IHSAN HOMES

Innovative Affordable Housing Design for Tropical Climate Through Technology

CIDB TECHNICAL PUBLICATION NO: 216

CIDB MALAYSIA

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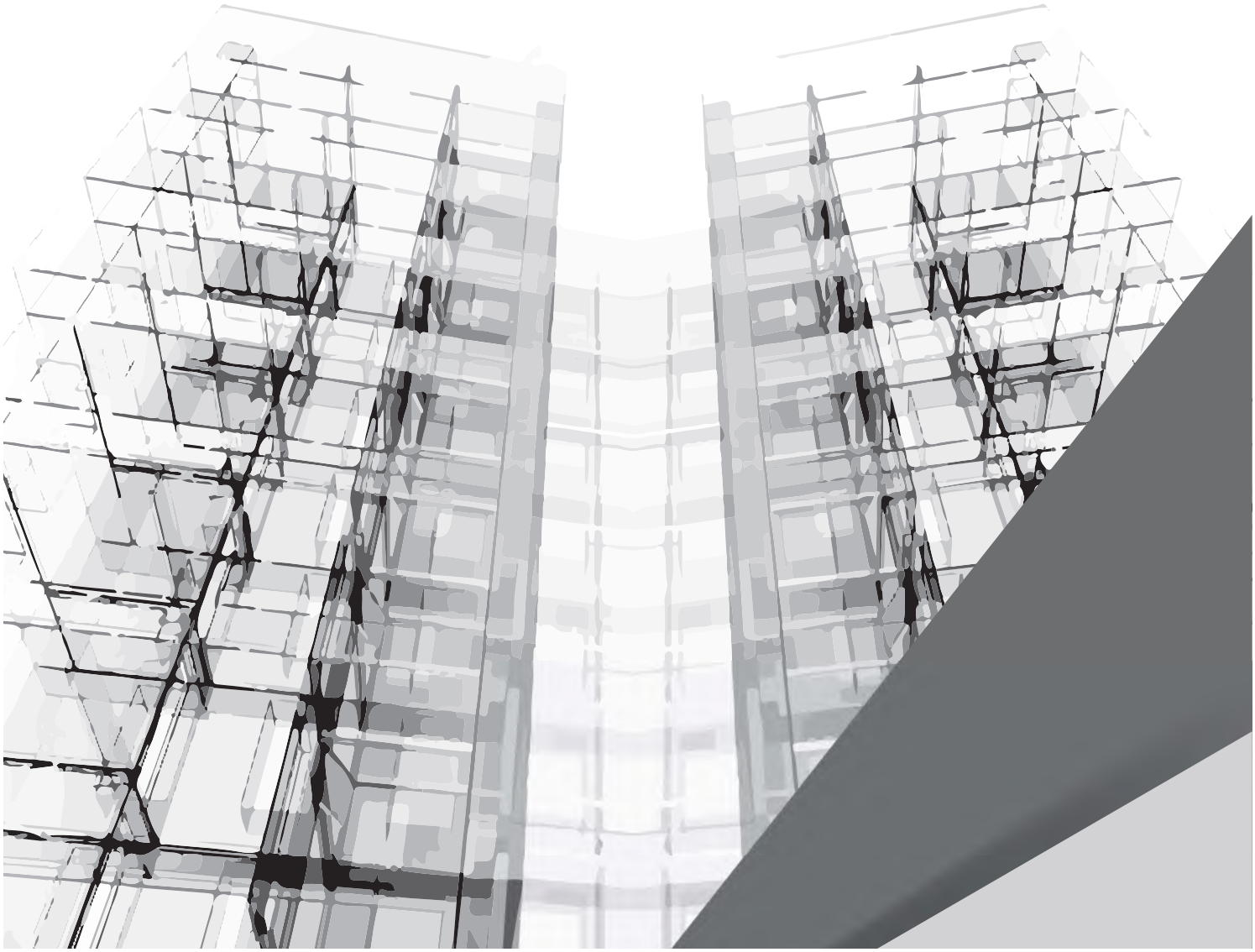

Research Collaboration

CREAM CONSTRUCTION RESEARCH INSTITUTE OF MALAYSIA

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GREENIBS CONSULT

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PREFACE

Shortage of Affordable Housing is the main issue in many countries including Malaysia. The limited supply of affordable housing is due to growing market, which leads to high demand in many places. The Malaysian government plays a big role to deliver and create affordable housings as quickly as possible. Therefore, the Construction Industry Development Board (CIDB) Malaysia takes the responsibility to support the government to fulfil the need of people in Malaysia. CIDB takes a step ahead to conduct the research on affordable housing, with its research arm, the Construction Research Institute of Malaysia (CREAM) to provide a sufficient affordable housing so that the target receivers can enjoy the quality, decent, comfortable, and sustainable design, especially in Malaysia that has the tropical climate throughout the year. Besides, cost-efficient, innovative, and forward-thinking designs are the features required for a great house, while taking into account the aspects of expediency, wellbeing, society driven as well as value for living for the residents and their family.

This handbook entitled **Innovative Affordable Housing Design for Tropical Climate Through Technology** is a one of the outputs completed from the research, which aims to diversify affordable housing design and realises the national agenda to provide innovative, hum anising, sustainable, and tropical climate-based design known as **IHSAN Homes**. The IHSAN Homes integrate passive design concept in the tropical region, with the optimised open concept, even during the heat of the day to maximise cross ventilation and convective air flow via the forward-thinking modern design. Moreover, this research has embraced the Building Information Modelling (BIM) platform, which is utilised and incorporated by the team during the design stage for better coordination of the developed design. A set of requirements is established prior to design commencement with standardised naming or code and set in the BIM Execution Plan (BEP). The Industrialised Building System (IBS) is the catalyst to leverage the modern construction with new technology adoption in this research.

IHSAN Homes is the comprehensive design affordable housing that includes of high-rise apartment, 1-storey terrace, and 2-storey townhouse. This handbook consists of manual on architectural, civil and structural, mechanical, electrical and plumbing designs, including BIM integration. The estimated cost of construction is also incorporated in this book as the rule of thumb in estimating the cost of developing the affordable housing projects.

This publication serves as the added value to the standard guide, to be utilised as the pre-approved plan and reference by the industry players in working on the affordable housing projects. Policymakers and housing authorities shall apply this handbook as a basic guide to encourage players in the housing industry to adopt new technology and innovation with sustainable housing design strategy.

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EDITORIAL

This project was funded by the Construction Industry Development Board (CIDB) Malaysia and executed by the Construction Research Institute of Malaysia (CREAM) from December 2019 to December 2020. We would like to thank the editorial team for their contribution and support.

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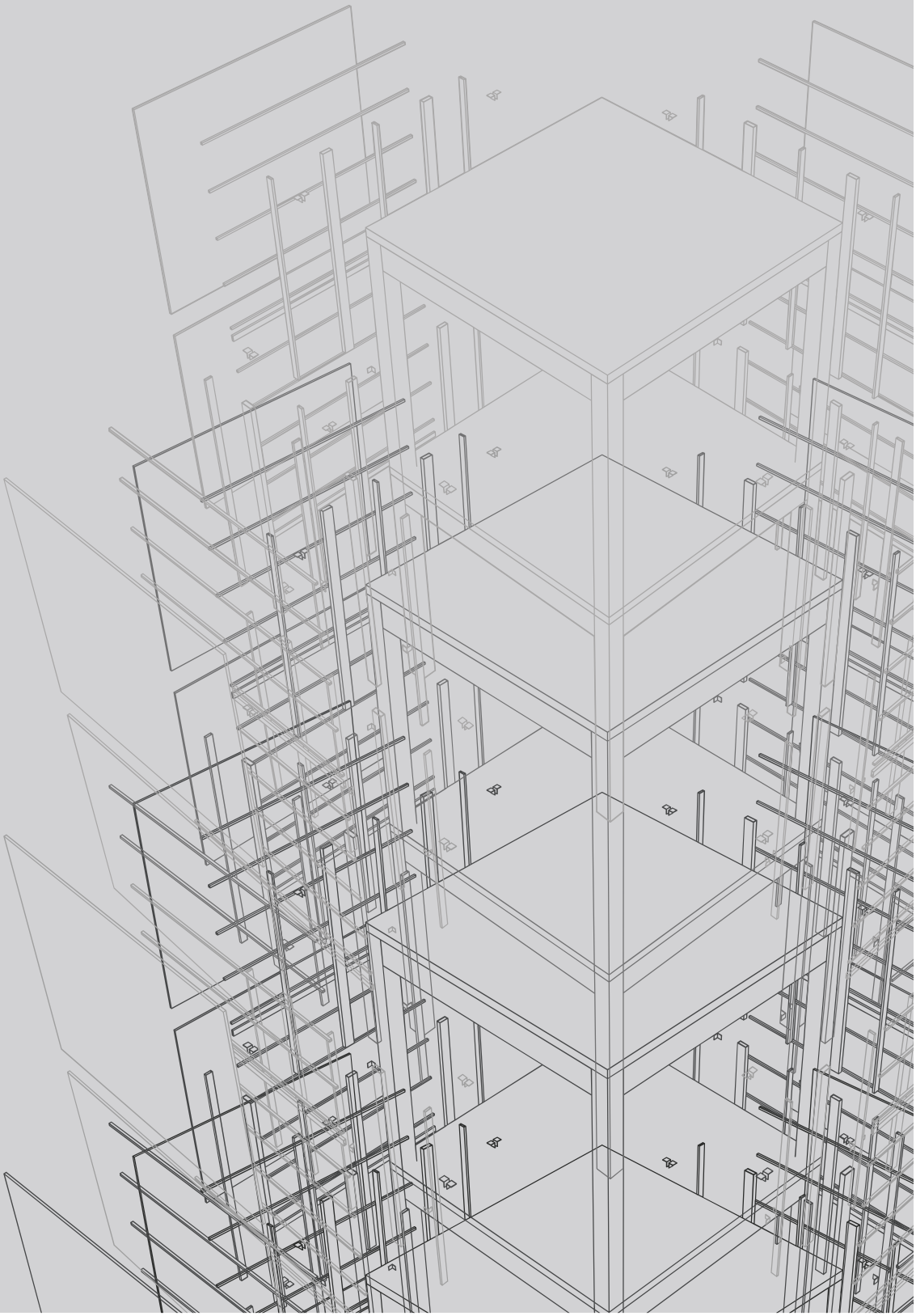
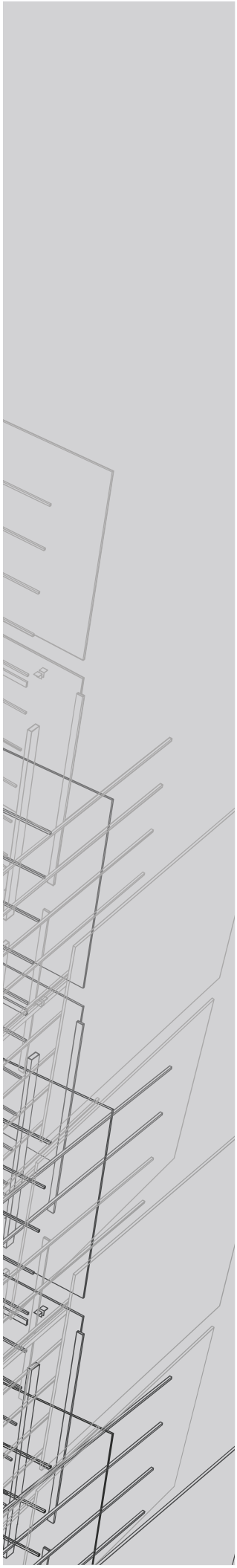




ACB	Air Circuit Breaker
ACSU	Air Cooled Split Units
ASHRAE	American Society of Heating and Refrigeration Engineers
BEP	BIM Execution Plan
BIM	Building Information Modelling
CCTV	Closed-circuit television
CDE	Common Data Environment
CIDB	Construction Industry Development Board
CREAM	Construction Research Institute of Malaysia
dB	Decibel
DRMM	National Affordable Housing Policy (Dasar Perumahan Mampu Milik)
EIR	Employer's Information Requirements
HVAC	Heating, Ventilation, and Air Conditioning
HAP	Hazardous Air Pollutant
IBS	Industrialised Building System
IES	Illuminating Engineering Society
KWH	Kilowatt hour
LV	Low Voltage
MATV	Master Antenna Television
MDF	Main Distribution Frame
MEP	Mechanical Electrical Plumbing
MHZ	Megahertz
MS	Malaysia Standard
MSB	Main Switchboard
NFPA	National Fire Protection Association
PBU	Prefabricated Bathroom Unit
PDN	Project Document Numbering
PVM	Prefabricated Volumetric Module
RH	Relative Humidity
RWHT	Rainwater Harvesting Tank
SESB	Sabah Electricity Sdn Bhd
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
TNB	Tenaga Nasional Berhad
UBBL	Uniform Building By-Laws

INTRODUCTION TO IHSAN HOMES

IHSAN Homes Design Philosophy
IHSAN Homes Design Approaches
IHSAN Homes Housing Types

IHSAN HOMES DESIGN PHILOSOPHY

The global market is witnessing increasing demand for affordable housing, even in Malaysia. Over the years, CIDB comes up with initiatives to develop affordable housing designs via research and publication according to the industry of standard support government's effort in providing affordable housing to the nation. The collaboration between CIDB, CREAM and industry players has resulted in a new affordable housing design known as IHSAN Homes. The term IHSAN reflects the characteristics of the design concept as follows:

I Innovative
H Humanising
S Sustainable
A Affordable
N New technology

The concept of IHSAN Homes focuses on balancing good design with cost consideration. It adheres to the National Affordable Housing Policy (Dasar Perumahan Mampu Milik Negara, DRMM) guidelines in terms of specifications and dimensions. It is suitable for all household variety while being able to adapt to the changes in household.

In addition to affordable housing, the quality and sustainability aspects of the design are taken into consideration, since Malaysia is a tropical country. Sustainable affordable housing design is the main concern in this region. Furthermore, the comfort and wellbeing of the occupants in a home is the utmost priority.

The philosophy of this design concept is beyond provision of adequate shelter, it is to bring joy in living via affordable housing.

IHSAN HOMES DESIGN APPROACHES

A good design is essential for cost saving, particularly in affordable housing development. Hence, a development that provides a convenient and quick access to commute to work should be the aim for affordable housing.

The design allows each unit to enjoy good ventilation and natural lighting while offering a conducive living environment for the residents. The key aims in developing this design are to take into account these four components:

IHSAN Homes

IHSAN HOMES HOUSING TYPES

IHSAN Homes High-Rise Apartment

IHSAN Homes 2-Storey Townhouse

IHSAN Homes 1-Storey Terrace House

SECTION 1

IHSAN HOMES
HIGH-RISE APARTMENT

Architectural Design Concept
Civil & Structural Design
Mechanical, Electrical & Plumbing Design
Construction Cost Estimation

ARCHITECTURAL DESIGN CONCEPT

Design Overview

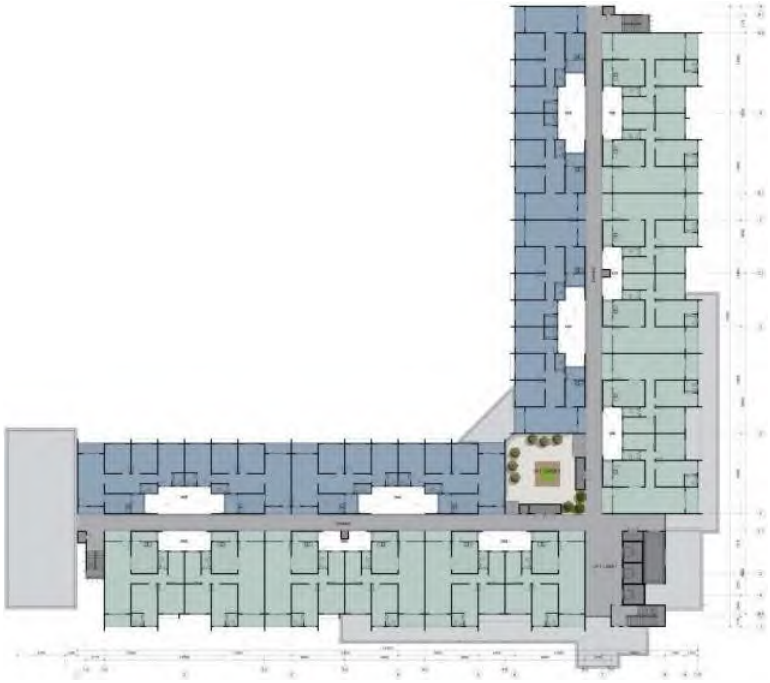
Perspective View of the Apartment Block (Artist Impression)

The tower blocks are arranged in L-shape to optimise the use of space on in the urban areas. Assuming the tower shall be built on 5 acres of land with a total of 352 units and 430 carparks, including the green areas and recreational zone strategically placed in the housing area.

The L-shape layout can accommodate more units with shorter corridor length and distance to the lift for each floor. With more units per floor (as in our case 20 units per floor), the number of lifts provided can be optimised, hence meeting the technical requirements at lesser cost. The empty spaces at the inverted corner or junction serve as the "secured communal space" (e.g. Sky Garden, Community Park at Ground Level).

SECTION 1

Apartment Block Site Plan Layout (Master Plan)



Typical Floor Plan Layout

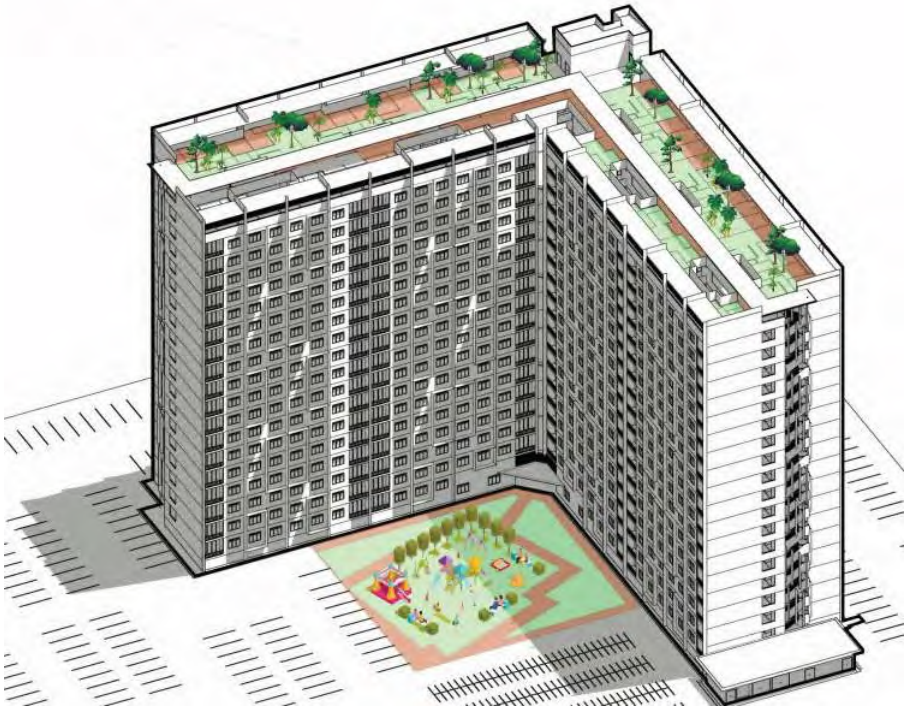
Design Features

Centralised Square	• Connecting people by providing more common spaces • Activating the community living via neighbourhood programmes
Integrated Development	• Offering spaces for living and experiences • To recreate a friendly neighbourhood even at the high-density apartment
Wealth & Sustainability	• Conducive environment considering all aspects of life

Design Concept of the IHSAN Homes Apartment

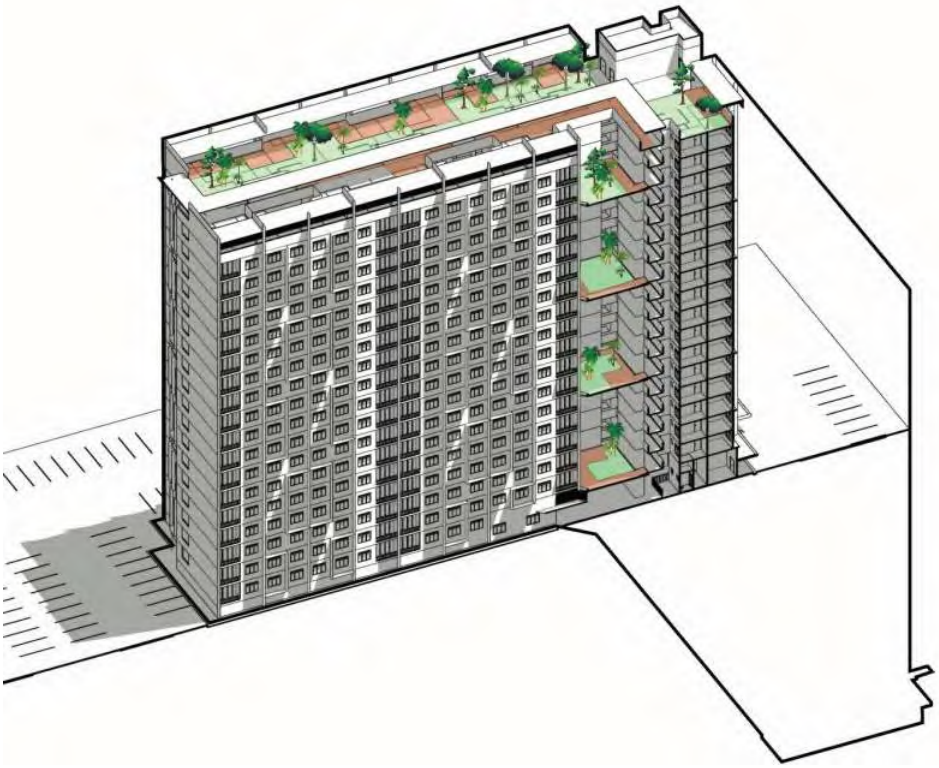
Skyrise Greenery at the Rooftop

Facilities such as the Rooftop Farming and Co-working Spaces are designed to create a building that is centred around community production and activity. Skyrise Greenery serves as a place of retreat for social, recreational and leisure events.



Sky Garden at the Intermediate Floor Level

The common facilities are positioned and carefully designed to offer the greatest amenity to the residents from all walks of life to enjoy. They will be complemented by luscious landscape and vertical sky gardens to impart a luxurious, natural feeling. Sky garden at the distributed floor levels is to accommodate smaller gathering and activities.



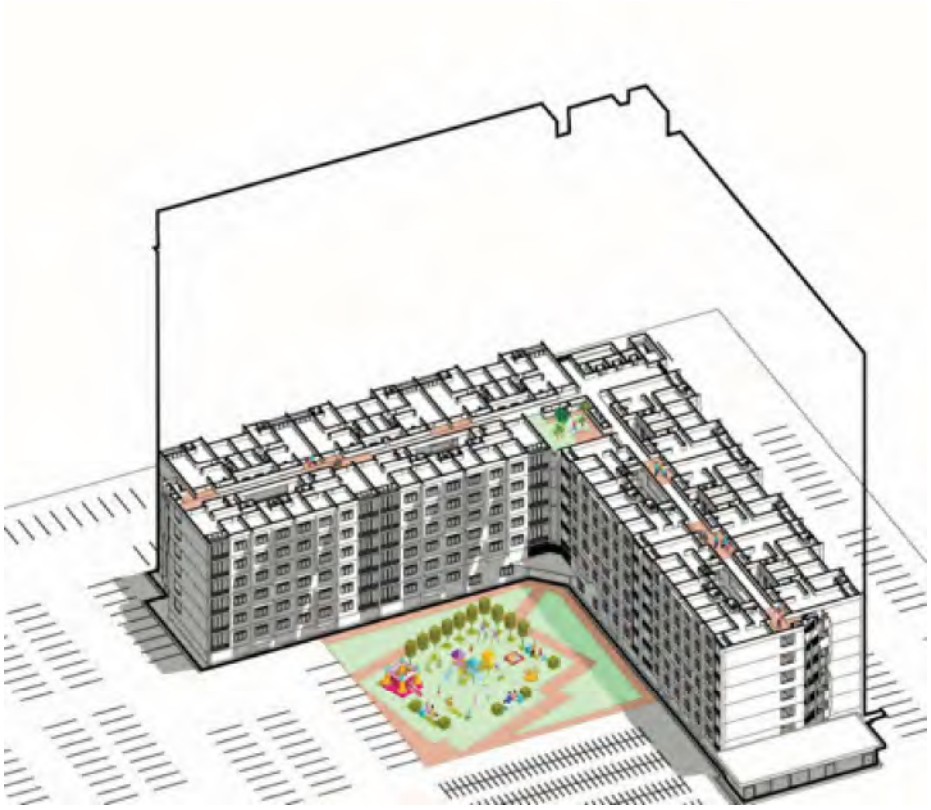
SECTION 1

Aim

- To creates a social space that enhances interaction.
- To connect people by providing extra common spaces.
- To recreate a friendly neighbourhood even at the high-density apartment.

Connected Corridor

Airy and well-lit corridors provide a healthy and joyful space for residents to bump into each other and have a great community interaction. The corridors are designed as a social space, with ample sunlight and ventilation to ensure comfort and safety.



Community Living and Facilities

Facilities at the Ground Floor

• *Multiple information screens to be placed in common areas.*

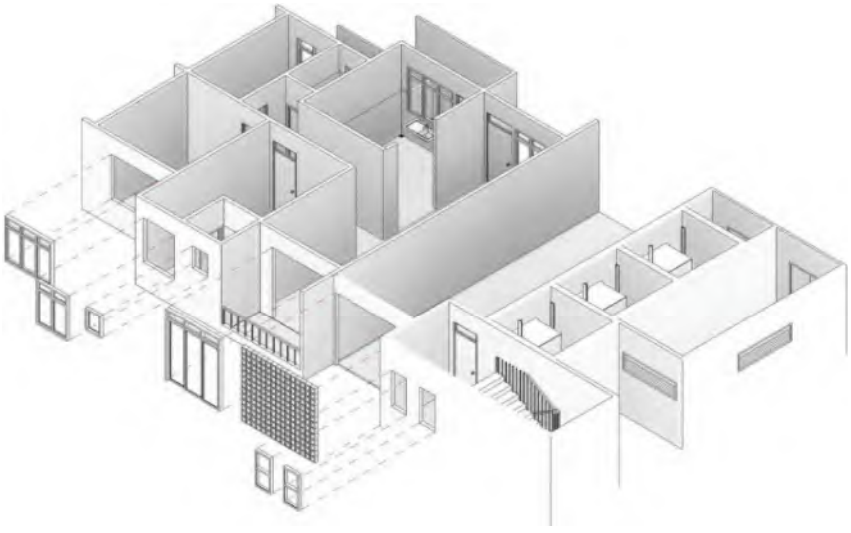
• *Spacious & welcoming lift lobby assuring comfort & security.*

Spacious, brightly lit and naturally ventilated waiting area at the ground level for extra comfort & security

Sustainability Design

Sustainable strategies are passive systems that are cost-effective to achieve a minimum of Silver Rating according to GreenRE (green building rating system). Innovation such as the monsoon window can reduce the use of air conditioning, thus save energy. The apartment is equipped with circulation of light and air for the sake of health, safety, and comfort of the residents. The windows allow natural ventilation throughout the day, even during the rainy days.

Sustainability Design Features



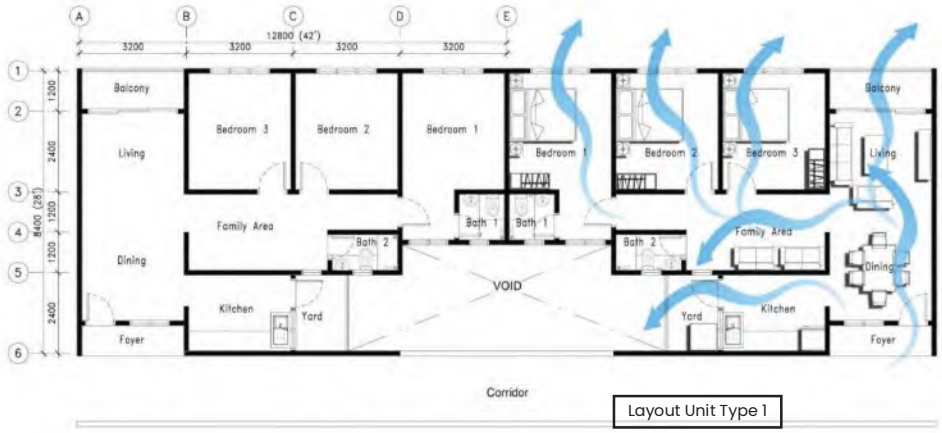
Arrangement of Windows and Openings of the Apartment Unit

SUSTAINABLE DESIGN COMPONENT

PASSIVE SUSTAINABLE DESIGN	• Internal Room Size & Location. • Use of Sun Shading Device • Emphasis on Natural Ventilation & Natural Lighting. • Structural Modular Design. • Time & Construction Waste Saving Method of Construction (IBS, PVM).
ACTIVE SUSTAINABLE DESIGN	• Implement High - efficiency Electrical, Plumbing, HVAC.
RENEWABLE ENERGY SYSTEM	• Energy Efficient - Use of LED Lighting System. • Use of Variable Speed Drive (VSD) System for Cold Water Pump. • Water Efficient Plumbing and Irrigation
GREEN BUILDING MATERIALS & FINISHES	• Use of Non - Toxic, Hard Standing and Durable Building Materials & Finishes
STORM WATER MANAGEMENT	• Recycling of Storm Water for planting and landscaping

Natural Ventilation

Layout Unit Type 2



Layout Unit Type 1

Natural Day Lighting

Layout Unit Type 2

Layout Unit Type 1

Facade/Sun Shading Device

The design of façade is based on a modular system that visually attractive and avoid the monotonous look. In addition, the windows can fully adapt to the tropical climate. Vertical shading fins or coping function to shade from the sun from the west side.

Design Layout

The design is intrinsically modular, from the main structural grid all the way to the door and windows. Therefore, it can be built using the IBS system. All units have universal design which is disabled-friendly.

The apartment consists of:

- 17-storey residential units
- 12 units per floor at the ground floor.
- 20 units per floor at the typical floor (from the 1st floor and beyond)

Typical Unit Layout

Apartment Unit Type 1

Apartment Unit Type 1 Floor Area Schedule

AREA	FLOOR AREA (NETT)	
	M²	FT²
Foyer	2.1	22.6
Living	21.1	227.0
Dining	11.5	124.0
Balcony	3.5	37.3
Bedroom 1	12.2	130.80
Bath 1	3.6	38.7
Bedroom 1	10.8	116.2
Bedroom 2	6.9	74.2
Bath 2	3.6	38.7
Kitchen	9.3	100.1
Yard	3.8	40.4
TOTAL	**88.3**	**950.1**

Apartment Unit Type 2

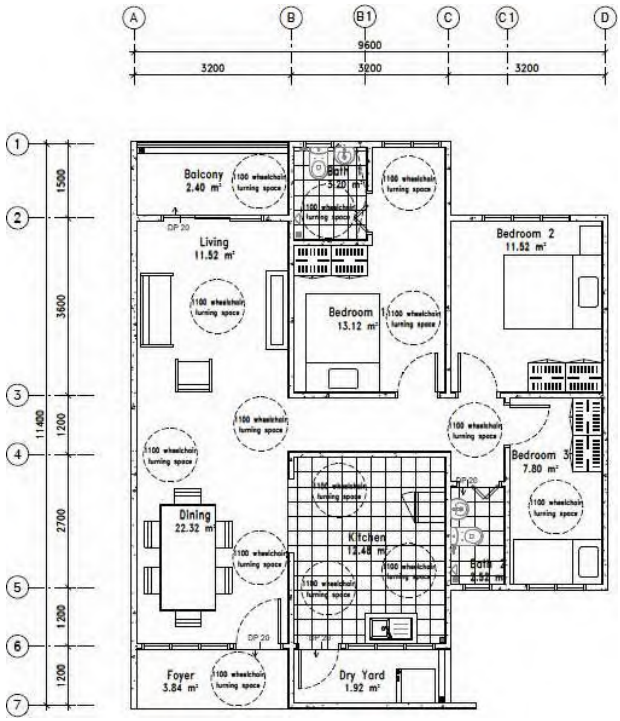
Apartment Unit Type 2 Floor Area Schedule

AREA	FLOOR AREA (NETT)	
	M²	FT²
Foyer	1.9	20.0
Living	17.3	185.9
Dining	11.4	122.8
Balcony	3.8	41.3
Bedroom 1	13.4	144.6
Bath 1	3.2	34.4
Bedroom 1	11.5	124.0
Bedroom 2	9.6	103.2
Bath 2	3.2	34.3
Kitchen	11.0	118.8
Yard	5.3	56.8
TOTAL	**91.7**	**986.3**

Accessibility

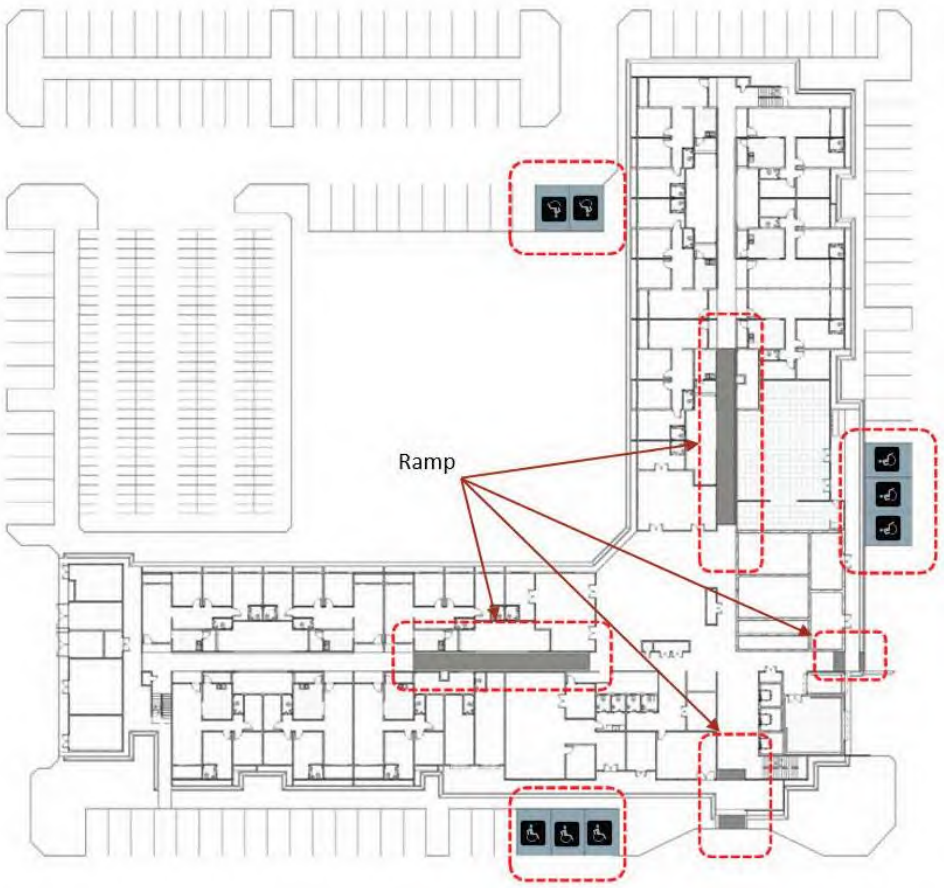
Accessibility of The Apartment Unit

The house plans are designed in a way that accommodates people with limited mobility. It promotes self-dependency so that dwellers are happy and confident. Wider doors and hallways enable easy passage for those using wheelchair. A wider entrance makes the bathroom accessible for wheelchair users.



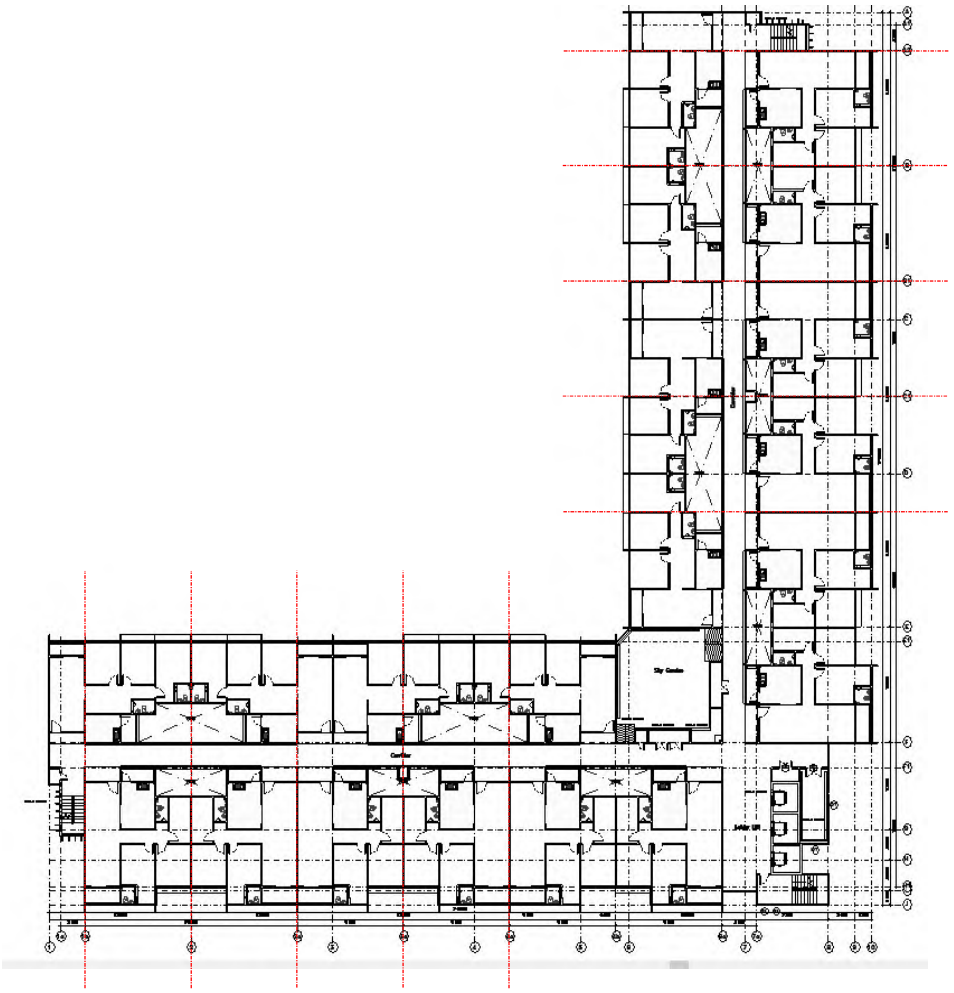
Accessibility of Block

The apartment is equipped with ample car parking space that is accessible by the residential block. Ramp is also provided for the ease of the wheelchair users.



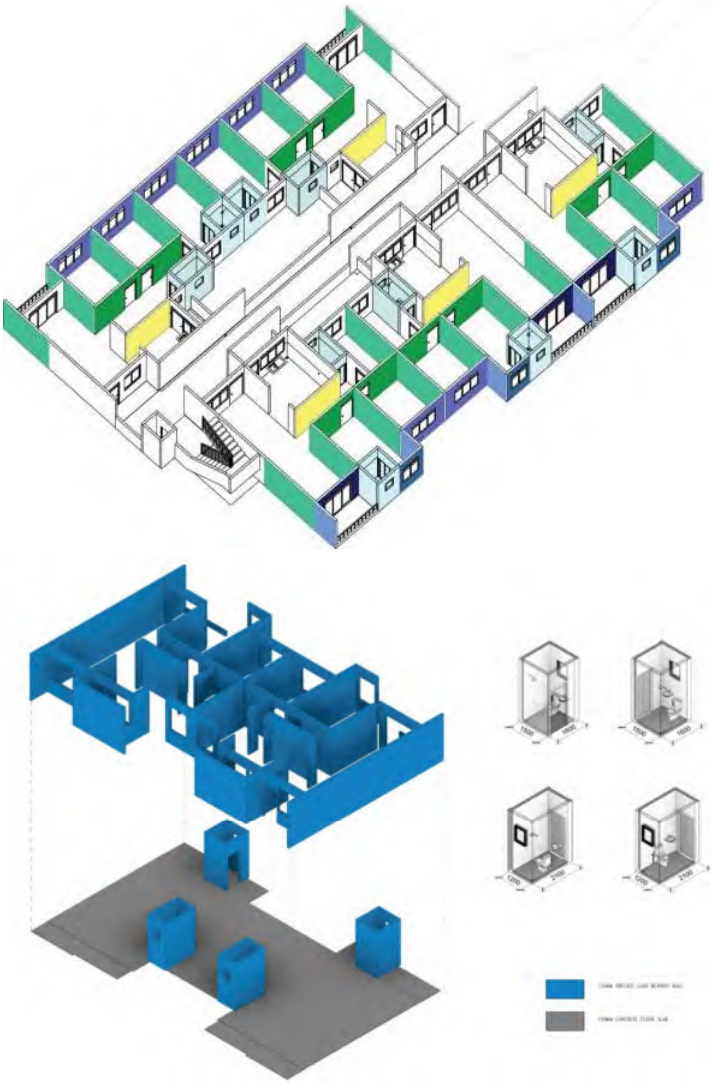
Modularisation Design

Major grid is the basis of the structures and it is based on the Malaysian Standard MS 1064 prefabrication guidelines. This makes the building ready for IBS, in the event of the developer decides to adopt the industrialised system.



Modularity enables the building to be prefabricated with economies of scale. This development strategy enables faster design coordination and the use of IBS system.

The modular system that is adopted for the entire building allows quick adoption of IBS construction. Even it does not necessarily result in short term savings, it does allow the project to be completed faster.

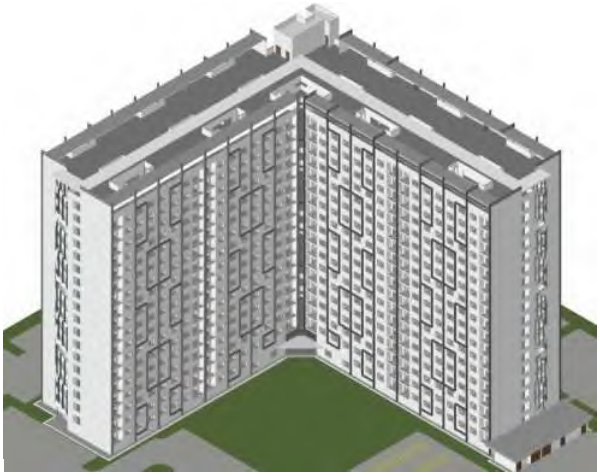


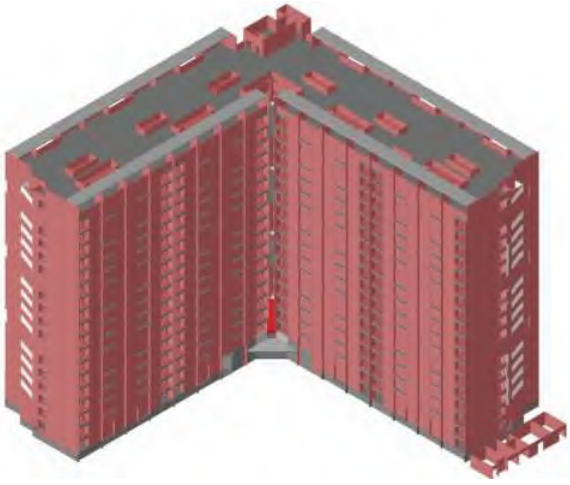
Modular System for the Apartment Unit

Integration of BIM

The Building Information Modelling (BIM) is integrated during design and construction stages, using lesser manpower and shorter duration to be completed.

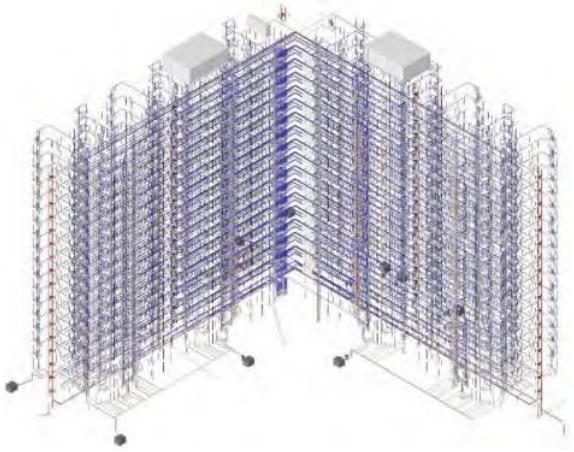
- *Architectural Model*





- *Structural Model*

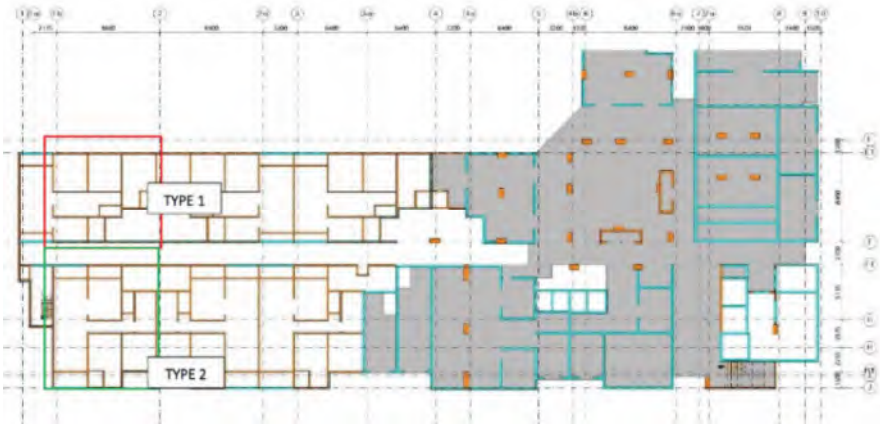
- *MEP Model*



CIVIL & STRUCTURAL DESIGN

Structural Layout

The 18-floor apartment model utilises the precast walls and precast slabs. There are two types of units, namely Type 1 and Type 2. The difference between both is the layout. Type 1 has the area of 80.64 m² while Type 2 has the area of 105.60 m².

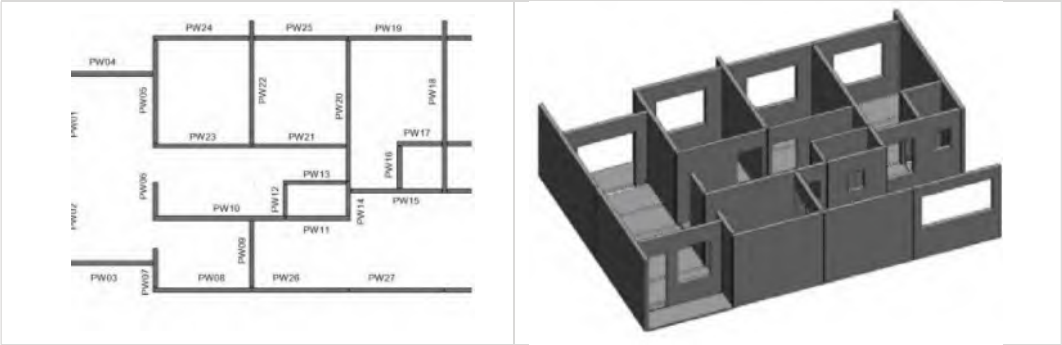


Type 1 and Type 2 Apartment Unit Layout at the Ground Floor

Wall Design

The load-bearing precast walls have the specifications of maximum length of 6220 mm, thickness of 150 mm, and weight of 6.33 tonnes. The load-bearing walls transfer load from different components and reduce additional elements such as columns and beams. Thus, the removal of load-bearing walls does affect the structural integrity of the building. Each unit of the apartment requires 19 wall panels.

