CONTENTS

FLEETWOOD CHALLENGE CUP

TEAM 5

01. EXECUTIVE SUMMARY

ABSTRACT

We are currently at a junction where it is imperative that we design with the intent of net zero. With rising climate issues it is the responsibility of the construction industry to lead in creating sustainable initiatives for construction.

With the site on border of one of midlands most desired areas, this project will look at addressing issues of sustainable innovation while also tackling the crisis of affordable housing in Perth.

Due to the issues facing the surrounding area, the development will focus on housing for lower socio-economic communities, who are seen to be more at risk. With the creation of a community environment seen as the primary way to tackle a lack of social engagement. This will be done by using basic principles for supplying amenities that promote social interaction engagement.

EXEUTIVE SUMMARY

This development looks at the creation of a flexible mixed use development, as stratergised by the planning guidelines of the area.

This is in order to deliver affordable housing for the surrounding midland community core principles of adaptability in arrangement, sustainability and promoting community living will act as leading ideas for revitalization.

The site will contain 12 apartment modules with a strong focus on communal spaces. With the complex housing containing a public cafe, community Centre space, public toilets, creche/daycare, gym, short term accommodation and garden spaces.

The design looks at tackling flexible building by using modular construction with opportunists of adaptability. With apartment layout open to alternative opportunities. With this comes the possibility of philosophies of circular economy. With building re-usability, seen in the module structure, material choice and module sizes. Making the modules easily transportable.

Off site construction and prefabrication will be utalised for a speedier construction time. With efficiency, reduction of costs, worker safety and economic reliability more suited for affordable construction.

Innovation through new materials has been on of the focal points of this development, with luxury finishes being created through new sustainable means. Such as timber terrazzo, cork flooring and sycon matrix cladding.

Overall the design looks at providing quality affordable housing by integration in a developed neighborhood. To help further develop the area by incorporating effective community spaces. Providing successful spaces for business as well as challenging philosophies behind social housing and the quality of these kinds of development.

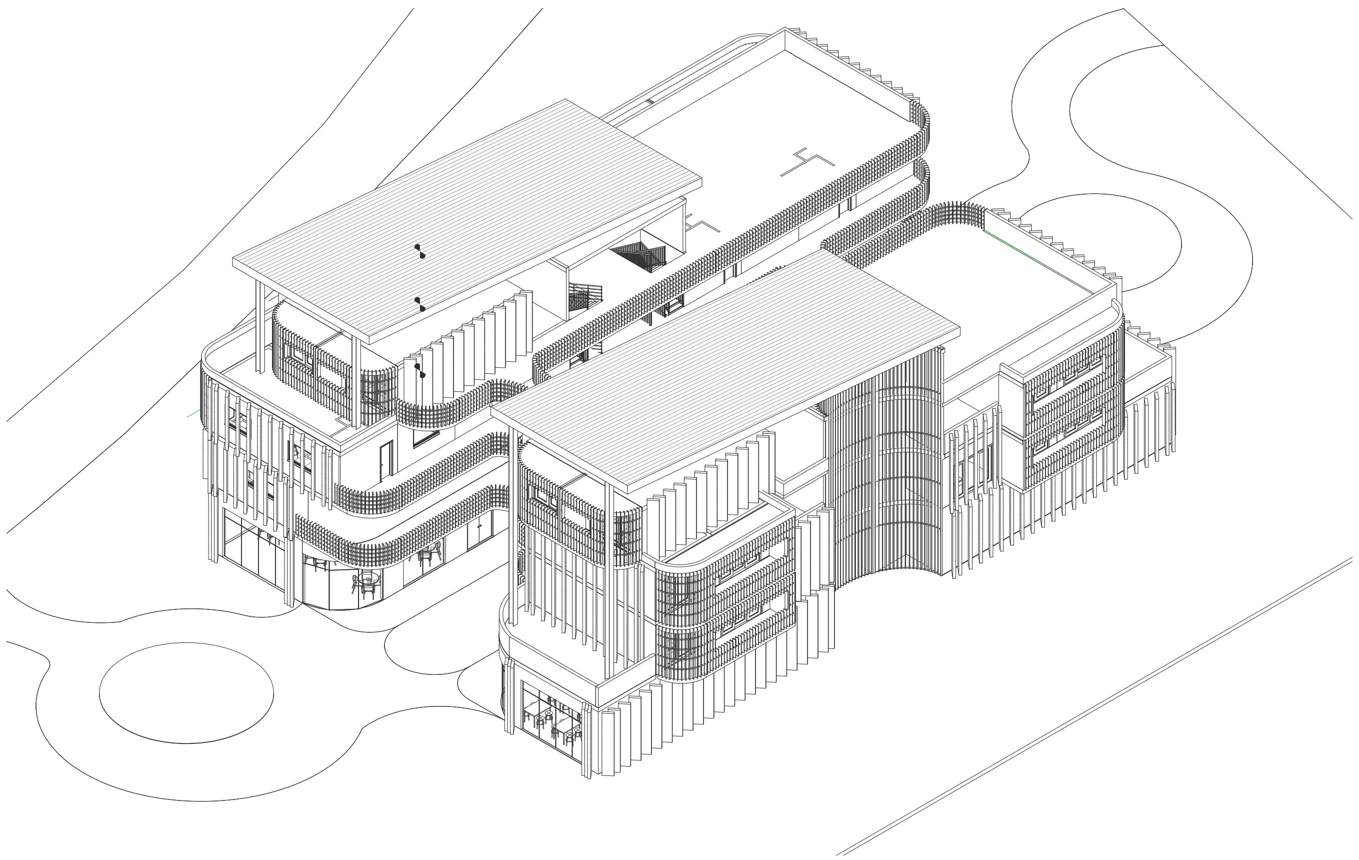
02. SITE INFORMATION AND DESIGN CONCEPT

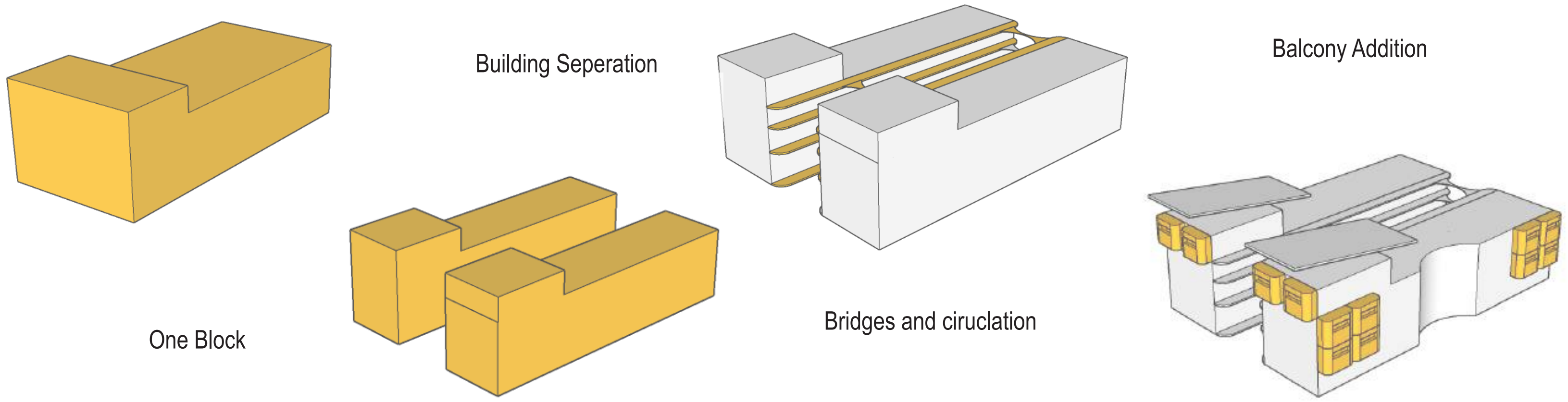
SITE INFORMATION

The site will be Lot 602 located on Yelverton Drive alongside the Midland Train line. The location is seen to be closed to both the university, hospital and a large suburban neighborhood. Therefore amenities will be incorporated to support the surrounding community. However no on-site parking will been provided given the proximity to a major train station and various public transport options.

