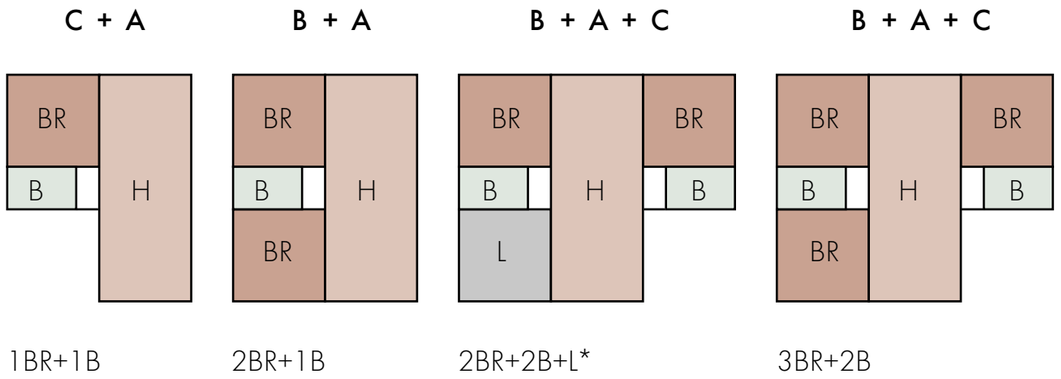
Timber Waves

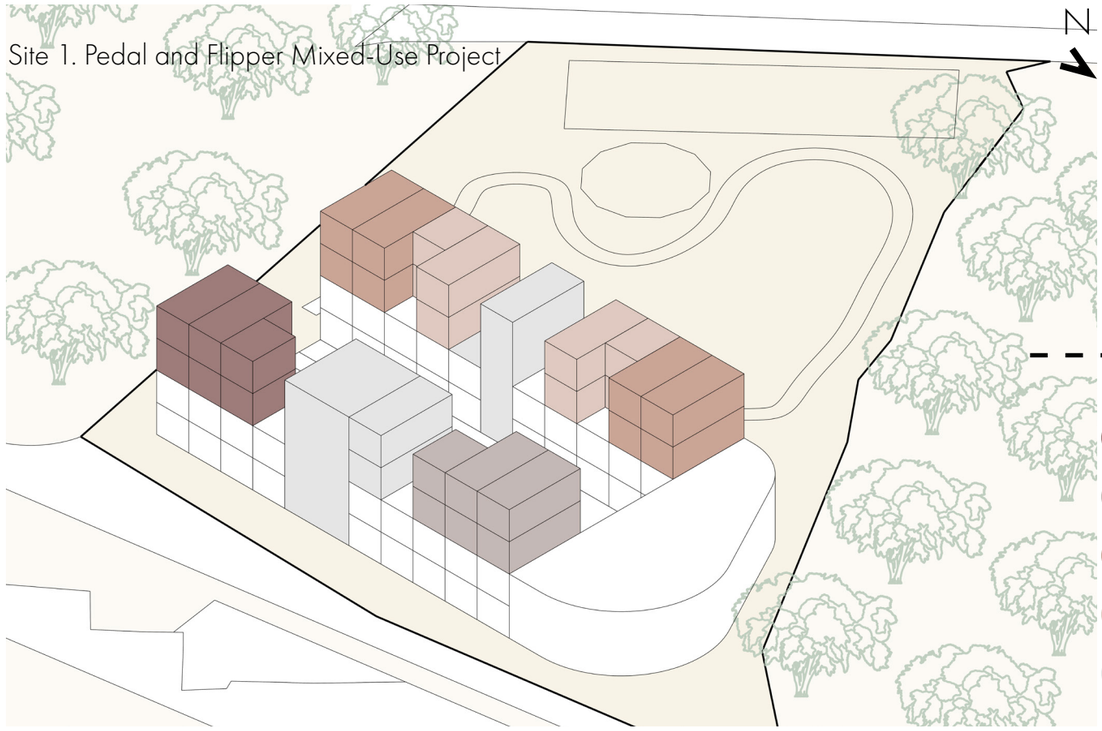
Concept Validation Report

Modular Reconfiguration

The modular apartments are designed to be easily disassembled and reconfigured in the future. The Hall Module contains the Living, Dining and Kitchen Area, and is common for all apartment unit types. The same base module is fit out differently to fit the bedroom and bathrooms as required for the design. The units are derived from a combination of module types A, B and C. The communal laundry is attached to the 2BR + 2B unit type.

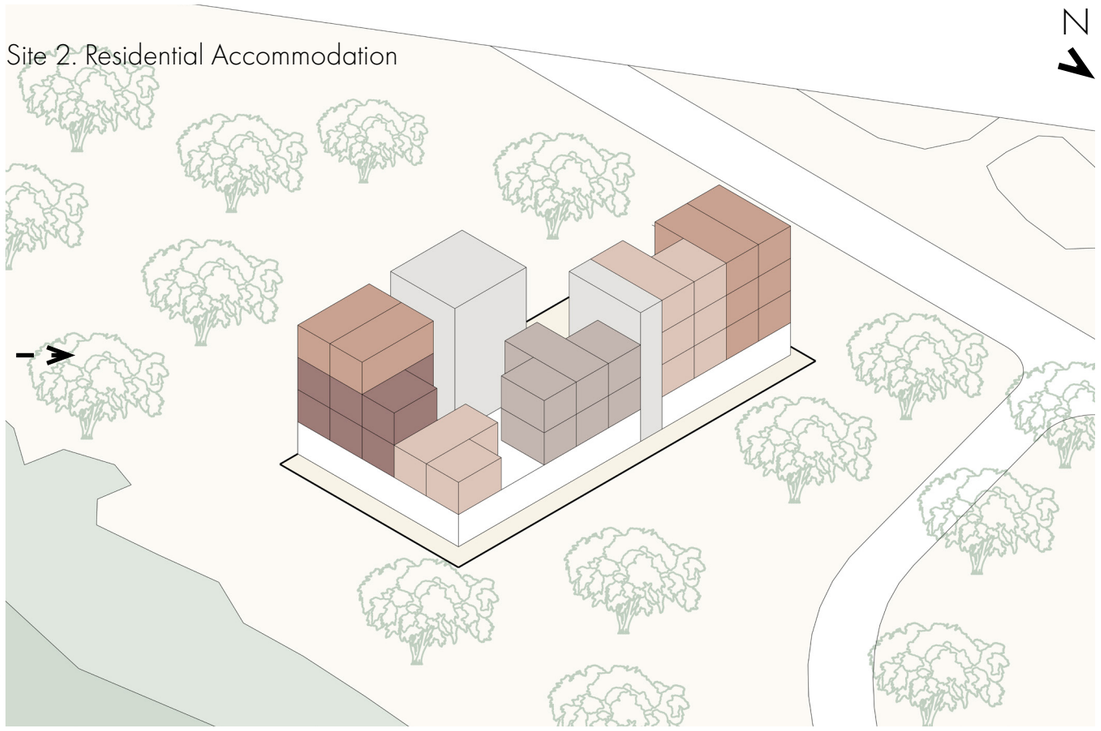
Both designs contain four 1Br + 1B, four 2 Br + 1B, two 2Br + 2B, and two 3Br + 2B unit types. The first site is planned with fenestration openings towards East and West, and the second site is planned with fenestration openings towards North and East.





