Livin Modular Design Guide

3D | MONOLITHIC | VOLUMETRIC

Table of Contents

Introduction

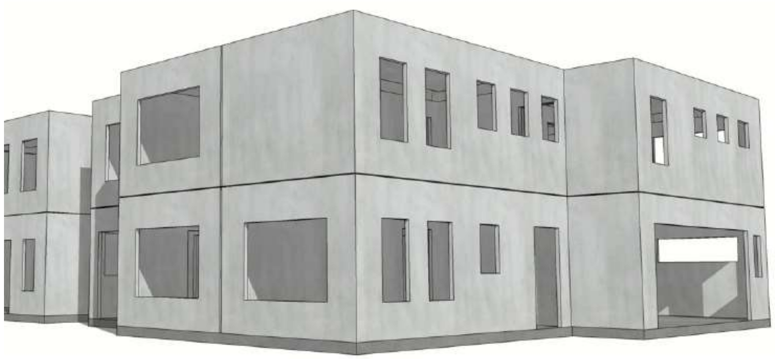
1.1 Introduction

Livin Modular is unique to other precast systems in that it has developed an innovative way to create a fully integrated seamless '5 panels in 1' concrete housing module that can be poured complete with window, door, electrical and plumbing conduits already inlaid.

This has many significant advantages over traditional building practices, especially on volume projects, multi-storey remote locations or projects requiring the ultimate in durability and strength.

This design guide details the Livin Modular monolithic construction system and how it can be utilised in a wide range of building types, from schools, cabins, offices, and medium-rise residential buildings to commercial projects. It is intended for designers, contractors, building owners and developers in giving an overview of the system, its core features and design principles..

If required, more detailed design instructions and structural drawings can be provided on request



1.2 Benefits of the System

The **Livin Modular** construction system provides many intrinsic benefits that traditional building methods cannot provide without significant cost. Examples include;

Acoustics – Superior acoustic performance between adjacent rooms with 90mm concrete

Durability/Resilience – Constructed from 40MPA, highly compacted, reinforced concrete, a Livin Modular building comprises individual, structurally independent rooms able to withstand the extremes of fire, high winds, hail, termites.

Fire Rating – The minimum firing rating as determined via NZBC Clause C1 – C6 is 30minutes for a single wall, however a structure comprised of multiple modules with two 90mm walls together will dramatically increase the fire rating and act to contain fire within modules should a fire occur.

Temperature Control – The extremely high thermal mass from the walls and ceiling, combined with the externally fitted foam insulation creates a highly efficient building space which minimizes the need for heating and cooling by dampening temperature fluctuations and therefore reducing running costs.

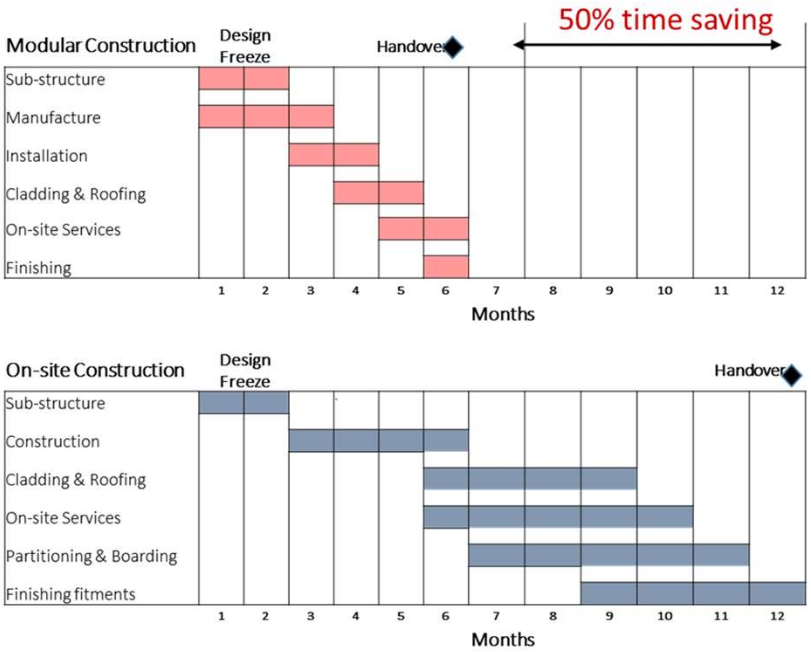
Structural Strength – The module combines the benefits of transportability with the rigidity and robustness of concrete construction – the structure has a look and feel of something much more substantial than a lightweight transportable building

Maintenance – The almost total replacement of internal plasterboard with concrete walls of identical finish creates a structure that is highly resistant to damage and general wear and tear, thus reducing maintenance costs.

1.2 Benefits of the System (cont)

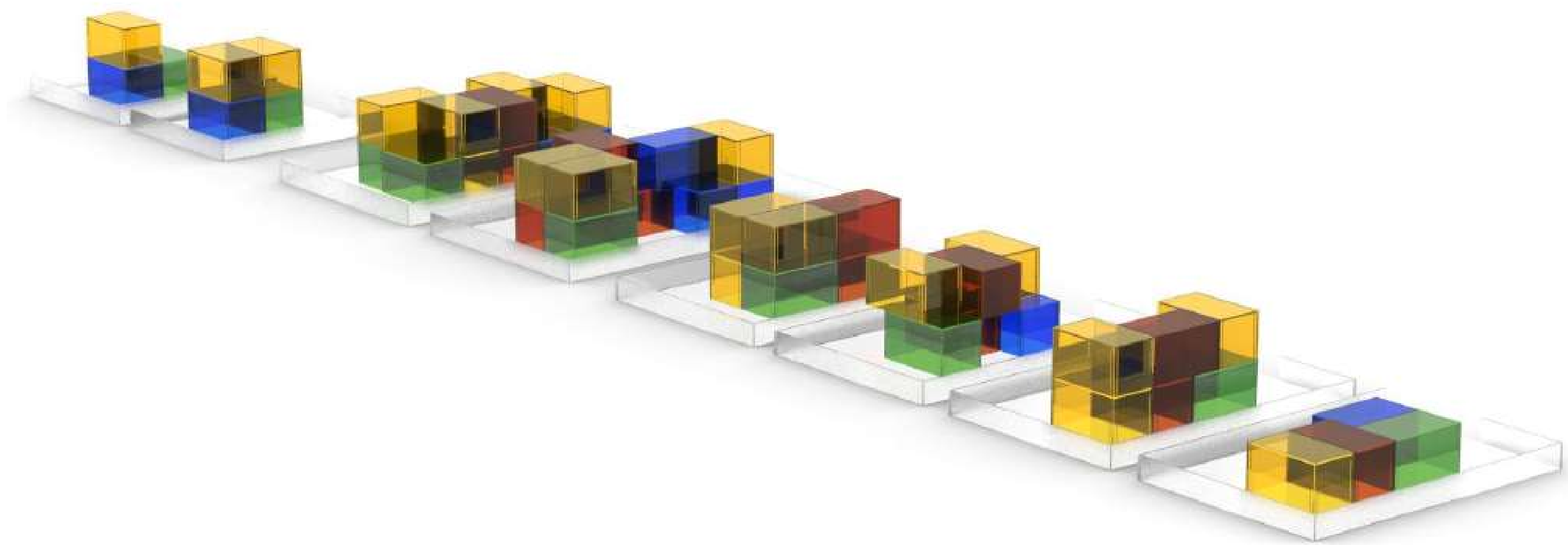
Cost Effectiveness – The total cost of building in this type of construction has proved to be superior over a number of projects, however when the overall speed of construction and total asset life costs are assessed, the overall cost effectiveness is far superior

Green Credentials – The concrete used in the modules can be specified to include a minimum of 20% (of total cementitious content) fly ash as a cement replacement. This has the dual advantage of firstly reducing the cement content and thereby reducing the embodied energy in the product, but also increases the long term strength and enhances the durability of the concrete. In addition, at the end of the design life, the modules can be crushed into road base and the steel recovered to be recycled



Relative construction periods for a 6-storey modular building compared to fully on-site construction.

1.3 Disclaimer

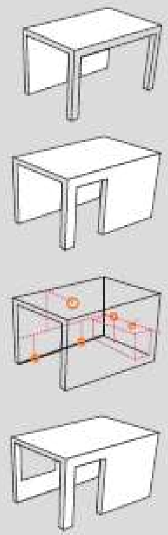


The manual is meant for preliminary design of buildings and structures. The use of the structural solutions (and reference values) shown here does not replace the need for final design and calculations by responsible designers (including but not limited to structural, acoustic, fire or building physics experts). All solutions and details used in construction should be reviewed, verified and approved by the responsible designers of the project. Conformance with local building regulations shall be confirmed by the responsible designers. Livin Modular does not give any warranties, representations or undertakings about the accuracy, validity, timeliness or completeness of any information or data in this manual and expressly disclaims any warranties of merchantability or fitness for particular purpose. In no event will Livin Modular be liable for any direct, special, indirect, consequential incidental damages or any other damages of any kind caused by the use of this manual.

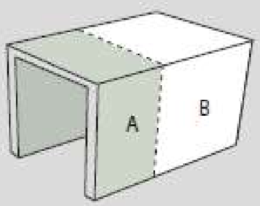
Overview of the Livin Modular System

2.1 The Livin Modular System - Overview

Streamlined construction under factory conditions.



OFF SITE



Two different sized pre-fabricated concrete modules for the basic building blocks for a project design.

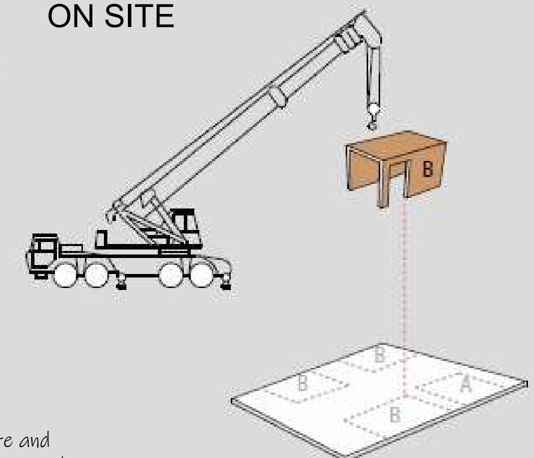
Module A: 4980mm x 3480mm
Module B: 6980mm x 3480mm

Each module is cast to include window & door openings.

Pre-installed servicing and electrical conduits can be installed within the thickness of the concrete walls ready for connection.

Kitchens and bathrooms can be measured and constructed prior to delivery to site, removing the complicated and labour intensive process of building and installing onsite.

ON SITE

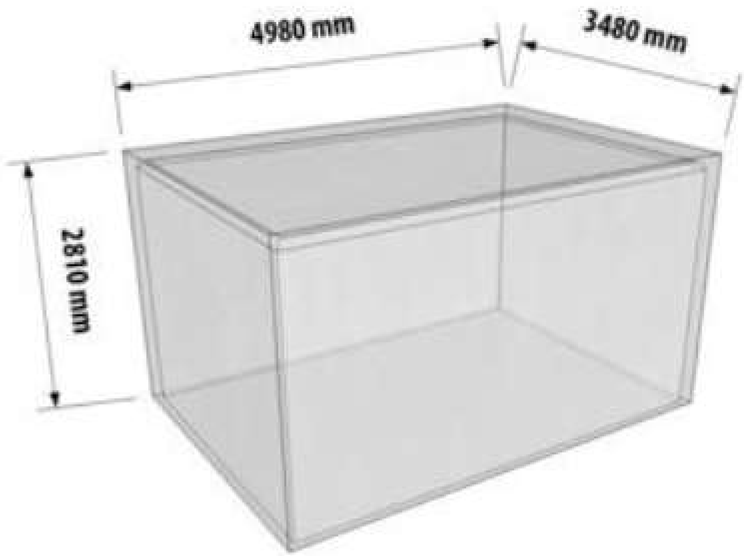


Modules are then delivered to site and craned into position onto the pre-poured slab or piers.

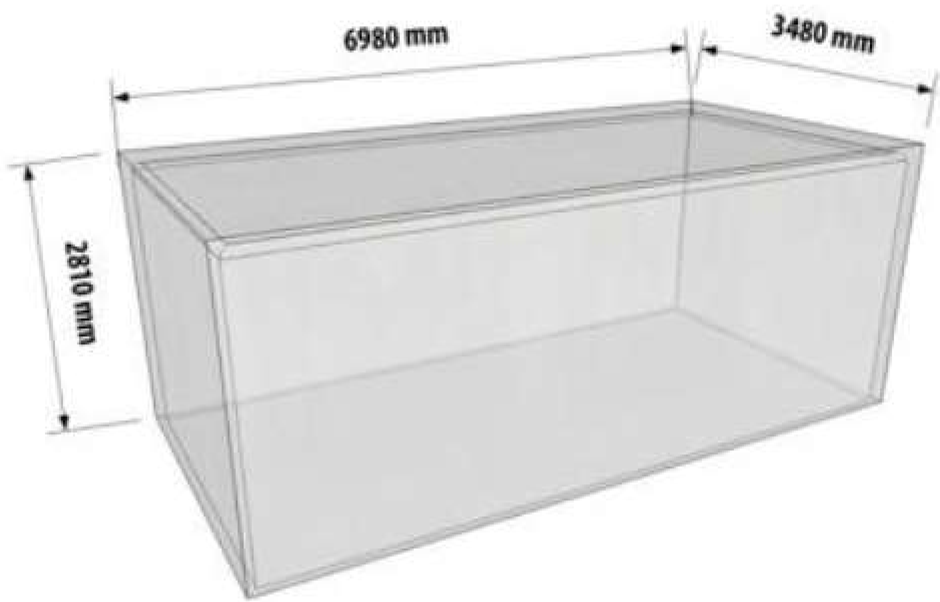
livinmodular
CONSTRUCTION

2.2 The Livin Modular System – Standard Mould Sizes

Each mould is fully automated and hydraulically driven with fine tolerances (+/-2mm) to allow accurate, repetitious casting on a daily basis.



5m Module



7m Module

Mould #1 4.98m*3.48m*2.81m

Mould #2 6.98m*3.48m*2.81m

2.3 The Livin Modular System – Mould Size Options

Generic Name	Mould External Dimensions	Internal Area (m2)	External Area (m2)	Popular Uses
"A"	(5M) 5m*3.5m *2.81 high	15.84	17.33	• 2 No good-sized rooms • Larger main room • Large toilet block
"B"	(7M) 7m*3.5m *2.81 high	22.44	24.29	• 2 bedrms with dividing wall • Kitchen & Dining • Good sized single garage • Good sized double garage • Main bedroom & ensuite • Toilet blocks
"C"	(6M) 6m*3.5m *3.11 high	15.84	17.33	• Half of double garage • Toilet block (small) • Study • Student Accommodation • Storage
"D"	(8M) 8m*3.5m *3.11 high	39.64	31.76	• Wider bedrooms • Larger Living & Dining Areas
"E"	(9M) 9m*3.5m *3.11 high	29.04	31.25	• 2 No good-sized rooms • Larger main room • Large toilet block

Note: Sizes above are the approximate sizes of the moulds and do not take into account the joint spaces

2.4 The Livin Modular System – Step by Step Process

Step 1 – Reinforcing & Insulation

Step 2 – Steel Hydraulic Mould

Step 3 – Reinforcement Lifted & Placed in Mould

Step 4 – M E P Positioned

Step 5 – 40mPa Concrete Poured

Step 6 – Cured Module Lifted

2.3 The Livin Modular System – Step by Step Process (cont)

Step 7 – Cure & Commence Fit-Out

Step 8 – Windows & Doors Fixed

Step 9 – Move to Loading Bay

Step 9 – Load on Trucks

Step 10 – Crane Into Position

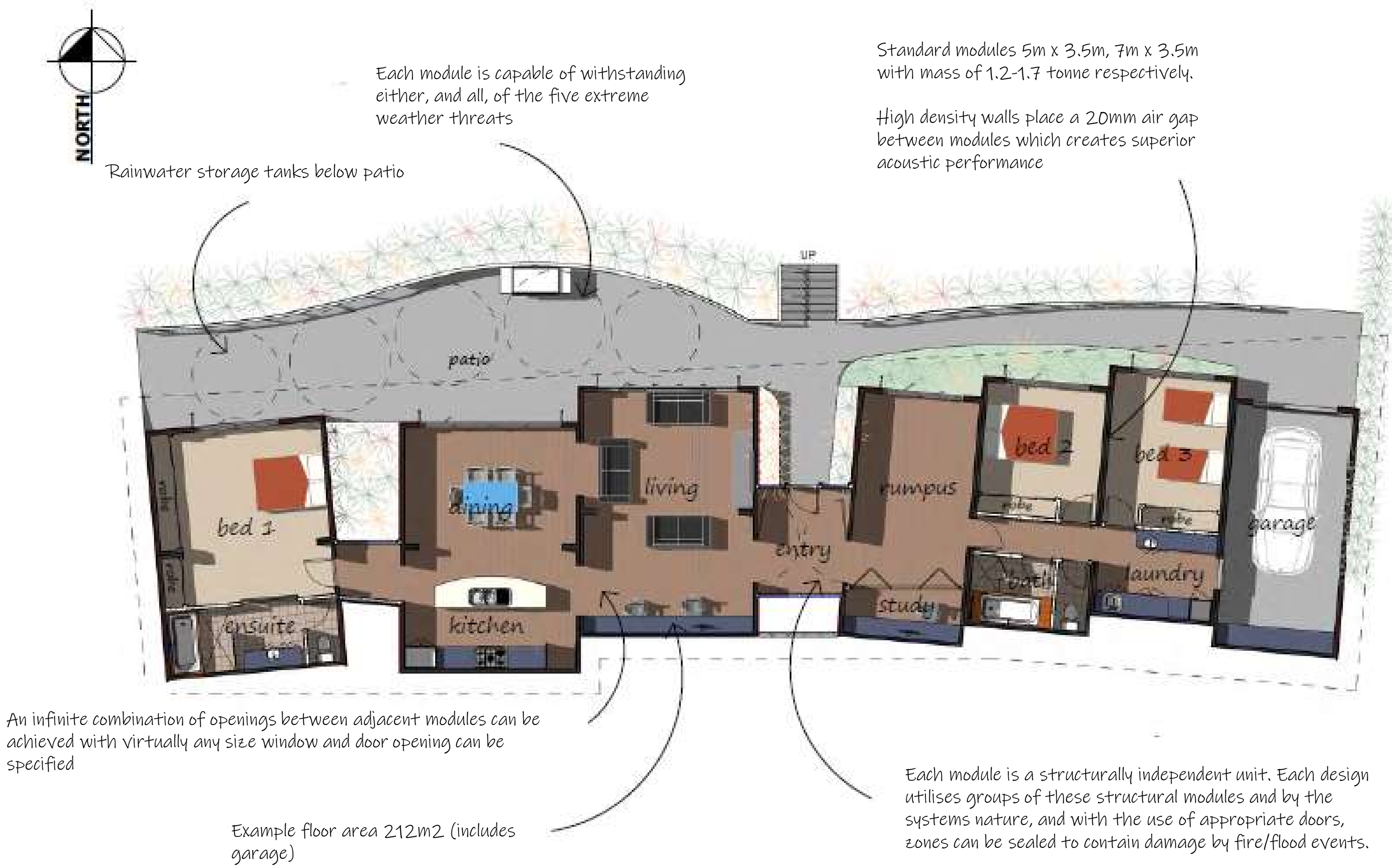
Step 11 – Assemble & Fit off

The Livin Modular Building

Design Examples

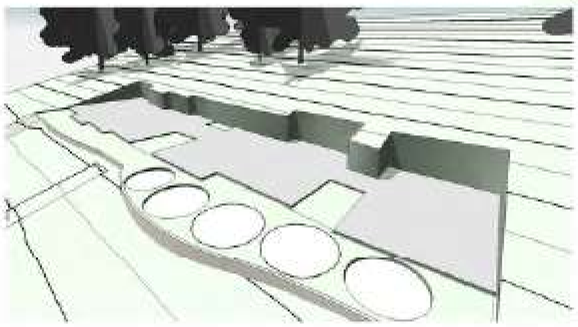
3.1 Livin Modular Design Example (Single Storey)

3.1 Livin Modular Design Example (Single Storey) – (cont)

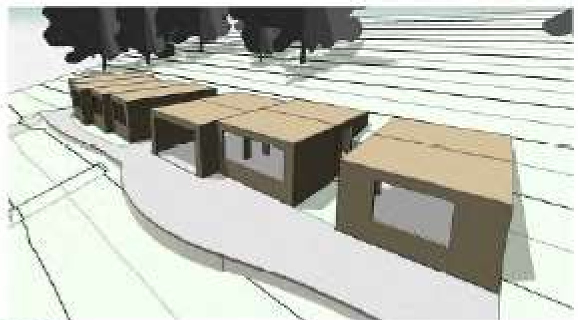


![Livin Modular logo]

3.1 Livin Modular Design Example (Single Storey) – (cont)



1. The Engineered Solution
-Modules can form part of the civil works, acting as retaining walls
-In Ground Storage tanks are utilised in this design

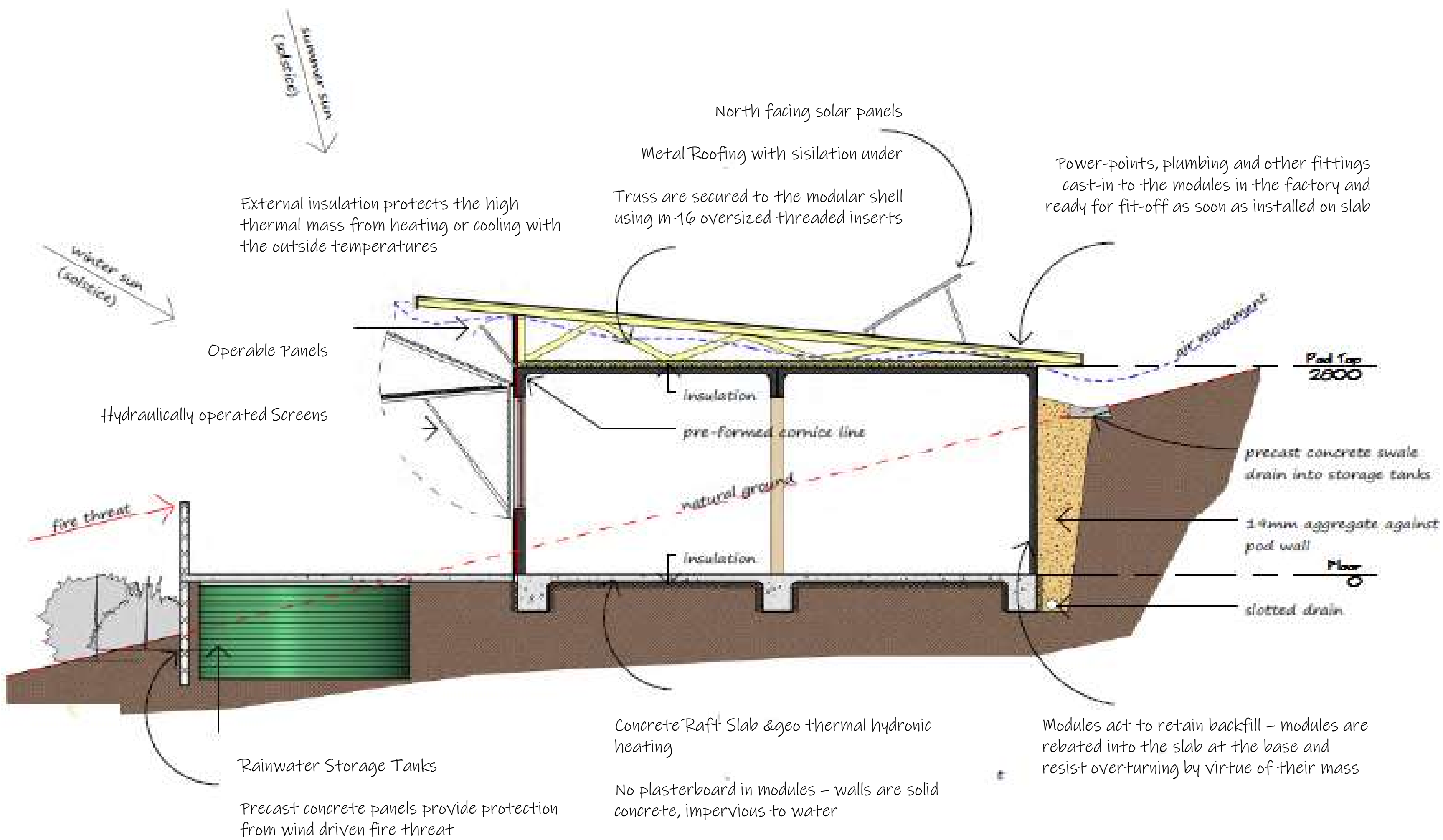


2. The Modular Concrete Structure
-The shall of the design is robust and durable
- Can be trucked to site and installed in one day

3. Lock-Up
-Lock up achieved within days of module installation

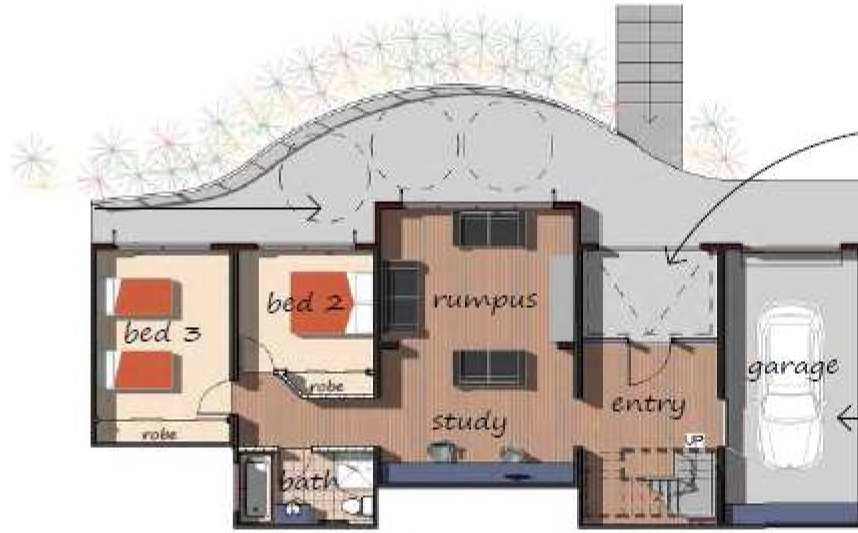
4. Finishes
-The design can be 'dressed' up to suit any client and environmental conditions

3.1 Livin Modular Design Example (Single Storey) – (cont)



3.2 Livin Modular Design Example (Double Storey)

3.2 Livin Modular Design Example (Double Storey) – (cont)



Ground Level – 120m2 (incl garage)

Upper Level – 92m2

Entry setback to protect it from the elements

Modules, by default, create a larger than average garage, leaving additional storage space

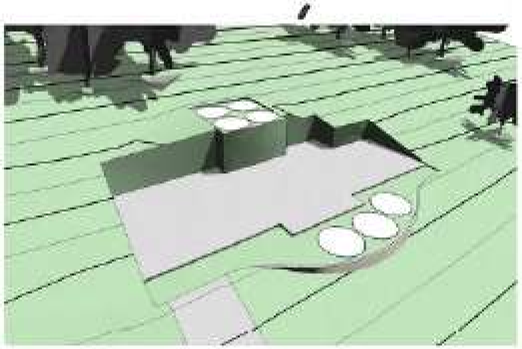
Hebel blocks are used for all internal walls meaning all walls are impervious to water

Each module includes a load bearing top, allowing us to claim floor space on the module roof

