Abstract

The cube is a mix use development which emphasize timber usage as main material in the middle of industrial site to provide sense of warmth and to reconnect the environment with nature.
This 4-storey timber building is located at 12 Stack Street, Fremantle.

The old warehouse is reused as the convenience store in order to maintain the heritage value of the building. Whereas the boat skeleton from the existing site is reused as an outdoor sitting area. Both can potentially be an icon of this area.

Commercial tenancies in ground floor include a click and collect stop, which supports local business and improves the amenity for community.

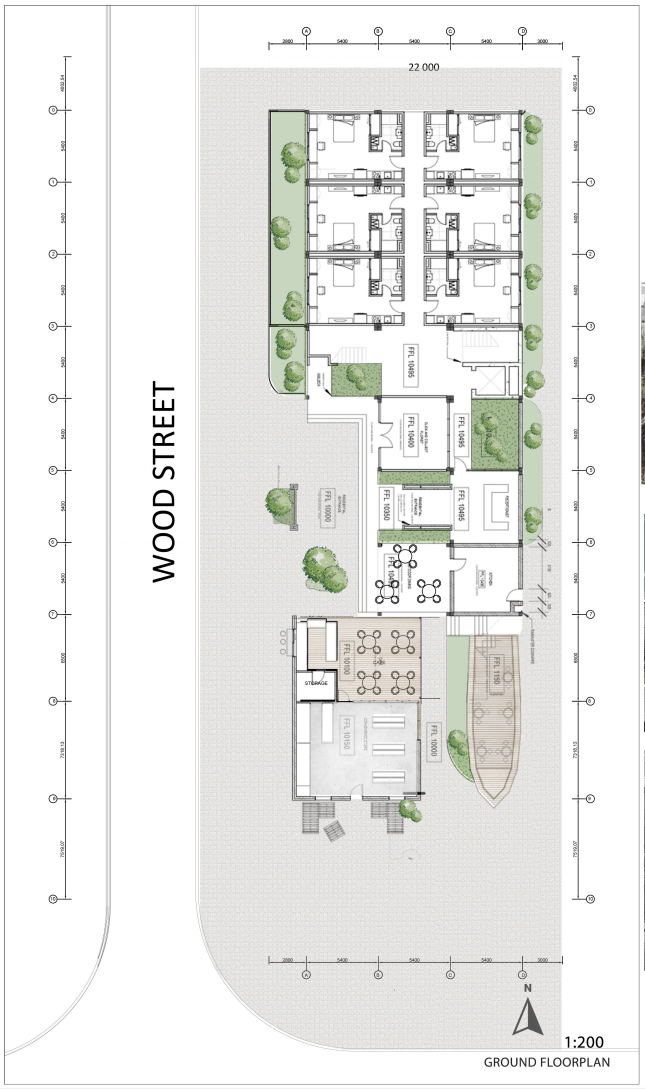
This apartment consists of 6-units of student accommodation in ground floor, 4-off one-bedroom units on the first floor, and 4-off of two-bedroom units in the second and third floor. The building highly accentuates interaction within the building, which can be shown in the play of open space relocation between the neighbourhood.

The apartments use modular prefabrication construction method and specific connectors which significantly saves the construction time. This type of construction offers the flexibility to reconfigure, assemble and disassemble to be moved to another site when necessary. In a result, efficiency in time construction is optimised as one of the biggest benefit to adapt this construction method.

The Glulam timber and SIP are the main material used in this building. This timber is proven to have enough strength to support the building compared to concrete with high durability and sustainability to be reused and recycled. Moreover, SIP is lightweight and low carbon emission material which can be found less than 10 km from the site.

THE CUBE APARTMENTS

12 STACK STREET, FREMANTLE



GROUND FLOORPLAN

The unused bricks in the site can be reused as the feature wall at the ground floor
Large amount of wooden palletes are discovered at the bac of the site.
The existing boat structure will be reused as outdoor sitting area and it can be the icon of the site.

