and Predictive Analytics	- None	0
	iv. Blockchain	- None	0
	v. Cloud and Realtime Collaboration	**Apply Cloud and Realtime Collaboration between project teams.** Utilised cloud sharing design collaboration for multidiscipline teams across project teams from different organisations in the execution of project.	**1**
	vi. Internet of Things	- None	0
c)	Smart Construction		
	i. 3D Printing & Additive Manufacturing	- None	0
	ii. 3D Scanning and Photogrammetry	- None	0
	iii. Autonomous Construction	- None	0

No.	Item	% Usage / Description	Points
	iv. Advanced Building Material	**Apply Cross-laminated timber (CLT) as trusses at lobby area.**	**2**
	v. Prefabrication & Modular Construction		
	(a) Prefabricated Volumetric Module (PVM)	- None	0
	(b) Prefabricated staircase	**Apply prefabricated staircase.** - Prefabricated timber staircase = 2 - Prefabricated concrete staircase = 4 - Cast in situ concrete staircase = 4 Total staircase = 10nos % usage = 6 / 10 = 0.6 x 100 = 60%	**2**
	(c) Usage of Prefabricated Mechanical, Electrical, Plumbing (MEP) systems	- None	0
d)	Other enhancing solutions		
	i. Usage of self-climbing working platform	- None	0
	ii. Usage of Modular Gridlines in drawings	**Apply modular gridlines for the major plan grids (x and y direction).** - x = 5 out of 10 are modular gridlines - y = 10 out of 12 are modular gridlines Total modular gridlines = 5 + 10 = 15nos Total gridlines = 10 +12 = 22nos % modular gridlines = 15 / 22 = 68%	**3**
		Total points calculated	**15**
Maximum points for this subcategory = 14 points		**Points awarded**	**14**

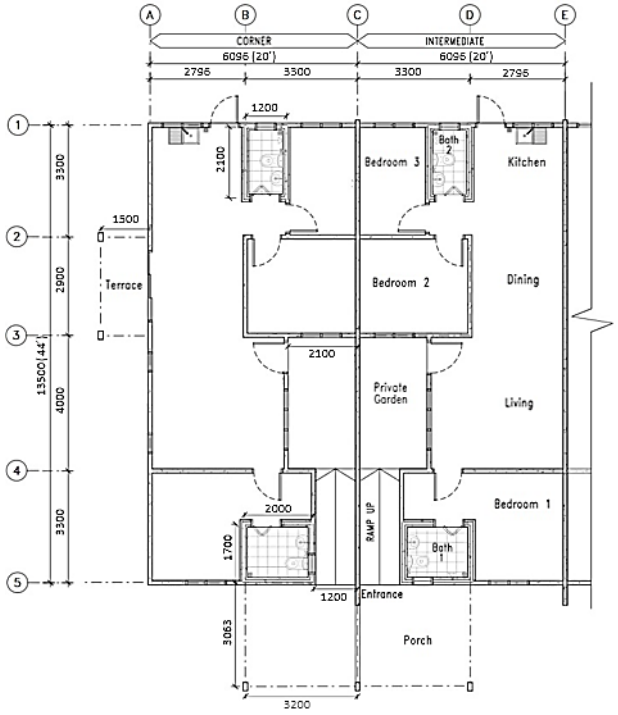
SECTION 4: EXAMPLES OF IBS SCORE CALCULATION

4.1 General

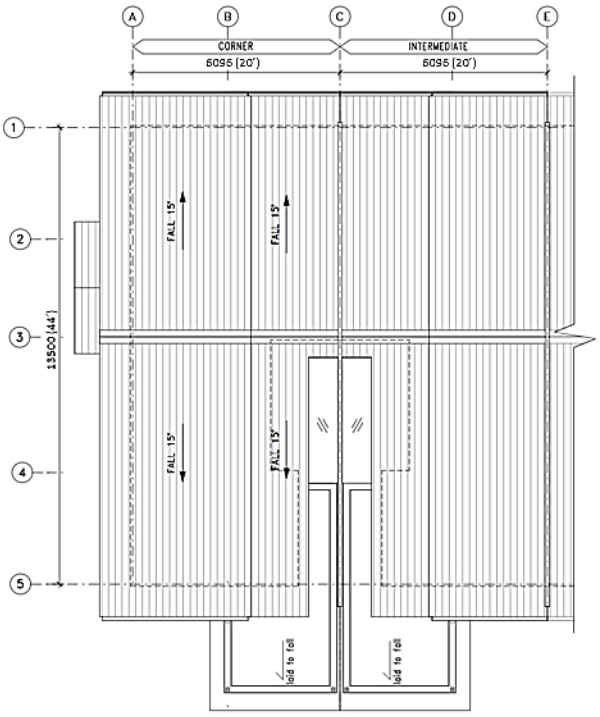
This section provides examples to illustrate the calculation methods for determining the IBS Score for various building types.

4.2 Example 1 – Single-Storey Terrace House Development

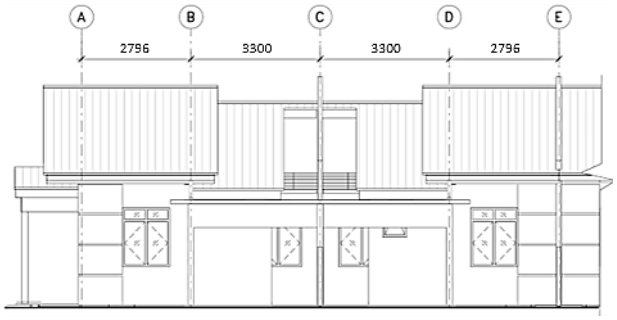
A development of 1 block of 10 single-storey terrace house units consists of 2 corner-lot units and 8 intermediate-lot units.