Module tops can be finished off, polished, at the pre-installation stage

Rainwater storage tanks below patio

3.2 Livin Modular Design Example (Double Storey) – (cont)



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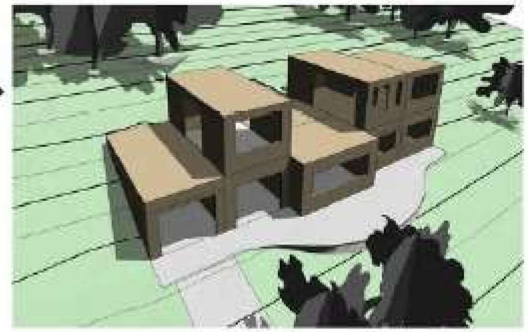
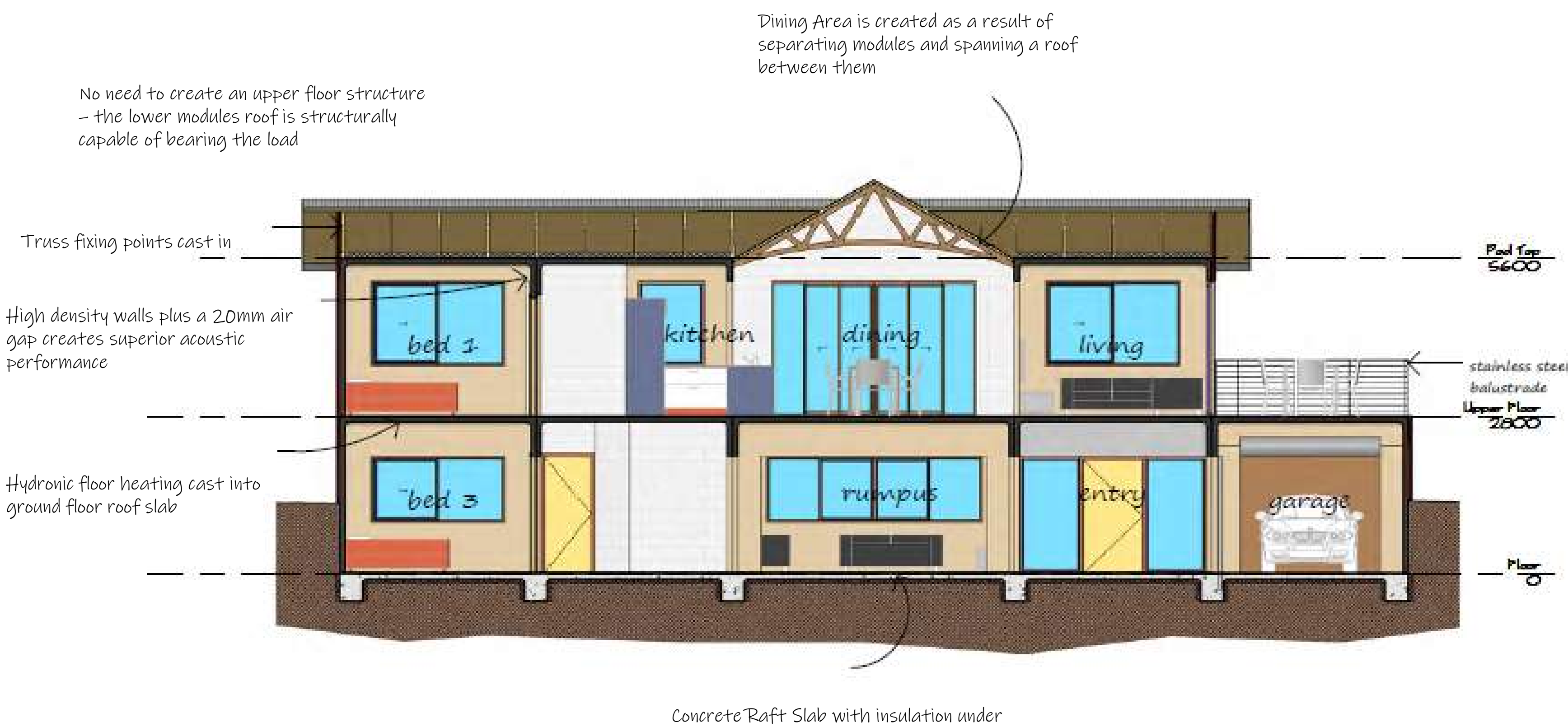


2. The Modular Concrete Structure
-The shall of the design is robust and durable
- Can be trucked to site and installed in two days

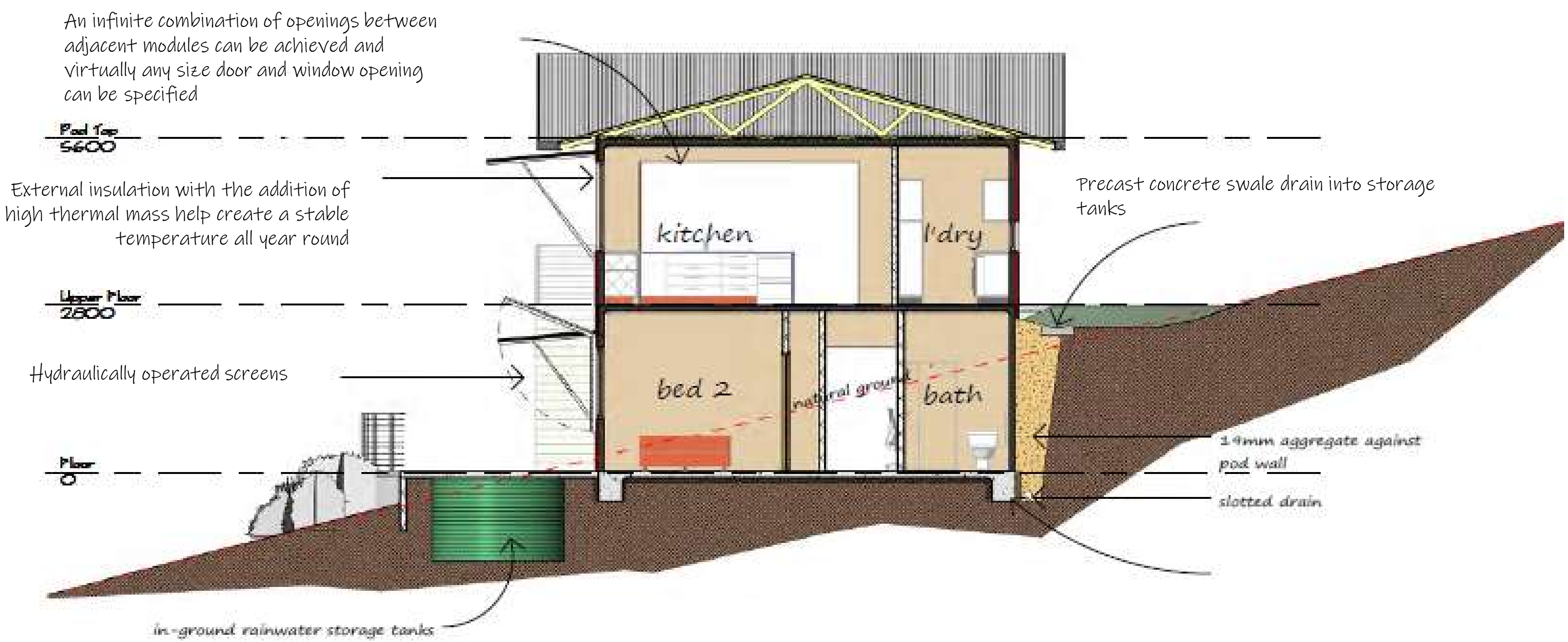
3. Lock-Up
-Lock up achieved within days of module installation

4. Finishes
-The design can be 'dressed' up to suit any client and environmental conditions

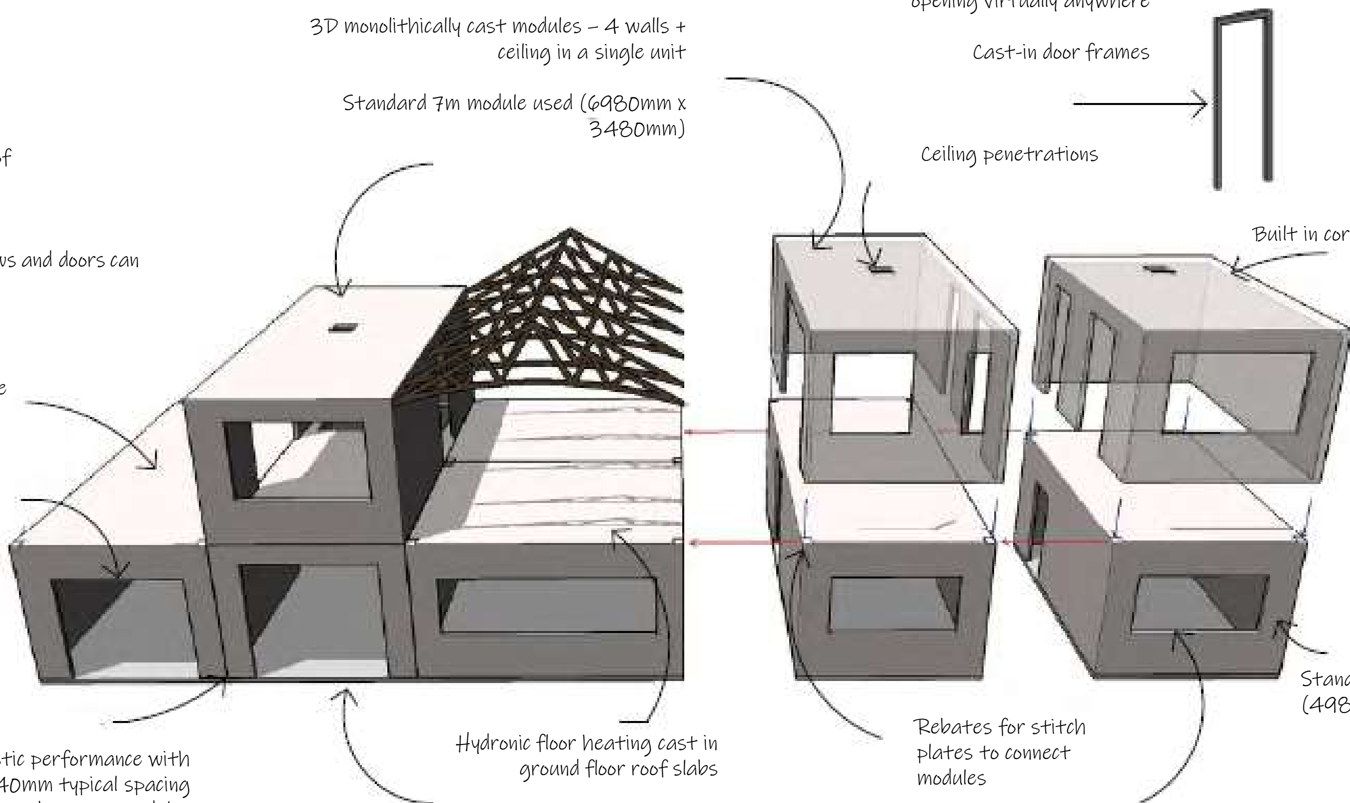
3.2 Livin Modular Design Example (Double Storey) – (cont)



3.2 Livin Modular Design Example (Double Storey) – (cont)

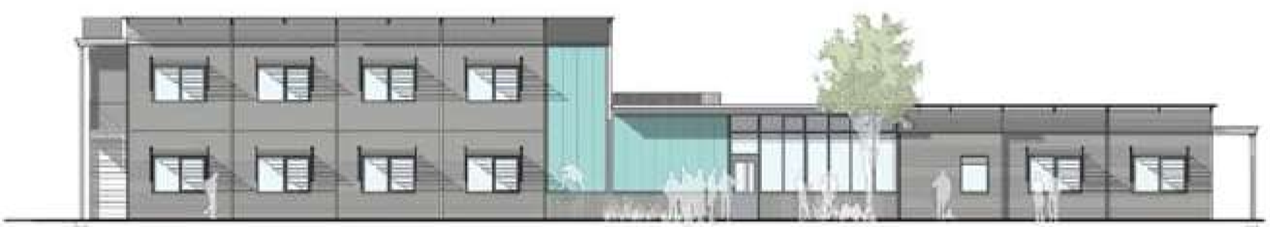


3.2 Livin Modular Design Example (Double Storey) – (cont)

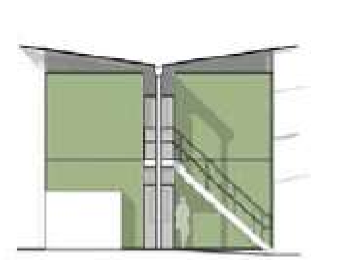


3.3 Livin Modular Design Example (Commercial Project)

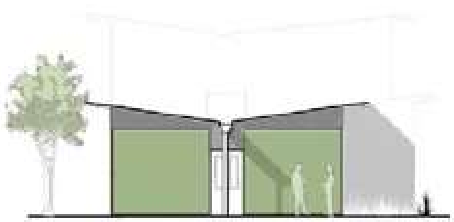
3.3 Livin Modular Design Example (Commercial Project) – (cont)



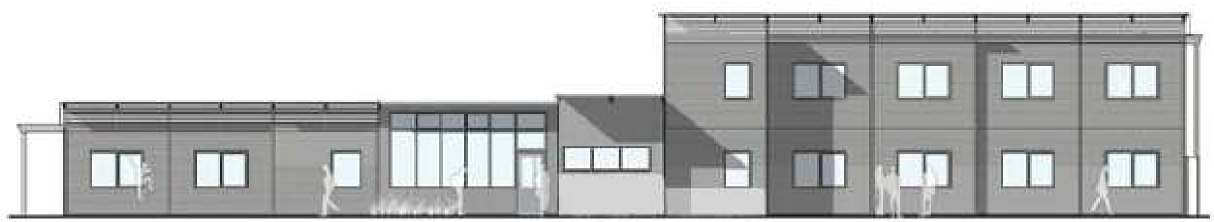
north elevation



west elevation

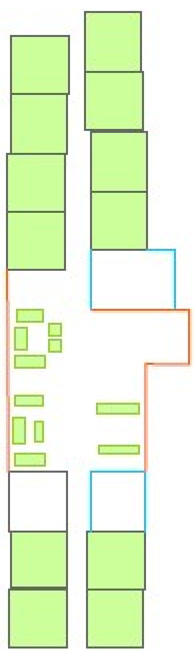


east elevation



south elevation

3.3 Livin Modular Design Example (Commercial Project) – (cont)

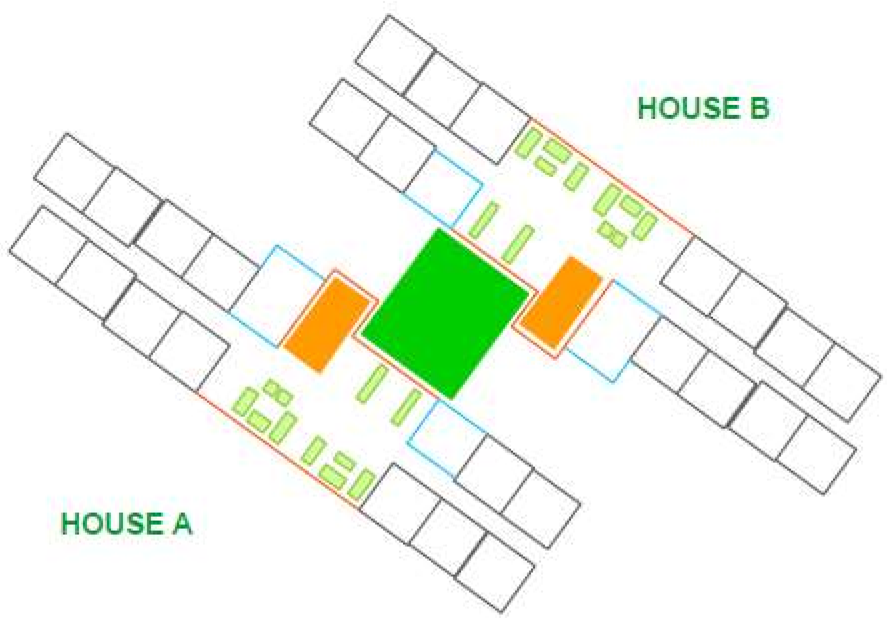


This overall design aimed to give a strong identity for the university campus providing a focus & social hub for the students, encouraging peer group learning and student interaction.

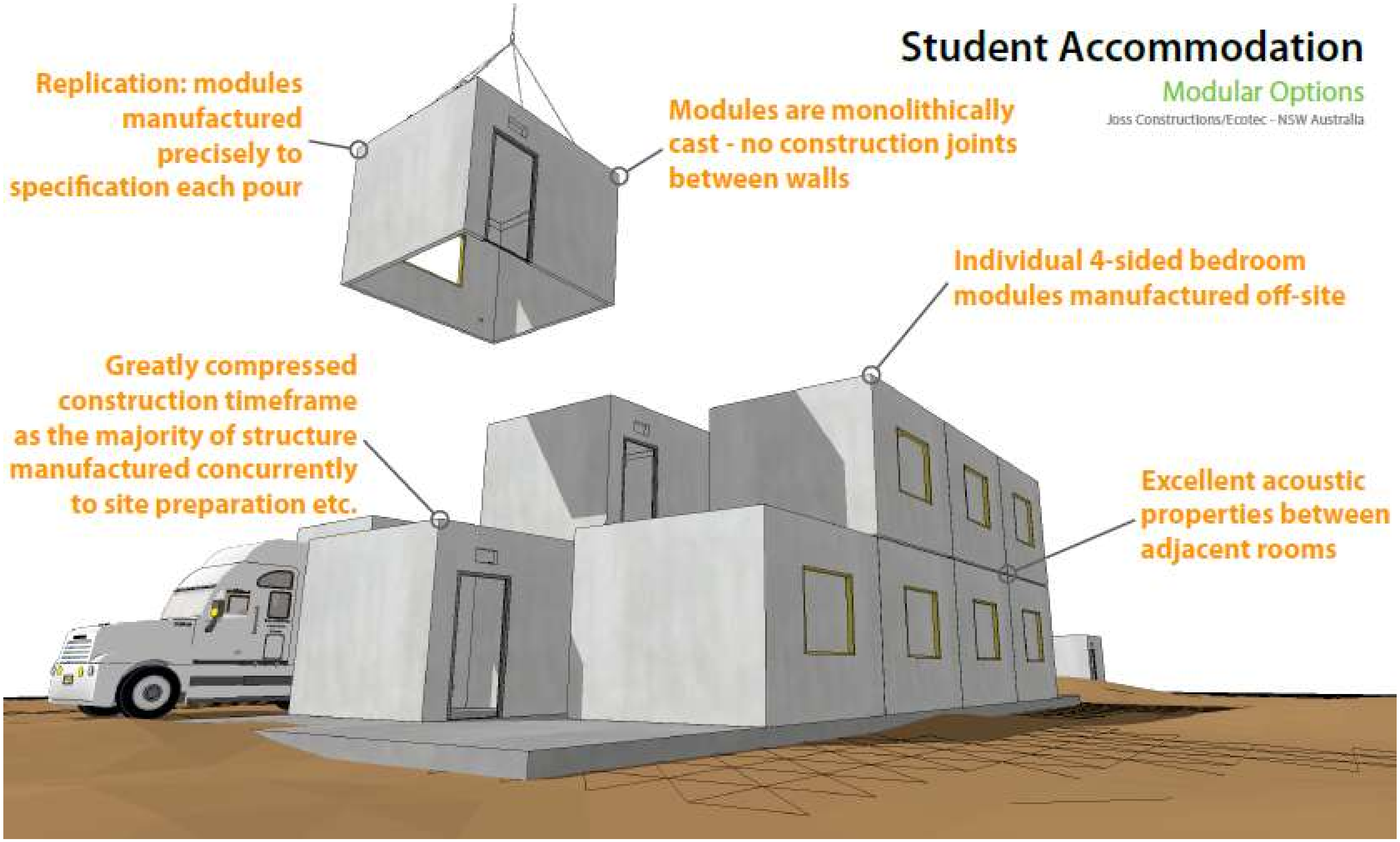
Each of the 20 bedroom student houses were paired so as to create a shared courtyard which was naturally shaded by the buildings. These were linked by a footpath, weaving between each of the clusters, minimising any hard surfacing whilst providing access for disabled students.

Each of the 10 houses had a shared kitchen, dining and living area at ground level situated in the middle of the building. These spaces were directly accessed from the central courtyard space and had been designed as 'open plan'.

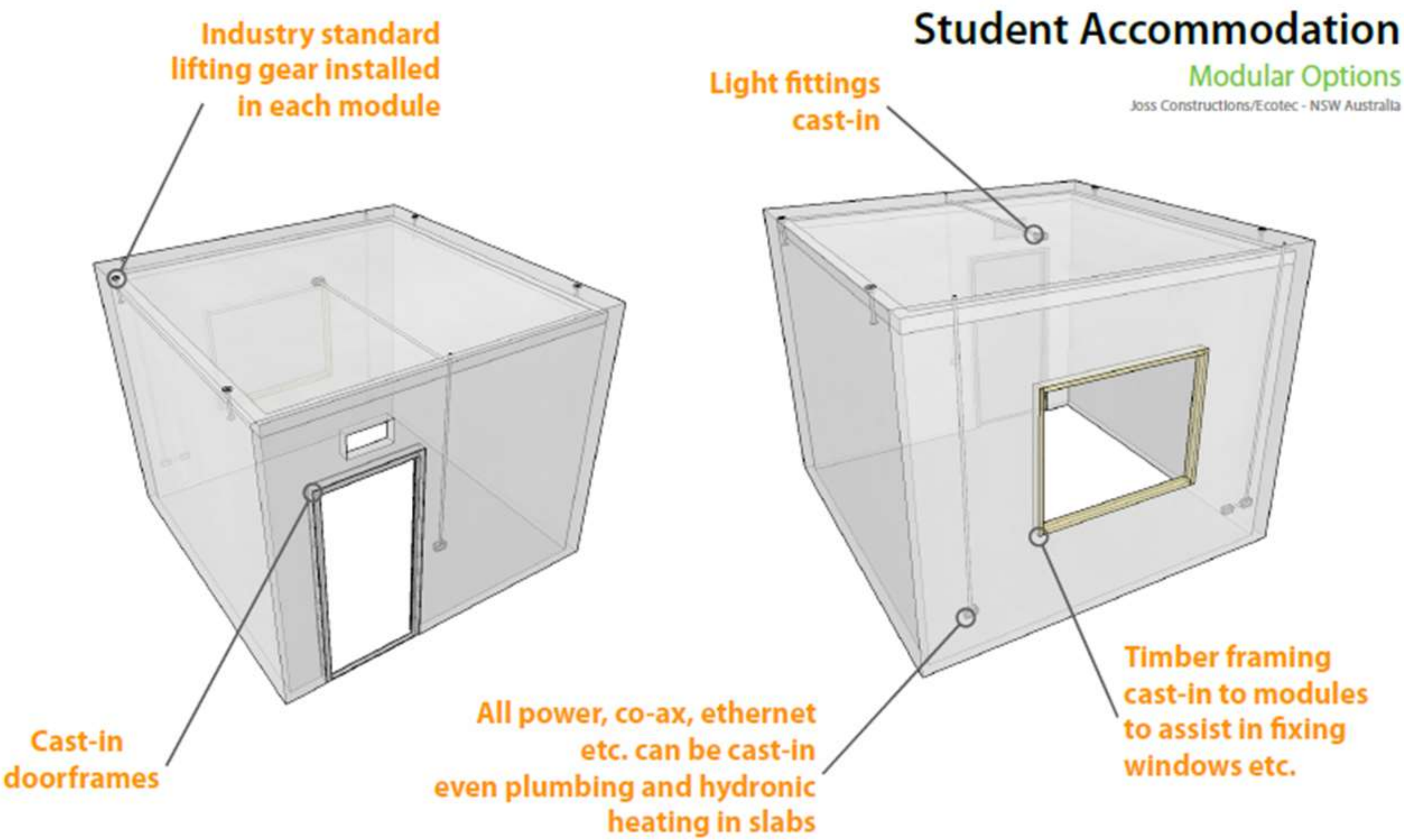
The design was part single storey and part double storey.
This was o make overall building mass appear less visually obtrusive providing views through the site with the houses appearing to nestle into the sloping block.



3.3 Livin Modular Design Example (Commercial Project) – (cont)



3.3 Livin Modular Design Example (Commercial Project) – (cont)



3.3 Livin Modular Design Example (Commercial Project) – (cont)

3.3 Livin Modular Design Example (Commercial Project) – (cont)

Architectural Guidelines

4.1 Architectural Guidelines

4.2 Design Considerations

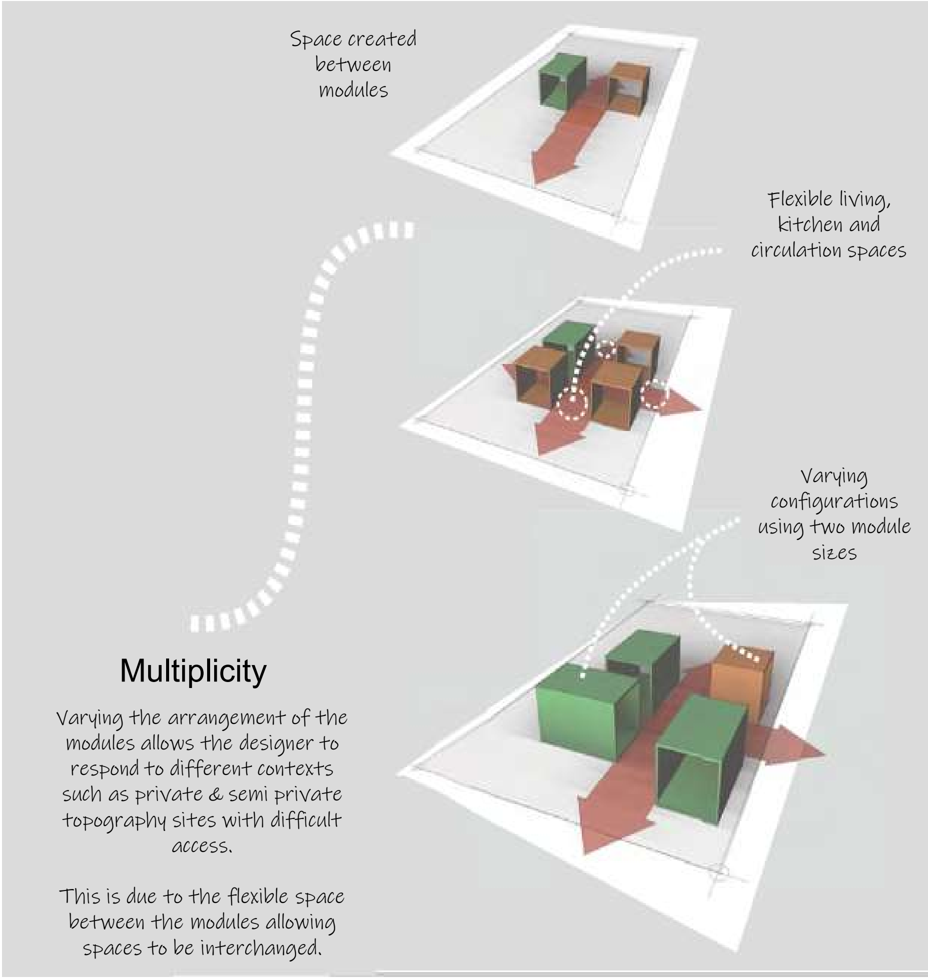
The following guidelines are meant to help architects apply the Livin Modular system to the particular needs of various types of building projects. These basic principles may be applied in any order according to the particular needs of the project. However, distribution of modular room and technical elements should be considered and applied in the early stage of design.

Define the Urban Scale

In the preliminary design phase, determine the modular massing strategy and building volume. The size of the volumes may vary from multi level to residential or special projects. Depending on the particular site and surroundings, the architect can consider and propose varying typologies for the whole project or for specific buildings.