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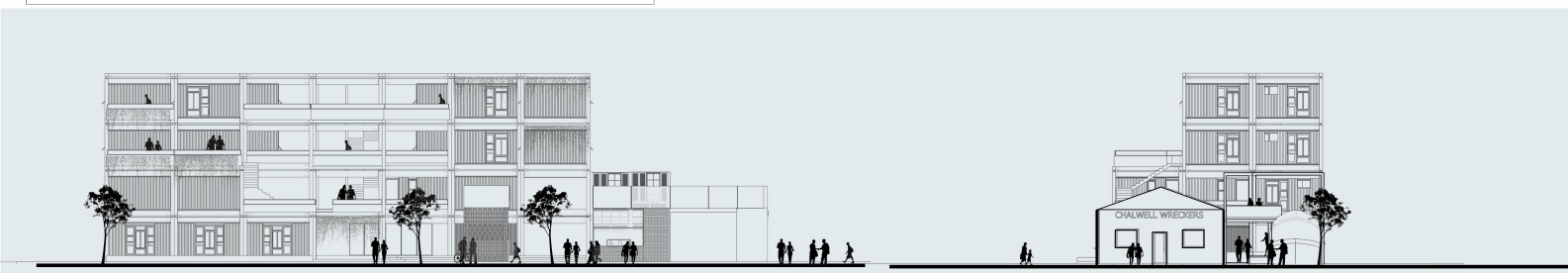
The apartments use modular prefabrication construction method which significantly saves construction time than conventional method. This type of construction offers the flexibility to reconfigure, assemble and disassemble to be moved to another site when necessary. In a result, efficiency in time construction is optimised as one of the biggest benefit to adapt this construction method.

The Glulam timber and SIP panel are the main material used in this building. This timber is proven to have enough strength to support the building compared to concrete with high durability and sustainability to be reused and recycled. Moreover, SIP is known as the lightweight yet less carbon emission materiial.



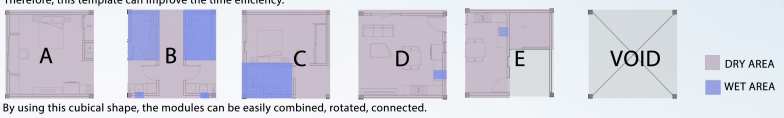
WEST ELEVATION

SOUTH ELEVATION

MAIN FRAME

6 BASICS MODULES

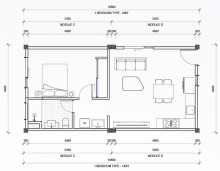
These template modules covers the basic need of living. By providing some templates/selection of wet and dry area combination, the client can be assisted on the design and the construction engineer can be assisted for the exact location of wet area/ plumbing. Therefore, this template can improve the time efficiency.



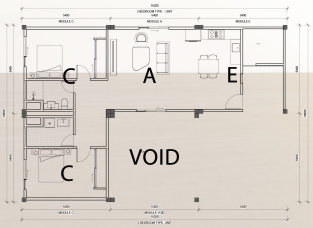
By using this cubical shape, the modules can be easily combined, rotated, connected.

CONFIGURATION

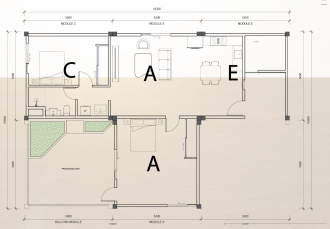
STUDENT ACCOMMODATION (GROUND FLOOR)



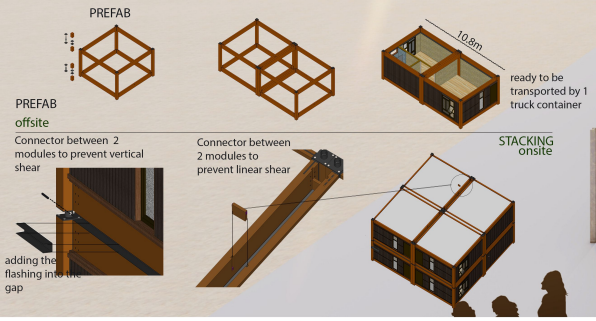
1 BEDROOM UNIT (1ST FLOOR)