Ground floor plan



Roof plan



Front view

Rear view

Figure 5. Typical Plan Layout and View for a Single-Storey Terrace House

Table 20. Summary of the Systems used for a Single-storey Terrace House

No.	Systems	Description
a)	Structural systems	
	i. Beams	In situ concrete using reusable formwork system
	ii. Columns	In situ concrete using reusable formwork system
	iii. Load-bearing walls (party walls)	In situ concrete using reusable formwork system
	iv. Slabs (porch)	In situ concrete using reusable formwork system
b)	Roof systems	Prefabricated roof truss (Metal)
c)	Wall systems	
	i. External walls	Blockwork system
	ii. Internal walls	Common brick walls

a) Part 1: IBS Score Calculation for Structural Systems

Table 21. Calculation for the Structural Systems

No.	Structural Component	Construction Area (m^2)	IBS Factor	Coverage	IBS Score
a)	Units area - In situ columns and beams / load-bearing wall using reusable formwork system Units slab: - Void	= [(6.096 x 6.2) + (4 x 3.996) +(3.3 x 4.896)] x 10 units **= 699.36m^2**	0.5	= 699.36/ 1553.736 = 0.45	= 0.45 x 0.5 x 50 = 11.25
b)	Porch structure - In situ columns and beams using reusable formwork system Porch roof slab: - In situ slab using reusable formwork system	= [(1.2 x 3.3) + (3.063 x 3.2)] x 10 units **= 137.616m^2**	0.3	= 137.616/ 1553.736 = 0.08	= 0.08 x 0.3 x 50 = 1.2
c)	Terrace structure (Corner-lot units) - In situ columns and beams using reusable formwork system Terrace (Corner-lot units) roof slab: - Void	= [1.5 x 2.9] x 2 units **= 8.7m^2**	0.5	= 8.7/ 1553.736 = 0.01	= 0.01 x 0.5 x 50 = 0.25
d)	Roof system (units) - Prefabricated roof trusses (metal)	= [(6.096 x 6.2) + (4 x 3.996) +(3.3 x 4.896)] x 10 units **= 699.36m^2**	1.0	= 699.36/ 1553.736 = 0.45	= 0.45 x 1.0 x 50 = 22.5
e)	Roof system (terrace) - Prefabricated roof trusses (metal)	= [1.5 x 2.9] x 2 units **= 8.7m^2**	1.0	= 8.7/ 1553.736 = 0.01	= 0.01 x 1.0 x 50 = 0.5
	Total	**1553.736m^2**		**1.00**	**35.7**

Total IBS Score for structural systems is 35.7.

b) Part 2: IBS Score Calculation for Wall Systems

Table 22. Calculation for the Wall Systems

No.	Wall Component	Length (m)	IBS Factor	Coverage	IBS Score
a)	Wall system 1: - In situ concrete with reusable formwork system	Party wall = (13.5 + 0.963) x 9 units **= 130.167m**	0.3	= 130.167/ 587.047 = 0.22	= 0.22 x 0.3 x 20 = 1.33
b)	Wall system 2: - Blockwork system	External wall and Internal wall <u>Corner unit:</u> = (6.096 + 13.5 + 4.896 + 3.3 + 4.896 + 4 + 3.3 + 2.9 + 3.3 + 3.3) x 2 units = 98.976m <u>Intermediate unit:</u> = (6.096 + 3.3 + 3.3 + 2.9 + 4 + 3.3 + 4.896 + 3.3 + 4.896) x 8 units = 287.904m Total length for wall system 2 **= 386.88m**	0.5	= 386.88 / 587.047 = 0.66	= 0.66 x 0.5 x 20 = 6.59
c)	Wall system 3: - Brick walls	Internal wall for bathroom = (1.2 + 2.1 + 2 + 1.7) x 10 units **= 70m**	0	= 70/ 587.047 = 0.12	= 0.12 x 0 x 20 = 0
	Total	**587.047m**		**1.00**	**7.92**

Total IBS Score for the wall systems is 7.92.

c) Part 3: IBS Score Calculation for Other Simplified Construction Solutions

Table 23. Calculation for Standardised Components Utilisation

No.	Component	Dimension (mm)	Unit	% Usage	Points
a)	Beam	a. 150 x 300 b. 150 x 400	a. 36 b. 58 <u>Total = 94nos</u>	= 94 / 94 = 1.0 x 100 **= 100%**	4
b)	Column	a. 150 x 150	a. 64 <u>Total = 64nos</u>	= 64 / 64 = 1.0 x 100 **= 100%**	4
c)	Wall	a. 115 b. 150 c. 200	a. 70 b. 386.88 c. 130.167 <u>Total = 587.047m</u>	= 517.047 / 587.047 = 0.88 x 100 **= 88%**	4
d)	Slab	a. 150	a. 137.616 <u>Total = 137.616m^2</u>	= 137.616 /137.616 = 1.0 x 100 **= 100%**	4
e)	Door	a. 1000 x 2400 b. 900 x 2400 c. 900 x 2100 d. 2100 x 2400	a. 10 b. 40 c. 20 d. 2 <u>Total = 62nos</u>	= 62 / 62 = 1.0 x 100 **= 100%**	4
f)	Window	a. 600 x 750 b. 600 x 1500 c. 1200 x 1500 d. 1800 x 1500	a. 20 b. 4 c. 40 d. 12 <u>Total = 76nos</u>	= 56 / 76 = 0.74 x100 **= 74%**	2
				Total points calculated	**22**
Maximum points for this subcategory = 16 points				**Points awarded**	**16**

Table 24. Calculation for Repetition of the Structural Layout

No.	Item	Description	% Usage	Points
a)	Horizontal repetition of structural layout			
	a. Unit 1 (corner) b. Unit 2 (intermediate) c. Unit 3 (intermediate) d. Unit 4 (intermediate) e. Unit 5 (intermediate) f. Unit 6 (intermediate) g. Unit 7 (intermediate) h. Unit 8 (intermediate) i. Unit 9 (intermediate) j. Unit 10 (corner)	a. Structural layout type A b. Structural layout type B c. Structural layout type B (mirror) d. Structural layout type B e. Structural layout type B (mirror) f. Structural layout type B g. Structural layout type B (mirror) h. Structural layout type B i. Structural layout type B (mirror) j. Structural layout type A (mirror)	The most repeated layout is <u>layout type B.</u> = 8 / 10 = 0.8 x 100 **= 80%**	6
			Total points calculated	**6**
Maximum points for this subcategory = 6 points			**Points awarded**	**6**