Apartment Unit Type 1

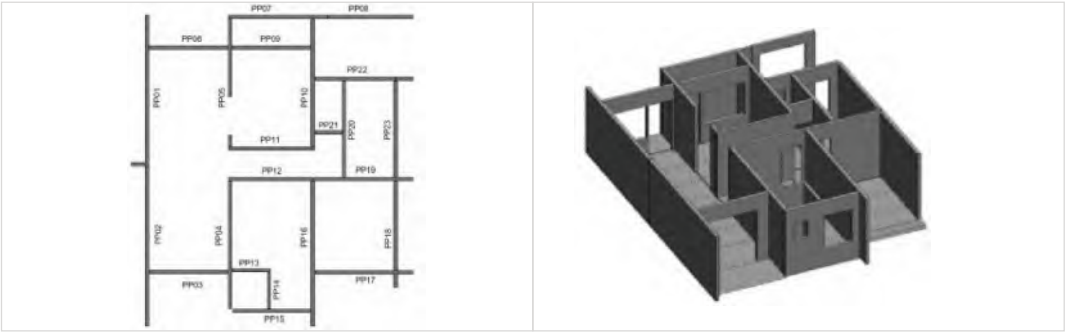


Type 1 Precast Wall Layout and 3D View

Type 1 Precast Wall Specifications

WALL MARKING	THICKNESS (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PW01	150	5148	2.32	5.56
PW02	150	3863	1.74	4.17
PW03	150	3007	0.72	1.74
PW04	150	3008	0.62	1.48
PW05	150	3433	1.54	3.71
PW06	150	1110	0.5	1.2
PW07	150	1298	0.58	1.4
PW08	150	3266	1.47	3.53
PW09	150	2208	0.4	0.96
PW10	150	4388	1.91	4.58
PW11	150	2148	0.9	2.16
PW12	125	1020	0.15	0.36
PW13	125	2060	0.77	1.85
PW14	150	1148	0.52	1.24
PW15	150	3020	1.03	2.46
PW16	150	1408	0.35	0.84
PW17	150	1485	0.67	1.6
PW18	150	5750	2.58	6.2
PW19	150	3079	0.98	2.35
PW20	150	4658	1.78	4.27
PW21	125	3095	0.9	2.15
PW22	150	4113	1.84	4.43
PW23	125	3275	0.97	2.32
PW24	150	3185	1.03	2.47
PW25	150	3103	0.99	2.38
PW26	150	3200	1.44	3.46
PW27	150	3165	0.9	2.17
TOTAL	**27**			

Apartment Unit Type 2



Type 2 Precast Wall Layout and 3D View

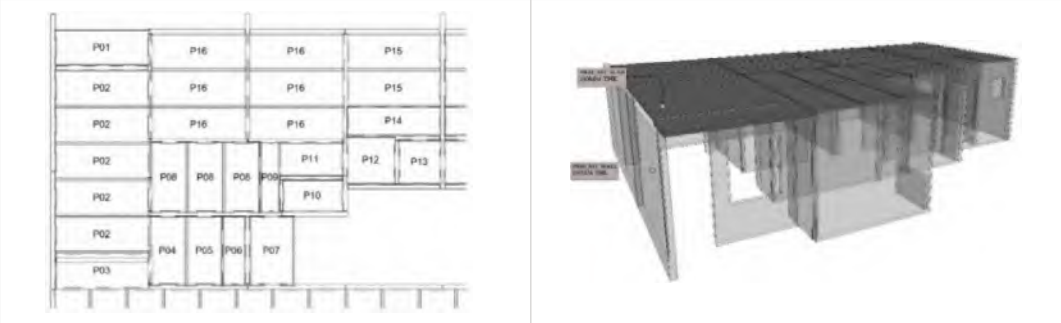
Type 2 Precast Wall Specifications

WALL MARKING	THICKNESS (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PP01	150	5861	2.64	6.33
PP02	150	6150	2.77	6.64
PP03	150	3035	0.61	1.47
PP04	150	4920	2.21	5.31
PP05	150	4920	1.54	3.69
PP06	150	3065	0.61	1.47
PP07	150	3850	1.73	4.16
PP08	150	2603	0.77	1.84
PP09	150	3020	0.63	1.51
PP10	150	4920	2.21	5.31
PP11	125	3350	1.26	3.01
PP12	125	3265	0.95	2.29
PP13	125	1472	0.55	1.32
PP14	125	1408	0.29	0.7
PP15	150	3185	1.01	2.43
PP16	150	5597	2.52	6.04
PP17	150	6220	1.99	4.77
PP18	150	4098	1.84	4.42
PP19	125	3196	0.93	2.22
PP20	150	3733	1.36	3.25
PP21	150	1019	0.18	0.43
PP22	150	3100	1.06	2.54
PP23	150	3733	1.68	4.03
TOTAL	**23**			

Slab Design

The slabs are designed in the form of half slab with these specifications; 3020 mm length, thickness of 150 mm, and weight of 1.0 ton. One apartment unit requires 17 slabs. Precast half slab has flat soffit with a good finish that requires minimum formwork. Both precast walls and slabs of the apartment are highly standardised with repeated elements. These are the key aspects of an efficient and economical precast design.

Apartment Unit Type 1

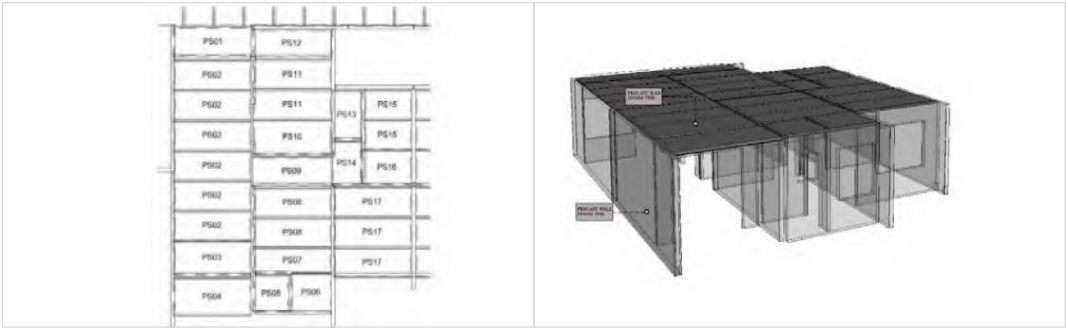


Type 1 Precast Slab Layout and 3D View

Type 1 Precast Slab Specifications

SLAB MARKING	THICKNESS (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
P01	3012	1200	0.33	0.78
P02	3012	1200	0.27	0.65
P03	1095	3099	0.33	0.79
P04	2185	1200	0.2	0.48
P05	2185	1200	0.2	0.48
P06	2185	759	0.15	0.36
P07	2185	1475	0.3	0.71
P08	2216	1200	0.2	0.49
P09	2203	650	0.13	0.30
P10	1899	1082	0.19	0.45
P11	2026	1107	0.2	0.49
P12	1520	1598	0.23	0.55
P13	1320	1475	0.18	0.44
P14	2970	994	0.26	0.63
P15	2962	1200	0.27	0.64
P16	3050	1200	0.28	0.66
TOTAL	16			

Apartment Unit Type 2



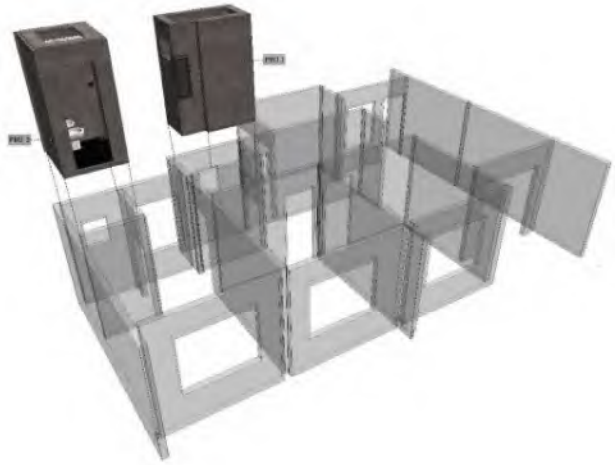
Type 2 Precast Slab Layout and 3D View

Type 2 Precast Slab Specifications

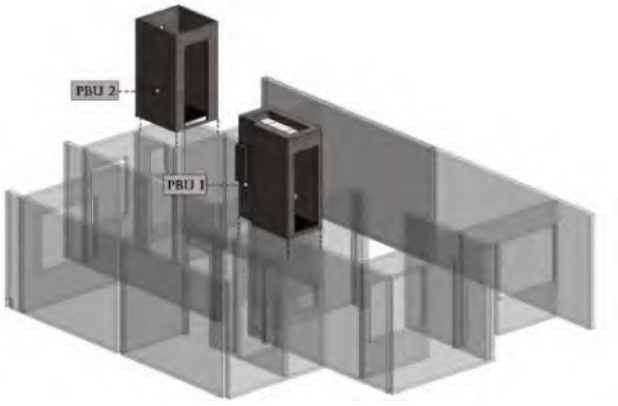
SLAB MARKING	THICKNESS (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PS01	1100	3230	0.34	0.83
PS02	3020	1200	0.27	0.65
PS03	3020	1376	0.38	0.9
PS04	3020	1516	0.42	1.00
PS05	1333	1488	0.19	0.45
PS06	1533	1555	0.22	0.53
PS07	3020	1018	0.28	0.66
PS08	3020	1200	0.27	0.65
PS09	1039	3230	0.33	0.79
PS10	3020	1390	0.38	0.91
PS11	3020	1200	0.27	0.65
PS12	1008	3230	0.32	0.76
PS13	1075	1974	0.2	0.49
PS14	1075	1735	0.18	0.43
PS15	1820	1200	0.17	0.4
PS16	1855	1407	0.24	0.58
PS17	3020	1200	0.27	0.65
TOTAL	**17**			

Bathroom

The construction of the bathroom area is the most cumbersome. The conventional method requires extensive workforce for waterproofing, finishes, plumbing, sanitary and electrical works, which lead to low productivity at the construction site. Another issue is the leakage of water from one unit to the other unit(s). Hence, the latest construction method known as prefabricated bathroom unit (PBU) is developed to overcome these issue. PBU is pre-fitted with electrical points, plumbing, ceilings, windows, and internal finishes, this tremendously shortens bathroom construction period and offers a better and controlled quality. There are two PBU units that are required namely PBU 1 and PBU 2 for every apartment types.



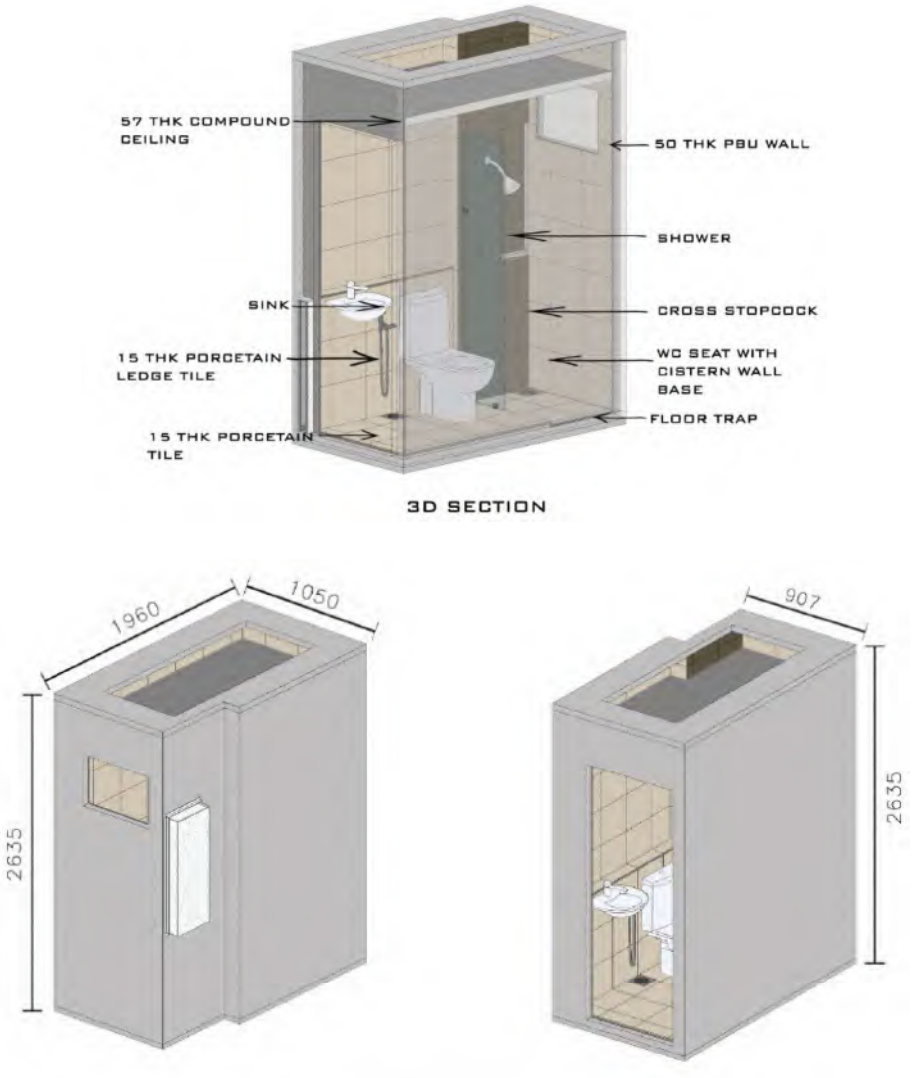
Precast Bathroom Unit Layout for Apartment Type 1



Precast Bathroom Unit Layout for Apartment Type 2

PBU Type 1

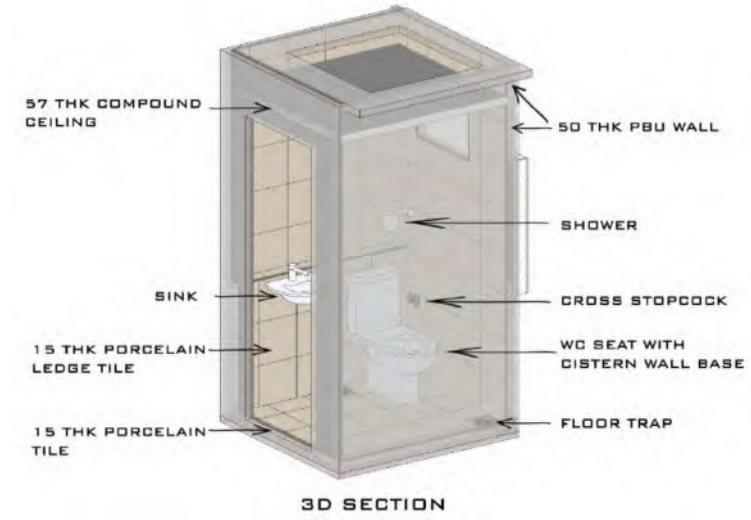
PBU Type 1 is pre-assembled with sink, shower, cross stopcock, water closet seat with cistern wall base, floor trap, 57 mm compound ceiling, 15 mm porcelain ledge tile, and 15 mm porcelain tile. The wall thickness of PBU Type 1 unit is 50 mm. PBU Type 1 has the height of 2635 mm, 1050 mm width and 1960 mm length.



PBU Type 1 3D and Dimensional Views

PBU Type 2

PBU Type 2 is pre-assembled with sink, shower, cross stopcock, water closet seat with cistern wall base, floor trap, 57 mm compound ceiling, 15 mm porcelain ledge tile, and 15 mm porcelain tile. The wall thickness of PBU Type 2 unit is 50 mm. PBU Type 2 has the height of 2635 mm, 1050 mm width and 1938 mm length.



PBU Type 2 3D and Dimensional Views

MECHANICAL, ELECTRICAL & PLUMBING DESIGN

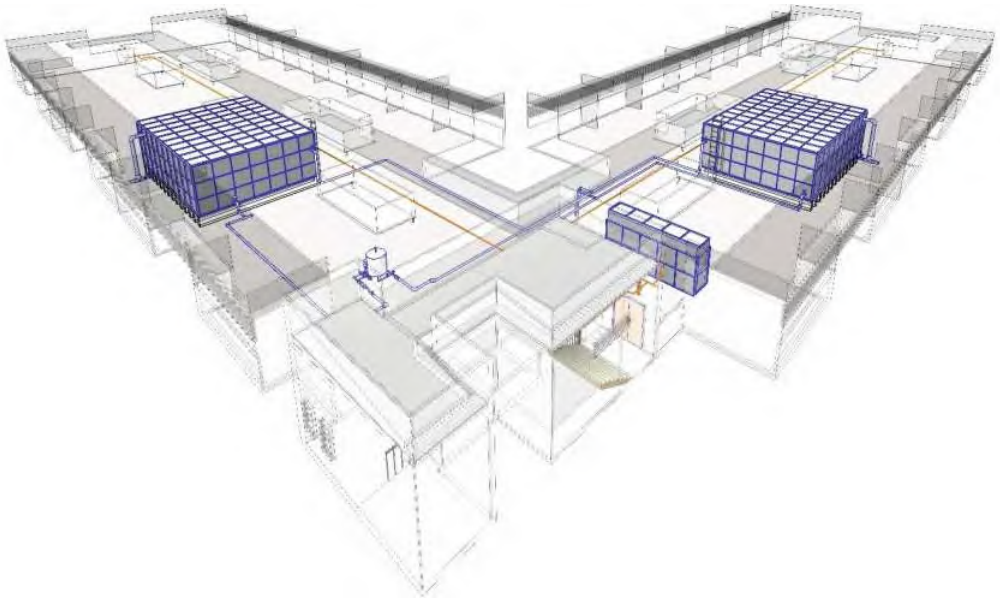
MEP Layout

Overview of MEP Layout for The Apartment Building

Floor Layout

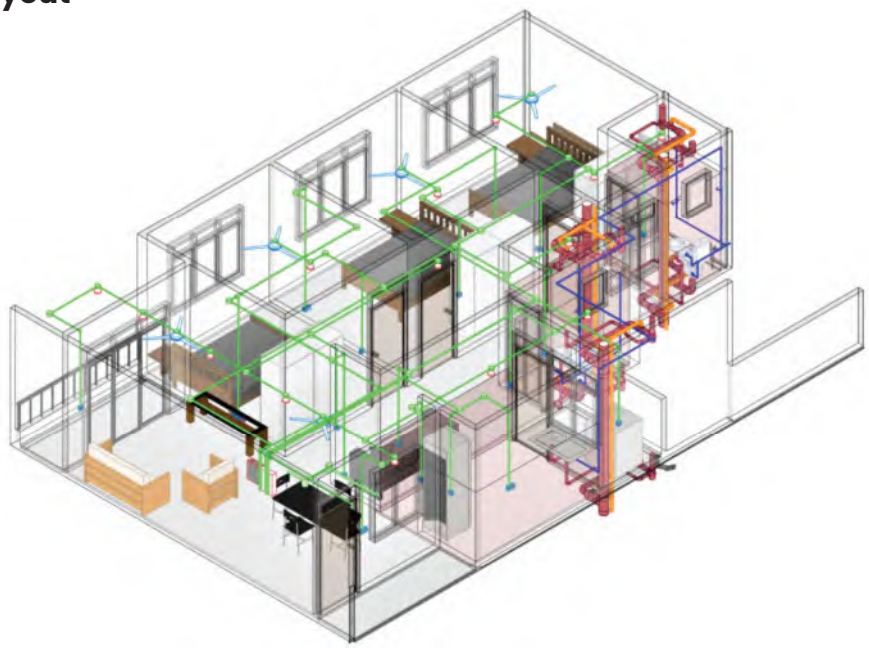
MEP Layout (Typical Floor)

MEP Layout (Ground Floor)

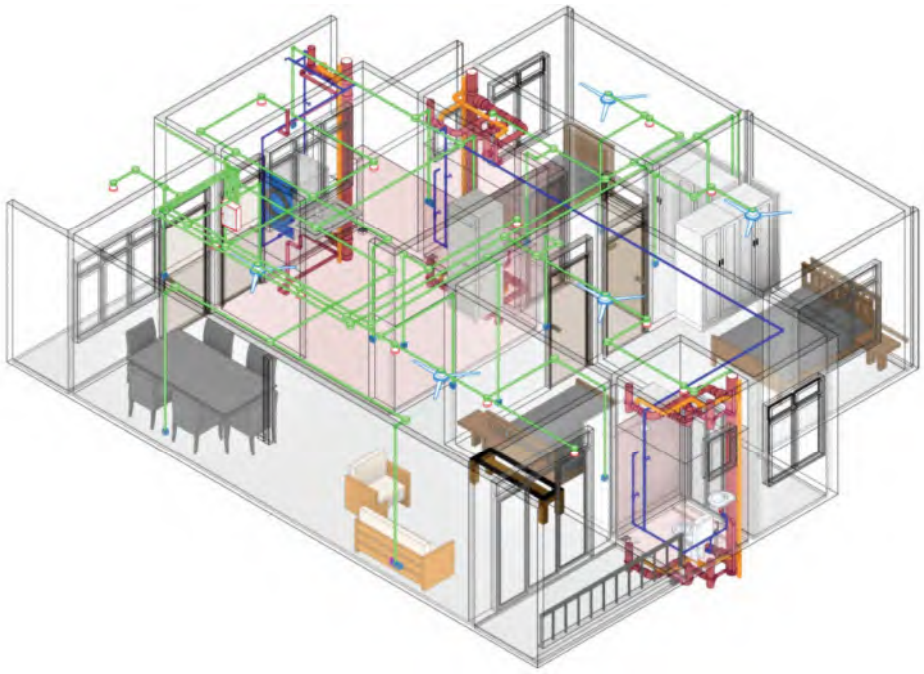


MEP Layout (Roof Floor)

Unit Layout

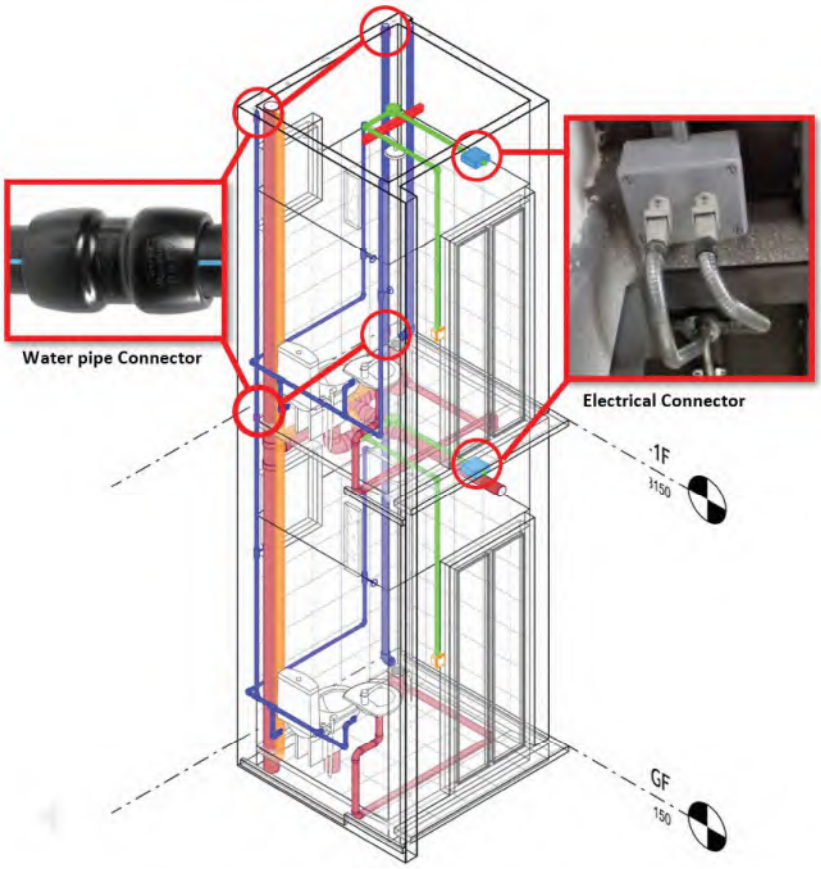


MEP Layout (Apartment Type 1)



MEP Layout (Apartment Type 2)

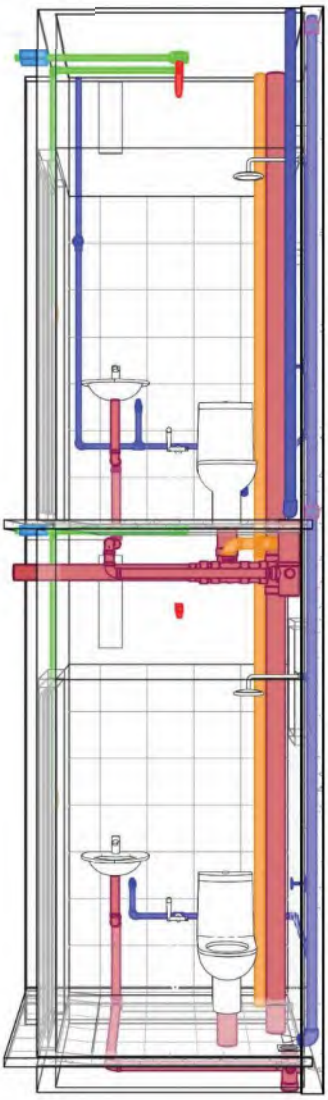
PBU Module Concept



MEP for PBU Module

Design of cold water services shall consider the following criteria :

- Proper specification of bracket and hanger for all domestic water piping by considering mobilisation of modules from factory to the site.
- All domestic water piping shall undergo pressure test prior to delivery to the site.
- Water fittings that are to be concealed shall be watertight and suitable for the default conditions (e.g. pressure and temperature).
- Concealed components embedded in structural elements shall take into account the strength of structural design.



Side View of PBU

Electrical services shall consider the following criteria :

- The electrical design shall not compromise safety and performance.
- Plug and play connector between modules to ensure integrity connections.
- All cables and conduits shall not compromise fire safety as such conduit materials are vital for MEP modules.

MEP Points

The desired quantity of MEP points for an apartment unit is as follows:

MEP Point for Apartment Type 1

DESCRIPTIONS	BEDROOM 1 & BATHROOM 1	BEDROOM 2	BEDROOM 3	BATHROOM 2	KITCHEN/ YARD	DINING/LIVING BALCONY
Lighting Points	2	1	1	1	2	5
13A Power Points	1	1	1	0	4	4
Fan Points	1	1	1	0	0	2
Switches	3	2	2	1	2	4
Stopcock Valves	1	0	0	1	0	0
Water Closet Angle Valves	1	0	0	1	0	0
Sink Angle Valves	0	0	0	0	1	0
Basin Angle Valves	1	0	0	1	0	0
Shower Stopcock Valves	1	0	0	1	0	0
Water Tap	1	0	0	1	0	0

MEP Point for Apartment Type 2

DESCRIPTIONS	BEDROOM 1 & BATHROOM 1	BEDROOM 2	BEDROOM 3	BATHROOM 2	KITCHEN/ YARD	DINING/LIVING BALCONY
Lighting Points	3	1	1	1	2	7
13A Power Points	1	1	1	0	4	3
Fan Points	1	1	1	0	0	2
Switches	3	2	2	1	2	5
Stopcock Valves	1	0	0	1	0	0
Water Closet Angle Valves	1	0	0	1	0	0
Sink Angle Valves	0	0	0	0	1	0
Basin Angle Valves	1	0	0	1	0	0
Shower Stopcock Valves	1	0	0	1	0	0
Water Tap	1	0	0	1	0	0

MEP Design Consideration

MEP system shall have junction box or service that are accessible to all the connection areas. This will be further discussed in the following sections. Thus, designer must design the prefabricated MEP system in a way to be utilised by the contractors, manufacturers and maintenance team to aim for sustainable building system.

BIM for MEP Design & Coordination

Early coordination of services is carried out via BIM Level of Development (LOD) 300. Constraints for installation and maintenance should be addressed earlier to avoid impact on the finished works in the later stage. Upfront design coordination for structural prefabricated component is important.

Therefore, the BIM model shall include structural component and ceiling finishes with MEP services for coordination purpose. The BIM coordination ease the construction works and shorten the prefabricated construction period.

For BIM coordination, the tolerance and gradient of pipe connection shall be reviewed. Thus, the connection flexibility between prefab panels, modules and corridors shall be applied. The flexible connections include junction box, service manhole, stopcock/ valve, and structural openings.

Fire Resistance and Compliance with Building By-Laws

All openings and access shall consider fire resistance and compliance with Building By-Laws. The finishing method shall be specified during the design stage.

Modules or Prefabricated MEP Integrations

Design stage shall consider the continuity of all prefabricated MEP services. If possible, implement plug and play connector system that does not compromise the safety, performance and integrity of prefab MEP services.

In general, the concept of prefab MEP services shall be installed in each panel in the assembly factory before being mobilised to site. If the required panels are in place, MEP services shall utilise plug and play connector for the MEP elements.

MEP services shall consider the following criteria:

- The MEP design shall not compromise safety and performance.
- To minimise number of circuits within the units for ease of construction and prefab integrity connections.
- Plug and play connector system between modules or prefab panels to ensure integrity connections.
- All cable and conduit shall not compromise fire safety since such proper selection of conduit material is vital for MEP modules/prefab panels.
- Junction box with termination bar shall be installed nearby joint area between modules and common corridor for cable connection.

Electrical Services

The electrical services shall include but not limited to the following criteria:

Internal Electrical Installation

a. LV 400/230V Distribution System
b. Earthing System
c. Lightning Protection System
d. Lighting & Power System
e. Telecommunication System
f. Satellite Master Antenna TV System
g. CCTV System

External Electrical Infrastructure

a. External underground infrastructure for energy provider (TNB/SESB)
b. External underground infrastructure work for telecommunication provider such as Telekom Malaysia

LV 400/230V Distribution System

The estimated maximum demand (MD) for electricity is about 1.7MVA, 1.445MW@0.85pf. As such, electricity supply shall be set at 400V from the 1 no. TNB Double Chamber (can be 'Attached' or 'Standalone') for this project.

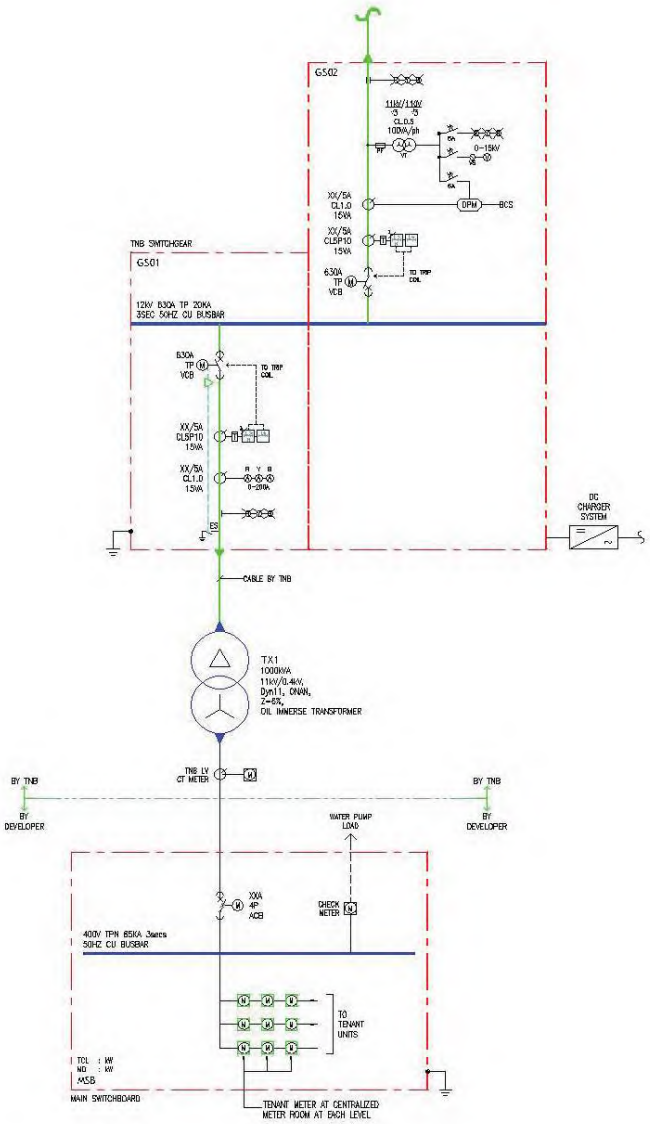
In general, MSB arrangement is as follows:

ITEM / LOAD DESCRIPTION	MAIN SWITCHBOARD	
ELECTRICAL LOADS	NO. OF MSB	NO. OF EMSB
Apartment	2	-
Common Area	1	1

Under normal operating conditions, the electrical system shall obtain power supply from TNB. In the event of supply failure, i.e. TNB power outage, the essential power supply will be fed to the serviced apartment common management load from the standby generating set.

The main LV switchboard shall be equipped with incoming ACBs, protection relay, electronic surge protector, digital power meter, and its associated accessories. The switchboard shall be of free standing, Form 2B type construction, ASTA full type tested to IEC 60439-1. All incoming feeders to LV switchboards and outgoing circuits rated 1000A and above shall be provided by Air Circuit Breaker c/w IDMT over-current and earth fault protection relay. In general, 30% of the spare capacity shall be provided with minimum two (2) nos. of 100A TPN MCCB and two (2) nos. of 60A TPN MCCB for future expansion.

KWh Metering Installation



Example of kWh Metering Schematic Diagram

KWh metering installation scheme shall refer to the diagram as above for metering concept of the apartment. Check meter shall be installed at owner content (e.g. pump load). For 230/400V LV distribution, the panel sizing shall be installed according to TNB requirements. The TNB kWh metering panel shall be located and installed inside electrical riser at each floor.

Earthing System

The earthing system shall be designed according to MS IEC 62305, the Energy Commission's standard practices as well as TNB rules and regulations.

The earthing system installation shall include all the necessary materials & accessories as follows:-

- Earth electrodes, copper or aluminium tapes, bare stranded copper or aluminium cables;
- Exothermic welding and bonds;
- Earth cabling and conductors;
- Earth bars and disconnecting links; and
- Heavy-duty earth pits.

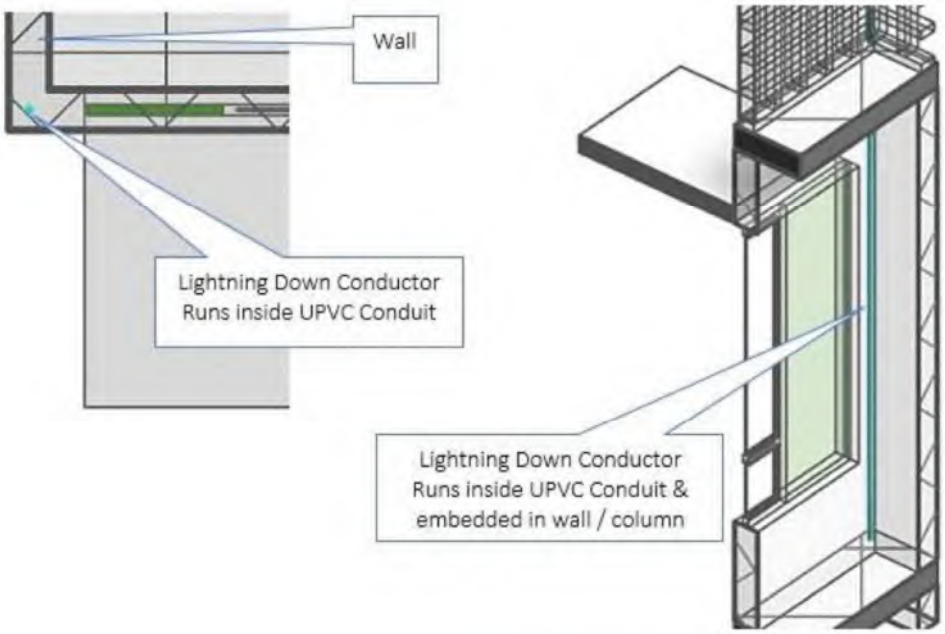
The whole earthing bed shall be interconnected and interlinked with exothermic welding to form a common earth grid. The overall earthing resistance for the entire installation shall not exceed 1 ohm requirements.

Lightning Protection System

The lightning protection system for the high-rise apartment shall comply with MS IEC 62305 part 1 to 4.

The perimeter of the roof shall be installed with air terminatination and connected using 25 mm x 3 mm copper or aluminium tape encased in uPVC conduit and 500mm height air terminal with sharp edges. The air termination will link to down conductor with 25 m apart using 25 mm x 3 mm copper or aluminium tape in uPVC conduit concealed inside a column. All down conductors shall be connected to earth termination with a test point.

All metal material on the roof shall be bonded to the nearest aluminium tape to avoid flash over.



Lightning Down Conductor Installation Method

Lighting Luminaire

The lighting will be designed to comply with the Department of Occupational Safety and Health (DOSH), Illuminating Engineering Society (IES) codes, JKR codes of practice and current standard of engineering practice for intelligent serviced apartment to achieve the average illumination levels as described.

The illumination level is in accordance with the Guidelines on Occupational Safety and Health for Lighting at Workplace published by DOSH, which becomes a benchmark for a good lighting design guideline.

The corridors, waiting areas, and public areas shall be controlled by timers. The dark common areas will require lighting during daytime.

(i) Staircase Lighting Timer Control
- 100% staircase lighting from 7 pm to 1 am
- 50% staircase lighting from 1 am to 7 am
- 0% from 7 am to 7 pm natural lighting

(ii) Common Corridor Lighting Timer Control
- 100% staircase lighting from 7 pm to 1 am
- 50% staircase lighting from 1 am to 7 am
- 0% from 7 am to 7 pm natural lighting

The type of luminaires and illumination levels in the specific areas in this project shall be as follows:

AREA	TYPE OF LUMINAIRES	ILLUMINATION LEVEL (LUX)
Lift Lobby & apartment common corridor	Surface Mounted/Recessed LED down light	200
Ground floor main entrance	Surface Mounted/Recessed LED down light	200
Staircase	Surface Mounted T5/LED Flourescent light with prismatic diffuser	150
Plant Room & Electrical Room	T5/LED Fluorescent fitting with wire guard	150

Preserve exit light (the KELUAR sign) and self-contained LED emergency light with rechargeable battery that lasts within at least three hours shall be provided in all areas as stipulated by the Fire and Rescue Department, local council, and Uniform Building By-Laws.

The lighting system is designed by organising the alternating circuit, group of light switches and a separate switch to enable off-of switching if necessary.

Landscape lighting, if any shall be provided based on the lighting layout proposed by the landscape architects.

Telecommunication System

In general, the telecommunication services shall be designed and provided as follows:-

a. Each apartment/residential unit shall be provided with at least one (1) no. of fibre wall socket.

b. For the high-rise residential unit, the telephone/riser room shall allocate spare space for future fibre optic backbone system subscribed by tenants.

Satellite Master Antenna TV System

a. The satellite master antenna TV/FM system is equipped with coaxial cables, antennae assemblies, boosters, distribution units, and outlet points shall be provided. At least one (1) no. of SAT/TV/FM outlet points shall be provided at apartment/residential unit.

b. The antenna system shall be capable of receiving the Malaysian Digital TV channel including free and paid channels, FM radio broadcasting and ASTRO HD satellite broadcast, free from "snow and ghost" effects and other interferences. ASTRO Decoder shall be provided by tenants themselves.

c. The vertical and horizontal distribution cable shall be based on minimum transmission rate of 2,150 MHz.

e. The signal output levels at any outlet shall be 60 dB minimum and maximum of 80 dB.

d. The satellite MATV cable signal from the antenna/satellite disk to the SMATV headend equipment shall be protected with the data/signalsurge protector.

CCTV System

The CCTV shall be a state-of-the-art using the latest technology. The works shall include the design, supply, delivery, unloading, storage, installation, termination, testing and commissioning, as well as maintenance thereafter during defect liability period of the entire CCTV system, which consists of interface, firmware and software including but not limited to the following components:-

- CCTV system consisting of CCTV cameras, fixed camera hardware and control equipment.
- CCTV monitors, matrix switchers, and interface subsystem.
- Digital video recording (DVR) system complete with archiving capability that uses the network.
- All cables, conduits, trunking, junction boxes, fittings, access panels, and fire stopping.

The CCTV System shall be installed, tested and commissioned at the following areas, but not limited to :-

- Lift lobby with fixed camera. The camera housing shall be aesthetically acceptable to the owner and shall blend into the architectural design of the lift lobby/hallway. The camera shall be positioned to view and record images of people approaching the lift lobby, with a clear view of their faces.
- For control room, cameras shall automatically record to the recording device, images of all persons entering and leaving the control room. Placement of the camera shall ensure that faces of the persons can be captured and recorded.

Scopes of Mechanical Services

The Mechanical Services shall include but not limited to the following scopes :-

a. Air Conditioning & Mechanical Ventilation System

b. Fire Protection System

c. Cold Water & Sanitary Plumbing System

d. Vertical Transportation System

Air Conditioning & Mechanical Ventilation System

Basic services are necessary to provide a comfortable condition in the residential units. The design shall also fully comply with the requirements set out by the Uniform Building By-Laws, local authorities, and utility companies.

The design shall adopt the recommendations from the following codes unless otherwise different from the Uniform Building By-Laws or other authorities :

- American Society of Heating and Refrigeration Engineers. (ASHRAE) Handbook.
- ASHRAE 62 "Ventilation for acceptable Indoor Air Quality"
- Smoke Control in Protected Escape Routes Using Pressurization - MS 1472 for pressurization system.
- SMACNA Second Edition and its addendum.

Design Parameter

The following design criteria shall be applicable to all air conditioning and ventilated areas, to be equipped with the proposed system.

OUTSIDE AIR CONDITION		
General	34.0°C DB 28.0°C WB	Actual external air temperature profile used shall be according to data published by ASHRAE, which is used by HAP 4.3
INSIDE DESIGN CONDITION		
Residential Unit	23.0°C DB + 1.0°C 50 + 5% RH	Not Applicable
Electronic Sensitive Rooms including Fire Control Room and all other telecommunication rooms defined elsewhere in this document	22.0°C DB + 1.0°C 50 + 5% RH	Or as specified by manufacturer recommendation or latest ASHRAE recommendations
M&E Equipment Rooms	5°C above the maximum design ambient	Or as required by equipment manufacturer

Noise Level

The design shall consider the noise generated by the equipment and in any instances where the low-noise equipment are not available or economically infeasible, sound attenuation and vibration isolation shall be used to ensure the noise level is in accordance with AS 2107 at the recommended acceptable limits or, listed as follows, whichever is lower:

LOCATIONS	NOISE LEVEL
Kitchen	NC 55
Lobby & Corridor	NC 40
Toilet	NC 45
Staircases	NC 65
Plant/Equipment Rooms:	<80 dBA
Other Areas	AS 2107 recommendations

*** Noise level measured at any position 1.2 m from floor, wall, grilles and registers*

Air Conditioning System

Air Cooled Split Units (ACSU) shall be used for the areas mentioned in the table below. Each ACSU shall have local control for 3 fan speed and on/off refrigerant compressor. Refrigerant shall be the inverter R410a/R134a-R32 type.

LOCATIONS	SYSTEM PROPOSED
Residential Unit	Air-conditioning ledge for future installation of air-conditioning outdoor
Fire Control Room	Air Cooled Split Unit System with n+1 configuration for systems requiring 24 hours operation
MDF Room	Air Cooled Split Unit System with n+1 configuration for systems requiring 24 hours operation

Ventilation for Toilet

Non-naturally ventilated toilet shall be provided with mechanical ventilation with extraction duct and fan, while the make-up air shall be natural airflow from the outside due to the negative pressure in the toilet. Ventilation rate is at 10 air changes per hour. The start stop command of the extraction fan shall be based on lighting on/off.

Ventilation for Kitchen

No ventilation system provided in the kitchen area, it is recommended to have pipe sleeve 150mm diameter for future tenant to install their own kitchen exhaust.

Ventilation for Plant Room

Mechanical ventilation system shall be provided to keep room temperature below 40 °C with thermostat control. Heat rejection used for calculation shall be substantiated with technical literature according to the equipment's manufacturer such as transformer, UPS, heater, relays, switches, and hubs. Enclosed areas will be mechanically ventilated with supply and exhaust air fans and ducts whereas rooms fitted with external fresh air louvers shall be provided with only mechanical exhaust air. The make-up air shall be natural airflow from the outside to the room due to the negative pressure in the room. Minimum ventilation rate is at 10 air changes per hour. Electrical rooms such as transformer rooms and switch rooms shall be installed with temperature sensor. The start stop command of the extraction fan shall be based on room temperature.

Ventilation for Lift Motor Room

Lift motor room shall be provided with propeller fan for exhaust side, while the make-up air shall be natural airflow from the external to the room due to the negative pressure in the room.

Fire Protection System

Firefighting and protection services shall be designed and installed in accordance with UBBL, requirements of the authorities, and the applicable standards.

These shall include the following :-

- External Fire Hydrants
- Wet Riser and Hose Reel
- Automatic Fire Detection
- Automatic Fire Alarm
- Gas Extinguishing System
- Portable Fire Extinguishers
- Other systems as stated in the latest version of UBBL

External Fire Hydrant

External fire hydrants shall be provided, tapped frreticulation brought in under the civil scope of work. The hydrant shall be positioned along the road accessible to the fire-fighting vehicle at intervals as required by Fire authority requirements. Where additional fire hydrants are required, the system shall comprise pillar hydrants and sluice valves permanently connected to the external water supply. Hydrant outlets shall be of double outlet pillar type complete with sluice valves.

Wet Riser System

Wet riser and hose reel system shall be installed according to MS 1489: Part 1:1999. Water storage tank of the required capacity (without considering inflow) reserved for the system shall be connected to the pumps and the whole system shall be charged with water under pressure. The system shall be automatically set to operate by means of a fail-safe control system when the pressure within the system drops beyond the specified limit.

The landing valves shall be secured at the lobby area at the height of 1.0 meter above floor slab on each level, ready for firemen's use. Two lengths of canvas hose of 65mm diameter and 30 m length shall be provided in a hose cradle and placed with each landing valve.

Wet riser pumps shall consist of one (1) duty pump, one (1) standby pump and one (1) jockey pump along with control panel. Each pump shall be capable of providing a flow of 25 L/s (1500 L/min) in the wet riser and provide the required pressure of 4 bar at the wet riser-landing valve.

One wet riser tank located at the ground floor shall be provided at the ground floor and typical floors. A four-way fire brigade breeching inlet shall be provided at the ground floor in a labelled glass-fronted box for firemen to pump in water to the water storage tank.

Each stage of wet riser system shall not exceed 70.15 m, in accordance with Fire and Rescue Department of Malaysia, otherwise each stage shall not exceed 61nm.

The summary of pump set is as follows:

STAGE	FLOOR SERVED
Stage 1 (Located at Ground Floor)	Ground Floor to Roof Level

Hose Reel System

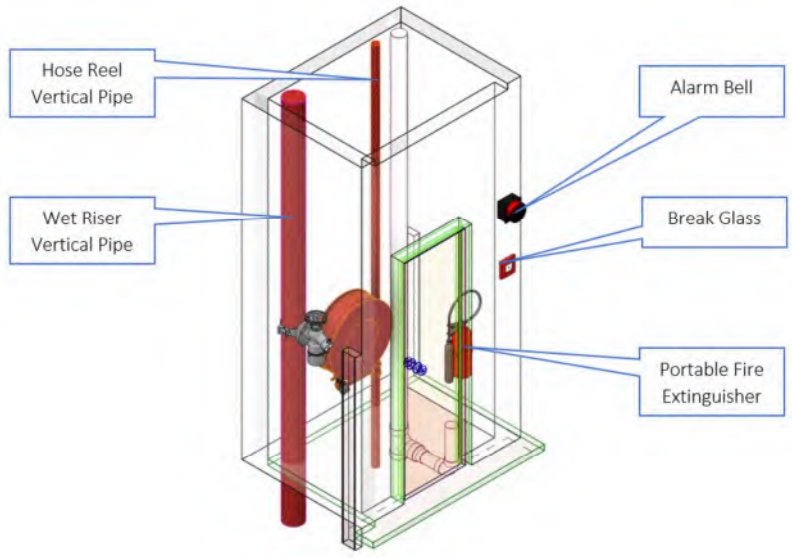
The hose reel pump capacity enables the flow rate of 120 L/min at a running pressure of at least 2 bars for any of four hose reels operating at the same time, which is in accordance with MS 1489: Part 1. The pressure required by the hose reel nozzle shall be in accordance with MS 1489: Part 1. Hose reel tank to be provided at roof top to serve for ground floor and typical floors.

Hydraulic hose reels shall be strategically placed along all escape routes, adjacent to the fire exits. Hose reels shall be positioned in such a way that they can be used without obstruction. It shall be able to be taken to every room and within 6 meters of every part of the room and discharge of a minimum of 30 l/min of water.

The hose reel drum shall consist of a stop valve, reel, 25 mm diameter, 30 m rubber, internally reinforced with a single rayon braid or double cotton braid and an red abrasion resistant rubber covering the outside, shut-off nozzle assembly, nozzle, brackets and the necessary fittings.

The position of hose reels shall be as follows:

STAGE	FLOOR SERVED
Served by Hose Reel Pump	Ground Floor to Roof Level



Typical Wet Riser & Hose Reel Room of the Apartment Building

Gas Extinguishing System

Occupied electronic rooms such as MDF room shall be provided with clean agent fire suppression system according to NFPA 2001 requirement.

Unoccupied electrical rooms such as MSB room and genset room shall be protected with CO_2 suppression system, which is listed in MS 1590.

PMU, SSU and TNB Substation shall be protected with gas-based clean agent automatic fire extinguishing system to NFPA 2001 with TNB approved gas type.

The gas suppression system is designed for total flooding and fire detection. It shall be activated automatically using the smoke and heat detectors arranged for double-knock control to prevent system activation due to false alarm. Total flooding system shall be set at specific concentration, the rate of application and duration of gas release for the purpose of extinguishing fire in the protected rooms. The control panel shall be located outside the room along with remote manual cable with pull box mechanism as per Fire and Rescue Department of Malaysia's requirement.

Portable Fire Extinguisher

Portable fire extinguishers with occupancy hazard shall be provided within the buildings. All fire extinguishers installed shall be approved by Bomba and preferably SIRIM.

Portable extinguishers shall be located at strategic positions, along escape routes and where required in the specifications, the extinguishers shall be mounted to the wall.

The sizes proposed shall be:

*9 kg ABC dry powder capacity, the steel cylinder shall be located along egress passages at 30-45 m intervals, staircases and firemen lift lobbies.
*6 kg ABC dry powder capacity, the steel cylinder shall be located in each apartment unit.
* 2.27 kg CO_2 capacity, the steel cylinder shall be located in electrical rooms, generator rooms, pump rooms and lift motor rooms.

Automatic Fire Alarm System

The automatic fire alarm system shall be installed in accordance with the applicable standards and subjected to the jurisdiction of the local authority having jurisdiction. It shall be designed, installed, tested and commissioned to achieve the following functions :-

- Integrated fire detection and fire alarm annunciation ;
- Evacuation signalling ;
- Emergency voice communication;
- Fireman telephone system; and
- Auxiliary function control system.