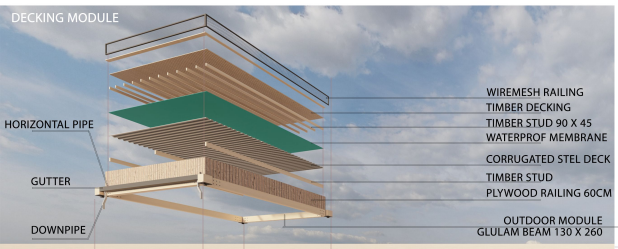


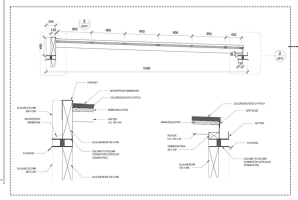
2 BEDROOM UNIT A (2ND FLOOR)

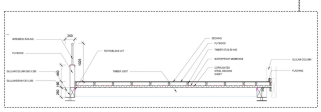


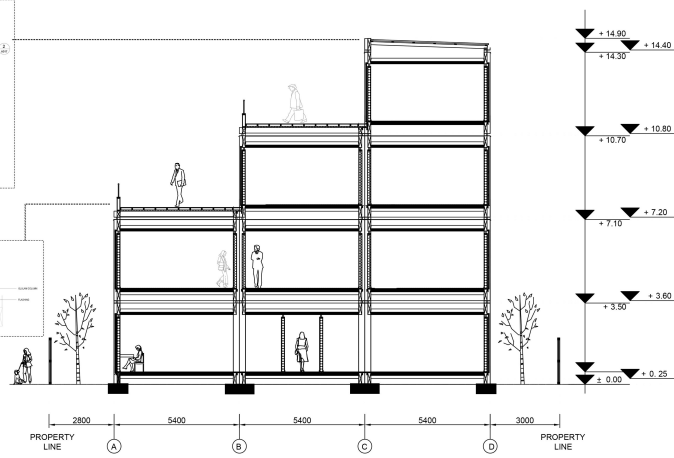
2 BEDROOM UNIT B (3RD FLOOR)