Table 25. Calculation for Productivity Enhancing Solutions and Technology Adoption

No.	Item	% Usage / Description	Points
a)	Simulation and Modelling		
	i. Building Information Modelling (BIM)	**Apply BIM Level 2 between project teams.**	**6**
b)	Digitalisation and Virtualisation		
	i. Augmented Reality & Virtualisation	- None	0
	ii. Artificial Intelligence	- None	0
	iii. Big Data and Predictive Analytics	- None	0
	iv. Blockchain	- None	0
	v. Cloud and Realtime Collaboration	**Apply Cloud and Realtime Collaboration between project teams.** Utilised cloud sharing design collaboration for multidiscipline teams across project teams from different organisations in execution of project.	**1**
	vi. Internet of Things	- None	0
c)	Smart Construction		
	i. 3D Printing & Additive Manufacturing	- None	0
	ii. 3D Scanning and Photogrammetry	- None	0
	iii. Autonomous Construction	- None	0
	iv. Advanced Building Material	- None	0
	v. Prefabrication & Modular Construction		
	(a) Prefabricated Volumetric Module (PVM)	- None	0
	(b) Prefabricated staircase	- None	0
	(c) Usage of Prefabricated Mechanical, Electrical, Plumbing (MEP) systems	- None	0
d)	Other enhancing solutions		
	i. Usage of self-climbing working platform	- None	0
	ii. Usage of Modular Gridlines in drawings	**Apply modular gridlines for the major plan grids (x and y direction).** - x = 2796 x 10, 3300 x 10 10 out of 20 are modular gridlines - y = 3300, 2900,4000, 3300 2 out of 4 are modular gridlines Total modular gridlines = 10 + 2 = 12nos Total gridlines = 20 +4 = 24nos % modular gridlines = (12 / 24) x 100% **= 50%**	**3**
		Total points calculated	**10**
Maximum points for this subcategory = 14 points		**Points awarded**	**10**

Table 26. Summary of IBS Score Calculation for Other Simplified Construction Solutions

No.	Part 3: Subcategory	Points	
		Maximum	Awarded
1	Utilisation of Standardised Components (Table 23)	16	16
2	Repetition of the Structural Layouts (Table 24)	6	6
3	Productivity Enhancing Solutions and Technology Adoption (Table 25)	14	10
	Total points calculated		**32**
	Total IBS Score for Part 3	**30**	**30**

d) Total IBS Score Calculation for Example 1 – Single-Storey Terrace House Development

Table 27. Summary of IBS Score Calculation for Single-Storey Terrace House Development

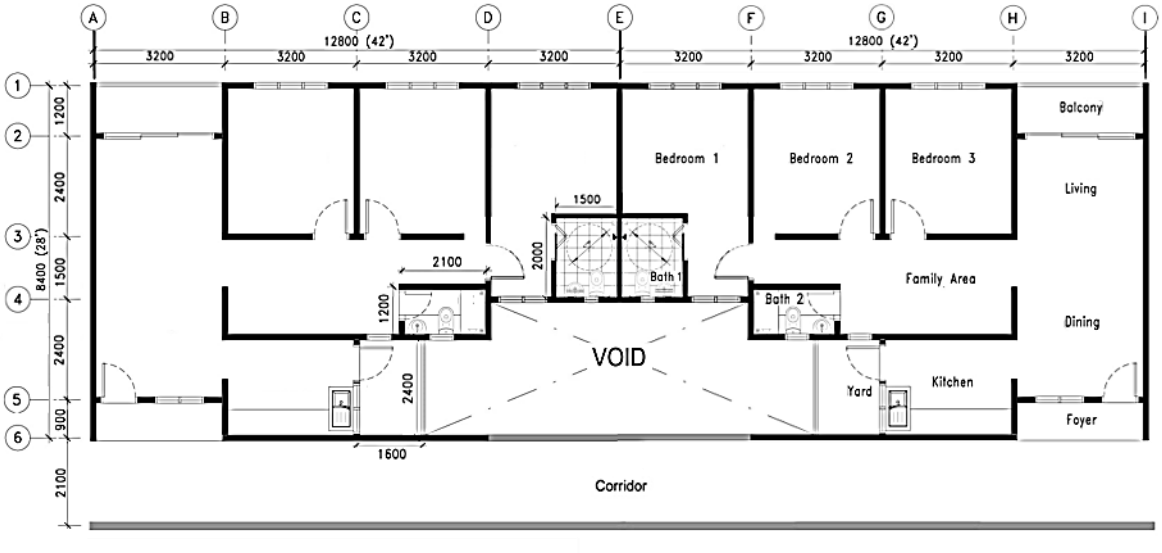
No.	IBS Content	IBS Score	
		Maximum	Awarded
1	Part 1: Structural systems (Table 21)	50	35.7
2	Part 2: Wall systems (Table 22)	20	7.92
3	Part 3: Other simplified construction solutions (Table 26)	30	30
	Total IBS Score for Example 1	**100**	**73.62**

The total IBS Score for Example 1 (Single-storey terrace house development) is 73.62.