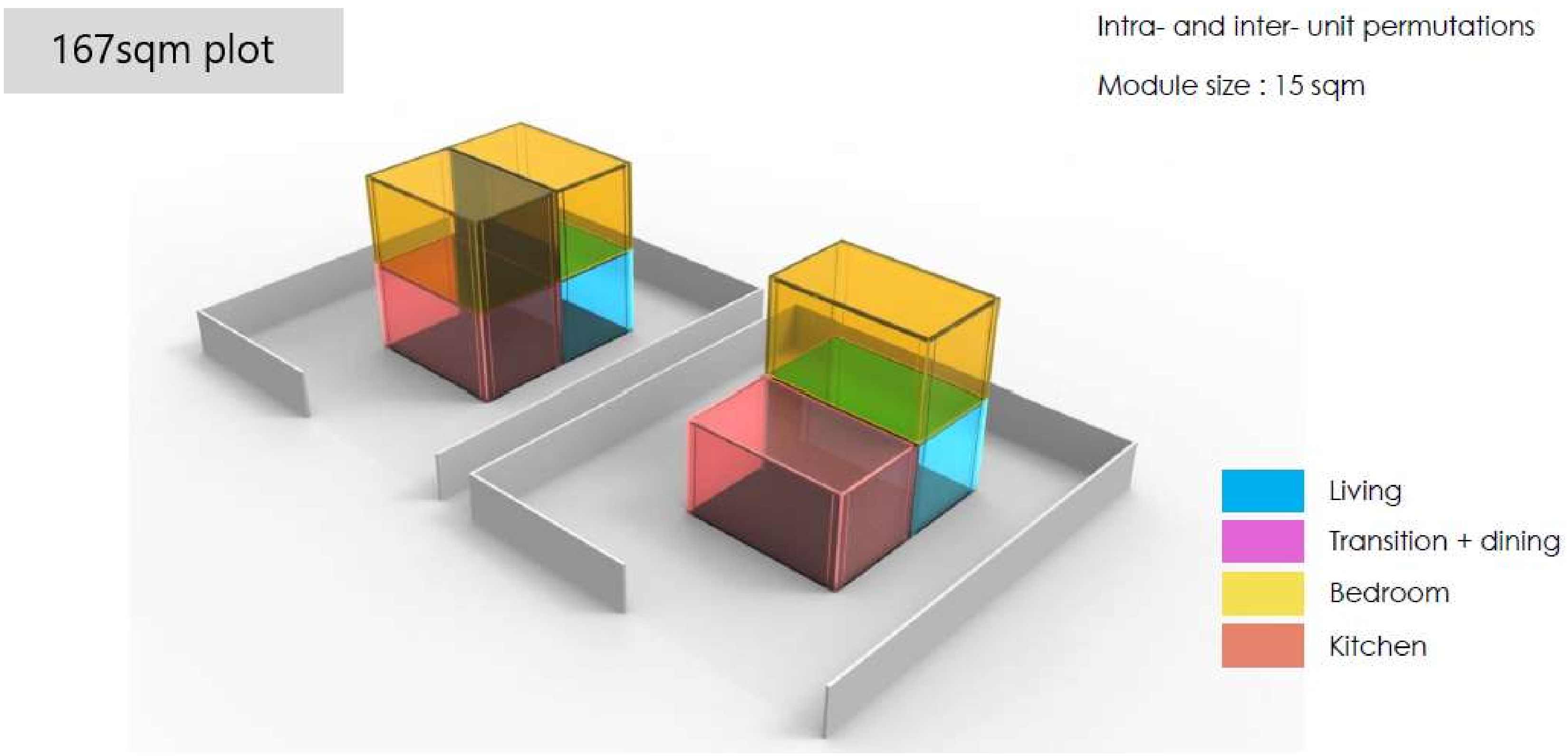
Define the Modular Configuration

The footprint of the building as well as the distribution of modules, module sizes and position of the living areas form the basic parameters of the building structure.



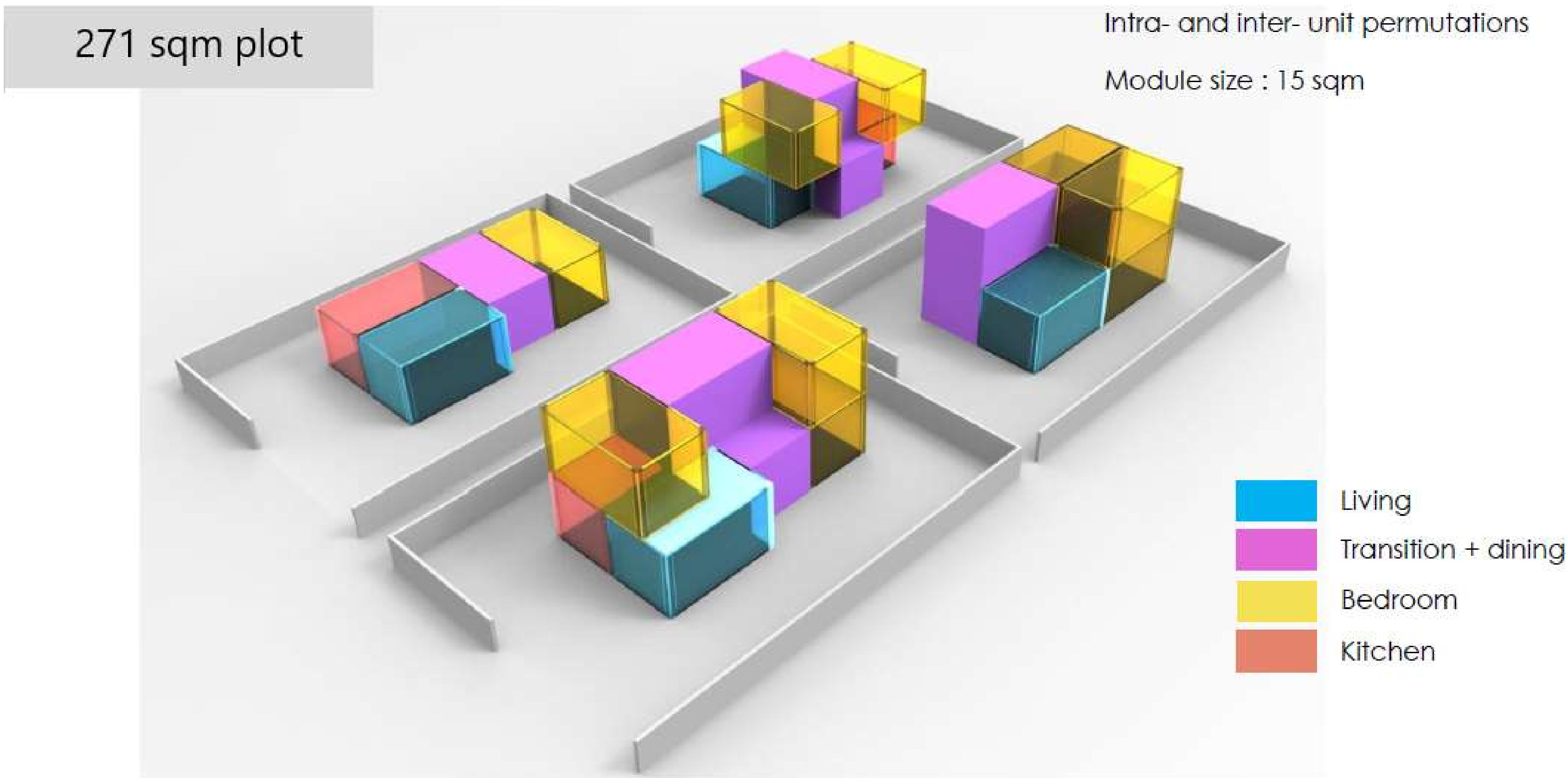
4.2 Design Considerations - (cont)

Configuration Tip 1 • Standardize the dimensions • Ensure repetitive usage of the same dimensions when possible • Componentization of various elements • Design for manufacture and assemble (DfMA)



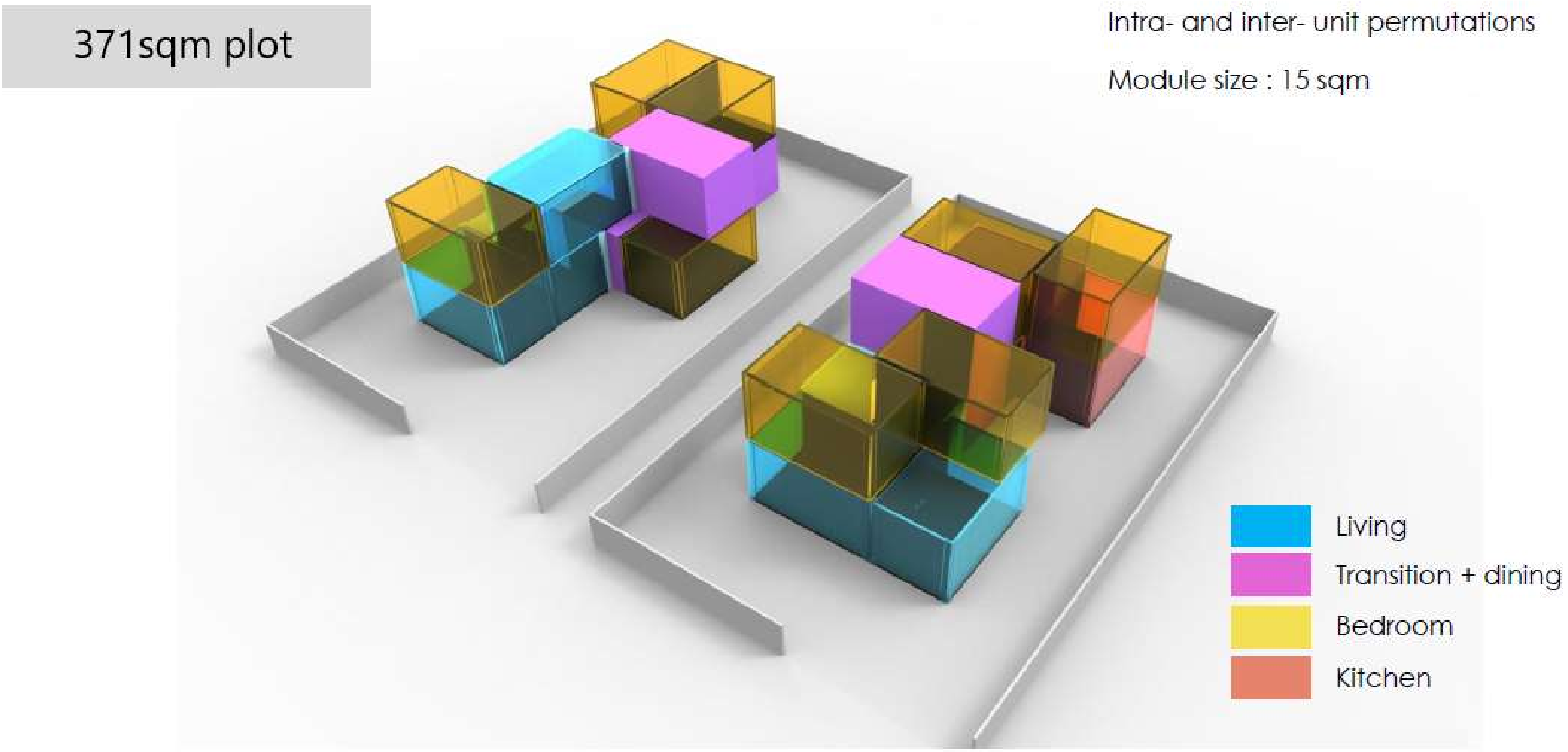
4.2 Design Considerations - (cont.)

Configuration Tip 2 Consider where external or internal finishes can become part of the modular components. For example; balconies, hallways, elevator shafts



4.2 Design Considerations - (cont.)

Configuration Tip 3 Consider the interface between in-situ and modular components.



4.2 Design Considerations - (cont)

Structural Principles and Bearing Elements

The Livin Modular system consists of one monolithic 5-panel in one pour modular concrete super structure produced from a hydraulic mould. Once manufactured and delivered to site, this module serves simultaneously as the load bearing structure and the solid envelope of the building.

Basically, the module acts as a 3 dimensional frame where the horizontal roof element ties all the walls together and stiffens the unit. Although penetrations, doors, windows etc. can be placed practically anywhere, there is a beam on all 4 sides and the corner columns that should not be compromised if possible, especially for multi-storey construction. A general guide is that the columns should not be reduced to within 600mm from the corners and the perimeter beam should be a minimum 500mm deep. Individual structural certification is required if these conditions are compromised.

Vertical Load Paths

Obviously it is important to ensure that the loads of the building are taken to the ground through continuous supports. For this reason it is best that similar sized modules sit above each-other so that the walls from L1 & L2 line up above those of say LG. However this is not always essential for 2 & 3 level construction, as the modules have enough strength to take eccentric loading subject to engineering approval.

Penetrations & Openings

Can be cast into each module (preferred) or cut out later. The corner columns and perimeter top beam are the structural elements and should not be compromised, although some exceptions are possible. The walls on all four sides can have block outs / penetrations wherever required. The roof slab can also be moulded for stair openings, skylights, services ducts, lifts and the like.

4.2 Design Considerations - (cont)

Part Modules & Hybrid Designs

As we can cast part modules we have found over time that the most important dimension is the width of the mould. Transport and Handling are a large consideration especially when you go over the 3.5m dimension. Similarly, once the 4m dimension is reached then there are extra structural considerations, reinforcement and concrete thickness that increase, costs, and weight. Hence the 3.5m & 4m wide moulds are proven to be the most efficient, flexible and can be transported, lifted and installed with local and easily sourced equipment.

Conduits

We can cast in electrical and plumbing conduits, timber for fixing shelves and furniture, rebates for framing, steel door jams and many other items. For example, plumbing and electrical services for future use can be cast into the modules and accessed when required at a later date.

Window & Door Openings

Window and door openings are case at time of pour. While any window or door opening size can be cast, it is recommended that you use a set of standard sizes for production efficiency. The windows can be fixed in the manufacturing yard prior to delivery onsite of the modules.

Additional Fittings & Fixtures

Ability to cast in threaded inserts (ferrules) for roof trusses, awnings, pergolas, other structural items. These fittings can be cast into the modules for future use, if and when required.

External Finishes

5.1 External Finishes – Foam

Exterior Foam Insulation

It is recommended that 70mm to 75mm Extruded Polystyrene Foam boards are fixed to the module with glue and special galvanised screws if necessary.

The joints should be sealed with a polyurethane foam and have mesh jointing tape.

External corners are to be reinforced with metal strips.

Your selected cladding is then fixed to the foam. If render is applied, a minimum of 5mm of acrylic render should be applied, normally in a three layer system.

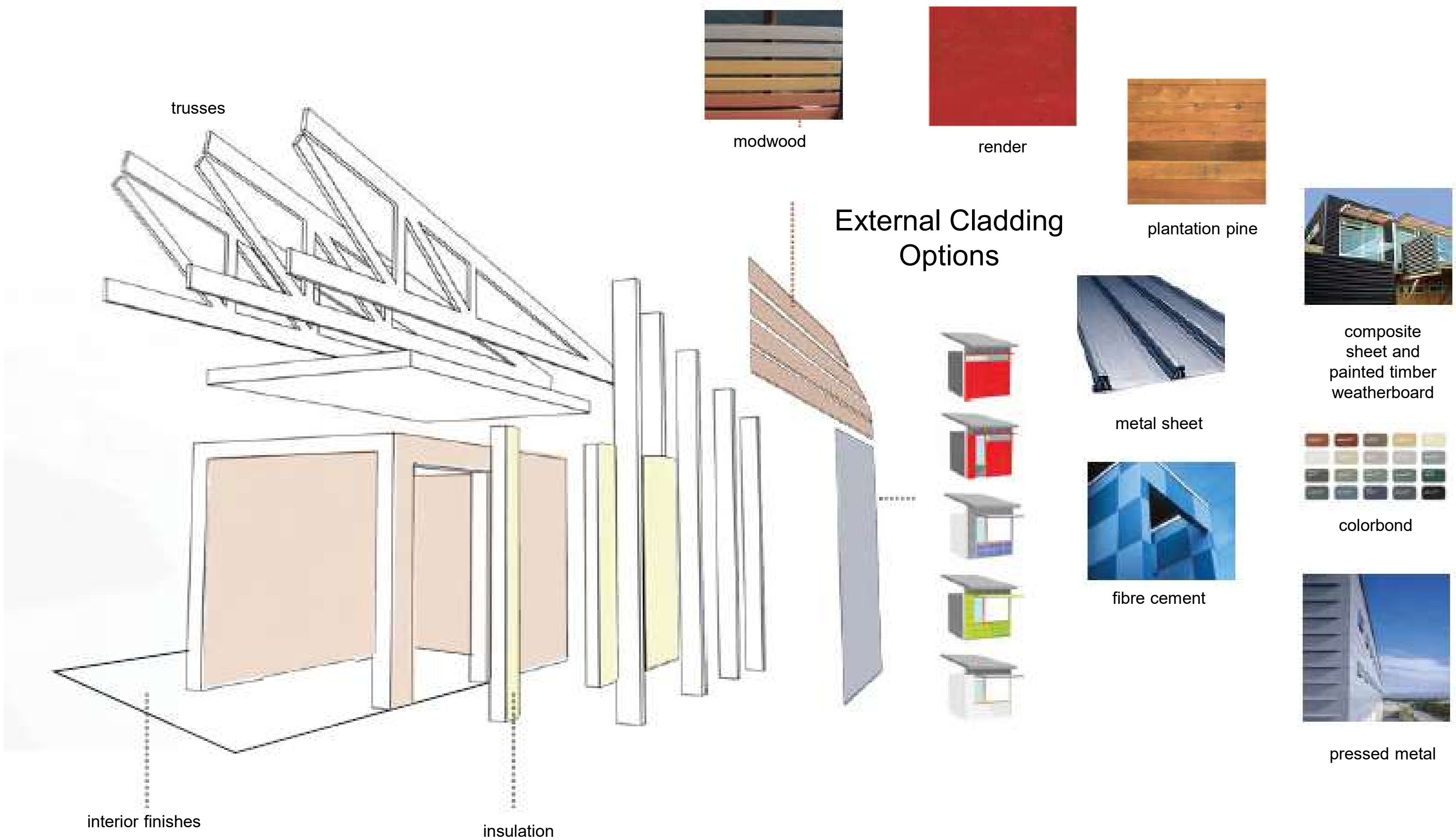
Example product properties of the exterior foam is contained in the table opposite.

Table 8.2

PRODUCT PROPERTIES

Property	Unit	EXPOL ThermaSlab S	EXPOL ThermaSlab H	EXPOL Platinum Board	EXPOL Platinum Board H	EXPOL-X	Test Reference
Material		EPS	EPS	EPS (with graphite)	EPS (with graphite)	XPS	
Density	kg/m3	16	24	18	24	30	
Thickness / R Value	m2K/W						ASTM C518-04
	20mm	R 0.53	R 0.56	R 0.63	R 0.65	-	
	25mm	R 0.66	R 0.69	R 0.78	R 0.81	-	
	30mm	R 0.79	R 0.83	R 0.94	R 0.97	R 1.10	
	40mm	R 1.05	R 1.11	R 1.25	R 1.29	R 1.45	
	50mm	R 1.32	R 1.39	R 1.56	R 1.61	R 1.80	
	60mm	R 1.58	R 1.67	R 1.88	R 1.94	-	
	70mm	R 1.84	R 1.94	R 2.19	R 2.23	-	
	80mm	R 2.11	R 2.22	R 2.50	R 2.58	-	
	90mm	R 2.37	R 2.50	R 2.81	R 2.90	-	
	100mm	R 2.63	R 2.78	R 3.13	R 3.23	-	
	110mm	R 2.89	R 3.06	R 3.44	R 3.55	-	
	120mm	R 3.16	R 3.33	R 3.75	R 3.87	-	
Compressive Resistance	KPA at 1%	34	64				
Compressive Resistance	KPA at 2%	59	108				
Compressive Resistance	KPA at 5%	74	133				
Compressive Resistance	KPA at 10%	84	146	105	135	250	AS 2498.3
Youngs Modulus	(MPA)	3.8	6.2				
Cross breaking strength	KPA	165	260	200	260	-	AS 2498.4
Determination of flame propagation surface ignition							
Medium flame duration (max)	sec	2	2	2	2	-	AS2122.1-1993
Eighth value	sec	3	3	3	3	-	
Fire behaviour - Spread of Flame Index	(0-10)	0	0	0	0	0	AS/NZS 1530.3:1999
- Smoke Developed Index	(0-10)	5	5	5	5	3	
Dimensional stability of length, width & thickness (max) at 70 deg C for 7 days	%	1	1	1	1	-	AS2498.6
Recycled content	%	0	0	0	0	0	
Rate of water vapour transmission (max) measured parallel to rise at 23°C	mg/m2s	520	460	520	460	-	AS 2498.5

5.2 External Finishes – Cladding Options & Examples



Technical Specifications

6. Technical Specification

Structural Components of the System

a- Concrete 40MPA, low shrinkage, super plasticized mix with steel reinforcement. . Reinforcing steel yield strength = 460 mpa. Class 1 & 2 finish is achieved on internal and external surfaces, which is suitable for direct finish application.

b- Design loads are as follows :
i- Dead load
ii- Super imposed dead load = 2.5 kpa
iii- Live load living quarters = 2 kpa, corridors = 5kpa
iv- Wind load basic wind speed = 45 m/s
v- Earthquake zone = 4
vi- Explosion impact load in the three orthogonal directions = 25 kpa
vii- Design Fire Duration = 2 hrs
viii- Allowable soil pressure = 1.5 kg / cm2 = 150 kpa
c- Design provisions of the NZBC Clause B1 are employed.

Building Acoustics

Walls constructed from two leaves of 90mm concrete with 20mm cavity between leaves without connections except at the periphery will achieve an Rw in excess of 50 (STC > 55 / IIC > 55), provided there are no mechanical connections within the 20mm cavity.

Thermal Properties

Concrete has an inherent capacity (related to its mass) to absorb and store thermal energy. R-value is defined as "a materials thermal conductivity divided by it's thickness“. The metric unit is [m2K/W]. In accordance with NZS 4218:2009 solid concrete (2400kg/m3) has a thermal conductivity of 1.44 [W/mK]. The published thermal conductivity of Styrofoam (by Dow Chemical) is 0.0.28 [W/mK]. Hence, the thermal resistance of an insulated concrete wall assembly made up of 90/75/60 (conc/insulation/conc) is as per the following table:

6. Technical Specification (cont)

Foam Thickness

	40mm	50mm	60mm	75mm
outside air film (7m/s)	0.03	0.03	0.03	0.03
concrete 60mm	0.04	0.04	0.04	0.04
Styrofoam	1.405	1.78	2.136	2.67
concrete 90mm	0.06	0.06	0.06	0.06
inside air film (up, still air)	0.11	0.11	0.11	0.11
TOTAL R-VALUE	**1.645**	**2.02**	**2.376**	**2.91**

For comparison, R Values of some common building materials:

Foamular metric XPS 250 /50mm = R1.78
Expanded polystyrene 50mm, m = R1.20
Brickwork, 110mm = R0.18
Weather boards, 12 mm avg, pine = R0.08
Fibre cement sheet, 6mm = R0.019
Concrete slab, 2400kg/m3, 100mm = R0.069
Plaster board, 10mm = R0.059

Fire Ratings

Fire Rated to two hours.

Energy Ratings

The superior acoustic and thermal properties ensure the modular designed house regularly obtain 7 and 8 star ratings (NABERS Rating system).

Room Sizes

Internal dimensions for rooms are at the discretion of the owner and the designer but there are typical ranges that are generally used for functionality and practicality.

Room	Internal Dimensions	Recommended sizes (Modular)	Generic Name
Main bedrooms	3.3m – 3.8m	3.3m + 3.8m	5m & 8m ("A" & "D")
Secondary bedrooms	2.9m – 3.5m	3.3m	5m & 7m ("A" & "B")
Study	2.9m -3.3m	3.3m	5m ("A")
Bathrooms	2.2m-3.0m	3.3m (part module)	5m ("A")
Kitchen /Living	Flexible	3.3m+ 3.8m	7m & 8m ("B" & "D")
Garages -Single	3.5m*5.8m	3.8m	8m ("D")
-Double	5.5m*5.5m-6.8m	3.0m (part 3.3m)	6m ("C")
-Double Plus	6.8m*6.8m	3.3m	7m ("B")

6. Technical Specification (cont)

Seismic Design

Seismic Rating of Modules – **Seismic Zone 4**

As per the following building codes:

UBC 97 Uniform Building Code 1997, Volume II structural engineering design provisions

BS 8110 – 1 1996 British Standards, Structural use of concrete, Codes of practise for design and construction

BS 81102 1985 British Standards, Structural use of concrete, Codes of practise for special circumstances

BS 6399 –1 1996 British Standards, Loading for buildings, Codes of practise for dead and live loads

BS 6399 – 2 1997 British Standards, Loading for buildings,
Codes of practise for wind loads

BS EN 1993 – 1 – 8: 2005 Eurocode 3: Eurocode 3: Design of Steel Structures Part 1 – 8 Design of joints

TABLE 16-I—SEISMIC ZONE FACTOR *Z*

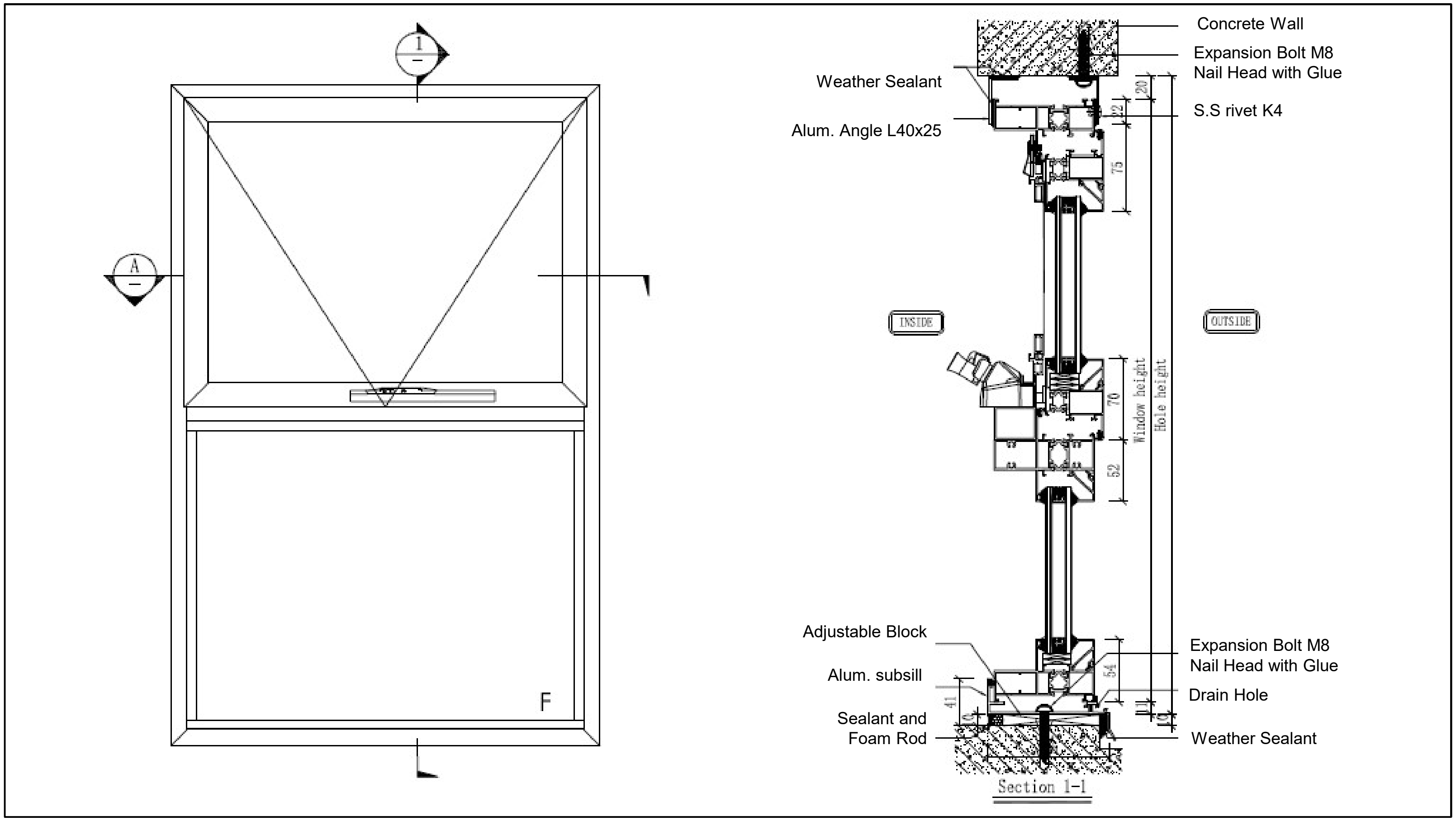
ZONE	1	2A	2B	3	4
Z	0.075	0.15	0.20	0.30	0.40

NOTE: The zone shall be determined from the seismic zone map in Figure 16-2.