Fire Command Centre

The fire command centre (FCC) shall provide the following functions:-

- Complete fire alarm annunciation;
- Manual evacuation and alert signalling controls;
- Manual auxiliary function controls; and
- Control equipment for the firemen's intercom.

The FCC shall run on Window-based interfaces. The FCC shall consist of the following equipment:-

- Fire alarm panel;
- Mimic panel;
- System alarm printer;
- System event printer; and
- Manual auxiliary function control panel or fire fan control panel (FFCP).
- Head end equipment for voice announcement
- Head end equipment for firemen's telephone

Evacuation Signalling Control Equipment

Evacuation signalling shall be established throughout the premises via one-way FAS voice/tone speakers and strobe lights controlled by the headend equipment in the FCC. The evacuation signalling system shall be arranged to operate automatically, with provision for manual override/ operation.

Cold Water Plumbing System

The Plumbing System shall include but not limited to the following equipment and ancillary:

a. FRP tank for the domestic water storage shall be equipped with accessories and electrode control system. There are pipe sleeves, tank fittings and tank accessories for the reinforced concrete (RC) tank (suction tank and wet riser tank).

b. Pump sets (booster pumps for suction tanks, variable speed pumps sets, equipped with starter, control panel, and accessories.

c. Cold water service consists of incoming water pipe from external water reticulation mains through bulk metering to suction tank, wet riser tank, transfer pipe to domestic roof tank, and distribution piping water meter to the cold water and sanitary fittings.

Water supply for domestic services shall be tapped from the external water reticulation mains through bulk metering to every suction tank, under the civil work scope.

Water storage specifications shall be according to the SYABAS guidelines as follows:

1	Storage capacity	Apartment unit – 1000 L/unit/day as per SPAN requirement.
2	Storage capacity	Dwelling houses – 800 L/unit/day as per SPAN requirement.
3	Total Storage	1.5 days as per SPAN/authority requirement.
4	Tank Type	FRP for Roof Tank and RC for Suction Tank (located at Ground Floor)

External incoming water pipes shall be made from ductile iron for underground and above ground installations.

All RC tanks (domestic water tank) shall be equipped with internal HDPE lining/other. Potable water tanks shall be FRP panel type. Surge anticipator is to be installed at all transfer pump outlet. Vortex Inhibitor shall installed in all suction tanks. All float valves to tanks shall be pilot float type. Adequate isolating valves shall be provided to control the flow of water at different sections of the pipe works.

Domestic cold water shall be transferred from suction tank to the domestic break tanks/ roof tank via pumping. These tanks shall be fitted with pilot-operated float valves. A set of domestic water pumps which consist of one duty and one standby pump along with control panels shall be placed in the basement cold water pump room of the building. Pumping delivery piping shall be made of ductile iron, as per SYABAS/SPAN requirements.

Distribution of water from the roof storage tanks to the toilets and kitchen shall be via gravity feed except the top four floors, in which the water shall be served by VSD pump sets due to low pressure.

Gravity delivery piping shall be made of HDPE PN12.5 pipes, as per SYABAS/SPAN requirement.

Minimum outlet pressure of the required standards shall be adopted at the most remote point for the user or the equipment and fittings, besides being used in the design of cold water system. The pressure limit is between 103 kPa (15 psig) and 517 kPa (75 psig) in general.

Tabulation Of Pipe Schedules

TYPE OF PIPES	MATERIAL
Incoming Pipe	Flange Type Ductile Iron/MSCL
Transfer Pipe	MSCL
Pumping Distribution Pipe	HDPE PN 12.5
Gravity Distribution Pipe	HDPE PN 12.5

Summary of Transfer Pump Set and Roof Top Pump

TYPE OF PIPES	MATERIAL
Suction Pump is located at Ground Floor	Ground Floor to RC Flat Roof Level
Roof Top Vaariable Speed Pump	Level 14 to Level 17

For domestic water services, if the toilets are detached, each toilet shall consider a separate system from another toilet. At such all-distribution piping shall be connected to the main pipe on top of the toilet with stopcock.

When modules are installed on site, the domestic water pipe shall be connected using the plug and play joint fitting, via connection between modules and common corridor. The plumbing design shall consider the following criteria:

- Proper specification of bracket and hanger for all domestic water piping by considering mobilisation of modules from factory to site.
- All domestic water piping shall undergo pressure test prior to delivery to site.
- Water fittings that are to be concealed shall be watertight and suitable for the default conditions (e.g. pressure and temperature).
- Concealed components embedded in structural elements shall take into account the strength of structural design.

Sanitary Plumbing System

The plumbing system shall include but not limited to the following equipment and ancillary:

a. Cold water service consists of incoming water pipe from external water reticulation mains through bulk metering to suction tank, wet riser tank, transfer pipe to domestic roof tank, and distribution piping w a t e r meter to the cold water and sanitary fittings

b. Sanitary drainage service includes soil, waste and vent piping system from sanitary fittings and condensate drain from the air conditioning system to the internal chambers.

A fully ventilated two-pipe system with vent and soil/waste stacks shall be used. Waste discharge shall be routed to the external underground manholes of the sewerage reticulation network. The sanitary system shall be designed to dispose soil and waste from all plumbing fixtures, through a vented gravity piping system inside the building and discharged to external manholes. All the external manholes shall be connected and discharged to the public manhole.

Tabulation of Pipe Schedules

DESCRIPTION	AREA OF APPLICATION	CODES/TYPE OF PIPE
All soil, waste and vent pipe	Typical unit	Unplasticized PVC BS 4514 & BS 5255
Above 50mm diameter	Above ground	Unplasticized PVC BS 5255
50mm diameter and below	Above ground	Unplasticized PVC BS 4514
Above 50mm diameter	Under ground	Unplasticized PVC BS 4660

There shall be floor traps for all hose reel and wet riser shafts. For the bin room and refuse chamber, there should be water taps and floor drains for the purpose of room cleaning.

For the lowest floor of the typical units, cast iron elbow is required to withstand the pressure of the flow.

The sanitary service design shall consider the following criteria:

- All sanitary discharge pipes gradient shall be designed to enable allowable structural and architecture finishing gaps.
- Design and specification of support brackets for sanitary piping is important due to mobilisation from factory to site.
- Conventional P or S trap or top accessed floor trap can be installed in sanitary system. The selection depends on the allowable space by structural and architecture.
- All pipe sleeves shall have proper water proofing system.
- In terms of mounting of WC (floor mounted (S Trap) or wall mounted (P Trap), it is recommended to use P trap WC for the ground floor units.
- BIM coordinated model is vital for the design of sanitary system. This is because there is frame structure right after basin or kitchen sink discharge. Therefore, proper termination or box up shall be placed at these areas.
- Concealed components embedded in structural elements shall take into account the strength of structural design.
- To ensure access and working space for pipe connection between modules.

Vehicle Transportation System

System Description

Traffic analysis is carried out to ensure that the lift capacity, speed and quantity meet the standard of transportation systems in buildings (CIBSE Guide D).

CIBSE Guide D for Residential Building

DESCRIPTION	CIBSE PARAMETERS	PROPOSED PARAMETERS
Loading Factor	Max 80%	Max 80%
Population (Residence)	1 bedroom - 1.8 pax 2 bedroom - 3.0 pax 3 bedroom - 4.0 pax	3 bedroom - 4.0 pax
5 Min Handling Capacity (Residential)	< 5 - 7 % (Low Income) < 6 - 8 % (Normal)	Min 5%
Waiting Interval	50 - 70 seconds (Low Income) 50 - 60 seconds (Normal) 45 - 50 seconds (Luxury)	< 60 seconds
Door Opening Time	2.0 seconds	2.0 seconds
Door Closing Time	2.5 seconds	2.5 seconds
Rated Speed	i) 2.5 m/s for 50-63m lift travel ii) 3.0 m/s for 63-100m lift travel iii) 6.0 m/sfor >120m lit travel	Subject to Lift Traffic Analysis Result.
Lift Acceleration	i) 0.8 - 0.9 m/s^2 for 50 - 63m travel ii) 1.0" m/s^2 for 63 - 100m travel	0.9 m/s^2 - 1.1 m/s^2

Lift Control and Operation

One unit of centralised, computerised lift supervisory panel shall be provided in the Fire Control Room. Intercom link between the lift cars and control panels shall be established.

Supervisory and Control Panel

There shall be a computer linked to the lift management system and equipped with the following functions :-

a. Status Display

- Illuminated indicators to show operational mode of an individual lift e.g. Auto, Manual, Under Maintenance "Out of Service" Lift Fail, VIP operation or fully loaded.

b. Alarm Display

- Flashing indicator and audible "emergency alarm" condition. Acknowledgement button shall only cancel the audible alarm. Flashing indicator can only be cancelled through a reset button.

c. Switches control (For panel in the fire control room, security control room and lift machine room only).

- Key switches to enable individual lift car to home for either independent service or security control.
- Key switches to separate services to floor(s). When activated, lift car and hall buttons for the selected floors shall become inoperative. In the event of emergency, the fireman's key switch is activated for operation and control.

e. Indicators to show either "Mains" or "Standby Power".

d. Intercom handset and selector switches to enable communication between individual lift and control panels.

f. All controls and indications to be powered by self-contained power pack that lasts for at least 2 hours in the event of power failure. Other than control panel in the fire control room that complies with the requirements of the Fire and Rescue Department and the control panel shall be microprocessor-based.

g. Hall call button shall have minimum 3-digit buttons.

Fire Emergency Operation

All lifts shall be subject to operation under emergency conditions, except stated otherwise.

In case of FIRE alarm or any EMERGENCY by operation of the key switches in the control panels, all lifts are immediately required to ignore lift car and landing calls and return non-stop in sequence to the lobby floor and open their doors.

The fireman's switch shall be provided at the lobby or otherwise stated and unauthorised persons cannot easily interfere with it. It shall be equipped with a label of "ON" and "OFF" position and shall be housed in a recessed metal box with a metal-rimmed breakable glass cover/ fireman key switch. The cover shall be engraved "Fire Switch" with red letters. This operation will comply with the requirement of the Fire Services Department, Fire and Rescue Department of Malaysia.

Vibration

Vibration of car lift shall comply with maximum 15 mG peak to peak x,y,z axis (ISO 2631 filtration system).

CONSTRUCTION COST ESTIMATION

Specifications

ELEMENT	SPECIFICATIONS
Piling	RC spun piles
Structure	Reinforced concrete slab and precast concrete slab Reinforced concrete beam and precast concrete beam Precast concrete column Precast concrete wall: 125 mm/150 mm/200 mm thickness
Roof framing	Lightweight steel roof truss and reinforced concrete flat roof
Roof covering	Metal decking
Doors	Metal door frame, timber plywood flush door, fire rated door, aluminium powder-coated sliding door, bifold door, and roller shutter
Wall	Precast wall, vent block, wall cladding, aluminium louvres
Windows	Powder coated aluminium frame window, 6 mm thickness clear glass
Wall Finishes	Skim coat, paint, and ceramic tiles
Floor Finishes	Ceramic tiles, and cement render
Ceiling finishes	Skim coat, paint, and moisture resistant ceiling board
Sanitary fittings	Water closet, basin, shower rose, hand bidet, toilet roll holder, floor trap, sink, and tap
Miscellaneous	Stainless steel rainwater harvesting tank (RWHT) with accessories

Assumption of Rates

1. The cost estimate is based on 352 apartment units (18 storey).
2. The cost estimate for this Apartment includes architecture, structure, mechanical, electrical and plumbing works.
3. The cost estimate excludes preliminaries and contingencies.
4. The rate of precast items encompass moulding, supply, transportation and installation.
5. Assumption for infrastructure works (earthworks, roadworks, water reticulation, sewerage, and drainage) is about RM 500,000.00 per acre.
6. Actual cost of a building depends on the design and other factors, which may vary from the figures shown.
7. Land cost, contribution cost/fees, management cost, professional fees, legal fees and the Developer's profit margin are excluded.

8. This is based on the current rates obtained by competitive tendering. No allowance has been made for the increases in costs of labour, materials and plant in the future. This cost is subject to passage of time, changes of business condition in the building industry, and availability of information. Even we endeavour to give reasonable estimated costs for each element at the time of preparation, we are not responsible for future changes in the market or contractor's pricing strategy.

9. Mechanical & Electrical Services :

a. Mechanical ventilation system only involves ventilation in the M&E plantroom

b. External cold water and sanitary piping are excluded.

c. All RC tanks are excluded.

d. Vertical transportation system is based on 17 pax capacity with rated speed of 2.0 m/s.

e. The cost above excludes carpark management system.

f. Telephone system is estimated based on fibre optic backbone system.

g. The costs of compound lighting and street lighting are excluded.

h. Light fitting is for common/public area only.

i. The costs of all water features and related pumps are excluded.

j. The cost of façade/landscape lighting point fitting is excluded.

Cost Estimate of the Apartment

DESCRIPTION	APARTMENT (BUILDING)	APARTMENT (INFRASTRUCTURE)	APARTMENT (BUILDING & INFRASTRUCTURE)
Total Cost Estimate 18 Storey Apartment	RM43,061,370.60	RM2,355,000.00	RM45,416,370.60
Total Cost Estimate for 1 Unit House (352 unit)	RM122,333.44	RM6,690.34	RM129,023.78
Total Cost Estimate Per m^2 (93 m^2 per unit)	RM1,315.41	RM71.94	RM1,387.35
Total Cost Estimate Per ft^2 (1,001 ft^2 per unit)	RM122.21	RM6.68	RM128.89

Approximate Bills for an Apartment

Item	Description	Unit	Quantity	Rate	Amount
	BUILDING				
	PILING				
A	RC spun piles	M2	2,734	200.00	546,800.00
	EARTHWORKS				
B	Earthworks to ground floor	M3	450	30.00	13,500.00
	REINFORCED CONCRETE SLAB				
	Concrete Slab				
C	200mm Thick slab	M3	442	300.00	132,600.00
	Reinforcement				
D	10mm - 32mm Diameter bar	Kg	44,200	3.50	154,700.00
	Formwork to Slab				
E	To edges of slab n.e. 200mm high	M	515	22.00	11,330.00
	Waterproofing System				
F	Waterproofing to ground floor	M2	2,561	3.00	7,683.00
	Termite Treatment System				
G	Anti-termite to ground floor	M2	2,561	2.50	6,402.50
	REINFORCED CONCRETE BEAM				
	Concrete beam				
H	450mm x 1600mm Concrete beam	M3	137	300.00	41,100.00
	Reinforcement				
J	10mm - 32mm Diameter bar	Kg	21,920	3.50	76,720.00
	Formwork to Beam				
K	To sides and soffit of beam	M2	692	35.00	24,220.00
	PRECAST CONCRETE SLAB				
	Plank Slab				
L	Hollow core precast slab	M3	2,708	600.00	1,624,800.00
	PRECAST CONCRETE BEAM				
M	Beam	M3	222	1,900.00	421,800.00
	PRECAST CONCRETE COLUMN				
N	Column	M3	157	2,600.00	408,200.00
				TOTAL CARRIED TO COLLECTION	**3,469,855.50**
					Page No: 1/6

Item	Description	Unit	Quantity	Rate	Amount
	PRECAST CONCRETE WALL				
A	125 mm Thick	M3	1,324	1,900.00	2,515,600.00
B	150mm Thick	M3	9,336	1,900.00	17,738,400.00
C	200mm Thick	M3	200	1,900.00	380,000.00
	REINFORCED CONCRETE ROOF SLAB				
	Concrete Roof Slab				
D	150mm thick slab	M3	339	300.00	101,700.00
	Reinforcement				
E	10mm - 32mm Diameter bar	Kg	50,850	3.50	177,975.00
	Formwork to Roof Slab				
F	To soffit of slab	M2	2,265	32.24	73,023.60
	STAIRCASE				
G	Staircase inclusive finishes	No	54	5,000.00	270,000.00
	LIGHTWEIGHT ROOF				
H	Supply and install lightweight roof truss complete with metal decking roof covering, aluminium foil, rockwool, gutter, flashing, fascia board, capping and all other finishes and accessories	M2	461	120.00	55,320.00
J	Supply and install lightweight roof truss complete with polycarbonate roof covering, gutter and all other finishes and accessories	M2	25	150.00	3,750.00
	Rainwater down pipe (RWDP) system	Item	-	-	15,000.00
	EXTERNAL WALL				
K	Vent block	M2	100	100.00	10,000.00
L	Wall cladding	M2	200	250.00	50,000.00
M	Aluminium louvres	M2	209	120.00	25,080.00
	DOORS				
N	Overall size 1000mm x 2400mm high, single leaf 2 hours fire rated door complete with fixed glass above (Type D1)	No	352	912.00	321,024.00
P	Overall size 900mm x 2400mm high, single leaf timber plywood flush door complete with fixed glass above (Type D2)	No	1,061	821.00	871,081.00
Q	Overall size 900mm x 2400mm high, single leaf timber plywood flush door complete with fixed glass above (Type D3)	No	352	821.00	288,992.00
				TOTAL CARRIED TO COLLECTION	**22,896,945.60**
					Page No: 2/6

Item	Description	Unit	Quantity	Rate	Amount
	DOORS (Cont'd)				
	Supply and fix powder coated aluminium frame fixed panel complete with ironmongeries and accessories including 6mm thick clear glass				
A	Overall size 2100mm x 2400mm high, 3 panel glass sliding door complete with fix glass above (Type SD1)	No	352	2,016.00	709,632.00
B	1800mm x 2350mm high, glass door (Type D6)	No	1	1,692.00	1,692.00
	Supply and fix powder coated aluminium frame fixed panel complete with ironmongeries and accessories				
C	900mm x 2100mm high, bottom trackless bifold door (Type D4)	No	714	756.00	539,784.00
	Supply and fix in position door including framing, in-fill with concrete complete with ironmongeries				
D	2000mm x 2400mm high Lightweight greaseless aluminium roller shutter (Type RS1)	No	3	1,824.00	5,472.00
E	3200mm x 2400mm high Lightweight greaseless aluminium roller shutter (Type RS2)	No	1	2,919.00	2,919.00
	Supply and fix in position fire rated door; including door frame, ironmongeries, lockset, rebated part and door closer, door selector and hinges to the approved manufacturer's details and in compliance with Fire Authority's requirement				
F	Overall size 2700mm x 2400mm double leaf 2 hour timber fire rated door with aluminium anti vermin netting fixed inside (Type FD1)	No	2	2,463.00	4,926.00
G	Overall size 1500mm x 2100mm double leaf 2 hour timber fire rated door with aluminium anti vermin netting fixed inside (Type FD2)	No	4	1,197.00	4,788.00
H	Overall size 615mm x 2100mm single leaf 2 hour timber fire rated door (Type FD3)	No	54	491.00	26,514.00
J	Overall size 1200mm x 2100mm double leaf 2 hour timber fire rated door (Type FD4)	No	56	958.00	53,648.00
	WINDOWS				
	Supply and fix powder coated aluminium frame fixed panel complete with aluminium frame including 6mm thick clear glass and all necessary fixing accessories				
K	1800mm x 1500mm high, 3 panel casement glass window (Type W1)	No	1,066	945.00	1,007,370.00
L	1200mm x 1500mm high, 2 panel casement glass window (Type W2)	No	847	630.00	533,610.00
				TOTAL CARRIED TO COLLECTION	**2,890,355.00**

Item	Description	Unit	Quantity	Rate	Amount
	WINDOWS (Cont'd)				
A	600mm x 750mm high, top hung window (Type W3)	No	712	158.00	112,496.00
B	600mm x 1200mm high, 1 panel casement glass window with top hung (Type W4)	No	36	252.00	9,072.00
	Supply and fix natural anodised aluminium frame complete with aluminium window frame				
C	2100mm x 600mm high louvres window (Type LV1)	No	36	441.00	15,876.00
	EXTERNAL FINISHES				
	Curtain Wall				
D	Glazed wall panel system	M2	65	800.00	52,000.00
	Mild Steel Railing				
E	1100mm high m.s. railing	M2	1,857	250.00	464,250.00
	External Wall Finishes				
F	Skim coat to wall	M2	20,655	10.50	216,877.50
G	Weathershield paint to wall	M2	20,655	7.00	144,585.00
	External Floor Finishes				
H	Cement render	M2	2,921	20.00	58,420.00
J	Waterproofing to apron	M2	494	3.00	1,482.00
K	Waterproofing system to flat roof	M2	2,921	20.00	58,420.00
	INTERNAL WALL FINISHES				
L	Skim coat to wall	M2	133,617	10.50	1,402,978.50
M	Emulsion paint to wall	M2	133,617	5.00	668,085.00
N	Ceramic tiles	M2	11,975	60.00	718,500.00
	INTERNAL FLOOR FINISHES				
P	50mm Cement render	M2	34,358	20.00	687,160.00
Q	150mm Cement render	M2	182	40.00	7,280.00
R	Ceramic tiles	M2	5,443	60.00	326,580.00
S	Waterproofing system	M2	5,443	20.00	108,860.00
	INTERNAL CEILING FINISHES				
T	Skim coat to ceiling	M2	34,363	10.50	360,811.50
U	Moisture resistant ceiling board	M2	5,528	45.00	248,760.00
V	Emulsion paint to skim coat	M2	34,636	5.00	173,180.00
W	Emulsion paint to ceiling board	M2	5,528	5.00	27,640.00
				TOTAL CARRIED TO COLLECTION	**5,863,313.50**
					Page No: 4/6

Item	Description	Unit	Quantity	Rate	Amount
	SANITARY FITTINGS				
A	Water closet	No	711	350.00	248,850.00
B	Handicap water closet	No	1	500.00	500.00
C	Wash hand basin	No	711	150.00	106,650.00
D	Handicap wash hand basin	No	1	400.00	400.00
E	Shower rose	No	685	85.00	58,225.00
F	Hand bidet	No	712	45.00	32,040.00
G	Toilet roll holder	No	712	30.00	21,360.00
H	Floor trap grating	No	2,243	10.00	22,430.00
J	Single bowl sink	No	353	120.00	42,360.00
K	Basin tap	No	712	50.00	35,600.00
L	Pillar tap	No	353	50.00	17,650.00
M	Bib tap	No	1,059	50.00	52,950.00
N	Handrailing	No	1	350.00	350.00
	RAIN WATER HARVESTING TANK (RWHT)				
P	Stainless steel tank complete with flush diverter, pump, valve, floating intake and others accessories	Item	-	-	54,200.00
	MECHANICAL, ELECTRICAL AND PLUMBING				
	Mechanical & Plumbing				
Q	Mechanical Ventilation System	Item	-	-	19,200.00
R	Fire Protection System	Item	-	-	1,122,900.00
S	Cold Water & Sanitary Plumbing System	Item	-	-	1,292,096.00
T	Vertical Transportation System	Item	-	-	1,500,000.00
	Electrical System				
U	Switchboard	Item	-	-	853,000.00
V	Submain Cable	Item	-	-	637,000.00
W	Common Area Light Fitting and Small Socket Outlet	Item	-	-	86,000.00
X	Lightning & Earthing System	Item	-	-	50,000.00
Y	Total for Typical Unit (Type 1&2)	Item	-	-	1,032,340.00
Z	Genset System	Item	-	-	150,000.00
	ELV System				
AA	CCTV System	Item	-	-	12,000.00
AB	Fiber Optic System	Item	-	-	316,800.00
AC	SMATV System	Item	-	-	176,000.00
	TOTAL CARRIED TO COLLECTION				**7,940,901.00**
					Page No: 5/6

Item	Description	Unit	Quantity	Rate	Amount
	INFRASTRUCTURE				
A	Earthworks, Roadworks, Water Reticulation, Sewerage, Drainage, Etc. (Approx: 4.71 acres)	Item	-	-	2,355,000.00
				TOTAL CARRIED TO COLLECTION	**2,355,000.00**
					Page No: 6/6

Item	Description	Amount
	A. COLLECTION (BUILDING)	
	Page No. 1/6	**3,469,855.50**
	Page No. 2/6	**22,896,945.60**
	Page No. 3/6	**2,890,355.00**
	Page No. 4/6	**5,863,313.50**
	Page No. 5/6	**7,940,901.00**
	TOTAL (A)	**43,061,370.60**
	B. COLLECTION (INFRASTRUCTURE)	
	Page No. 6/6	**2,355,000.00**
	TOTAL (B)	**2,355,000.00**
	GRAND TOTAL (A) + (B)	**RM45,416,370.60**

SECTION 2

IHSAN HOMES SINGLE-STOREY TERRACE HOUSE

Architectural Design Concept
Civil & Structural Design
Mechanical, Electrical & Plumbing Design
Construction Cost Estimation

ARCHITECTURAL DESIGN CONCEPT

Design Overview

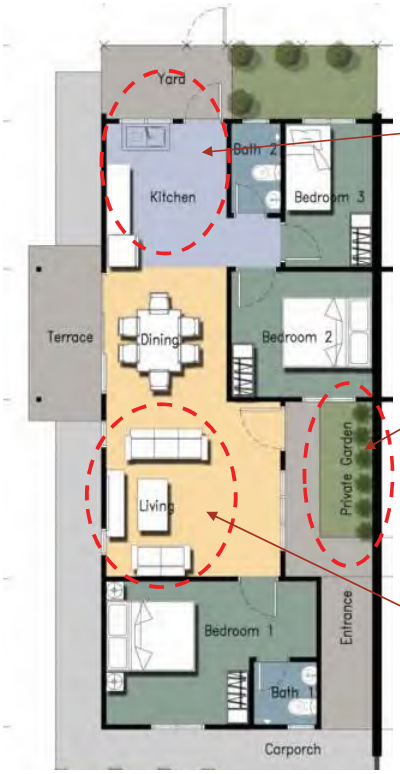
The terrace house is comprised of 3 bedrooms, 2 bathrooms, kitchen, dining room, living room, private garden, and yard.

Perspective View of Terrace House (Artist Impression)

Front View of Architectural Model

Rear View of Architectural Model

Design Features



Large & Multiple Openings for Maximum Natural Ventilation & Lighting

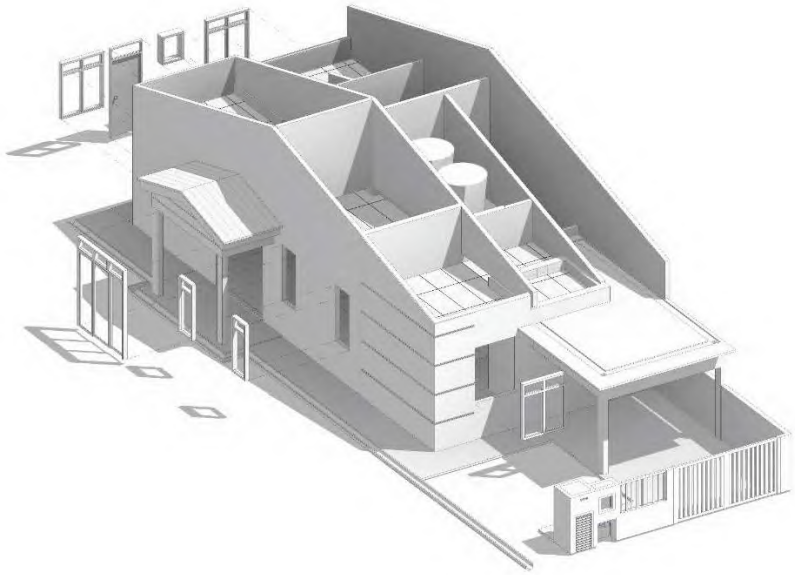
Garden-inspired Entrance to Connect to the Outdoor Area

Spacious & Brightly Lit Living Area for the Comfort of Family & Friends

The garden-inspired entrance is introduced for the occupants to connect to the outdoor area. The total GFA of the units remain the same without compromising the private garden. These arrangements are aimed to foster relationship between neighbours. The polycarbonate roof helps to maximise natural sunlight to light up the entrance and enhance the welcoming sense.

Sustainability Design

The windows enables natural ventilation throughout the day, even during the rainy days.



Windows and Openings of the Terrace House

Natural Ventilation and Daylighting Simulations of the Terrace House Unit

Design Layout

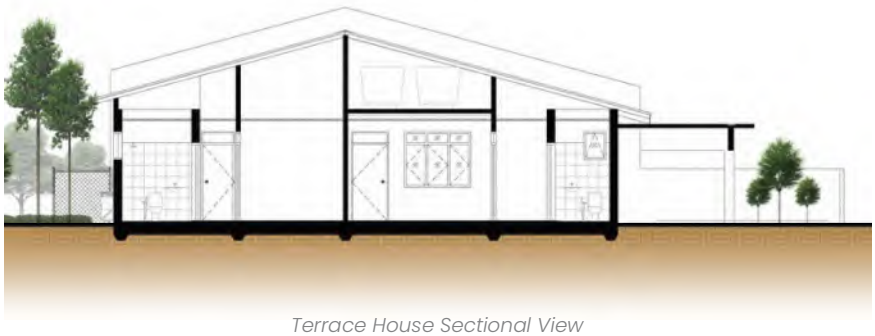
Typical Unit Layout

The floor plans are designed with the intention of reducing construction wastage and enhancing the speed of installation for the finishes.

Terrace House Typical Unit

Terrace House Floor Area Schedule

AREA	FLOOR AREA (NETT)	
	M^2	FT^2
Carporch	5.13	55.22
Entrance	2.02	21.74
Living	15.98	172.01
Dining	8.11	87.30
Private Garden	3.77	40.58
Bedroom 1	13.04	140.36
Bath 1	2.64	28.42
Bedroom 2	9.43	101.50
Bedroom 3	6.87	73.95
Bath 2	2.52	27.13
Kitchen	10.66	114.74
Yard	2.43	26.16
TOTAL	**82.60**	**889**

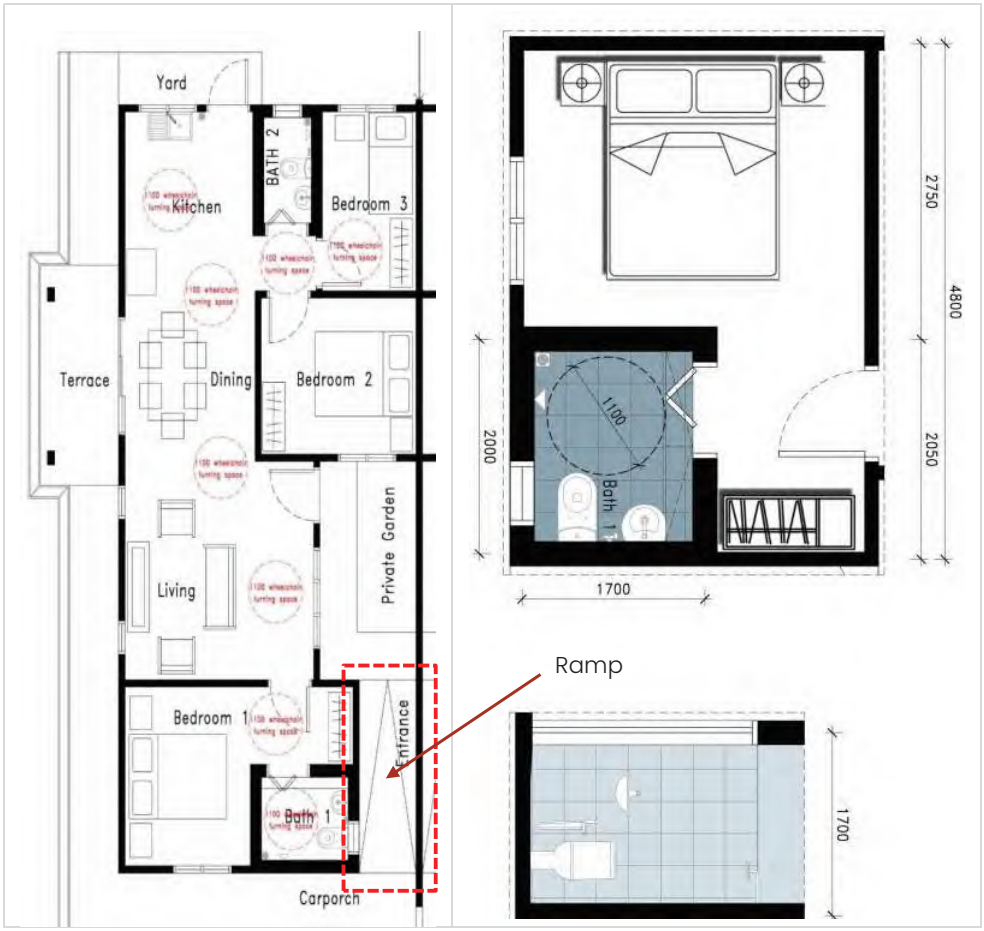


Terrace House Sectional View

Accessibility

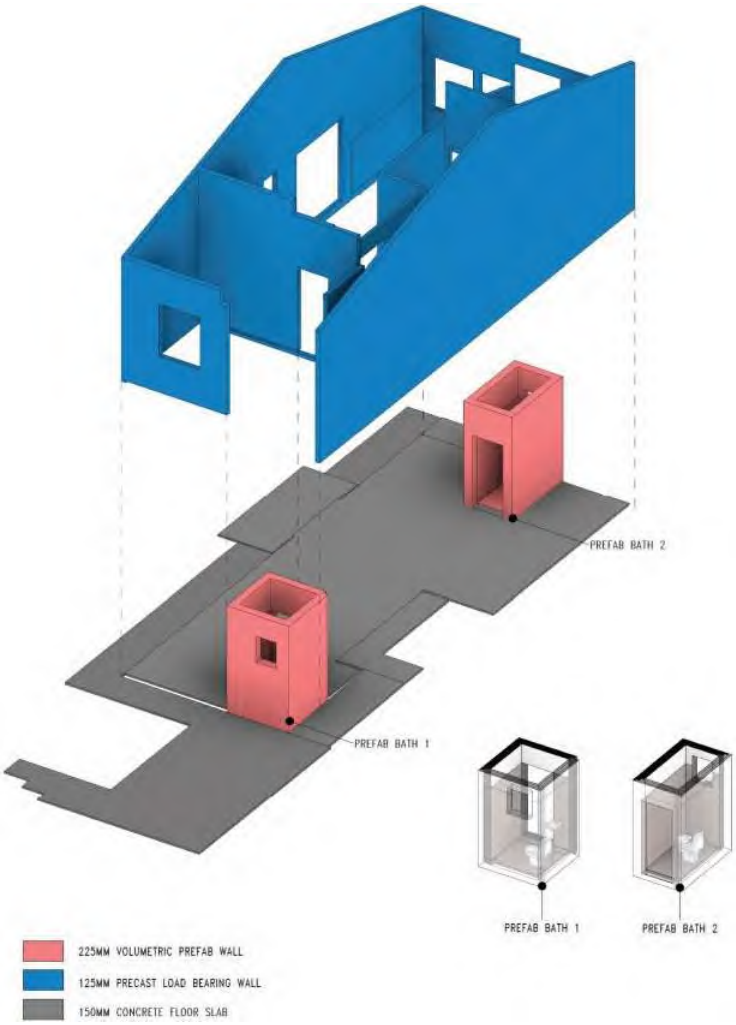
Accessible house plans are designed to accommodate people with limited mobility. It increases self-dependency thus making the dwellers happy and confident. The doors and hallways are wider to allow easy passage for those using wheelchairs.

Ramp leading to the front door is specifically designed to accommodate the disabled and elderly citizens. This feature makes things easier for them, besides benefitting the wheelchair users. A wider entrance to the bathroom makes it accessible for wheelchair users.



Design for Modularisation

A rational unit is optimised in terms of modularity, making it IBS-ready. The floor plans are designed with the intention to reduce construction wastage and enhancing the speed of installation and finishes.



CIVIL & STRUCTURAL DESIGN

Structural Layout Overview

Terrace houses are constructed in two ways. The **first construction type** is to build wall panels by incorporating the prefabricated bathroom units (PBU). There are three types of terrace units, they are intermediate, end, and corner units. The intermediate unit is different from the end and corner units in terms of wall opening for the window and door on both sides of the wall panel. There is no opening on both sides of the wall panel for the intermediate unit. The balcony of the corner unit is different from the end unit of the terrace.

The **second construction type** is to fully implement the volumetric module. Volumetric module (VM) is a standardised construction unit, produced by using prefabricated concrete modules. The unit is pre-fitted with electrics, plumbing, windows, and internal finishes and commissioned before leaving the factory. The self-weight of prefab-concrete VM units are between 8 and 20 tonnes per unit. The VM units are designed with a maximum length of 6300 mm so they can be stacked on a trailer. 14 volumetric modules are required for the terrace house.

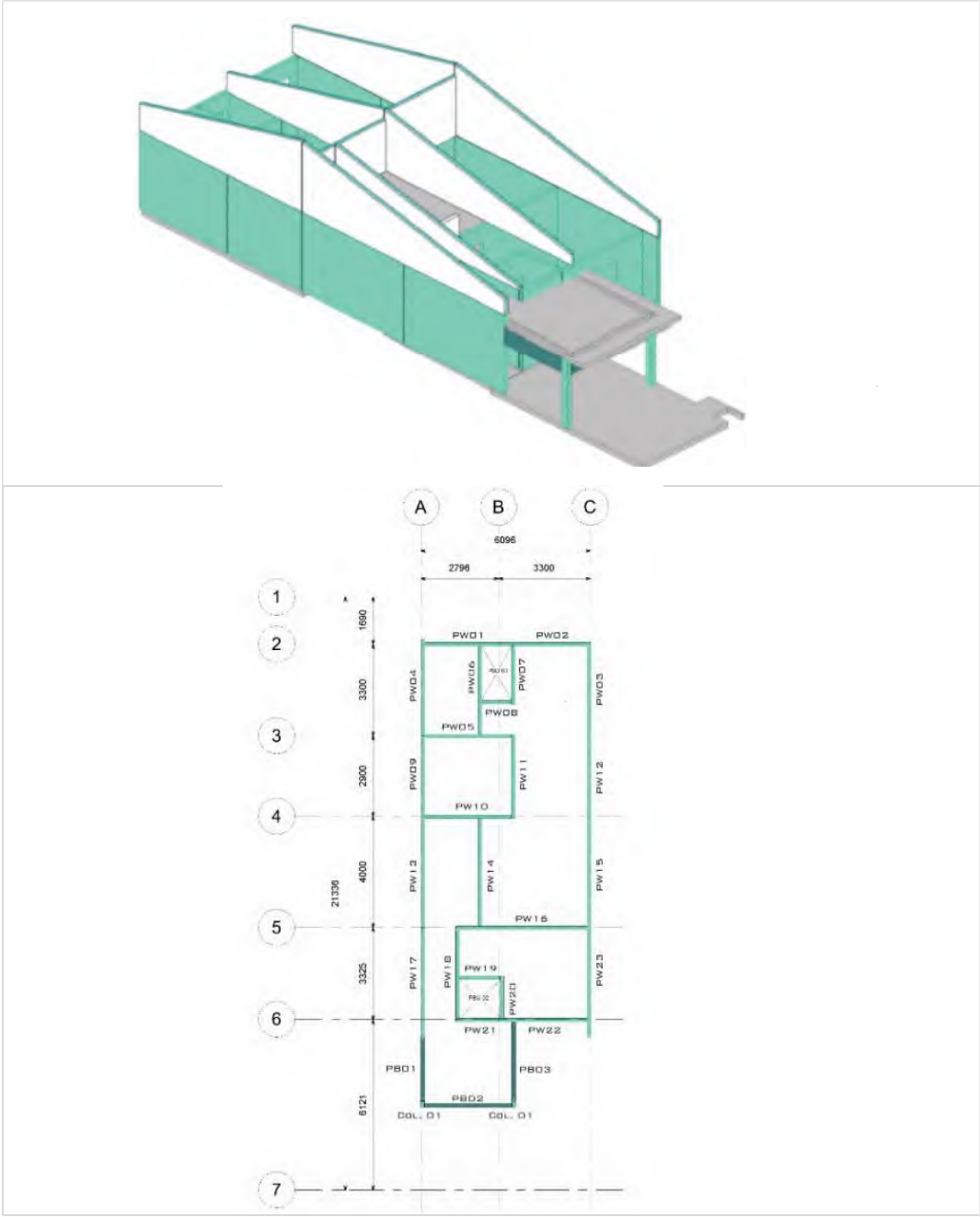
Construction Type 1 – Panel and PBU

Wall Design

Construction Type 1 for terrace house is built using 23 wall panels, 10 gabble end walls, a few beams, and two prefabricated bathroom units. The slab will be cast-in-situ.

The precast walls are designed as load-bearing walls with the maximum length of 4723 mm, 3200 mm height, 125 mm thickness, and the weight of 3.65 tonnes. The total number of wall panels for a terrace house is 23 and 10 gables end walls with two PBU units.

Intermediate Unit



Intermediate Unit Precast Wall and Beam Layout Level 1 and 3D View

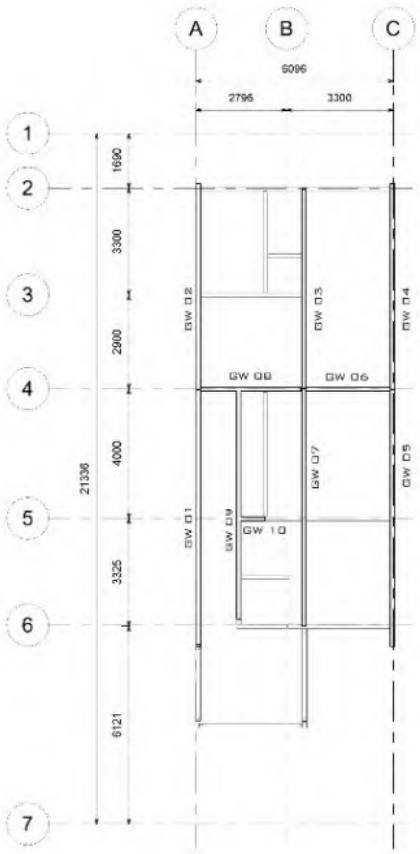
SECTION 2

Intermediate Unit Precast Wall Level 1 Specifications

WALL MARKING	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PW01	2656	0.52	1.24
PW02	3170	0.93	2.22
PW03	3451	1.32	3.16
PW04	2940	1.12	2.69
PW05	3989	1.52	3.65
PW06	3941	1.5	3.61
PW07	1540	0.53	1.27
PW08	3168	0.98	2.36
PW09	3940	1.5	3.6
PW10	3988	1.29	3.11
PW11	2882	0.45	1.07
PW12	3358	1.28	3.07
PW13	2073	0.79	1.9
PW14	3148	0.93	2.24
PW15	1045	0.16	0.39
PW16	3107	0.92	2.2
PW17	3025	1.15	2.77
PW18	3107	0.96	2.3
PW19	3845	0.73	1.76
PW20	4723	1.52	3.66
PW21	3173	1.21	2.9
PW22	1500	0.56	1.35
PW23	1445	0.31	0.75

Intermediate Unit Precast Beam Level 1 Specifications

BEAM MARKING	WIDTH (mm)	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PB01	150	600	2900	0.25	0.61
PB02	150	600	3237	0.28	0.68
PB03	150	600	2376	0.21	0.49

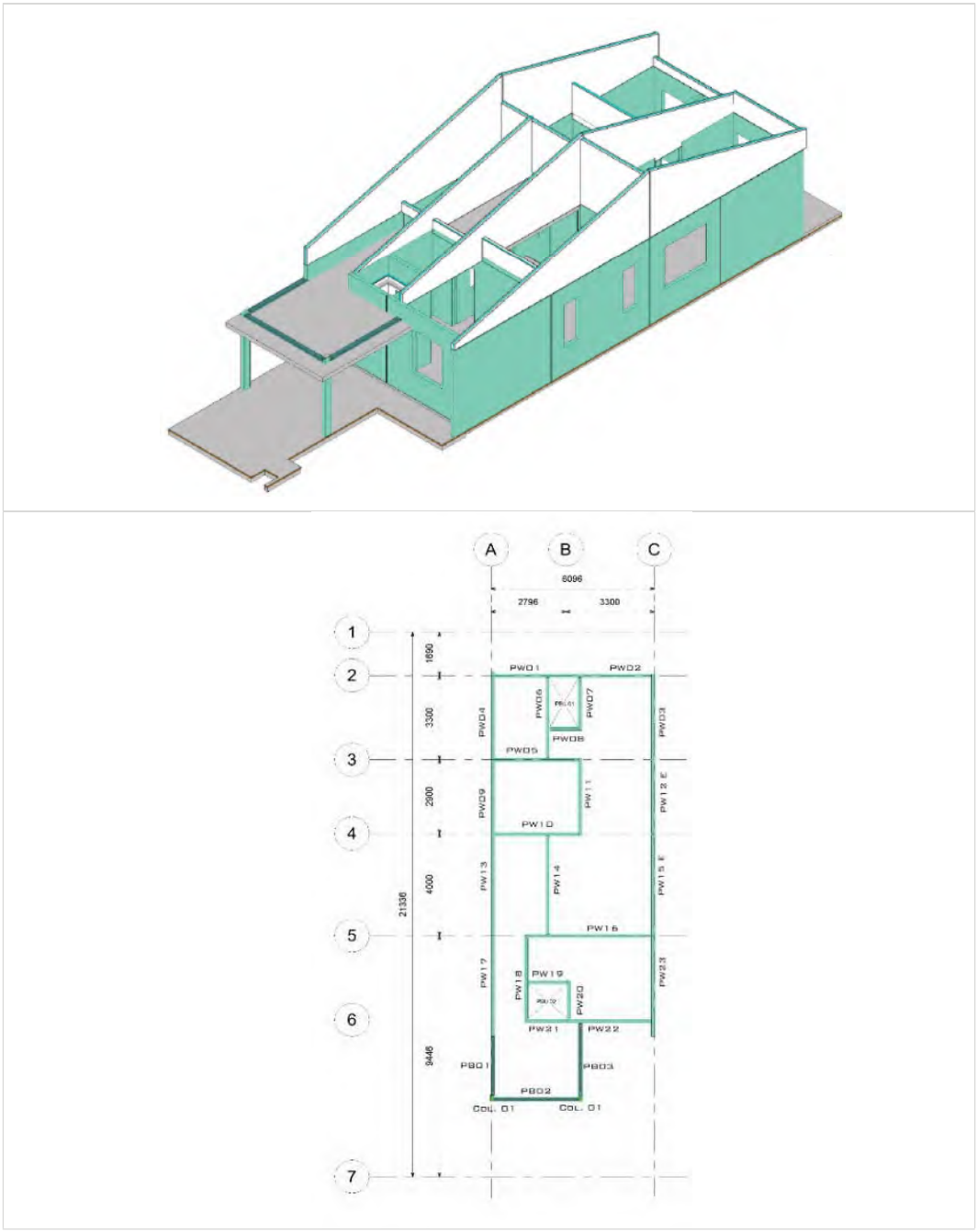


Intermediate Unit Precast Gable End Wall Level 2 Layout

Intermediate Unit Precast Gable End Wall Level 2 Specifications

PANEL MARK	LENGTH (mm)	AREA (m^2)	VOLUME (m^3)	WEIGHT (tonne)
GW01	7962	13	1.66	3.97
GW02	6356	12	1.48	3.55
GW03	6157	10	1.22	2.93
GW04	6356	9	1.18	2.84
GW05	7957	10	1.25	3.01
GW06	2670	6	0.75	1.8
GW07	7317	11	1.32	3.16
GW08	3166	6	0.76	1.82
GW09	7263	8	0.96	2.31
GW10	1249	1	0.07	0.16

End Unit



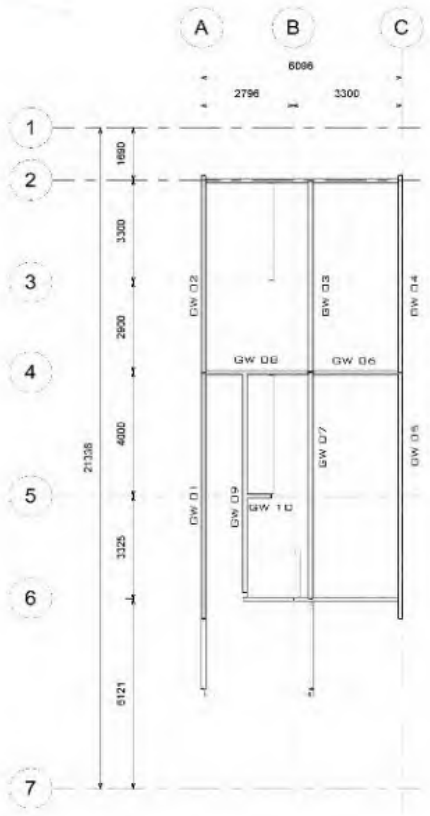
End Unit Precast Wall and Beam Layout Level 1 and 3D View

End Unit Precast Wall Level 1 Specifications

WALL MARKING	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PW01	2656	0.52	1.24
PW02	3170	0.93	2.22
PW03	3451	1.32	3.16
PW04	2940	1.12	2.69
PW05	3989	1.52	3.65
PW06	3941	1.5	3.61
PW07	1540	0.53	1.27
PW08	3168	0.98	2.36
PW09	3940	1.5	3.6
PW10	3988	1.29	3.11
PW11	2882	0.45	1.07
PW12E	2940	1.12	2.69
PW13	2073	0.79	1.9
PW14	3148	0.93	2.24
PW15E	3988	1.29	3.11
PW16	3107	0.92	2.2
PW17	3025	1.15	2.77
PW18	3107	0.96	2.3
PW19	3845	0.73	1.76
PW20	4723	1.52	3.66
PW21	3173	1.21	2.9
PW22	1500	0.56	1.35
PW23	1445	0.31	0.75

End Unit Precast Beam Level 1 Specifications

BEAM MARKING	WIDTH (mm)	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PB01	150	600	2900	0.25	0.61
PB02	150	600	3237	0.28	0.68
PB03	150	600	2376	0.21	0.49