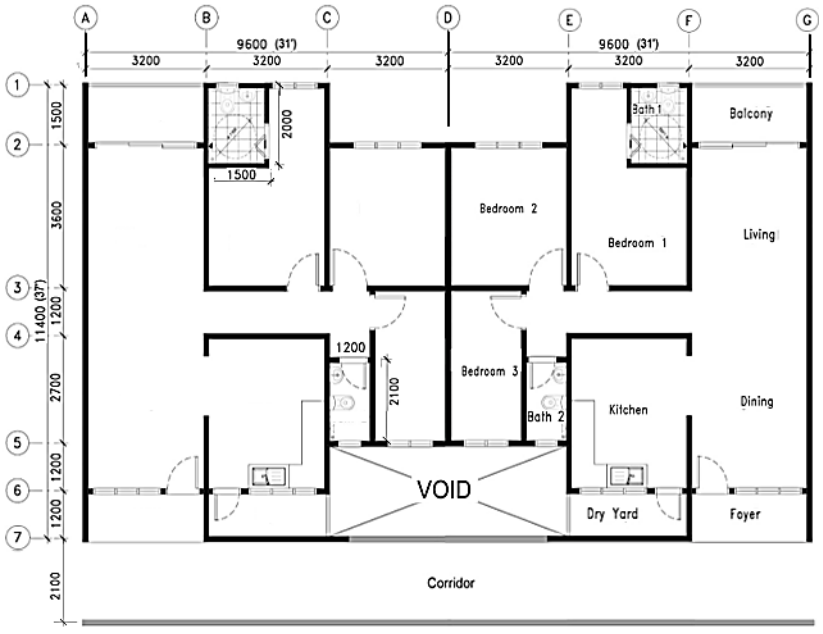
4.3 Example 2 - 18-Storey Apartment Development

A development of one block of 18-storey apartment consists of 352 units comprising 142 units of Type 1 and 210 units of Type 2 as detailed below:

a) 20 units per floor at typical floor (1st floor to 17th floor)
b) 12 units at ground floor
c) A typical floor comprises 8 units of Type 1 and 12 units of Type 2