The lot has already been demolished and is ready for construction.

Midland is an area located outside of the Perth CBD, and is seen to be the regional center for the city of swan. With strong affiliations with local businesses such as midland brick and other construction companies. Which will be utalised heavily in the supply of materials intended in the project. Overall the city has a strong industrial background and buildings in the surrounding center reflect this history.





Desgin For Dis-assemebely

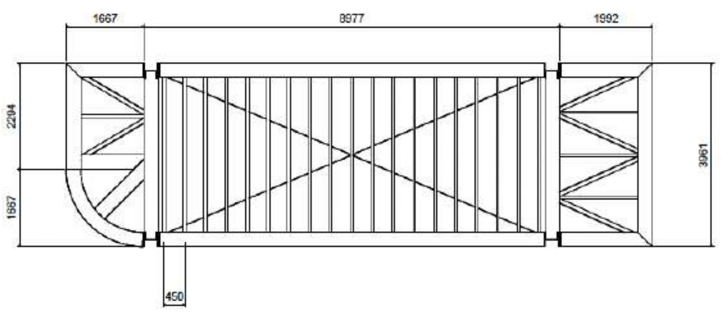
The design for each module has been made for demountable design. Which means the structure uses member sizes and materials to ensure re-use is an option. The building utalises 4m x 9m modules with cantilever pathway and balcony on each side. This means in theory the building should be able to be dismantled and applied to a different site if necessary.

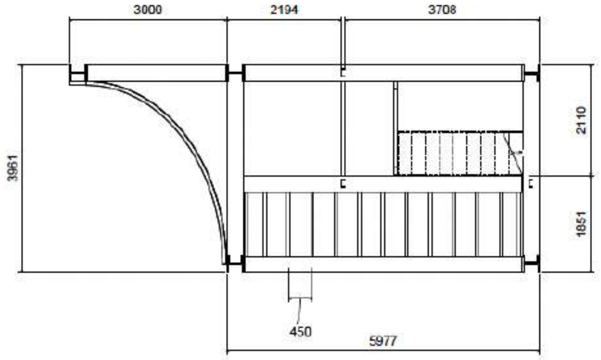
All services required for electricity, gas, telecommunications and water etc will be located underground. With each module being intended to be prefitted with services to be connected to the existing outlet when placed on site.

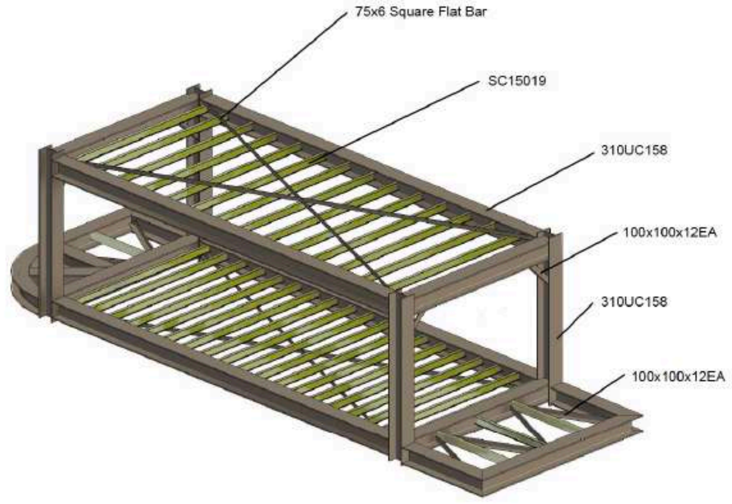
Innovative Materials

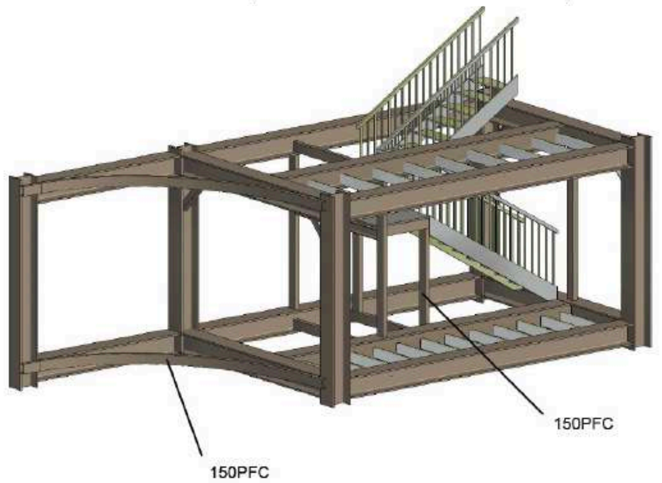
The structure aims to re-purpose as many elements as possible. Such as reclaimed timber, steel and insulation. This is as all elements that aren't renewable are aimed to be as low carbon as possible to be implemented in the building. For those materials that are unable to recycled and must be new will be selected for their properties to be recycled at the end of the buildings lifespan through dis-assembly and circular economy.

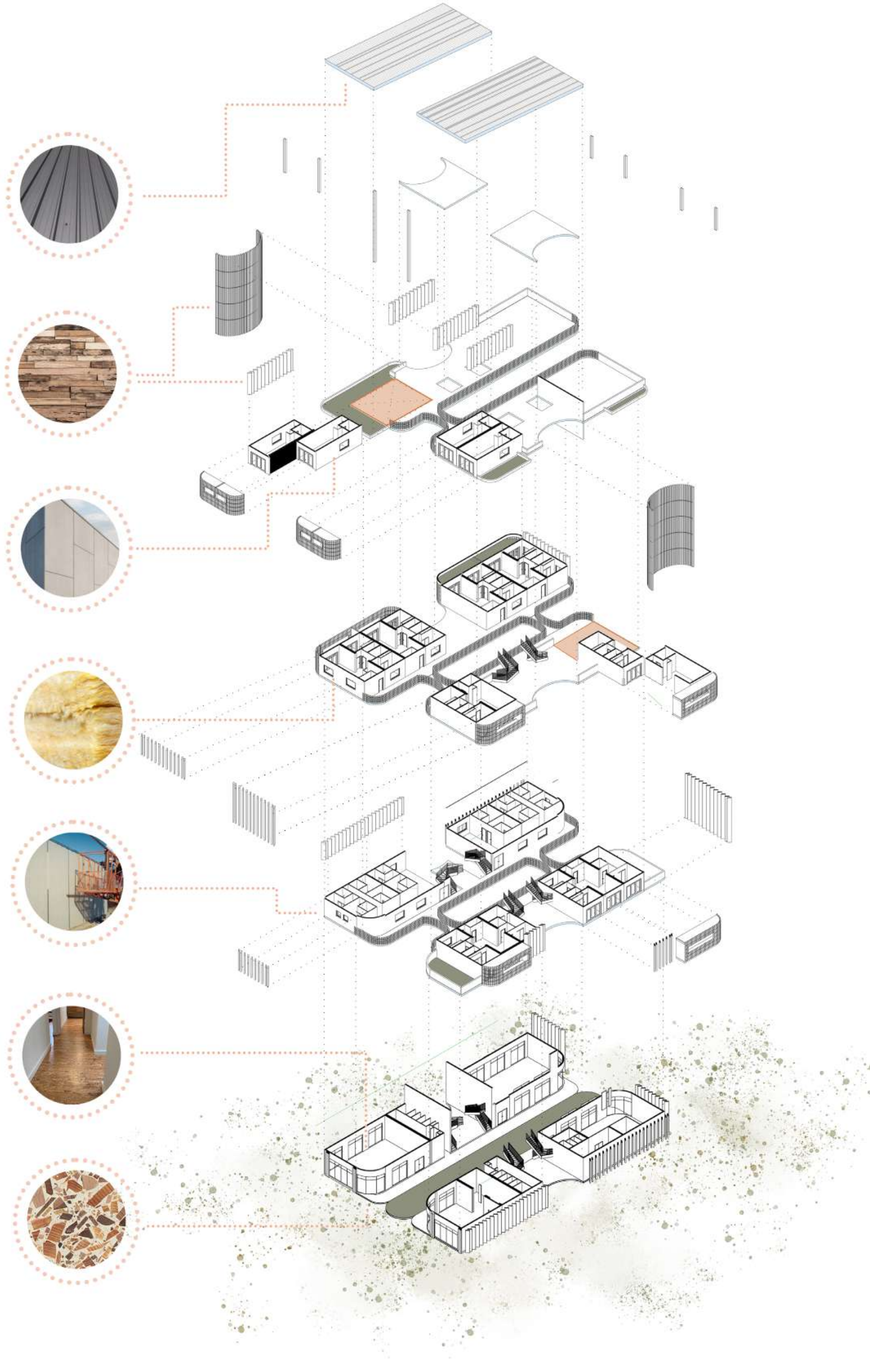
In additions all materials have been chosen for their innovative nature. Sycon matrix has been chosen as a fiber cement alternative as it has reduced cracking when moved as well as environmental efficiency. Timber terrazzo has been chosen as a flooring alternative due to its renewable typology as well as luxury finish. and cork has bee chosen for its lightness and thermal and acoustic qualities.











