

GROOT APARTMENTS AND WAREHOUSE:

ABSTRACT:



At GROOT apartments, leisure is a strong driver in encouraging neighbourhood interaction and enabling a strong sense of community. Within their apartment block, tenants can interact while watering the plants at the verge garden or cooking with friends and family at the communal ground floor area. The Groot warehouse actively aims to welcome the larger Fremantle community by directly connecting to the frequent markets that occur at the stack wood parallel to the akin warehouse. It hosts a vibrant café space, a grocery store and a click and collects space for upcoming artists to sell their products. The private balconies have also been designed to connect to the vibrant street life where residents can enjoy watching the street while enjoying their morning and evening tea or coffee. Hyper flexibility is also a key driving force at Groot apartments; each apartment is made from three CLT primary modules that can be mirrored across x and y-axis; this allows Akin apartments to easily be configured onto any site. All the modules are optimized to fit onto a standard truck and each level can be stacked onto a site in seven days!



40 TRUCKS
REQUIRED TO
TRANSPORT THE
ENTIRE PROJECT

TOTAL PROJECT
COST IS
2.1 MILLION

ENTIRE PROJECT
IS FABRICATED
AND ASSEMBLED
IN 6 MONTHS

MEET GROOT

At GROOT apartments it is believed that leisure is a strong driver in encouraging neighborhood interaction and enabling a strong sense of community. Within their apartment block tenants can be found interacting while watering the plants at the verge garden or cooking with friends and family at the communal ground floor area. The Groot warehouse actively aims to welcome the larger Fremantle community by making a direct connection to the frequent markets that occur at the stack wood parallel to the Groot warehouse. It hosts a vibrant café space a grocery store and a click and collect space for upcoming artists to sell their products. The private balconies have also been designed to connect to the vibrant street life where residents can enjoy watching the street while enjoying their morning and evening tea or coffee. Hyper flexibility is also a key driving force at Groot apartments, each apartment is made from three CLT primary modules that can be mirrored across x and y axis, this allows Groot apartments to easily be configured onto any site. All the modules are optimized to fit onto a standard truck and each level can be stacked onto a site in seven days!

- EACH MODULE CAN BE REFLECTED WHICH ALLOWS HYPER FLEXIBILITY
- EXTERNAL SCREENS ALLOW GROOT TO WORK UNDER ANY SITE ORIENTATION
- COMPACT SIZE ONLY TAKES 300 SQM OF FOOTPRINT.

URBAN FARMING AND WEEKEND MARKETS



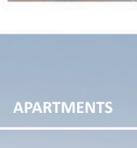
A COWORKING ENVIRONMENT



COMMERCIAL RETAIL SPACE FOR GROCERY STORE AND ARTIST STUDIOS.

