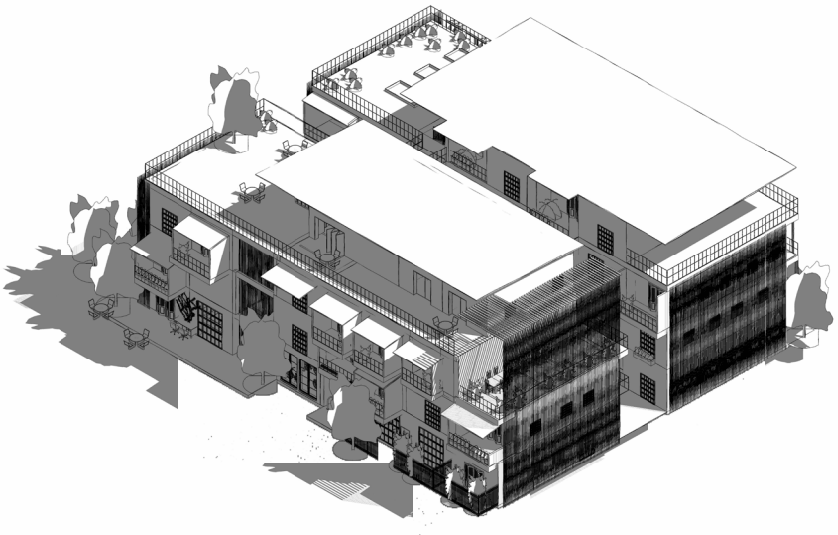
THE FLEETWOOD CHALLENGE CUP 2022

WOODBRIGDE LAKES
LOT 602 YELVERTON DRIVE, COAL DAM, PERTH
WESTERN AUSTRALIA



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0.1 ABSTRACT

This project aims to create a precedent for future construction and housing, challenging the current trend of onsite construction using heavy materials with high embodied energy such as bricks and aluminium. With the current housing and climate crisis we as architects have a key role in tackling these issues, by coming up with innovative designs.

Prefabrication could be the future of design and construction. Prefabrication is often thought of as boring or simple design; however, this project explores innovative materials and spaces and design to create a desirable and luxurious yet affordable housing.

The construction of this project focuses on prefabrication, modular components and designing for disassembly. These three key design requirements address the issue of climate change as the design and layout of these modular apartments can be rearranged, recycled and repurposed. When designing The Midland Bio-Base I have considered the lifecycle of the entire building as well as the lifecycle of single component like the steel beams and columns. Once it is time for this building to be disassembled each item can be recycled.

This project aims to increase activity around the Midland centre and promote local living, reducing carbon emissions produced by transport. By sharing amenities such a laundromat, communal kitchen, communal terrace garden, and sharing tools and equipment between tenants.

With Perth's population set to increase to 3.5 million by 2050 and the need for approximately 600,000 new dwellings to accommodate for this increase. Prefabricated, modular housing allows for adaptability and diversity of housing with quick construction and the ability to be a sustainable and promote local living.

0.2 EXECUTIVE SUMMARY

This project aims to create an innovative, affordable and sustainable housing in the form of modular housing that has been designed for disassembly, built with the building's lifecycle in mind. This project is located in Midland Perth in the sub-precinct Woodbridge Lakes, lot 602 Yelverton Drive. This site is currently an empty lot located along the Midland train line with approximately a ten-minute walk to the train station and across the road from Coal Dam, displaying greenery to the otherwise sterile site.

Designing for disassembly creates infinite possibilities of the future of this building. The idea is that these modules can in thirty ears be disassembled and relocated to a completely different location and potentially for a completely different purpose. By prefabricating off site and using BIM technology the construction of the modules will create less waste from excess materials. The steel construction of these modules uses a bolt down construction method, where a 10mm thick plate Is welded to the base of the steel beams. These plates allow for modules to connect to each other with a simple, easy and quick assembly and disassembly process. This construction will decrease the construction timeline as well as creating a safer working environment.