Floor Layout for Type 1



Floor Layout for Type 2

Figure 6. Typical Floor Plan Layout for Apartment Units

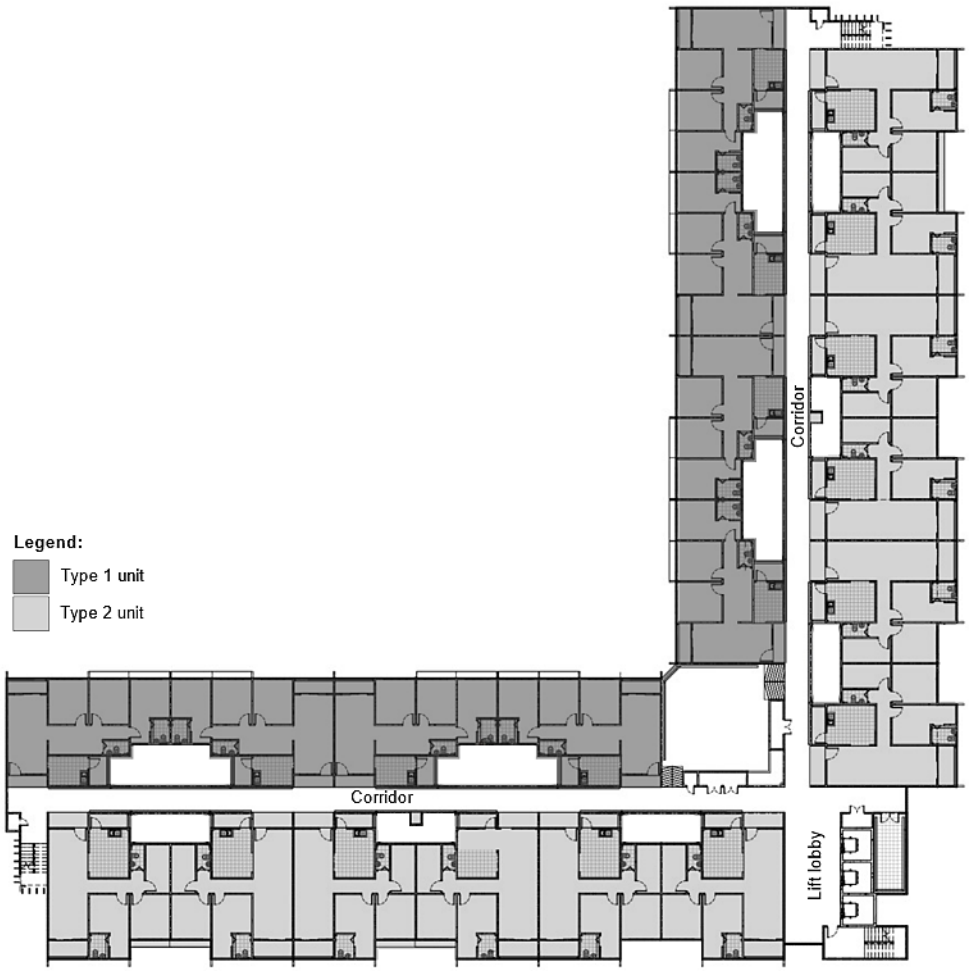


Figure 7. Typical Floor Plan Layout for 18-Storey Apartment

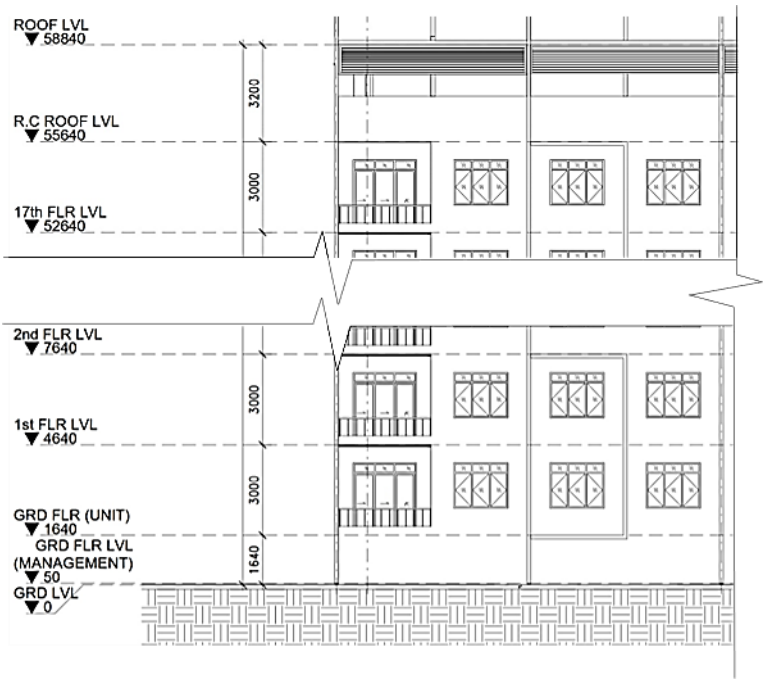


Figure 8. Typical Floor Height for 18-Storey Apartment

Table 28. Summary of the Systems used for 18-Storey Apartment

No.	Systems	Description
a)	Structural systems	
	i. Load-bearing walls (units)	Prefabricated wall using precast concrete
	ii. Load-bearing walls (lift core)	In situ concrete using reusable formwork system
	iii. Slabs	In situ concrete using reusable formwork system
b)	Roof systems	Prefabricated roof truss (Metal)
c)	Wall systems	
	i. External walls	Prefabricated wall using precast concrete
	ii. External walls (office/ shop lot at ground floor)	Prefabricated wall using glass panel
	iii. Internal walls (units)	Prefabricated wall using precast concrete
	iv. Internal walls (lift core)	In situ concrete using reusable formwork system

a) Part 1: IBS Score Calculation for the Structural System

Table 29. Calculation for the Structural Systems

No.	Structural Component	Construction Area (m^2)	IBS Factor	Coverage	IBS Score
a)	Typical floor (1st to 17th floor): - Prefabricated wall, column and beams. - In situ concrete using reusable formwork system slab. Type 1 area = 93.1m^2/unit x 8 units = 744.8m^2 Type 2 area = 96.9m^2/unit x 12 units = 1,162.8m^2 Corridor, lift lobby, utility room area = 364.7m^2	= (744.8 + 1162.8 + 364.7) = 2,272.3m^2 2,272.3 x 17 storey = **38,629.1m^2**	0.7	= 38,629.1/ 42,285.1 = 0.91	= 0.91 x 0.7 x 50 = 31.85
b)	Ground floor: - Prefabricated wall, column and beams. - In situ concrete using reusable formwork system slab (1st-floor slab). Type 1 area = 93.1m^2/unit x 6 units = 558.6m^2 Type 2 area = 96.9 m^2/unit x 6 units = 581.4m^2 Corridor, lift lobby, utility room area, shop, surau, entrance = 1,452.80m^2	= 558.6 + 581.4 + 1,452.8 = **2,592.8m^2**	0.7	= 2,592.8 / 42,285.1 =0.06	= 0.06 x 0.7 x 50 = 2.1
c)	Rooftop system - Prefabricated roof trusses (metal)	**= 1063.2m^2**	1.0	=1,063.2/ 42,285.1 = 0.03	= 0.03 x 1.0 x 50 = 1.5
	Total	**42,285.1m^2**		**1.00**	**35.45**

The total IBS Score the for the structural systems is 35.45.

b) Part 2: IBS Score Calculation for the Wall Systems

Table 30. Calculation for the Wall Systems

No.	Wall Component	Length (m)	IBS Factor	Coverage	IBS Score
a)	Wall system 1: - Prefabricated wall panels (precast concrete)	Typical floor units (1st -17th floor) = 1,560 x 17 storeys = 26,520m Ground floor (unit, management office, multi-purpose room, surau, shop, nursery) = 1,379m Rooftop = 564m = 26,520 + 1,379 + 564 = **28,464m**	1.0	= 28,464/ 28,949 = 0.984	= 0.98 x 1.0 x 20 = 19.6
b)	Wall system 2: - Prefabricated wall panel (Glass panel)	Management office: **= 4.3m**	1.0	= 4.3/ 28,949 = 0.00015	= 0.00015 x 1.0 x 20 = 0.003
c)	Wall system 3: - In situ concrete with reusable formwork	Lift core 25.3 x 19 storeys = **480.7m**	0.3	= 480.7/ 28,949 =0.0166	= 0.0166 x 0.3 x 20 = 0.0996
	Total	**28,949m**		**1.00**	**19.7**

The total IBS Score the for the wall systems is 19.7.

c) Part 3: IBS Score Calculation for Other Simplified Construction Solutions

Table 31. Calculation for the Standardised Components Utilisation

No.	Component	Dimension (mm)	Unit	% Usage	Points
a)	Beam	Refer to Section 2.5(c)(ii)): Maximum points shall be provided under the beams and columns section for structures using load-bearing walls systems (without beams and columns).			4
b)	Column				4
c)	Wall	a. 125 b. 150 c. 200	a. 3,415.68 b. 24,479.04 c. 569.28 d. Total = 28,464m	= 28,464 / 28,464 = 1.0 x 100 **= 100%**	4
d)	Slab	a. 150 b. 200	a. 2,240.0 b. 41,234.2 Total = 43,494.2m^2	= 43,494.2 /43,494.2 = 1.0 x 100 **= 100%**	4

No.	Component	Dimension (mm)	Unit	% Usage	Points
e)	Door	a. 1000 x 2400 b. 900 x 2400 c. 2100 x 2400 d. 1800 x 2350 e. 900 x 2100 f. 2700 x 2400 g. 1500 x 2100 h. 615 x 2100 i. 1200 x 2100	a. 352 b. 1,413s c. 352 d. 1 e. 714 f. 2 g. 4 h. 54 i. 56 Total = 2,948nos	= 2,893 / 2,948 = 0.98 x 100 **= 98%**	4
f)	Window	a. 1800 x 1500 b. 1200 x 1500 c. 600 x 750 d. 600 x 1200	a. 1,066 b. 847 c. 712 d. 36 Total = 2,661nos	= 1,949 / 2,661 = 0.73 x100 **= 73%**	2
				Total points calculated	**22**
Maximum points for this subcategory = 16 points				**Points awarded**	**16**