Section Details

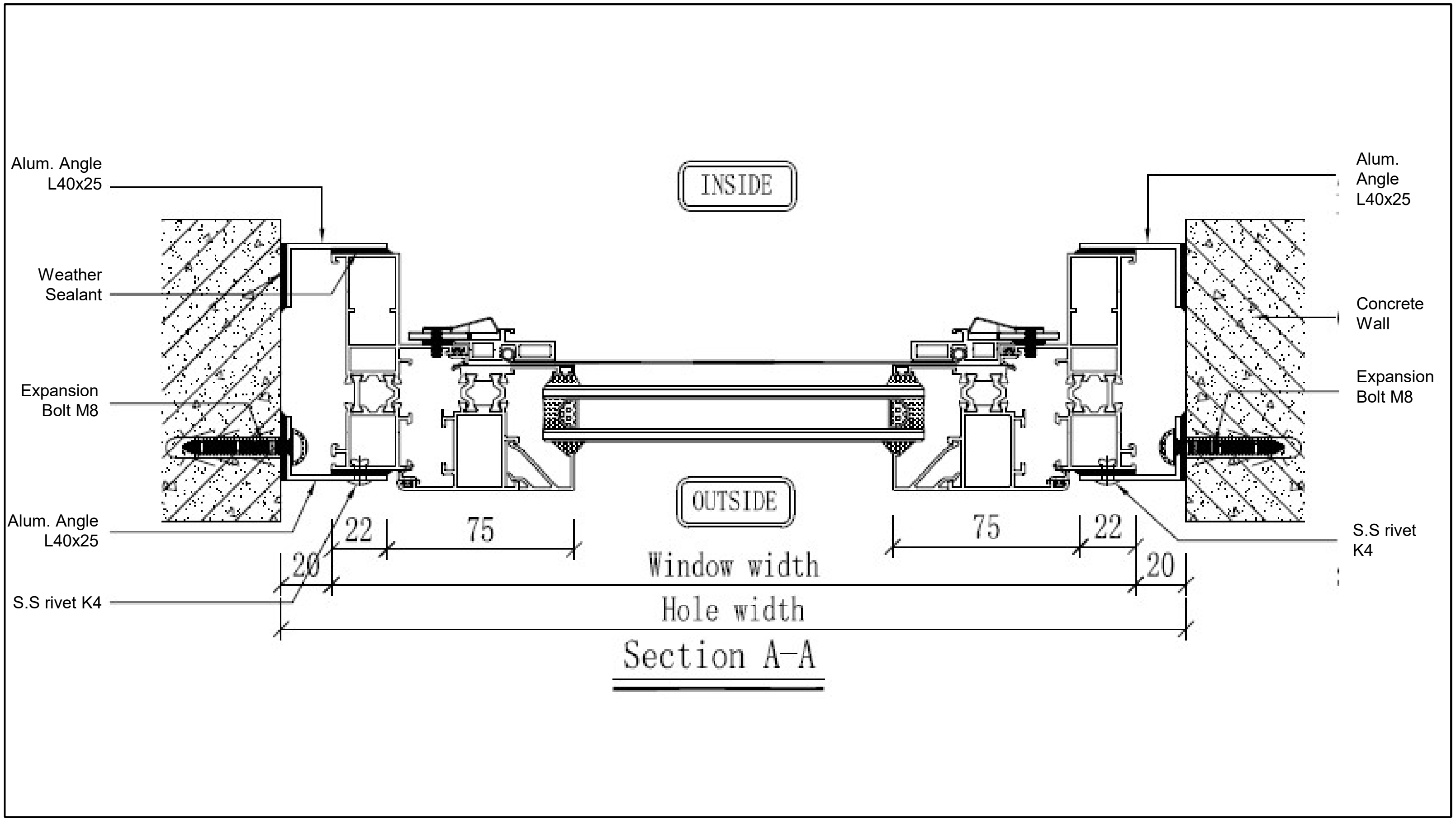
7. Section Details

Typical Window Detail – Awning plus Fixed



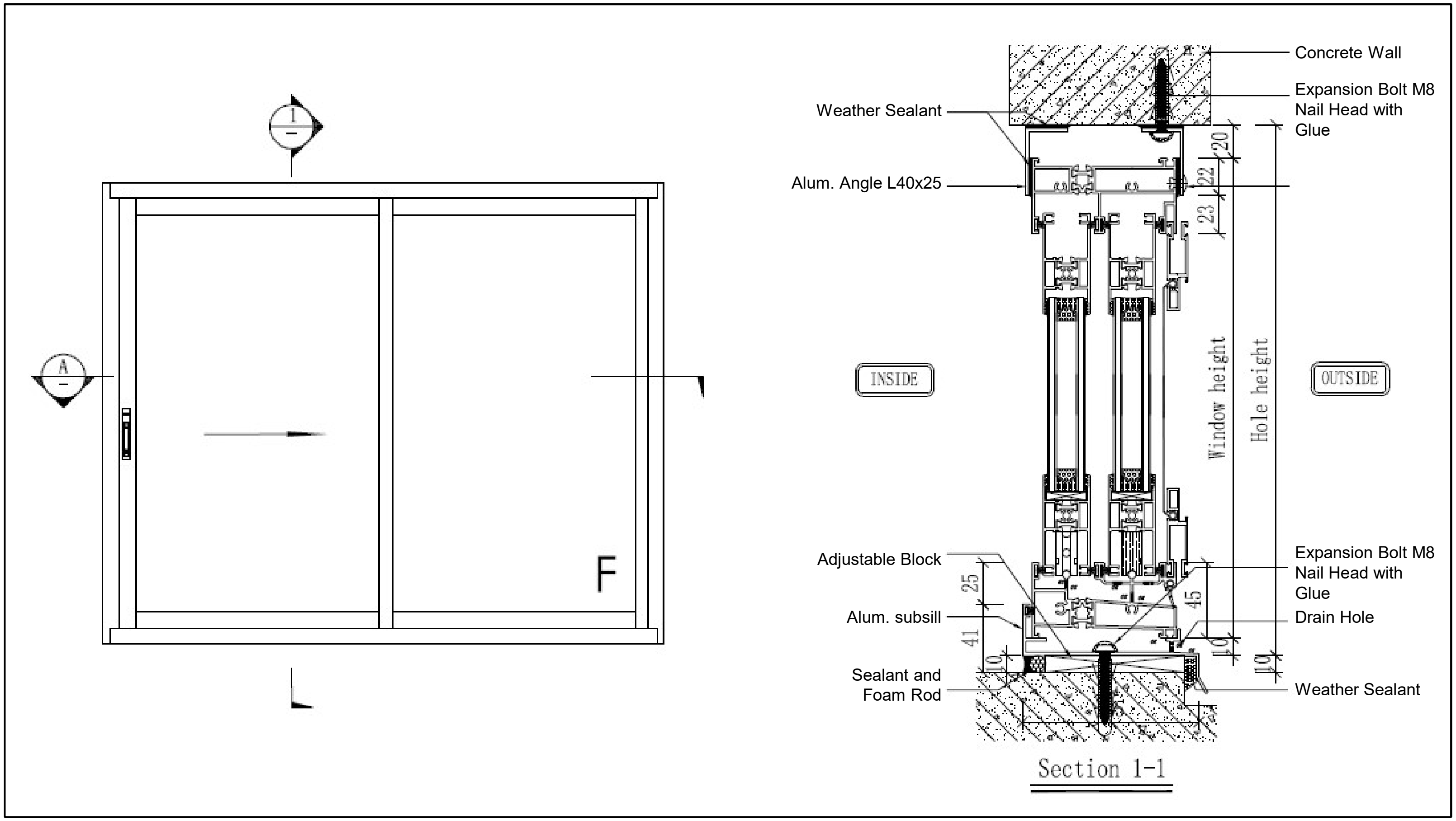
7. Section Details

Typical Window Detail – Awning plus Fixed (cont)



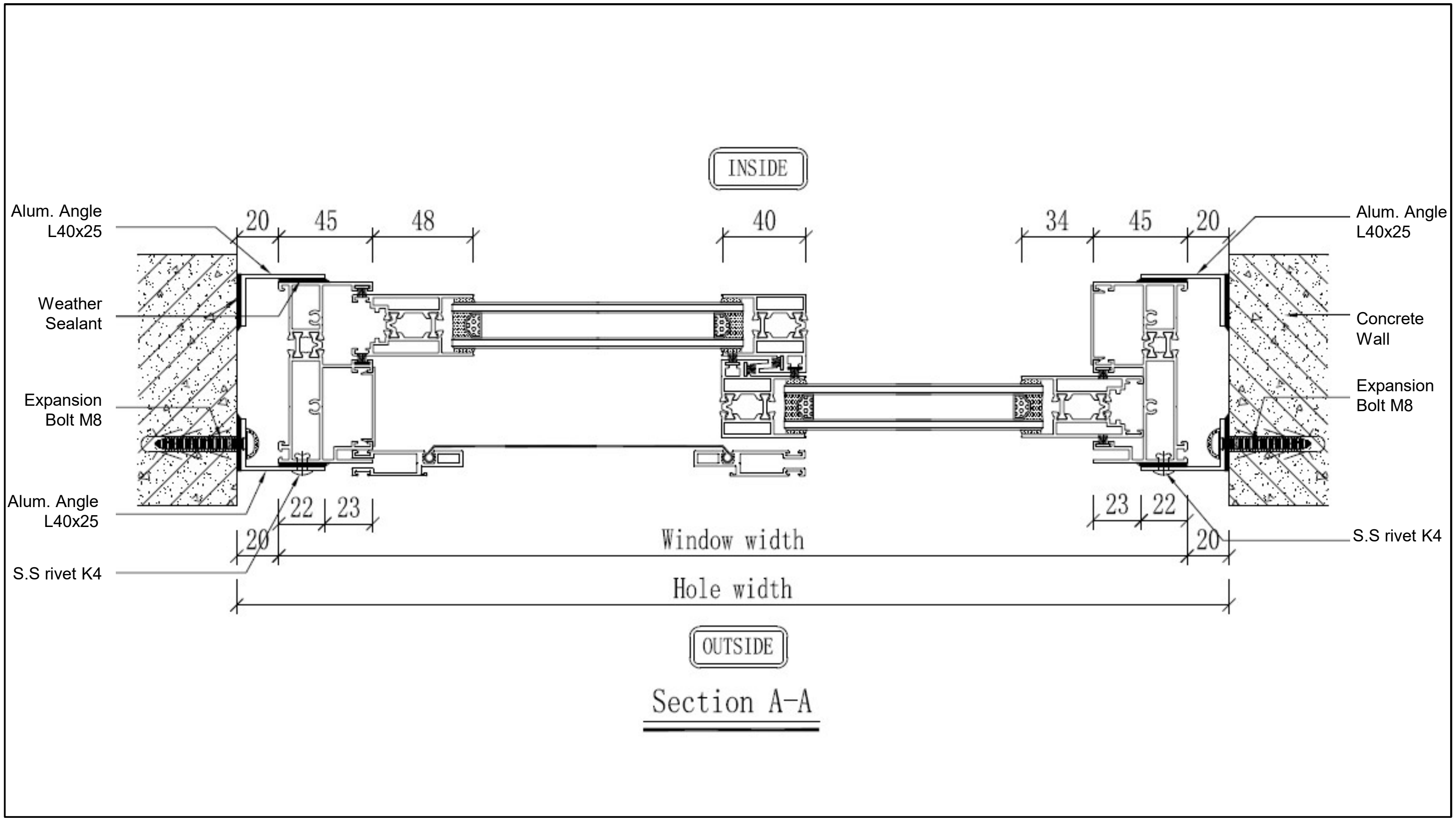
7. Section Details

Typical Window Detail – Sliding



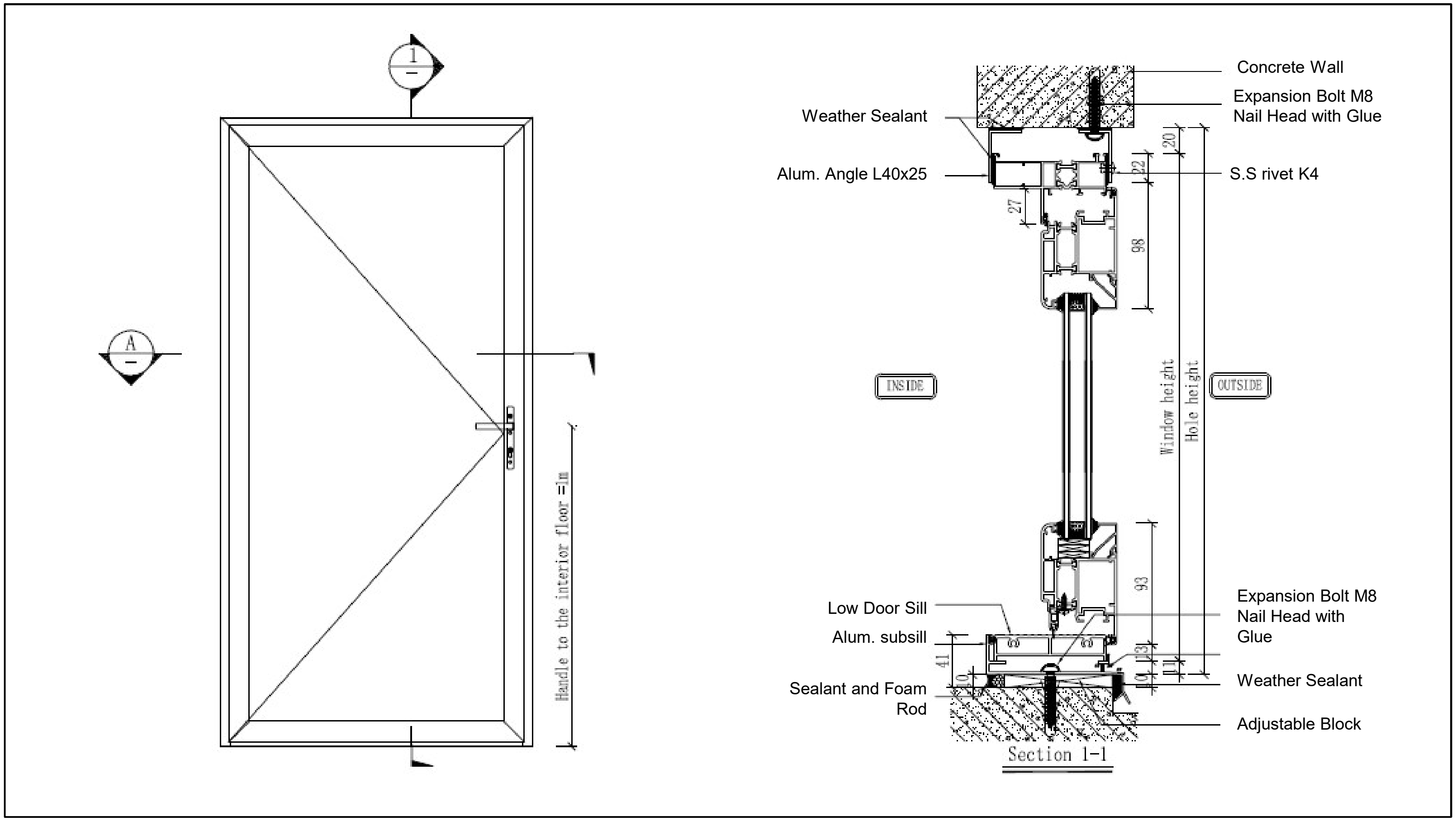
7. Section Details

Typical Window Detail – Sliding (cont)



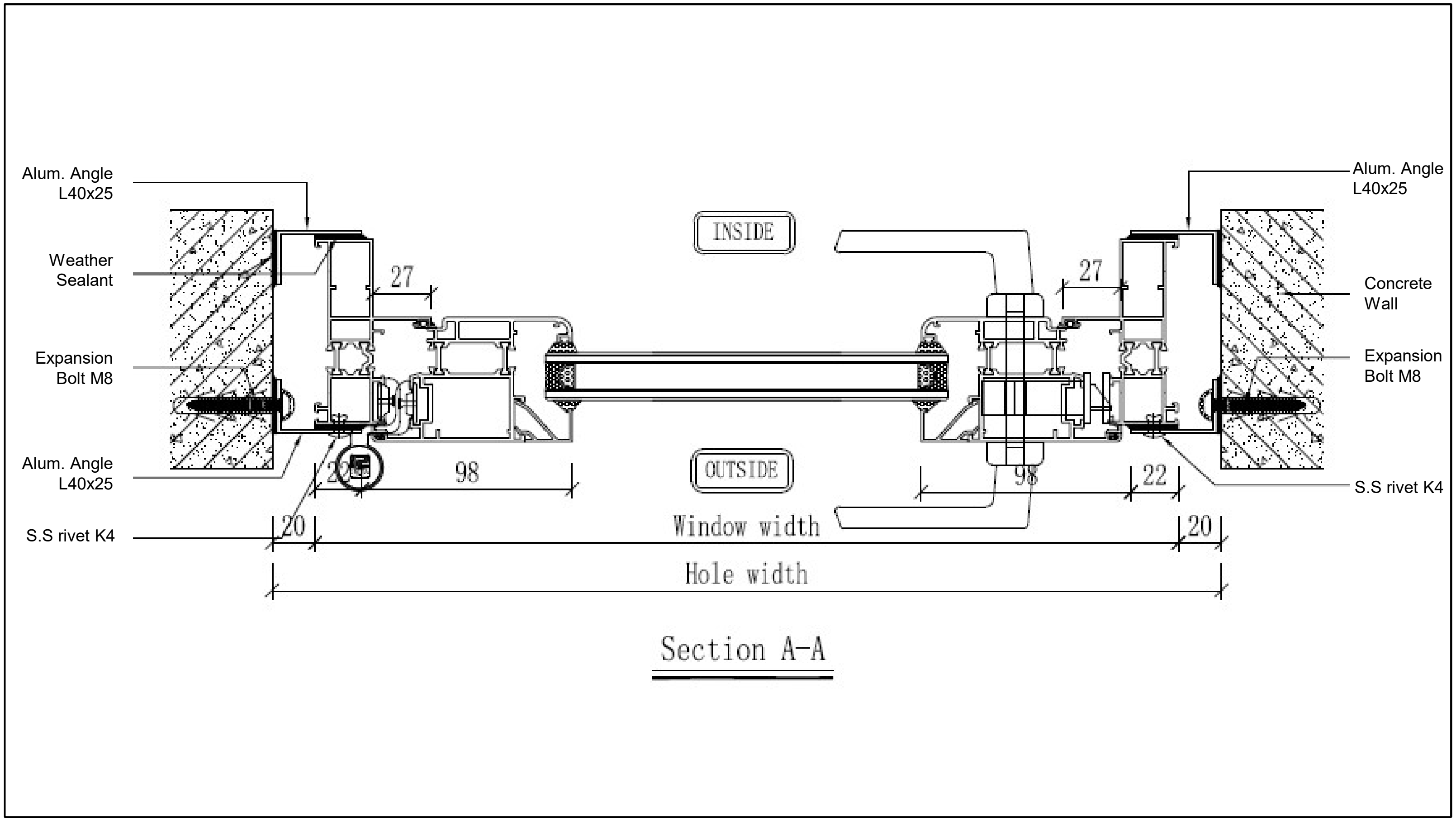
7. Section Details

Typical Door Detail – Hinged External Door



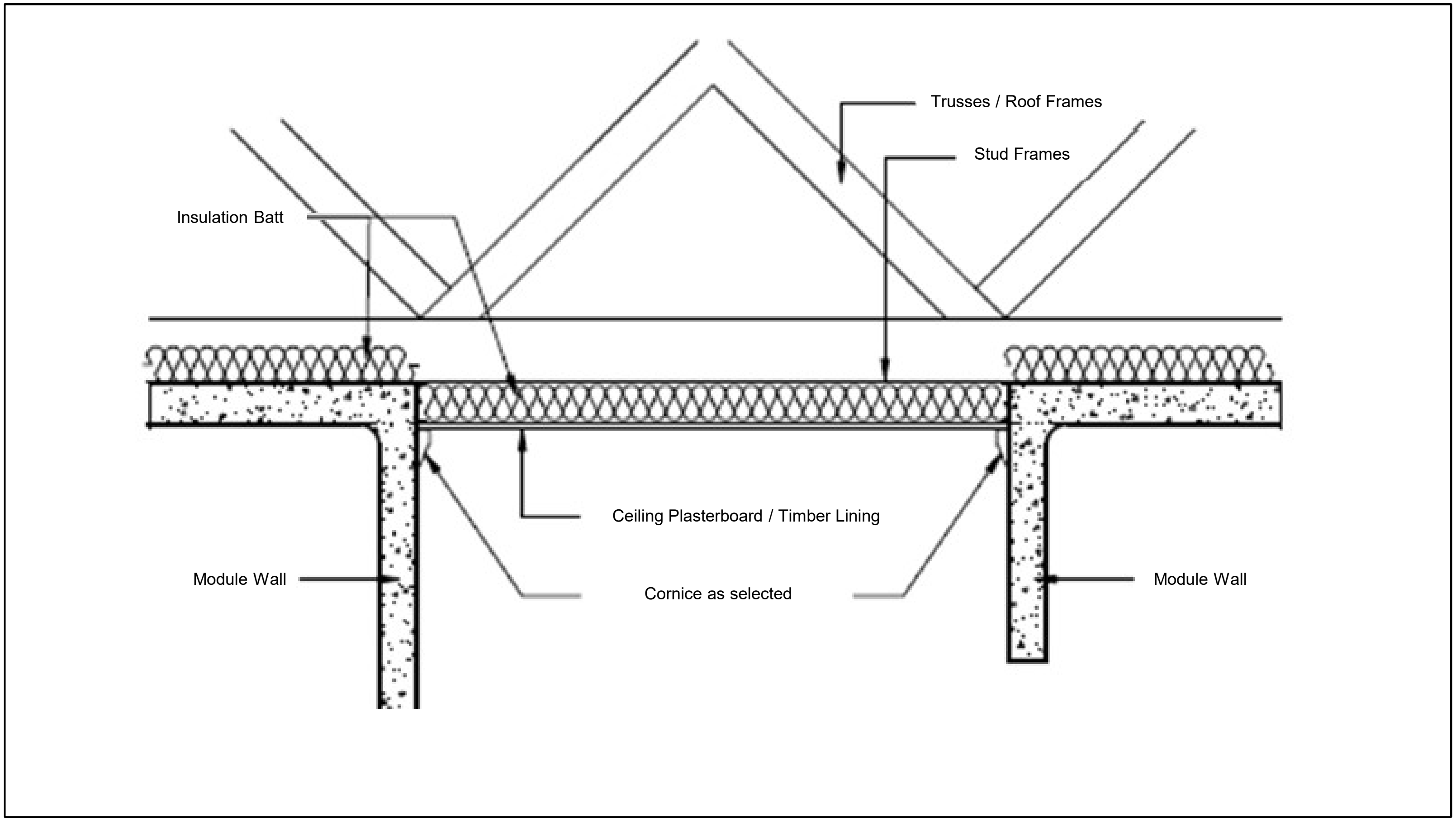
7. Section Details

Typical Door Detail – Hinged External Door (cont)



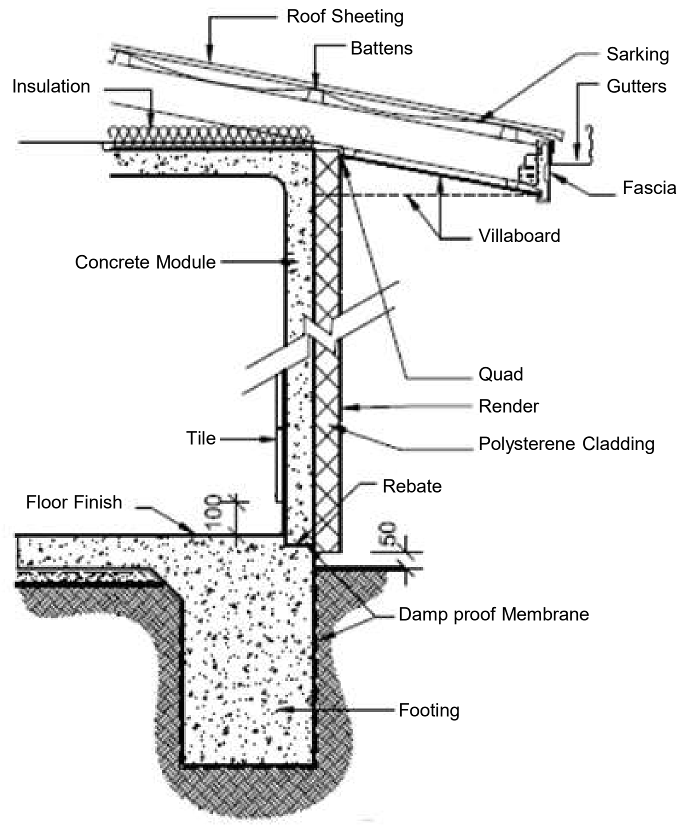
7. Section Details

Typical Corridor Section (infill at ceiling)



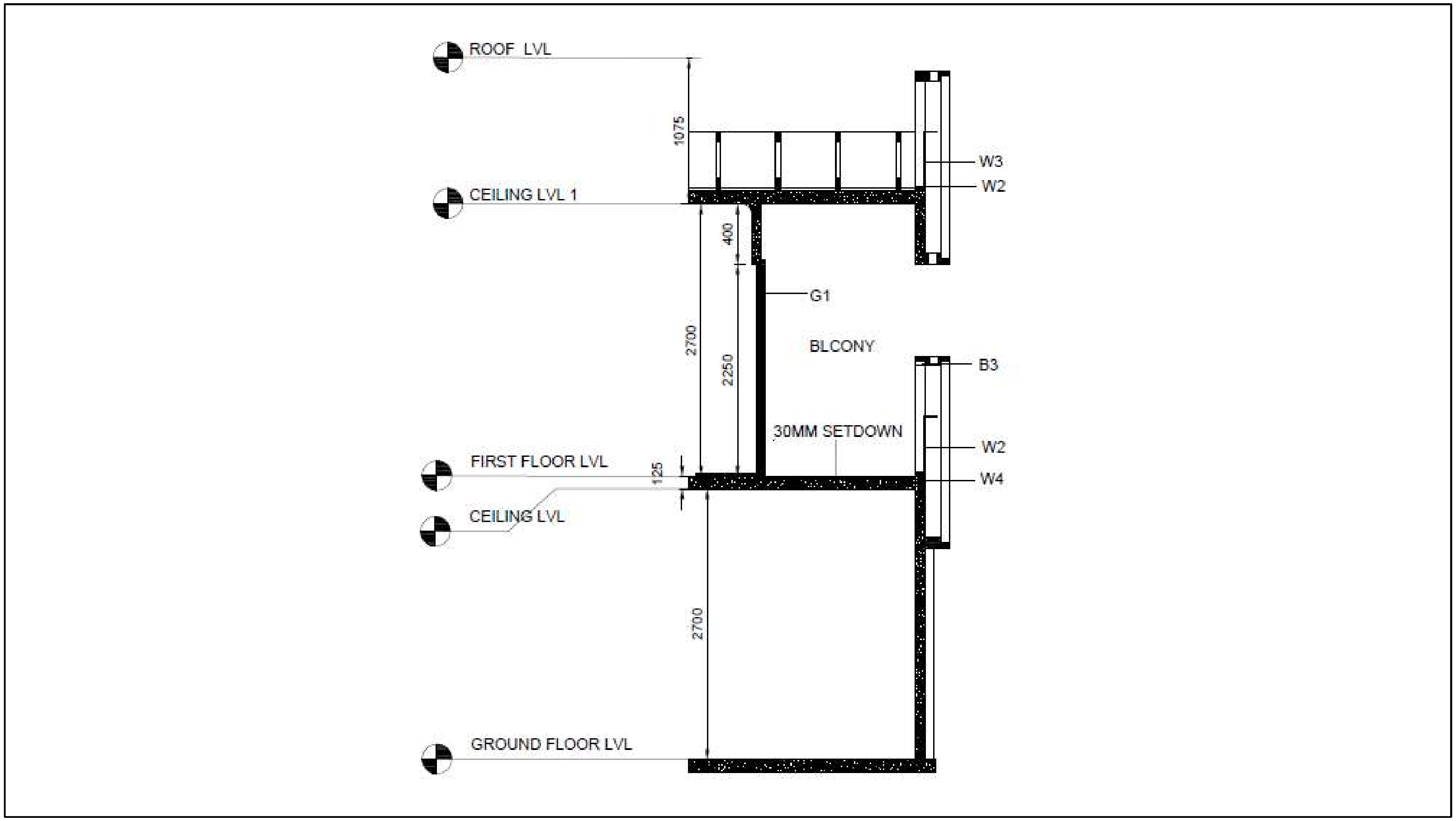
7. Section Details

Typical Wall Section Detail



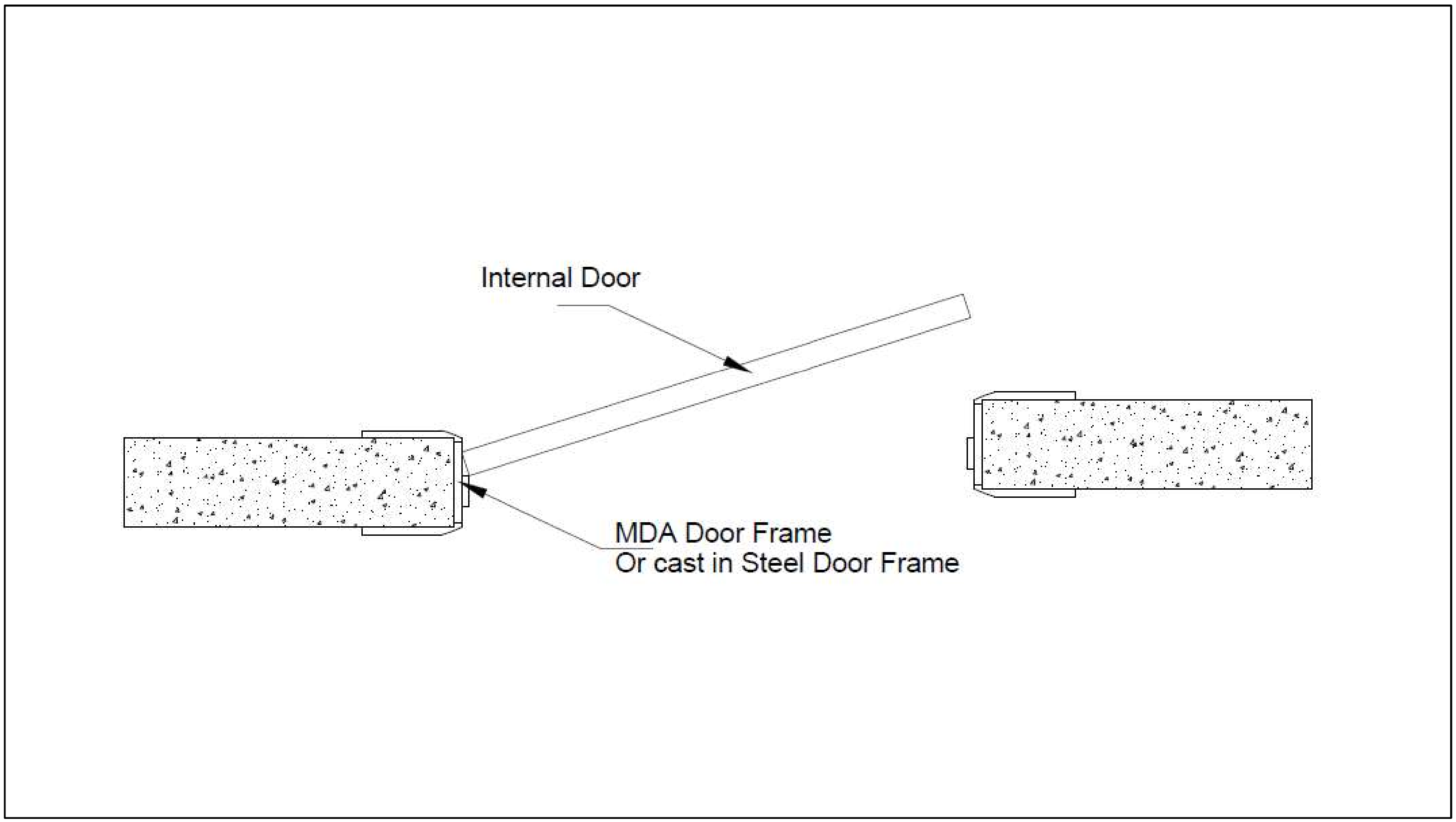
7. Section Details – (cont)