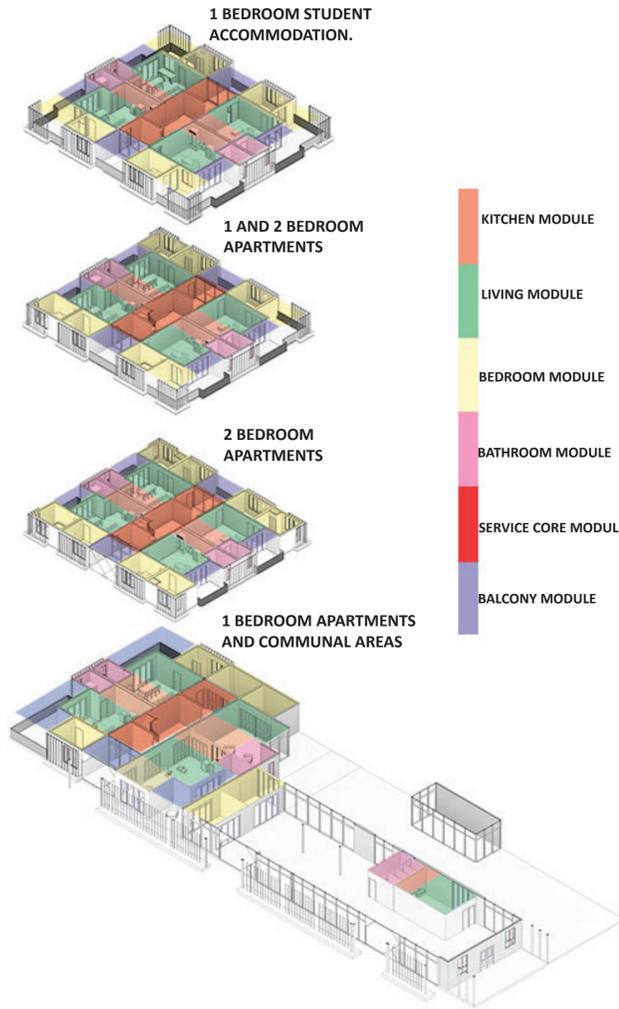


TRANQUIL LIVING SPACES



PRIMARY ENTRANCE ALONG WOOD STREET

Material used.	Sustainability factor.
CLT walls and flooring (exposed internally).	CLT can be easily dismantled at the end of its 40 years building life and can be recycled or be used as a bio fuel. Self insulated so does not require additional insulation.
Colorbond custom orb roofing.	Part of the Freo vernacular, Australian made, contains recycled content and is 100% recyclable at the end of its useful life. Light colour also reflects excessive sunlight.
Weatherex wall cladding.	Weatherex panels are manufactured from timbermillings that would otherwise be discarded as waste, and are combined with other non-toxic, low embodied energy materials to form a durable external cladding.
Recycled brick.	Brick found on and around the site is used for the pavement and boundary walls.
Timber boat frame.	The timber boat frame found on site is reused as an entry way on the stack street entrance and also to be used for furniture where appropriate.
Existing warehouse structure.	The existing warehouse structure is retained and reused.
7kW total solar PV array.	Solar panels are all oriented on east and west facing roofs.
Greenery Intergrated shading screen.	Natural shading methods that can easily be decomposed at end of life.



49.4%
YEARLY ENERGY
SAVINGS
COMPARED TO
TRADITIONAL
APARTMENTS

APARTMENT
FOOTPRINT IS
ONLY 300 SQM
COMPACT SIZE
REDUCES ENV
FOOTPRINT

CONTRIBUTES
TO LOCAL
BUSINESSES AND
ECONOMY THROUGH
MULTIPLE SHARED
SPACES

50+ YEAR
LIFE EXPECTANCY
WITH ABILITY TO
BE RECYCLED AFTER
END OF USE

REFLECTIVE
MODEL MAKES
GROOT HYPER
ADAPTABLE SO IT
CAN BE ADAPTED
TO ANY SITE

25% LESS
CARBON
EMISSIONS
COMPARED TO
CONCRETE
APARTMENTS

ARTIST STUDIOS PRODUCT DISPLAY AREA GROCERY STORE CAFE KITCHEN CAFE DINING

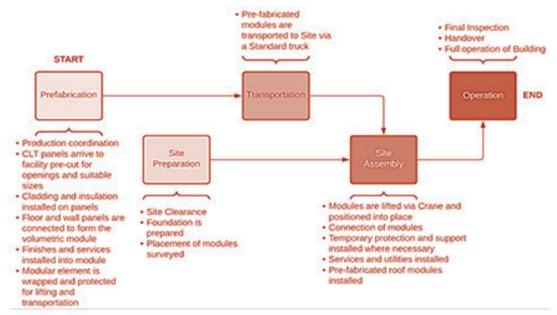
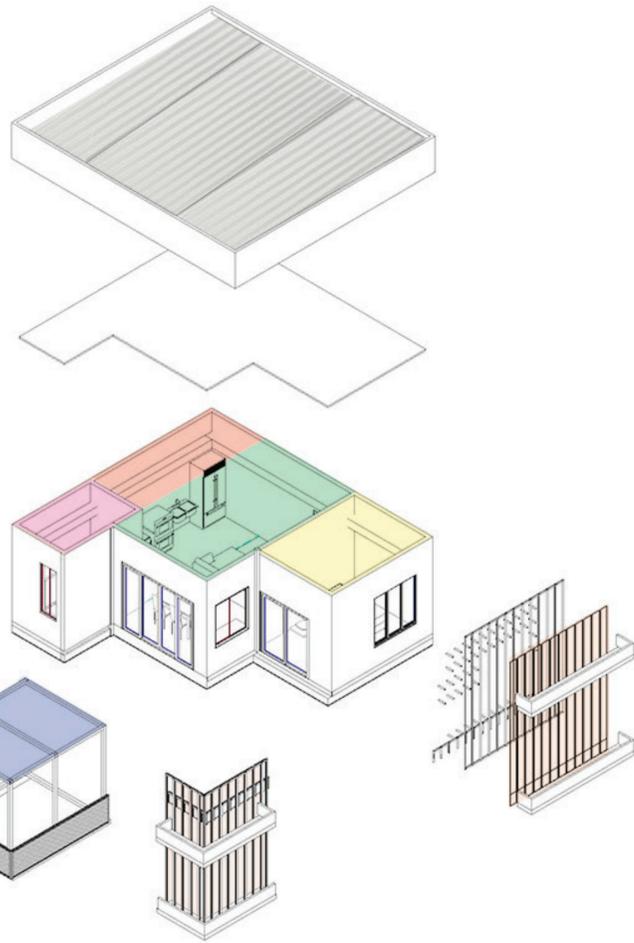