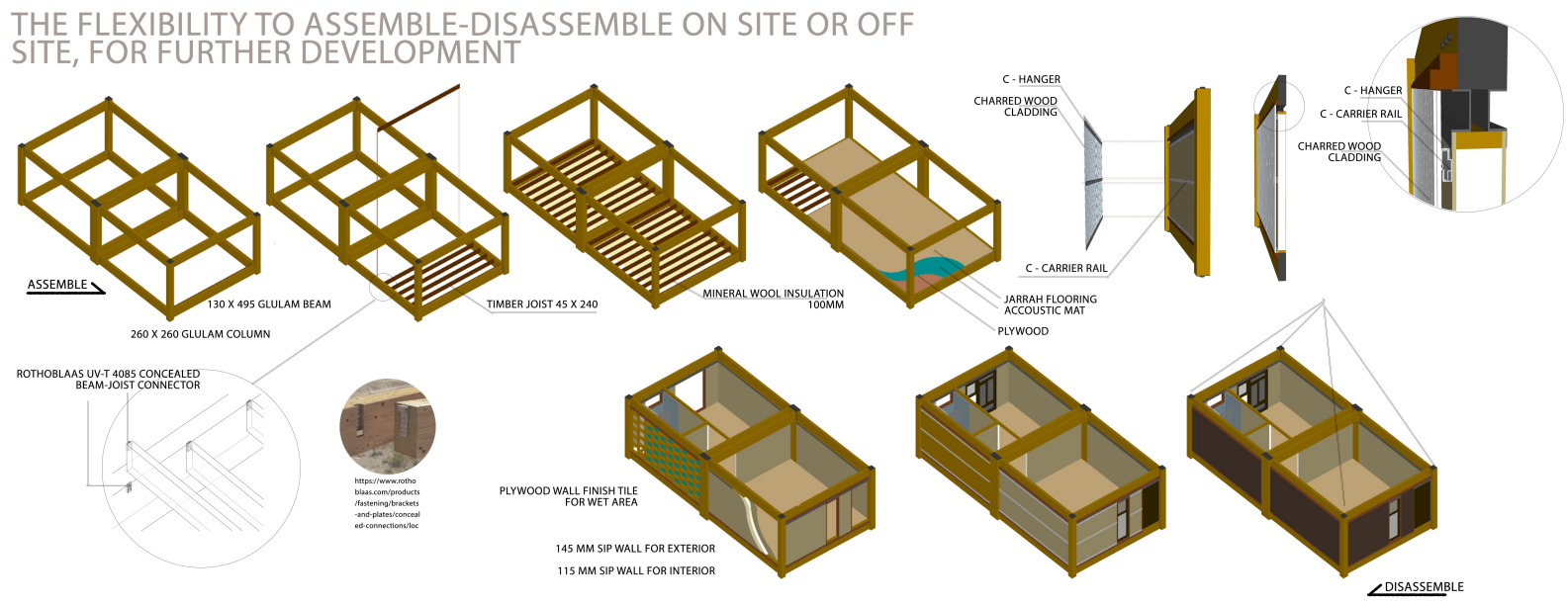






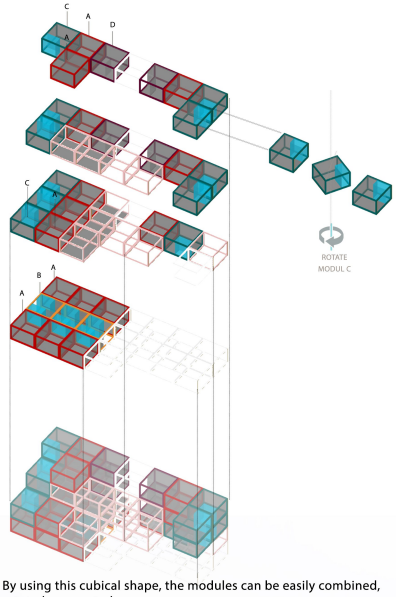






THE FLEXIBILITY TO ASSEMBLE-DISASSEMBLE ON SITE OR OFF SITE, FOR FURTHER DEVELOPMENT

https://www.rothoblaas.com/products/fastening/brackets-and-plates/concealed-connections/loc



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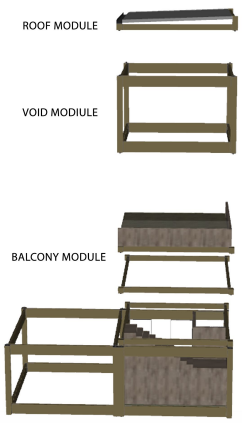
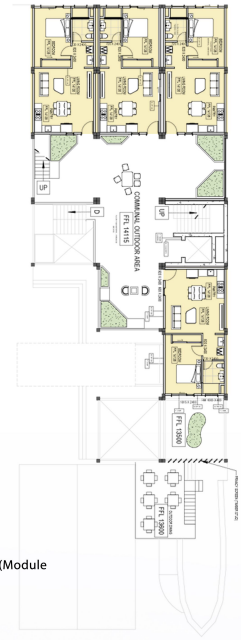
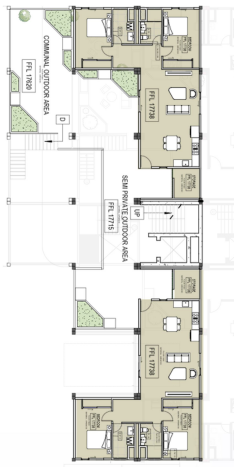