The project has been named 'The Midland Bio-Base' as the main concept of the design is to use materials that come from a living matter, so that they are regenerative and are usually bio-degradable. The design embodies the idea of a living organism that mimics nature. Timber construction has been used in the floor, roof and wall systems. The timber used has been locally sourced and is a biobased material that also has the potential to be recycled. This material has a low thermal mass and low embodied carbon. By using
timber, the building can also compliment the coal dam landscape with the abundance of
gum trees, enhancing the connection to nature and the site. I have explored and researched into hemp construction, and have implemented hemp fiber cladding for the exterior of the building as well as hempcrete panels that are framed within timber joists to create walls. Recycling materials such as steel, timber, window frames and bathroom and kitchen tiles.

The mix-use residential building consists of 56 modules spanning 3.5m x 4.5m x 12m over four storeys. Within the mix-use building a diverse range of apartments have been provided to accommodate families, singles, students, couples and older generation, this design requirement is very important as Perth's current housing trend often does not consider smaller housing for singles and empty nesters and with Australia's aging population creating communities with affordable housing, access to amenities and social interaction is increasingly important.

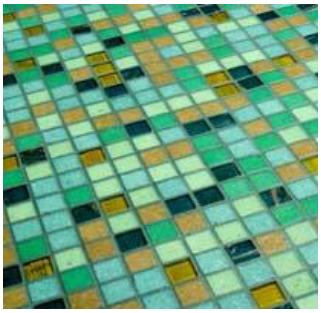
TACKLING HOUSING AFFORDABILITY

THE COOPERATIVE FINANCIAL MODEL CHALLENGES THE CURRENT HOME TENSURE, OWNING AND RENTING.

Perth is expected to reach a population of around 3.5 million by 2050, resulting in the need to build 650,000 new dwellings (Future Perth, 2022). This increase in housing demand will and is resulting in an increase in housing prices.

To begin a coop, a group of people must come together and pay equal shares in a building or plot of land, this land or building is now owned by this group and not by the council, government, or other private landowners. This co-operative enables long term affordability, as the residents can now decide how much they pay for their housing, this price does not fluctuate over time.

My Yelverton modular design provides shared amenities such as:
Communal kitchen
Laundromat
Work spaces
Shared tools/equipment such as gardening supplies
Vegetable patch
Shared terrace garden



Recycled Materials

Recycled tiles , Window
frames, Recycled steel frame

Flat House By Material Cultures,

Photographed by Oskar

Hemp Fibre Cladding

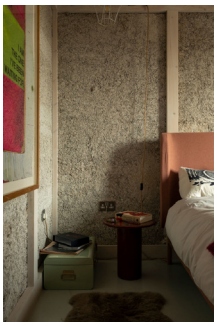
The high cellulose content (60 - 70%) of the plant makes it a very strong and durable material.
The sheet is bound with a sugar based resin made entirely from agricultural waste.
The sun will case the material to lighten over time, this emphasises the idea of a 'living' building that the biobased materials create, mimicking nature.
5.7 x less energy than aluminium
1.5 x less energy than galvanised steel per square meter

Flat House By Material Cultures,

Photographed by Oskar

Hempcrete Panels:

This is a combination of Hemp Hurds, lime, and sand. This material has been used for hundreds of years, predominately in Europe. This material is lightweight and allows for the building to breath, therefore preventing mould growth. Hempcrete has great sound absorption and is fireproof. The hempcrete panels have been left exposed ot the interior of the modules so showcase the innovative material, connect to nature, as wll as to reduce materials used such as paint which can have toxins.



Flat House By Material Cultures,
Photographed by Oskar

Timber:

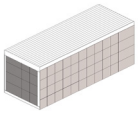
Timber has been locally sourced and is a biobased material that also has the potential to be recycled. This material has a low thermal mass and a low embodied carbon. By using timber, the building can also compliment the coal dam landscape with the abundance of gum trees, enhancing the connection to nature and the site.

Flat House, designed by Material Cultures, has designed a building that explores the benefits of prefabrication and biobased materials. They created a prefabricated Hempcrete panel that was made from hemp grown on the farm the building is located. This combination of prefabricating elements and biobased and locally sourced materials has created a ' radically low embodied carbon house'.