PACKAGING GROOT

Each module will be entirely wrapped with a suitable protective membrane at the prefabrication factory prior to transportation. This is a crucial component in order to provide sufficient protection of the modular structures during transport and on-site. Module connections can be protected through installation of a divider plank on the façade boarding and taping the joints (Stora Enso Building Solutions, 2016). The nominated Class 1 RAV, low loader with maximum gross tonnes of 92.5 tonnes, is required to conform with Mainroads' Oversize Period Permit to allow safe movement of the dwellings and structures and prevent damages on existing infrastructure along its route. Figure 9 below illustrates the transportation programme as per Main Roads Western Australia (MRWA) and will be adjusted accordingly to suit project-by-project basis.

Crane sizes used to lift modular structures usually range from 20 to 350 tonnes (Sarens, 2014), although for this instance, location of safe access points, rotation allowed, and the desired heights is critical. The volumetric module weights for Modules A, B, C and D, are 12.9 tonnes, 8.6 tonnes, 8.0 tonnes, and 5.2 tonnes respectively. These values were only based on the CLT weights and 1.5kPa for services and finishes. Nonetheless, the handling and lifting process should allow for efficient assembly of the modules on Site and safety of all site personnel. Hoisting and rigging system will allow direct vertical lift. Given the weight and size of the modules, the Design Team proposes site erection via 4 to 6 lifting points, to reduce the stress on the panel to clutch connection. Lifting points can either be from the bottom or top panel, depending on the final weight of the structure. However, lifting from the bottom panel is identified to be more ideal in case of tight factory access and preventing the likelihood of excessive bending of the entire module. There are various lifting connections such as standard bolted clamp plate, load rings, swivel eye bolt (FPInnovations, 2019) or other proprietary connections from suppliers like Camlock or Ranger.

The QR coding system is proposed to identify each individual volume in design and manufacturing stages and will also be used during the site assembly process. Scanning the QR codes will provide contractors critical information, such as the location and orientation of each volume plus material and labour information on structural and service connections. In addition to providing contractors quick access to assembly information, Schultz (2021) suggests QR system can be used in project to provide access to safety videos, instruction manuals and workforce information.