1ST FLOOR

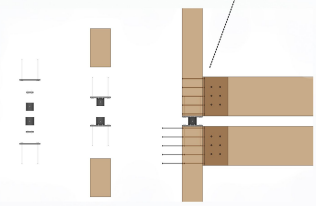


2ND FLOOR

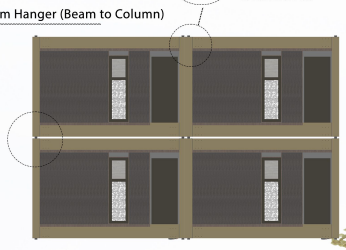
3RD FLOOR

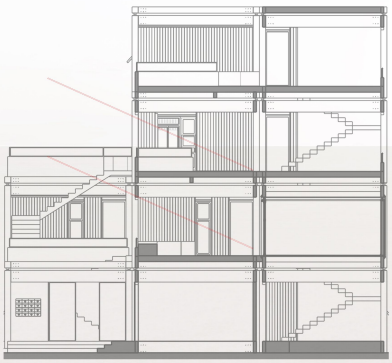
Concealed Hook Timber (Module to Module - Beam)
ROTHOBLAAS UV-T 40B5

Concealed Beam Hanger (Beam to Column)



Circular Connector (Column to Column)





THE CONFIGURATION OF MODULES IS DECIDED TO RESPOND THE SUMMER AND WINTER SUN. THE MODULES ITSELF CAN BE THE FLEXIBLY ADJUSTED AND BE TREATED AS THE SHADING DEVICE FOR THE OTHER DWELLINGS.

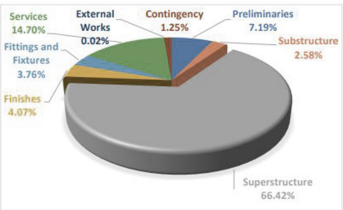
SUMMER SUN ANGLE (81° NORTH; 24° WEST)

Construction time: 301 days

Modules Construction

6 xStudent accommodation: 45 days offsite; 24 days onsite
4 x1 Bedroom unit (1st floor): 52 days offsite; 35 days onsite
2 x 2 Bedroom unit (2nd floor): 52 days offsite; 35 days onsite
2 x 2 Bedroom unit (3nd floor): 52 days offsite; 35 days onsite
Preliminary Cost for The Cube Apartment: $3,158,706.65

Cost Breakdown:



The architect and contractor have been engaged by a potential client to produce and provide a structural design for a timber building located at 12 Stack Street in Fremantle. The client strongly encouraged the use of a modular design to a four-storey apartment building. Obviously, the buildings design itself has to be environmentally friendly, minimises costing and also does not look out of place with the structures around this location. For simplistic reasons and convenience, the design will be prefabricated off site and transferred to site therefore careful consideration will be required to ensure this is possible. In order to achieve contractual obligation, we will be required to maintain a close relationship with the client themselves in order to satisfy their project outcomes and requirements. Some of the basic requirements of this structure is that it contains 4 two-bedroom units, 4 one-bedroom units and 6 one-bedroom student accommodation units. The Lot itself is 1000m2 which broken down is 30m by 30m. Accessing the site comes from the south side where the Chalwell Wreckers warehouse is located. The maximum height of the building is 15 metres and therefore we must not breach this design specification. The structures around the site are low level café buildings and small warehouses made from steel and tin sheeting. Therefore, producing an extremely modern building would not suit the surrounding structures and is one of the reasons we have opted to predominantly used a more natural looking timber design. Located near the site is a public transport bus link to allow easy transportation for university students as well as easy road transportation with available parking on site.

The engineer and architect designed the structure so that the columns and beams were able to take all of the critical load combinations therefore supporting elements such as the walls were not considered load bearing. For simplistic reasons and ease of construction and dismantling, all of the modules are the exact same dimensions (5.4m by 5.4m by 3.5m). Having the structure being as symmetrical as possible allowed a more accurate analysis. Although the modules throughout the structure are the same size, interior walls of the modules can be taken out in order to create larger rooms. This is how the larger 2-bedroom apartments on the top 2 floors are designed with the middle interior wall being removed and freeing up more space. This will not have an effect on the analysis of the structure as it was assumed that the columns and beams are taking all of the load and has been designed accordingly. After conducting some calculation and consideration, Glulam is applied for the main structure (beam and column) in this building. GL 17 130mm x 495 mm is used as the beam, GL 260 x 260 is used as the column.