Modular Reconfiguration

3BR + 2B
2BR + 2B
2BR + 1B
1BR + 1B
Circulation Core



Site 1 Residential Program

Residential apartments are planned along a linear atrium, with vertical circulation cores situated in middle zone for building compliance for class 2 and 6 buildings. Apartment units are formed through horizontal and vertical connection of modules; east and west orientation allows for optimum sunlight, cross-ventilation, and scenic views for all units. All units get more than 4 hours of sunlight during the winter.

Site 2 Residential Program

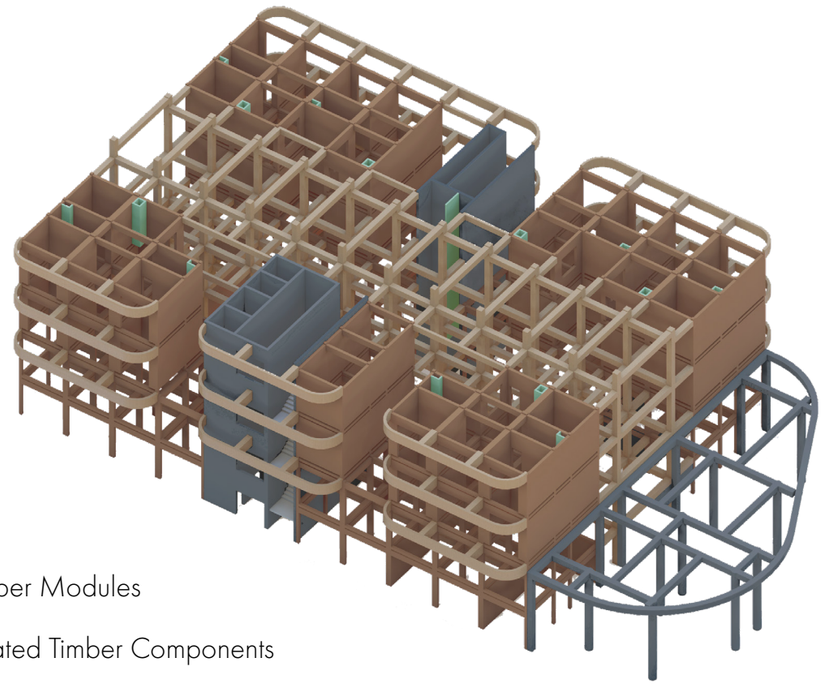
Modules are reconfigured on site with stepped terraces for communal visual access to water views; north and east orientation allows for optimum sunlight and water views for all apartment units. Prefabriacted corridor slabs, columns and beams are also used from the first site. New prefabricated cores are assembled on site which are compliant with fire safety codes. All units get more than 4 hours of sunlight during the winter.

Built Form: Structure and Services

The mixed-use building on site 1 is constructed through a hybrid system of modular and prefabricated manufacturing systems which are carbon-neutral and have low embodied energy. Mass-Timber modular apartments and bike storage are linked through prefabricated glulam columns and beams in the transitional spaces. The vertical circulation core is assembled through prefabricated fly-ash concrete panels. Similarly, the double-height structure in the front is assembled from recycled steel columns and beams. The low carbon structural materials are further discussed below.

The individual module is assembled from glulam columns and beams, with Cross-Laminated Timber (CLT) floors and walls. Wood-fiber insulation is used to separate the claddings from CLT wall panel, and Fyrchek Plasterboard provides additional protection from fire. Space for services is provided above the false ceiling and underneath the floor, while the vertical services movement between modules happens through the service ducts.

Columns are inter-connected through steel dowels, while column to beam connections take place through concealed steel knife plates. This allows for flexibility in design as modules can be made bigger or smaller through partial removal of beams and columns.



Mass-timber Modules

Prefabricated Timber Components

Prefabricated Concrete Panels & Recycled Steel Components

Services

Cross Laminated Timber

CLT reduces the global warming potential of the project as it stores carbon throughout the building's lifecycle. It's also fully recyclable and reuseable as a building material, which is a key circular economy principle.

Glue Laminated Timber

Glulam (GLT) is a structural material used for columns and beams in mass timber projects. Similar to CLT, it reduces global warming potential thorugh carbon sequestration. It can be reused as a biofuel.

Woodfibre Insulation

Woodfibre insulation is made from waste wood materials produced from the wood processing industry due to which it has low embodied carbon. It's higher specific heat capacity improves thermal performance of the building.