Typical Balcony Detail



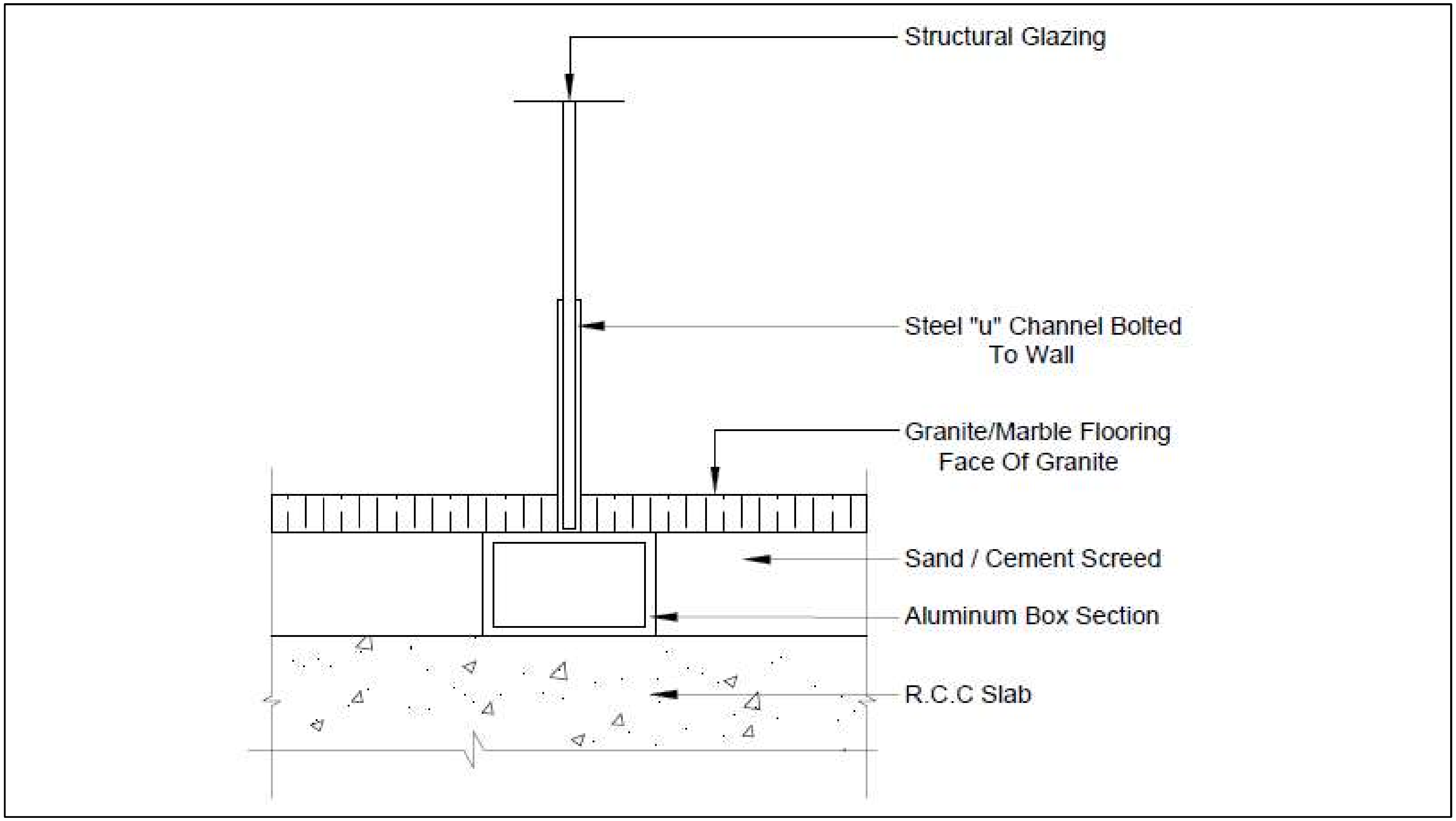
7. Section Details – (cont)

Typical Internal Door Detail



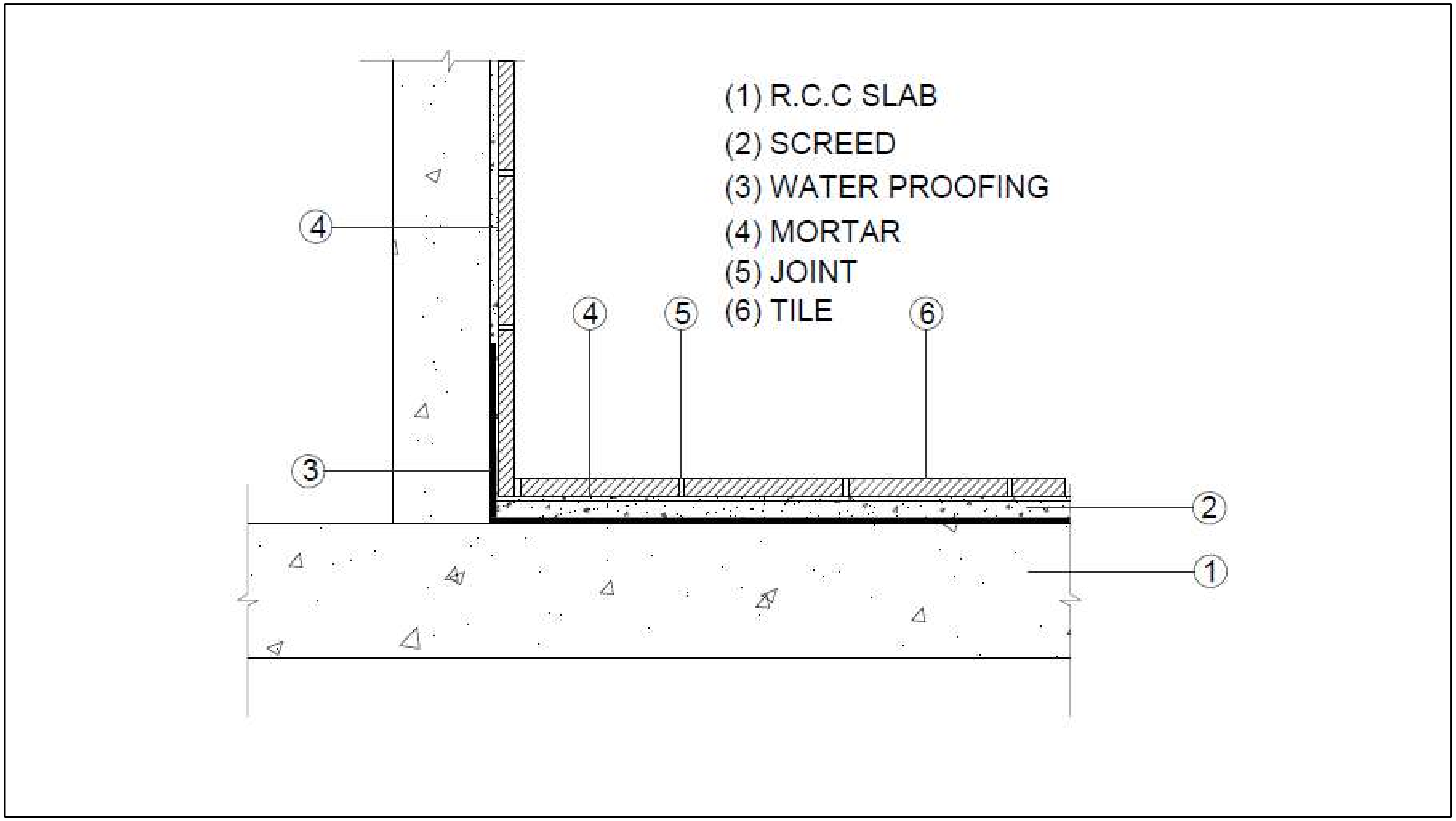
7. Section Details – (cont)

Glass Screen Base Detail



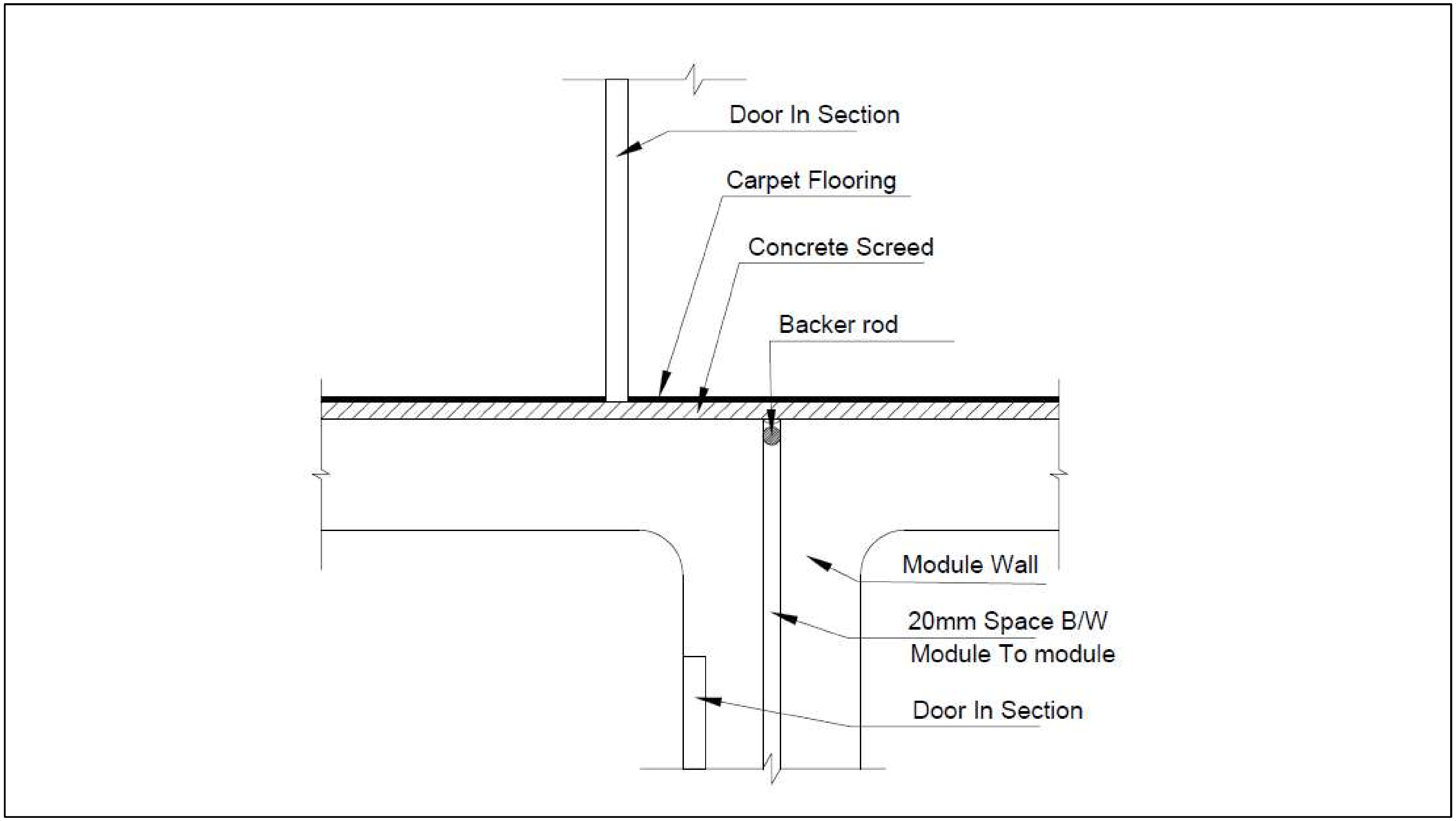
7. Section Details – (cont)

Kitchen / Bathroom Waterproofing Detail



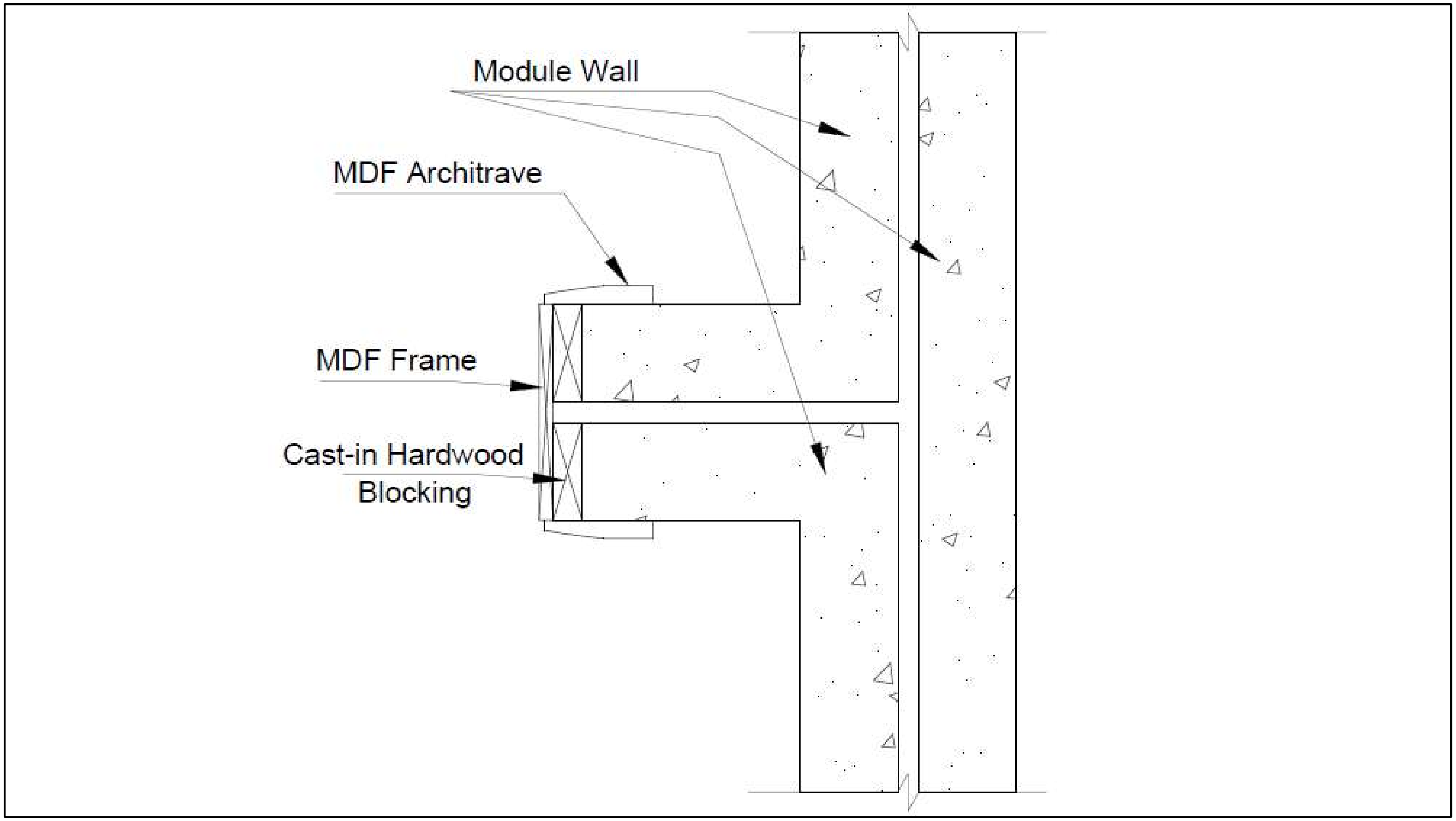
7. Section Details – (cont)

Typical Carpet Detail



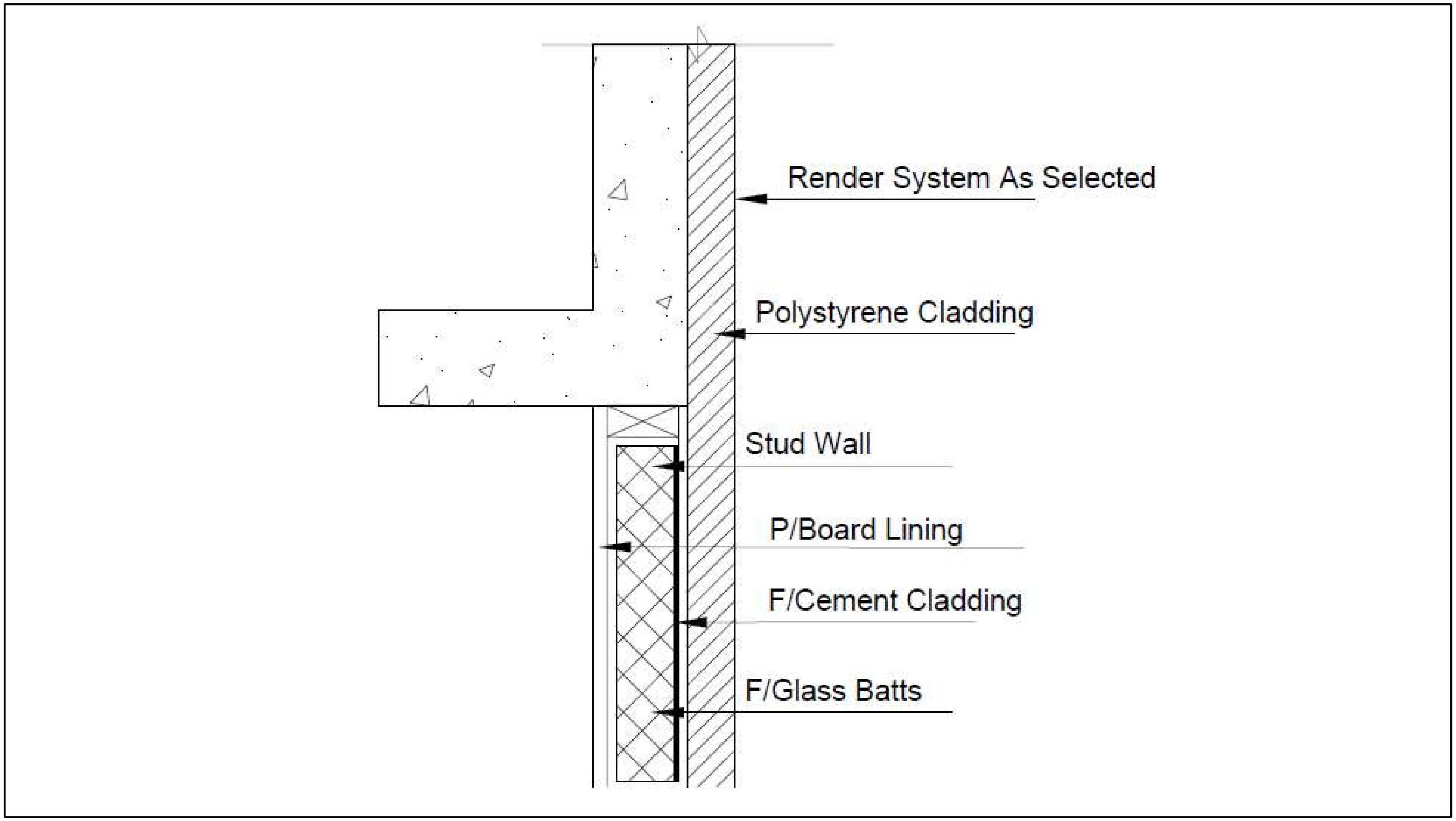
7. Section Details – (cont)

Module Nib to Nib Finishing Detail



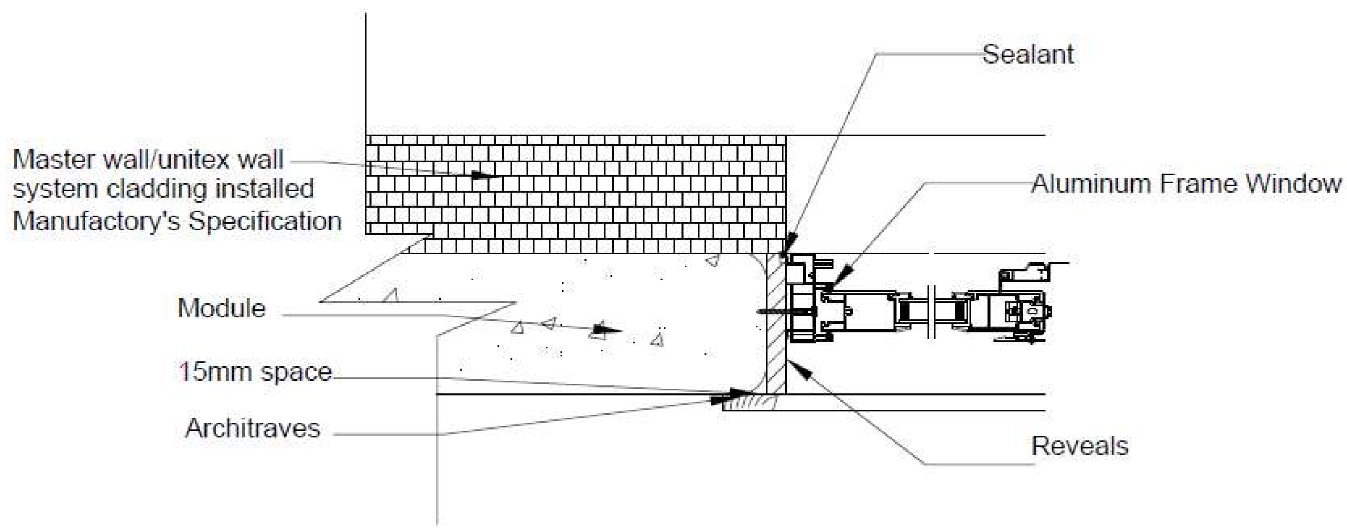
7. Section Details – (cont)

Module to Stud Wall Detail



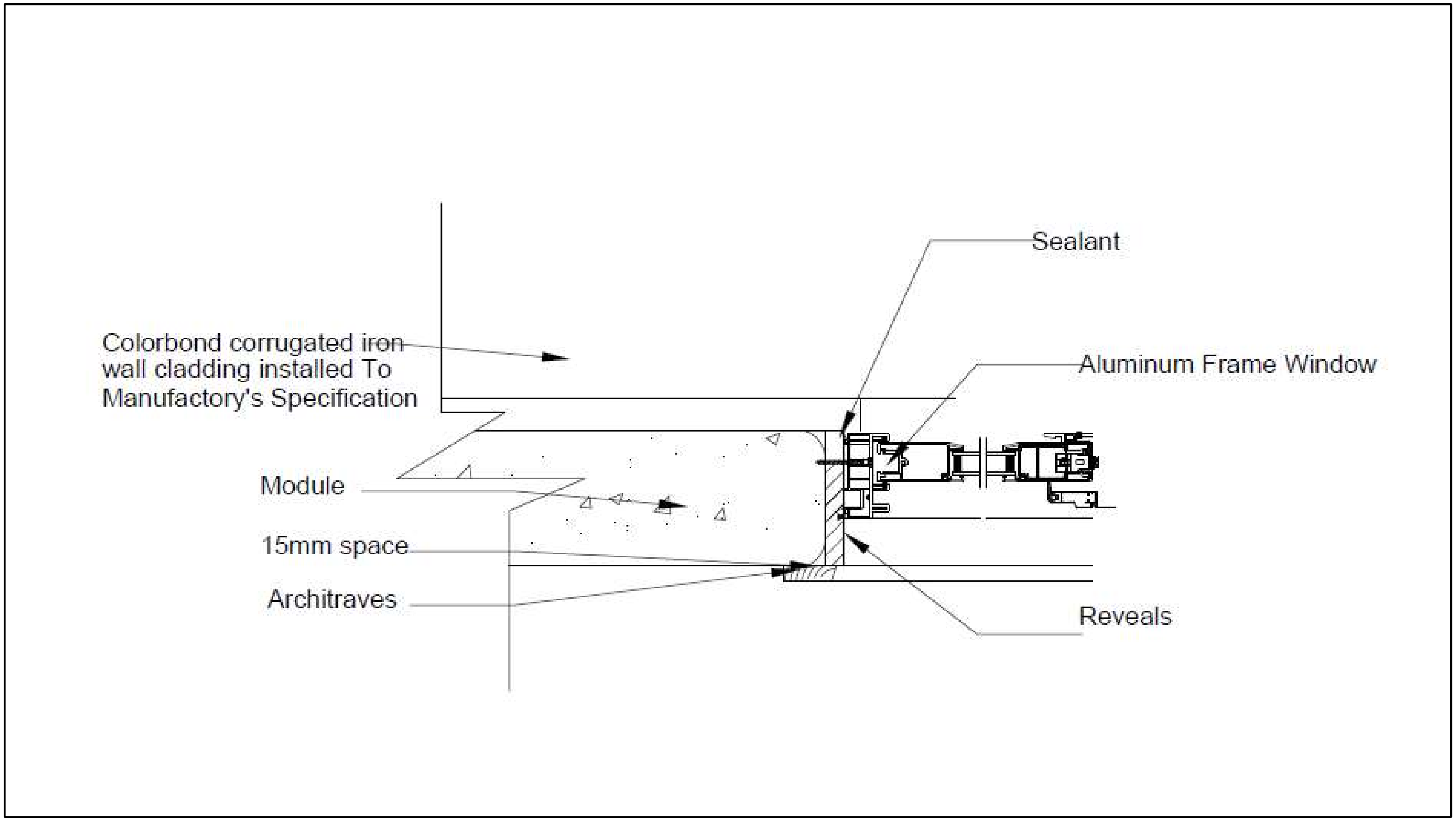
7. Section Details – (cont)