03. INIATATIVES AND RESEARCH

1

New Technologies/Manufacturing and Materials

Through technical advancements the building process will look to limit as many people on site as possible. Through robotics and drones the creation of a more efficient site is created. Through the use of industrial robots the modules will be created off site. Such as articulated robots. Drones will also be considered for safety evaluations to assist with less human contact In addition to the technological advancements certain new world materials have also been used for example such as:

- •Supafloor Sub Flooring
- •Sycan Matrix Cladding
- •Glass Wool
- •Enviroboar
- •Cork Flooring
- •Timber Terrazzo

2

Advanced Design for Community

Through the analysis of site it is seen that the lot has much opportunity to provide good standing relationships with the wider community. As well as create aspiration s of self sufficiency and circular economy for the area.

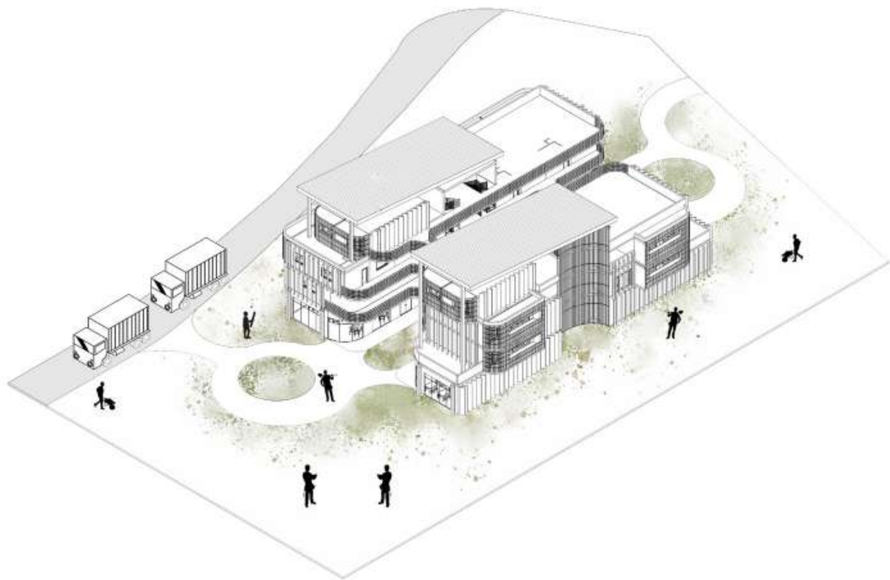
Something that is clear from data and site analysis is that there is an emerging younger community within midland. This is further encouraged by university developed facilities and emerging industries such as medical and more.

Therefore facilities such as a community Centre with study areas and student/short term accommodation has been made for more community engagement.

3

Design For Manufacture and Assembly

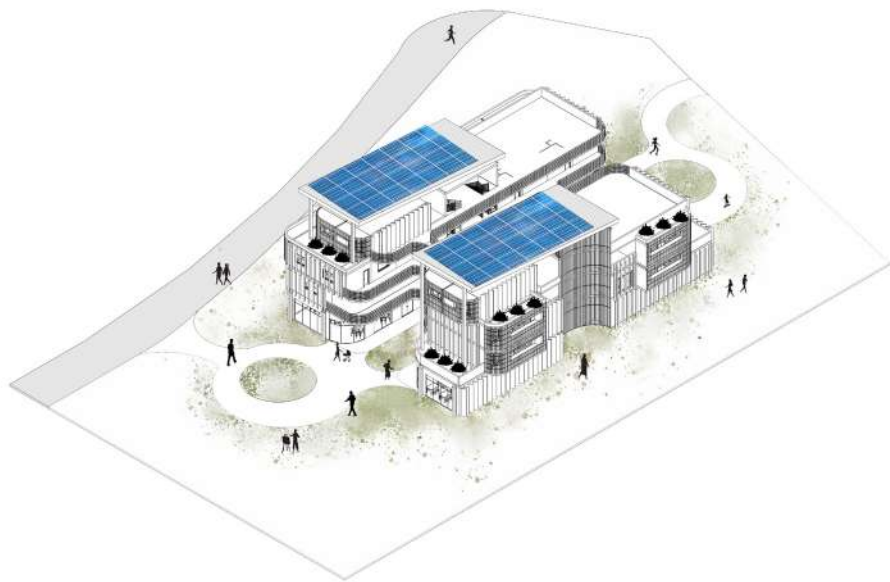
Due to the modular nature of the project the building and assembly practices that will be used are through 3d volumetric construction. The reason for this assessment is due to the use of an off sight facility for construction. This is further utalised in the material choice of re-purposed steel frame systems in the walls and floors. Making the module have the ability to slide into place. This means that individual units are put together off site and then transported and secured on site. This types of materials and advancements that can be done with this is much higher do to the smaller construction scale of each pod. Transported on trucks the building is then completed and joined together on site. This means that the Least amount of time as possible on site for construction. Compared to a flat packed system the 3d volumetric construction utalises less construction time and speedier development. This system is utalised mainly through creating limited differing sized pods, with all apartment and commercial facilities using pods of 9000 x 4000mm. With additional modules in balcony and circulation systems.