Table 32. Calculation for the Repetition of the Structural Layout

	Item	Description	% Usage	Points
a)	Repetition of floor-to-floor height			
	a. Ground Floor to 1st Floor b. 1st Floor to 17th Floor c. 17th Floor to Roof	4640 3000 3000	The height with the most repetition is **3000 mm**. = 17 / 18 = 0.94 x 100 = **94%**	3
b)	Vertical repetition of structural layout			
	a. Ground Floor b. 1st Floor to 17th Floor	a. Structural layout (ground level layout) – 1nos b. Structural layout (typical layout) – 17nos	The most repeated layout is a **typical layout**. = 17 / 18 = 0.94 x 100 = **94%**	3
			Total points calculated	**6**
Maximum points for this subcategory = 6 points			**Points awarded**	**6**

Table 33. Calculation for the Productivity Enhancing Solutions and Technology Adoption

No.	Item	% Usage / Description	Points
a)	Simulation and Modelling		
	i. Building Information Modelling (BIM)	**Apply BIM Level 2 between project teams.**	**6**
b)	Digitalisation and Virtualisation		
	i. Augmented Reality & Virtualisation	**Apply VR technology with build-up 3D models containing information about the building during project planning.**	**1**
	ii. Artificial Intelligence	- None	0
	iii. Big Data and Predictive Analytics	- None	0

No.	Item	% Usage / Description	Points
	iv. Blockchain	- None	0
	v. Cloud and Realtime Collaboration	**Apply Cloud and Realtime Collaboration between project teams.** Utilised cloud-sharing design collaboration for the multidiscipline team across project teams from different organisations in the execution of projects.	**1**
	vi. Internet of Things	- None	0
c)	Smart Construction		
	i. 3D Printing & Additive Manufacturing	- None	0
	ii. 3D Scanning and Photogrammetry	- None	0
	iii. Autonomous Construction	- None	0
	iv. Advanced Building Material	- None	0
	v. Prefabrication & Modular Construction		
	(a) Prefabricated Volumetric Module (PVM)	- None	0
	(b) Prefabricated staircase	**Apply precast concrete staircase.** - Prefabricated concrete staircase = 51nos - Cast in situ concrete staircase = 3nos Total staircase = 54nos **-** 51/ 54 = 0.94 = 94%	**4**
	(c) Usage of Prefabricated Mechanical, Electrical, and Plumbing (MEP) systems	**Apply prefabricated horizontal or vertical ceiling modules for pipes, cable tray and trunking.** - 95% utilisation	**4**
d)	Other enhancing solutions		
	i. Usage of self-climbing working platform	**Apply self-climbing working platform.** - integrated with a reusable formwork system during lift core construction	**2**
	ii. Usage of modular gridlines in drawings	**Apply modular gridlines for the major plan grids (x and y directions).** - x = 5 out of 10 are modular gridlines - y = 1 out of 10 is a modular gridline Total modular gridlines = 5 + 1 = 6nos Total gridlines = 20nos % modular gridlines = (6 / 20) x 100% **= 30%**	**0**
		Total points calculated	**18**
Maximum points for this subcategory = 14 points		**Points awarded**	**14**

Table 34. Summary of IBS Score Calculation for Other Simplified Construction Solutions

No.	Part 3: Subcategory	Points	
		Maximum	Awarded
1	Utilisation of Standardised Components (Table 31)	16	16
2	Repetition of the Structural Layouts (Table 32)	6	6
3	Productivity Enhancing Solutions and Technology Adoption (Table 33)	14	14
	Total points calculated		**36**
	Total IBS Score for Part 3	**30**	**30**

d) Total IBS Score Calculation for Example 2 – 18-Storey Apartment Development

Table 35. Summary of IBS Score Calculation for 18-Storey Apartment Development

No.	IBS Content	IBS Score	
		Maximum	Awarded
1	Part 1: Structural systems (Table 29)	50	35.45
2	Part 2: Wall systems (Table 30)	20	19.70
3	Part 3: Other simplified construction solutions (Table 34)	30	30.00
	Total IBS Score for Example 2	**100**	**85.15**

The total IBS Score for Example 2 (18-storey apartment development) is 85.15.

4.4 Example 3 – Open Hall (Building without Wall)

A development of one open hall without a wall system. Structural systems are prefabricated metal column and beam. Roof systems are prefabricated metal roof trusses.