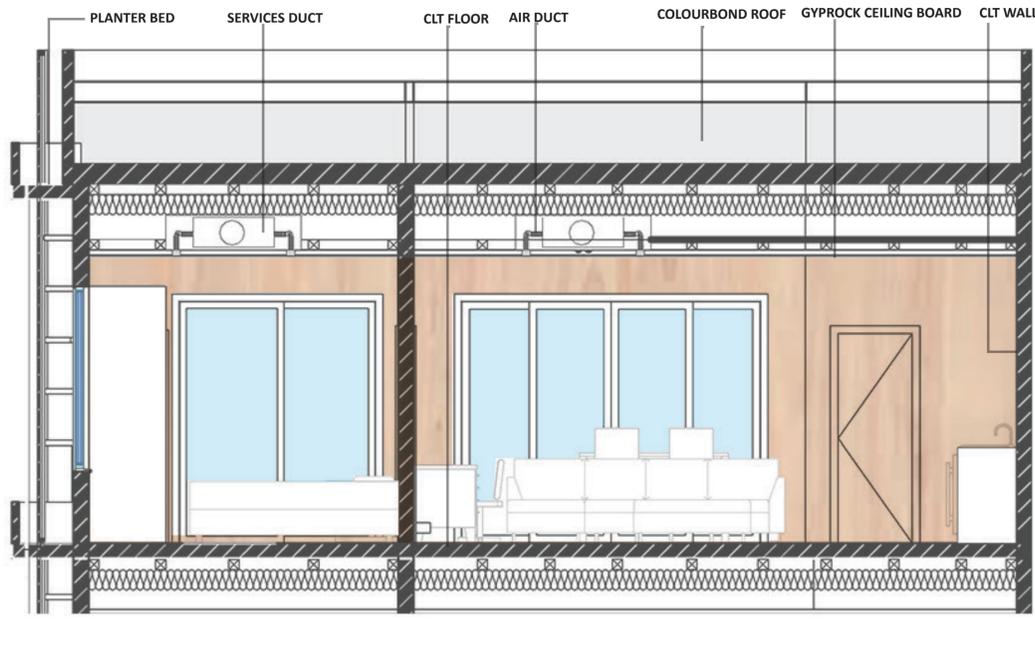
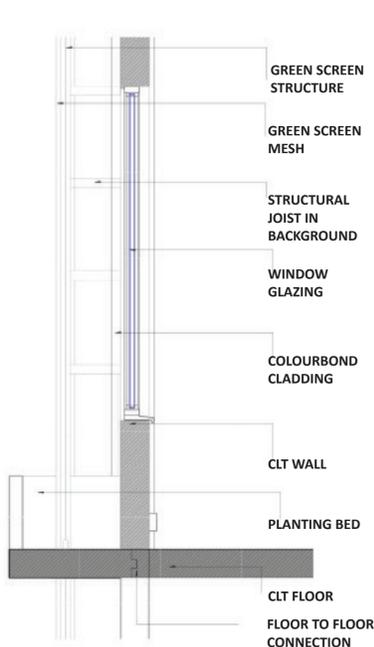


	Module A	Module B	Module C	Module D
Height (m)	3.5	3.5	3.5	3.5
Width (m)	3.9	2.2	3.0	2.2
Length (m)	6.0	6.0	4.3	3.3
CL5/225 mass (kg)	2695	1520	1486	836
CL5/145 mass (kg)	6615	5038	4567	3265
Finishes (kg)	2385	1346	1315	740
Services (kg)	1193	673	657	370
Total mass (tonnes)	12.9	8.6	8.0	5.2

Number of Trucks Required	Max H	Max W	Max L
17 trucks (Modules A + B)	3.50	4.00	12
19 trucks (Modules C + D + E)	3.50	4.30	3.0
4 trucks (Module F)	3.50	4.10	12
Total of 40 trucks (Minimum)			