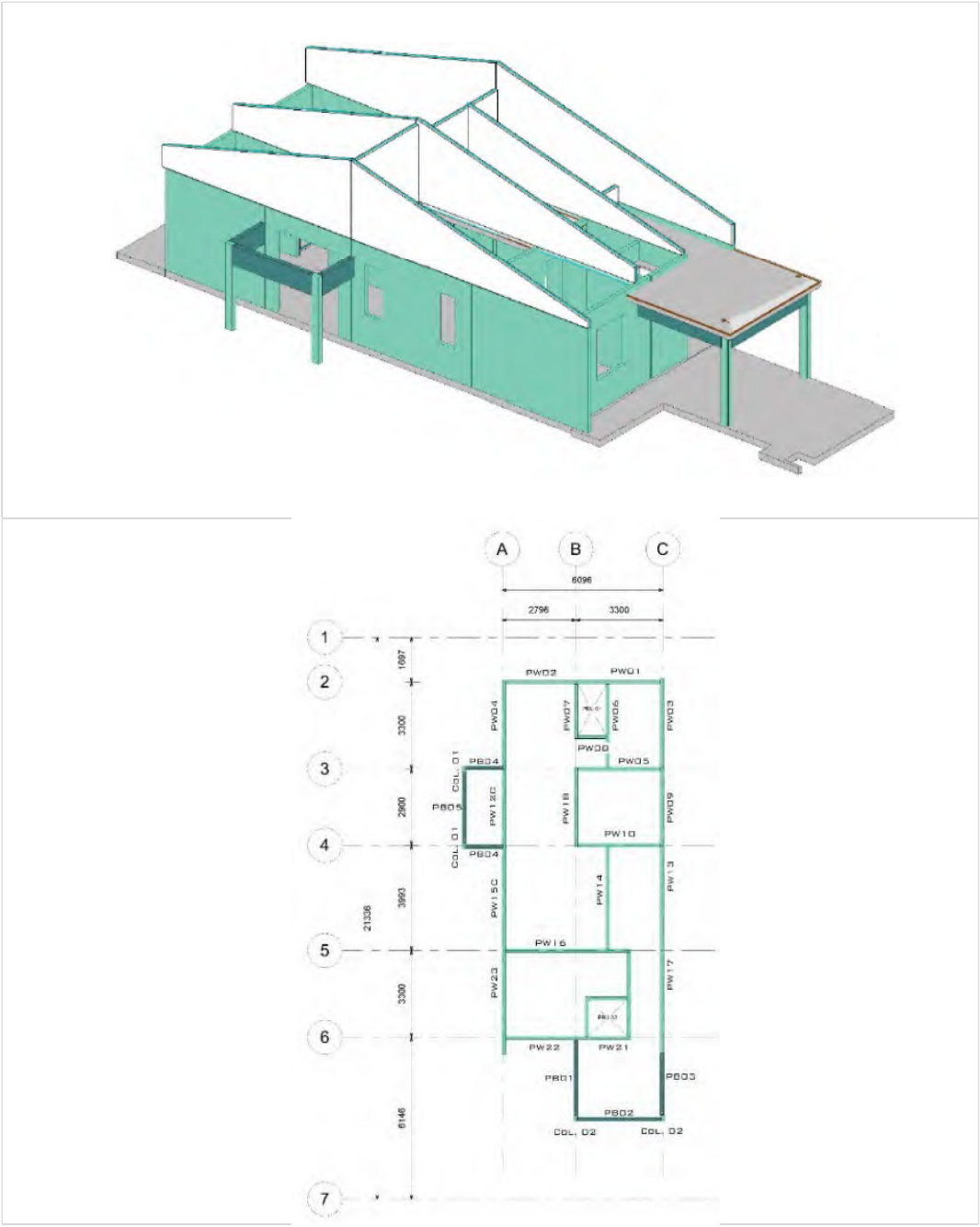


End Unit Precast Gable End Wall Layout

End Unit Precast Gable End Wall Specifications

PANEL MARK	LENGTH (mm)	AREA (m^2)	VOLUME (m^3)	WEIGHT (tonne)
GW01	7962	13	1.66	3.97
GW02	6356	12	1.48	3.55
GW03	6157	10	1.22	2.93
GW04	6356	9	1.18	2.84
GW05	7957	10	1.25	3.01
GW06	2670	6	0.75	1.8
GW07	7317	11	1.32	3.16
GW08	3166	6	0.76	1.82
GW09	7263	8	0.96	2.31
GW10	1249	1	0.07	0.16

Corner Unit



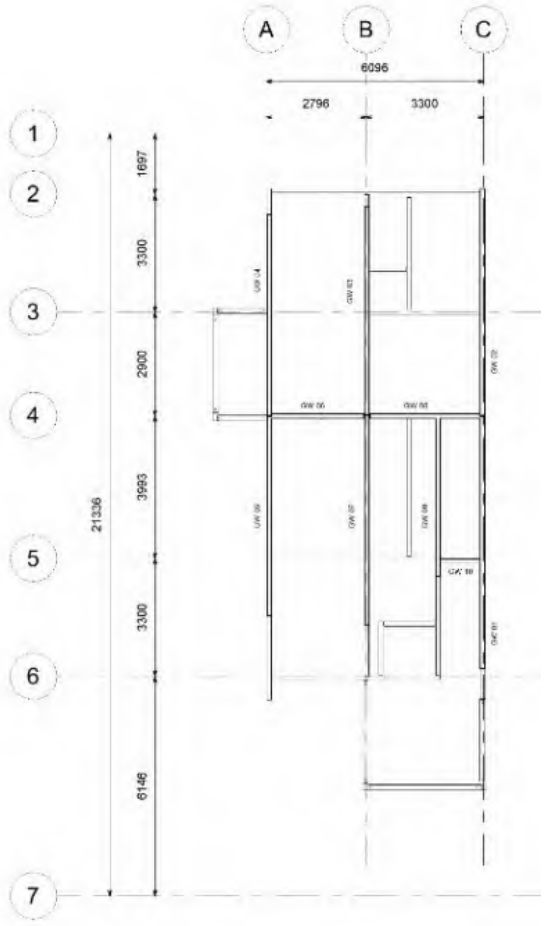
Corner Unit Precast Wall and Beam Layout Level 1 And 3D View

Corner Unit Precast Wall Level 1 Specifications

WALL MARKING	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PW01	2656	0.52	1.24
PW02	3170	0.93	2.22
PW03	3451	1.32	3.16
PW04	2940	1.12	2.69
PW05	3989	1.52	3.65
PW06	3941	1.5	3.61
PW07	1540	0.53	1.27
PW08	3168	0.98	2.36
PW09	3940	1.5	3.6
PW10	3988	1.29	3.11
PW11	2882	0.45	1.07
PW12C	2882	0.45	1.07
PW13	2073	0.79	1.9
PW14	3148	0.93	2.24
PW15C	3988	1.29	3.11
PW16	3107	0.92	2.2
PW17	3025	1.15	2.77
PW18	3107	0.96	2.3
PW19	3845	0.73	1.76
PW20	4723	1.52	3.66
PW21	3173	1.21	2.9
PW22	1500	0.56	1.35
PW23	1445	0.31	0.75

Corner Unit Precast Beam Level 1 Specifications

BEAM MARKING	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PB01	600	2900	0.25	0.61
PB02	600	3237	0.28	0.68
PB03	600	2376	0.21	0.49
PB04	600	1446	0.12	0.29
PB04	600	1446	0.12	0.29
PB05	600	2738	0.24	0.57



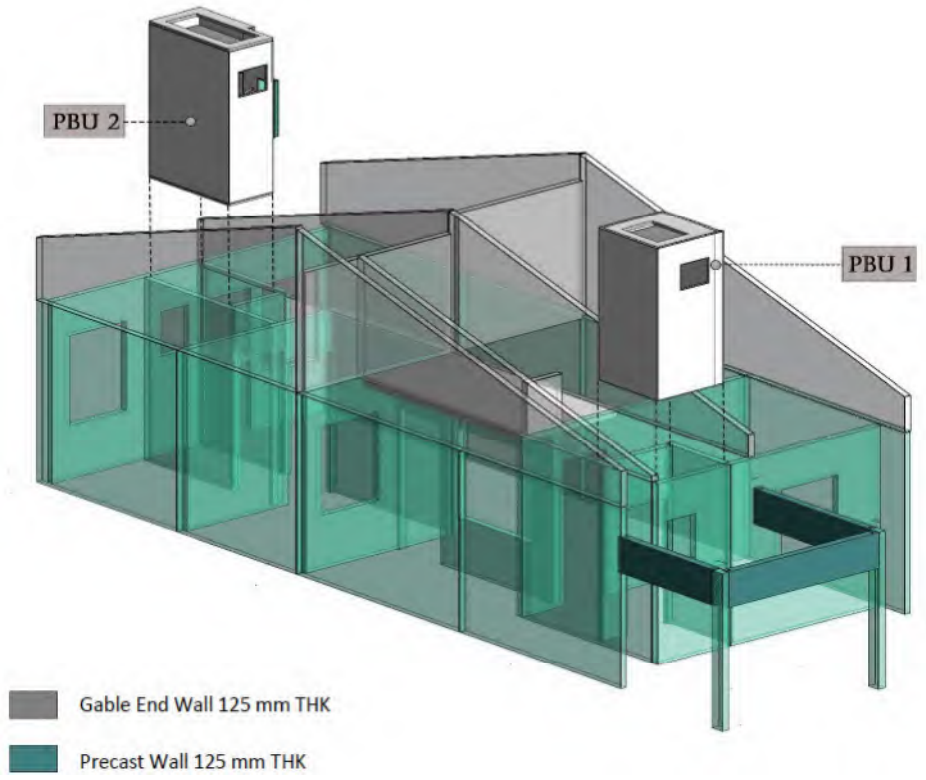
Corner Unit Precast Wall Level 2 Layout

Corner Unit Precast Gable End Wall Level 2 Specifications

PANEL MARK	LENGTH (mm)	AREA (m^2)	VOLUME (m^3)	WEIGHT (tonne)
GW01	7962	13	1.66	3.97
GW02	6356	12	1.48	3.55
GW03	6157	10	1.22	2.93
GW04	6356	9	1.18	2.84
GW05	7957	10	1.25	3.01
GW06	2670	6	0.75	1.8
GW07	7317	11	1.32	3.16
GW08	3166	6	0.76	1.82
GW09	7263	8	0.96	2.31
GW10	1249	1	0.07	0.16

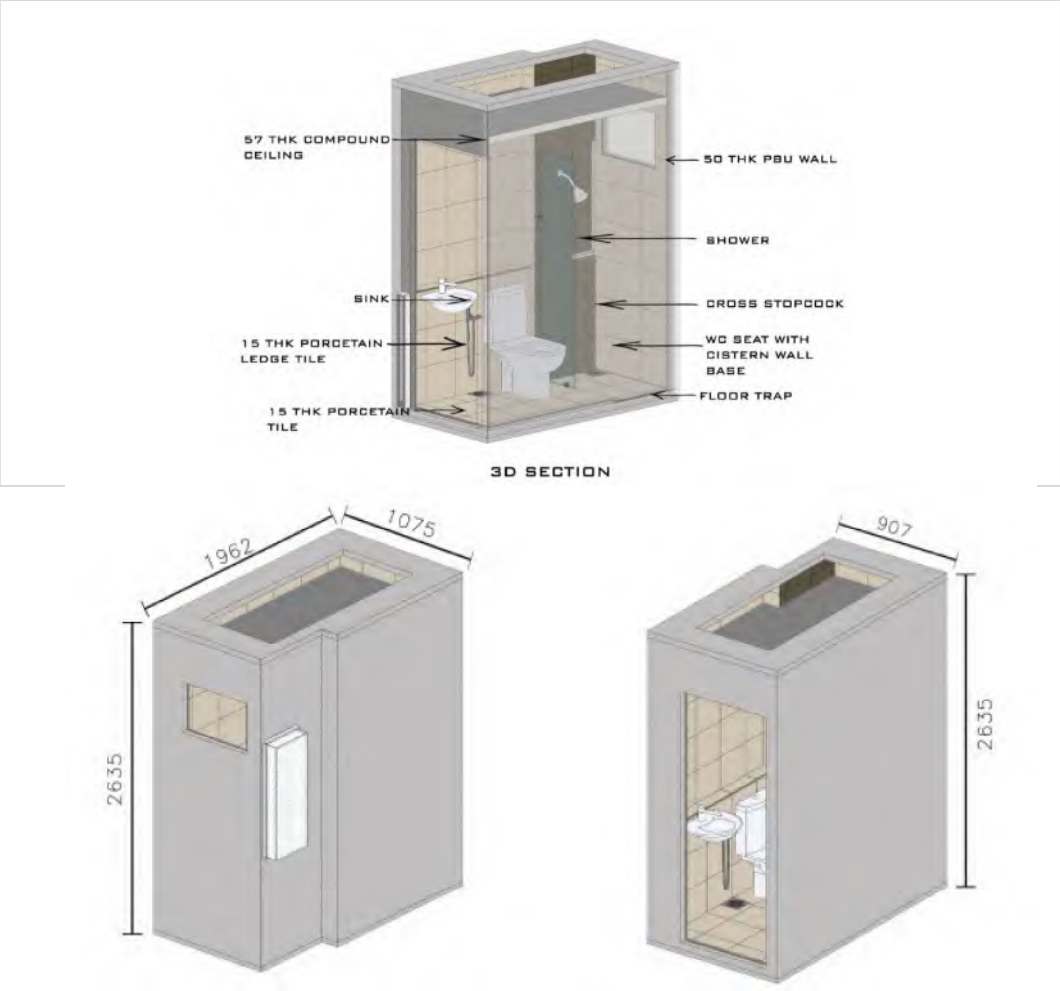
Bathroom

In the terrace house, two prefabricated bathroom units (PBU) are required along with precast wall panels. The PBU is preassembled with ceiling, wall, sink, tile, WC seat, floor trap, shower, and cross stopcock. The use of PBU helps to shorten the construction period.



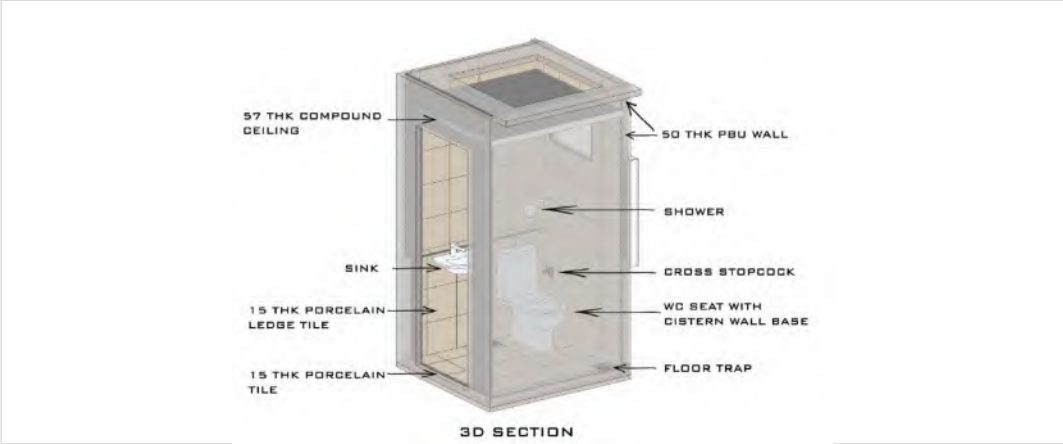
Precast Bathroom Unit Layout of the Terrace House

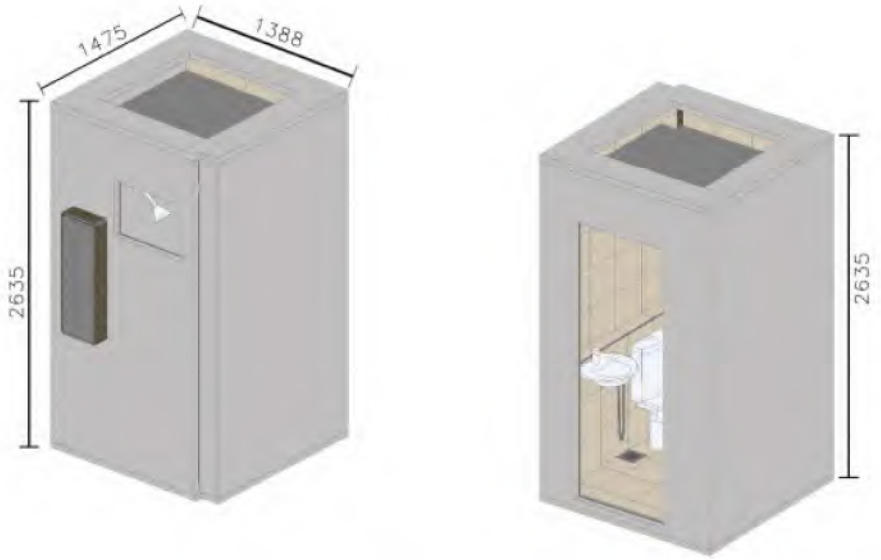
PBU Type 1



PBU Type 1 3D and Dimensional Views

PBU Type 2





PBU Type 2 3D and Dimensional Views

Construction Type 2 – Volumetric Module

14 Volumetric Modules (VM) are used to construct the terrace house. Volumetric Module (VM) is a standardised unit of construction, produced by using the prefab-concrete modules. The unit is pre-fitted with electrics, plumbing, heating, windows, and internal finishes and commissioned before leaving the factory. It is suitable in the construction of residential buildings for landed housing and apartments.

The self-weight of prefab-concrete VM units is between 5 and 20 tonnes per unit. The VM units are designed with a maximum length of 6.30 m so that they can be easily stacked on a trailer.

The benefits of using VM are as follows:

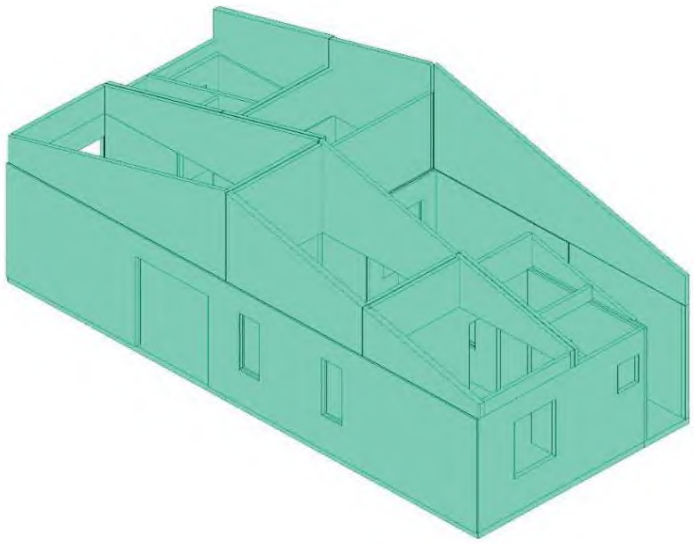
1. **Lesser construction period**
   VM practises Just-In-Time installation since it cannot be stored on-site. Hence, rapid deployment on-site helps to achieve faster completion time as compared to the cast-in-situ construction method.

2. **Better safety**
   The construction of the Volumetric Module is carried out at the factory. Hence, it reduces on-site labour and on-site storage requirements.

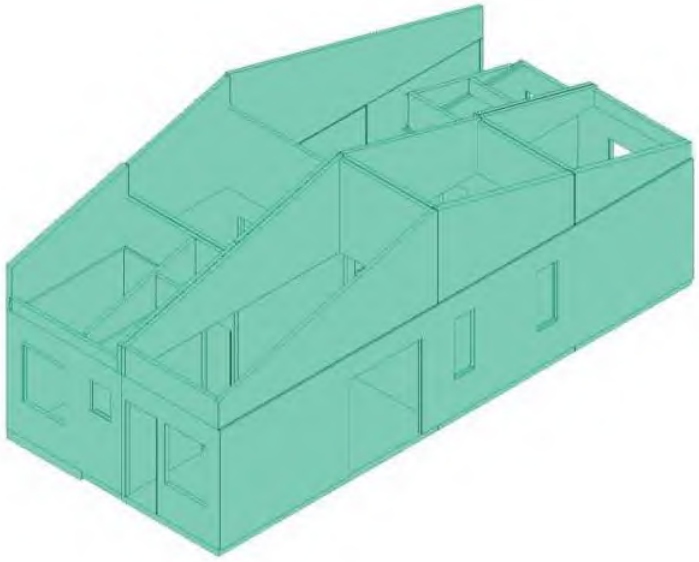
3. **On-site labour reduction**
   On-site labour can be reduced as most of the construction is performed at the factory.

4. **Environmental**
   Since the construction process is performed off-site, the waste generated from the construction process is lower, which lower the cost of construction, thus creates a cleaner, safer, and more sustainable site.

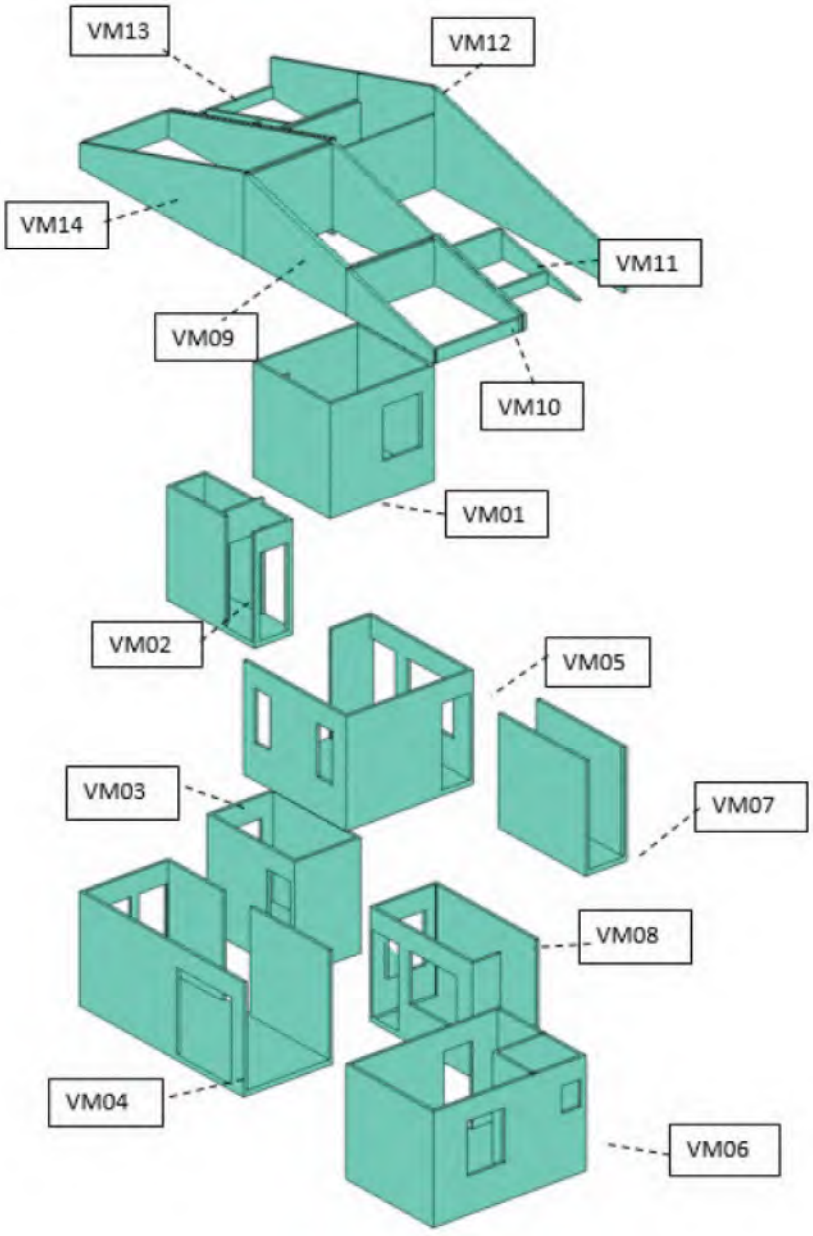
5. **Quality**
   Volumetric Module (VM) has a consistent quality due to the complete control over the manufacturing environment that the cast-in-situ construction cannot offer.



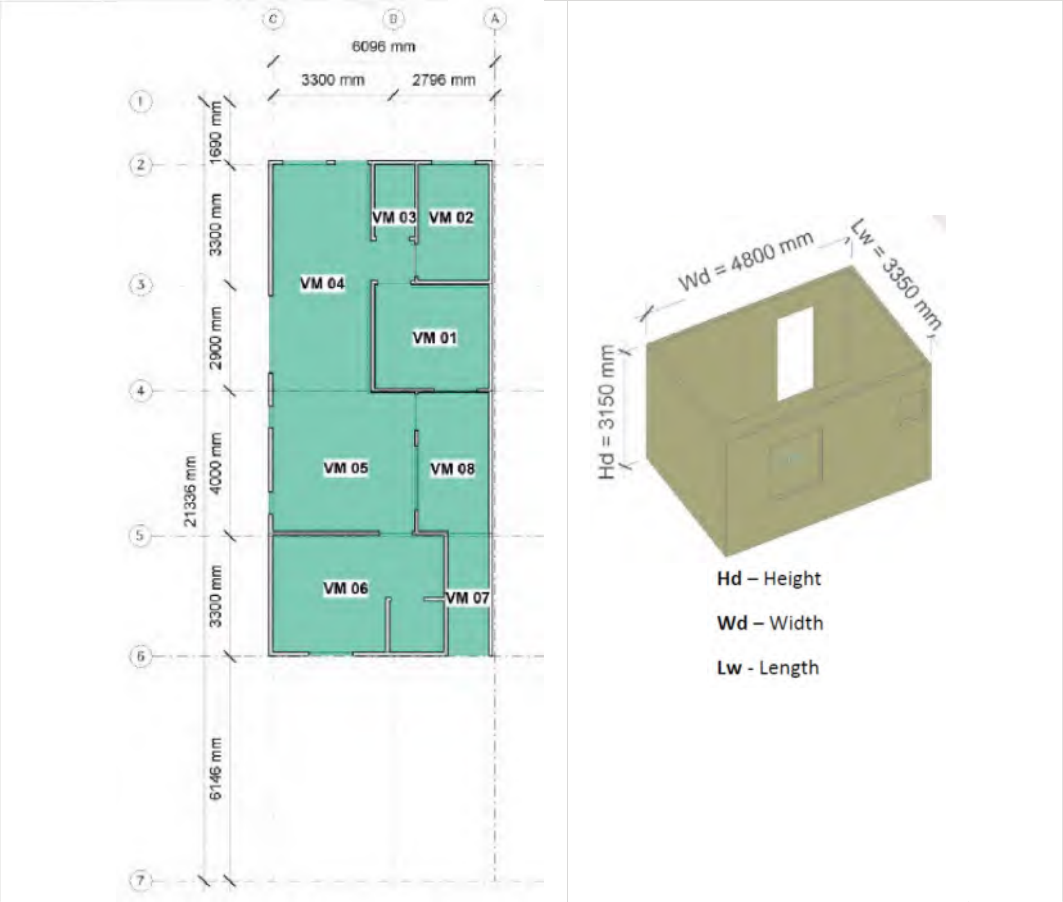
Intermediate Unit Volumetric Module Front View



Intermediate Unit Volumetric Module Rear View



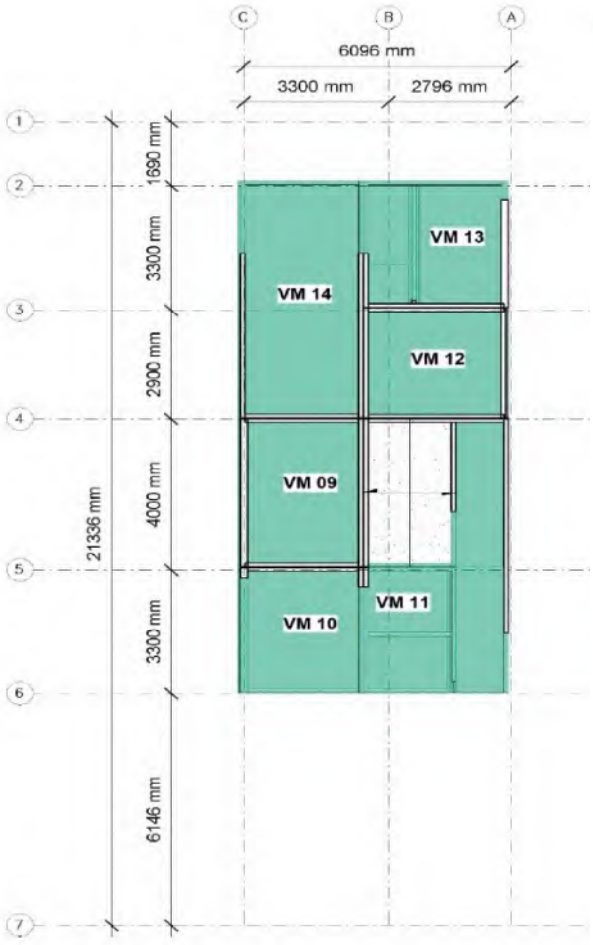
Intermediate Unit Volumetric Modules



Intermediate Unit Volumetric Module Layout Level 1

Intermediate Unit Volumetric Module Level 1 Specification

PANEL MARK	HEIGHT (mm)	LENGTH (mm)	WIDTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
VM01	3150	2950	3300	4.85	11.628
VM02	3150	3350	2100	4.18	10.03
VM03	3690	3350	1200	3.72	8.925
VM04	3150	6300	2796	8.37	20.094
VM05	3150	3950	3996	6.90	16.570
VM06	3150	3350	4800	6.84	16.412
VM07	3150	3350	1296	3.39	8.129
VM08	3150	3950	2100	4.81	11.542



Intermediate Unit Volumetric Module Layout Level 2

Intermediate Unit Volumetric Module Level 2 Specifications

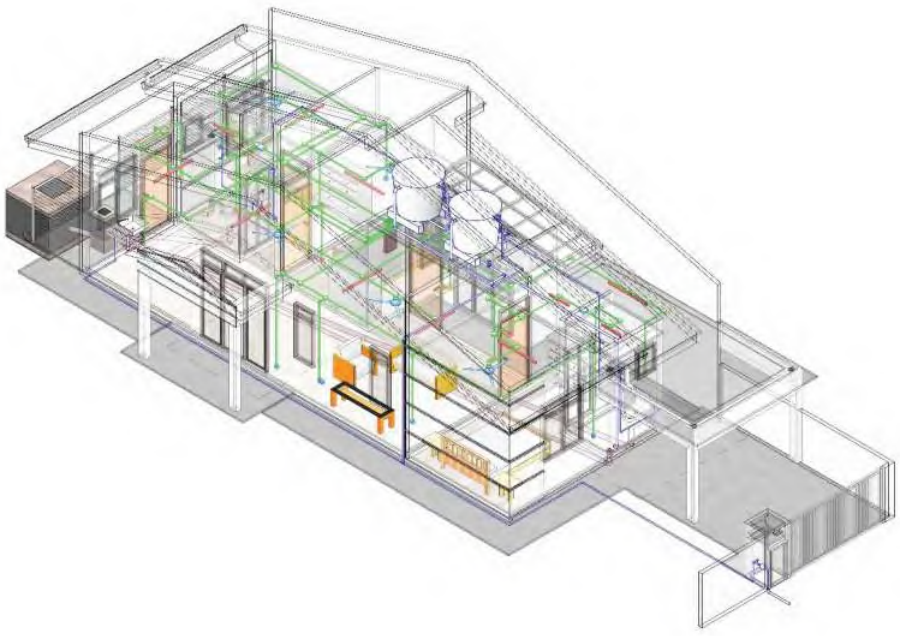
PANEL MARK	HEIGHT (mm)	LENGTH (mm)	WIDTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
VM09	2334	3935	2789	4.68	11.238
VM10	1276	3343	2789	3.07	7.377
VM11	1338	3343	2097	2.58	6.185
VM12	2712	2935	3293	4.42	10.603
VM13	1964	3343	3293	4.16	9.988
VM14	2363	6293	2789	7.14	17.144

MECHANICAL, ELECTRICAL & PLUMBING DESIGN

MEP Layout

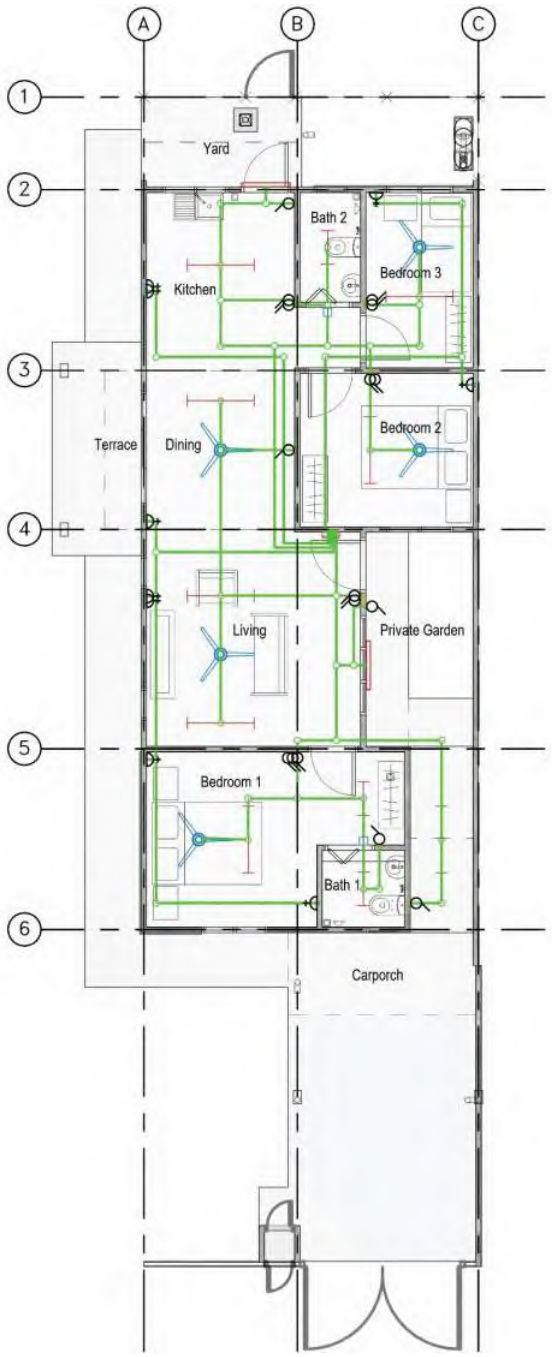
MEP prefabrication service in general will be installed at every panel in the assembly factory before being mobilised to the site. After all the panels have been put in place, the MEP services shall utilise the plug and play system.

3D View

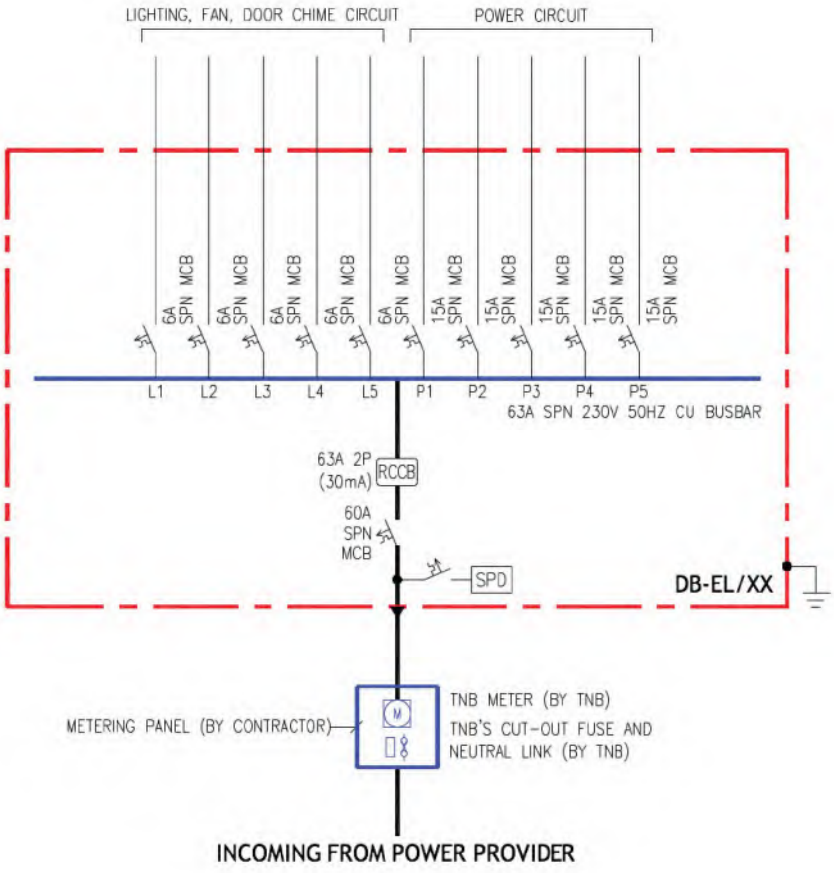


Overview of MEP Layout of the Terrace House

Electrical



Lighting and Power Layout

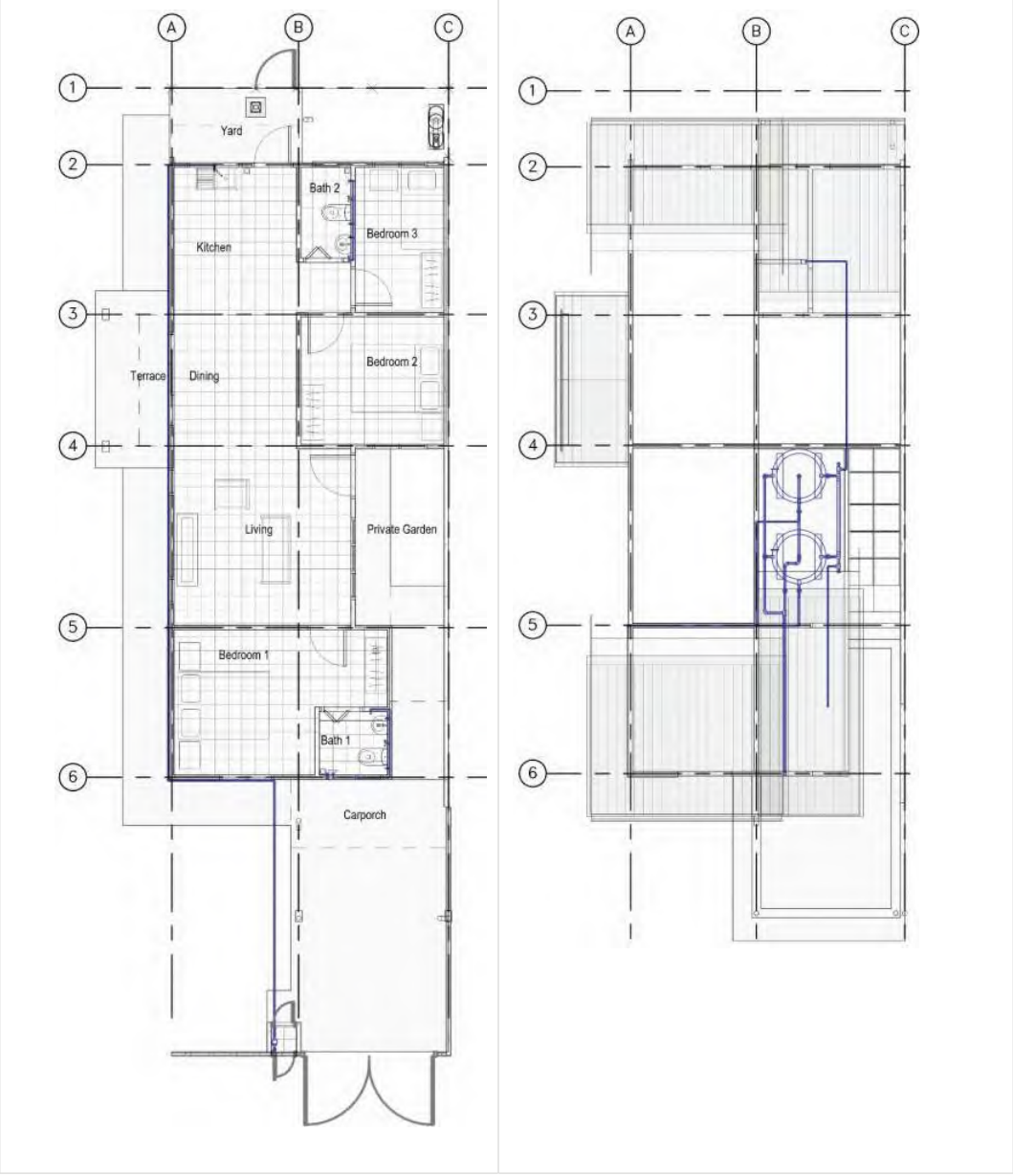


Metering Concept of the Terrace House

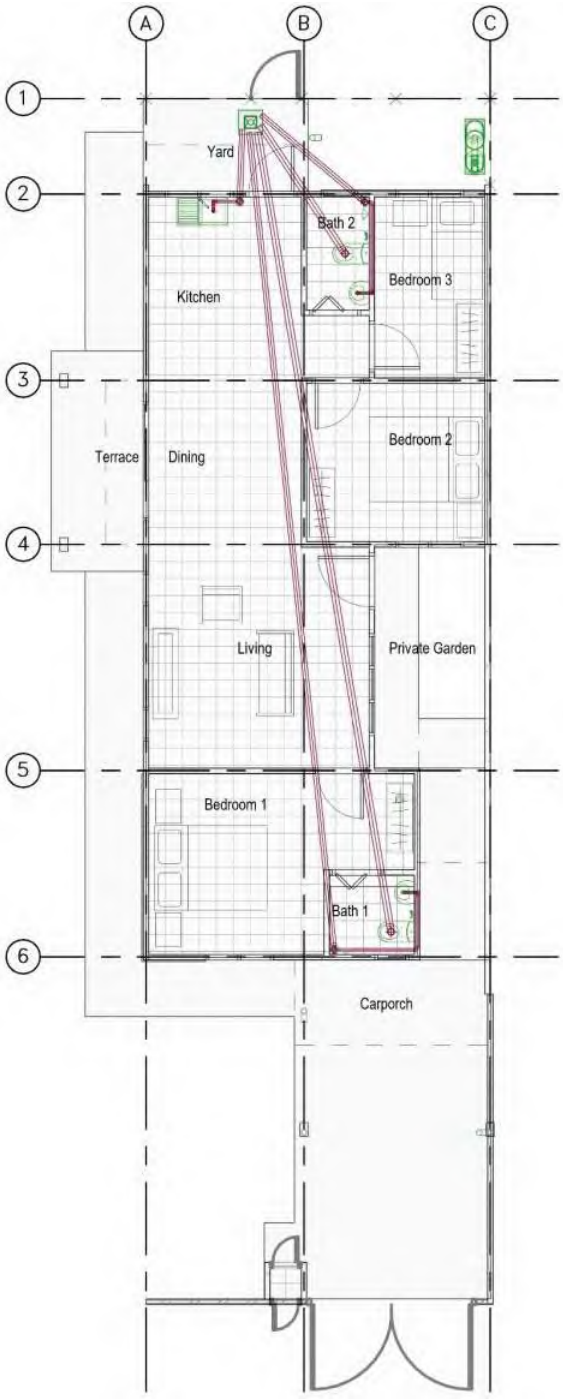
Mechanical & Plumbing

Water storage capacity shall be according to the guidelines as follows:

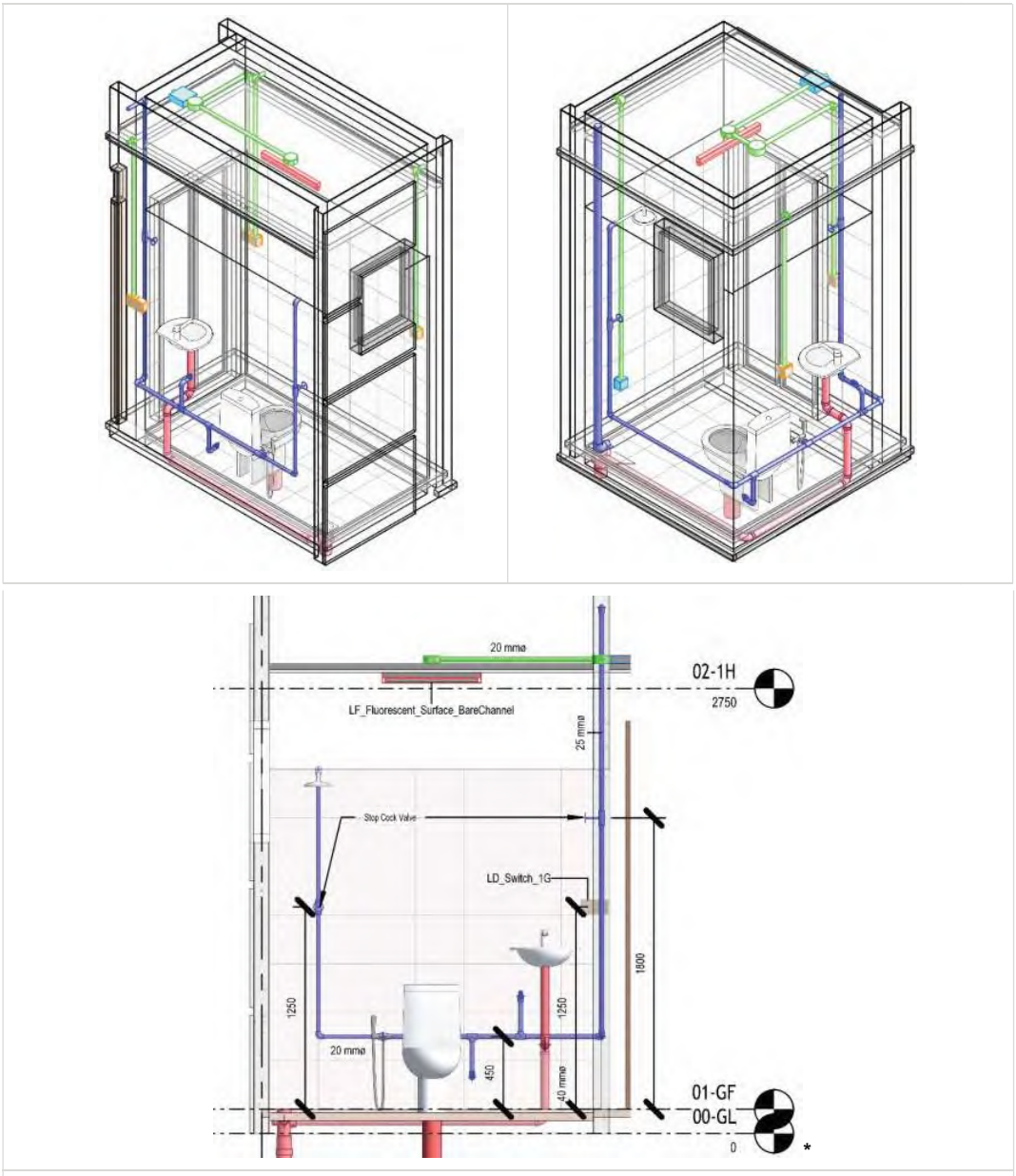
1 Storage capacity of domestic dwelling – 800 L/unit/day as per SPAN requirement.