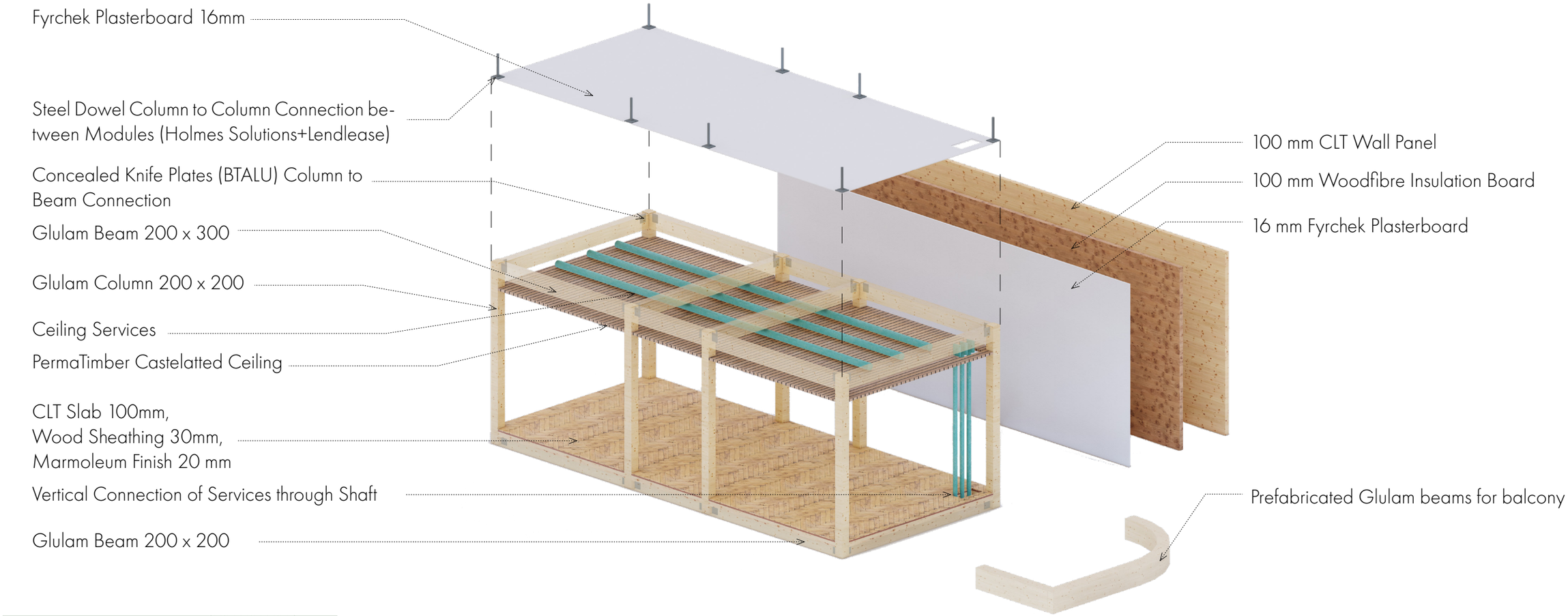
FlyAsh Concrete

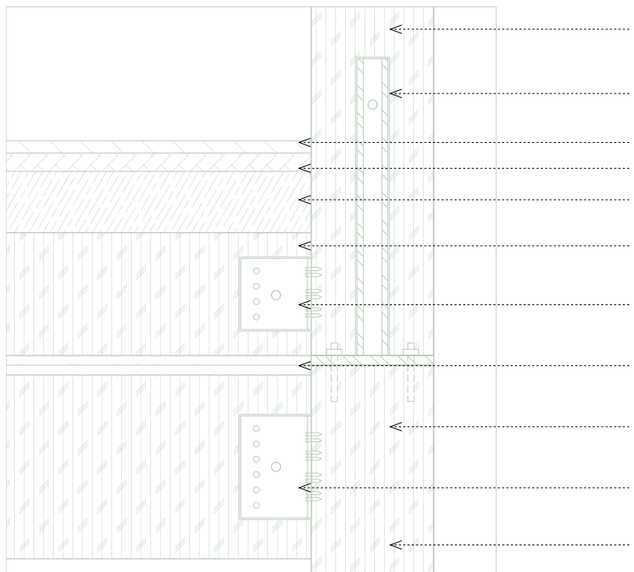
FlyAsh is a byproduct of Coal production and is sourced from Collie ,WA. It is used to replace cement in concrete to lower the embodied carbon of the project; cement production accounts for 8% of the world's carbon emissions.

Recycled Steel

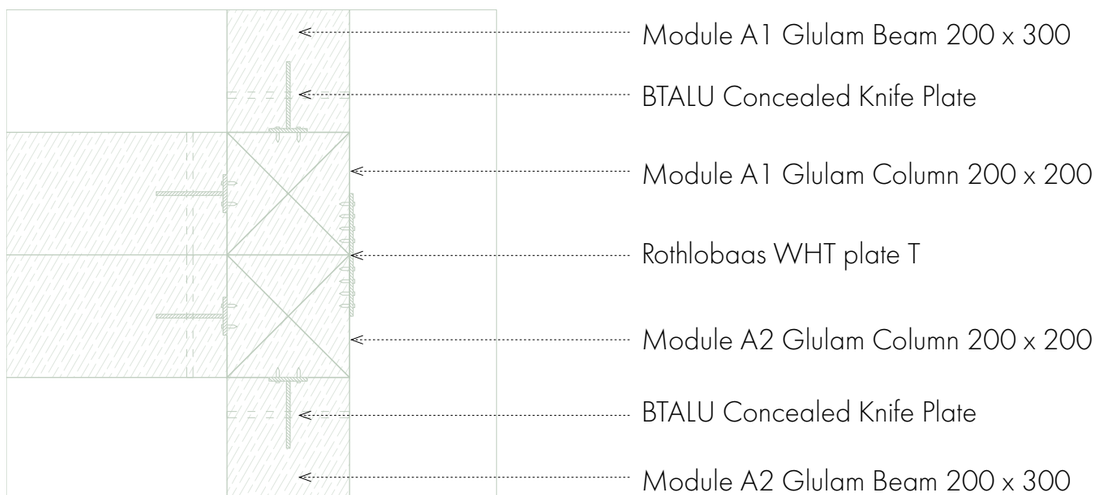
Connecting Dowels and Knife Plates are made from recycled steel. It reduces the energy spent on mining iron ore, coal, and limestone which is required for producing new steel.