4

Sustainability and Aim for Net-Zero

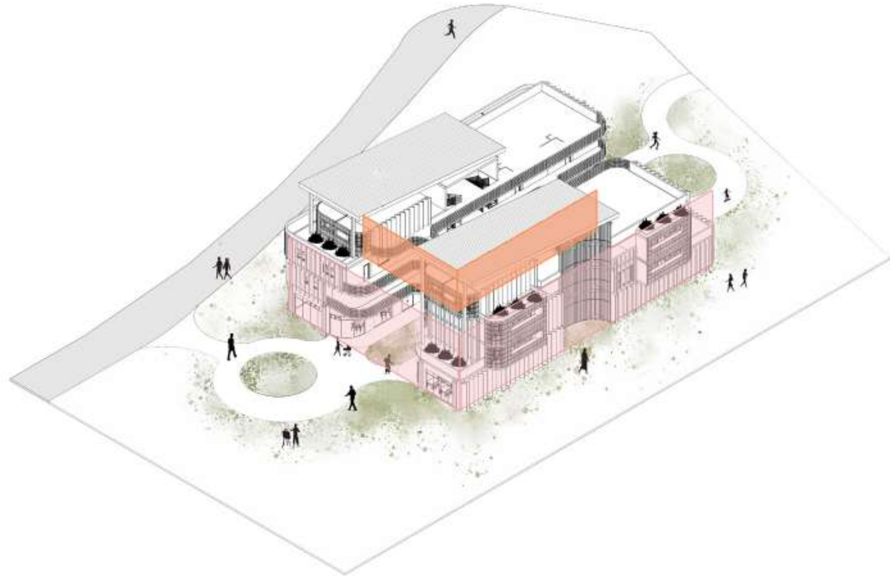
In recent years the main way that has been seen to achieve net zero in the construction industry is by using sustainable materials. Therefore the first step in the designs aim to be sustainable is through these new energy materials. The first sustainable material is through sycon matrix cladding. Matrix cladding's resistance to cracking, warping and swelling therefore less maintenance is required and is self sufficient. High fireproofing properties more protection from outside temperatures are created with greater thermal resistance. Another material is Environmental used in the wall construction. This material uses 99% less energy than that of typical gypsum and is created by a milling process that converts agricultural waste fiber into low-cost, environmentally friendly building panels. A further benefit is that it provides acoustic benefits especially with the train. Further opportunity for the building to create its own energy is through application of renewable energy such as solar/wind.



5

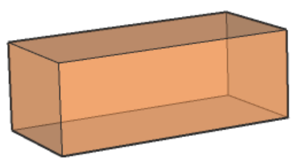
Designing for Local Guidelines and Policy

Due to the heritage nature of the Coal Dam the Helena precinct has a series of design and policies that need to be met.
•Whilst this lot should be a predominantly residential development, the ground floor will incorporate flexible
•Spaces to facilitate the opportunity to incorporate a mix of active uses. Demonstrate a contemporary response to the setting that is in keeping with other higher density infill in the locality.
•Nil setback is required to Yelverton Drive, with potential for variation where the lot boundary deviates. Nil setback permitted to the western and eastern lot boundaries however note that windows and awnings shall be provided on these frontages and may necessitate a setback.
•To reduce building bulk, development must be appropriately articulated and set back above the third floor.