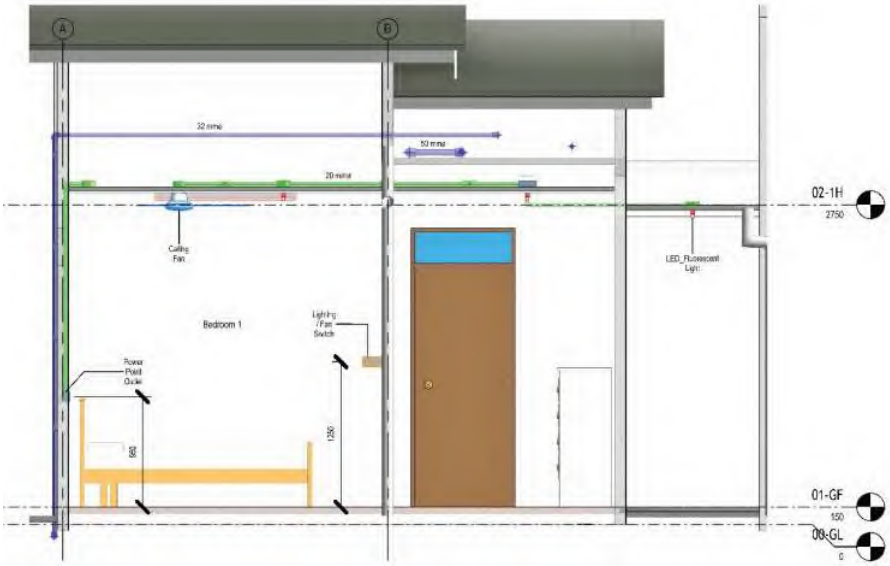
Cold Water Plumbing Layout for the Ground Floor and Roof Floor



Sanitary Plumbing Layout



MEP System Design of PBU



MEP Point Setting in the Bedroom (Sectional View)

MEP Points

The desired numbers of MEP point and quantity for the terrace unit are as follows:

MEP Point of the Terrace House Unit

DESCRIPTIONS	BEDROOM 1 & BATHROOM 1	BEDROOM 2	BEDROOM 3	BATHROOM 2	KITCHEN/ DINING/ LIVING/YARD	PRIVATE GARDEN
Lighting Points	3	1	1	1	5	2
13A Power Points	2	1	1	0	5	0
Fan Points	1	1	1	0	2	0
Switches	4	2	2	1	5	2
Stopcock Valves	1	0	0	1	0	0
Water Closet Angle Valves	1	0	0	1	0	0
Sink Angle Valves	0	0	0	0	1	0
Basin Angle Valves	1	0	0	1	0	0
Shower Stopcock Valves	1	0	0	1	0	0
Water Tap	1	0	0	1	0	0

CONSTRUCTION COST ESTIMATION

Specifications

ELEMENT	SPECIFICATIONS
Foundation	Pad footing
Structure	Reinforced concrete slab and precast concrete slab Precast concrete beam Precast concrete column Precast concrete wall: 125 mm thickness
Roof framing	Lightweight steel roof truss
Roof covering	Metal decking and glazed roof panel
Doors	Metal door frame, timber plywood flush door, powder coated aluminium sliding door, and bifold door
Windows	Powder coated aluminium frame window, 6 mm thickness clear glass
Wall Finishes	Skim coat, paint, and ceramic tiles
Floor Finishes	Ceramic tiles, and cement render
Ceiling finishes	Skim coat, paint, and moisture resistant ceiling board
Sanitary fittings	Water closet, basin, shower rose, hand bidet, toilet roll holder, floor trap, sink, and tap
External works	Chain link fencing, mild steel gate, refuse chamber and mailbox
Miscellaneous	Stainless steel rainwater harvesting tank (RWHT) with accessories

Assumption of Rates

1. The cost estimate is based on 200 units of terrace house.
2. The cost estimate for the terrace units includes architecture,structure, mechanical, electrical and plumbing works.
3. This cost estimate excludes preliminaries and contingencies.
4. Infrastructure costs are excluded.
5. Rate for the precast items does include moulding, supply, transportation and installation.
6. Actual cost of a building depends on the design and other factors and may vary from the figures shown.
7. Land cost, contribution cost/fees, management cost, professional fees, legal fees and the developer's profit margin are excluded.
8. This is based on the current rates obtained via competitive tendering. No allowance has been made for the increases in costs of labour, materials and plant in the future. This cost is subject to passage of time, changes in business of the building industry, and availability of information. Even we endeavour to give reasonable estimated costs for each element at the time of preparation, we are not responsible for the changes in market or the contractor's pricing strategy in the future.

9. Mechanical Services:

   a. External cold water and sanitary piping are excluded.

   b. Dry powder portable fire extinguisher for fire protection services is included.

Cost Estimate of the Terrace House

DESCRIPTION	INTERMEDIATE	END	CORNER
Total Cost Estimate for 1 Unit House	RM105,382.00	RM114,017.50	RM115,045.60
Total Cost Estimate Per m^2 (83 m^2 per unit)	RM1,269.66	RM1,373.70	RM1,386.09
Total Cost Estimate Per Sqft (893 sqft per unit)	RM118.01	RM127.68	RM128.83

Approximate Bills of Quantity for Single Storey Terrace

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	FOUNDATION								
A	Pad footing	M3	15.00	83	1,245.00	83	1,245.00	83	1,245.00
	REINFORCED CONCRETE SLAB								
	Concrete Slab								
B	200mm Thick slab	M3	270.00	21	5,670.00	21	5,670.00	21	5,670.00
	Reinforcement								
C	10mm - 32mm Diameter bar	Kg	3.50	1,890	6,615.00	1,890	6,615.00	1,890	6,615.00
	Formwork to Slab								
D	To edges of slab n.e. 200mm high	M	22.00	40	880.00	40	880.00	40	880.00
	Waterproofing System								
E	Waterproofing to ground floor	M2	3.00	70	210.00	70	210.00	70	210.00
	Termite Treatment System								
F	Anti-termite to ground floor	M2	2.50	70	175.00	70	175.00	70	175.00
	PRECAST CONCRETE BEAM								
G	Beam	M3	783.00	0.8	626.40	0.8	626.40	1.2	939.60
	PRECAST CONCRETE COLUMN								
H	Column	M3	783.00	0.2	156.60	0.2	156.60	0.5	391.50
	PRECAST CONCRETE WALL								
J	125 mm Thick wall	M3	783.00	18	14,094.00	20	15,660.00	20	15,660.00
K	125 mm Thick gable wall	M3	783.00	8	6,264.00	12	9,396.00	10	7,830.00
	REINFORCED CONCRETE SUSPENDED SLAB								
	Concrete Roof Slab								
L	150mm thick slab	M3	270.00	4	1,080.00	4	1,080.00	4	1,080.00
	Reinforcement								
M	10mm - 32mm Diameter bar	Kg	3.50	360	1,260.00	360	1,260.00	360	1,260.00
	TOTAL CARRIED TO COLLECTION				**38,276.00**		**42,974.00**		**41,956.10**
									Page No.: 1/6

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	REINFORCED CONCRETE SUSPENDED SLAB (CONT'D)								
	Formwork to Suspended Slab								
A	To soffit of slab	M2	35.00	26	910.00	26	910.00	26	910.00
	Waterproofing System								
B	Waterproofing to flat roof	M2	20.00	18	360.00	18	360.00	18	360.00
	LIGHTWEIGHT ROOF								
C	Supply and install lightweight roof truss complete with metal decking roof covering, aluminium foil, rockwool, gutter, flashing, fascia board, capping and all other finishes and accessories	M2	100.00	98	9,800.00	115	11,500.00	122	12,200.00
D	Rainwater down pipe (RWDP) system	Item	-	-	500	-	500	-	500
	DOORS								
	Supply and fix in position door; including metal door frame, in-fill with concrete complete with ironmongeries								
E	Overall size 1000mm x 2400mm high, single leaf timber plywood flush door complete with fix glass above (Type D1)	No	912.00	1	912.00	1	912.00	1	912.00
F	Overall size 900mm x 2400mm high, single leaf timber plywood flush door complete with fix glass above (Type D2 & D3)	No	821.00	4	3,284.00	4	3,284.00	4	3,284.00
	Supply and fix powder coated aluminium frame fixed panel complete with ironmongeries and accessories								
G	900mm x 2100mm high, bottom trackless bifold door (Type D4)	No	756.00	2	1,512.00	2	1,512.00	2	1,512.00
	TOTAL CARRIED TO COLLECTION				**17,278.00**		**18,978.00**		**19,678.00**
									Page No.: 2/6

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	DOORS (CONT'D)								
	Supply and fix powder coated aluminium frame fixed panel complete with aluminium frame including 6mm thick clear glass								
A	2100mm x 2400mm high, 3 panel glass sliding door complete with fix glass above (Type SD1)	No	2,016.00	-	-	-	-	1	2,016.00
	WINDOWS								
	Supply and fix natural anodised aluminium frame complete with aluminium window frame including 6mm thick clear glass and all necessary fixing accessories								
B	600mm x 750mm high, 1 panel top hung glass window (Type W1)	No	158.00	2	316.00	2	316.00	2	316.00
C	600mm x 1500mm high, 1 panel fix glass window complete with top hung above (Type W2)	No	315.00	-	-	2	630.00	2	630.00
D	1200mm x 1500mm high, 2 panel casement glass window complete with fix glass above (Type W3)	No	630.00	4	2,520.00	4	2,520.00	4	2,520.00
E	1800mm x 1500mm high, 3 panel casement glass window complete with fix glass above (Type W4)	No	945.00	1	945.00	2	1,890.00	1	945.00
	EXTERNAL FINISHES								
	Curtain Panel								
F	Glazed roof panel system	M2	350.00	5	1,750.00	5	1,750.00	5	1,750.00
	External Wall Finishes								
G	Skim coat to wall	M2	10.50	29	304.50	88	924.00	85	892.50
H	Weathershield paint to wall	M2	7.00	29	203.00	88	616.00	85	595.00
	External Floor Finishes								
J	Cement render	M2	20.00	37	740.00	29	580.00	47	940.00
K	Water proofing system	M2	3.00	37	111.00	29	87.00	47	141.00
	TOTAL CARRIED TO COLLECTION				**6,889.50**		**9,313.00**		**10,745.50**
									Page No.: 3/6

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	EXTERNAL FINISHES (CONT'D)								
	External Ceiling Finishes								
A	Skim coat to ceiling	M2	10.50	18	189.00	18	189.00	18	189.00
	INTERNAL WALL FINISHES								
B	Skim coat to wall	M2	10.50	381	4,000.50	369	3,874.50	366	3,843.00
C	Emulsion paint to wall	M2	5.00	381	1,905.00	369	1,845.00	366	1,830.00
D	Ceramic tiles	M2	60.00	30	1,800.00	30	1,800.00	30	1,800.00
	INTERNAL FLOOR FINISHES								
E	Cement render	M2	20.00	8	160.00	8	160.00	8	160.00
F	Ceramic tiles	M2	60.00	65	3,900.00	65	3,900.00	65	3,900.00
G	Non slip ceramic tiles	M2	60.00	4	240.00	4	240.00	4	240.00
	INTERNAL CEILING FINISHES								
H	Skim coat to ceiling	M2	10.50	8	84.00	8	84.00	8	84.00
J	Moisture resistant ceiling board	M2	45.00	65	2,925.00	65	2,925.00	65	2,925.00
K	Emulsion paint to skim coat	M2	5.00	8	40.00	8	40.00	8	40.00
L	Emulsion paint to ceiling board	M2	5.00	65	325.00	65	325.00	65	325.00
	SANITARY FITTINGS								
M	Water closet	No	350.00	2	700.00	2	700.00	2	700.00
N	Wash hand basin	No	150.00	2	300.00	2	300.00	2	300.00
P	Shower rose	No	85.00	2	170.00	2	170.00	2	170.00
Q	Hand bidet	No	45.00	2	90.00	2	90.00	2	90.00
R	Toilet roll holder	No	30.00	2	60.00	2	60.00	2	60.00
S	Floor trap grating	No	10.00	3	30.00	3	30.00	4	40.00
T	Stainless steel single bowl sink	No	120.00	1	120.00	1	120.00	1	120.00
U	Basin tap	No	50.00	2	100.00	2	100.00	2	100.00
V	Pillar tap	No	50.00	1	50.00	1	50.00	1	50.00
W	Bib tap	No	50.00	3	150.00	3	150.00	2	100.00
	TOTAL CARRIED TO COLLECTION				**17,338.50**		**17,152.50**		**17,066.00**
									Page No.: 4/6

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	EXTERNAL WORKS								
	Fencing								
A	1500mm High PVC coated chainlink	M	80.00	18	1,440.00	18	1,440.00	18	1,440.00
	Main Entrance Gate								
	Supply and install mild steel gate finished mild steel with anti rust protection, coated finished with metal paint and including all necessary accessories and ironmongeries								
B	Overall size 3000mm x 1500mm high	No	1,250.00	1	1,250.00	1	1,250.00	1	1,250.00
	Rear Gate								
	Supply and install swing gate including all accessories and ironmongeries all according to Architect's drawing								
C	Overall size 900mm x 1500mm high	No	500.00	1	500.00	1	500.00	1	500.00
	Refuse and Mail Box Compartment								
D	Construct refuse compartment and mail box compartment complete with all necessary excavation, foundation, waterproofing works, brickwall, plastering, concrete works, reinforcement, BRC, formwork, paint to all exposed concrete and brickwall externally and to skim coat soffit internally, ceramic tiles to floor and wall for compartment internally and including 550mm x 1000mm high steel door and 550mm x 250mm letter box opening all as per Architect's drawing	No	1,500.00	1	1,500.00	1	1,500.00	1	1,500.00
	Rain Water Harvesting Tank								
	230 Litre polypropylene (UV resistant PP) RWHT	No	2,100.00	1	2,100.00	1	2,100.00	1	2,100.00
	TOTAL CARRIED TO COLLECTION				**6,790.00**		**6,790.00**		**6,790.00**

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	MECHANICAL, ELECTRICAL & PLUMBING								
A	Cold Water Services	Item	-	-	7,220.00	-	7,220.00	-	7,220.00
B	Sanitary Plumbing Services	Item	-	-	5,090.00	-	5,090.00	-	5,090.00
C	Fire Protection Services	Item	-	-	180.00	-	180.00	-	180.00
D	Electrical System	Item	-	-	6,320.00	-	6,320.00	-	6,320.00
	TOTAL CARRIED TO COLLECTION				**18,810.00**		**18,810.00**		**18,810.00**
									Page No.: 6/6

Item	Description	Intermediate	End	Corner
		Amount	Amount	Amount
	COLLECTION			
	Page No. 1/6	38,276.00	42,974.00	41,956.10
	Page No. 2/6	17,278.00	18,978.00	19,678.00
	Page No. 3/6	6,889.50	9,313.00	10,745.50
	Page No. 4/6	17338.50	17,152.50	17,066.00
	Page No. 5/6	6,790.00	6,790.00	6,790.00
	Page No. 6/6	18,810.00	18,810.00	18,810.00
	GRAND TOTAL	**105,382.00**	**114,017.50**	**115,045.60**

SECTION 3

IHSAN HOMES
TWO-STOREY TOWNHOUSE

Architectural Design Concept
Civil & Structural Design
Mechanical, Electrical & Plumbing Design
Construction Cost Estimation

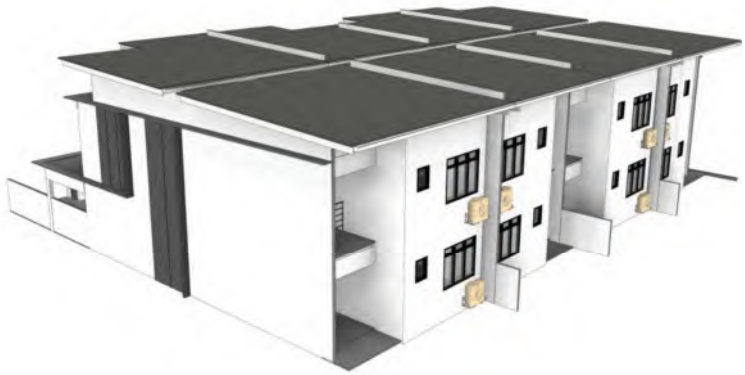
ARCHITECTURAL DESIGN CONCEPT

Design Overview

Each unit (upper and lower) consists of 3 bedrooms, 2 bathrooms, kitchen, dining room, and living room. Other features include internal courtyard, double frontage lot and private backyard garden at the lower unit that is aimed to create beautiful living spaces.

Perspective View of Townhouse (Artist Impression)

Front View of Architectural Model

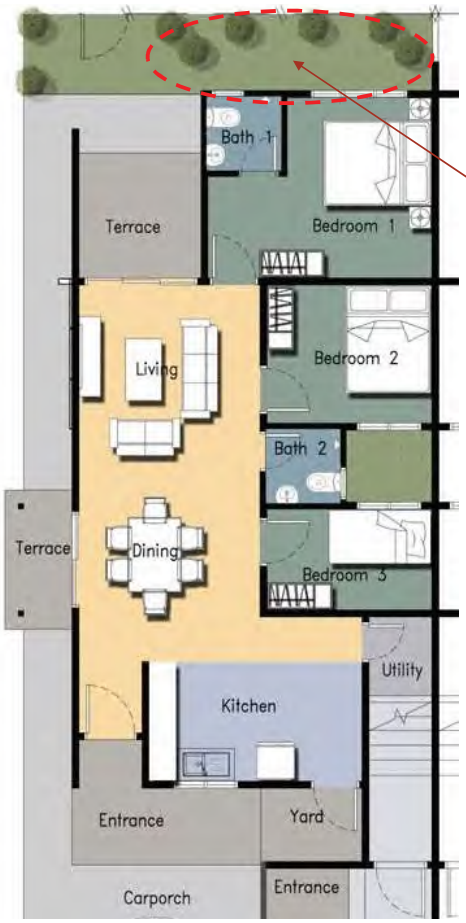


Rear View of Architectural Model

Design Features

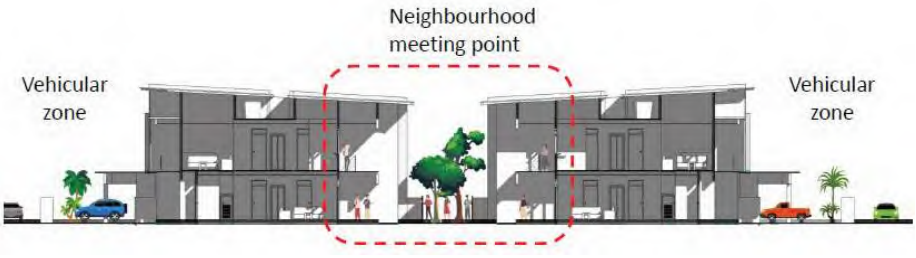
Every Feature Beautifully Expressed to Create an Inspired Way of Living

Luxurious Floor Plans Designed to Delight Even the Most Space Conscious



Create Your Own Herbal Garden Within the Harmonious Private Backyard

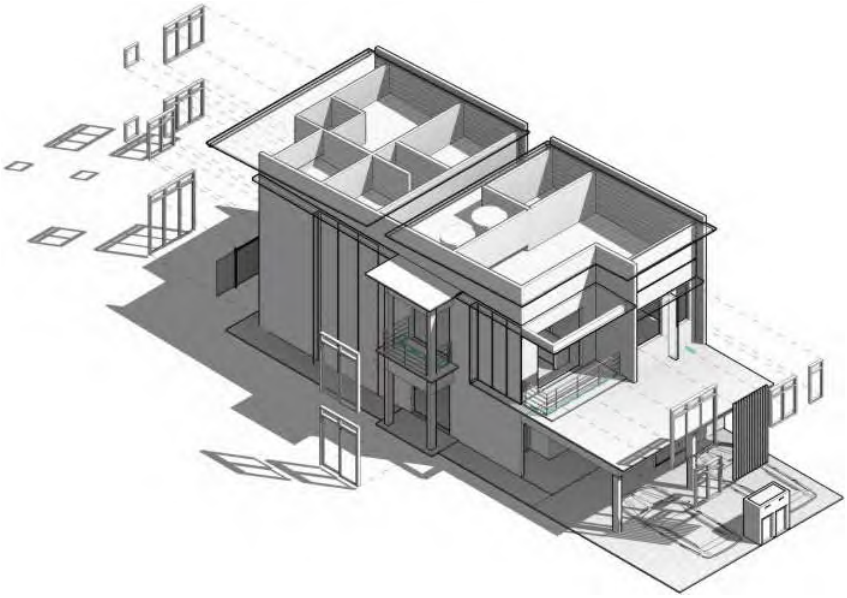
Private backyard at the back of the house is to encourage interaction between neighbours. There is also a segregating vehicular zone with communal spaces.



Perspective View of Private Backyard (Artist Impression)

Sustainability Design

The windows allow natural ventilation throughout the day, even during the rainy days.



Window and Openings of the Townhouse

Natural Ventilation and Daylighting Simulations of the Lower Unit

Natural Ventilation and Daylighting Simulation of the Upper Unit

Design Layout

Typical Unit Layout

Lower Unit Layout

Townhouse Floor Area Schedule (Lower Unit)

AREA	FLOOR AREA (NETT)	
LOWER UNIT	**M^2**	**FT^2**
Carporch	5.25	56.51
Entrance	1.32	14.21
Living	14.68	158.01
Dining	9.10	97.95
Kitchen	11.74	126.37
Terrace	2.97	31.97
Bedroom 1	12.84	138.21
Bath 1	2.25	24..22
Bedroom 2	8.66	93.22
Bedroom 3	6.42	69.10
Bath 2	2.25	24.22
Utility	2.08	22.39
Yard	2.85	30.68
TOTAL	**82.41**	**887.0**

SECTION 3

Upper Unit Layout

Townhouse Floor Area Schedule (Upper Unit)

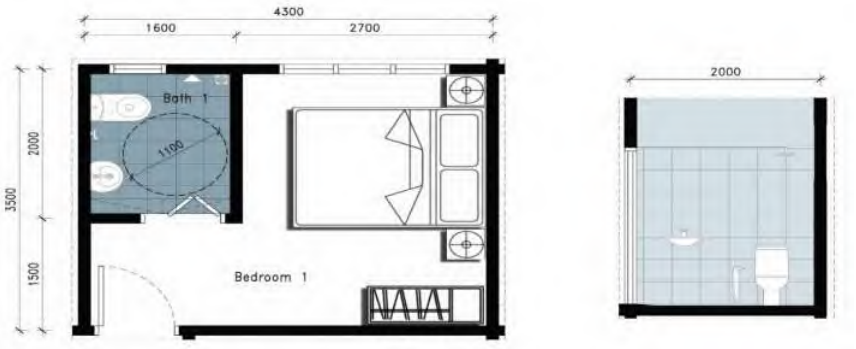
AREA	FLOOR AREA (NETT)	
UPPER UNIT	**M^2**	**FT^2**
Carporch	3.40	36.60
Entrance	1.00	10.76
Staircase	3.77	40.58
Living	11.11	119.59
Dining	12.23	131.64
Kitchen	9.45	101.72
Balcony	2.40	25.83
Bedroom 1	12.84	138.21
Bath 1	2.25	24.22
Bedroom 2	8.66	93.22
Bedroom 3	6.42	69.10
Bath 2	2.25	24.22
Study Area	6.65	71.58
Balcony	2.40	25.83
TOTAL	**84.83**	**913.0**

Accessibility

The two bathrooms are spacious, with enough room for 360-degree turn. Be it universal or inclusive, the bathroom is designed in a way to cater every level of physical ability, allowing family members to live together more easily.

The house floor layout plan takes a holistic approach in catering the disabled persons. There is slope/ramp to provide access between vertical levels, an alternative to stairs for those using wheelchair. Circulation area is made sure free from barrier where the furniture is placed at strategic spots.

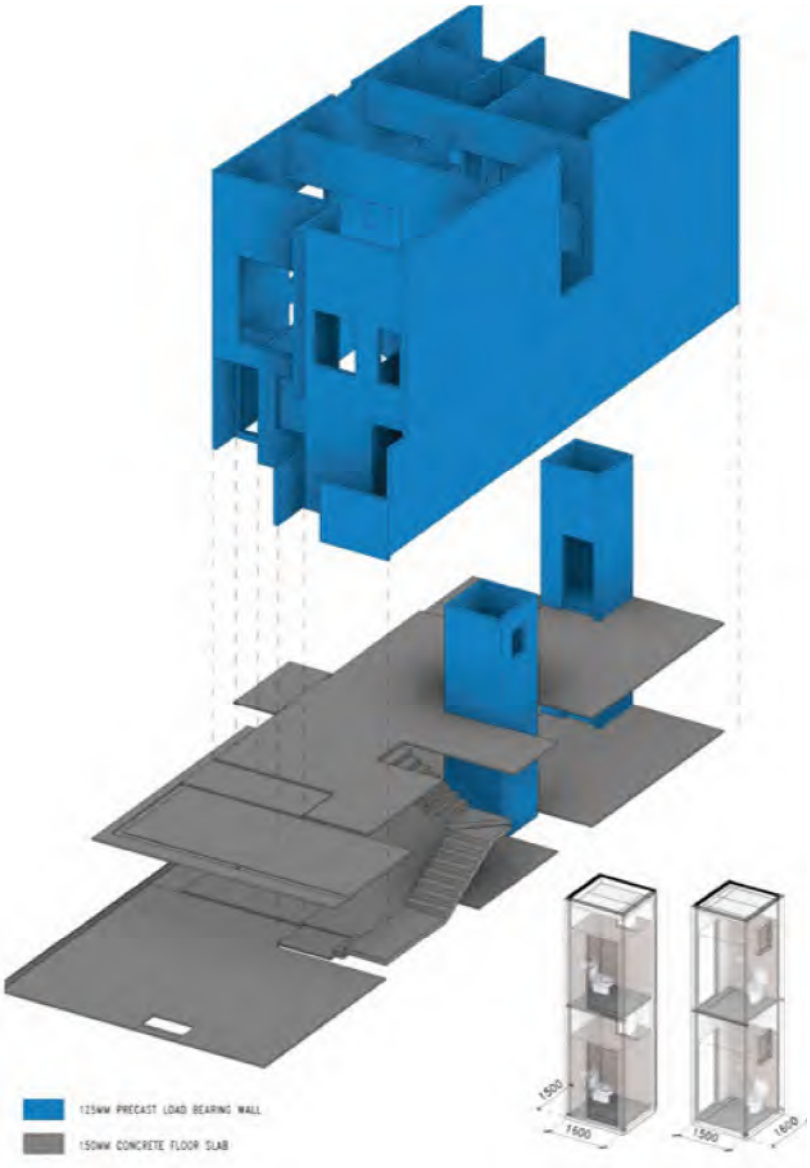
Accessibility for Disabled in Townhouse Unit



Access to Bathroom for Disabled Persons

Design for Modularisation

A rational unit is optimised in terms of modularity, making it IBS-ready. The floor plans are designed with the intention to reduce construction wastage and enhancing the speed of installation and finishes.



CIVIL & STRUCTURAL DESIGN

Structural Layout Overview

In Malaysia, townhouse refers to two terrace houses stacked on top of each other with different main entrances. The **first construction type** of townhouse model is the one that is built with precast wall panel and precast slab by incorporating prefabricated bathroom unit (PBU).

There are three types of IHSAN Homes townhouse, namely intermediate, end and corner units. Intermediate unit is different from the end and corner units in terms of wall opening for windows and doors on both sides of the wall panel. There is no opening on both sides of the wall panel for intermediate unit. The balcony of the corner unit of the townhouse model is different form its end unit.

Meanwhile, the **second construction type** using Volumetric Module is an alternative to the townhouse construction. The self-weight of prefab-concrete VM units for a townhouse is between 5 and 20 tonnes per unit. The VM units are designed with a maximum length of 6200 mm so that they can be stacked together on a trailer.

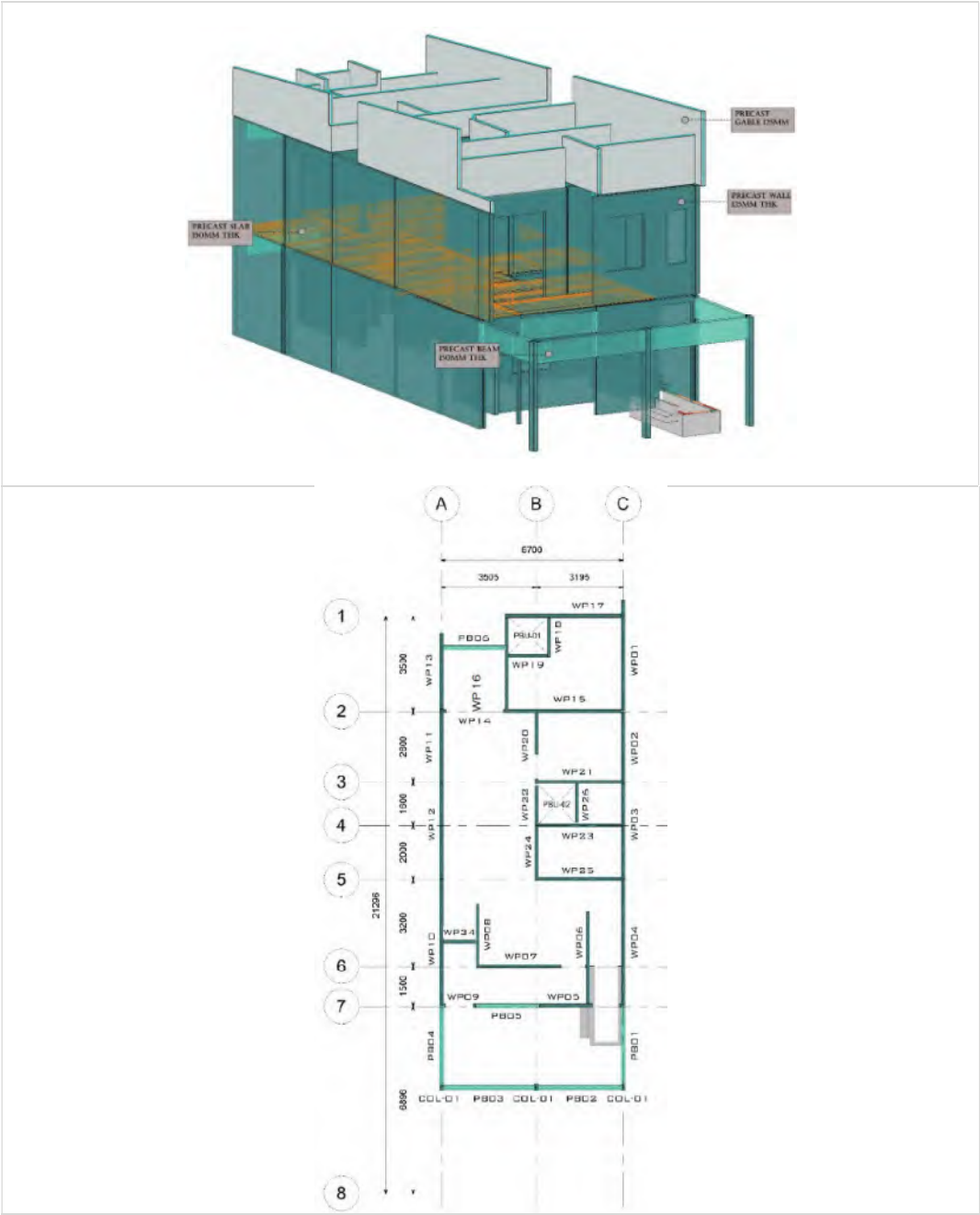
Construction Type 1 – Panel and PBU

Wall Design

Townhouse can be constructed using 125 mm precast walls, 125 mm precast gable end wall, 150 mm precast slabs and four prefabricated bathroom units (PBU).

The precast walls are designed as load-bearing walls with 4723 mm maximum length, 125 mm thickness, and weight of 3.65 tonnes. The slabs are designed as half plank slab with a maximum length of 3237 mm, 150 mm thickness of, and weight of 0.68 ton. The total number of wall panels and slab elements for a townhouse is 27 and 23 respectively, with two PBU units.

Intermediate Unit



Intermediate Unit Precast Wall and Beam Level 1 Layout and 3D View

Intermediate Unit Precast Wall Level 1 Specifications

WALL MARKING	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
WP01	3150	4092	1.53	3.68
WP02	3150	2683	1.01	2.41
WP03	3150	3488	1.31	3.14
WP04	3150	4755	1.78	4.28
WP05	3150	3045	0.79	1.89
WP06	3150	3430	1.29	3.09
WP07	3150	3920	0.96	2.3
WP08	3150	2350	0.88	2.11
WP09	3150	1170	0.12	0.29
WP10	3150	4747	1.78	4.27
WP11	3150	3491	1.31	3.14
WP12	3150	2615	0.98	2.35
WP13	3150	2755	1.04	2.5
WP14	3150	2458	0.26	0.61
WP15	3150	4212	1.31	3.13
WP16	3150	3350	1.26	3.01
WP17	3150	4285	1.21	2.91
WP18	3150	1460	0.55	1.31
WP19	3150	1420	0.29	0.7
WP20	3000	2615	0.65	1.55
WP21	3150	3045	0.92	2.2
WP22	3150	1485	0.32	0.76
WP23	3150	3045	0.92	2.2
WP24	3150	2055	0.5	1.19
WP25	3150	3045	1.14	2.74
WP26	3150	1420	0.48	1.14
WP34	3150	1170	0.17	0.41
TOTAL	**27**			

Intermediate Unit Precast Beam Level 1 Specifications

BEAM MARKING	THICKNESS (mm)	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PB01	150	600	2918	0.26	0.62
PB02	150	600	3118	0.28	0.67
PB03	150	600	3353	0.3	0.72
PB04	150	600	2951	0.26	0.63
PB05	150	600	2380	0.21	0.51
PB06	150	600	2320	0.21	0.49
TOTAL	**6**				

Intermediate Unit Precast Wall Level 2 Layout

Intermediate Unit Precast Wall Level 2 Specifications

WALL MARKING	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
WP01	3150	4092	1.53	3.68
WP04	3150	4755	1.78	4.28
WP11	3150	3491	1.31	3.14
WP12	3150	2615	0.98	2.35
WP13	3150	2775	1.04	2.5
WP15	3150	4212	1.31	3.13
WP16	3150	3350	1.26	3.01
WP17	3150	4285	1.21	2.91
WP18	3150	1460	0.55	1.31
WP19	3150	1420	0.29	0.7
WP21	3150	3045	0.92	2.2
WP22	3150	1485	0.32	0.76
WP23	3150	3045	0.92	2.2
WP25	3150	3045	1.14	2.74
WP27	3150	2615	0.71	1.7
WP28	3150	2055	0.5	1.19
WP29	3150	2458	0.42	1.01
WP30	3150	3400	0.65	1.56
WP31	3150	1830	0.69	1.65
WP32	3150	3123	0.83	2
WP33	3150	4687	1.76	4.22
WP35	3150	1700	0.64	1.53
WP36	3150	621	0.23	0.56
WP37	3150	3485	1.31	3.14
WP38	3150	2695	1.01	2.42
WP39	3150	1986	0.74	1.79
WP40	3150	1460	0.49	1.18
TOTAL	**27**			

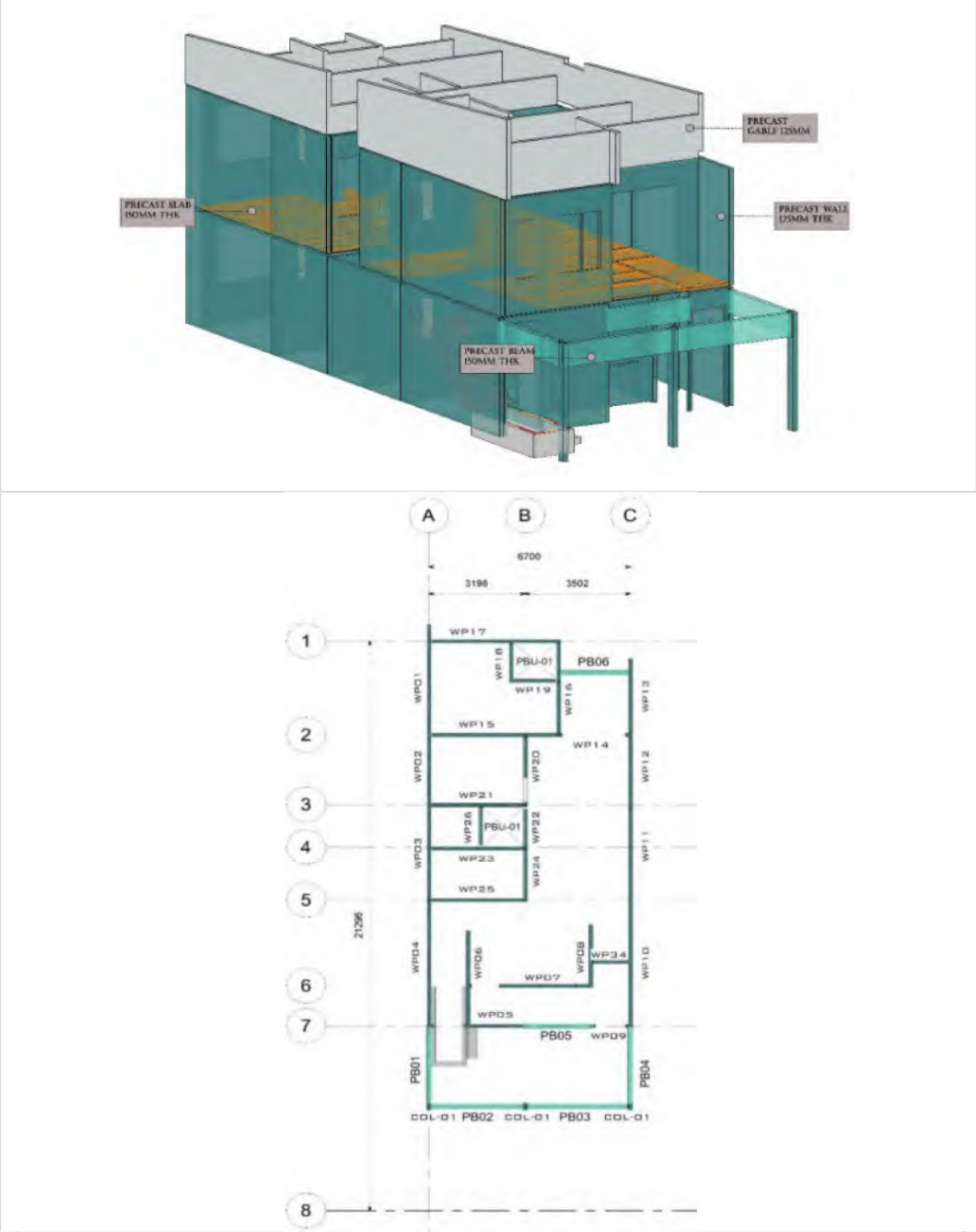
SECTION 3

Intermediate Unit Gable End Wall Level 3 Layout

Intermediate Unit Gable End Wall Level 3 Specifications

GABLE MARK	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
GW01	6713	1.21	2.91
GW02	9450	1.68	4.03
GW03	3200	0.52	1.25
GW04	3500	0.51	1.22
GW05	14413	1.35	3.23
GW06	14413	0.98	2.36
GW07	2388	0.21	0.5
GW08	1495	0.17	0.41
GW09	1600	0.13	0.31
GW10	2713	0.11	0.27
GW11	1495	0.2	0.47
GW12	1600	0.11	0.28
GW13	2018	0.15	0.37
GW14	6700	0.74	1.78
GW15	1763	0.09	0.2
GW16	2613	0.19	1.45
GW17	6700	0.61	1.48
GW18	3200	0.37	0.89
GW19	2013	0.22	0.54
GW20	6700	0.58	1.39
GW21	1863	0.3	0.72
TOTAL	**21**		

End Unit



End Unit Precast Wall and Beam Level 1 Layout and 3D View

End Unit Precast Wall Level 1 Specifications

WALL MARKING	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
WP01	3150	4092	1.53	3.68
WP02	3150	2683	1.01	2.41
WP03	3150	3488	1.31	3.14
WP04	3150	4755	1.78	4.28
WP05	3150	3045	0.79	1.89
WP06	3150	3430	1.29	3.09
WP07	3150	3920	0.96	2.3
WP08	3150	2350	0.88	2.11
WP09	3150	1170	0.12	0.29
WP10	3150	4747	1.78	4.27
WP11	3150	3491	1.31	3.14
WP12	3150	2615	0.98	2.35
WP13	3150	2755	1.04	2.5
WP14	3150	2458	0.26	0.61
WP15	3150	4212	1.31	3.13
WP16	3150	3350	1.26	3.01
WP17	3150	4285	1.21	2.91
WP18	3150	1460	0.55	1.31
WP19	3150	1420	0.29	0.7
WP20	3000	2615	0.65	1.55
WP21	3150	3045	0.92	2.2
WP22	3150	1485	0.32	0.76
WP23	3150	3045	0.92	2.2
WP24	3150	2055	0.5	1.19
WP25	3150	3045	1.14	2.74
WP26	3150	1420	0.48	1.14
WP34	3150	1170	0.17	0.41
TOTAL	**27**			

End Unit Precast Beam Level 1 Specifications

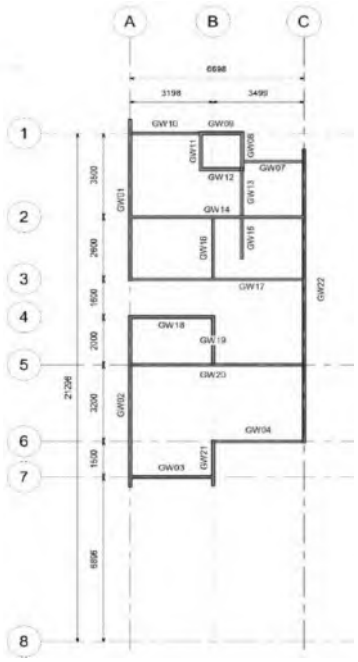
BEAM MARKING	THICKNESS (mm)	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PB01	150	600	2918	0.26	0.62
PB02	150	600	3118	0.28	0.67
PB03	150	600	3353	0.3	0.72
PB04	150	600	2951	0.26	0.63
PB05	150	600	2380	0.21	0.51
PB06	150	600	2320	0.21	0.49
TOTAL	**6**				

End Unit Precast Wall Level 2 Layout

End Unit Precast Wall Level 2 Specifications

WALL MARKING	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
WP01	3150	4092	1.53	3.68
WP04	3150	4755	1.78	4.28
WP11	3150	3491	1.31	3.14
WP12	3150	2615	0.98	2.35
WP13	3150	2775	1.04	2.5
WP15	3150	4212	1.31	3.13
WP16	3150	3350	1.26	3.01
WP17	3150	4285	1.21	2.91
WP18	3150	1460	0.55	1.31
WP19	3150	1420	0.29	0.7
WP21	3150	3045	0.92	2.2
WP22	3150	1485	0.32	0.76
WP23	3150	3045	0.92	2.2
WP25	3150	3045	1.14	2.74
WP27	3150	2615	0.71	1.7
WP28	3150	2055	0.5	1.19
WP29	3150	2458	0.42	1.01
WP30	3150	3400	0.65	1.56
WP31	3150	1830	0.69	1.65
WP32	3150	3123	0.83	2
WP33	3150	4687	1.76	4.22
WP35	3150	1700	0.64	1.53
WP36	3150	621	0.23	0.56
WP37	3150	3485	1.31	3.14
WP38	3150	2695	1.01	2.42
WP39	3150	1986	0.74	1.79
WP40	3150	1460	0.49	1.18
TOTAL	**27**			

SECTION 3

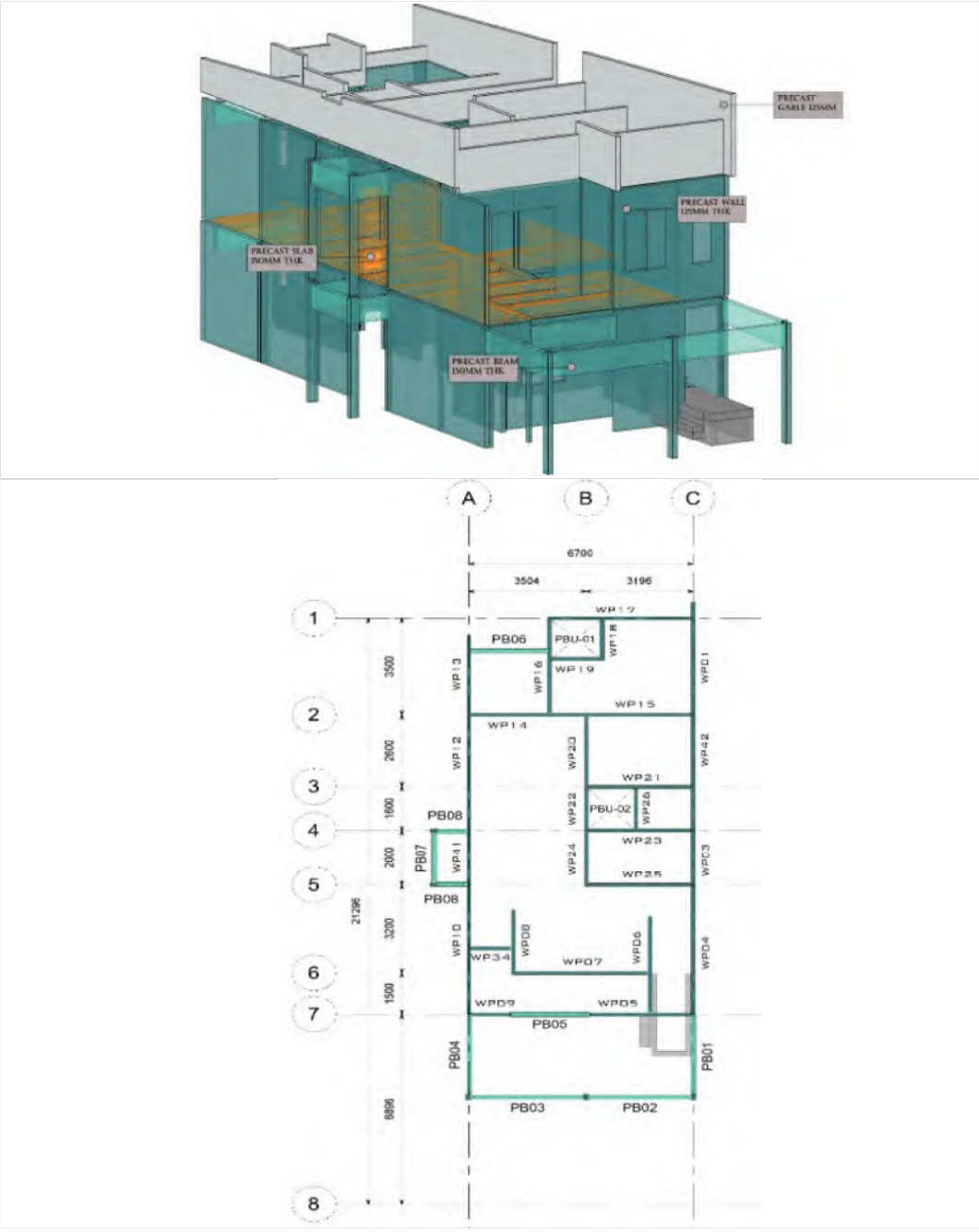


End Unit Precast Gable End Wall Level 3 Layout

End Unit Precast Gable End Wall Level 3 Specifications

GABLE MARK	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
GW01	6713	1.21	2.91
GW02	9450	1.68	4.03
GW03	3200	0.52	1.25
GW04	3500	0.51	1.22
GW07	2388	0.21	0.5
GW08	1495	0.17	0.41
GW09	1600	0.13	0.31
GW10	2713	0.11	0.27
GW11	1495	0.2	0.47
GW12	1600	0.11	0.28
GW13	2018	0.15	0.37
GW14	6700	0.74	1.78
GW15	1763	0.09	0.2
GW16	2613	0.19	1.45
GW17	6700	0.61	1.48
GW18	3200	0.37	0.89
GW19	2013	0.22	0.54
GW20	6700	0.58	1.39
GW21	1863	0.3	0.72
GW22	12250	1.75	4.2
TOTAL	**20**		

Corner Unit



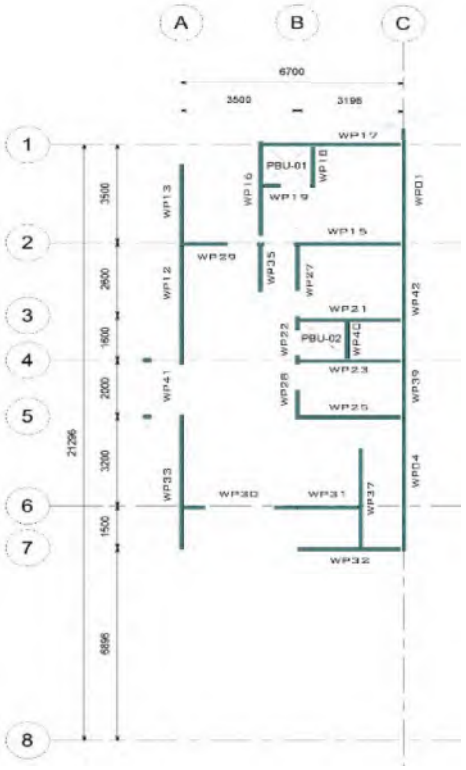
Corner Unit Precast Wall and Beam Level 1 Layout and 3D View

Corner Unit Precast Wall Level 1 Layout

WALL MARKING	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
WP01	3150	4092	1.53	3.68
WP03	3150	3488	1.31	3.14
WP04	3150	4755	1.78	4.28
WP05	3150	3045	0.79	1.89
WP06	3150	3430	1.29	3.09
WP07	3150	3920	0.96	2.3
WP08	3150	2350	0.88	2.11
WP09	3150	1170	0.12	0.29
WP10	3150	4747	1.78	4.27
WP11	3150	3491	1.31	3.14
WP12	3150	2615	0.98	2.35
WP13	3150	2755	1.04	2.5
WP14	3150	2458	0.26	0.61
WP15	3150	4212	1.31	3.13
WP16	3150	3350	1.26	3.01
WP17	3150	4285	1.21	2.91
WP18	3150	1460	0.55	1.31
WP19	3150	1420	0.29	0.7
WP20	3000	2615	0.65	1.55
WP21	3150	3045	0.92	2.2
WP22	3150	1485	0.32	0.76
WP23	3150	3045	0.92	2.2
WP24	3150	2055	0.5	1.19
WP25	3150	3045	1.14	2.74
WP26	3150	1420	0.48	1.14
WP34	3150	1170	0.17	0.41
WP41	3150	3491	0.76	1.83
WP42	3150	4216	1.58	3.79
TOTAL	**27**			

Corner Unit Precast Beam Level 1 Specifications

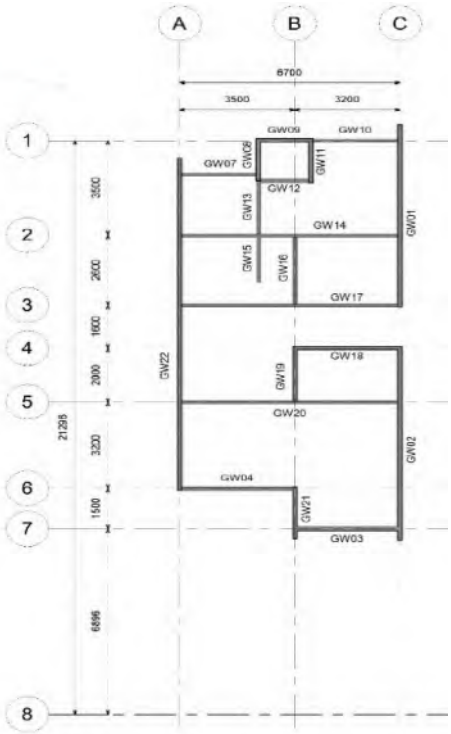
BEAM MARKING	THICKNESS (mm)	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
PB01	150	600	2918	0.26	0.62
PB02	150	600	3118	0.28	0.67
PB03	150	600	3353	0.3	0.72
PB04	150	600	2951	0.26	0.63
PB05	150	600	2380	0.21	0.51
PB06	150	600	2320	0.21	0.49
PB07	150	600	1922	0.17	0.41
PB08	150	600	923	0.08	0.19
TOTAL	**8**				