Module: Structure and Services



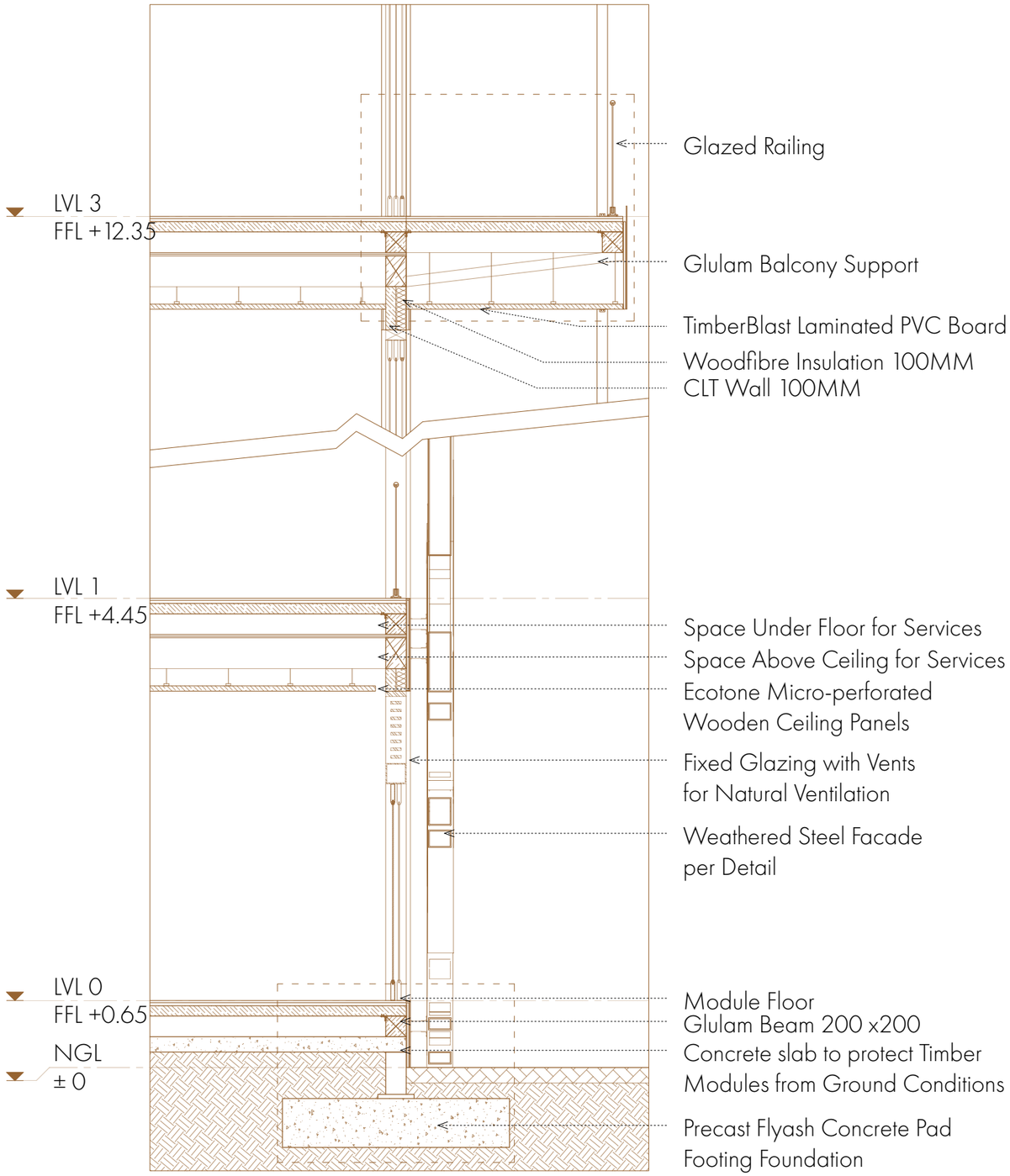


Section Detail: Vertical Module Connection

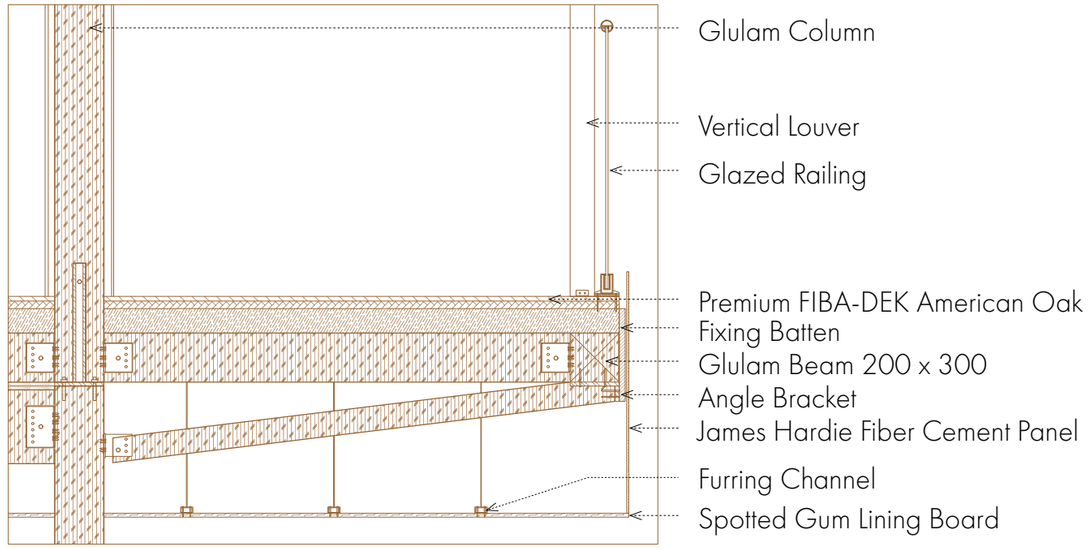


Plan Detail: Horizontal Module Connection

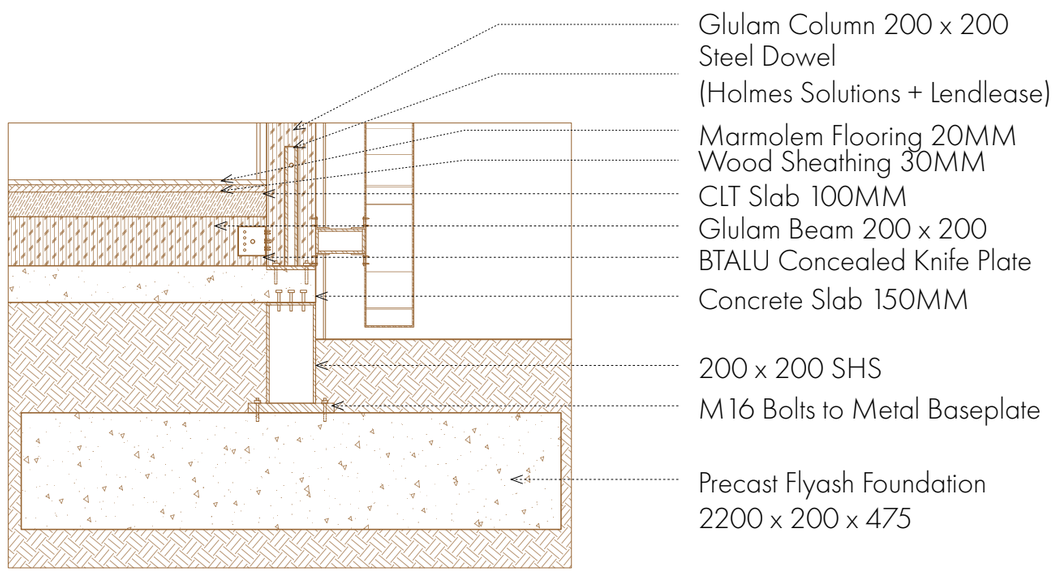
Structural Details



1. External Wall Section 1:50@A3



2. Balcony Detail 1:25@A3



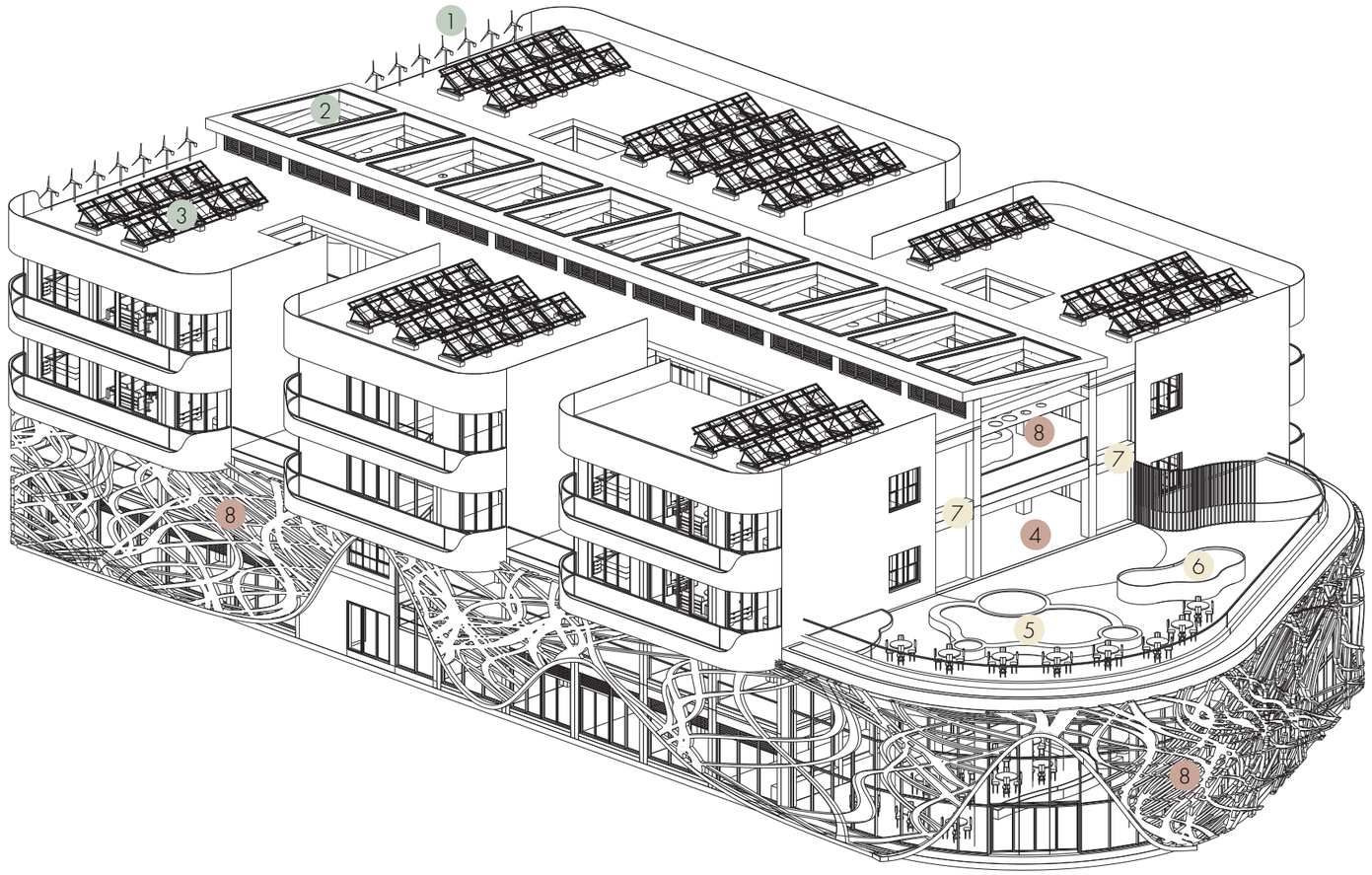
3. Foundation Detail 1:25@A3

Planet: Sustainability & Innovation

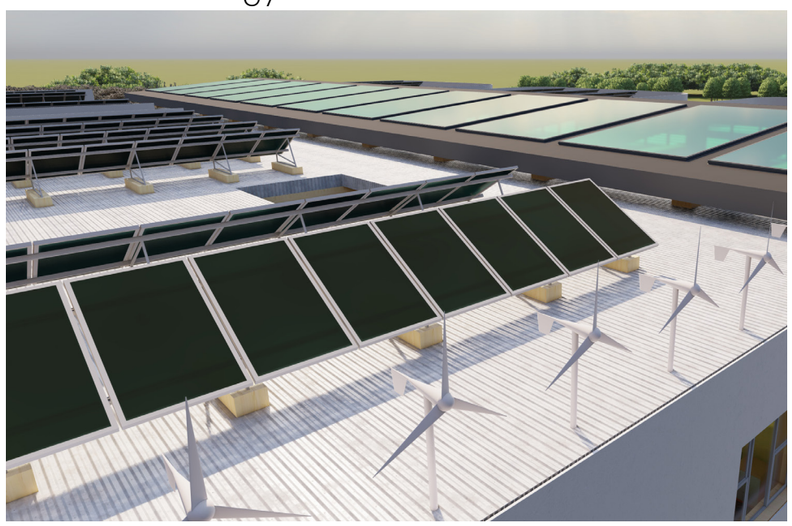
The design considers the existential crisis of climate change and addresses it through innovative mitigation technologies and net-zero materials that can be used in addition to sustainable construction techniques. This approach overlaps with indigenous design principles of "Caring for Country."

These principles include generating energy through renewable sources, using durable and recyclable cladding, integrating vegetable gardens and water feature, and reduce solar heat gain though the building envelope.

1. MOWEA Micro-WindTurbine
2. Clearvue Solar Glass
3. Solar Panels
4. Marmoleum Flooring
5. Water Feature
6. ModBOX Raised GardenBed
7. MOSSwall
8. Weathering Steel



Renewable Energy Generation - Roof View



Sustainable Facades - Front View

Integrated Nature - Terrace View

Sustainable Design Features

1. MOWEA Micro-WindTurbine

MOWEA utilizes a modular wind energy system integrated with IoT to generate renewable energy. Microturbines with a small diameter are utilized on the south side of the roof to generate electricity from the strong southern winds of Rottnest.

2. Clearvue Solar Glass

ClearVue Technologies is a Perth based company that is innovating with solar glass to generate sustainable energy. This product is used in the atrium skylights of the building to optimize its energy efficiency.

3. Solar Panels

Solar Panels are used on the roof of the modular construction system for additional sustainable energy generation. They are oriented towards the North to maximize the energy generated during the day.

4. Marmoleum Flooring

Marmoleum is a linoleum resilient flooring material made from linseed oil, wood flour, limestone, resin, and jute. Its free from plasticizers and synthetic additives, and is carbon neutral without offsets.

5. Water Feature

Water features tie in local landscape of Rottnest Island with the built form by bringing the water in. It also improves the microclimate of the space. Organic water bodies acknowledge the cultural connection of water to Noongar culture.