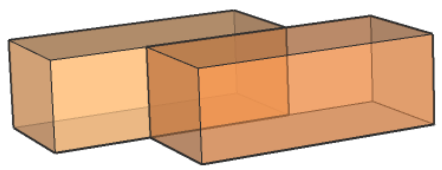
ONE BED

4000 x 9000mm



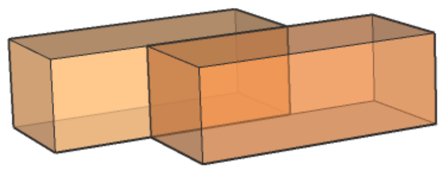
TWO BED ONE BATH

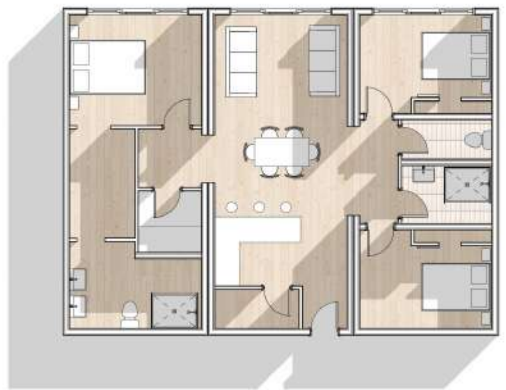
8000 x 9000mm



TWO BED TWO BATH

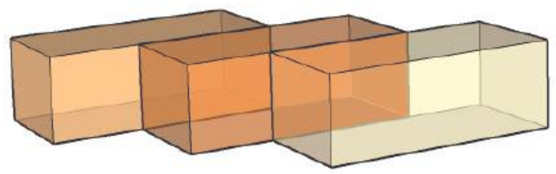
8000 x 9000mm





THREE BED TWO BATH

12000 x 9000mm



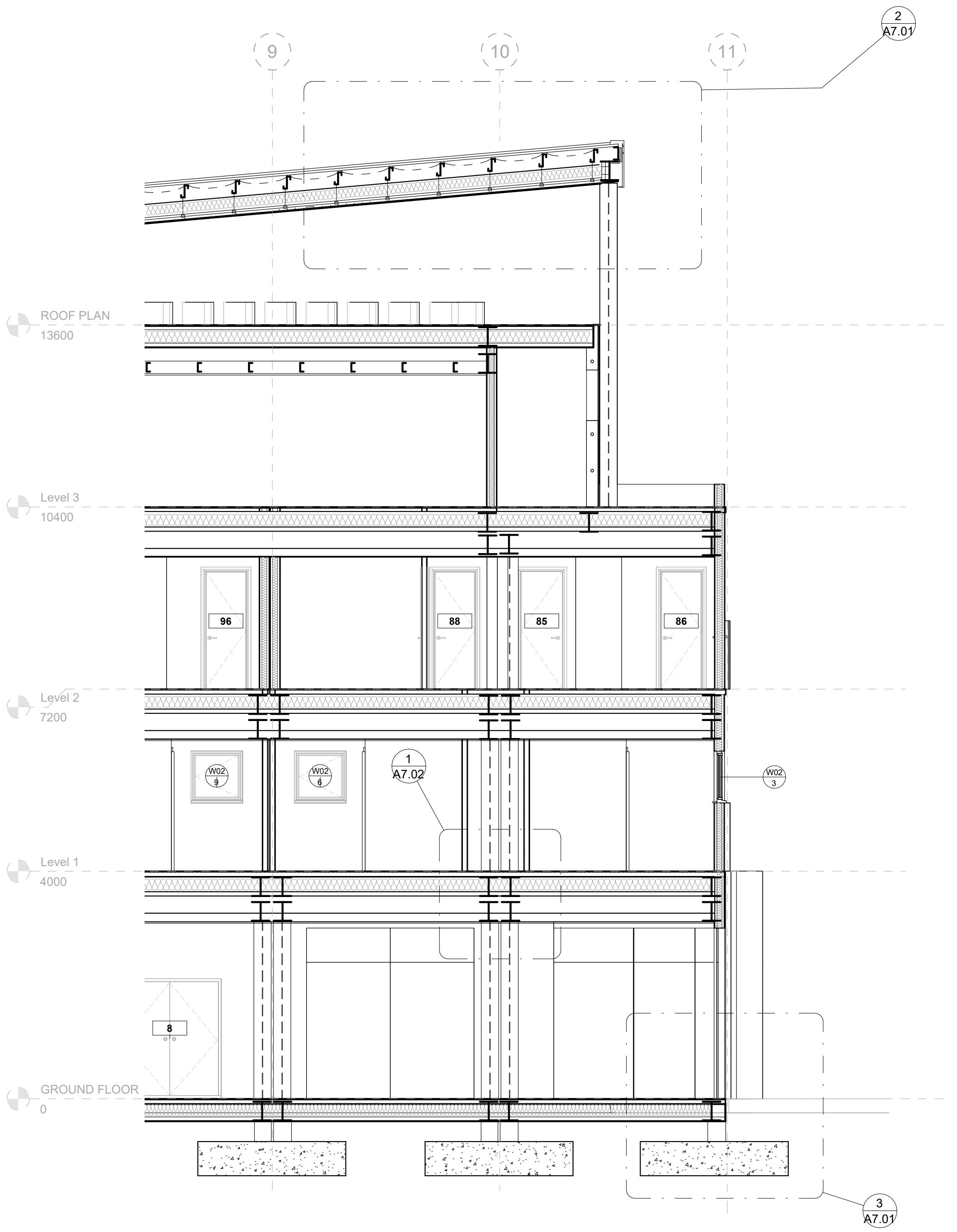
04. STRUCTURAL BREAKDOWN

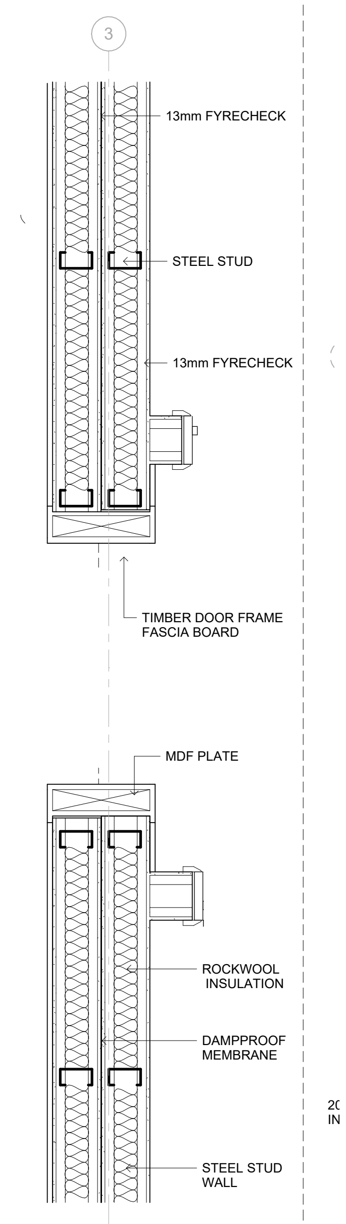
The lot is created through the use of 62 modules. Which will be fabricated off site and brought to site for quicker assembly and future disassembly. All modules will be 4m x 9m steal frame. with built in balconies, pathways and ceilings. For ease of assembly the modules have been designed to be moved by crane and can be seen to be lifted by each corner. Steel strapping is used in the floor and ceiling to aid with the movement.

The integrity of the materials selected have been tested and checked. Structural element materials have also been selected and detailed in the following. This includes but is not limited to member checks, deflection checks, the design and check of connections for the structure, lifting check, verification of fire resistance check, the design of the concrete footings and staircases check.

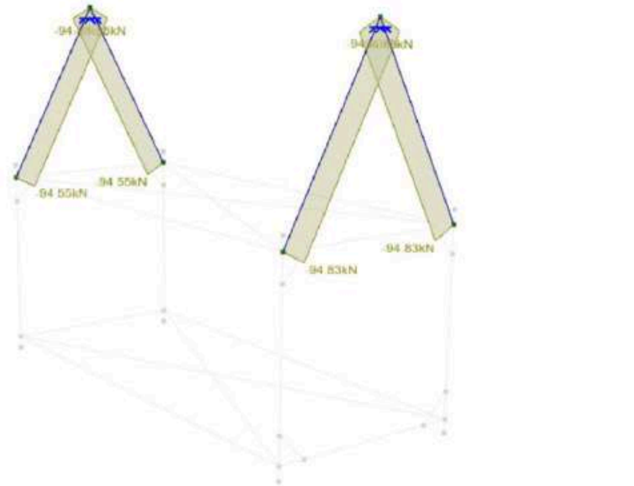
The majority of the structure is through a framework construction made by steel beams and columns, the structure will be made by steel checked by AS4100 . And will be constructed by the combination of different modules and attached by a series of different connections

The building at ground level will require footings. Pad footing have been decided. Since the columns of each module will be very close together, one pad footing will provide enough capacity to support the equivalent combined force of two columns. The pad footing will have a square cross section and the strength of the concrete will be f' c = 30MPa. The strength of the footings steel reinforcement will be fsy = 400MPa.



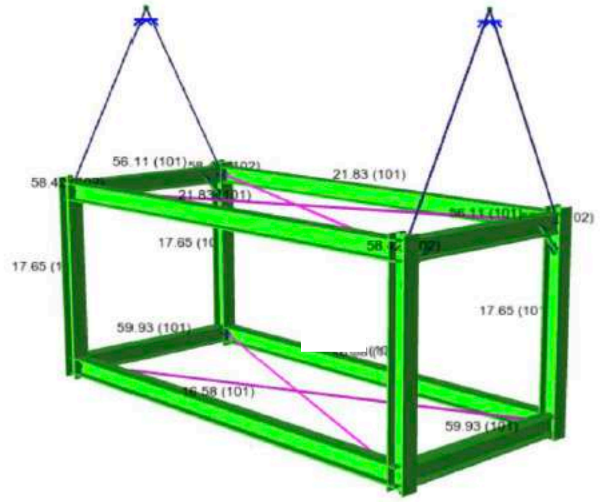


MODULE OPENING DETAIL



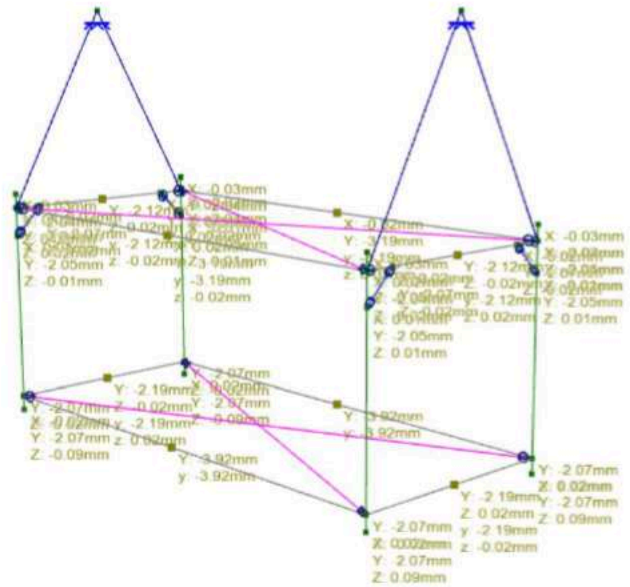
Space Gass Lift Check for Modules - Tension Load

Maximum Sling Tension Load = 94.83kN so use four 10T WWL Slings



Space Gass Lift Check for Modules - Load Factors

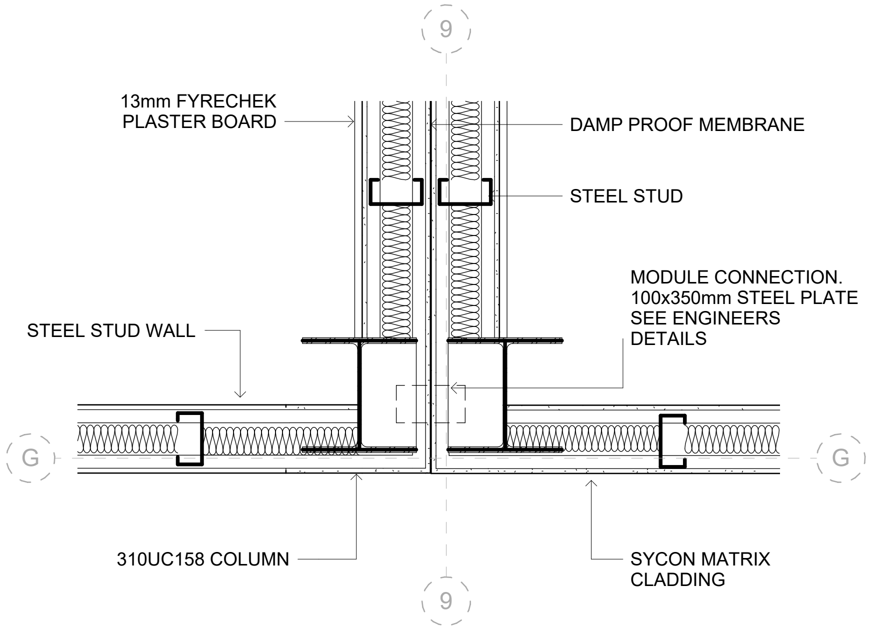
All Load Factors > 1 so members are ok during lifting