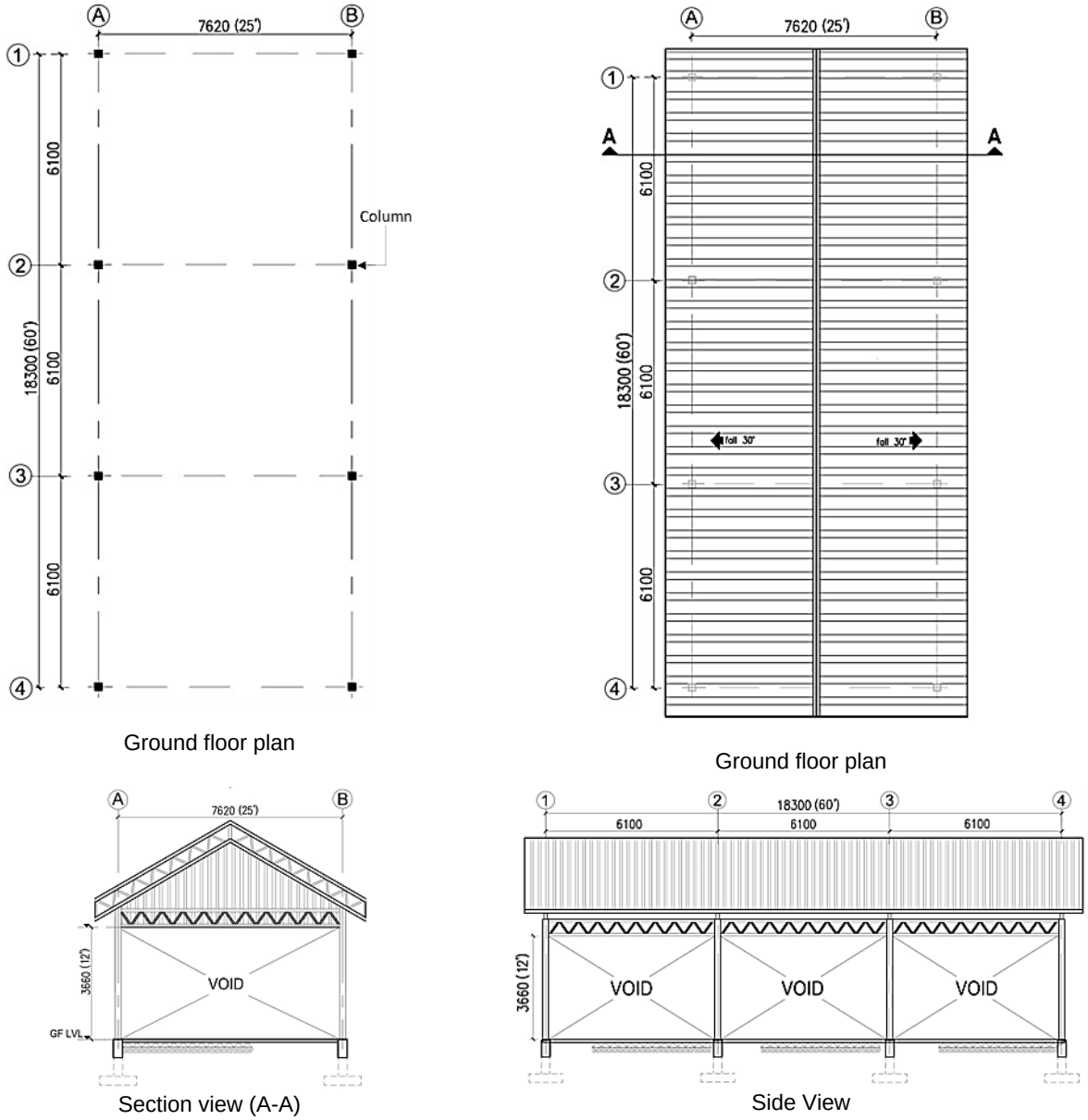


Figure 9. Typical Plan Layout and View for Open Hall (Building without Wall)

Table 36. Summary of the Systems used for Open Hall (Building without Wall)

No.	Systems	Description
a)	Structural systems	
	i. Beams	Prefabricated beams using metal framing
	ii. Columns	Prefabricated columns using metal framing
b)	Roof systems	Prefabricated roof truss (Metal)

a) Part 1: IBS Score Calculation for Structural Systems

Table 37. Calculation for Structural Systems

No.	Structural Component	Construction Area	IBS Factor	Coverage	IBS Score
a)	**Hall area:** Main structure - Prefabricated column and beam (metal framing). Slab - Void	= (7.62 x 18.3) = **139.45m^2**	1.0	= 139.45/ 278.9 = 0.5	= 0.5 x 1.0 x 50 = 25
b)	Roof system - Prefabricated roof trusses (metal)	= (7.62 x 18.3) **= 139.45m^2**	1.0	= 139.45/ 278.9 = 0.5	= 0.5 x 1.0 x 50 = 25
	Total	**278.9m^2**		**1.00**	**50**

The total IBS Score for structural systems is 50.

b) Part 3: IBS Score Calculation for Other Simplified Construction Solutions

Table 38. Calculation for the Utilisation of Standardised Components

No.	Component	Dimension (mm)	Unit	% Usage	Points
a)	Column	200 x 200	8 Total = **8nos**	= 8 / 8 = 1.0 x 100 **= 100%**	4
b)	Beam	150 x 200	10 Total = **10nos**	= 10 / 10 = 1.0 x 100 **= 100%**	4
				Total points calculated	**8**
Maximum points for this subcategory = 16 points				**Points awarded**	**8**

Remarks: No points were obtained under Subcategory 2 and Subcategory 3.

c) Total IBS Score Calculation for Example 3

Table 39. Summary of IBS Score Calculation for Open Hall (Building without Wall)

No.	IBS Content	IBS Score	
		Maximum	Awarded
1	Part 1: Structural systems (Table 37)	50	50
2	Part 3: Other simplified construction solutions (Table 38)	30	8
	Refer clause 2.2.2 and Equation 2, for a building without wall		**(58/80) x 100**
	Total IBS Score for Example 3	**80**	**72.50**

The total IBS Score for Example 3 (Open Hall (Building without Wall)) is 72.50.

4.5 Example 4 - Group of Buildings Development

Assume examples 1, 2, and 3 in one development. The summary of the whole development is as set out below:

a) **Zone 1 – 8 blocks of 10 units single-storey terrace house (refer to clause 4.2)**

- Construction area, $Q_{ST\ (building)}$ (1,553.74m^2 x 8) = 12,429.92m^2
- IBS Score = 73.62

b) **Zone 2 – 2 blocks of 18-storey apartment (refer to clause 4.3)**

- Construction area, $Q_{ST\ (building)}$ (42,285.10m^2 x 2) = 84,570.20m^2
- IBS Score = 85.15

c) **Zone 3 – Open hall (refer to clause 4.4)**

- Construction area, $Q_{ST\ (building)}$ = 278.90m^2
- IBS Score = 72.50

d) **Total construction area for the whole development,** $Q_{ST\ (project)}$ **= 97,279.02m^2**

IBS Score for projects with a group of buildings can be calculated using Equation 3 from Clause 2.6. The calculation and summary of the IBS Score is shown in Table 40.

Table 40. Calculation and Summary for the IBS Score (Group of Buildings Development)

ZONE	CONSTRUCTION AREA (m^2)	COVERAGE	IBS SCORE (BUILDING)	IBS SCORE (PROJECT)
1	12,429.92	12,429.92 / 97,279.02 = 0.128	73.62	0.128 x 73.62 = 9.41
2	84,570.20	84,570.20/ 97,279.02 = 0.869	85.15	0.869 x 85.15 = 74.03
3	278.90	278.90/ 97,279.02 = 0.003	72.50	0.003 x 72.50 = 0.21
Total	**97,279.02**	**1.0**	**-**	**83.64**

The total IBS Score for the whole project development is 83.64.