Masterwall / Unitex Wall Cladding Detail



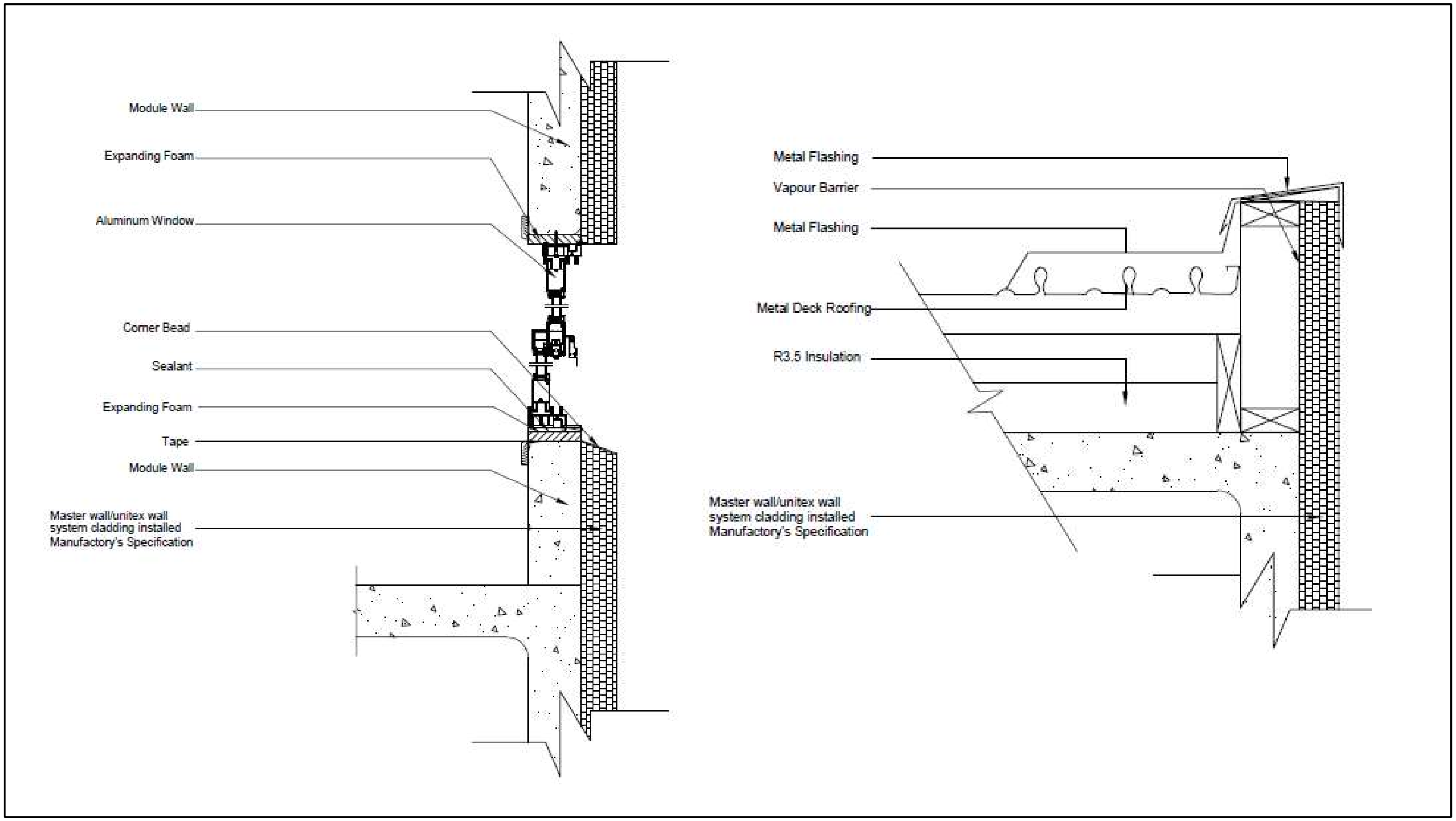
7. Section Details – (cont)

Corrugated Iron Wall Cladding Detail



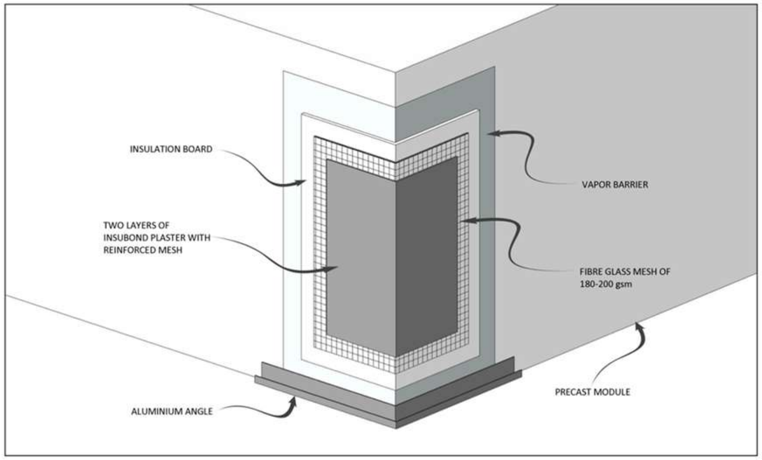
7. Section Details – (cont)

Masterwall / Unitex Wall Cladding



7. Section Details – (cont)

Foam & Render



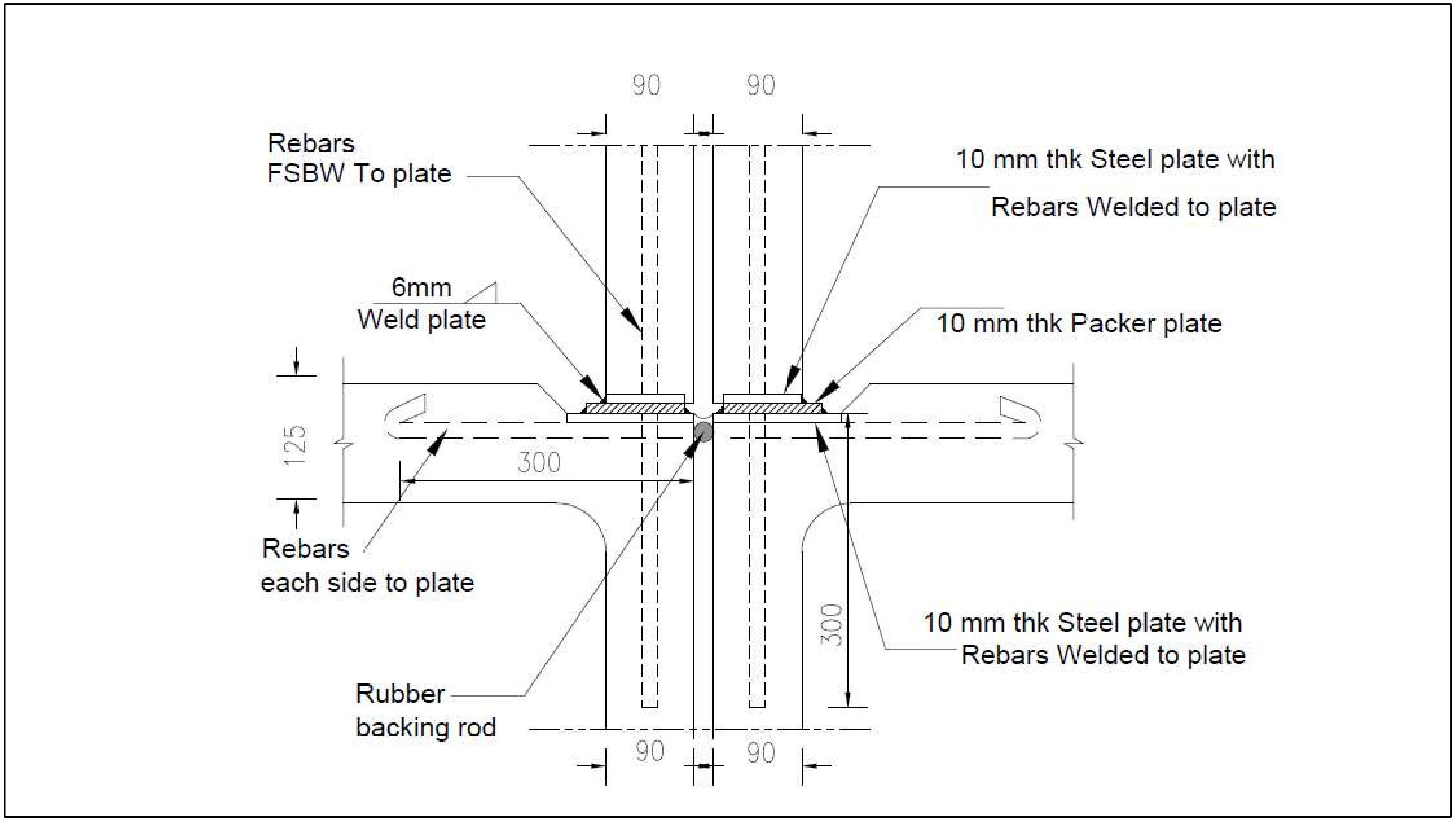
Post Fixed Foam & Render is the most versatile system as it is done independently of the modular manufacture process and can be placed on any wall or return required, can be done in the factory, or on the site. It is also a relatively simple process that can be outsourced to other trades as required. The insulation value can also be varied quite simply by increasing the thickness of the foam layer at minimal extra cost.

The process involves applying a foam thickness via direct adhesive to the concrete substrate. A fibreglass or plastic mesh is then applied all over with reinforced corner angles. A 2 to 4 coat render system is then applied to give the desired finish. The render can also be coloured up to eliminate the need for painting the final coat. Post Fixed Foam & Cement Sheeting is another technique that combines both of the above processes to give a greater durability. The process involves prefixing the foam to 20mm compressed fibre cement sheet that has mechanical anchors protruding from it. The prefixed foam & sheet are placed on the mould outer skin and the structural layer of concrete is then poured against this and bond in the moulding process. When the module is extracted from the mould the insulation and outer cement sheet are integrally cast to the concrete. The thermal resistance for typical extruded polystyrene foam thicknesses are as follows:

75mm thickness 2.59 R-Value 0.386 U-Value
100mm thickness 3.46 R-Value 0.289 U-Value

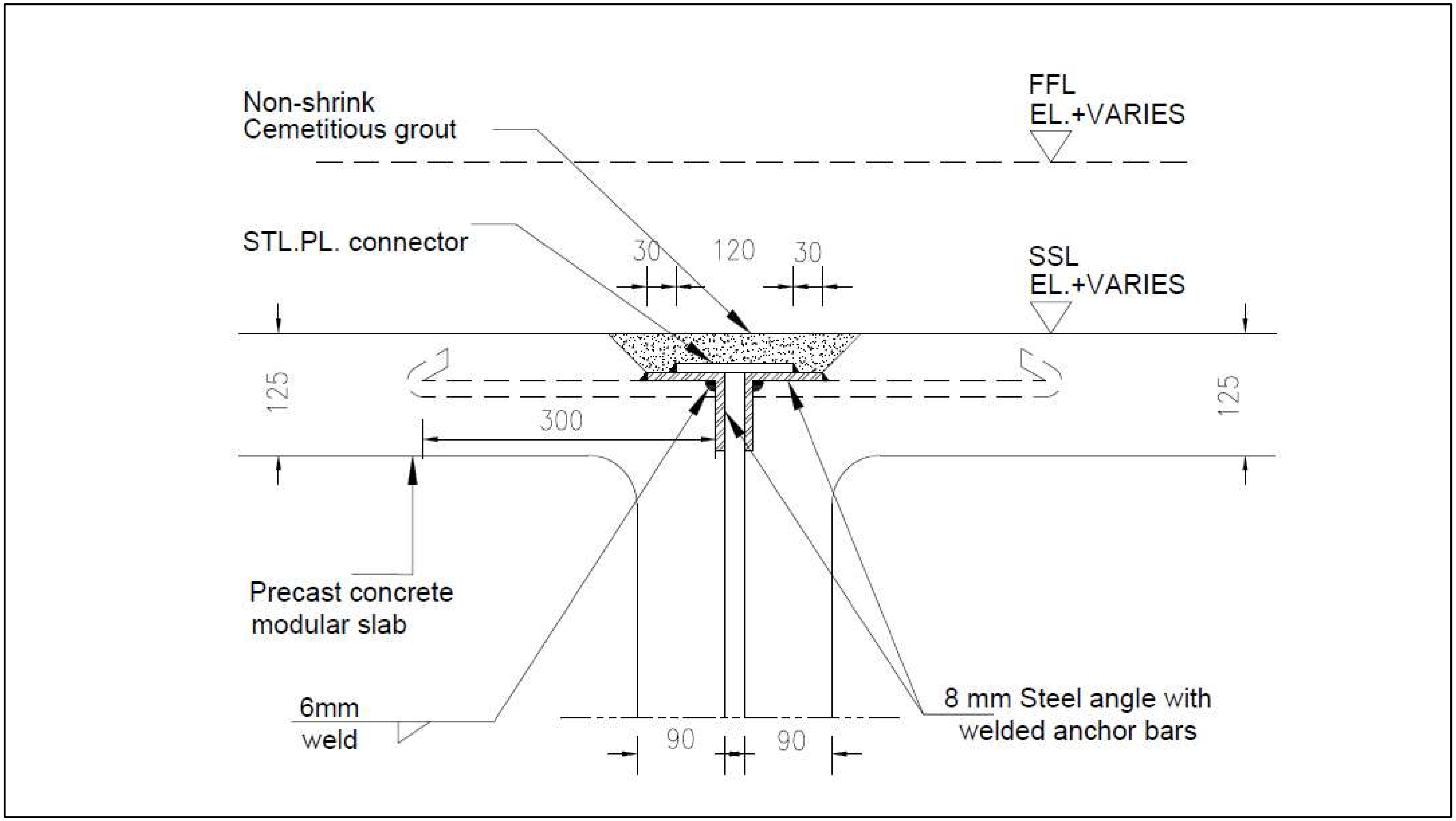
7. Section Details – (cont)

Module Connections – Typical Bottom Connection for Internal Walls



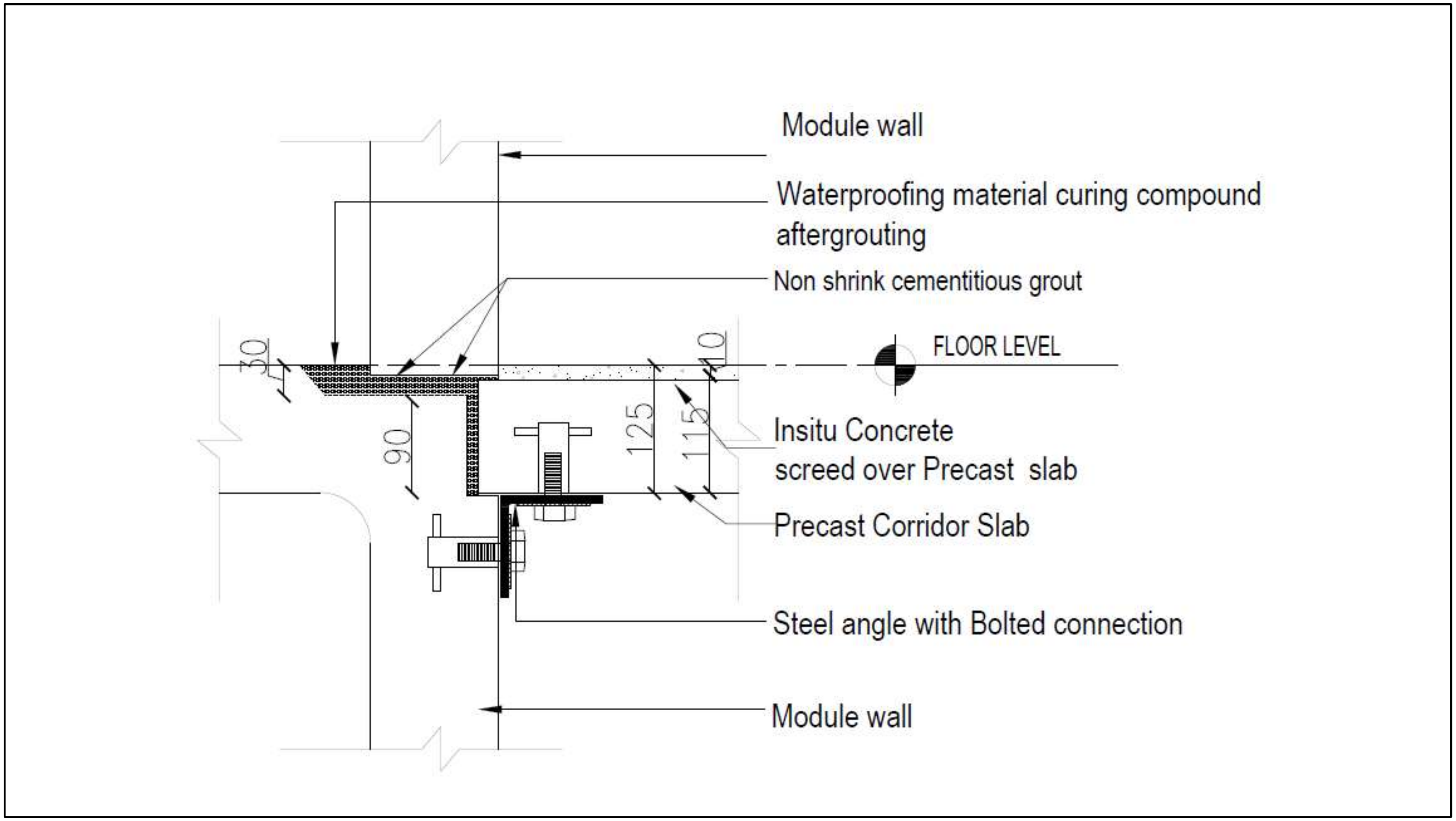
7. Section Details – (cont)

Module Connections – Typical Top Connection for Internal Walls



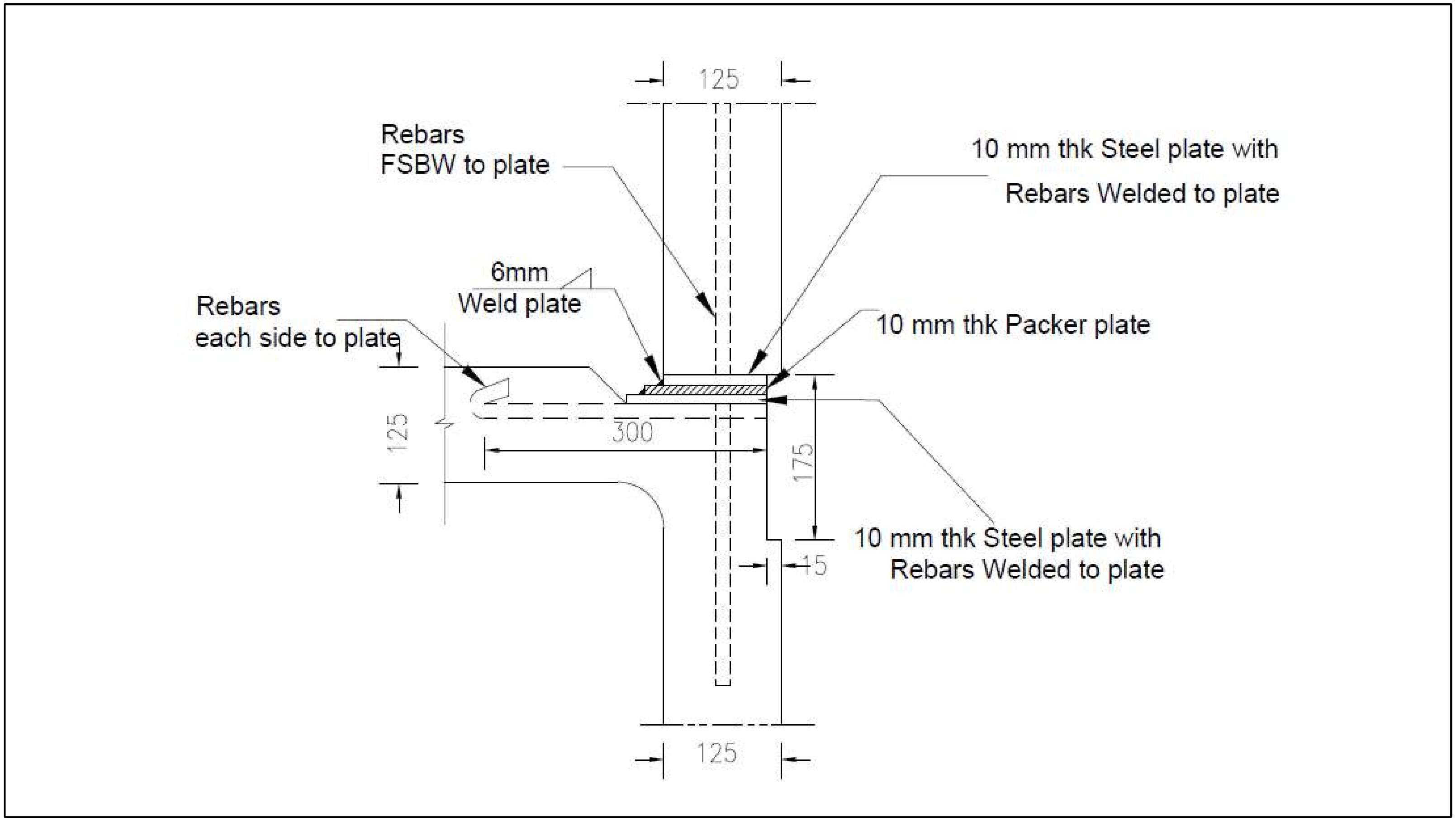
7. Section Details – (cont)

Module Connections – Typical Detail at Corridor to Module Wall



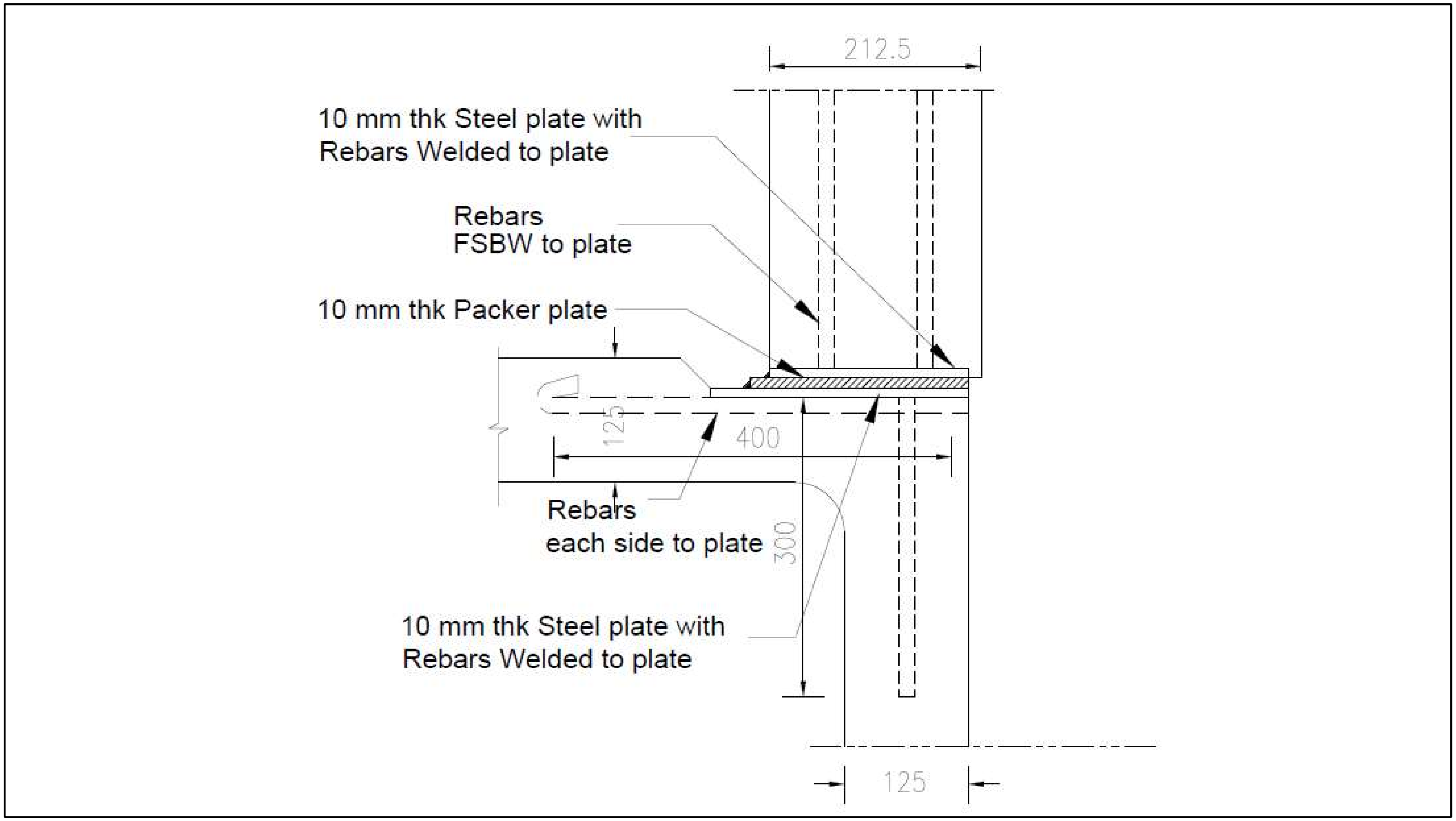
7. Section Details – (cont)

Module Connections – Typical Bottom Connection for External Walls



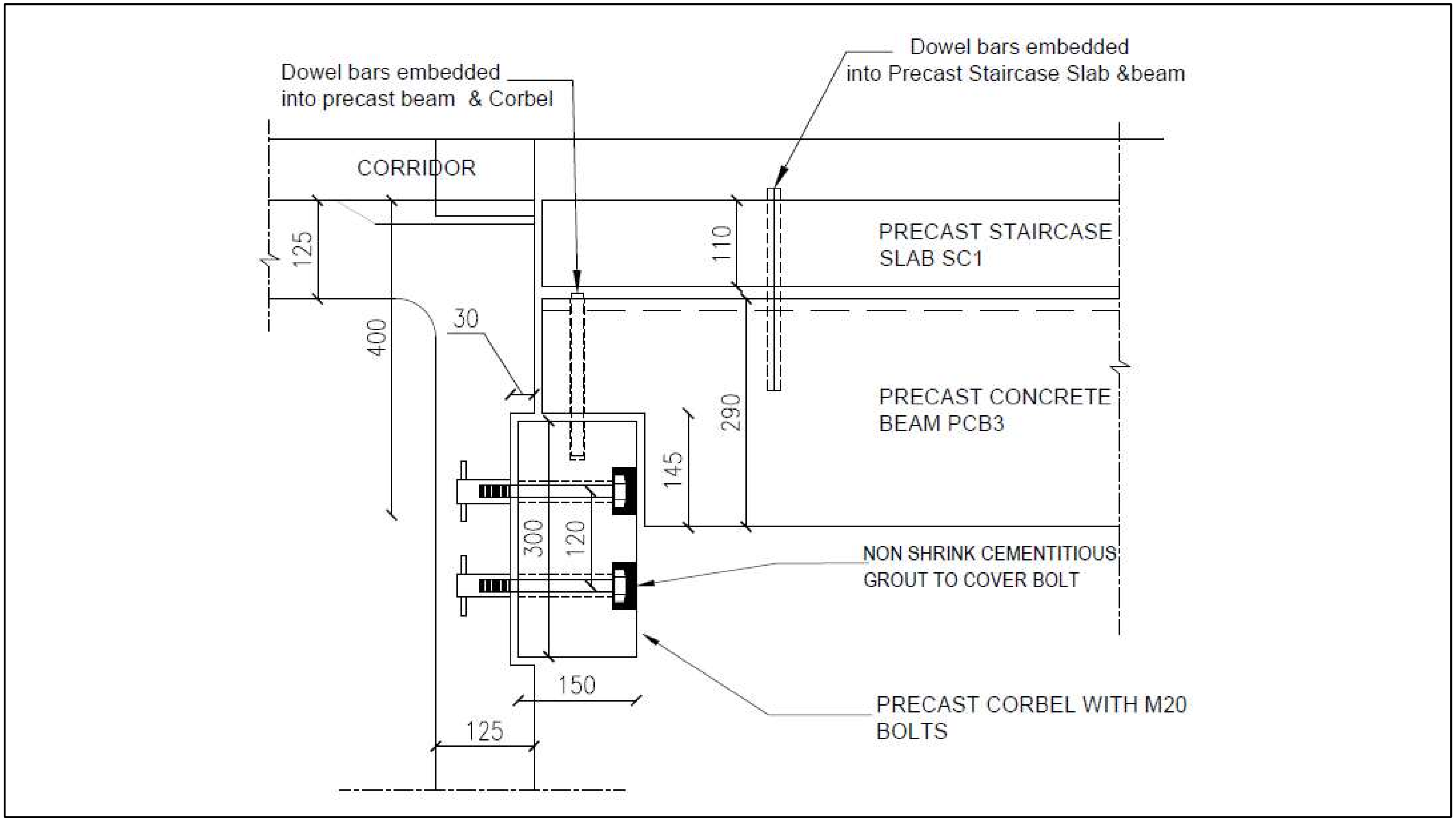
7. Section Details – (cont)