WALL TO GREEN SCREEN DETAIL

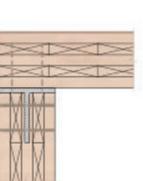
TYPICAL MODULE SECTION



WALL TO FLOOR CONNECTION DETAIL TYPE 1



ROOF TO WALL CONNECTION DETAIL



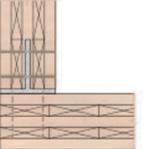
FLOOR TO FLOOR CONNECTION DETAIL



WALL TO FLOOR CONNECTION DETAIL TYPE 2

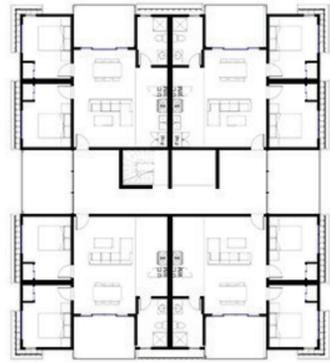


WALL TO FLOOR CONNECTION DETAIL TYPE 3

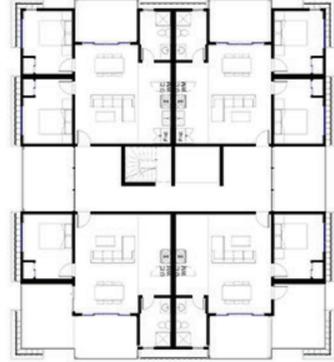




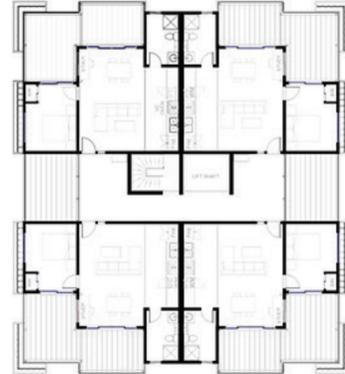
LEVEL 1 FLOOR PLAN: 2 BEDROOM APARTMENTS



LEVEL 2 FLOOR PLAN: 1 AND 2 BEDROOM APARTMENTS



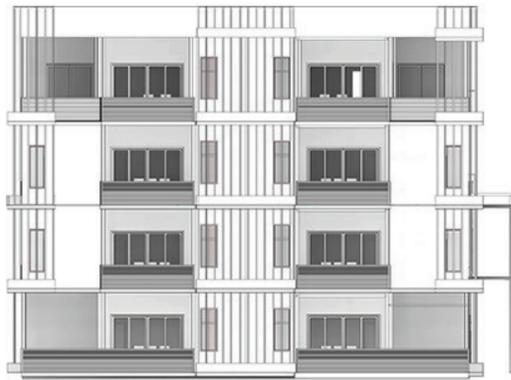
LEVEL 3 FLOOR PLAN: 1 BEDROOM STUDENT ACCOMMODATION.