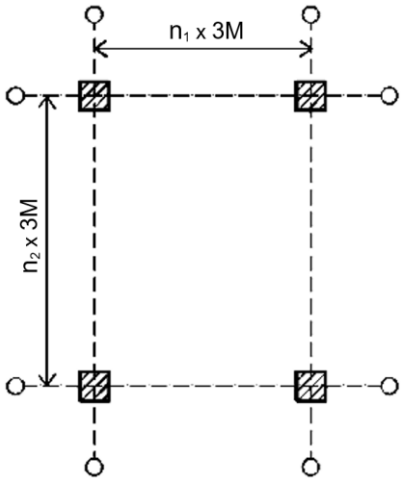
ANNEX A
(normative)
Modular sizes for standardised component

a. A series of modular standards for the standardisation of building components are being produced to facilitate the rationalisation and industrialisation of this sector in the country. The components considered in this section are standardised components.

b. M is the symbol for the basic module defined in MS1064-1 and having the value of 100 mm.

c. The spaces for these components have been related to the horizontal and vertical plane of the modular controlling reference system.

d. Reference system to which horizontal dimensions are related is illustrated in Figure A1.



Plan View

Figure A1. Reference System for Horizontal Controlling Dimensions

i. Standardised sizes for beam

Beam is the horizontal member connected to column or beam or wall or any structural member to form a structural frame or system. The beam depth shall be measured from full depth based on structural design depth. In vertical section, the depth and width are defined in Figure A2.

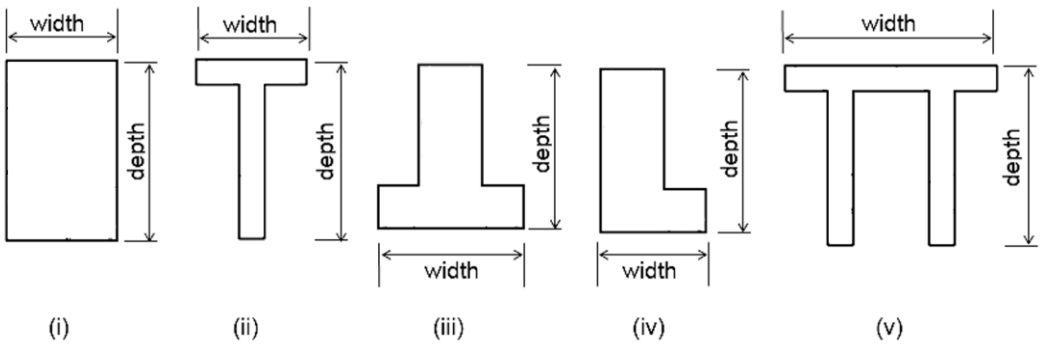


Figure A2. Example of Beam Sections

The standard sizes for beam shall be as set out in Table A1.

Table A1. Standard Sizes for Beam

Dimensions	Sizes
Width	Minimum of 1M at increment of 0.25M
Depth	Minimum of 2M at increment of 0.5M

ii. Standardised sizes for column

Column is the vertical member connected to beam to form a structural frame or system. Columns can be square, rectangular, or circular. For rectangular column sections, the length in horizontal cross sections does not exceed four times their width, as illustrated in Figure A3.

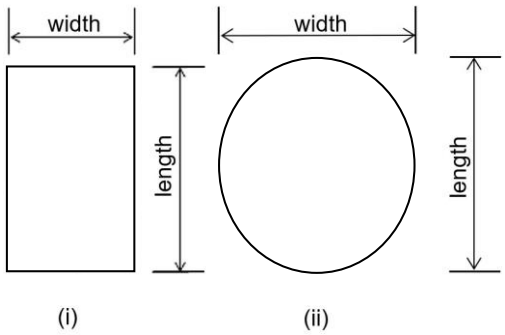


Figure A3. Example of Column Sections

The standard sizes for columns shall be as set out in Table A2.

Table A2. Standard Sizes for Columns

Dimensions	Sizes
Width	Minimum of 1M at increment of 0.25M
Length	Minimum of 1M at increment of 0.25M

iii. Standardised sizes for wall

Wall is the vertical member connected to slab and beam to form a structural frame or system. Walls are normally rectangular and their length in horizontal cross sections are greater than four times their thickness, as illustrated in Figure A4.

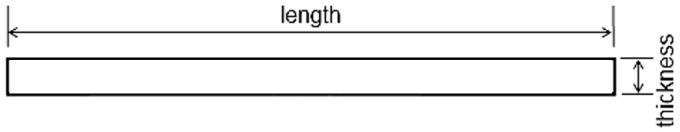


Figure A4. Example of Typical Wall Section

The standard sizes for walls shall be as set out in Table A3.

Table A3. Standard Sizes for Walls

Dimensions	Sizes
Thickness	Minimum of 0.75M at increment of 0.25M

iv. Standardised sizes for slab

Slab is the horizontal floor member supported by beams, walls or columns. In section view, the slab thickness are defined in Figure A5.

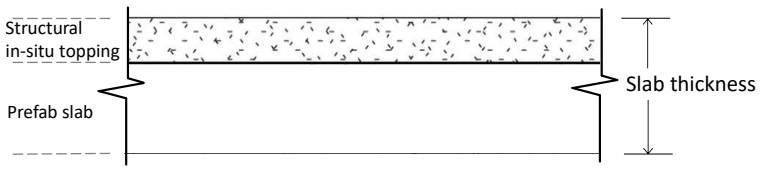


Figure A5. Example of Typical Slab Section

The standard sizes for slabs are as set out in Table A4.

Table A4. Standard Sizes for Slabs

Dimensions	Sizes
Thickness	Minimum of 1M at increment of 0.25M

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