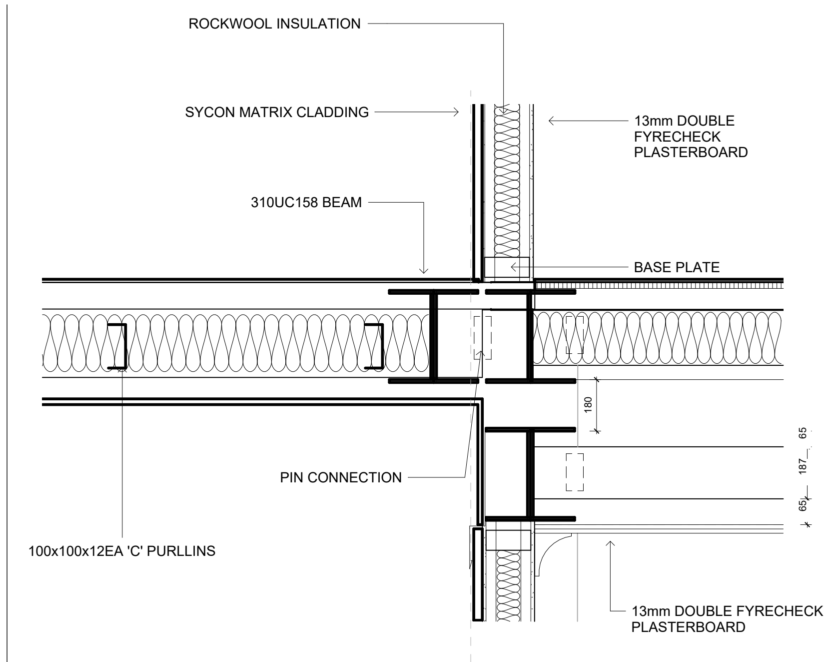
Space Gass Lift Check for Modules - Deflections

All deflections within deflection limits specified above so members are ok during lifting