Module Connections – Typical Bottom Connection at Terrace Level



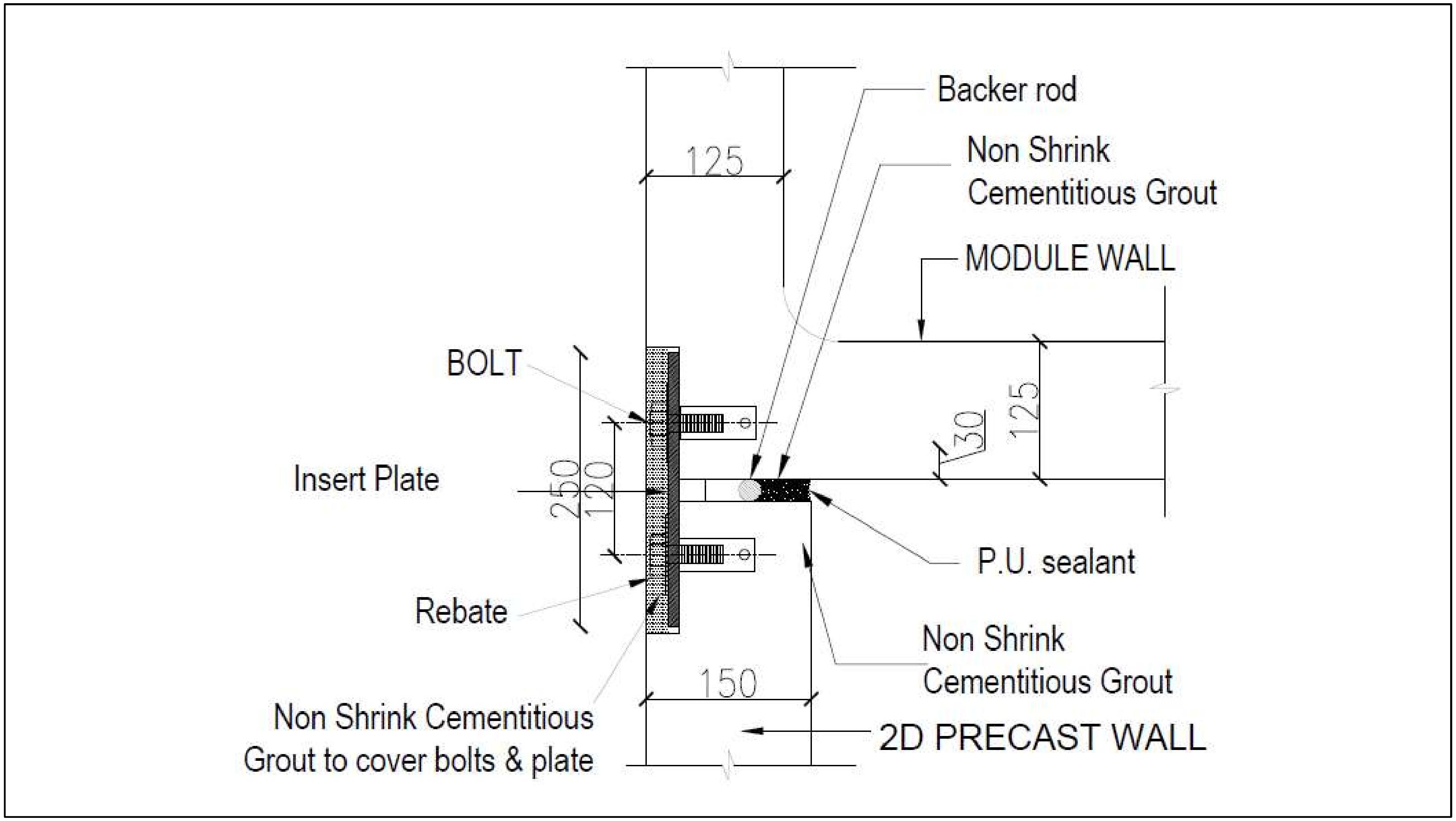
7. Section Details – (cont)

Module Connections – Typical Connection b/w Precast Beam and Module Wall



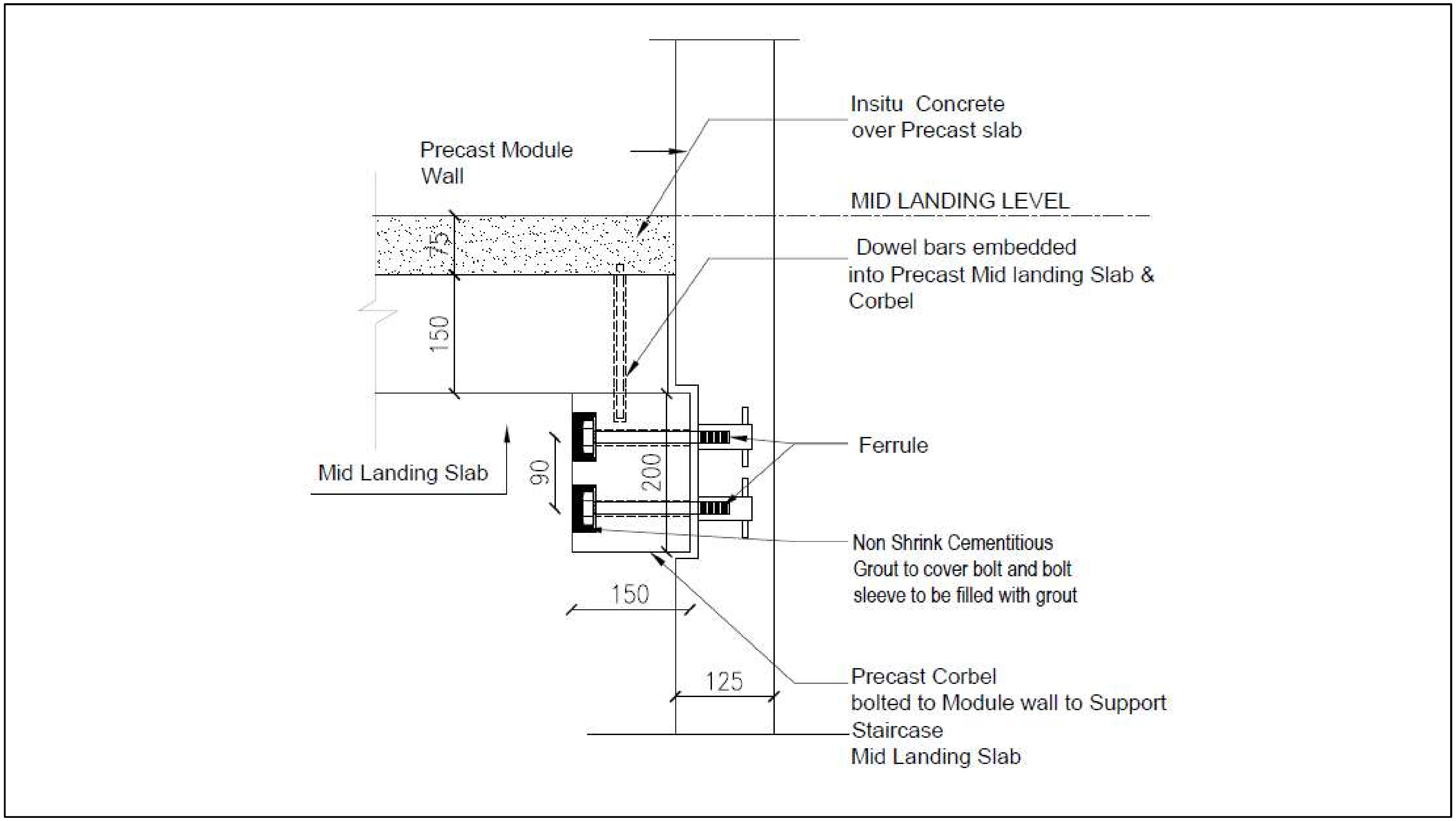
7. Section Details – (cont)

Module Connections – Typical Connection b/w Module Wall & 2D Precast Wall



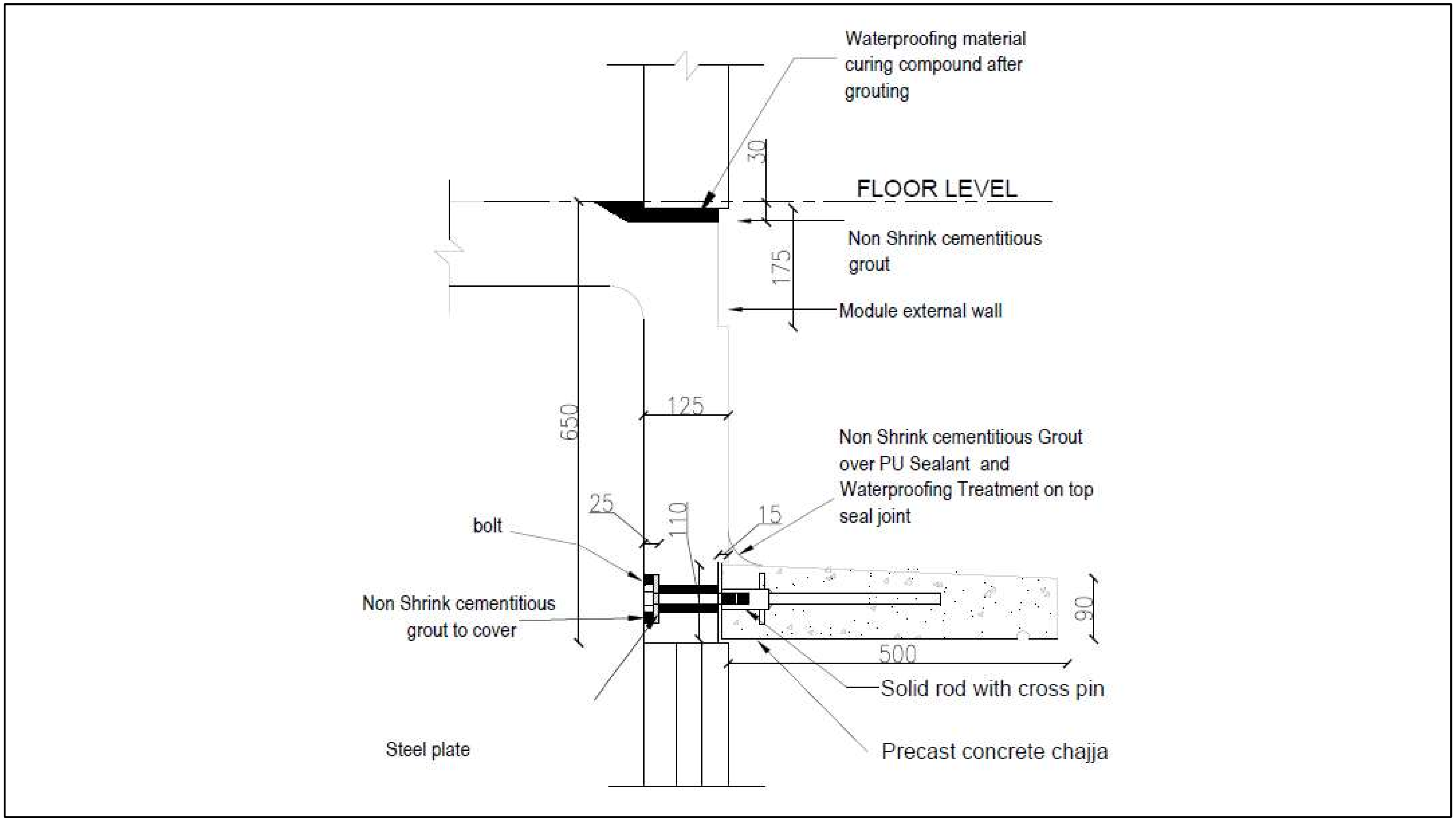
7. Section Details – (cont)

Module Connections – Typical Staircase Mid Landing Connection



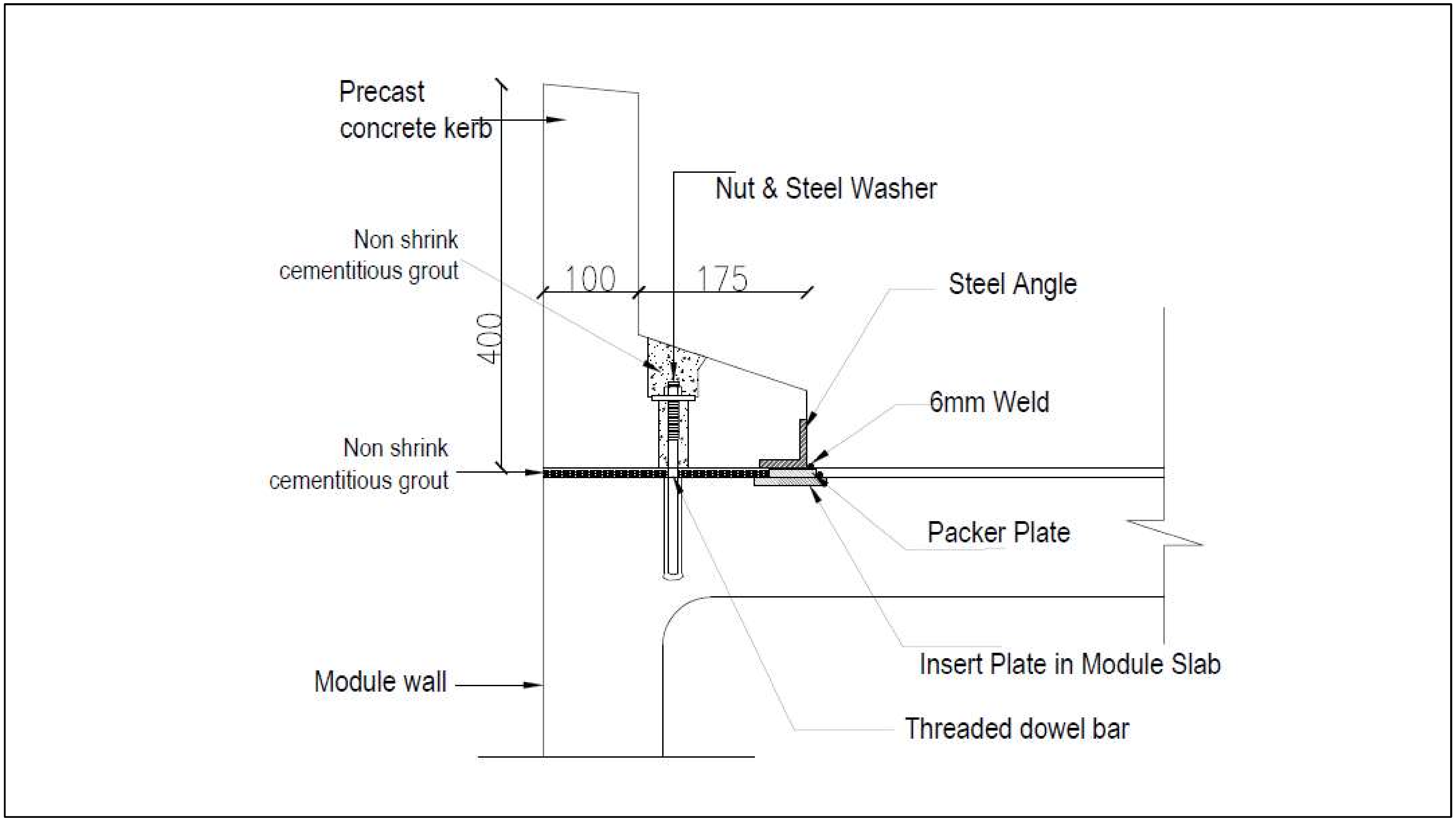
7. Section Details – (cont)

Module Connections – Typical Connection Chajja to Module



7. Section Details – (cont)

Module Connections – Typical Parapet Connection



Transportation & Onsite Delivery

8.1 Transport & Onsite Delivery

Transportability
Generally 3.5m wide (Excluding chains) and 4.6m high (total height from road) are the gazetted wide and high load limits without escort vehicles required in most regions. Large steel transport frames are used across a traditional truck tray to transport the units around the manufacture site to their installation position or to another site (up to several hundred kilometres away). Chains are generally used to secure the loads either over the top or to specifically designed anchor points cast in to the underside of the units. This transport method generally has to be decided prior to manufacture so that relevant cast in points can be catered for.

Standard trailers vs "Drop Deck Trailers"
Usually 12m long and 2.4m wide and can carry approx. 24t. However, we usually like to use "drop deck" trailers that have a 9m drop tray to keep the load lower. The modules can travel on standard "flat tops" are a higher centre of gravity.

	Standard Trailer	Drop Deck	Low Loader
Tray length	12m	9m drop tray/3m	10m
Tray Width	2.4m	2.4m	Up to 3m
Tray Height	1.5m	1.1m	0.9m
Frame	0.25m	0.25m	
Max permit height	4.6m	4.6m	4.6m
Total Height (From Rd)	4.56m	4.16m	3.96m
Max basic permit width	3.5m	3.5m	

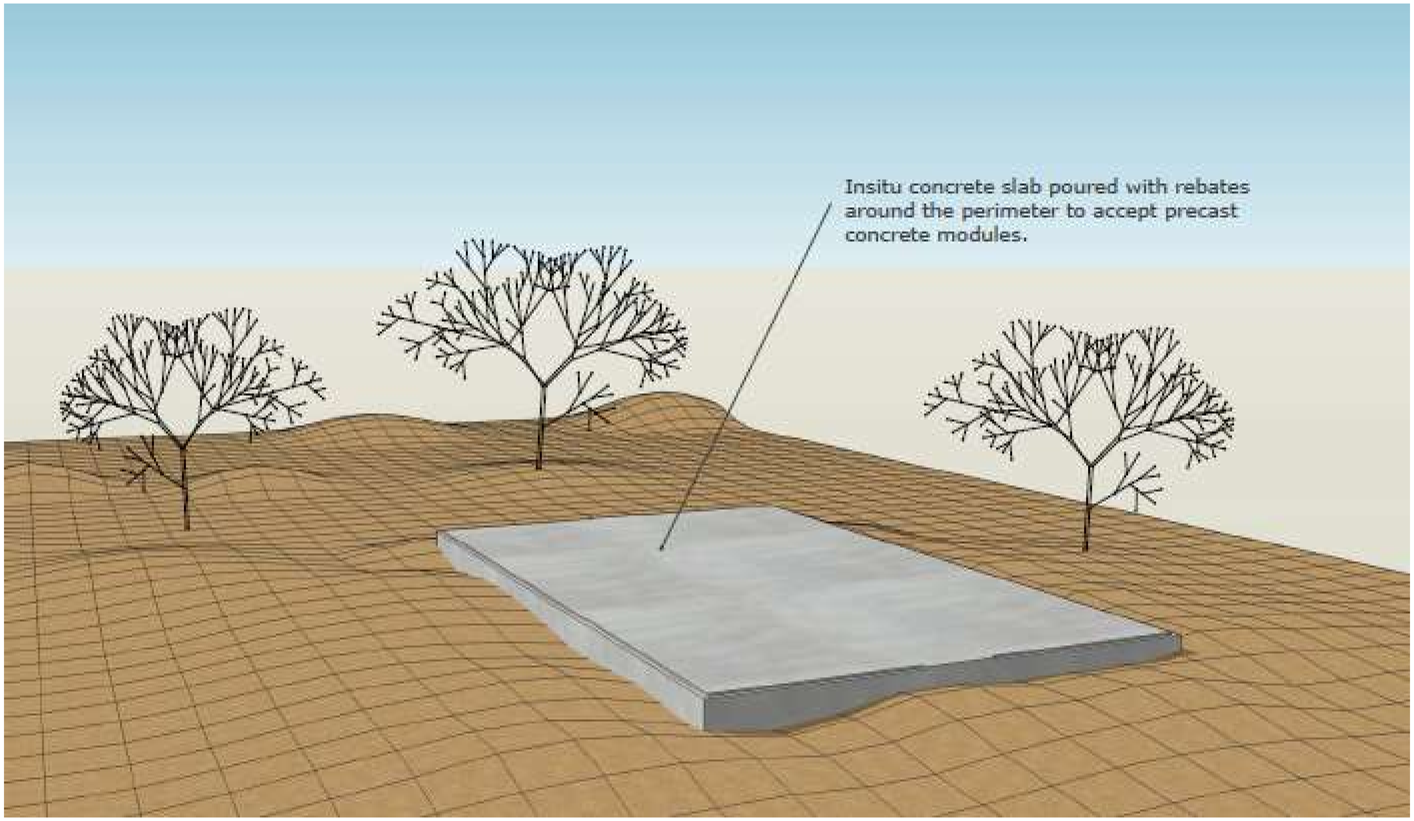
8.1 Transport & Onsite Delivery (cont)

Centre of Gravity
The manufactured units are very stable rectangular structures with a centre of gravity just over half way up their height. This is affected by the amount and configuration of openings for doors and windows etc.. Each unit during the shop drawing phase has it's own specific Centre of Gravity calculated and located on the shop drawing so that the lifting points can be positioned to ensure that the modules lift level from the mould and are easy to install.

Lifting
The cast in lifting points are usually from a proprietary precast lifting supplier. We lift from 4 points located depending on the COG calculated. The lifting chains should always be 60 degrees or more from the horizontal and in some instances a lifting spreader is used.

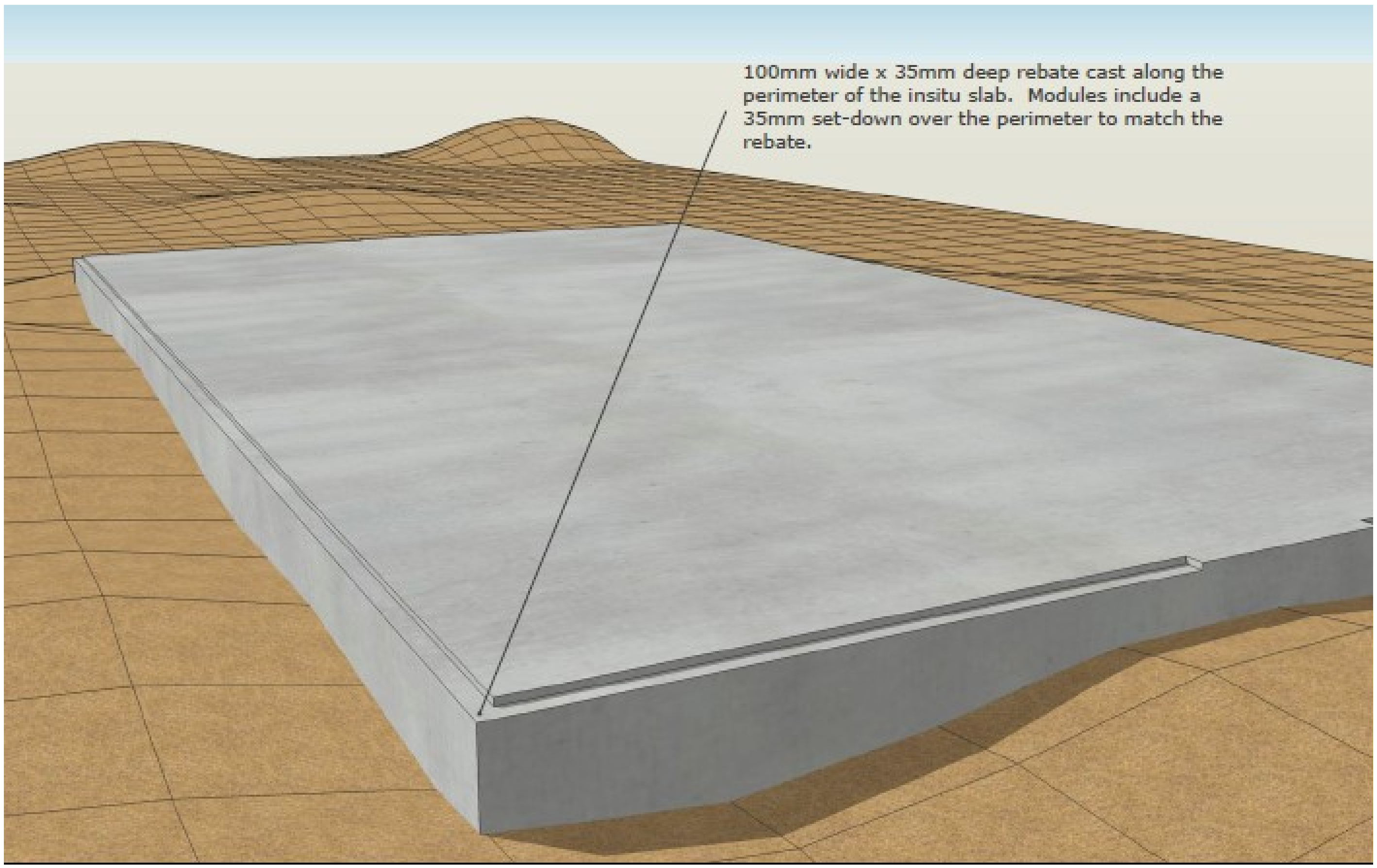
8.2 Transport & Onsite Delivery – Installation Guide

Step 1



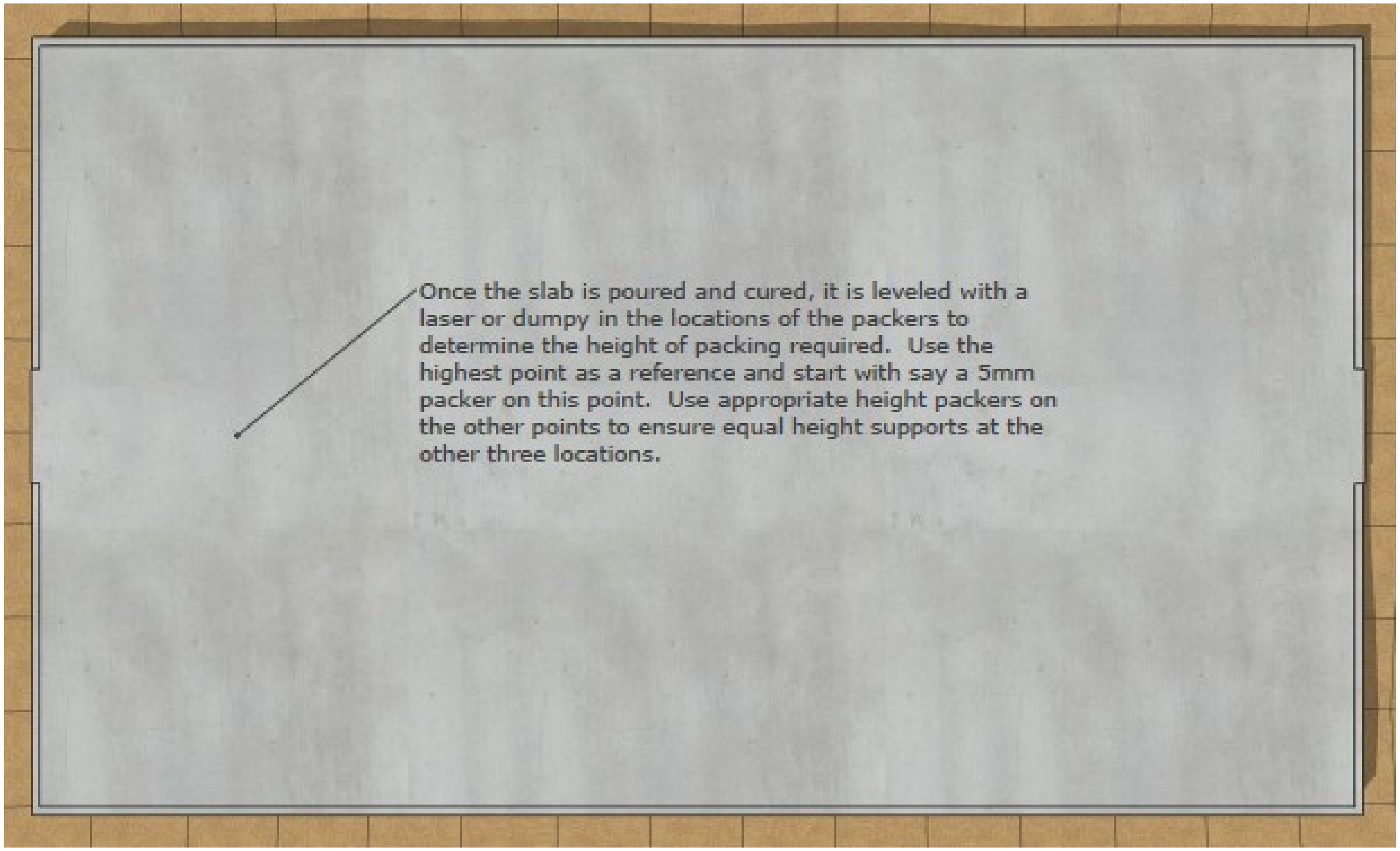
8.2 Transport & Onsite Delivery – Installation Guide (cont)