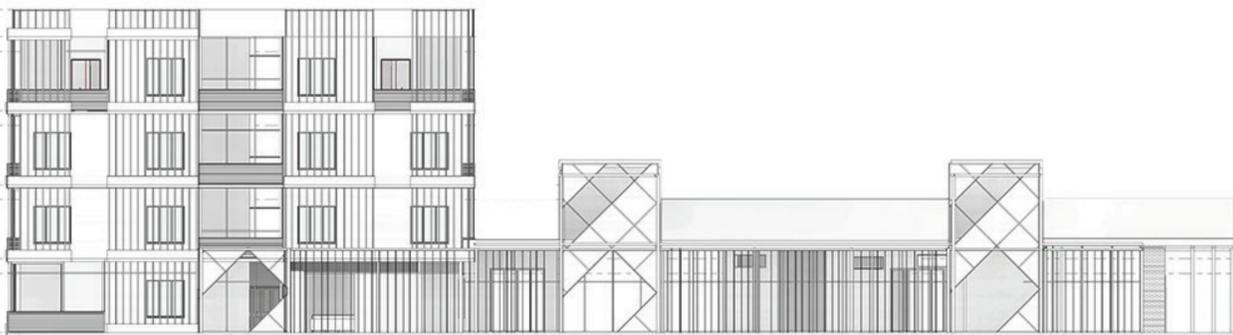
SOUTH ELEVATION



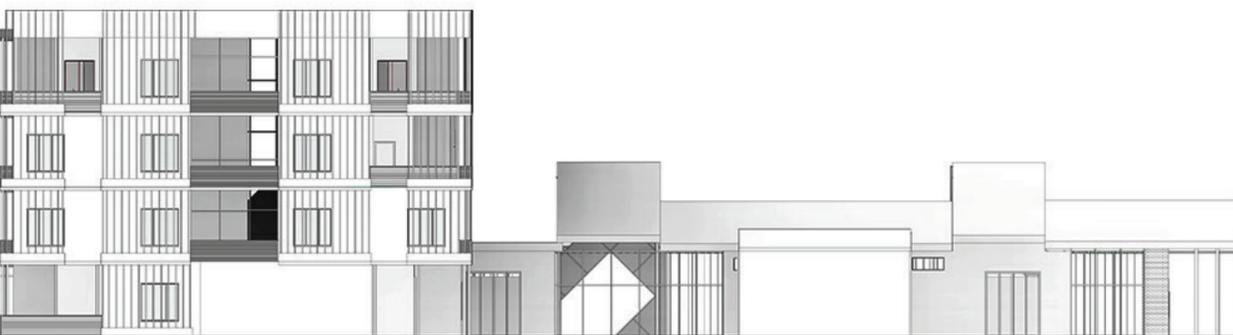
NORTH ELEVATION



EAST ELEVATION



WEST ELEVATION



PROJECT SCHEDULE

Task	Duration	Start	End
PRELIMINARIES	15 days	Mon 5/07/21	Fri 23/07/21
Site possession	1 day	Mon 5/07/21	Mon 5/07/21
Insurances	5 days	Tue 6/07/21	Mon 12/07/21
Mobilisation	2 days	Tue 13/07/21	Wed 14/07/21
Recycle stockpiled material	7 days	Thu 15/07/21	Fri 23/07/21
SITE WORKS	45 days	Mon 26/07/21	Fri 24/09/21
Earthworks	5.5 days	Mon 26/07/21	Mon 2/08/21
Underground Services	21 days	Tue 27/07/21	Wed 25/08/21
Existing Structure	29.5 days	Mon 26/07/21	Fri 3/09/21
Footings	22.5 days	Wed 25/08/21	Fri 24/09/21
OFF SITE VOLUMETRIC CONSTRUCTION	81 days	Tue 13/07/21	Tue 2/11/21
GROUND FLOOR	50 days	Tue 13/07/21	Mon 20/09/21
FIRST FLOOR	50 days	Fri 23/07/21	Thu 30/09/21
SECOND FLOOR	50 days	Tue 3/08/21	Mon 11/10/21
THIRD FLOOR	50 days	Fri 13/08/21	Thu 21/10/21
ROOF	20 days	Wed 6/10/21	Tue 2/11/21
VOLUMETRIC INSTALLATION	54 days	Mon 27/09/21	Thu 9/12/21
GROUND FLOOR	7 days	Mon 27/09/21	Tue 5/10/21
FIRST FLOOR	12 days	Wed 6/10/21	Thu 21/10/21
SECOND FLOOR	12 days	Fri 22/10/21	Mon 8/11/21
THIRD FLOOR	12 days	Tue 9/11/21	Wed 24/11/21
ROOF	11 days	Thu 25/11/21	Thu 9/12/21

TRANSPORTATION OF VOLUMES

Subtask	Scheduling (Plant, labour & equipment)	Materials
Transportation of volumes to site	Schedule 7 days prior. 1 days' work per level.	Nil.
Lift volumes from truck	Schedule: 0.25 days per module 1 x Crane and Operator 1 x Spotter 2 x Riggers	Levelled temporary lay down area required.
Place volumes to form superstructure	Schedule: 0.25 days per module 1 x Crane and Operator 1 x Spotter 2 x Riggers	Lifting equipment.
Position, level, secure volumes	Schedule: 0.5 days per module 1 x Crane and Operator 1 x Spotter 2 x Riggers 1 x Surveyor 1 x Engineer 4 x Labourers.	Lifting equipment, survey equipment, survey benchmark, connection bolts, plates and fastening equipment.

CARBON FOOTPRINT CALCULATIONS

Materials	kg CO ₂ (eq/kg)	kg of materials	Impact materials (eq)
Concrete	0.19	2000	380
Reinforcing bars	1.63	200	326
Structural steel	2.21	100	221
Timber	0.45	14000	6369.58775
Clay bricks	0.24	500	119.8248059
Tiles	0.76	2000	1520
Insulation (EPS)	3.24	500	1620
Plaster	0.23	3000	690
Total impact of materials			11,246.41

PROJECT COST ESTIMATION

Class A: General items	\$216,340.77
Class B: Ground Investigation	\$6,000.00
Class D: Demolition and Site Clearance	\$465.50
Class E: Earthworks	\$19,678.96
Class F: In Situ Concrete	\$35,965.27
Class M: Structural Metalwork	\$50,374.91
Class O: Timber	\$988,774.40
Class W: Waterproofing	\$121,984.01
Class Z: Simple building works incidental to civil engineering works	\$410,292.81
Contingency	\$272,481.49
Total	\$2,127,358.12

GROOT APARTMENTS AND WAREHOUSE:

EXECUTIVE SUMMARY.