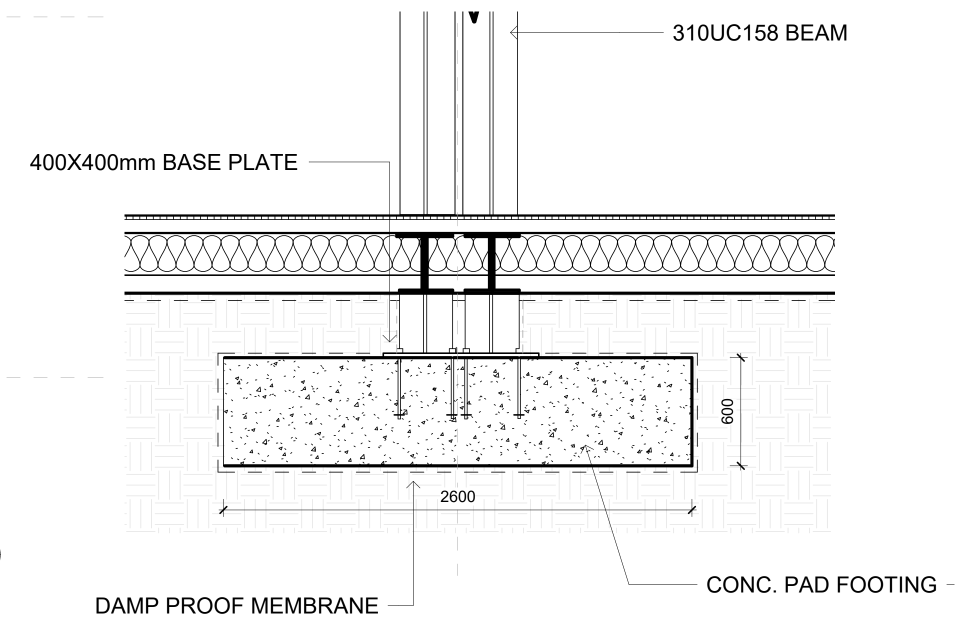
STRUCTURE BREAKDOWN



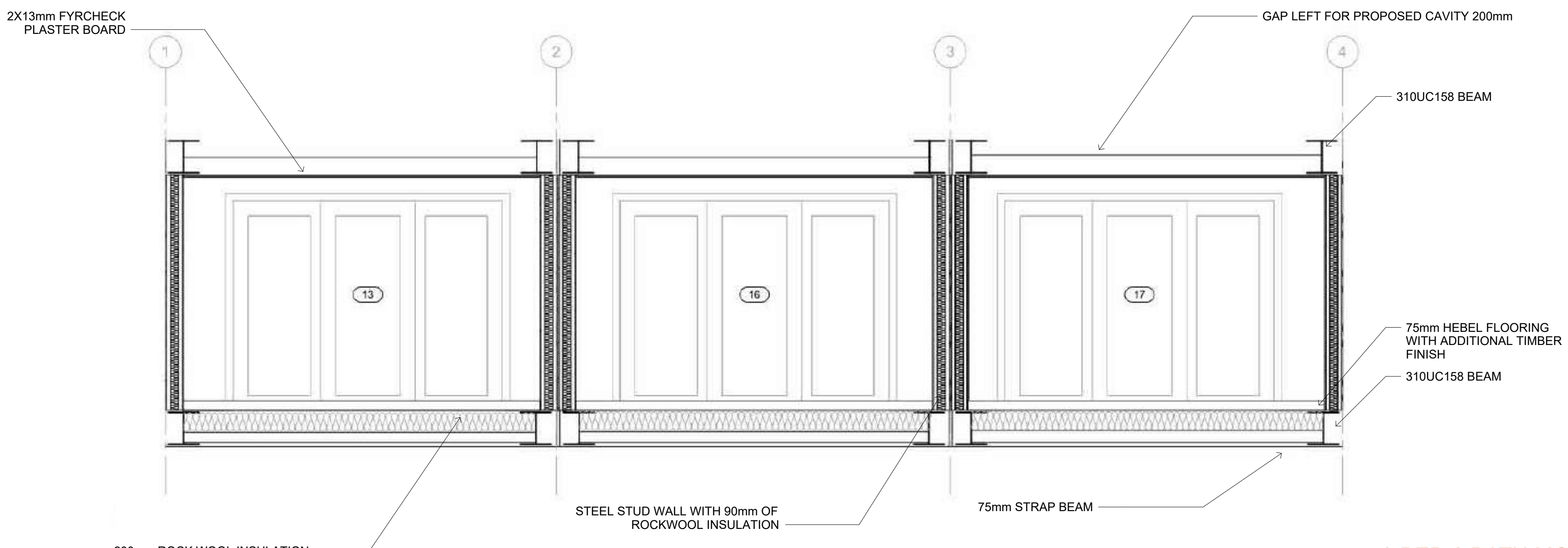
PLAN VIEW MODULE CONNECTION



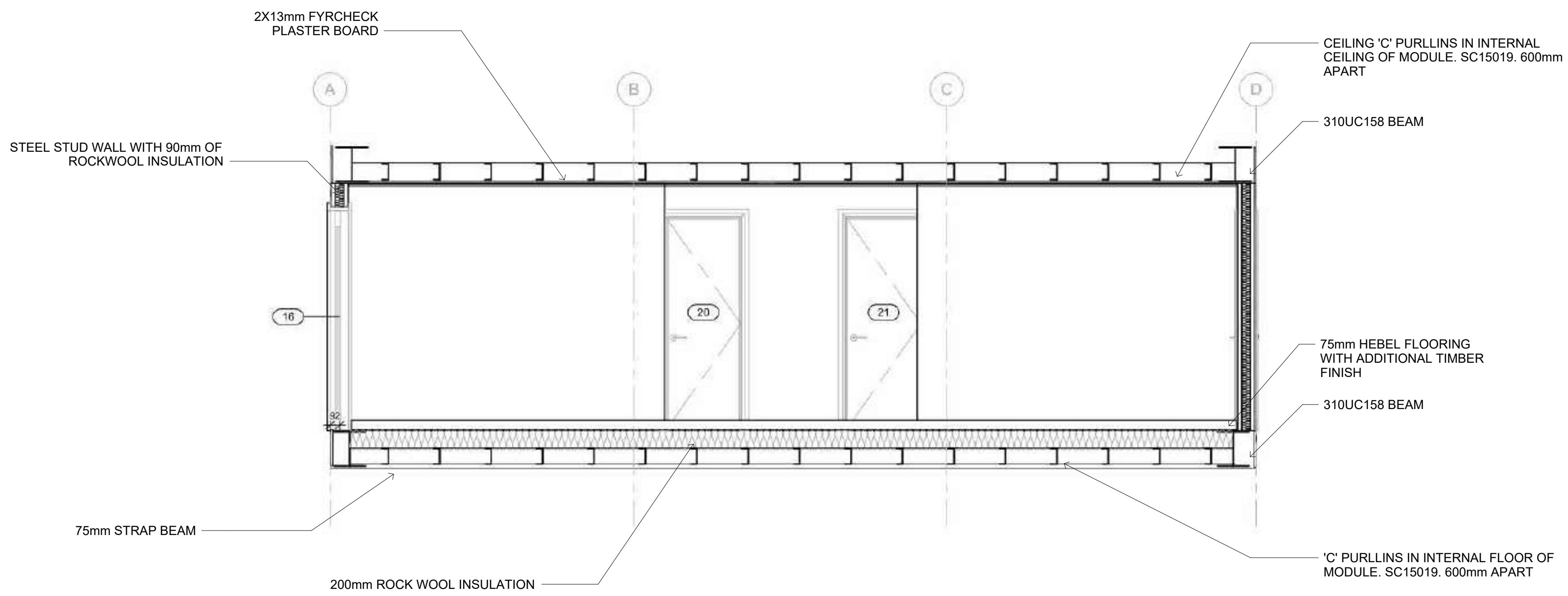
BALCONY CONNECTION



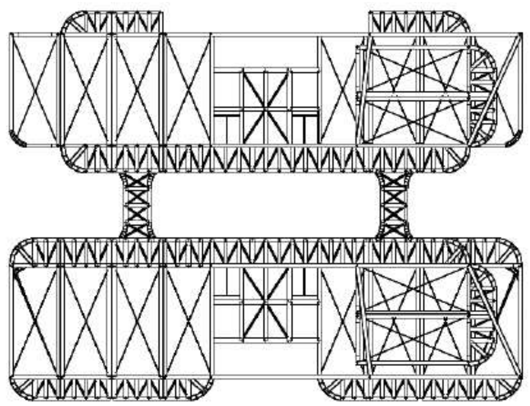
FOOTING DETAIL



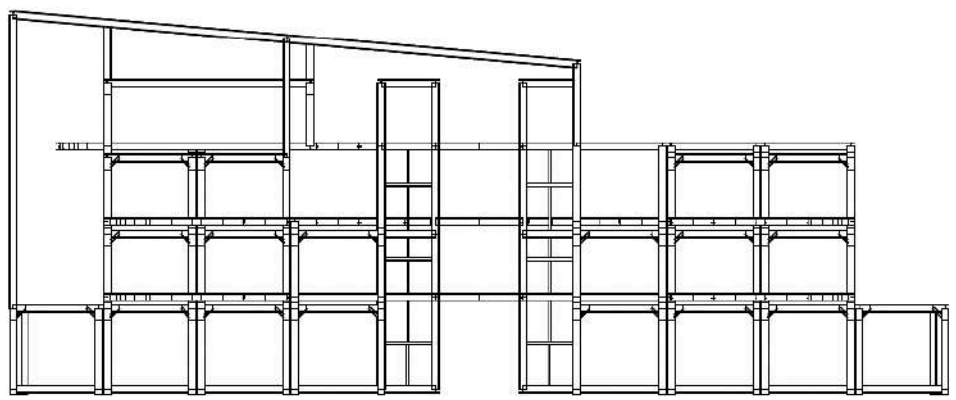
3 BED 2 BATH MODULE SECTION



3 BED 2 BATH MODULE SECTION



STRUCTURE PLAN



STRUCTURE SECTION

05. CALCULATIONS

Loading
The loads are determined to the relevant Australian Standards and the Project Design Criteria listed in reference documents. The following loads were applied as part of the design:

LC1 – Self Weight (SW)
The self-weight of the structure was automatically considered by the analysis software package used.

LC2- Floor Permanent Load
The architect has decided on recycled brick tiles to line the floor. The weight is 48.5kg/m2 or 0.476kPa C15019 Floor joists at 450mm centres. The self-weight of a C15019 joist = 4.51kg/m. This gives an approximate overall pressure of 4.51/0.45 = 10.02kg/m2 or 0.098kPa Hebel 75mm PowerWall panels will be used to support the recycled brick tiles. The weight is 510kg/m3.

As we are only using 75mm thick panels, the weight will be 38.25kg/m2 or 0.375kPa.
So total load on floor = 0.476 + 0.098 + 0.375 = 0.95kPa

LC3- Ceiling Permanent Load
The architect has decided on recycled gyprock for the roof with an estimated weight of 8.5kg/m2 or0.083kPa. C15019 Ceiling joists will be utilised at 600mm centres. The self-weight of a C15019 joist = 4.51kg/m.
This gives an approximate overall pressure of 4.51/0.6 = 7.52kg/m2 or 0.07kPa
The ceiling will also be lined with 13mm Gyprock Fyrchek panels. The weight is 10.5kg/m2 or 0.103kPa So total load on ceiling = 0.083 + 0.07 + 0.103 = 0.256kPa.

LC4- Wall Permanent Load
The external wall cladding that the architect has chosen is sycon cladding by James Hardie. This has aweight of 12.6kg/m2 = 0.124kPa
The internal walls will be lined with recycled gyprock and will be supported by steel stud walls. Thisweight was estimated as 8.5kg/m2 + 0.6kg/m2 = 9.1kg/m2 or 0.089kPa
The walls will also be lined with 13mm Gyprock Fyrchek panels. The weight is 10.5kg/m2 or 0.103kPa So total load from walls is 0.124 + 0.089 + 0.103 = 0.316kPa.

LC5- Soil Permanent Load
Assuming a soil depth of 200mm and a saturated unit weight of 22kN/m3. Soil will be supported by masonry at an estimated depth of 100mm with a unit weight of 18.83kN/m3. Also, assuming that only small plants will be planted, the total load is. The total load is 0.2 x 22 + 0.1 x 18.83 = 6.3kN/m2 or 6.3kPa.

5.7 LC6- Balustrade Permanent Load
The architect has decided on timber balustrade and façade. This was estimated as 0.15kN/m.