Corner Unit Precast Wall Level 2 Layout

Corner Unit Precast Wall Level 2 Specifications

WALL MARKING	HEIGHT (mm)	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
WP01	3150	4092	1.53	3.68
WP04	3150	4755	1.78	4.28
WP12	3150	2615	0.98	2.35
WP13	3150	2775	1.04	2.5
WP15	3150	4212	1.31	3.13
WP16	3150	3350	1.26	3.01
WP17	3150	4285	1.21	2.91
WP18	3150	1460	0.55	1.31
WP19	3150	1420	0.29	0.7
WP21	3150	3045	0.92	2.2
WP22	3150	1485	0.32	0.76
WP23	3150	3045	0.92	2.2
WP25	3150	3045	1.14	2.74
WP27	3150	2615	0.71	1.7
WP28	3150	2055	0.5	1.19
WP29	3150	2458	0.42	1.01
WP30	3150	3400	0.65	1.56
WP31	3150	1830	0.69	1.65
WP32	3150	3123	0.83	2
WP33	3150	4687	1.76	4.22
WP35	3150	1700	0.64	1.53
WP36	3150	621	0.23	0.56
WP37	3150	3485	1.31	3.14
WP38	3150	2695	1.01	2.42
WP39	3150	1986	0.74	1.79
WP40	3150	1460	0.49	1.18
WP41	3150	3491	0.76	1.83
WP42	3150	4216	1.58	3.79
TOTAL	**26**			



Corner Unit Gable End Wall Level 3 Layout

Corner Unit Gable End Wall Level 3 Specifications

GABLE MARK	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
GW01	6713	1.21	2.91
GW02	9450	1.68	4.03
GW03	3200	0.52	1.25
GW04	3500	0.51	1.22
GW07	2388	0.21	0.5
GW08	1495	0.17	0.41
GW09	1600	0.13	0.31
GW10	2713	0.11	0.27
GW11	1495	0.2	0.47
GW12	1600	0.11	0.28
GW13	2018	0.15	0.37
GW14	6700	0.74	1.78
GW15	1763	0.09	0.2
GW16	2613	0.19	1.45
GW17	6700	0.61	1.48
GW18	3200	0.37	0.89
GW19	2013	0.22	0.54
GW20	6700	0.58	1.39
GW21	1863	0.3	0.72
GW22	12250	1.75	4.2
TOTAL	**20**		

Slab Design

Intermediate Unit

Intermediate Unit Precast Slab Layout

Intermediate Unit Precast Slab Specifications

SLAB MARKING	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)	NOS.
SL01	3416	0.44	1.06	1
SL02	4103	0.6	1.44	1
SL03	4003	0.31	0.76	1
SL04	4003	0.59	1.43	1
SL05	2933	0.44	1.05	1
SL06	3395	0.46	1.1	1
SL07	1888	0.29	0.69	2
SL08	1888	0.13	0.32	1
SL09	3377	0.5	1.21	4
SL10	1515	0.23	0.55	1
SL11	3975	0.46	1.1	2
SL12	4175	0.41	0.99	1
SL13	2275	0.34	0.83	2
SL14	4175	0.37	0.9	1
SL15	2570	0.4	0.96	1
SL16	1485	0.22	0.54	1
SL17	3075	0.09	0.21	1
TOTAL	**23**			

End Unit

End Unit Precast Slab Layout

End Unit Precast Slab Specifications

SLAB MARKING	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)	NOS.
SL01	3416	0.44	1.06	1
SL02	4103	0.6	1.44	1
SL03	4003	0.31	0.76	1
SL04	4003	0.59	1.43	1
SL05	2933	0.44	1.05	1
SL06	3395	0.46	1.1	1
SL07	1888	0.29	0.69	2
SL08	1888	0.13	0.32	1
SL09	3377	0.5	1.21	4
SL10	1515	0.23	0.55	1
SL11	3975	0.46	1.1	2
SL12	4175	0.41	0.99	1
SL13	2275	0.34	0.83	2
SL14	4175	0.37	0.9	1
SL15	2570	0.4	0.96	1
SL16	1485	0.22	0.54	1
SL17	3075	0.09	0.21	1
TOTAL	**23**			

Corner Unit

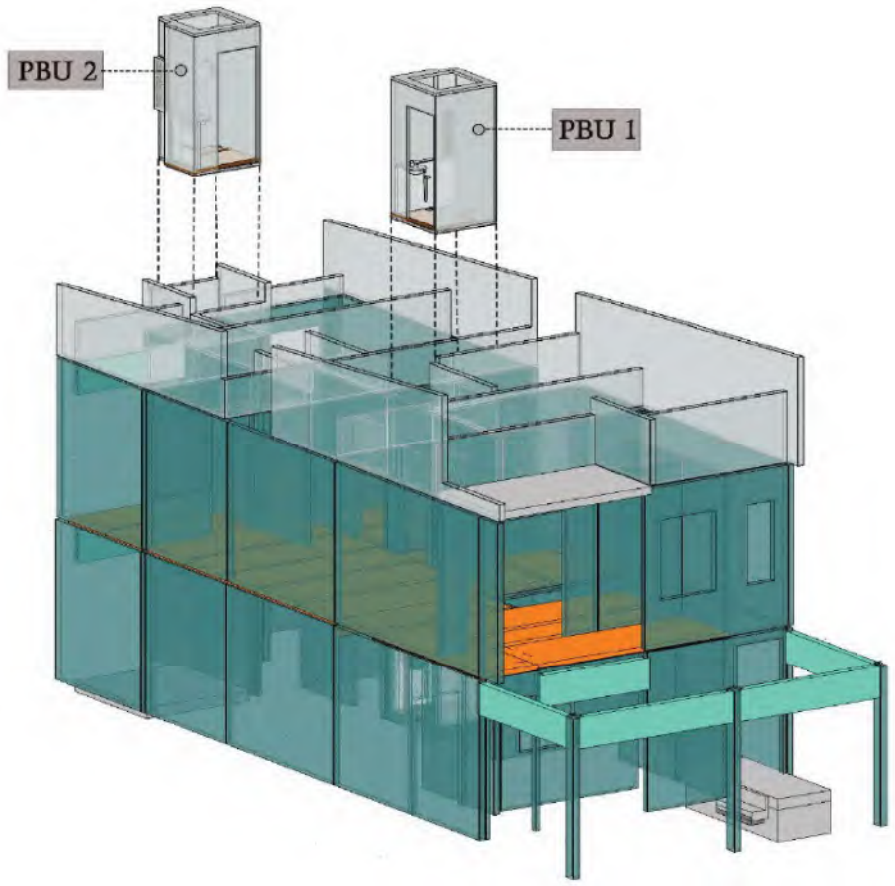
Corner Unit Precast Slab Layout

Corner Unit Precast Slab Specifications

SLAB MARKING	LENGTH (mm)	VOLUME (m^3)	WEIGHT (tonne)	NOS.
SL01	3416	0.44	1.06	1
SL02	4103	0.6	1.44	1
SL03	4003	0.31	0.76	1
SL04	4003	0.59	1.43	1
SL05	2933	0.44	1.05	1
SL06	3395	0.46	1.1	1
SL07	1888	0.29	0.69	2
SL08	1888	0.13	0.32	1
SL09	3377	0.5	1.21	4
SL10	1515	0.23	0.55	1
SL11	3975	0.46	1.1	2
SL12	4175	0.41	0.99	1
SL13	2275	0.34	0.83	2
SL14	4175	0.37	0.9	1
SL15	2570	0.4	0.96	1
SL16	1485	0.22	0.54	1
SL17	3075	0.09	0.21	1
TOTAL	**23**			

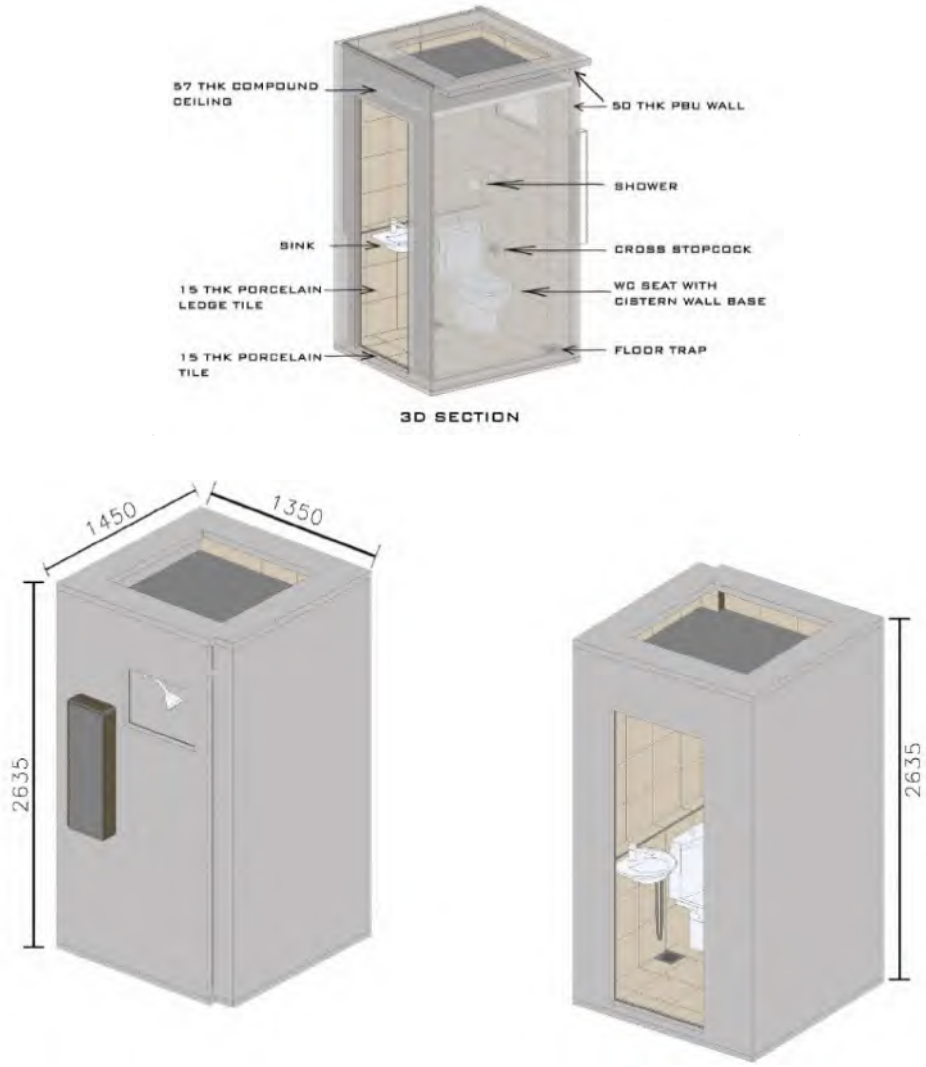
Bathroom

There are two types of prefabricated bathroom units (PBU), namely PBU Type 1 and PBU Type 2 for each level. PBU is preassembled with wall, ceilings, sink, shower, WC, floor trap, cross stopcock and tile. The dimension of PBU Type 1 is 1450 mm x 1350 mm x 2635 mm while the dimension of PBU Type 2 is 1490 mm x 1360 mm x 2635 mm.



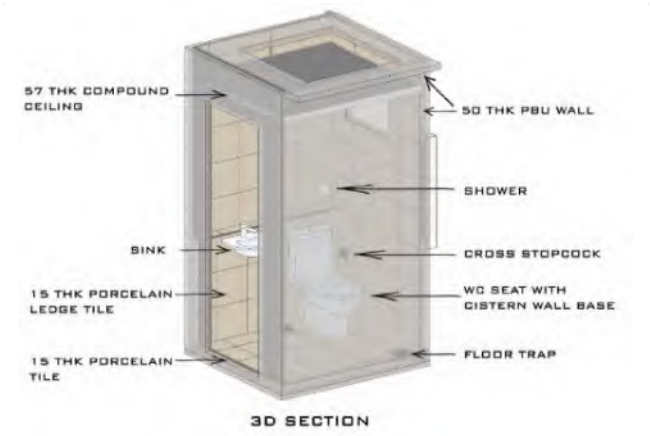
Precast Bathroom Unit Layout of the Townhouse

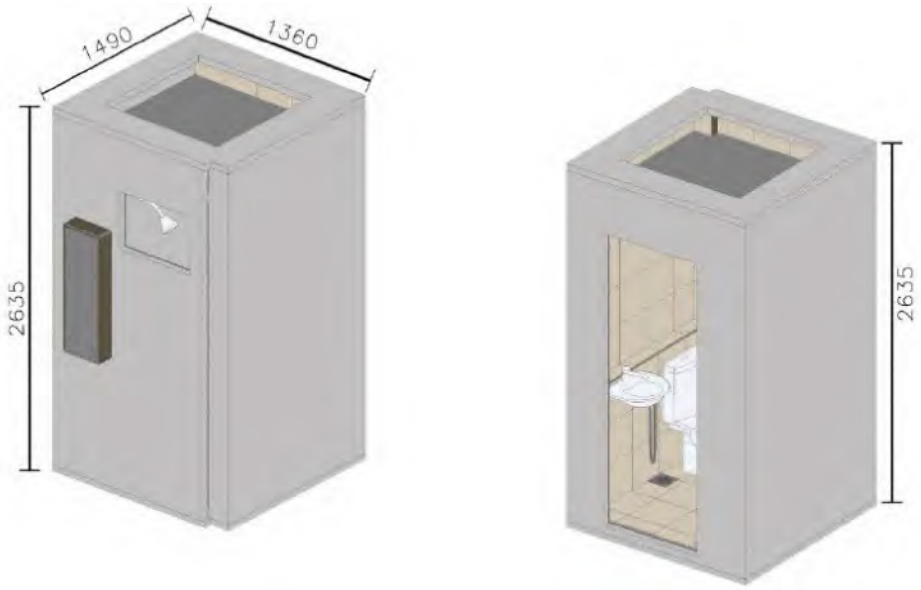
PBU Type 1



PBU Type 1 3D and Dimensional Views

PBU Type 2

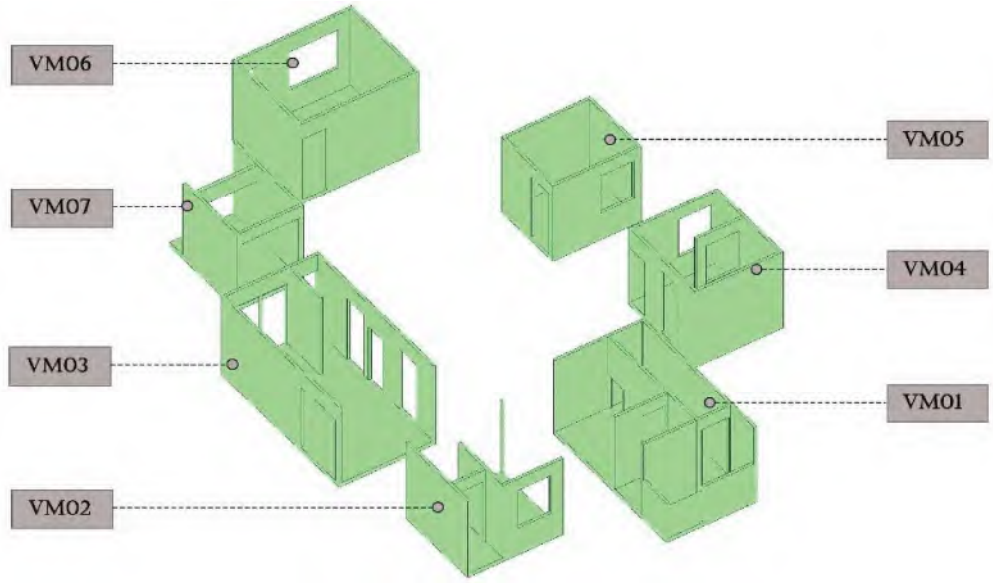




PBU Type 2 3D and Dimensional Views

Construction Type 2 – Volumetric Module

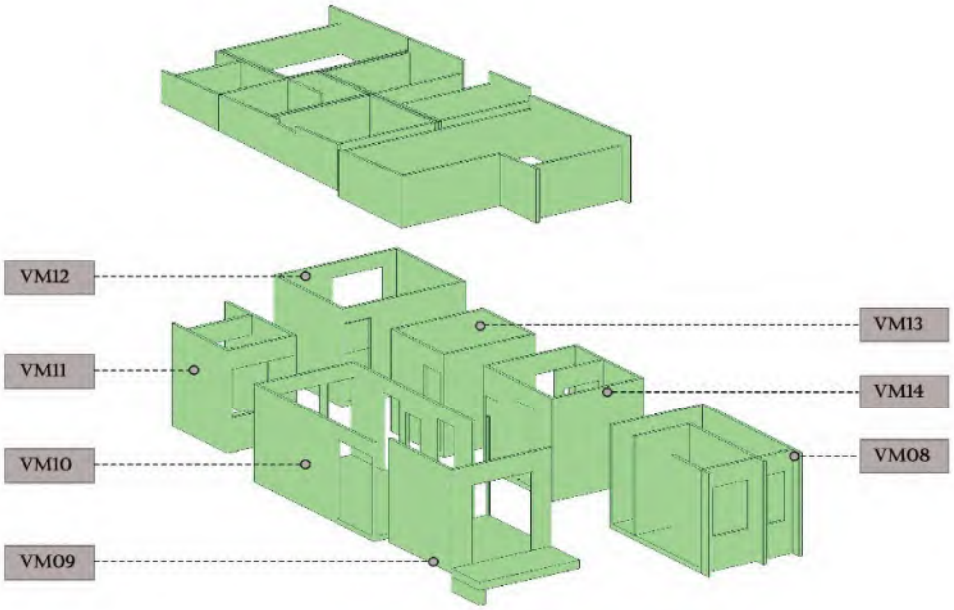
The second option to construct the townhouse is via Volumetric Module. There are 14 volumetric modules required to form a complete townhouse.



Intermediate Unit Volumetric Module Level 1

Intermediate Unit Volumetric Module Level 1 Specifications

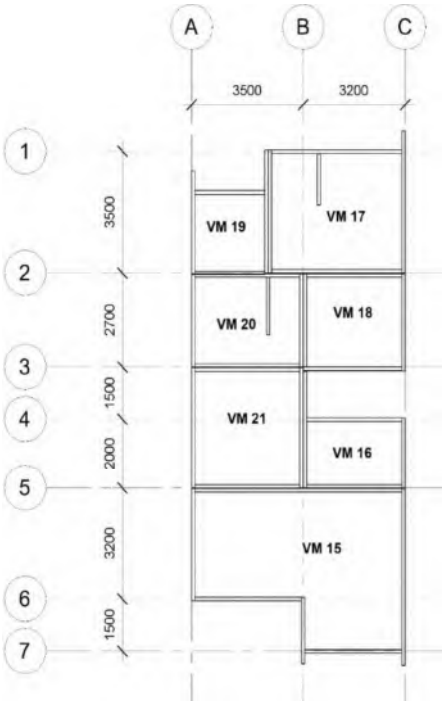
PANEL MARK	LENGTH (mm)	HEIGHT (mm)	WIDTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
VM01	5960	3000	3250	7.46	17.91
VM02	3250	3000	3450	5.14	12.34
VM03	6200	3000	3500	7.99	19.18
VM04	3500	3000	3200	5.14	12.34
VM05	2700	3000	3200	4.40	10.57
VM06	3550	3000	4300	6.24	14.97
VM07	3550	3000	2400	4.42	10.61



Intermediate Unit Volumetric Module Level 2

Intermediate Unit Volumetric Module Level 2 Specifications

PANEL MARK	LENGTH (mm)	HEIGHT (mm)	WIDTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
VM08	5110	3150	3250	6.93	16.63
VM09	4700	3250	3450	6.92	16.61
VM10	6200	3150	3500	8.28	19.87
VM11	3550	3150	2400	4.60	11.04
VM12	3550	3150	4300	6.47	15.53
VM13	2700	3150	3200	4.58	10.99
VM14	3500	3150	3200	5.34	12.82



Intermediate Unit Volumetric Module Level 3

Intermediate Unit Volumetric Module Level 3 Specifications

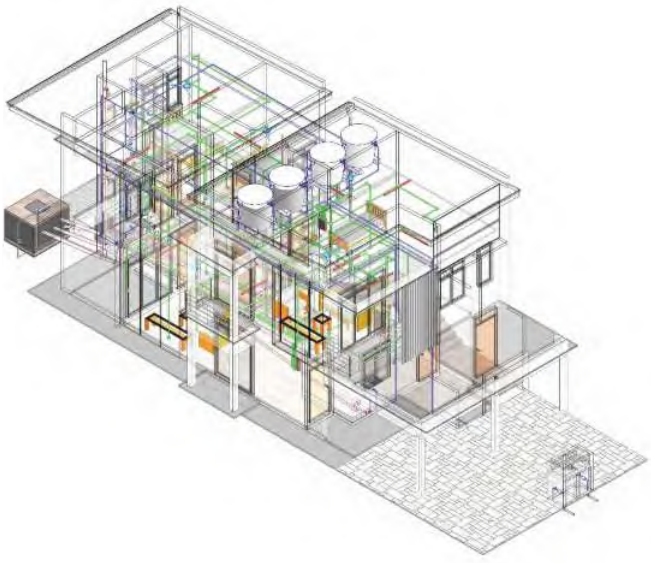
PANEL MARK	LENGTH (mm)	HEIGHT (mm)	WIDTH (mm)	VOLUME (m^3)	WEIGHT (tonne)
VM15	5100	2061	6700	8.28	19.87
VM16	3390	1683	3193	3.30	7.92
VM17	4100	1477	4193	4.17	10.01
VM18	2790	1228	2993	2.26	5.41
VM19	3490	1085	2293	2.06	4.93
VM20	2690	1228	3393	2.41	5.78
VM21	3490	1412	3393	3.13	7.51

MECHANICAL, ELECTRICAL & PLUMBING DESIGN

MEP Layout

Prefab MEP service in general is installed at every panel in the assembly factory before being mobilised to the site. After all the panels have been put in place, the MEP services shall utilise the plug and play system.

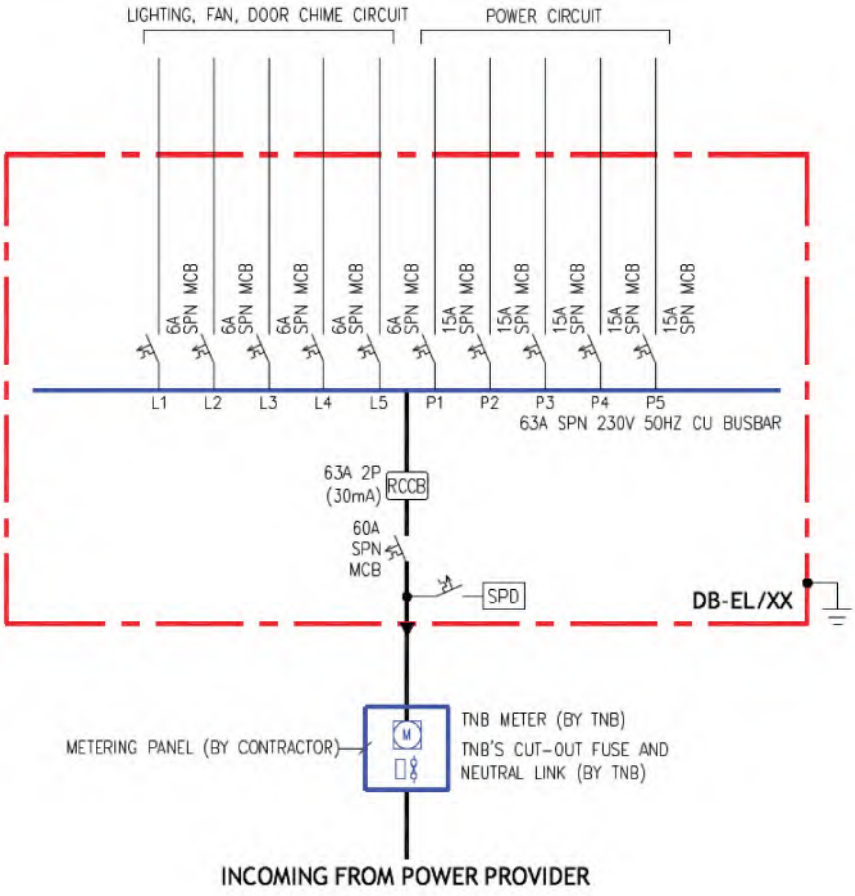
3D View



Overview Of MEP Layout of the Townhouse

Electrical

Lighting and Power Layout for the Ground Floor and the 1st Floor



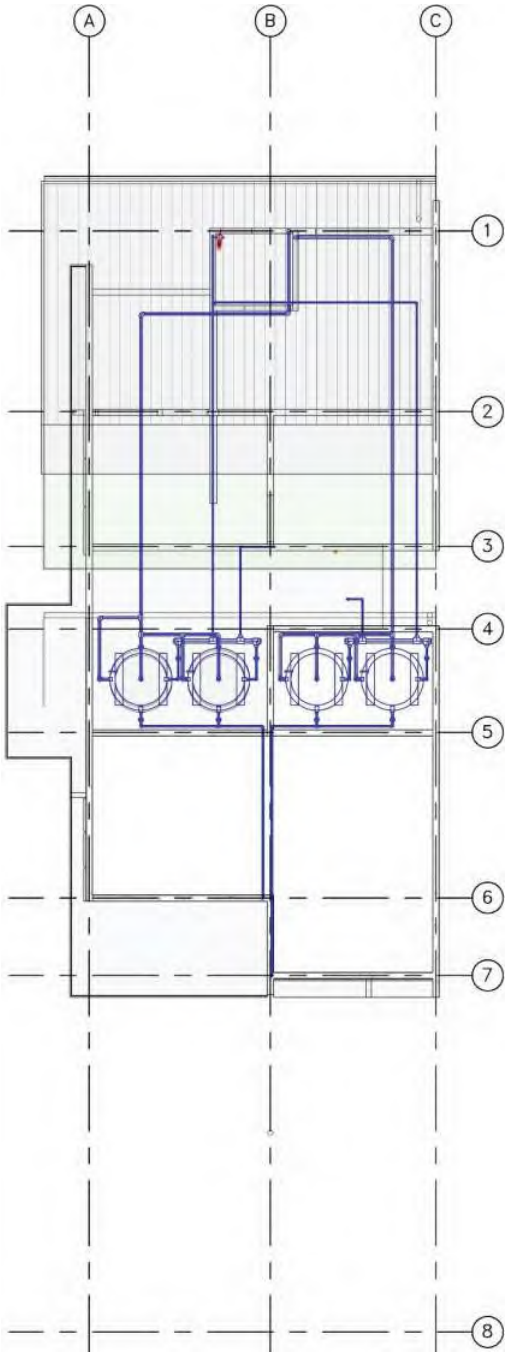
Metering Concept for Each Townhouse Unit

Mechanical & Plumbing

Water storage capacity shall be according to the guidelines as follows:

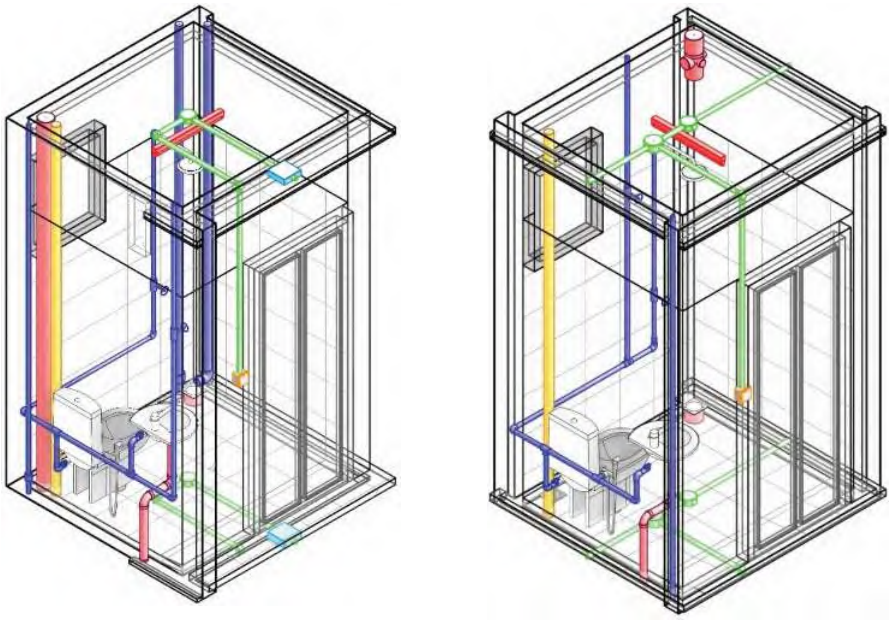
1 Storage capacity of Domestic dwelling (each unit) – 800 L/unit/day as per SPAN requirement.

Cold Water Plumbing Layout for the Ground Floor and the 1st Floor

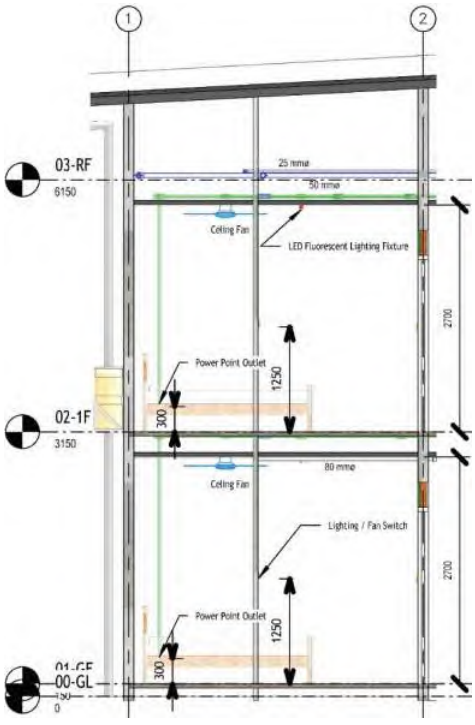


Cold Water Plumbing Layout for the Roof Floor

Sanitary Plumbing Layout for the Ground Floor and the 1st Floor



MEP System Design of PBU



MEP Point Setting in the Bedroom (Sectional)

MEP Points

The desired numbers of MEP point and quantity for townhouse unit are as follows:

MEP Point of the Ground Floor Unit

DESCRIPTIONS	BEDROOM 1 & BATHROOM 1	BEDROOM 2	BEDROOM 3	BATHROOM 2	KITCHEN/ DINING/LIVING/ TERRACE/YARD	UTILITY
Lighting Points	2	1	1	1	4	1
13A Power Points	1	1	1	0	3	0
Fan Points	1	1	1	0	2	0
Switches	3	2	2	1	7	1
Stopcock Valves	1	0	0	1	0	0
Water Closet Angle Valves	1	0	0	1	0	0
Sink Angle Valves	0	0	0	0	1	0
Basin Angle Valves	1	0	0	1	0	0
Shower Stopcock Valves	1	0	0	1	0	0
Water Tap	1	0	0	1	0	0

MEP Point of The First Floor Unit

DESCRIPTIONS	BEDROOM 1 & BATHROOM 1	BEDROOM 2	BEDROOM 3	BATHROOM 2	KITCHEN/ DINING/LIVING/ STUDY/YARD	STAIRCASE
Lighting Points	2	1	1	1	6	1
13A Power Points	1	1	1	0	5	0
Fan Points	1	1	1	0	2	0
Switches	3	2	2	1	7	1
Stopcock Valves	1	0	0	1	0	0
Water Closet Angle Valves	1	0	0	1	0	0
Sink Angle Valves	0	0	0	0	1	0
Basin Angle Valves	1	0	0	1	0	0
Shower Stopcock Valves	1	0	0	1	0	0
Water Tap	1	0	0	1	0	0

CONSTRUCTION COST ESTIMATION

Specifications

ELEMENT	SPECIFICATIONS
Foundation	Pad footing
Structure	Reinforced concrete slab and precast concrete slab Precast concrete beam Precast concrete column Precast concrete wall: 125 mm thickness
Roof framing	Lightweight steel roof truss and reinforced concrete flat roof
Roof covering	Metal decking
Doors	Metal door frame, timber plywood flush door, powder coated aluminium sliding door, and bifold door
Windows	Powder coated aluminium frame window, 6 mm thickness clear glass
Wall	Powder coated aluminium frame window, 6 mm thickness clear glass
Wall Finishes	Skim coat, paint, and ceramic tiles
Floor Finishes	Ceramic tiles, and cement render
Ceiling finishes	Skim coat, paint, and moisture resistant ceiling board
Sanitary fittings	Water closet, basin, shower rose, hand bidet, toilet roll holder, floor trap, sink, and tap
External works	Chain link fencing, mild steel gate, refuse chamber and mailbox
Miscellaneous	Stainless steel rainwater harvesting tank (RWHT) with accessories

Assumption on Rates

1. This cost estimate is based on 200 townhouse units.
2. The cost estimate for townhouse does include architecture, structure, mechanical, electrical and plumbing works.
3. This cost estimate excludes preliminaries and contingencies.
4. Infrastructure costs are excluded.
5. Rate for precast items include moulding, supply, transportation and installation.
6. Actual cost of a building depends on the design and many factors and may vary from the figures shown.
7. Land cost, contribution cost/fees, management cost, professional fees, legal fees and the Developer's profit margin are excluded.

8. This is based on the current rates obtained via competitive tendering. No allowance has been made for the increases in costs of labour, materials and plant in the future. This cost is subject to passage of time, changes in business of the industry, and availability of information. Even we endeavour to give reasonable estimated costs to each element at the time of preparation, we are not responsible for future changes in market or the contractor's pricing strategy.

9. <u>Mechanical & Electrical Services:</u>

   a. External cold water and sanitary piping are excluded.

   b. Dry powder portable fire extinguisher for fire protection services is included.

Cost Estimate of the Townhouse

DESCRIPTION	INTERMEDIATE	END	CORNER
Total Cost Estimate for 2 Unit House	RM197,708.00	RM207,527.50	RM215,376.00
Total Cost Estimate Per Unit House	RM98,854.00	RM103,763.75	RM107,688.00
Total Cost Estimate Per m^2 (834 m^2 per unit)	RM588.42	RM617.64	RM641.00
Total Cost Estimate Per ft^2 (904 ft^2 per unit)	RM109.35	RM114.78	RM119.12

Total Cost Estimate Per ft^2
(904 ft^2 per unit)

Approximate Bills of Quantity for Townhouse

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	FOUNDATION								
A	Pad footing	M3	15.00	169	2,535.00	169	2,535.00	169	2,535.00
	REINFORCED CONCRETE SLAB								
	Concrete Slab								
B	200mm Thick slab	M3	270.00	27	7,290.00	27	7,290.00	31	8,370.00
	Reinforcement								
C	10mm - 32mm Diameter bar	Kg	3.50	2,430	8,505.00	2,430	8,505.00	2,790	9,765.00
	Formwork to Slab								
D	To edges of slab n.e. 200mm high	M	22.00	50	1,100.00	50	1,100.00	50	1,100.00
	Waterproofing System								
E	Waterproofing to ground floor	M2	3.00	75	225.00	75	225.00	75	225.00
	Termite Treatment System								
F	Anti-termite to ground floor	M2	2.50	75	187.50	75	187.50	75	187.50
	PRECAST CONCRETE SLAB								
	Plank Slab								
G	75mm Thick	M3	600.00	6	3,600.00	6	3,600.00	6	3,600.00
	Reinforced Concrete Topping								
	Concrete								
H	75mm Thick concrete topping	M3	270.00	6	1,620.00	6	1,620.00	6	1,620.00
	Reinforcement								
J	BRC A9	M2	35.00	82	2,870.00	82	2,870.00	82	2,870.00
	PRECAST CONCRETE BEAM								
K	Beam	M3	783.00	1.7	1,331.10	1.7	1,331.10	2.2	1,722.60
	PRECAST CONCRETE COLUMN								
L	Column	M3	783.00	0.3	234.90	0.3	234.90	0.8	626.40
	TOTAL CARRIED TO COLLECTION				**29,498.50**		**29,498.50**		**32,621.50**
									Page No.: 1/6

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	PRECAST CONCRETE WALL								
A	125 mm thickness wall	M3	783.00	40	31,320.00	44	34,452.00	43	33,669.00
B	125 mm thickness gable wall	M3	783.00	10	7,830.00	12	9,396.00	12	9,396.00
	REINFORCED CONCRETE ROOF SLAB								
	Concrete Roof Slab								
C	150mm thick slab	M3	270.00	7	1,890.00	8	2,160.00	9	2,430.00
	Reinforcement								
D	10mm - 32mm Diameter bar	Kg	3.50	630	2,205.00	720	2,520.00	810	2,835.00
	Formwork to Roof Slab								
E	To soffit of slab	M2	35.00	49	1,715.00	54	1,890.00	61	2,135.00
	Waterproofing System								
F	Waterproofing to flat roof	M2	20.00	49	980.00	54	1,080.00	61	1,220.00
	STAIRCASE								
G	Staircase inclusive finishes	No	5,000.00	1	5,000.00	1	5,000.00	1	5,000.00
	LIGHTWEIGHT ROOF								
H	Supply and install lightweight roof truss complete with metal decking roof covering, aluminium foil, rockwool, gutter, flashing, fascia board, capping and all other finishes and accessories	M2	100.00	99	9,900.00	112	11,200.00	112	11,200.00
J	Rainwater down pipe (RWDP) system	Item	-	-	1,000.00	-	1,000.00	-	1,000.00
	DOORS								
	Supply and fix in position door; including metal door frame, in-fill with concrete complete with ironmongeries								
K	Overall size 1000mm x 2400mm high, single leaf timber plywood flush door complete with fix glass above (Type D1)	No	912.00	2	1,824.00	2	1,824.00	2	1,824.00
	TOTAL CARRIED TO COLLECTION			**63,664.00**		**70,522.00**		**70,709.00**	
								Page No.: 2/6	

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	DOORS (Cont'd)								
A	Overall size 900 mm x 2400 mm high, single leaf timber plywood flush door complete with fix glass above (Type D2)	No	821.00	6	4,926.00	6	4,926.00	6	4,926.00
B	Overall size 900 mm x 2400 mm high, single leaf timber plywood flush door complete with fix glass above and waterproof paint finish (Type D3)	No	821.00	1	821.00	1	821.00	1	821.00
C	Overall size 750 mm x 1400 mm high, single leaf timber plywood flush door complete with fix louvres panel (Type SD1)	No	399.00	1	399.00	1	399.00	1	399.00
	Supply and fix powder coated aluminium frame fixed panel complete with ironmongeries and accessories								
D	900 mm x 2100 mm high, bottom trackless bifold door (Type D4)	No	756.00	4	3,024.00	4	3,024.00	4	3,024.00
	Supply and fix powder coated aluminium frame fixed panel complete with aluminium frame including 6mm thick clear glass and all necessary fixing accessories								
E	2100 mm x 2400 mm high, 3 panel glass sliding door complete with fix glass above (Type W1)	No	2,016.00	2	4,032.00	2	4,032.00	2	4,032.00
F	1800 mm x 2400 mm high, 2 panel glass sliding door complete with fix glass above (Type W2)	No	1,728.00	-		-		2	3,456.00
	WINDOWS								
	Supply and fix natural anodised aluminium frame complete with aluminium window frame including 6mm thick clear glass								
G	600 mm x 750 mm high, 1 panel top hung glass window (Type W1)	No	158.00	4	632.00	4	632.00	4	632.00
	TOTAL CARRIED TO COLLECTION				**13,834.00**		**13,834.00**		**17,290.00**
									Page No.: 3/6

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	WINDOWS (Cont'd)								
A	600 mm x 1500 mm high, 1 panel fix glass window complete with top hung above (Type W2)	No	315.00	1	315.00	1	315.00	1	315.00
B	1200 mm x 1500 mm high, 2 panel casement glass window complete with fixed panel above (Type W3)	No	630.00	7	4,410.00	7	4,410.00	7	4,410.00
C	1800mm x 1500mm high, 3 panel casement glass window complete with fixed panel above (Type W4)	No	945.00	2	1,890.00	2	1,890.00	2	1,890.00
	EXTERNAL FINISHES								
	Aluminium Louvres								
D	Supply and install aluminium louvres overall size 1550mm x 3100mm high fixed panel	No	1000.00	1	1000.00	1	1000.00	1	1000.00
	Reinforced Concrete Coping								
E	RC coping	M2	100.00	7	700.00	26	2,600.00	30	3,000.00
	Mild Steel Railing								
F	Supply and install complete with painting and necessary works	M2	150.00	6	900.00	6	900.00	11	1,650.00
	External Wall Finishes								
G	Skim coat to wall	M2	10.50	100	1,050.00	183	1,921.50	183	1,921.50
H	Weathershield paint to wall	M2	7.00	100	700.00	183	1,281.00	183	1,281.00
	External Floor Finishes								
J	Concrete imprint	M2	25.00	42	1,050.00	42	1,050.00	61	1,525.00
K	Cement render	M2	20.00	59	1,180.00	64	1,280.00	72	1,440.00
	External Ceiling Finishes								
L	Skim coat to ceiling	M2	10.50	35	367.50	48	504.00	55	577.50
	INTERNAL WALL FINISHES								
M	Skim coat to wall	M2	10.50	576	6,048.00	551	5,785.50	551	5,785.00
N	Emulsion paint to wall	M2	5.00	576	2,880.00	551	2,755.00	551	2,755.00
P	Ceramic tiles	M2	60.00	50	3,000.00	50	3,000.00	50	3,000.00
	TOTAL CARRIED TO COLLECTION				**25,490.50**		**28,692.00**		**30,550.50**
									Page No.: 4/6

Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	INTERNAL FLOOR FINISHES								
A	Cement render	M2	20.00	16	320.00	16	320.00	16	320.00
B	Ceramic tiles	M2	60.00	139	8,340.00	139	8,340.00	139	8,340.00
C	Non slip ceramic tiles	M2	60.00	9	540.00	9	540.00	9	540.00
D	Waterproofing system	M2	20.00	25	500.00	25	500.00	25	500.00
	INTERNAL CEILING FINISHES								
E	Skim coat to ceiling	M2	10.50	16	168.00	16	168.00	16	168.00
F	Moisture resistant ceiling board	M2	45.00	157	7,065.00	157	7,065.00	141	6,345.00
G	Emulsion paint to skim coat	M2	6.00	16	96.00	16	96.00	16	96.00
H	Emulsion paint to ceiling board	M2	6.00	157	942.00	157	942.00	141	846.00
	SANITARY FITTINGS								
J	Water closet	No	350.00	4	1,400.00	4	1,400.00	4	1,400.00
K	Wash hand basin	No	150.00	4	600.00	4	600.00	4	600.00
L	Shower rose	No	85.00	4	340.00	4	340.00	4	340.00
M	Hand bidet	No	45.00	4	180.00	4	180.00	4	180.00
N	Toilet roll holder	No	30.00	4	120.00	4	120.00	4	120.00
P	Floor trap grating	No	10.00	4	40.00	4	40.00	8	80.00
Q	Stainless steel single bowl sink	No	120.00	2	240.00	2	240.00	2	240.00
R	Basin tap	No	50.00	4	200.00	4	200.00	4	200.00
S	Pillar tap	No	50.00	2	100.00	2	100.00	2	100.00
T	Bib tap	No	50.00	4	200.00	4	200.00	4	200.00
	EXTERNAL WORKS								
	Fencing								
U	1500mm High PVC coated chainlink	M	80.00	13	1,040.00	10	800.00	10	800.00
	TOTAL CARRIED TO COLLECTION				**22,431.00**		**22,191.00**		**21,415.00**
									Page No.: 5/6

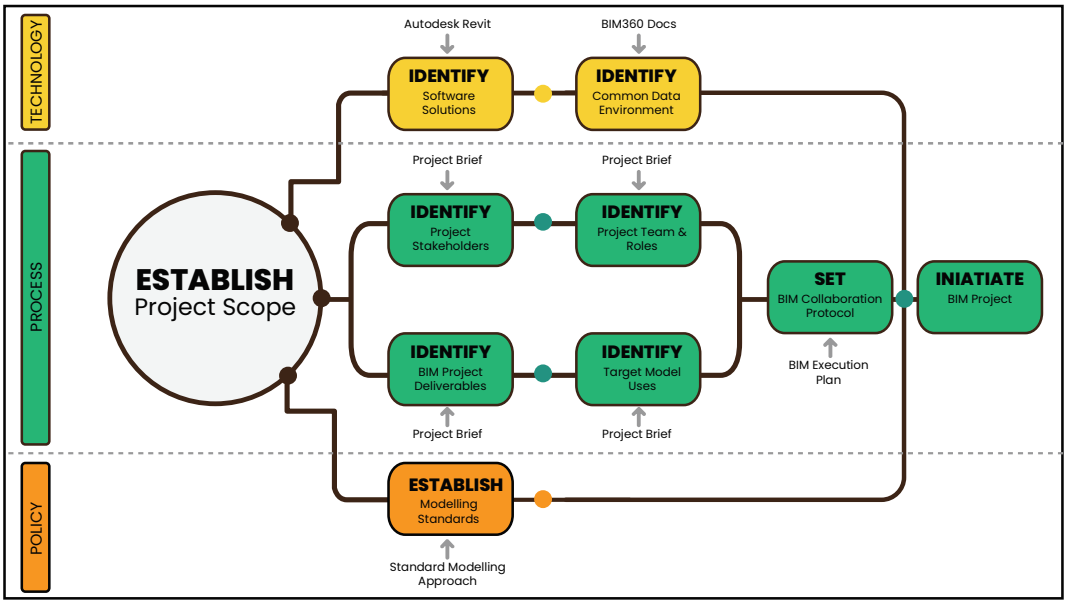
Item	Description	Unit	Rate	Intermediate		End		Corner	
				Qty	Amount	Qty	Amount	Qty	Amount
	Main Entrance Gate								
	Supply and install mild steel gate finished mild steel with anti-rust protection, coated finished with metal paint and including all necessary accessories and ironmongeries								
A	Overall size 3000mm x 1500mm high	No	1,250.00	2	2,500.00	2	2,500.00	2	2,500.00
	Rear Gate								
	Supply and install swing gate including all accessories and ironmongeries all according to Architect's drawing								
B	Overall size 900mm x 1500mm high	No	500.00	1	500.00	1	500.00	1	500.00
	Refuse and Mail Box Compartment								
C	Construct refuse compartment and mail box compartment complete with all necessary excavation, foundation, waterproofing works, brickwall, plastering, concrete works, reinforcement, BRC, formwork, paint to all exposed concrete and brickwall externally and to skim coat soffit internally, ceramic tiles to floor and wall for compartment internally and including 550mm x 1000mm high steel door and 550mm x 250mm letter box opening all as per Architect's drawing	No	1,500.00	2	3,000.00	2	3,000.00	2	3,000.00
	Rain Water Harvesting Tank								
D	230 Litre polypropylene (UV resistant PP) RWHT	No	2,100.00	1	2,100.00	1	2,100.00	1	2,100.00
	MECHANICAL, ELECTRICAL & PLUMBING								
E	Cold Water Services	Item	-	-	13,080.00	-	13,080.00	-	13,080.00
F	Sanitary Plumbing Services	Item	-	-	8,420.00	-	8,420.00	-	8,420.00
G	Fire Protection Services	Item	-	-	360.00	-	360.00	-	360.00
H	Electrical System	Item	-	-	12,830.00		12,830.00		12,830.00
	TOTAL CARRIED TO COLLECTION				**42,790.00**		**42,790.00**		**42,790.00**

Item	Description	Intermediate	End	Corner
		Amount	Amount	Amount
	COLLECTION			
	Page No. 1/6	29,498.50	29,498.50	32,621.50
	Page No. 2/6	63,664.00	70,522.00	70,709.00
	Page No. 3/6	13,834.00	13,834.00	17,290.00
	Page No. 4/6	25,490.50	28,692.00	30,550.50
	Page No. 5/6	22,431.00	22,191.00	21,415.00
	Page No. 6/6	42,790.00	42,790.00	42,790.00
	GRAND TOTAL	**197,708.00**	**207,527.50**	**215,376.00**

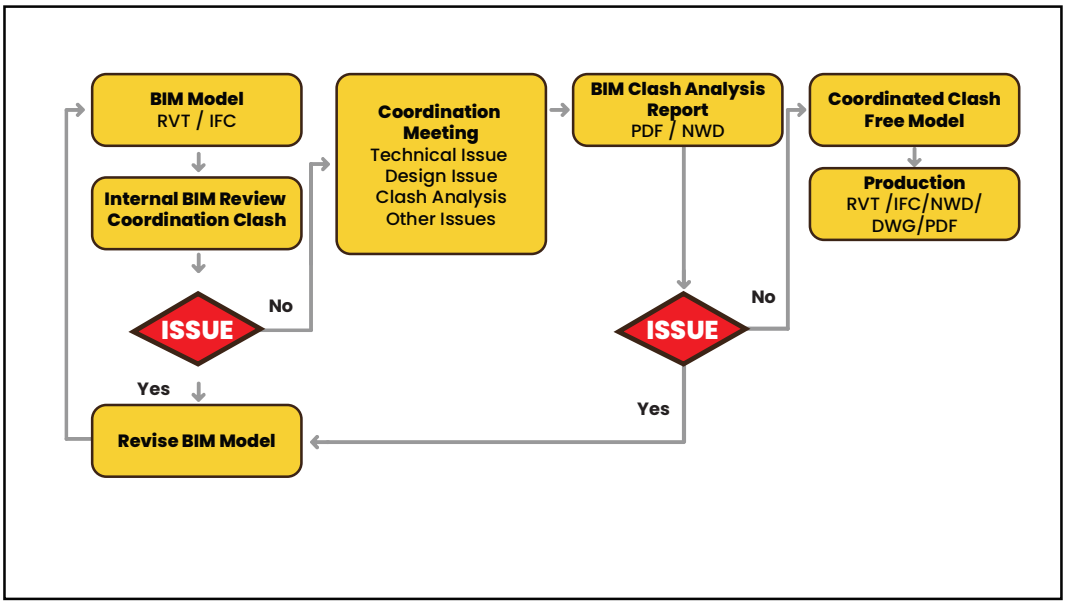
BUILDING INFORMATION MODELLING(BIM) INTEGRATION FOR IHSAN HOMES

BIM WORKFLOW

BIM Initial Workflow



BIM Project Workflow

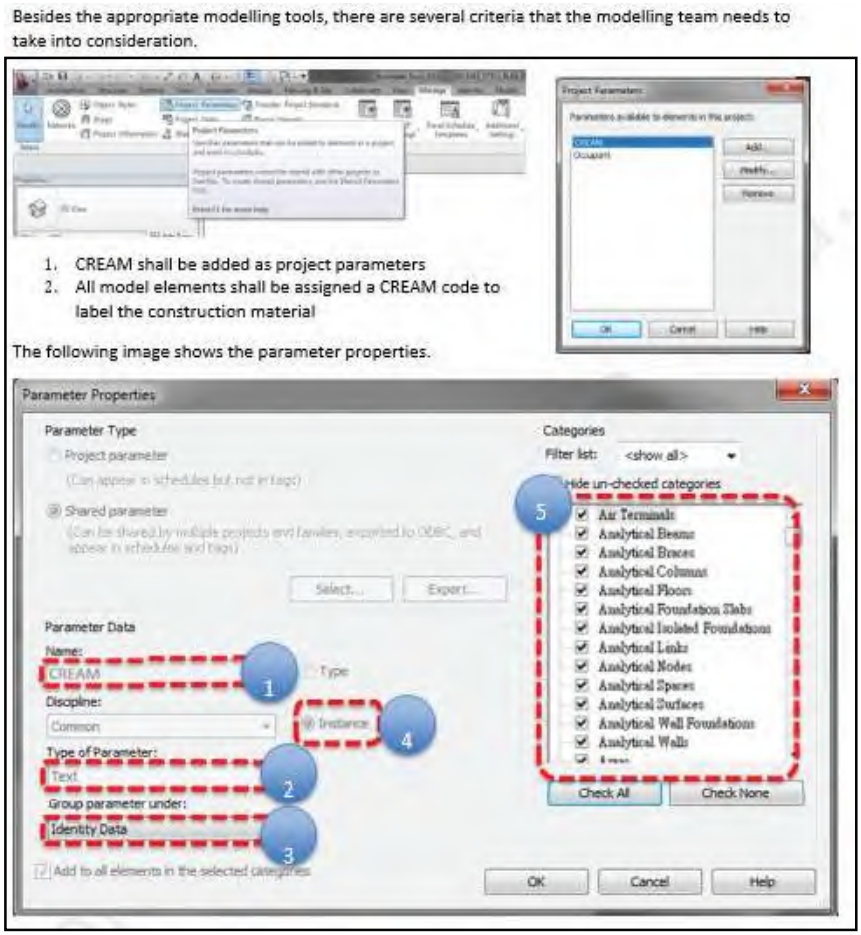


MODELLING STANDARD

Standard Modelling Approach (SMA)

The objective of preparing SMA document in this project is to describe and explain in detail of how the BIM Modelling team can develop the BIM model to extract an accurate model quantity for material take off (MTO).