6. ModBOX Raised GardenBed

ModBOX raised garden beds are used to grow vegetables on the landscaped terrace. The biophilc elements improve the liveability of the apartments.The modular systems can be customized and are made from sustainable sourced Australian Cypress.

7. MOSSwall

MOSSwall is an innovative maintenance free vertical green element which is used in the residential corridors. These walls act as wind barriers in addition to being biophilic design elements.

8. Weathering Steel

Weathering Steel is a highly durable material. A protective layer forms over time which prevents future corrosion and creates a rust like colour over it. The product is used in the facade which is abstracted from the waves and nest found in the topography, as well as the perforated sheet filtering light from the skylight.

Local and State Planning Policy Compliance

State Planning Policy 7.3 Residential Design Codes (Volume 2) 4.1 and 4.2

All dwellings receive more than 2 hours of direct sunlight between 9am and 3pm on 21 June. Every habitable room has a window on an external wall. Sun shading devices are used for units facing west.

Hall modules have openings on two sides for cross ventilation; awning windows allow control of breeze.

State Planning Policy 7.3 Residential Design Codes (Volume 2) 4.3 and 4.4

The dwelling sizes are bigger than the minimum sizes recommended by Table 4.3a and b.
Unit Areas
1B + 1Br : 72 m^2
2B + 1Br : 90 m^2
2B + 2Br : 99 m^2
3B + 2Br : 117 m^2

All dwellings have access to private open space in the form of balconies.

State Planning Policy 7.3 Residential Design Codes (Volume 2) 4.5, 4.6, and 4.7

The minimum internal circulation corridor is 2.5m. Each floor has a maximum of six dwellings per circulation core. Communal facilities includes a community hall with pantry, landscaped terrace and common laundry.
Common storage is integrated with the circulation core. Impact of noise is reduced through second skin facades and acoustic boards.

State Planning Policy 7.3 Residential Design Codes (Volume 2) 4.8, 4.9, and 4.10

There is a mix of dwelling types and sizes on each floor. Each floor has one 2B + 2Br and 3B + 2Br unit, and two 1B + 1Br and 2B + 1Br units.

Ramps, escalators and travelators allow for universal access.

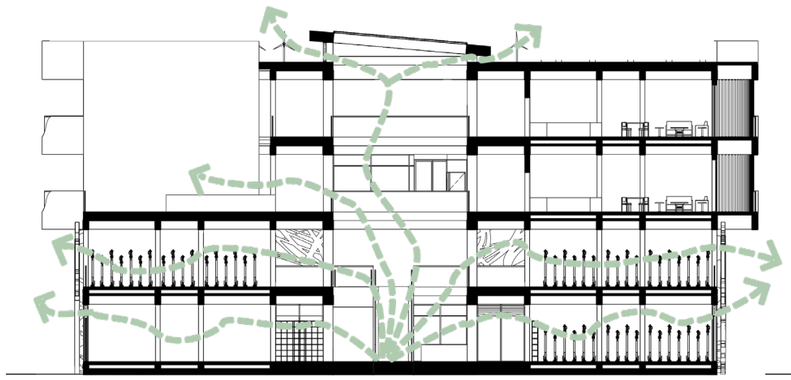
Facade references local topography and flora colours of Rottnest Island.

AS 2890.3 (2015)

The commercial bike hire facility complies with AS 2890.3 - Bicycle parking facilities. Multi-tier Bicycle Spacing Envelope has been considered and improved upon due to a large volume of bikes. The project considers an bike parking envelope of 2m x 0.5m, with minimum ceiling heights of 3m below the beam. The aisle widths are minimum 2m.

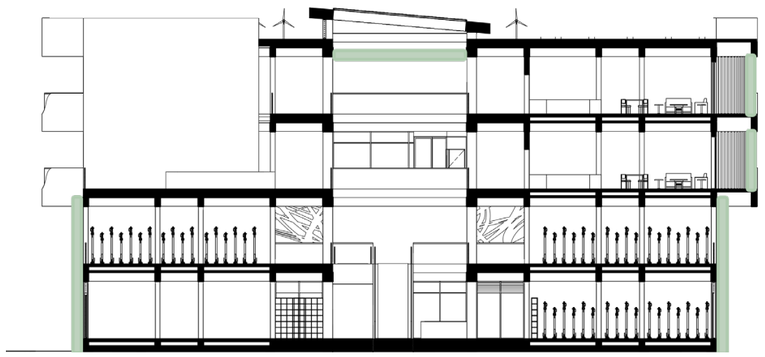
Rottnest Island Authority Development Planning Guidelines

The design takes into account multiple sustainable development guidelines into considerations, as demonstrated above. The weathered steel facade is abstracted from local topographical elements found at Rottnest Island such water waves and nests. The white fiber cement cladding reflects the white sand beaches of Rottnest Island.



Natural Ventilation throughout the building to reduce energy dependency

Interior spaces receive ample sunlight throughout the day



Second skin on facade and skylight to reduce solar heat gain

National Construction Code (NCC) Compliance

Section A
Building Classification

Site 1: The bike hire facility, including the reception and cafe on the ground and first floor, is classified as Class 6*, and the residential apartments for the island workers on the second and third floors are classified as Class 3.

Site 2: The short-term rental apartments for visiting tourists are classified as Class 3.

*The Bike Storage is a grey area, as it could be classified as Class 7b even though it has a retail functionality.

Section B
Structural Provisions

The engineers' report, as per Section B, focuses on safeguarding people from injury caused by structural failure, loss of amenities caused by structural behaviour (deflections, creep, vibration, settlement and the like), protection of other property from physical damage caused by structural failure and safeguarding people from an injury that may be caused by failure of, or impact with, glazing.

All modules and most prefabricated structures are primarily assembled from Glulam Columns, Beams, and CLT Walls and Slabs.

- Timber construction provisions-
  - Design of timber structures as per AS 1720.1
  - Timber structures as per AS 1684
  - Nail-plated timber roof trusses as per AS 1720.5

The sliding glass doors, vent window assemblies, glass railings and solar glass skylight are covered under glazed assemblies.

- Glazed Assemblies as per AS 2047 and AS 1288

The Lysaght metal roof assembly is used for the solar glass skylight and roof.

- Metal Roofing as per AS 1562.1

The vertical circulation core, foundation, and prefabricated double-height reception area are assembled using recycled steel and fly ash concrete structural members.

- Concrete Construction as per AS 3600
- Post-installed and cast-in fastenings as per AS 5216
- Steel structures as per AS 4100

The structure is primarily made from mass timber elements; therefore, termite management is crucial.