5.9 LC11- Floor Imposed Load
Library, café, gym, community UDL = 2kPa, Concentrated actions = 2.7kN (Ref AS/NZS 1170.1:2002 T3.1) Apartments UDL = 2kPa, Concentrated actions = 1.8kN (Ref AS/NZS 1170.1:2002 T3.1) Balcony UDL = 4kPa, Concentrated actions = 1.8kN (Ref AS/NZS 1170.1:2002 T3.1) Stairs UDL = 2kPa, Concentrated actions = 2.7kN (Ref AS/NZS 1170.1:2002 T3.1)

5.10 LC12- Imposed Services Load
This load case accounts for loads induced by services such as plumbing pipes, electrical wiring, cable trays, gas fittings, sprinkler systems etc. This services load was applied as an area load in the ceiling cavity of each module. This load was conservatively estimated to be 1kPa.

5.11 LC13- Positive Thermal Load
A temperature change of +25°C was applied for positive thermal load

5.12 LC14- Negative Thermal Load
A temperature change of -25°C was applied for negative thermal load

Bottom Floor Column
Bottom Floor Column Height (h) = 3.9m
Maximum Deflection (Δ) = 4.31mm
Δ / h = 1 / 905 < 1/150 Acceptable

Upper Floor Column
Upper Floors Column Height (h) = 3.2m
Maximum Deflection (Δ) = 6.44mm – 5.32mm = 1.12mm
Δ / h = 1 / 2857 < 1/150 Acceptable

Roof Column
Roof Column Height (h) = 12.5m
Maximum Deflection (Δ) = 8.42mm
Δ / h = 1 / 1484 < 1/150 Acceptable

Lift Column
Lift Column Height (h) = 10.3m
Maximum Deflection (Δ) = 4.43mm
Δ / h = 1 / 2325 < 1/150 Acceptable

Bottom Floor Beam (1)
Bottom Floor Beam Longitudinal Length (l) = 8.65m
Maximum Deflection (Δ) = 10.84mm
Δ / l = 1 / 798 < 1/250 Acceptable

Bottom Floor Beam (2)
Bottom Floor Beam Transverse Length (l) = 3.65m
Maximum Deflection (Δ) = 1.23mm
Δ / l = 1 / 2967 < 1/250 Acceptable

Upper Floor Beam (1)
Upper Floors Beam Longitudinal Length (l) = 8.65m
Maximum Deflection (Δ) = 8.37mm
Δ / l = 1 / 1033 < 1/250 Acceptable

Upper Floor Beam (2)
Upper Floors Beam Transverse Length (l) = 3.65m
Maximum Deflection (Δ) = 5.16mm
Δ / l = 1 / 707 < 1/250 Acceptable

Roof Beam
Roof Beam Length (l) = 9.2m
Maximum Deflection (Δ) = 9.9mm
Δ / l = 1 / 929 < 1/250 Acceptable

Balcony Cantilever
Balcony Cantilever Length (l) = 1.675m
Maximum Deflection (Δ) = 4.61mm
Δ / l = 1 / 363 < 1/150 Acceptable

Bridge
Bridge Length (l) = 5.35m
Maximum Deflection (Δ) = 4.63mm
Δ / l = 1 / 1155 < 1/250 Acceptable

Figure 1 Architectural Design

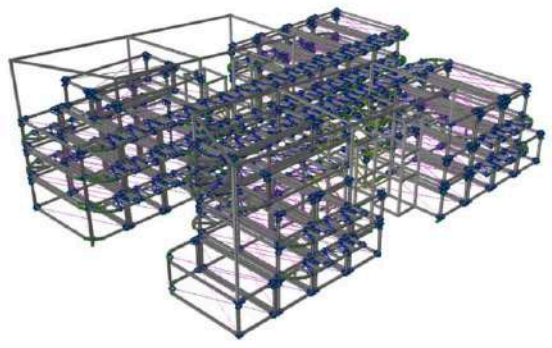


Figure 2 Space Gass Design

06. BUILDING COMPLIANCE

AUSTRALIAN STANDARDS

- Structural Design Actions - AS1170.0:2002, AS1170.1:2002
- Structural Steel - AS4100:2020
- Concrete Footings - AS3600:2018
- Fibre Cement Concrete Sheeting - AS2908.2:2000

BCA COMLIANCE

BUILDING CLASSIFICATION

The building has been classified by 1b, 2, 6 and 9b building, meaning it is a multiple classification building.

FIRE DESIGN

Material choice has been chosen to comply with FRL and are as such. Lightweight construction is used within the wall construction. Steel, which makes up a majority of the structure, is checked by AS4100. Though the specification outlines temperature limitations, it is not-sufficient to ensure safety, temperature or time in which the steel can sustain fire. To further ensure the fire rating of the steel, a product called "Cafco 300" will be used as a wet mix to coat the steel during construction. The Ground floor modules will require a coating of 20.3mm, while the First to Fourth floor modules will require a 10.4mm coating. Making it compliant with sections C1.1-C1.14, C2.4-C2.14, and C3.11.

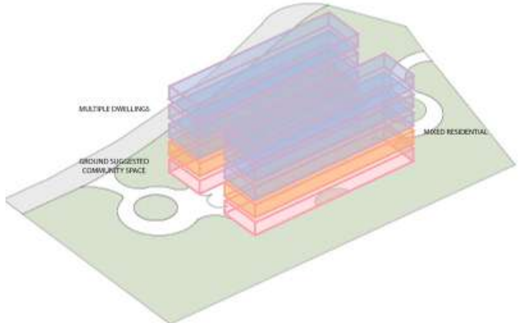
ACCESS

The building contains four central stairways and two lifts. These connect to the 3 storeys located above the ground floor. Meaning that fire isolated access points are not necessary in compliance to D1.9. All dwellings have direct access to exits with all exit points no further than 20m away at all times, and face an open courtyard upon exit

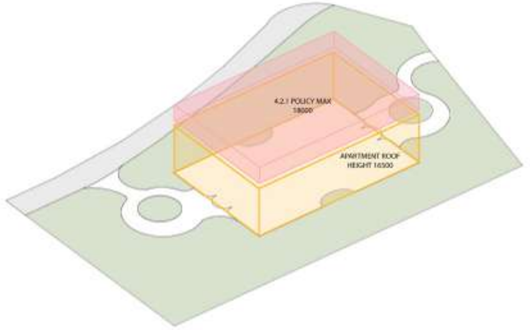
ACOUSTICS

In compliance to section F5 a minimum of 50mm glass wool has been met Two layers of 13 mm fire-protective grade plasterboard or one layer of 6 mm fiber cement. Sheet and one layer of 13 mm fire-protective grade plasterboard, fixed to each face.

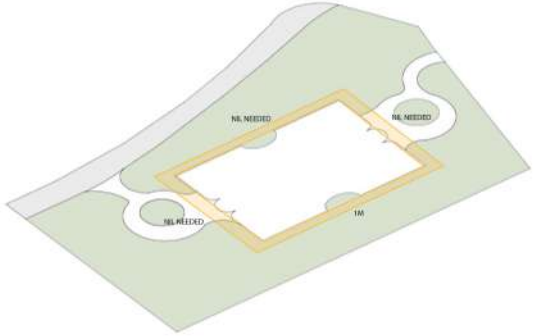
PLANNING COMPLIANCE



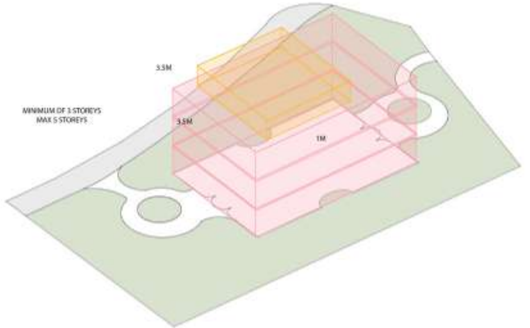
Preferred Land Use



Max Height



Boundary Setback



Fourth Level Offset