Step 2



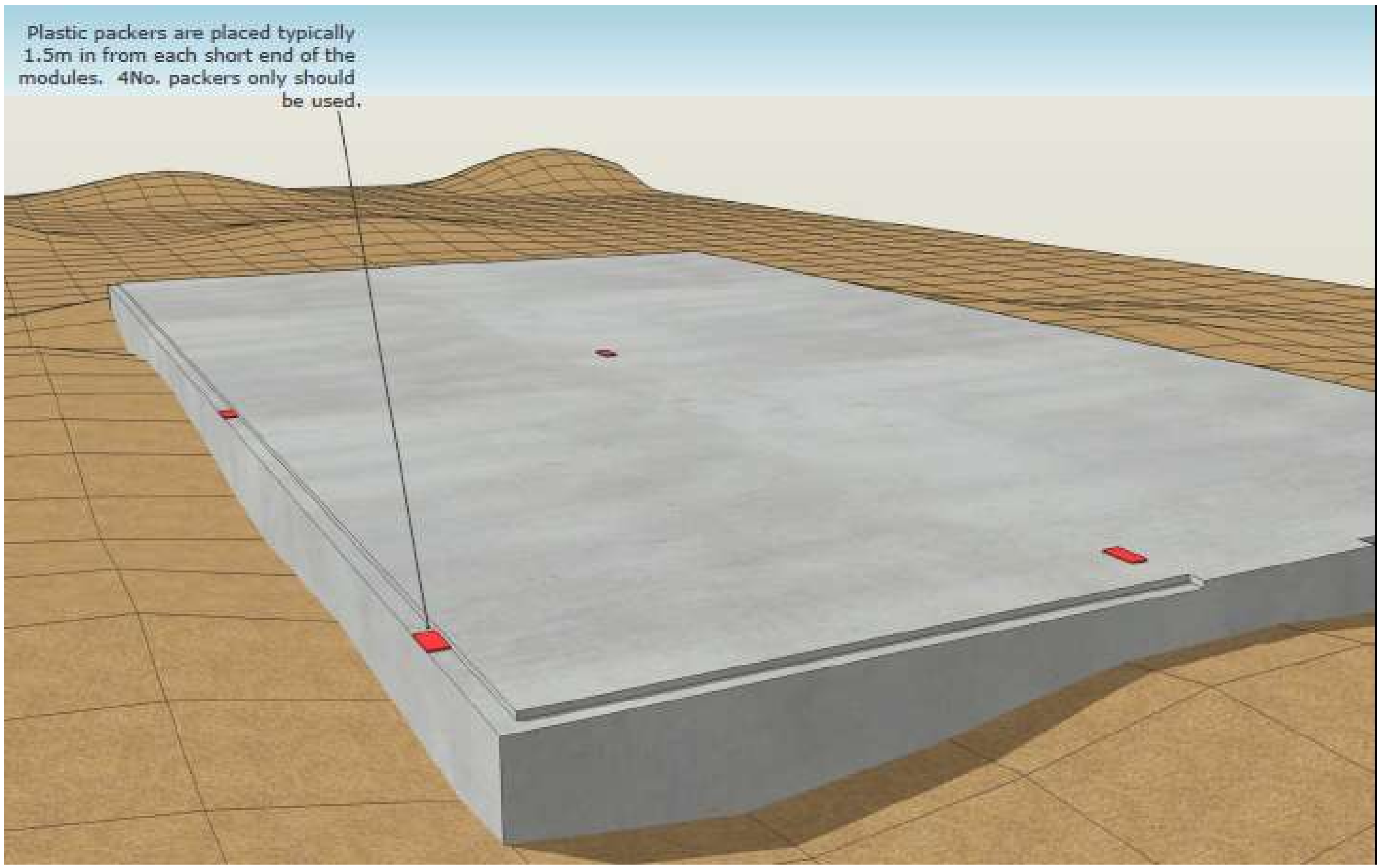
8.2 Transport & Onsite Delivery – Installation Guide (cont)

Step 3



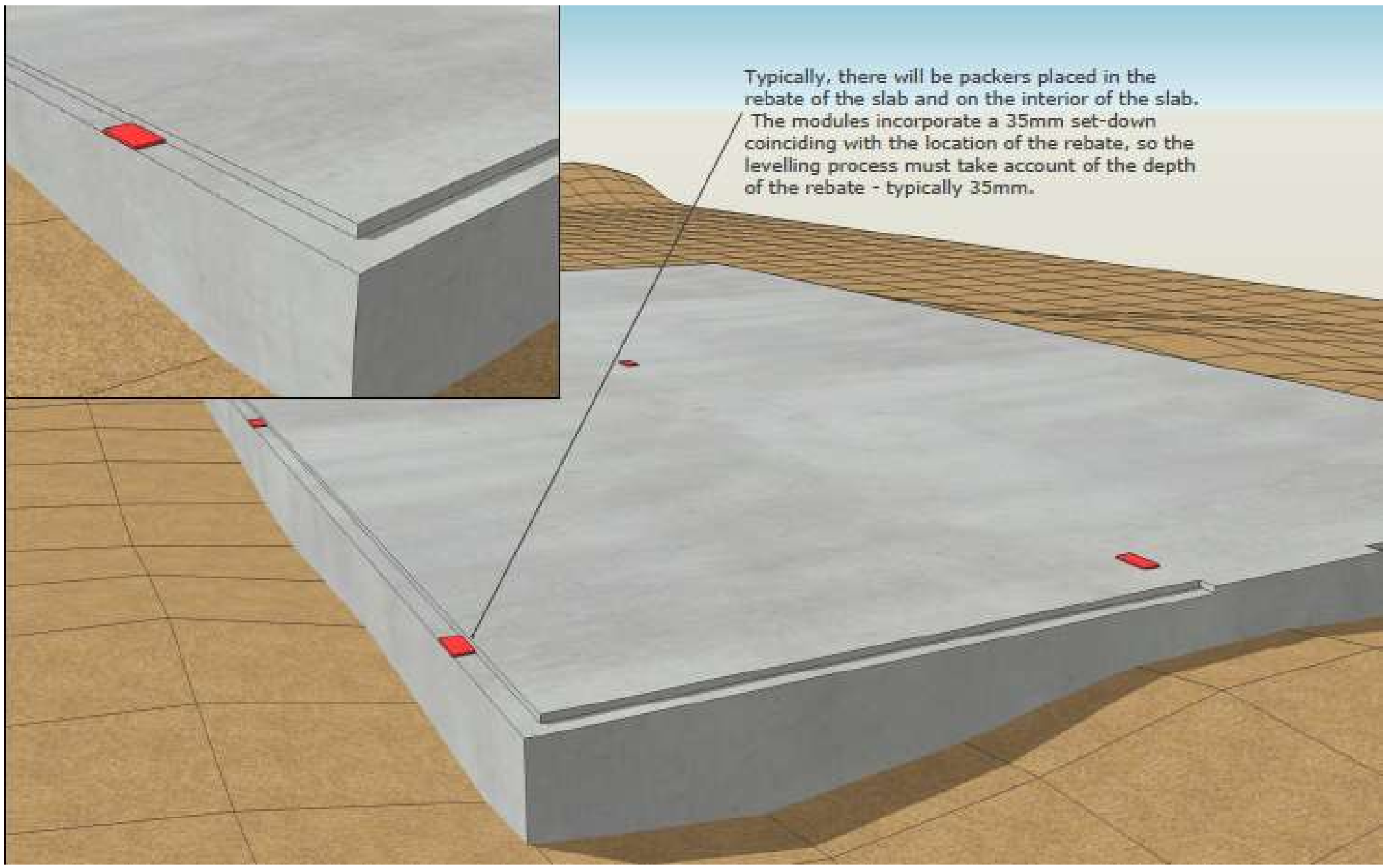
8.2 Transport & Onsite Delivery – Installation Guide (cont)

Step 4



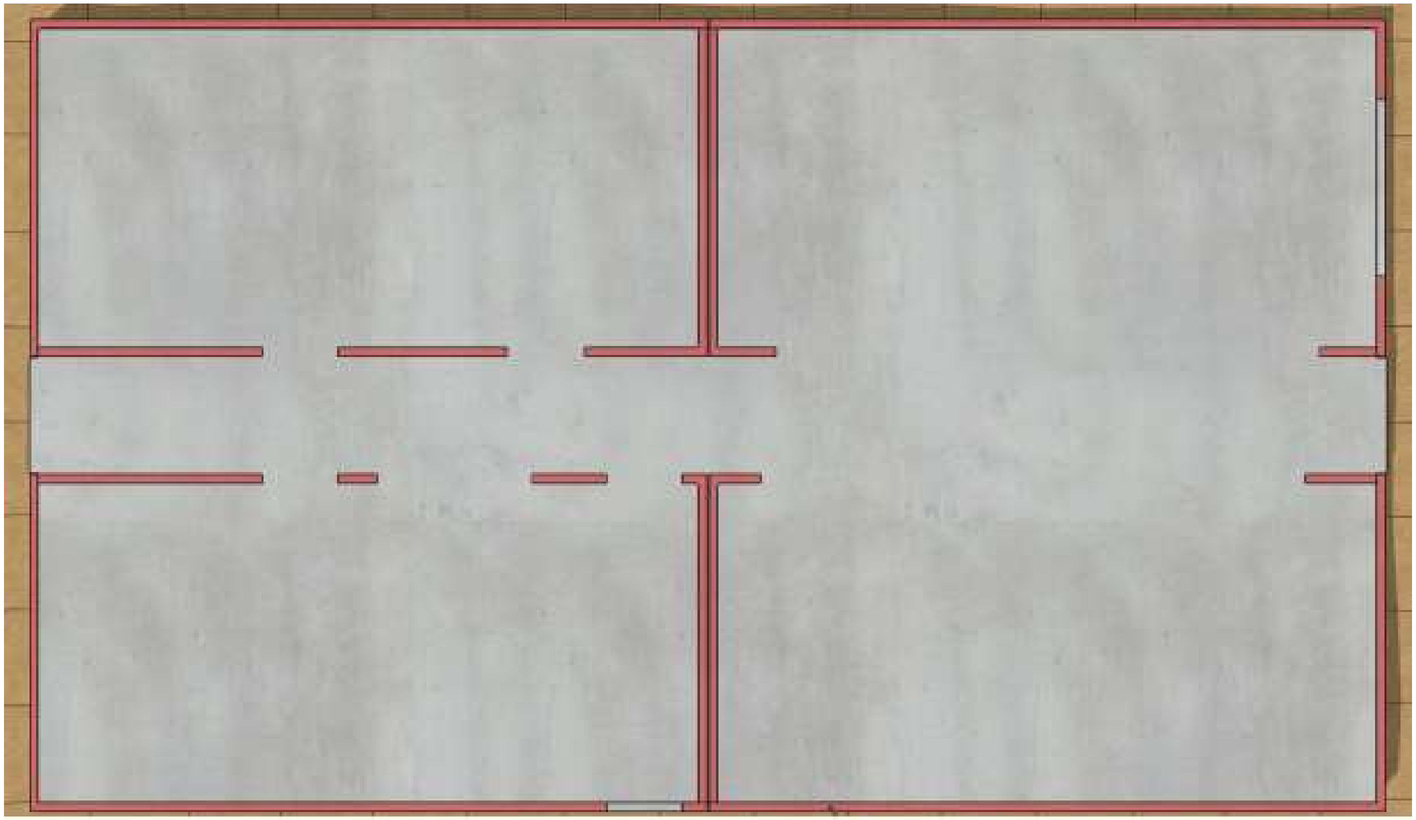
8.2 Transport & Onsite Delivery – Installation Guide (cont)

Step 5



8.2 Transport & Onsite Delivery – Installation Guide (cont)

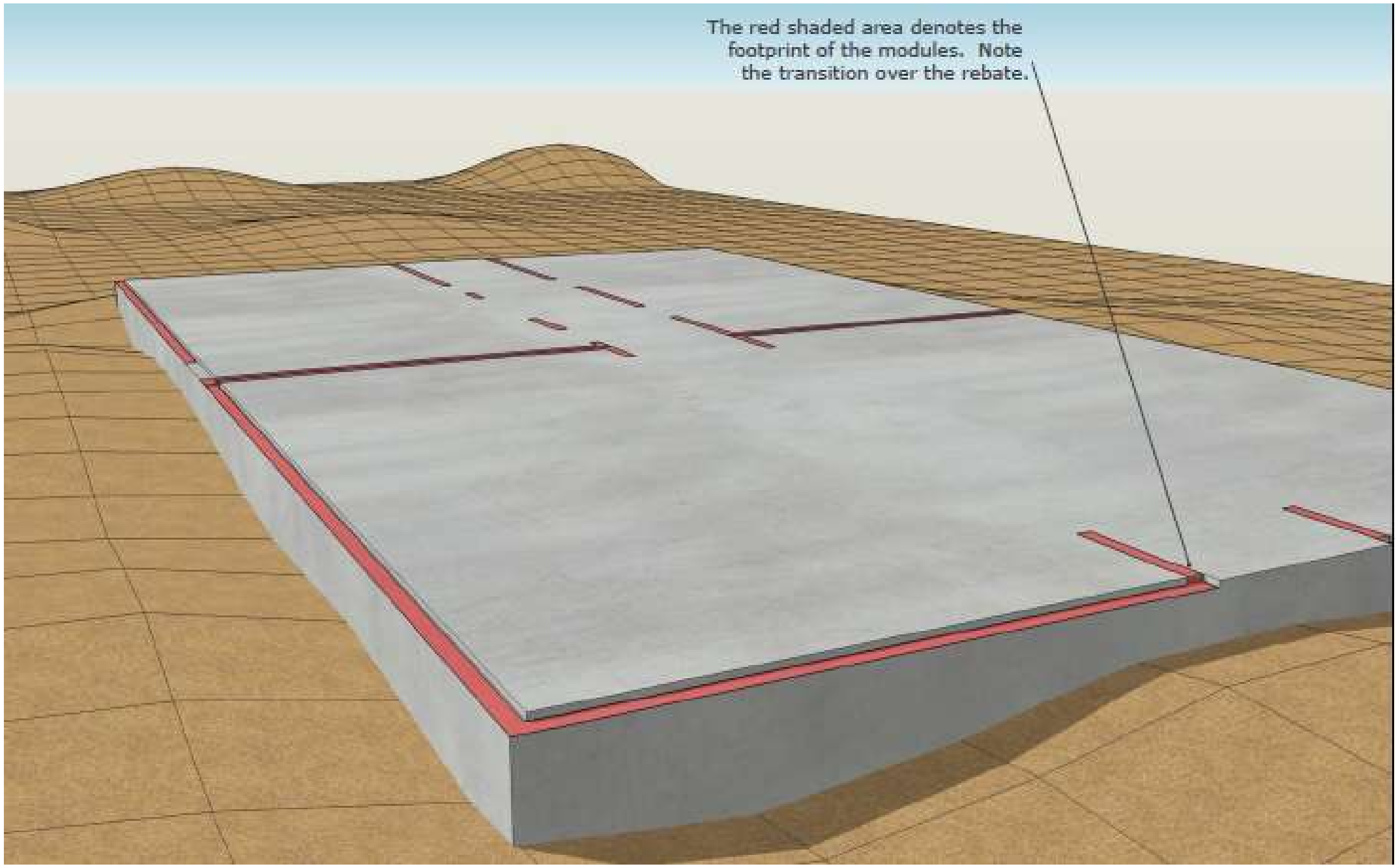
Step 6



Module outline. It is helpful to mark out the outline of the modules when surveying the slab and placing the packers prior to the modules arriving.

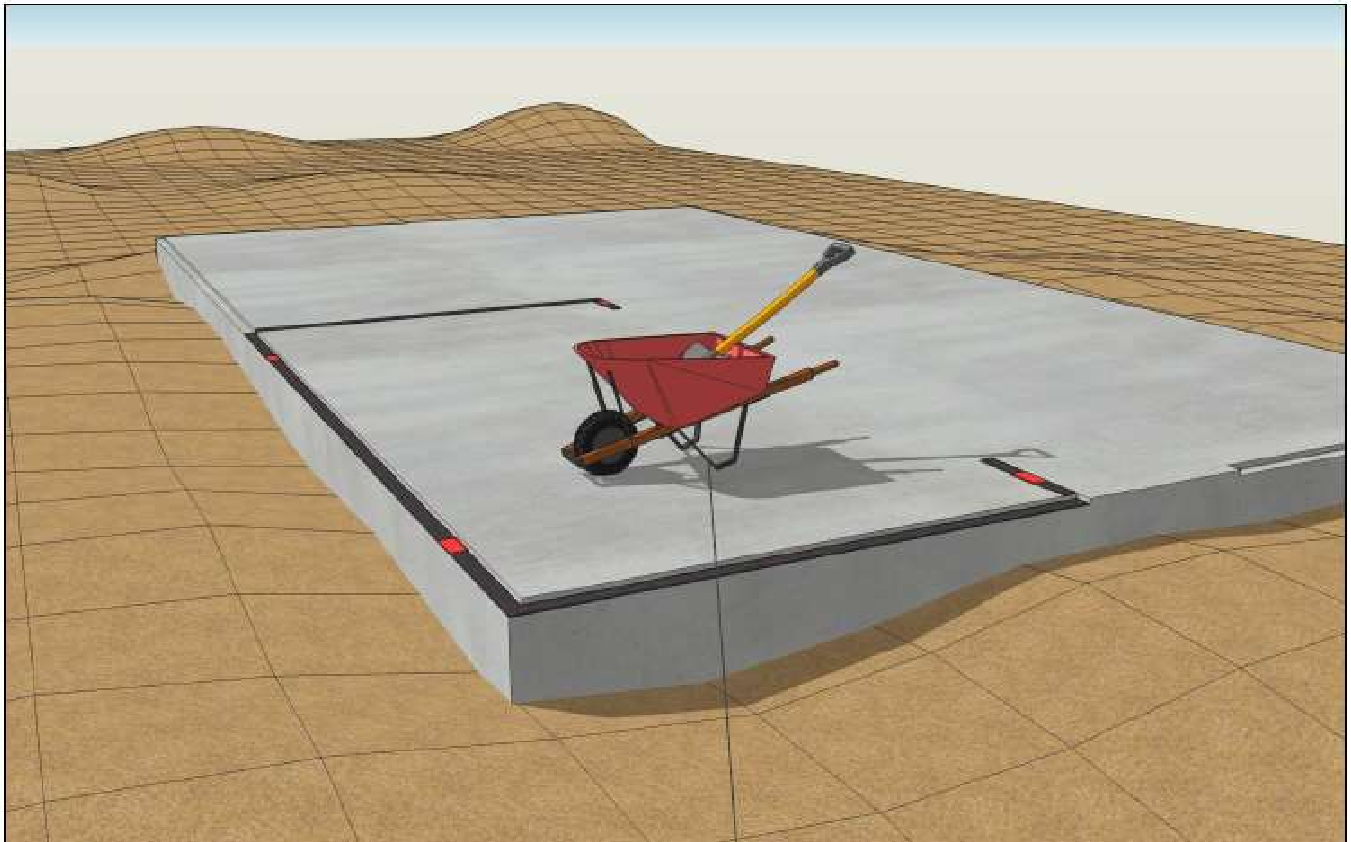
8.2 Transport & Onsite Delivery – Installation Guide (cont)

Step 7



8.2 Transport & Onsite Delivery – Installation Guide (cont)

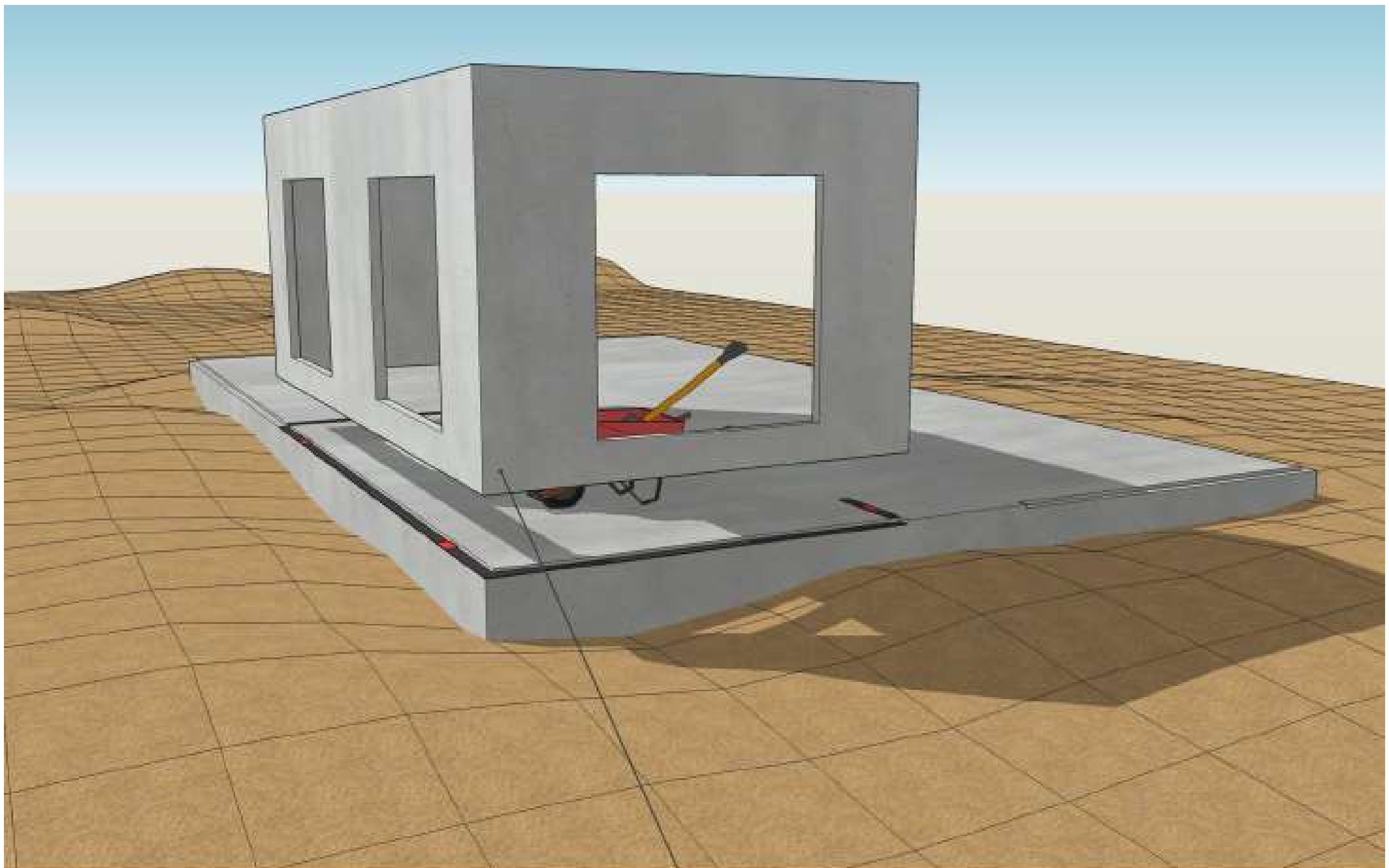
Step 8



Mix a batch of non-shrink grout for placement around the perimeter of the modules. The grout is used to obtain even bearing between the module and the slab. The packers ensure that the module rests in a level position once the grout is squeezed out as it is lowered into position.

8.2 Transport & Onsite Delivery – Installation Guide (cont)

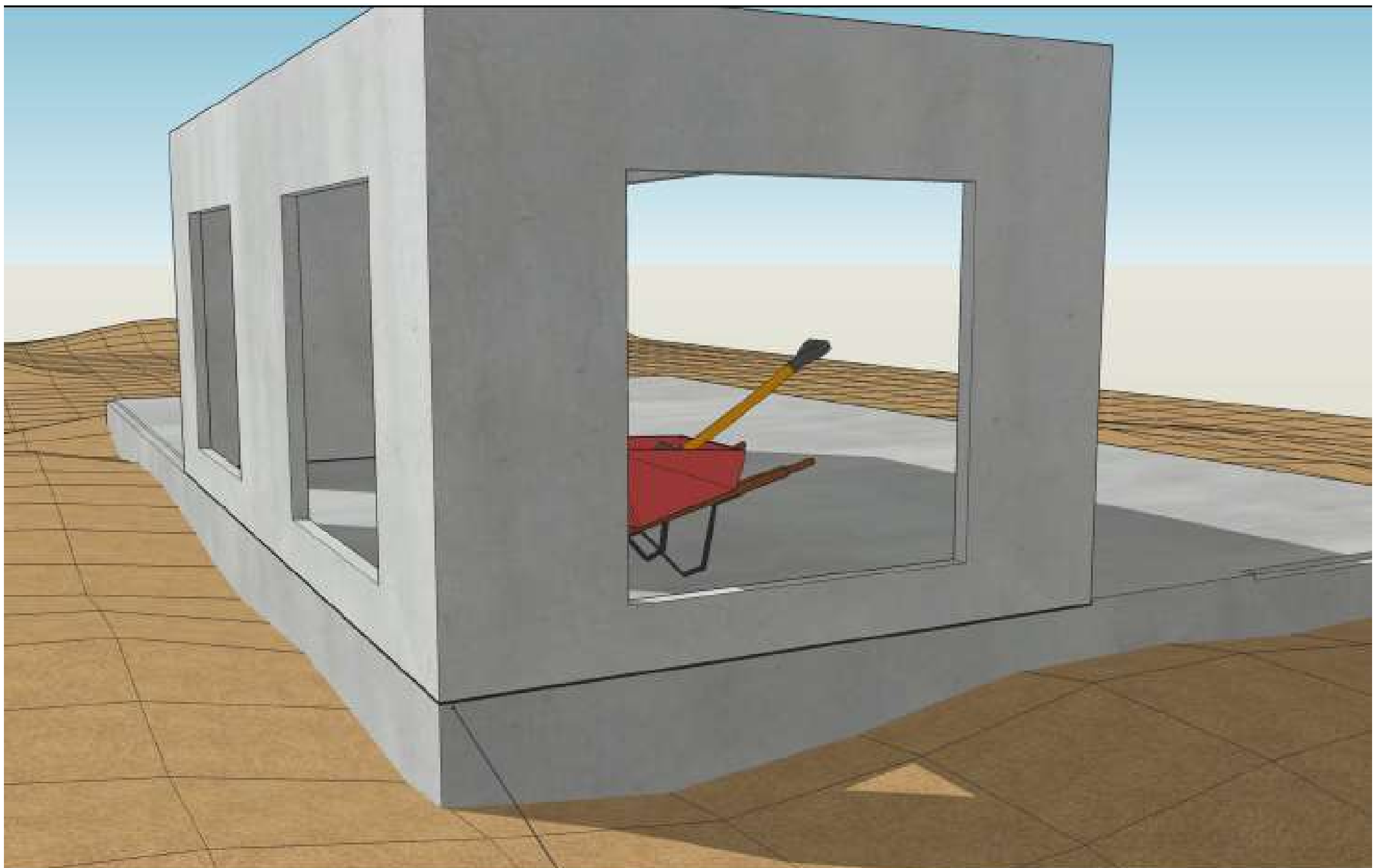
Step 9



Module lowered into position over grout and packers.

8.2 Transport & Onsite Delivery – Installation Guide (cont)

Step 10



Completed installation. Grout is squeezed out and trowelled off. Repeat process for other modules on slab.

Livin Modular Design Guide v2
11th February 2019
www.livinmodular.com.au