- Termite Risk Management as per AS 3660.1

Section C, D & E
Fire Resistance, Access and Egress, Firefighting Equipment

The project requires certification from professionals to deem the building safe for occupancy. FYRCHEK plasterboards are used between modules as well as for the interior lining of the projects to increase the fire rating of the structure. Promat SYSTEMPANEL fire retardant board is used as the substrate for workshops, battery storage, and other fire-prone areas.

Two fire-isolated staircases are provided, which open into either sheltered open space through fire-isolated corridors or into an entrance lobby which opens into a sheltered open space. Fire-rated concrete walls enclose the fire-isolated stairs and are within 20m of access points on every floor.

Fire extinguishers and fire hydrants are provided next to each fire escape staircase. Smoke alarms and sprinklers are provided in the ceiling space as required.

Section F
F5 Room Heights
F6 Light and Ventilation
F7 Sound Transmission

F5 Room Heights
The minimum clear internal height in all interior spaces is 3m, which is more than 2.4m which is the minimum required for the spaces in class 3 and 6 buildings.

F6 Light and Ventilation
All habitable spaces have openings and access to direct sunlight for a minimum of 4 hours during the winter. The building uses stack ventilation effect to keep the building naturally ventilated and passively cooled. The hall modules have openings on 2 sides for cross-ventilation. The ground-floor windows have vents above 2400mm, and the floors above have glazed railings in the public spaces above.

F7 Sound Transmission
Woodfibre insulation and acoustic ceiling boards reduce the noise through walls and ceiling, whereas wood sheathing substrate is used in the floor to reduce noise transmission between levels.

Section J

Energy efficiency is increased through passive design principles such as building orientation and form. Renewable energy generation features such as solar panels, solar glass and micro-wind turbines are used on the roof to create a sustainable built form. Solar shading devices such as perforated screens, vertical louvres and second-skin facade systems reduce the solar heat gain coefficient of the building and increase its energy efficiency. Woodfibre insulation in the roof reduces heat gain from above. Natural and cross-ventilated areas receive ample natural light and lessen the need for mechanical systems. Integrated greenery and water features create an ambient micro-climate for the comfort of people inhabiting these spaces.

Cost Planning

A unit rate for the transport and installation of a single module has been derived with the use of the BOQ and the task method statements. This formula of devising a unit rate for a specific task is to be used throughout the project to precisely confirm total cost of a given task. Rates are sourced from Rawlinson's Cost Guide 2023 and Cordell's 2019 Estimating Guide. Assumptions that are made for this unit rate include:

- Time required for transport to Rottnest Island and from there to site are taken into consideration
- A 20t mobile crane is used to lift a single module onto the bed of a truck
- A 50t crane is used on site to lift and lower the module into place
- Rigging slings attached to lifting points that are on the module prior to arrival on site
- Rigging engineer cost covered in overheads/markup
- Riggers are situated on two scissor lifts on either side of a single module
- Barge hire rate for a day is assumed as $7700/day (Maritime Construction 2023). This is the cost for the large barge (capacity two modules). Must be noted that two modules are transported per barge trip, halving the hourly cost per module.

With the individual unit rates outlined in the adjoining table T1, the representative unit rate for the transport and installation of a single module (inclusive of overheads and markups) is taken as **$1901.63/hr.**

Table T2 summarizes the detailed cost associated with both fabrication and construction. The total detail estimate cost is **$9.709 Million excluding GST and profit overheads**. The breakdown of the BOQ is attached in Appendix. A quantity surveyor consultancy is recommended to validate the costs associated with the Bill of Quantities.

Contractor profit margins are considered to be 9% and contingency as 5% based on the current economic situation. However, the project is based on Rottnest Island and there can be delays in construction due to material delivery requiring the combination of barges and trucks as well as rough sea conditions. This leads to a likely rise in the overall project cost when compared to a similar structure located on the mainland.

T1. Module Lifting Unit Rate

	RESOURCE ALLOCATION	RATE	TOTAL
LABOUR	3 X RIGGERS 4 X SITE WORKERS 1 X TRUCK DRIVER	$125/HR (X3) $75.50/HR (X4) $28/HR (X1)	$375/HR $302/HR $28/HR
PLANT	1 X 35T CRANE (INCL. OPERATOR) 1 X 55T CRANE (INCL. OPERATOR) 2 X HYDRAULIC SCISSOR LIFTS 1 X BARGE (PELAGIC 26 X 7M)	$200/HR (X1) $245/HR (X1) $48.75/HR (X2) $7700/DAY (2 MODULES PER BARGE, TAKE COST FOR 1)	$200/HR $245/HR $97.5/HR $481.25/HR
MATERIAL	LIFTING SLINGS	INCLUDED IN CRANE HIRE	-
OVERHEADS/ MARKUPS			+ 10%

T2. Bill of Quantities

CESMM4 - WORK CLASSIFICATION	AMOUNT
CLASS A: GENERAL ITEMS	$1,710,384.62
CLASS B: GROUND INVESTIGATION	$5,007.10
CLASS D: DEMOLITION AND SITE CLEARANCE	$3,552.19
CLASS E: EARTHWORKS	$41,408.38
CLASS F: IN SITU CONCRETE	$280,563.22
CLASS G: CONCRETE ANCILLARIES	$168,738.64
CLASS H: PRECAST CONCRETE	$422,524.14
CLASS M: STRUCTURAL METALWORK	$4,529,785.65
CLASS N: MISCELLANEOUS METALWORK	$462,002.95
CLASS O: TIMBER	$997,977.63
CLASS Z: SIMPLE BUILDING WORKS INCIDENTAL TO CIVIL ENGINEERING WORKS	$812,578.12
Additional Costs	$274,750.00
Sub-Total	$9,709,272.64
10% GST, 5% Contingency, 9% Profit Overheads	$2,330,225.43
Total including GST, Contingency and Profit Overheads	**$12,039,498.07**

Construction Programme

The project timeline from site investigation and survey to document completion and handing over is about one calendar year with 263 working days.

Referring to the project schedule Gantt chart; the critical path is the order of tasks that determines the progression of the project as a whole. Critical path tasks generally have prerequisite tasks that must be completed prior to the start of the next critical task. In the project schedule chart, the critical path items are identified as those tasks coloured in red. The majority of site tasks are therefore critical. Once the substructure and superstructure are complete there is a downtrend in tasks that are critical.