In the project, all structural elements, precast elements, excavation elements, architecture elements and underground utilities are modelled according to the drawings and specified requirements. Those elements are modelled according to this standard modelling approach.



Sample of Standard Modelling Approach

BIM COLLABORATION PROTOCOL – BIM EXECUTION PLAN

Overview

Purpose of BIM Execution Plan (BEP)

The purpose of the BIM Execution Plan (BEP) is to provide a framework that will enable the project team members delineate the roles and responsibilities of each party. BEP is developed for the Innovative Affordable Housing Design for Tropical Climate Through Technology (Project) based on the Project Brief/Exchange Information Requirements (EIR).

The aim of BEP is to provide a framework that will allow the Client, Architect, Engineers, Contractors and Project Manager to deploy the Building Information Modelling (BIM) technology so that the project can be delivered effectively in terms of time, cost and quality. This plan provides the detail and scope of information to be shared, including relevant business processes and the supporting software.

BEP that explains how the information management of the appointment will be carried out by the delivery team (CREAM, Consultants & Contractor). GreenIBS Consult that is appointed as the lead party (BIM Consultant) shall confirm the delivery team's BIM Execution Plan in line with each appointed party (Clause 5.4.1 – ISO 19650-2:2018 (E).

Indeed, BEP is a live document that has to be reviewed and updated every quarter if there are any changes.

IHSAN Homes BEP Project Overview (Work Example)

Terms Used in This Project

- The term "Company" or "CREAM" shall mean the Construction Research Institute of Malaysia.
- The term "JA" shall mean the Architect Consultant which is Jasmin Architect Sdn Bhd.
- The term "GC" shall mean the BIM Consultant which is GreenIBS Consult.
- The term "NSP" shall mean C&S Consultant which is NS Prefab Consultancy.
- The term "NUM" shall mean MEP Consultant which is NuMagineLab.
- The term "AMD" shall mean Quantity Surveyor Consultant which is AMD Quantity Surveyors.

Project Delivery Manager

This document is owned and maintained by the current Project Delivery Manager as follows:

PROJECT DELIVERY MANAGER - NAME	RESPONSIBLE COMPANY
Fadlullah Mat Ali	GreenIBS Consult Sdn Bhd
Kartina Khamarudin	Architect (SO, represent all consultants)
Maria Zura Mohd Zain	CREAM (Client)

Project Team Representative and Role

COMPANY NAME	REPRESENTATIVE AND AUTHORISED RESPONSIBLE AGENT	ROLE
CREAM	Mohd Ikhwan Abdullah	Project Manager
GreenIBS Consult	Fadlullah Mat Ali	BIM Manager
GreenIBS Consult	Hafizzudin Nizar	BIM Coordinator
Jasmin Architect	Kartina Khamarudin	Project Architect
NS Prefab Consultancy	Saiful Adli Abdul Karim	C&S Engineer
NuMagineLab	Febriyanshah	M&E Engineer
NuMagineLab	Jackson Siow	M&E Engineer
AMD Quantity Surveyers	Ameerul Ariffin	Quantity Surveyor

Document Authority

This project plan has been agreed by the representatives of the project team as listed above with the authority of their parent companies to accept this document as the Agreed BIM Execution Plan.

Project Information

BIM Project Information

Consultants shall develop and deliver information throughout the project that includes the aspect of modelling, coordination,collaboration process, compile and record relevant documentations, visualisation, simulation and optimisation.

BIM related works shall consist of but not limited to the following trades:

- Architecture
- Building Façade
- Civil works
- Structure
- Mechanical
- Electrical
- Building Security system
- All Nominated Sub-Contractors (NSC)

Project BIM Goal

The BIM goals of the Company for the Project are:

a. 3D Visualisation of the Project prior to actual construction;

b. Identification of discrepancies, request for information (RFI), analysis and coordination of the Project through parametric (with 3D features) modelling;

c. Progress updates, records and reports – BIM 4D;

d. Justification of any claims and/or variation order (VO) based on the BIM 5D requirements.

e. Deriving as-built model and parametric asset information at theend of the Project (LOD 500 based on ISO 19650-2 definition).

However, BIM goals are limited to the modelled items in the BIM models.

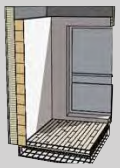
Level of Development

The objects or elements in the BIM models shall vary in their LOD. As the project starts, building objects are represented by more detailed geometry, with additional information attached to the components. The information that is attached to the components is based on the project requirements and the information purpose. LOD is a useful concept to obtain agreement regarding content of objects or components at different project stages.

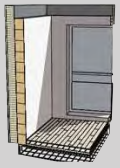
Level of Details and Purposes (Stage 01)

DETAILS OF LOD	MODEL CONTENT	PURPOSE	INFORMATION	VISUAL
LOD 100 Concept Design	• 2D drawings • 3D conceptual model Site layout based on design brief • Any document analysis at this stage	• Feasibility study • Preliminary costing /planning • Perfomance studies • DO submission	• Site analysis • Area • Volume	
LOD 200 Schematic Design	• Generic geometry models • Waterway • Roads • Drainage/utilities • Bridges/structures	• Preliminary cost estimates • Gross floor area analysis • Preliminary cost estimates for individuals elements. • Preliminary volume and quantity of elements • BP Submission	• Dimension • Area • Volume • Rooms • Material	
LOD 300 Detail Design	• Elements are modelled using accurate specific assemblies accurate in terms of quantity, size, shape, location,and orientation • Some generic information is attached to the key elements	• Develop cost estimation • Quantity take off • Clash analysis report • Construction simulation • Performance analysis • Tender	• Dimension • Area • Volume • Rooms • Material • Finishes	

Level of Details and Purposes (Stage 02)

DETAILS OF LOD	MODEL CONTENT	PURPOSE	INFORMATION	VISUAL
LOD 400 Construction Phase	• Model elements are the virtual representation of the updated as-built elements to suit progress on site • Elements along with material/finishes • Data regarding suppliers/vendors/ contractors	• Virtual representation of the constructed element. • Actual quantity take-off. • Ongoing clash coordination. • Listing of parts • Descriptive bills of quantities (BOQ) • Monitoring a construction progress • Construction coordination drawings	• Dimension • Area • Volume • Rooms • Material • Finishes • Site installation progress • Site zoning • Fire rated element • Model ID	
LOD 500 As-Built Phase	• Full model representative of the as-built elements • Elements are embedded with data regarding properties, construction, maintenance and operation manuals	• As-built documentation • Record of actual costs • O&M Manuals. • Equipment quantities • Test certification • Commissioning	• Dimension • Area • Volume • Rooms • Material • Finishes • Site installation progress • Site zoning • Fire rated element • Model ID • Maintenance schedule • Manufacture	

Level of Details and Purposes (Stage 03)

DETAILS OF LOD	MODEL CONTENT	PURPOSE	INFORMATION	VISUAL
Facility Management	• LOD 500 Model is integrated with the Facility Management/ Asset Management Tool (Software)	• Embedded LOD 500 Model is merged with/linked to a suitable Facility Management Tool • Query for Information or Data for Operations and Maintenance	• Dimension • Area • Volume • Rooms • Material • Finishes • Site installation progress • Site zoning • Fire rated element • Model ID Maintenance schedule Manufacture Warranty details Asset code Power rating (electrical)	

IHSAN Homes Project BIM Information (Work Example)

Project Name	Innovative Affordable Housing Design for Tropical Climate Through Technology
Project Address	Level 29, Sunway Putra Tower, No.100, Jalan Putra, Kuala Lumpur.
Project Number	
Contract Form	
Project Design Commencement Date	a. 23rd April 2020 (Concept) b. 1st July 2020 (Design stage)
Project Construction Commencement Date	n/a
Project Completion and Handover Date	1st September 2020
Project Description (EIR)	Development of Affordable Housing Design using IBS which includes designs for: a. Single-storey terrace b. Townhouse c. Apartment The elements of housing design include Architecture, Civil & Structure, Mechanical, Electrical & Plumbing as well as Building Cost.
Project Brief and CDM requirements	a. The research on affordable housing design is one of CIDB's initiatives to support the government effort in developing more affordable housing in the country. b. This is in line with the National Affordable Housing Policy (DRMM) developed by the Ministry of Housing and Local Government (KPKT) to outline standards, specifications, prices and guidelines for affordable housing development and fulfil the Government's aspiration to build 1 Million Affordable Homes over the next 10 years (2018-2028). c. The standard design references for affordable housing are developed to assist CIDB and KPKT in promoting the use of IBS for Affordable Housing projects. The use of IBS as the home component will help to achieve a minimum target of 70 IBS score in all government housing projects as well as a minimum of 50 IBS score for private housing projects.
Project Deliverables as defined in the EIR	The CIDB Affordable Housing Design Standard for construction industry.

Management

This section of the BEP covers the requirements of Clause 5.4.2 – ISO 19650-2:2018(E). GC, as the lead appointed party (BIM Consultant), has established the delivery team's detailed responsibility matrix, information delivery milestones, Project's information production methods and procedures.

Roles, Responsibility and Authority Matrix

Task and Responsibility Mapping

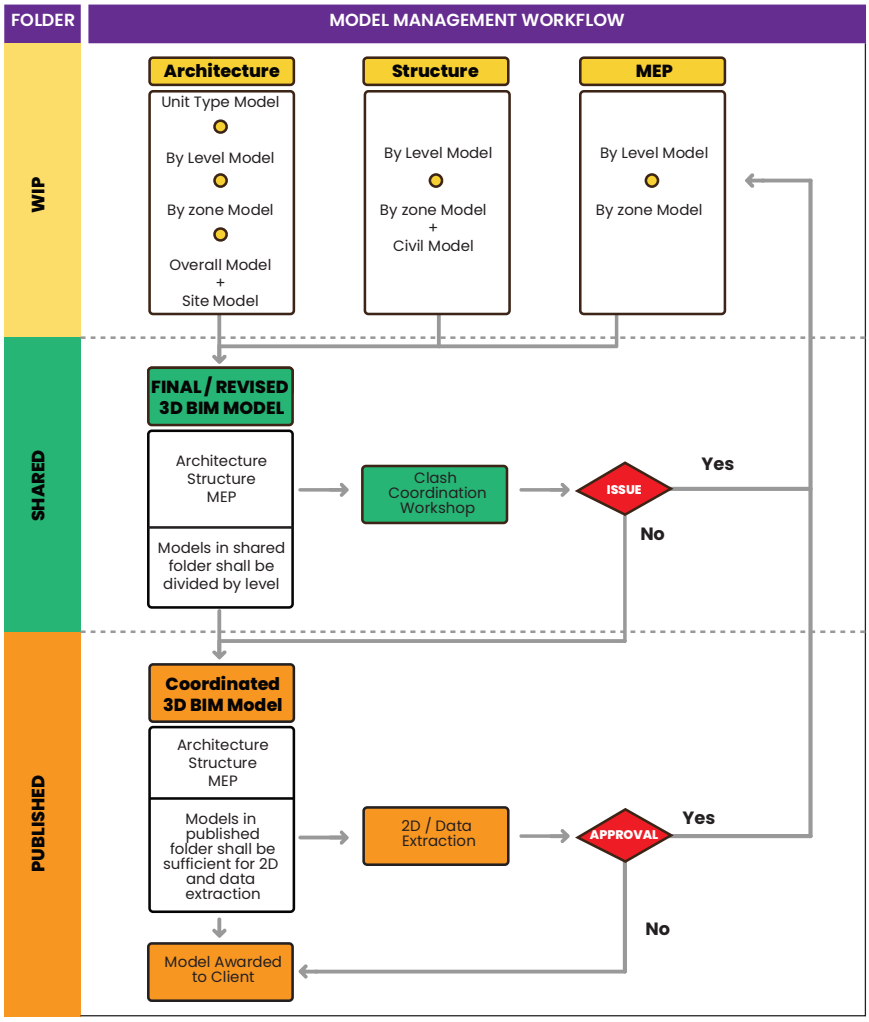
CLIENT (CREAM)	BIM Consultant (GC)	CONSULTANTS (JA,NSP,NUM,AMD)	CONTRACTOR
		LOD 300	
Review and verify Design.	Produce the BIM Execution Plan (BEP).	Produce the model design.	
		Verify the accuracy of the models as per design requirement.	
Final approval of the project design.	Produce the Design Coordination Report.	Respond to the Design Coordination Report.	
	Conduct BIM Clash Analysis Workshop.	Continue to refine the Design Model.	
		Produce 2D drawings.	
		LOD 400	
Review and verify .	Monitor and coordinate with Contractor's BIM team	Respond to construction RFIs and issuance of EIs.	Manage construction with subcontractors and suppliers. Update changes in the BIM model.
Monitor construction progress.	Make sure the shop drawing model is as per the LOD 300 clash free model.	Review and approval/ sign-off the shop drawings.	Produce and submit shop drawings using the LOD 400 model for approval.
Review and give instruction to design/ intent changes and issues.	Review and delegate the BIM Coordination Report from the contractor.		
		LOD 500	
Review and verify.	Collaborate with BIM Facility management consultant and contractor's BIM team for FM Model preparation	Verify the as-built model and drawings.	Prepare the as-built model.
			Verify the as-built BIM model prior to submission.

Note: GC-GreenIBS Consult; JA-Jasmin Architect; NSP-NS Prefab Consultancy; NUM-Numaginelab Sdn Bhd; AMD-AMD Quantity Surveyors

Model Management Workflow

A typical BIM process involves model creation (1), model coordination and data exchange (2) involving a team of model authors and users. Upon resolution of identified issues (e.g. coordination clashes) during each project milestone, a version of model can then be frozen and released to the model users (3).

Model Management Workflow



IHSAN Homes BIM Project Management (Work Example)

Roles, Responsibilities and Authorities

ROLE COMPANY	NAME	EMAIL AND TELEPHONE NUMBER
CREAM		**cream@**
Project Owner (CEO)	Tuan Hj. Razuki bin Hj. Ibrahim	razuki@ 013-xxx xxxx
Project Owner	Maria Zura Mohd Zain	maria@ 012-xxx xxxx
Project Owner	Nurulhuda Mat Kilau	nurulhuda@ 012-xxx xxxx
Project Owner	Mohd Ikhwan Abdullah	ikhwan@ 012-xxx xxxx
Project Owner	Syed Hamad Naguib Syed Azmi	syed.hamad@ 012-xxx xxxx
JASMIN ARCHITECT		**ja.arch@**
Principal	Ar. Jasmin Kamaruddin	jasmin@ 019-xxx xxxx
Project Architect/BIM Coordinator	Kartina Khamarudin	kartina@ 011-xxx xxxx
NS PREFAB CONSULTANCY		**nsprefabconsultancy@**
Manager	Ts. Ir Saiful Adli Abdul Karim	saiful@ 019-xxx xxxx
IBS Engineer/Civil Engineer	Siti Yusmaliza bt Mohd Yusuf	yusmaliza@ 017-xxx xxxx
Engineer/Coordinator	Nur Fasha Azuin binti Ridzuan	fasha@ 012-xxx xxxx
NUMAGINELAB		**numaginelab@**
Manager	Febriyanshah Musazumu bin Saad	febriyan@ 012-xxx xxxx
MEP Engineer	Ir Siow Jat Shern	siowJS@ 012-xxx xxxx
MEP Engineer	Ahmad Hariz Safwan Shahrani	hariz@ 012-xxx xxxx
MEP Engineer	Ts. Ir Najlan Ismail	najlan@ 012-xxx xxxx
MEP Engineer	Ir Soon Yoon Chia	soonyc@ 012-xxx xxxx
AMD QUANTITY SURVEYORS		**amdqs@**
Surveyors	Mohd Ameerul Mohd Ariffin	ameerul@ 012-xxx xxxx
GREENIBS CONSULT		**bimguide@**
BIM Manager	Fadlullah Mat Ali	fadlullah@ 019-xxx xxxx
BIM Coordinator	Hafizzudin Nizar	Hafizzuddin@ 013-xxx xxxx

Project Information Model Deliverable Strategy

THE USE OF BIM	DELIVERY MECHANISM	RESPONSIBILITY
Design Coordination	3D native and the federated models provide regular design review and look ahead. 2D drawings for formal submission to authority and client.	• Consultants (JA, NSP, NUM)
BIM Clash Analysis Report	Report document and 3D analysis supplied with images and information of the area with clashes.	• BIM Consultant (GC)
4D Simulation (Planning)	4D time/ Programme Visuals	• BIM Consultant (GC)
5D Quantity Take Off	Table of Quantity	• BIM Consultant (GC) Quantity Surveyors (AMD)
Common Data Environment (CDE)	Shared federated model in a hosted platform space	• CREAM • BIM Consultant (GC)
Construction coordination	3D native and the federated models provide regular design review and look ahead. 2D drawings for formal submission to consultant client approval.	• Contractor
4D Simulation (Planning vs Actual)	4D time/ Program Visuals of Project Progress Monthly Report	• Contractor
Facility management	Tool for asset monitoring system	• FM Consultant

GC shall take the lead to establish a schedule of information exchange requirements between consultants and client.

Approval of Information

To ensure that models, drawing files and spreadsheet extraction are adequately checked, some agreed approval processes have to be in place, to enable the Consultants and the Contractor (or Company) to approve and sign off the project design development. The approval flow shall strictly adhere to the BIM Project Coordination Workflow.

Standard Method and Procedure

Volume Strategy

a. The project shall be divided into series of volumes/levels/compartments where necessary.

b. All members of the Project shall agree to volumes as fully as possible at the beginning of a project and publish them as a shared document. This document shall be reviewed at successive project stages, amended and re-published where necessary.

c. For IHSAN Homes project, GC will determine the volumes.

Project Information Modelling (PIM) Origin and Orientation

The origin and orientation of the project site left perimeter point shall maintain the following coordinates for the Project Base Point and Survey Point:

- Project Base Point:
  N/S 0.0, E/W 0.0, Elevation 0.0
- Survey Point:
  N/S 0.0, E/W 0.0, Elevation 0.0

For IHSAN Homes project, GC will issue a Revit Template (.rte), where these points are already located. Do not move or alter these points for any reason.

IHSAN Homes Standard Method and procedure (Work Example)

BIM Model Convention

For IHSAN Homes project, all model communication is via Revit (.rvt) format.

Document Numbering Convention

a. The Project Document Numbering (PDN) shall explain the sequence of document codes and numbering for technical documents.

b. Technical documents are defined as design outputs that include BIM models, drawings, specifications, design calculations and engineering reports.

Project Document Numbering

SEGMENT 1	SEGMENT 2	SEGMENT 3	SEGMENT 4	SEGMENT 5	SEGMENT 6	SEGMENT 7
PROJECT	PACKAGE	ORG	DISCIPLINE	DOC TYPE	SERIAL	REVISION
CA	AP	JA	AR	3D	L2-L5	001

SEGMENT	ITEM	DESCRIPTION	SAMPLE
1	PROJECT	Project Tittle	CAH
2	PACKAGE	Project specific package	APT/TWH/TRC
3	ORGANISATION	Company Name	JA/NSP/NUM/GC
4	DISCIPLINE	Consultants' trades	AR/CI/ST/ME/EL/CO/QS
5	DOC TYPE	Input type	3D/2D
6	SERIAL	Model number sequence	L1
7	REVISION	Revision* . (applicable on in Publish Folder)	001

Agreed Construction Tolerance

Tolerances in the models and model elements must be within 10 mm of theoretical dimensions. Tolerances for specific items and systems shall be determined where necessary. Model tolerances shall not to be construed as construction tolerances.

Drawing Template

a. All drawing templates shall be in the standard format for sharing and interoperability.

b. All drawings must be presented in one of the approved scales, which are defined by the "BIM Modeller". Scales other than those approved shall not be used.

Drawing Scale

SCALE	DESCRIPTION OF DETAIL
1:1000	Detail shows shape and layout
1:500	Detail shows shape and layout
1:100	Detail shows shape, layout and construction elements
1:50	Detail shows how the construction elements meet at junctions
1:25	Detail shows the detailing of the construction elements
1:5	Detail Drawings
1:1	3D Model

Annotation, Dimensions, Abbreviations and Symbols

Annotation, abbreviation and symbol representation of the elements in models or drawings shall be understandable and shall include a legend table if necessary.

Dimensions shall be taken/derived from the dimension function of the authouring software, be it AutoCAD or Revit. All modelling works shall be performed by competent BIM Modeller in a legible manner, utilising the standard industry convention.

Attribute Data

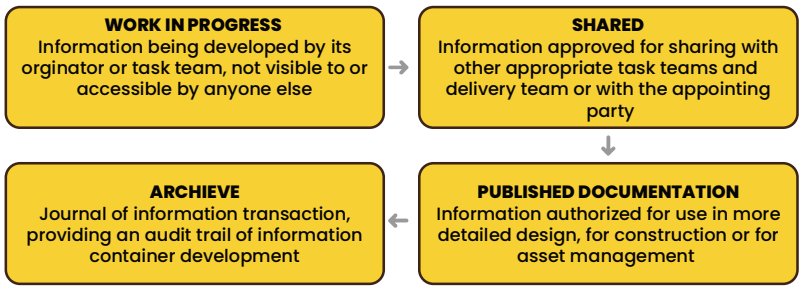
Attribute data to be uploaded to CDE once it has been confirmed.

BIM Collaboration Plan

The BIM Collaboration Plan describes the communication methods, document management, transfer and record of storage. The collaboration plan helps all team members to effectively communicate, share and retrieve information from the BIM model.

Collaboration Mapping

BIM360 Docs is to serve as CDE in the design stage of the Project.



Common Data Environment (CDE) Concept

a. The Work in Progress (WIP) states
The "WIP" state is used for information when it is developed by the task team. An information contained in this state shall not be visible or accessible to any other task team. This is important if the CDE solution is implemented through a shared system such as the shared server or web portal.

b. The Shared State
The purpose of the shared state is to enable constructive and collaborative development of information model in a delivery team.

c. Published Documentation
The published state is used for information that has been authorised for use, for example in the new project construction or asset operation. The Project Information Model (PIM) at the end of a project or the Asset Information Model (AIM) during asset operation only information in the published state or the archive state.

d. Archive
The "Archive" section of the CDE shall store a project history including transactions and changes.

Project Folder Management

A. Project Name
  a. 01 Architect
    i. 01 WIP

a)	01 CAD_Data	[CAD files (incl. 'Modified')]
b)	02 BIM_Models	[Design Models (incl. 'Modified')]
c)	03 Sheet_Files	[Sheet/dwg files]
d)	04 Export	[Export data e.g. gbXML or images]
e)	05 Families	[Component created during this project]
f)	99 WIP_TSA	[WIP Temporary Shared Area (TSA)]

ii. 02 Shared
a) 01 CAD_Data [CAD data/output files]
b) 02 BIM_Models [Design models]
c) 03 NWD_Models [Federated models]

iii. 03 Published
a) YYMMDD_Description [Specific submission folder]

(a) 01 CAD
(b) 02 BIM
(c) 03 NWD
(d) 04 PDF
(e) 05 OTHERS

iv. 04 Archived
a) YYMMDD_Description [Specific submission folder]
(a) 01 CAD
(b) 02 BIM
(c) 03 NWD
(d) 04 PDF
(e) 05 OTHERS

v. 05 Incoming
a) Source
(a) YYMMDD_Description [Specific submission folder]

i) 01 CAD
ii) 02 BIM
iii) 03 NWD
iv) 04 PDF
v) 05 OTHERS

vi. 06 Resource
a) Templates
(a) 01 Revit Templates
(b) 02 Other Templates

Collaboration Strategy

Open communication between all stakeholders is to achieve integrated project delivery, enabled via BIM process. The Project team will ensure that the flow of information from design to construction and ultimately the handover stage is efficient. The BIM Execution Plan is when all parties commit to work together in a disciplined manner and the team shall adhere to the following key principals:

a. CDE will serve as the single information source.

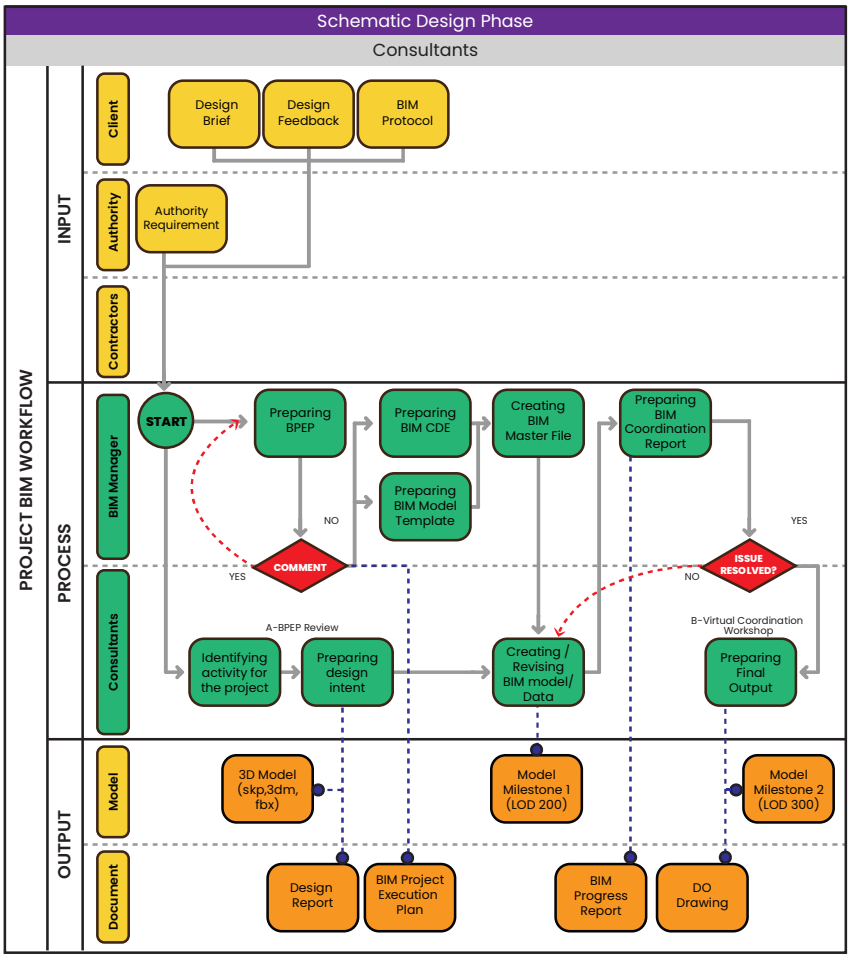
b. Folder structure in the CDE must reflect to all consultants' local folders.

c. GC shall administrate the CDE.

d. Only personnel who are highlighted in BEP can upload information in CDE. The uploaded information in any dedicated folder in CDE shall be deemed as the final version.

Project BIM Coordination Workflow

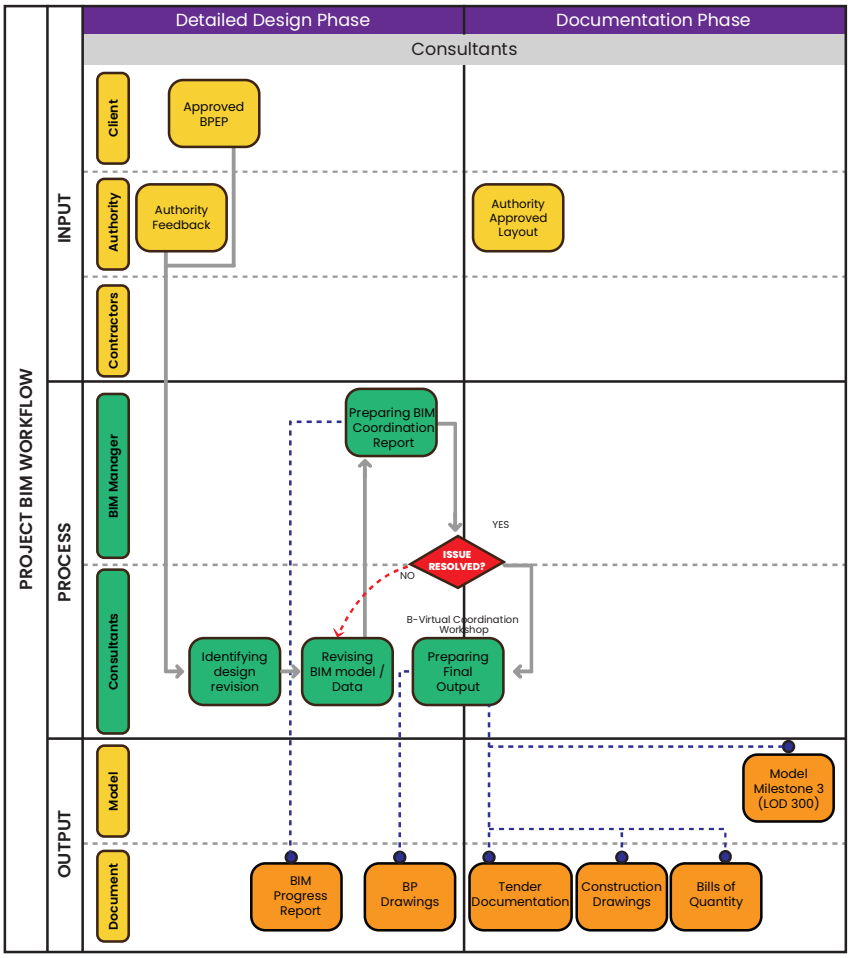
Project BIM Coordination Workflow – Overview



Model Review and Submission

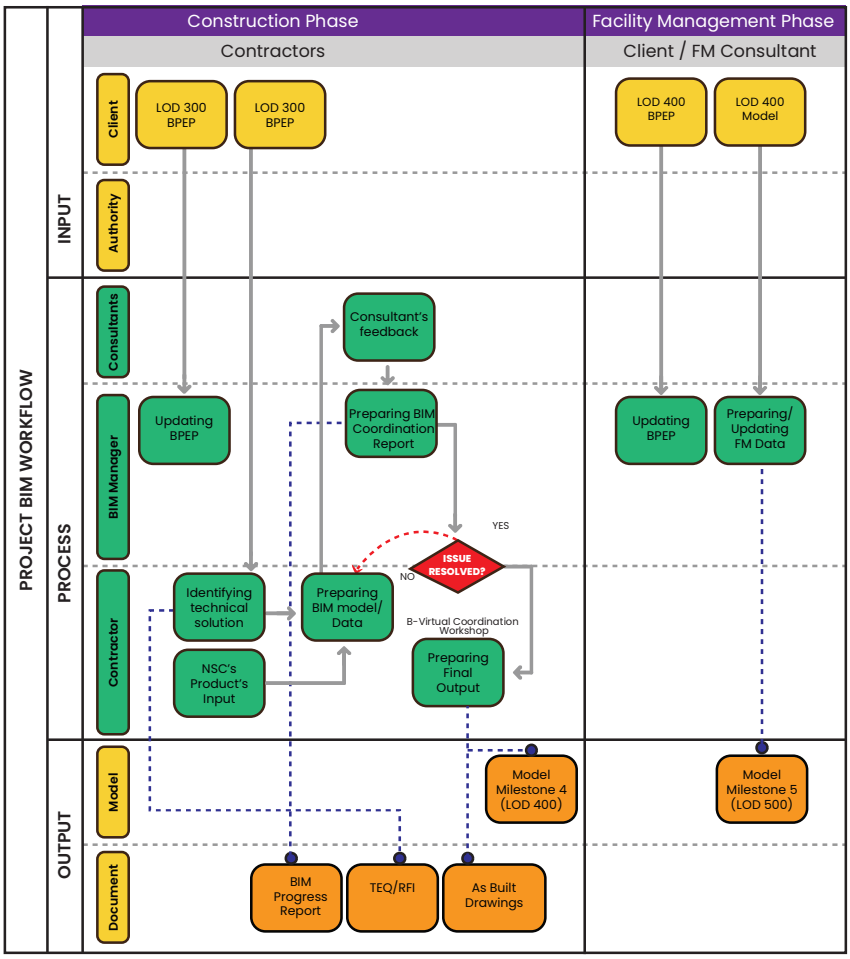
Design Stage

Project BIM Coordination Workflow – Detailed Design Phase & Documentation Phase



Construction Stage

BIM Coordination Workflow – Construction Phase & Facility Management Phase



IHSAN Homes BIM Collaboration Plan (Work Example)

Specific Collaboration Site

BIM360 Design is to serve as CDE in the design stage of the Project. BIM360 Design is used for the following purposes :-

1.0 Base platform for model sharing.
2.0 Online document review by CREAM.
3.0 Repository for all Project documents.
4.0 Transmittal management between Company and Contractor.
5.0 RFI or request for information submission by Contractor. Company shall provide the RFI template.
6.0 Site Memo
7.0 Non-Conformance Report (NCR)

Collaboration Strategy

Open communication between all stakeholders is to achieve integrated project delivery, enabled via BIM process. The Project team will ensure that the flow of information from design to construction and ultimately the handover stage is efficient. The BIM Execution Plan is when all parties commit to work together in a disciplined manner and the team shall adhere to the following key principals:

a. CDE will serve as the single information source.
b. Folder structure in the CDE must reflect all the consultants' local folders.
c. GC shall administer the CDE.
d. Only personnel who are highlighted in BEP can upload information in CDE. The uploaded information in any dedicated folder in CDE shall be deemed as the final version.

Project BIM Meeting

Meeting Schedule

MEETING TYPE	FREQUENCY	CONVENOR	PARTICIPANTS
BIM Kick off Meeting	Once	BIM Consultant	Consultant Client
BIM Coordination Meeting (Technical Meeting)	Based on requirements	BIM Consultant	Consultant Client

Line of Responsibility

Roles and Responsibility

DEFINED ROLE	RESPONSIBILITY	BIM RESPONSIBILITY
Project Manager	Manage and coordinate project execution to meet overall project BIM objectives	Oversight
Design Team Project Manager	Team manager and coordinator	Coordination & Review
BIM Manager	Coordinate BIM use on project, determine schedule of use, sharing activities,S quality control, modelling responsibilities and documentation in BEP	Oversight, managementexecution and model exchange
Lead BIM Coordinator	Assist BIM Manager	Implementing BIM Manager instructions with (Design or Construction) Team. Representing BIM Manager
Architecture Team	Design Execution - formulate with BIM Manager. Map BIM use for architecturaldesign.	Modelling and Review, Model Exchange.

DEFINED ROLE	RESPONSIBILITY	BIM RESPONSIBILITY
Structural Team	Engineering - formulate with BIM Manager. Map BIM use for structural design - determine BIM use structural simulations, analysis and documentation. Identify tools.	Modelling and Review, Model Exchange.
MEP Team	Engineering - formulate with BIM Manager. Map BIM use for MEP design - determine BIM use for simulations, analysis and documentation. Identify tools.	Data Development. Modellingand Model Exchange.
BIM Modelling Application Expert	Support BIM Manager on application specific content, issues.	Modelling and Data Integration.

Analysis Plan

A number of analysis tools allow you to leverage BIM technologies for superior foresight on design and construction. This section outlines the major analysis tools.

Visualisation

Visualisation tools allows the project team to see the design or construction of the project in 3D view, providing a more accurate perspective of the end product.

a. Views of the building exterior.

b. Enhanced visualisations for presentation purposes.

c. Views of the building interior.

d. Simulated videos of the building, e.g. 'walk through' and 'fly through'.

Functional Analysis

a. Walking distances between the main functional spaces.

b. Sightlines for supervision and security purposes.

c. Process areas where there may be issues in terms of timing and volume, e.g. areas used for queuing, waiting and delivery.

d. Supply, processing, and distribution of materials.

e. Construction logistics planning.

Quantity Take-off and Cost Planning

GC shall utilise LOD 300 BIM model for 5D BIM. Quantity take-off for justification of any claims and/or variation order (VO) will be based on the BIM Model and to meet SMM2 requirements. Quantity take-off and costing are only applicable for modelled item.

The list of modelled and non-modelled items is stated in the Table of "Items that will be excluded from the model"..

a. Quantity take-off and costing for modelled items only.

b. 5D BIM – Costing data used for report generation.

Construction Simulation

GC shall utilise Navisworks software for BIM 4D purpose. Navisworks software provides a highly interoperable digital platform to drive evolution in the construction industry from the traditional 2D planning and siloed workflows to a highly collaborative and efficient 4D visual planning.

The LOD 400 BIM model shall be used in construction simulation to help Project Manager to identify potential risks. To come up with the construction simulation, the BIM model in NWD and construction schedule in MS Project format will be imported into Navisworks software.

The three-dimensional (3D) colourised BIM model based on the actual progress in the Navisworks software promotes 4D visual planning and reporting..

a. Modelling complex building systems such as machineries to improve logistics planning, construction productivity, and safety.
b. Modelling to improve constructability review.

Coordination Analysis

To identify and resolve major clashes by utilising clash detection tools through a combined model from all disciplines. The coordination check shall include but not limited to the following aspects:

a. Ceiling Height Clearance
b. Corridor Width
c. Door Opening
d. Critical Room Dimension

Clash Detection Analysis

Clash detection analysis is done to check the interference between designs of one or many models. To reduce change orders during construction, clash detection shall be performed early and continued throughout design process. For clash detection to work, the project's models need to have a common reference point and they must be compatible with the clash detection tool.

Design Model Structure

Model Element Rules, General Completeness of Design

All physical building elements within the project are to be modelled (except those defined and excluded in the MEA Table) and represent the complete design of each level and element of the building. For example, if a single level of a building is identical to another level, each level has to be distinctive and represented in the Design and Construction models. The same applies to identical partial floor layouts.

Precision and Dimensioning

Models shall include the dimensioning required for design intent, analysis, and construction. With few exceptions listed hereinafter, the model will be considered accurate and complete. In the following table, enter which items' placement that is not deemed accurate and shall not be relied on for placement or assembly.

Modelling Object Properties

Model Attribute Data

The level of property information in the modelling objects and assemblies depends on the analysis that will be performed on the model. By diagramming expected and anticipated events, as well as solving workflow dynamics for the collaborative team, this will address the intent of the BIM project.

Modelling Level of Detail

Model elements by discipline, level of development (LOD) and any attributes important to the project. Refer **"Appendix C – BIM Modelling Guidelines."**

The Project Team shall use the following LOD requirements to execute the project in each given phase.

a. Exclusion: List of objects excluded from the model are in the Table of "Items that will be excluded from the model" as follows.

Items That Will Be Excluded from the Model

TRADE	ITEM/ELEMENT
Architecture	Roof tiles as the surface instead of individual model
Structure Civil	Rebar Steel connections, precast connection, and roof structure Substructure
	NA
Mechanical	Hangar for ACMV Ducting Cable ladder Trunking
Electrical	
Plumbing	Holder and bracket
Interior Design	
Landscape	NA

b. Size: Any object smaller than 25 mm shall not be included in the model.

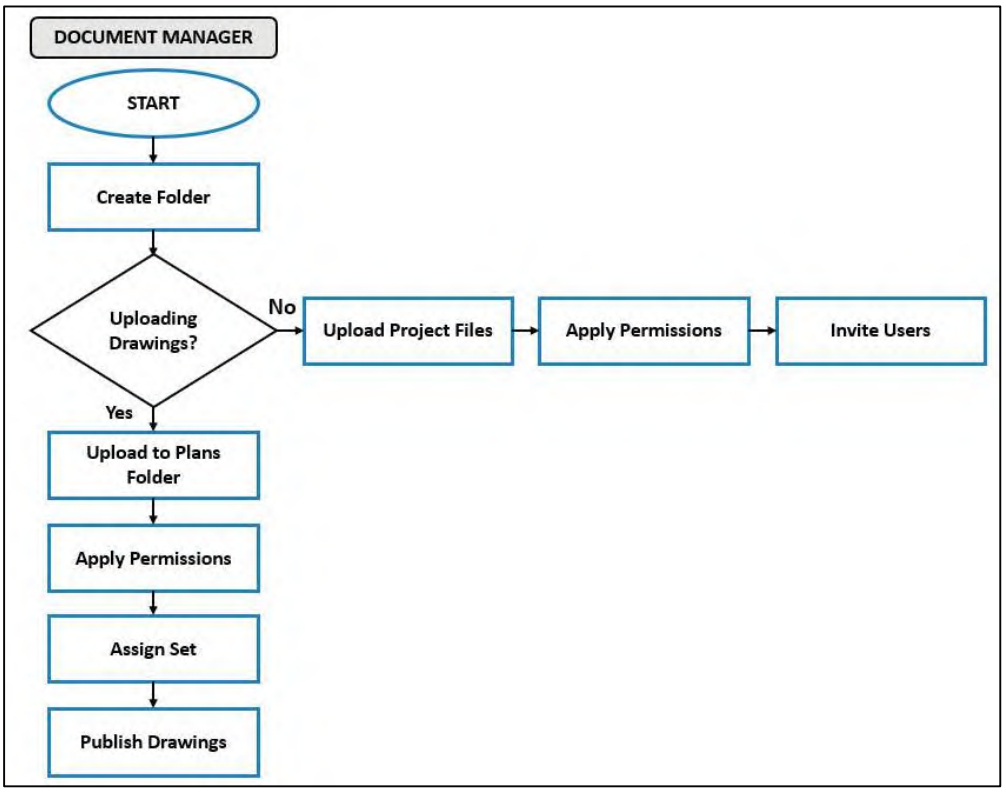
Model Ownership of the Elements

MODEL ELEMENT	DISCIPLINE OWNER	DISCIPLINE USAGE
Grids	Architecture	All - as in the template
Levels	Architecture	All - as in the template
Facade	Architecture	All - as in this link
Floor finishes	Architecture	All - as in this link
Brick walls	Architecture	All - as in this link
Ramp slab/stair steps and landing slab	Architecture	All - as in this link
Railing	Architecture	All - as in this link
RWDP	Architecture	All - as in this link
Roof finishes	Architecture	All - as in this link
Sanitary fittings	Architecture	All - as in this link
Floor slabs	Structure	All - as in this link
Foundations walls-retaining, stair/ramp walls, entry foundations	Structure	All - as in this link
Columns	Structure	All - as in this link
Roof deck (floor)	Structure	All - as in this link
RTU curbs	Mechanical	All - as in this link
Mechanical curbs	Mechanical	All - as in this link
Mechanical fixtures	Mechanical	All - as in this link
Electrical fixture	Electrical	All - as in this link
Landscape piping	Landscape Architect	All - as in this link
AV/IT equipment	Electrical	All - as in this link

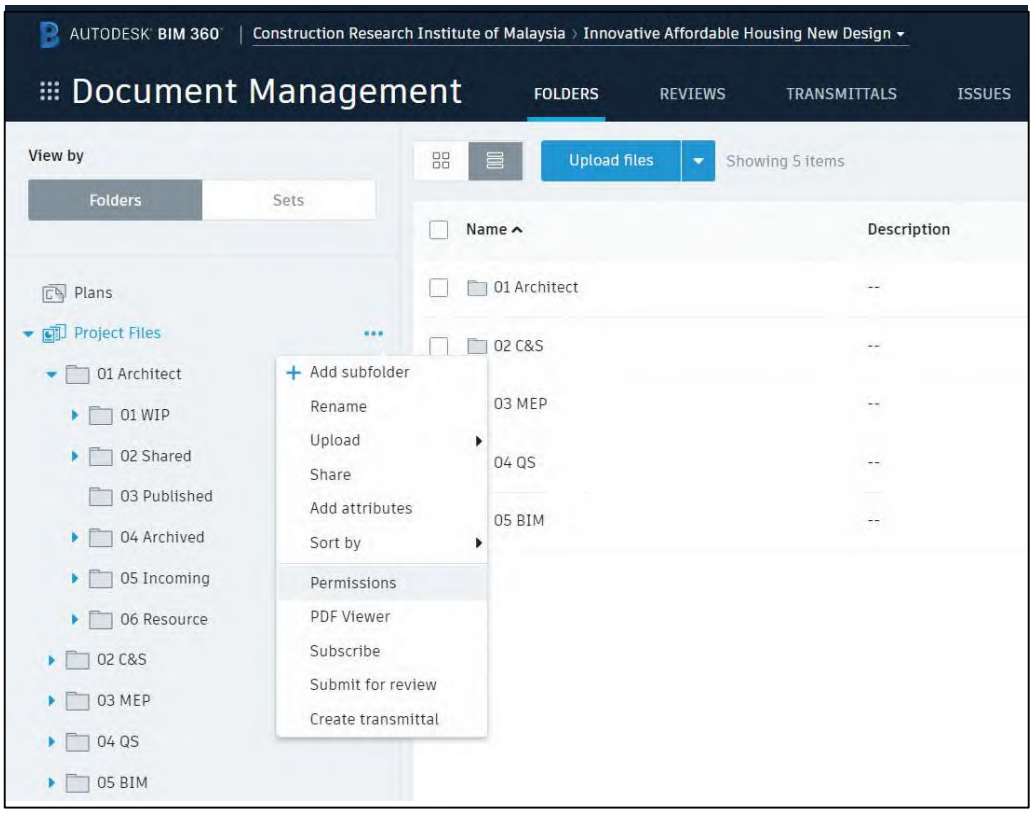
COMMON DATA ENVIRONMENT (CDE) – BIM360 DOCS FOR IHSAN HOMES PROJECT

Document Management Workflow

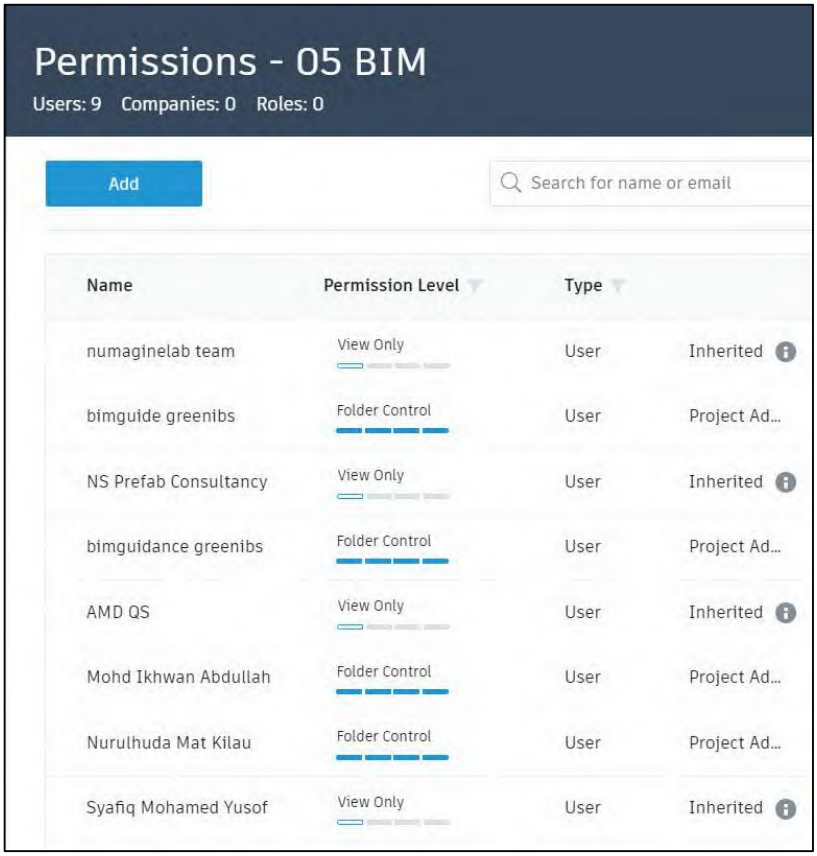
Teams can maximise the benefit of cloud-based file sharing by adopting the best practice workflow. The following diagram outlines the suggested document management workflow using BIM 360.