EXECUTIVE SUMMARY:

Advanced design that delivers community and client value:

- External cladding in the weather panelling along with the building-integrated greenery create the appearance of the building being non modular/ permanent.
- A modular apartment building that appears to be permanent can add value to the build to rent program and yield rental income similar to a traditional apartment building.
- The akin warehouse and annex open space aims to be a communal space that supports the upcoming local business and contribute to the circular economy of Fremantle.
- The roof space is optimized for the placement of solar panels with the intention of peer to peer sharing of energy micro grid of east Fremantle.

The potential of new technologies and New construction systems and smart materials:

- CLT connections offer potential to a variety of new technologies such as Knapp connectors that allow for self-locking mechanism between connections.
- This offers quick assembly of the different modules and excellent resistance while transportation and lifting of modules in assembly and disassembly.
- Similar to Knapp, dovetail joinery offers Japanese style joinery between the different components of the modules however it requires precise CNC machinery (Gagnon, Sylvain, and Karacabeyli. 2019)

Processes and professions in transdisciplinary design approaches and Processes and professions in transdisciplinary design approaches:

- A QR-Code System embedded into the CLT panels can further improve reduce project time, and utilize Just- In-Time (JITS) processes to achieve lean manufacturing (Wood solutions 2018).

Resilience and sustainability responses to the climate emergency:

- Timber is the core component of manufacturing CLT and it is renewable and can be locally sourced without using of heavy machinery it has a low embodied energy. Although
- CLT cannot be recycled as a building material after its lifespan it can readily be used as biofuel (Wood solutions 2018).
- For the roof a Colorbond custom orb roofing is used and it is Part of the Freo vernacular, Australian made, contains recycled content and is 100% recyclable at the end of its useful life.
- Light colour also reflects excessive sunlight. The weatherx wall cladding are manufactured from timbermillings that would otherwise be discarded as waste, and are combined with other non-toxic, low embodied energy materials to form a durable external cladding.
- Brick found on and around the site is used for the site paving and boundary walls. The timber boat frame found on site is reused as an entry way on the stack street entrance and also to be used for furniture where appropriate. 7kW Solar panels are all oriented on east and west facing roofs. Greenery is incorporated into the shading system and can be easily decomposed at the end of its life.

Design for Manufacture and Assembly (DfMA) and Disassembly processes and smart engagement with changing construction sites (refer to engineer's report for details).

- The number of modules has been limited to 5 modules only with all services running through the core of the building.
- Each module has at least three pick up points and is designed to be stacked on top of each other.
- The stacking method streamlines the optimizes the manufacturing, assembly and disassembly process and is quicker than other modular approaches such as creation of a mother structure or flat packing.
- All stacking can be done using an industry standard crane and modules self-lock on top of each other using the Knapp and Xradd joinery systems.

High building performance across the whole building lifecycle:

- Will CLT has great insulation capacities, all external walls are to be further insulated to reduce any infiltration.
- The east and west window provide great opportunity for heat gain during winter the external clip-on louvers shade the windows during summer.
- The apartments have been designed to allow cross ventilation and use Fremantle doctor to cool down the building during summer.

New construction systems and smart materials and Advanced & efficient manufacture of building components, digitization, robotics, LEAN manufacturing and operational efficiency:

- X-RAD from Rothoblaas can be used in joinery of the modules across different levels and also be used as a lifting hook for onsite handling of panels.
- It can also serve as a connection between the wall and the concrete foundation (Gagnon, Sylvain, and Karacabeyli. 2019).

Innovative business models and development and financing models.

- The build to rent program offers a great potential for the akin apartments to be used within areas where there is a shortage of rental accommodation.
- The various coworking spaces and space for local business such as artist click and collect, grocery store, co working café space and markets also adds to the value proposition.

References:

- Gagnon, Sylvain, and Erol Karacabeyli. 2019. Canadian CLT Handbook . FPIInnovations.
- Wood Solutions. 2018. "Wood Solutions Design Guide 16." Massive Timber Construction Systems.
- October. <https://www.woodsolutions.com.au/publications>.
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