Connections plays significant role in assemble and disassemble process for modular and stackable timber building. It also makes the timber reusable. Researchers from Delft University of Technology, Pozzi (2019) identified some timber connection and assess it based on several principles including: number of elements needed; finishing appearance (exposed or hidden); element of complexity; ease of assembly and disassembly; prefabrication degree; end of cycle waste ;reusability; degree of freedom; costs; structural strength. Concealed Beam Hanger which has 72/ 100 will be applied as Beam to Column connection. Moreover, Circular Connector which has the highest degree of reusability and disassemble will be proposed as column to column connection. Concealed Hook (Rothoblaas UVT 4085) will be used as Joist connector and Module to Module connector to against the sliding. Therefore, those 3 connectors will be the main connection applied in this building in order to achieve easy assembly and disassembly process.

Major elements

After careful consideration from both the architect and engineering team, the following materials were utilised for each component of design.

• Flooring – Wooden flooring was also discussed at length and is a design option put forward by the architect themselves. For the flooring, we utilised Plywood as we decided using CLT for the flooring itself was not necessary and saved us in the overall costing. We used 240x45 MGP 15 at 500mm centres for the joists which supported the F11 21mm Plywood on top and through our design checks, it was suitable for our design requirements. Further calculations were completed on the assumption of joists to find a conservative estimate of joist load transfer to perpendicular beams. The 500mm spacing satisfied the minimum requirements of AS1720.1 and Dindas HYSPAN 'Span Guide for Residential Framing' (CarterHoltHarvey 2021) . Refer to Appendix 3 for calculations on flooring design.

• Ceiling – For simplistic reasons, we used the same material for the roofing/ceiling of each module which was the F11 21mm Plywood and the rafters were 240x45 MGP 15 at 500mm centres as well. This however was not able to support the critical load combinations and therefore decreased the spacing between these joists allowed for this critical load combination to be supported. Therefore, it was found through calculations seen in the Appendix 4 that utilising 240x45 MGP 15 at 300mm centres will be sufficient to support this.

• Walls –Big discussions were done to discuss the material for the walls, with a consensus on CLT (Cross Laminated Timber) or SIP being adopted and utilised. Beams and columns are the primary structure to support all the critical load combinations. Therefore, it does not require CLT to be load bearing. However, in practicality, the CLT walls will most likely take a small amount of load. For that reason, a CLT panel was selected previously to support this. A CLT3/125mm panel was chosen from the XLAM design guide and verified by the architect that this would suffice their design requirements (Xlam 2017). Additionally, a 100mm thick fibre insulating layer will be added to the wall. After developing the project further with considering the weight, the time effectiveness (labour) and the life cycle analysis between CLT and SIPS, the architect modified the design and changed the main wall material into SIP

• Cladding- Charred timber cladding provides rustic, rawness and textured profile, which create perfect balance with the industrial look within the building (Timber Trader 2018). This texture could change subtly over time which reflects a recycled beauty. Moreover, Charring and oiling technique is effective to increase the material durability and extend its life up to double the normal source (Abodo 2021) with minimal maintenance requirements. Burning process in charred timber cladding produce layer of carbon, which transform the material to have higher level of water resistant compared to raw / untreated timber. The charring technique created a extra burnt layer (black lignin) on the outer charcoal, letting the inner core harder to penetrate the heat, which slowing down the burnt rate and provide a level of fire resistance. This cladding type does not require any glue or chemical finish. Installation can be completed by stainless steel screw. By the end of its lifecycle, timber will be be cut up for biofuel and screws will use for another building's building connector (Renew 2019)