Setting Up and Manage Folders.

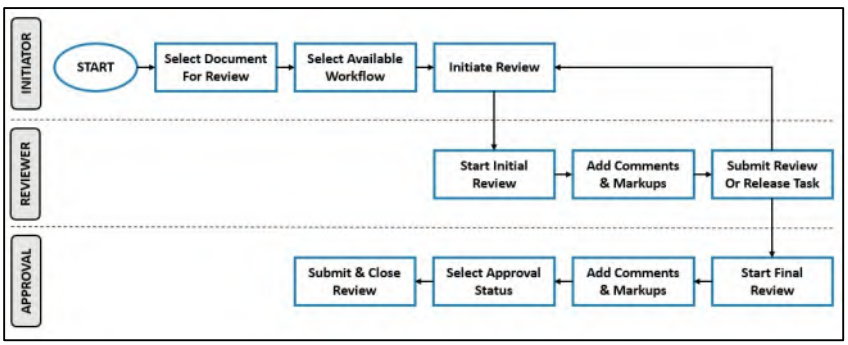


Setting up Permissions

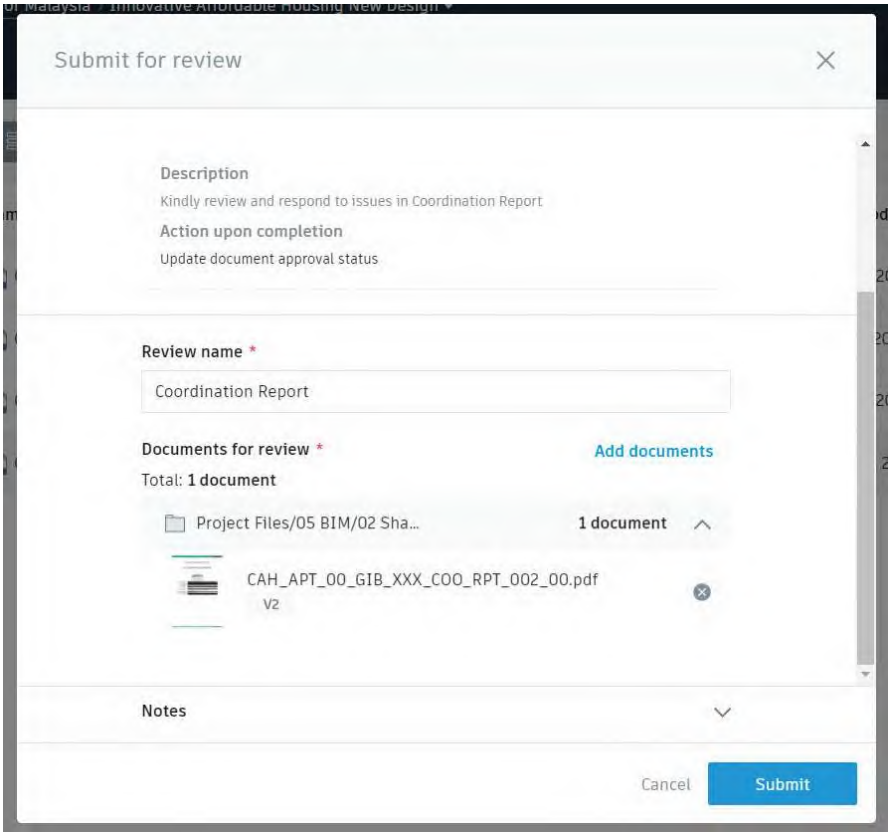


Approvals Workflow

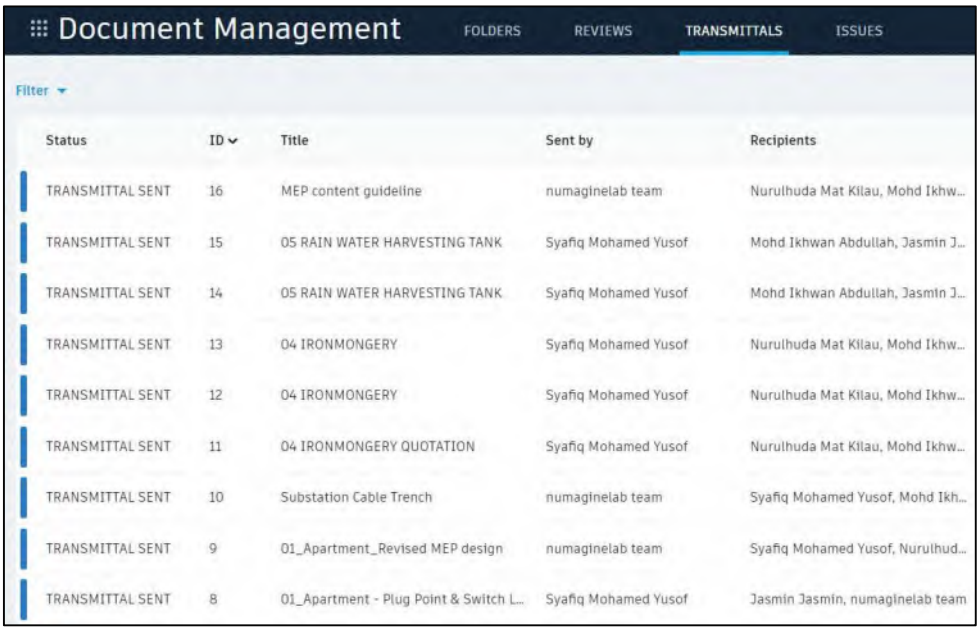
Keep the whole team involved in information review before being communicated to a broader group with the BIM 360's customisable approval workflow.



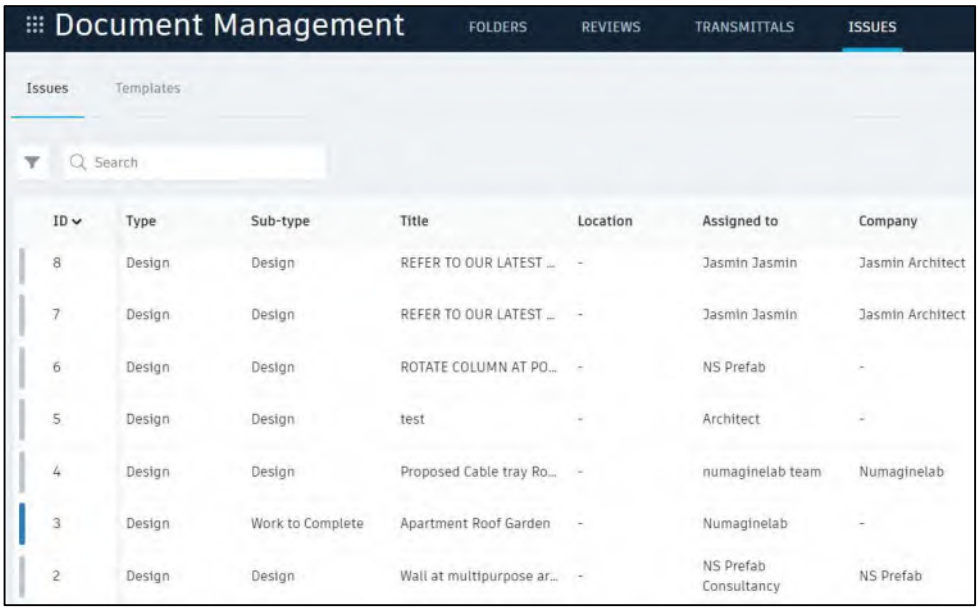
Document Reviews and Approvals



Document Transmittals

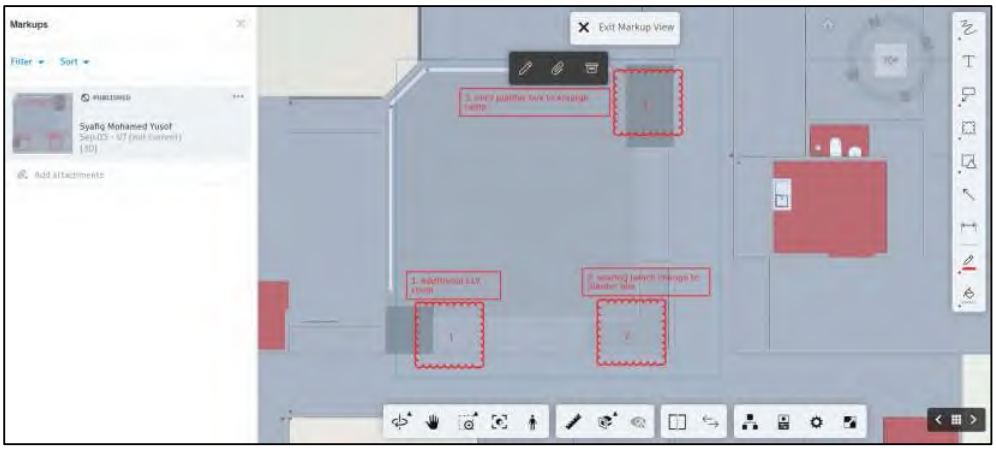


Document or Model-Based Issues

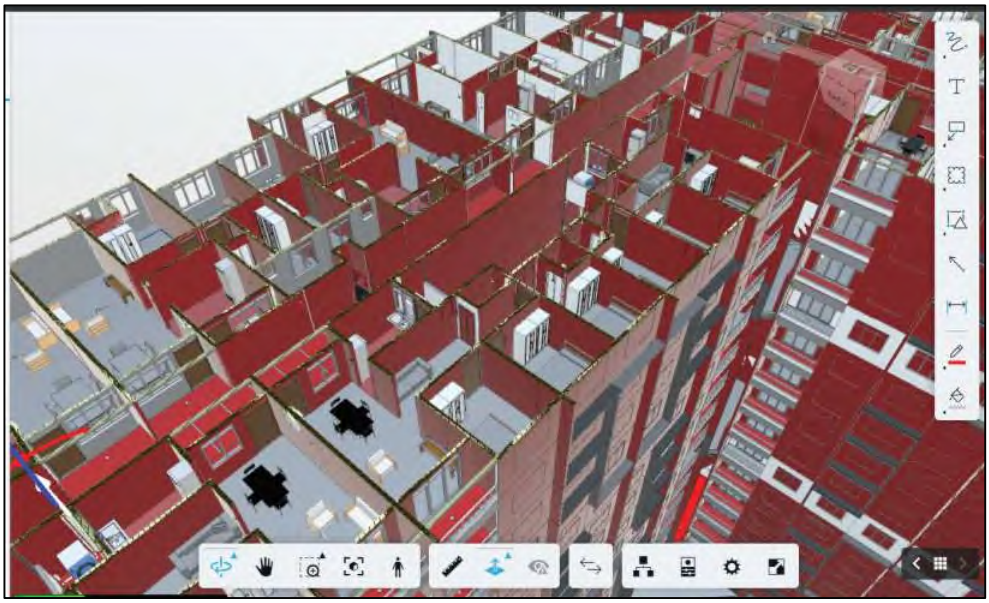


Split Screen Views Revit Files in 2D and 3D

Review Markups



View the Coordinated Navisworks Model



APPENDIX A: TYPICAL BIM ELEMENTS BY DISCIPLINE

Architecture and Structure

Architecture and Structure BIM elements

ELEMENT	PARAMETERS NEEDED
Site Model	Site infrastructure within site boundary (roads, pavements, car park spaces, access and parking arrangements and surrounding land use)
Rooms	Room spaces, corridors, other spaces, plant and equipment rooms (including designated use). Services Headroom.
Walls/Curtain Walls	Interior/Exterior walls/Non-structural walls Curtain wall with mullions and window glazing units including shading devices
Doors, Windows and Louvers	Interior/Exterior doors Interior/Exterior windows Louvers
Basic Structure	Beams (based on location and size indicated by the Structural Engineer) Columns (based on location and size indicated by the Structural Engineer) Slabs, including slab on grade and floating slab, recesses, curbs, pads and major penetrations. Stairs (steps, risers, threads, landings): all framing members and openings (Modelled in the Architectural Models. Structural to confirm dimensions and location) Shafts and Pits (and openings) Structural Steel system: all primary and secondary elements
Roofs	Roofs with overall thickness (including finishes & insulation) Structural elements modelled in the Structural Model
Rain Water Down Pipes	Gutter and Rain Water System and Down Pipes
Ceilings	Ceilings (without support sub-frames) including module arrangement, material choices and finishes.
Floors	Horizontal floors Sloped floors and ramps. Floor finishes details including tiling, carpet, screed only
Vertical Circulation	Steps & stairs including risers, threads and railings including headroom clearance requirements Elevator shafts (without fit-out installations by lift contractor)
Schedules	Schedules allowing information to be extracted from elements
Plumbing Fixture	2D or/and 3D Toilet fixtures, plumbing faucets

Civil

Civil BIM elements

ELEMENT	PARAMETERS NEEDED
Topo surface Model	3D surface based on topography that shows site conditions and building locations Include existing walkways, roads, curbs, ramps and parking lots etc.
Utilities Model	All points of connection for existing and new utilities within site boundary
Rainwater & storm water pipe work	Includes outlets, surface channels, slot channels and manholes
Others	Drains, canals, crossings, retaining walls, and underground harvesting tanks Underground electrical supply cables and sewer lines, Telecommunication line and Gas Lines.

MEP

MEP BIM elements

ELEMENT	PARAMETERS NEEDED
Air-Conditioning Mechanical Ventilation	• Air Handling unit • Variable refrigerant flow (VRF) for indoor and outdoor unit • Cooling Tower • Split-type indoor & outdoor air conditioning unit • Exhaust or extract air fans • Ventilation fans • Heat Exchanges Recovery Wheel • Exhaust air ducts (excluding hangars) • Fresh air ducts (excluding hangars) • Supply air ducts (excluding hangars) • Return air ducts (excluding hangars) • Transfer air ducts (excluding hangars) • Diffusers, air grilles, air filters, registers • Fire dampers, motorized dampers, volume control dampers, CO2 sensors, CO sensors, thermostat, control panel
Plumbing and Sanitary	• Piping fittings, valves including hot & cold-water pipe work with all plumbing equipment, sinks • Water meters • Storage, water holding tanks • Hot water Clarifier • Sanitary plumbing system including fittings and pipe works • Grey water systems • Foul drainage, kitchen waste pipe work including floor drains, open trapped gullies, sealed trapped gullies and clean outs, vents and manholes • Grease and sand traps • Sump and sewage pits • Water pumps
Fire Protection	• System piping, droppers, fittings, valves and sprinkler heads, sprinkler inlets, sprinkler control valve set, subsidiary valves, flow switches • Fire alarm gongs & break glass unit • Fire sprinkler pumps • Sprinkler tanks • Hydrants and hose reels (location of street fire hydrant determined by architect) • Gas piping for suppression systems • Heat or smoke detectors, control panels, fire alarm panels, pump panels • Fire extinguishers • Hose reel tanks • Hose reel pump • Hose reel unit, piping system
Electrical	• Cable ladder, cable trays, trunking & cable containment, electrical risers, conduit, bus duct • Outlets, panels, switches, circuiting to devices, security devices and card access • HV switchgear, LV switch boards, sub switch boards, distribution boards • Transformers • Light fittings & fixtures & housings for light fixtures • Telecommunication equipment and computer racks • Generators and exhaust flues including acoustic treatments • Diesel tanks & fuel pipes • Security system including CCTV camera, smart card system, door monitoring system • Car park control system, barrier gates • Equipment and associated installations maintained by public utility companies (including manholes and ducting for incoming cable) • Earthing and lightning protection system • Photovoltaic system • PA systems, BMS equipment including display panels (i.e. power consumption display)

APPENDIX B: BIM OBJECTIVE & RESPONSIBILITY MATRIX

The BIM Objective & Responsibility Matrix from the Schematic to the Detailed Design Stage is as follow, where the Project members involved are to fulfill their objective :

- A – model author
- U – model users

Abbreviations

Project members indicated in the matrix:

- Architect (Arc)
- Civil and Structural Engineer (CNS)
- Mechanical, Electrical & Plumbing Engineer (MEP)

Project members involved in the matrix are not limited to the following roles:

a. Project Manager
b. Interior Designer
c. Specialist Consultants
d. Sub-contractor
e. Quantity Surveyor
f. Specialist Sub-contractor
g. Landscape Designer

BIM PROJECT OBJECTIVE	BIM MANAGER	PROJECT MEMBER INVOLVED			
		ARC	C&S	MEP	OTHERS
BIM Execution Plan • All project members appointed to agree on needs, objectives, process and outcomes of BIM for the project. • Agreed cut-off dates for exchange of models and other deliverables shall be documented in BIM Execution Plan.					
Schematic/Preliminary Design (LOD100 – 200) • Generalized building component or system with approximate dimensions, shape, location, orientation , and quantity. Non- geometric properties may be provided.					
Develop, maintain and update Architecture BIM model • 2D Deliverables for regulatory submission (DO, BP)					
Develop, maintain and update Structure BIM model based on the architecture model • 2D Deliverables for regulatory submission (BP)					
Develop, maintain and update MEP BIM model based on the Architectural Model. The MEP Model may consist of Mechanical, Electrical, Plumbing, Water Piping, Fire Protection and Sewerage data. • Preliminary M&E analysis • 2D Deliverables for regulatory submission (DO,BP)					
Implement design coordination between the Architectural and Structural BIM Models. • Preliminary Design Coordination Report • 2D Deliverables for regulatory submission (DO,BP)					

BIM PROJECT OBJECTIVE	BIM MANAGER	PROJECT MEMBER INVOLVED			
		ARC	C&S	MEP	OTHERS
Generate, freeze, and store final documentation of the authorised BIM model in the Preliminary Design stage before progression into the Detailed Design stage.					
Detailed Design (LOD 300) More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation and quantity. Non- geometric properties should be provided.					
Maintain and update the Architectural Model • Design, analysis and detailing • 2D Deliverables for regulatory submission (Tender)					
Maintain and update the Structural Model, based on the latest Architectural Model and vertical Piping model (Pipe sleeves) • Design, analysis and detailing • 2D Deliverables for regulatory submission (Tender)					
Maintain and update the MEP Model, based on the latest Architectural Model and Structural Model. • Design, analysis and detailing • 2D Deliverables for regulatory submission (Tender)					
Implement design coordination between the Architectural, Structural and MEP Models • Identify element conflicts and interferences • Verify valid headroom and working spaces for building operations and maintenance activities • Penetration conflicts will be addressed					
Generate, freeze and store final documentation of the authorised BIM model in the Detailed Design stage, and BIM Execution Plan before progression into the Construction stage.					

APPENDIX C: BIM MODELLING GUIDELINES

The following guidelines recommend how BIM elements shall be modelled according to the disciplines at different project stages. It does not state who is the Model Author required to model the BIM elements. Modelling guidelines for Facility Management shall be addressed in the future version of the Guide.

i. Overview
ii. Quality Assurance
iii. Architectural BIM Modelling Guidelines
iv. Structural BIM Modelling Guidelines
v. MEP BIM Modelling Guidelines
    - ACMV
    - Fire Protection
    - Plumbing and Sanitary
    - Electrical

Overview

DISCIPLINE / STAGES	ARCHITECTURAL DESIGN	STRUCTURAL DESIGN	MEP DESIGN	INTENDED USE
Conceptual LOD 100	Topo, Massing, Site Elements, Site Boundary, Levels, Location, Orientation	Optional	Optional	Site planning, Location of the building(s) on the site, Starting situation for renovation project, Investigation, Visualisation, Design options, Investment analysis, Preliminary energy simulation, Alternate spatial designs, Scope management, Investment calculation, Energy simulation, Finalised spatial requirements for structures and MEP systems, Visualisation
Preliminary Design LOD 200	Building elements with nominal dimensions and details	Load-bearing structures, Proposed structural system & basic structure	MEP Schematics	Definition of building elements, Comparison of building element and structural alternatives, Management of quantity information, Preliminary dimensioning of structures, MEP Analysis, Visualisation
Detailed Design LOD 300	Building elements with actual dimensions and details	Frame structures, Foundations, Joining to foundations & Penetrations	Service areas of MEP systems, Central units, Ducts, Pipe work, Terminal devices, Switchboards, Cable routes, Lighting fixtures, Penetrations & Reservations	Dimensioning of structures to the precision required for tenders, Definition of MEP systems, Quantity take-off, Penetration & Reservation design, Visualisation, Combined Services Design

Quality Assurance

ARCHITECTURAL DETAILED DESIGN BIM	STRUCTURAL DETAILED DESIGN BIM	MEP DETAILED DESIGN BIM	MERGED MODEL AT PRELIMINARY DESIGN, DETAILED DESIGN, CONSTRUCTION AND AS- BUILT STAGES
• BIM in agreed version • BIM includes defined stories • Building elements & spaces modelled separately in each story • BIM includes required building elements • Building elements modelled using correct objects • Building elements include types • No excess building elements • No overlapping or doubled building elements • No significant clashes between objects • No conflicts between structures in architectural and structural BIM • BIM includes GFA spaces objects • Space areas match space program • BIM includes spatial reservations for MEP • Space height defined (including suspended ceilings) • Shape and size of spaces matches with walls • Spaces do not overlap • All spaces have unique • IDs	• BIM in agreed version • BIM includes defined stories • BIM includes required building elements Building elements modelled using correct objects • Building element types are as agreed • No excess building elements • No overlapping or doubled building elements • No significant clashes between objects • No conflicts between structures in architectural and structural BIM • No conflicts between penetrations in architectural and structural BIM • Columns and beams converge • MEP penetrations & reservations included in structures	• BIM in agreed version BIM includes defined stories • Components defined separately in each story • BIM includes required components • Components modelled using correct objects • Components belong to a correct system • System colours are defined systematically • System colours are defined systematically • No excess components • No overlapping or doubled components • No significant clashes between components • No clashes between MEP disciplines • No clashes between M&E and electrical BIM • Components fit into their spatial reservations • No clashes between M&E, architectural and structural BIM	• All agreed models available • Models represent the same design version • Models are located in the correct coordinate system • No conflicts between vertical shafts and MEP systems • No conflicts between horizontal reservations and MEP • No conflicts between suspended ceilings and MEP • Penetrations of columns OK • Penetrations of beams OK • Penetrations of slabs OK

Architectural BIM Modelling Guidelines

General Architectural Guidelines:

a. Architectural modelling is carried out in the following stages: Conceptual, Preliminary Design, Detailed Design, Construction and As-Built. The types of models produced at each stage depend on the BIM deliverables required.

b. If the design has precast or prefab design then those elements can be placed as Objects.

c. The building elements must be created using the correct tools (Wall tool, Slab tool, etc.). If the features of BIM authoring tool are not sufficient for modelling the element, the required building elements must be created using other appropriate objects. In that case, define the "Type" of the element correctly element correctly.

d. 2D can be used to complement the BIM model when the elements are smaller than the agreed size e.g. Elements smaller than 100mm do not need to be modelled.

e. 2D standard details can be used to complement the BIM model.

f. Required Parameters: Type, Material, ID, Size. Type is required for the Quantity Take-off.

g. If more than one tool is used to model certain elements then the elements should be grouped and identified correctly by "Type", e.g. Slabs and Beams can be used to model the Road. The elements must be grouped as one and define the "Type" as a "Road"

h. Structural elements should be modelled based on the information (e.g. Size) from Structural Engineers. The alternative is to link or work in a shared model with the Structural Engineers.

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Conceptual LOD 100	Topo (Existing Site)	• Existing site's contour and location should be modelled based on the land surveyor's information (spot levels,northing and easting). • Renovation Projects (A&A): If the existing buildings were not in BIM, then 2D drawings the existing building can be used to complement the BIM model.	
	Topo (Proposed Site)	• Proposed site's cuts and fills of earth should be shown with a proposed site Element	
	Massing (Buildings)	• Shape, Location and Orientation of building in site should be modelled using massing element. • Name/identify the Mass element clearly, e.g. BLK 1, PODIUM etc. • Site elements like Trees, Boundary, Roads, IC, etc can be drawn in 2D.	Output: Concept model that shows site arrangements and building geometries to share with the project members.
Preliminary Design LOD 200 Note: Conceptual model is further developed into Preliminary Design model (Massing of the selected design should be converted to real building elements like Wall, Slab, Door, Window, etc...)	General Requirement	• If the actual dimension is not available, then model using the nominal dimension or expected dimension. • Examples - Door opening modelled without considering the fittings. - Walls modelled without considering the different layers thickness. • Note: Since the designers has the libraries and templates with element settings, they can model the actual size	Output: Authorities submission requirement and Guidelines. Output: Model for co-ordination with Engineers.
	Wall	• Model all the Walls (Brick, Dry wall, Glass, Concrete, wood, etc...)from Finish Floor Level to soffit of Slab/Beam above. • When the Wall spans acrosss different heights, if the BIM authoring tool permits model as a single Wall with varying height then model as one Wall. Alternative is to model as multiple Walls. • Distinguish the internal and external Walls by "Type" parameter.	

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
	Slab/Floor	• Top of Slab = Finished Floor Level • When there is a slope in the Slab or the Slab has a special shape and the BIM authoring tool does not have the functionality to create such Slabs, then create the slab geometry using other tools and define the 'Type' as a "slab".	
	Door	• Place the Door object with nominal dimensions and parameters required for Preliminary Design.	
	Window	• Place the Window object with nominal dimensions and parameters required for Preliminary Design.	
	Column	• Model the Columns on the desired locations from Structural Floor Level to Structural Floor Level for the Preliminary Design co-ordination with Structural Engineer. • Columns must be modelled by their outer dimensions, taking into consideration the thickness of the finish and structure. • Create objects for Columns with special shapes and cross sections.	
	Roof	• Model using the Roof or Slab object and define the "Type" as Roof. The supporting structures can be modelled with general objects or beams.	
	Others	• If there is a need to model more elements than what is specified in the Preliminary Design based on the project, refer to the Detailed Design stage. Model those elements with the information available at this stage.	
	Space group (Zone or Space or Room object)	• Note: Similar to individual space/room object Examples • Apartment, Fire Compartment, Departments, GFA Boundary, etc • Follow BIM e-Submission guidelines for the details required for the Agencies requirement and display them accordingly in the plans	
	Individual Space (Space or Room object)	• Space height = floor height from FFL to the soffit of slab above or the suspended ceiling above. • One space may belong to more than one space groups. • Area/Volume will be automatically calculated from the space geometry. Follow BIM e-Submission guidelines for the details required by the Agency and display them accordingly in the plans. • Give a unique ID that can be used to locate the correct space when there is a need. • Name the space based on the function of the room, e.g. Office, Lobby, etc... • Follow the BIM e-Submission guidelines for various agencies requirement on the space requirements. • Category can be used to group the spaces like Commercial, Residential, etc...	

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Detailed Design LOD 300 Note: Preliminary Design model is further developed into Detailed Design model	General Requirement	• Model all the elements using the actual/ accurate dimension and correct materials.	
	Wall	• Update the Walls created in the preliminary design with the parameters required for Detailed Design, e.g. Add different Layer thickness, Fire Rating, etc...	
	Load-bearing wall	• Load bearing walls includes Core Walls/Shear Walls.	
	Slab/Floor	• Update the Slabs created in the Preliminary Design with the parameters required for Detailed Design, e.g. Add different Layer thickness, Fire Rating, etc...	
	Door	• Update the Doors placed in the Preliminary Design with the parameters required for Detailed Design, e.g. Fitting information. • It is good to identify the functional difference (Types), e.g. "Fire Door"	
	Window/ Louver	• Update the Windows placed in the preliminary design with the parameters required for Detailed Design, e.g. Fitting information.	
	Column	• Update the Columns created in the Preliminary Design based on the Location and Size information from the Structural Engineer.	
	Beam	• Model the Beams based on the Location and Size information from the Structural Engineer. • Create objects for Beams with special shapes and crosssections.	
	Staircase/ Step/Ramp	• Create objects for Staircases, Steps and Ramps with special shapes when it is not available in the BIM authoring tool. • If required then the Landings and Stair Platforms can be modelled as Slabs. In that case define their "Type" accordingly.	
	Curtain Wall	• Model the Curtain Wall to the full height and not necessary to break it storey by storey. Most BIM Authoring tools enable users to insert Doors and Windows into parts of the Curtain Wall.	
	Balcony	• Model using either as an Objects or use Walls, Floors, Beams and Railings. Check the specific elements for their modelling guideline.	
	Canopy		
	Roof	• Update the Roofs created in the preliminary design with the parameters required for Detailed Design. E.g. Add different Layer thickness, etc...	
	Skylight	• Model using objects and define the "Type" accordingly.	
	Hatch		
	Furniture		
	Balustrade / Railings		
	Project-specific objects		

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
	Suspended ceiling	• If the BIM authoring tool do not have a ceiling tool then modelled using a slab tool or object, and define the "Type" as a Ceiling.	
	Space	• Refer to Preliminary Design	
	Civil defence shelter, Service platforms, Structures of passageways, Service ducts, Others	• Model using Wall, Floor, Column, Roof, Opening, • Objects, Door, Space etc. Check the specific elements for their modelling guideline.	

Structural BIM Modelling Guidelines

General Structural Guidelines :

a. The structural consultant produces both an analysis model and a physical model (Structural BIM) with actual member size and position. The model will be used for documentation. These documents cover the Structural BIM only.

b. Structural modelling is carried out in the following stages: Conceptual, Preliminary, Detail, Construction and As-Built. The types of models produced at each stage depend on the BIM deliverables required.

c. If the design has precast or prefab design. The part can be designed and modelled by a specialist and incorporated/linked into the model for reference.

d. Structural BIM covers all load-bearing concrete, wood and steel structures, as well as non-load- bearing concrete structures. The basic building elements used are Wall, Slab, Beam, Column, and Lattice. The building elements must be created using the correct tools (Wall tool, Slab tool, etc.). If the features of BIM authoring tool are not sufficient for modelling the element, the required building elements must be created using other appropriate objects. In that case, define the "Type" of the element correctly.

e. The model can be phased and divided for various ST submissions as per the project planning/individual firm's practice.

f. 2D or 2D standard details can be used to complement the BIM model when the elements are smaller than the agreed size, e.g. Elements Smaller than 100mm do not need to be modelled.

g. 2D can be used for loading plans.

h. 2D can be used for the column schedule when the BIM authoring tool has limitations. The shape and cutting of each column should be included in the schedule.

i. Building Elements must be modelled separately for each storey

j. Required Parameters: Type, Material, ID, Size. Type is required for the Quantity Take-off.

k. If more than one tool is used to model certain elements then the elements should be grouped and identified correctly by "Type".E.g. Individual beams can be used to model the roof truss the elements must be grouped as one and define the "Type" as a "Truss"

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Conceptual LOD 100	Existing Buildings (As- Built Condition) for Addition & Alternations.	• The Structural Consultants expertise may be required when assessing and modelling existing structures, in particular the load-bearing structural system. The of Structural BIM model will be agreed upon on a project-specific basis. • If the existing Buildings were not in BIM then 2D drawings of existing building can be used to complement the BIM model.	Output: Structural Model of Existing Building or portions thereof.
	New Buildings	• The Structural Consultants expertise may be required in special cases in the assessment of the alternatives massing model from Architect and propose framing systems. Structural BIM model is optional at this stage.	Output: Structural concept alternatives.
Preliminary Design 200 Note: Preliminary Design model will be based on Architectural Conceptual Design model. It will be developed further based on the co-ordination during Preliminary Design stage.	General Requirement	• Model the elements using the nominal dimension or expected dimension based on precision available at Preliminary Design stage. • Model the elements that are critical and required for Preliminary Design co-ordination (based on projects requirement)	Input: Geotechnical information/ model, Architectural Conceptual Design Model for intended use (for load assumptions) and geometry of the building (to determine the framing system) Note: The location of load bearing elements and the elevation of the floor will be based on the info from the Architect. Output: ST submission. Output: Model for coordination with Architects and MEP Engineers
	Piling (Pile Cap and Pile)	• If the BIM authoring tool has relevant objects to represent the foundation elements then place them in the correct level and with the relevant parameter. • Alternative is to use Slab, Column and Wall to represent foundation elements. Group them and define the "Type" correctly.	
	Diaphragm/ Retaining Wall		
	Raft Foundation		
	Pad/Isolated Foundation		
	Strip Foundation		
	Slab/Roof Slab	• Top of Slab = Structural Floor Level • Multiple Slabs need to be placed if the levels, thickness, span direction and material are different. • The soffit of the structural slab should be shown. When there is a slope in the Slab or the Slab with a special shape and the BIM authoring tool does not have the functionality to create such Slabs, then create the slab geometry using other tools and define the 'Type' as a "slab".	
	Beam	• Top of Beam = As per design (Up stand Beam or Down hang Beam) • Create objects for Beams with special shapes and cross sections, e.g. Tapering and haunch.	
	Truss	• Model with multiple elements and group them as a truss. Note : Some BIM authoring tools have a function to automate this process.	

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
	Column	• Model from the Structural Floor level to Structural Floor Level of Slab below. • Create objects for Columns with special shapes and cross sections.	
	Wall	• All Load bearing Walls and concrete Walls (non-load bearing) need to be modelled, e.g. Core Walls, Shear Walls, Retaining Walls, Diaphragm Walls. • If the Walls are between floors then model from Structural Floor Level to Structural Floor Level of Slab below else the Walls need to model to the correct levels. • When the Wall spans across different heights, if the BIM authoring tool permits model as a single Wall with varying height then model as one Wall. Alternative is to model multiple Walls.	
	Staircase, Step and Ramps	• Model only the structure part of the Staircase, Steps and Ramps. • Create objects for Staircases, Steps and Ramps with special shapes when it is not available in the BIM authoring tool. • If required then the landings and Stair platforms can be modelled as Slabs. In that case define their "Type" accordingly.	
	Opening	• Model the structural Opening for the Doors, Windows and Ventilations based on location and size information from the Architects. • Model the structural Opening for the MEP elements like Ducts based on the location and size information from the MEP Engineers. • Model the Floor openings based on l ocation and Size from the Architects and MEP Engineers.	
	Special Structure Civil defence shelter, Tunnel, Link Way, External structures, Balcony, Canopy, Swimming pool, Temporary structures, Others	• Model using Wall, Slab, Column, Beam and Opening or placed as an Object and assign the "Type" accordingly. Check the specific elements for their modelling guideline.	When the design is not confirmed the elements can be modelled as reference to use in the Preliminary Design co-ordination with the Architects and MEP Engineers.
Detailed Design LOD 300 Note: Preliminary Design model is further developed into Detailed Design model	General Requirement	• Model all the elements using the actual/accurate dimension. • Model all the model elements that are critical and required for the Design co-ordination (based on projects requirement) • Divide the project/building as per various ST's or as per agreed Project Plan. Proceed with the modelling according to the schedule.	Output: Model for co-ordination with Architects and MEP Engineers.
	Refer to Preliminary Design	• Develop the Preliminary design with more confirmed parameters like Location, Size and Material. • Update the correct Type definition that helps detailed quantity take-off.	The detail can be done only for the agreed portion of the building based on the projects need

MEP Modelling Guidelines

ACMV

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Conceptual LOD 100	System distribution lines	• Use line diagrams to show the entire system distribution. • Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	New Buildings Space objects	• Use box objects to represent spaces required for MEP systems • Add names and colours to the space objects.	
Preliminary Design LOD 200	Zone Objects Air Handling Unit, Chiller Unit Variable refrigerant flow unit, Cooling tower, Exhaust air ducts, Fresh air ducts, Supply air ducts, Return air ducts, Transfer air ducts, Chilled water supply pipes, Chilled water return pipes, Condensate drain pipes	• Zone the spaces that have common design requirements with colour legends on plans. • Model each element using the correct BIM generic object. • Each element should have an approximate size. • Show only the main routes of the systems. • All ducts and pipes should be connected to the equipment. • Fasteners and hangers are not required. • In-line accessories, e.g. valves, fire dampers, volume controls and air filters are not required. • Use CP83 symbols.	Output: Preliminary Model Shows main distribution into different zones Engineers should verify the space allocated by the Architect.
Detailed Design LOD 300	Main elements of Preliminary Design Fire dampers, Motorized dampers, Volume control dampers, Split-type indoor & outdoor air conditioning units Exhaust or extract air fans, Fresh air fans, Other fans such as jet fans, Diffusers, air- boots, air grilles, air filters, registers Fan Coil unit Switch boards, Control, BMS & DDC panels BMS control & monitoring modules	• Use CP83 symbols and colour standards • Model each element using object correspond to actual component with actual size, material, type code and performance criteria. • Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. • Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. • Downward slopes of the pipes should be modelled realistically. • Required fittings allowances, cross-over spaces and maintenance spaces should be considered. • Fasteners and hangers are not necessary. • Commercial product libraries can be used to the extent allowed by the modelling software. • Fire rating should be included in the fire damper objects. • Pipe Accessories should follow the CP83 symbols in plan views. • For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Model for co-ordination with Architects and MEP Engineers.

Plumbing & Sanitary

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Conceptual LOD 100	System distribution lines	• Use line diagrams to show the entire system distribution • Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	• Use box objects to represent spaces required for MEP systems • Add names and colours to the space objects.	
Preliminary Design LOD 200	Zone objects, Plumbing equipment, Plumbing fixtures Sump and sewage pits, Storage, water holding tanks, pressure vessels Water meters chambers Manholes, outlets, surface and slot channels	• Zone the spaces that have common design requirements with colour legends on plans. • Model each element using the correct BIM generic object • Each element should have an approximate size. • Show only the main routes of the systems. • All main pipes should be connected to the equipment. • Fasteners and hangers are not required. • In-line accessories e.g. valves, filters, water meters are not required. • Use CP83 symbols.	Output: Preliminary Model Shows main distribution into different zones Engineers should verify the space allocated by the Architect.
Detailed Design LOD 300	Main elements of Preliminary Design Fresh water piping, Fittings, Valves, including hot and cold-water pipes Rainwater and storm water pipes, Foul drainage and kitchen waste pipe work including Floor drains, Open trapped gullies, Sealed trapped gullies, Clean outs, Vents, Control panels, Monitoring and control sensors Underground public utilities for water supply Underground public utilities for drainage	• Use CP83 symbols and colour standards • Model each element using object correspond to actual component with actual size, material, type code and performance criteria. • Include insulation to reflect actual size for coordination purpose. • System routing should be connected with fittings. • Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. • Downward slopes of the pipes should be modelled realistically. • Required fittings allowances, cross-over spaces and maintenance spaces should be considered. • Fasteners and hangers are not necessary. • Commercial product libraries can be used to the extent allowed by the modelling software. • Pipe Accessories should follow the CP83 symbols in plan views. • For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Detailed model Services should be coordinated with architecture model

Fire Protection

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Conceptual LOD 100	System distribution lines	• Use line diagrams to show the entire system distribution • Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	• Use box objects to represent spaces required for MEP systems • Add names and colours to the space objects.	

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Preliminary Design LOD 200	Zone objects	• Zone the spaces that have common design requirements with colour legends on plans.	Output: Preliminary Model Shows main distribution into different zones
Detailed Design LOD 300	Main elements of Preliminary Design Sprinkler pipework, Fire sprinkler pumps, Sprinkler heads, SIB (Sub-Indicator Board), Sprinkler control valve sets (Main stop valve, Subsidiary valve with indicator, Alarm valve, Water motor alarm/gong, Test and drain valve, Pressure gauges and Direct read water flow meter.) Hydrants and hose reels, including street fire hydrant system, Fire alarm gongs, Break glass unit Fire shutters and hoods above, Gas piping for suppression systems, Heat or smoke detectors, Control panels, Monitoring and control sensors, Pump panels, Check meter positions Breeching inlet Breeching inlet cabinet, Fire extinguishers	• Use CP83 symbols and colour standards • Model each element using object correspond to actual component with actual size, material, type code and performance criteria. • Include insulation to reflect actual size for coordination purpose. • The types, finish, temperature rating and orifice sizes should be indicated. • Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. • System routing should be connected with fittings. • Required fittings allowances, cross-over spaces and maintenance spaces should be considered. • Fasteners and hangers are not necessary. • Commercial product libraries can be used to the extent allowed by the modelling software. • Pipe Accessories should follow the CP83 symbols in plan views. • Size of breeching inlet cabinet • For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Detailed model Services should be coordinated with architecture model Engineers should verify the space allocated by the Architect.

Electrical

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
Conceptual LOD 100	System distribution lines	• Use line diagrams to show the entire system distribution • Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	• Use box objects to represent spaces required for MEP systems • Add names and colours to the space objects.	
Preliminary Design LOD 200	Zone Objects Transformers HV & LV switch boards, Switchgear, MCCB boards, Cable trays, Trunking & cable containment Electrical risers Generators and exhaust flues,	• Zone the spaces that have common design requirements with colour legends on plans. • Model each element using the correct BIM generic object • Each element should have an approximate size. • Show only the main routes of the systems. • All cable trays, conduits and trunkings should be connected to the equipment. • Wires, fasteners and hangers are not required. • In-line accessories e.g. valves, fire dampers, volume controls and air filters are not required. • Use CP83 symbols.	Output: Preliminary Model Shows main distribution into different zones

STAGES	ELEMENTS	MODELLING GUIDELINES	REMARKS
	including acoustic treatments, Diesel tanks & fuel pipes Telecom equipment and computer racks		
Detailed Design LOD 300	Main elements of Preliminary Design Light fittings, Fixtures, Housings for light fixtures, Conduit, Bus duct, Power feeds, Concealed and cast-in-place conduits Outlets, Panels, Wall switches, Circuiting to devices, Security devices, Card access, "Plug moulds" (socket points) Conduit associated with access, data communication, security systems and electrical equipment Security system including CCTV camera, smart card system, door monitoring system, Car park control system, Barrier gates Equipment and associated installations maintained by public utility companies Gas piping for suppression systems, Heat or smoke detectors, Control panels, Monitoring and control sensors, Pump panels, Check meter positions Breeching inlet Breeching inlet cabinet, Fire extinguishers	• Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. • Include insulation to reflect actual size for coordination purpose. • System routing should be connected with fittings. • Unavailable BIM objects that modelled using different objects should be identified accordingly, e.g. use proper names and colours. • Required fittings allowances, cross-over spaces and maintenance spaces should be considered • Fasteners and hangers are not necessary. • Commercial product libraries can be used to the extent allowed by the modelling software. • Electrical devices e.g. switches, power outlets, telephone and TV outlets should follow the CP83 symbols in plan views. • For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Detailed model Services should be coordinated with architecture model Engineers should verify the space allocated by the architect

ANNEX: IHSAN HOMES DESIGN OPTION

IHSAN HOMES APARTMENT

Design Layout

Apartment Unit Type 3 Layout

Apartment Unit Type 3 Floor Area Schedule

AREA	FLOOR AREA (NETT)	
	M²	FT²
Foyer	3.84	41.32
Living	13.44	144.61
Dining	11.52	123.96
Balcony	1.72	18.51
Bedroom 1	12.15	130.73
Bath 1	2.40	25.82
Bedroom 2	9.60	103.30
Bedroom 3	9.00	96.84
Bath 2	2.52	27.12
Kitchen	7.68	82.64
Yard	2.43	26.15
TOTAL	**76.30**	**821**

IHSAN HOMES SINGLE-STOREY TERRACE HOUSE

Design Layout Option 2

Terrace House Perspective View (Artist Impression)

Terrace House Floor Area Schedule

AREA	FLOOR AREA (NETT)	
	M^2	FT^2
Carporch	5.39	58.02
Entrance	1.16	12.49
Living	15.23	163.93
Dining	13.29	143.05
Private Courtyard	2.73	29.39
Bedroom 1	10.33	111.19
Bath 1	2.25	24.22
Bedroom 2	8.63	92.89
Bedroom 3	7.62	82.02
Bath 2	2.52	27.13
Kitchen	10.82	116.47
Yard	1.40	15.07
TOTAL	**81.37**	**876.0**

Terrace House Typical Unit Layout

Design Layout Option 3

Terrace House Perspective View (Artist Impression)

Terrace House Floor Area Schedule

AREA	FLOOR AREA (NETT)	
	M^2	FT^2
Carporch	5.74	61.78
Entrance	1.71	18.41
Terrace	2.47	26.59
Living	13.16	141.65
Dining	22.47	241.86
Private Courtyard	2.25	24.22
Bedroom 1	11.91	128.20
Bath 1	2.25	24.22
Bedroom 2	8.85	95.26
Bedroom 3	6.89	74.16
Bath 2	2.25	24.22
Kitchen	6.96	74.92
Yard	2.15	23.14
TOTAL	**89.06**	**959.0**

Terrace House Typical Unit Layout

IHSAN HOMES TWO-STOREY TOWNHOUSE

Design Layout Option 2

Townhouse Perspective View (Artist Impression)

Townhouse Floor Area Schedule (Lower Unit)

AREA	FLOOR AREA (NETT)	
LOWER UNIT	**M²**	**FT²**
Carporch	4.5	48.4
Entrance	2.3	24.2
Living	21.1	227.1
Dining	7.7	83.3
Yard	3.9	41.9
Kitchen	7.4	80.1
Yard	1.7	18.6
Bedroom 1	12.0	129.1
Bath 1	2.3	24.2
Bedroom 2	9.9	106.5
Bedroom 3	7.2	77.5
Bath 2	2.5	27.1
Utility	2.8	29.9
TOTAL	**85.3**	**917.0**

Townhouse Typical Unit Layout (Lower Unit)

ANNEX

Townhouse Floor Area Schedule (Upper Unit)

AREA	FLOOR AREA (NETT)	
UPPER UNIT	**M^2**	**FT^2**
Carporch	3.3	35.0
Entrance	1.7	18.7
Staircase	3.7	39.9
Living	18.9	203.5
Dining	7.7	83.3
Balcony	5.2	55.8
Kitchen	7.4	79.5
Bedroom 1	13.4	144.2
Bath 1	2.3	24.2
Bedroom 2	9.9	106.5
Bedroom 3	7.2	77.5
Bath 2	2.3	24.2
Study Area	3.1	32.9
Yard	3.7	39.9
TOTAL	**89.7**	**965.0**

Townhouse Typical Unit Layout (Upper Unit)

Design Layout Option 3

Townhouse Perspective View (Artist Impression)

Townhouse Floor Area Schedule (Lower Unit)

AREA	FLOOR AREA (NETT)	
LOWER UNIT	**M²**	**FT²**
Carporch	4.3	46.7
Entrance	3.5	38.0
Living	14.7	158.2
Dining	9.5	101.7
Terrace	2.6	27.7
Kitchen	16.3	175.3
Bedroom 1	12.1	129.7
Bath 1	3.0	32.3
Bedroom 2	8.6	93.0
Bedroom 3	8.6	93.0
Bath 2	2.7	29.1
Utility	4.2	44.8
Yard	2.0	21.3
TOTAL	**92.1**	**990.0**

Townhouse Typical Unit Layout (Lower Unit)

ANNEX

Townhouse Floor Area Schedule (Upper Unit)

AREA	FLOOR AREA (NETT)	
UPPER UNIT	**M^2**	**FT^2**
Carporch	4.8	51.6
Entrance	0.8	8.6
Staircase	3.3	35.8
Living	14.9	160.4
Dining	17.7	190.1
Balcony	3.5	37.4
Kitchen	6.5	69.7
Bedroom 1	12.1	129.7
Bath 1	3.0	32.3
Bedroom 2	8.6	93.0
Bedroom 3	8.6	93.0
Bath 2	2.7	29.1
Yard	4.8	51.6
TOTAL	**91.3**	**982.0**

Townhouse Typical Unit Layout (Upper Unit)

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