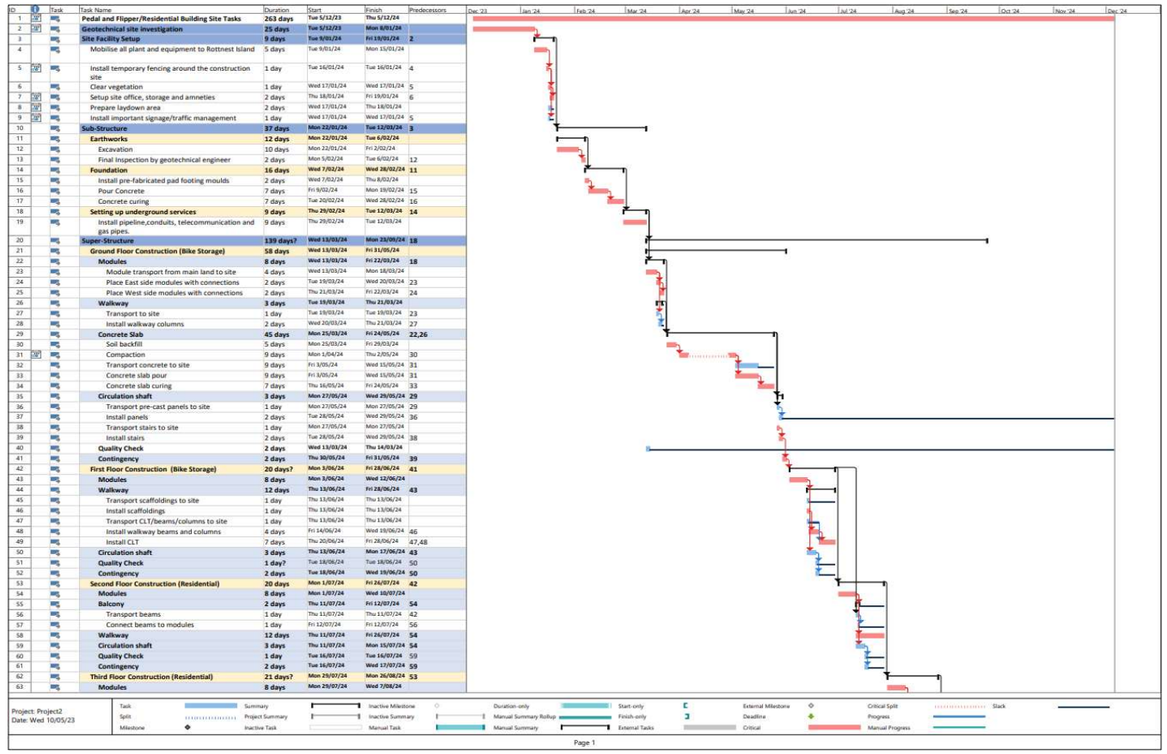
Those tasks that do not make up the critical path are considered float tasks. The float tasks each have a float time which can be identified by analysing the tasks within the Gantt chart project schedule in Appendix. For this project the majority of non-critical tasks occur once module installation/substructure/remaining superstructure construction is complete, at this point tasks can occur concurrently to complete the project with few or no inter-dependencies. Knowing this, resource allocation can be more flexible to achieve as much necessary work as possible with the limited dependencies between tasks.

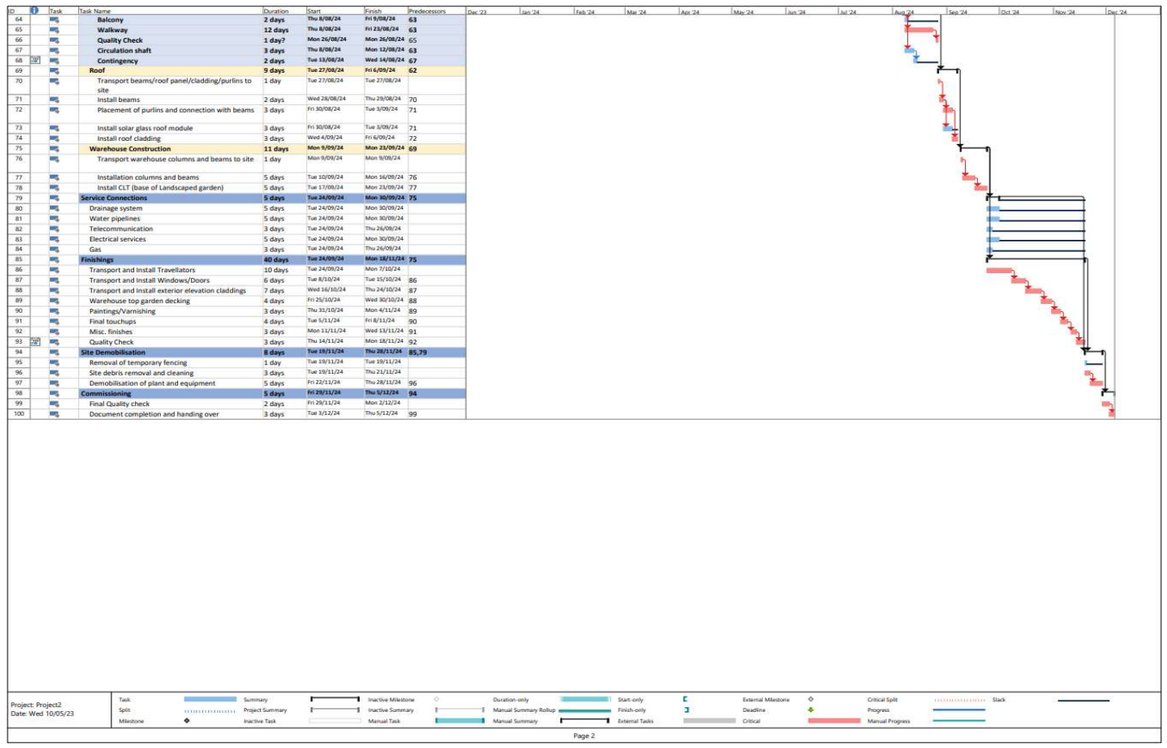
T3 summarises the non-critical float tasks as per the project schedule. The major float tasks for this project are the connection of services once the structure has been erected. As long as services are connected, tested and working as required before site handover the contractual works in this area are satisfied. During construction more tasks may become float tasks depending on the rate at which float tasks are completed, changes to resource allocation and other real-time site task exploitation.

T3. Float times for Non-Critical Tasks

FLOAT TASK	FLOAT TIME (DAYS)
PREPARE LAYDOWN AREA	1
INSTALL SIGNAGE	2
INSTALL WALKWAY COLUMNS (GROUND FLOOR)	1
TRANSPORT SCAFFOLDING TO SITE	11
TRANSPORT BUILDING MATERIAL TO SITE (FIRST FLOOR)	4
QUALITY CHECK	8
BEAM TO MODULE CONNECTION (SECOND FLOOR BALCONY)	10
BALCONY (THIRD FLOOR)	11
INSTALL SOLAR GLASS ROOF MODULE	3
SERVICE CONNECTION	35

Appendix A1: Schedule of Site Works





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