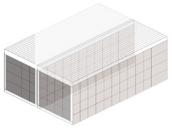
0.3 MATERIALITY AND INNOVATION

Stacking Modules

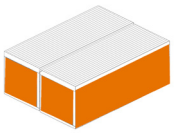
Enabled future rearranging, can adapt to different uses/ sites/ people, can add and take modules



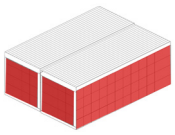
STUDENT HOUSING



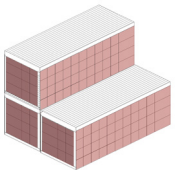
ONE BED, ONE BATH



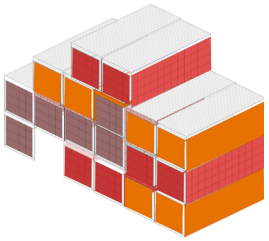
TWO BED ONE

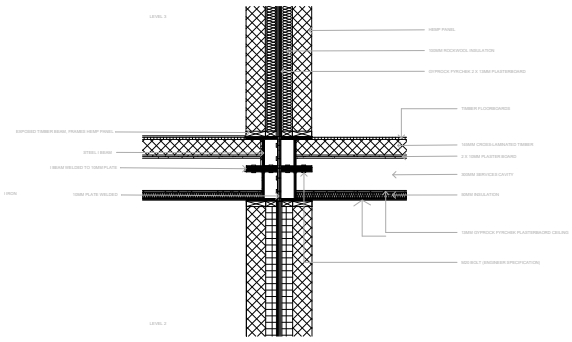


TWO BED TWO BATH

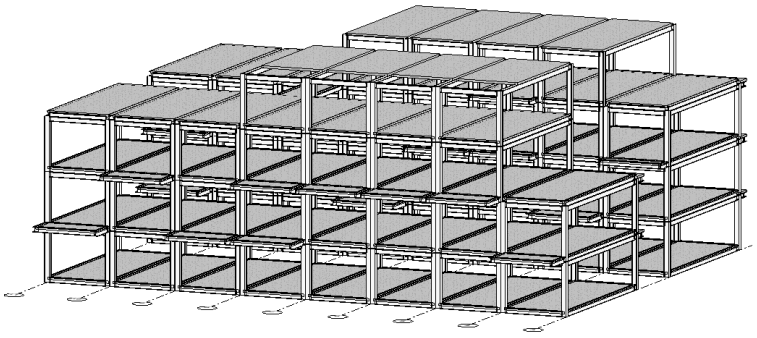


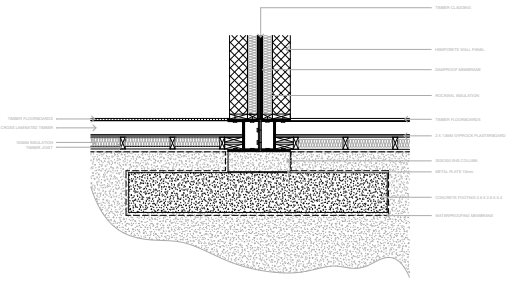
THREE BED TWO



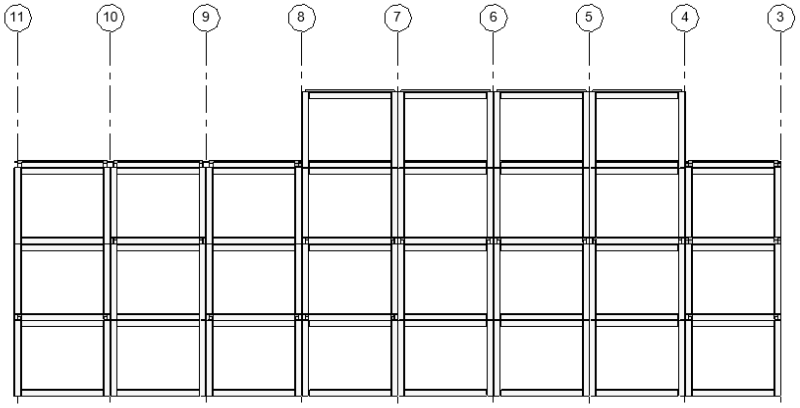


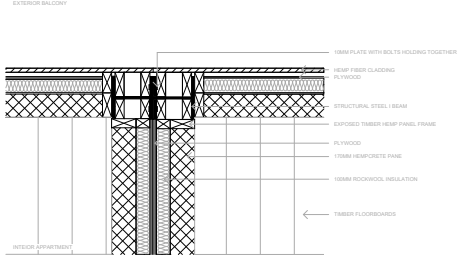
2 **MODULE CONNECTION**
1 : 20





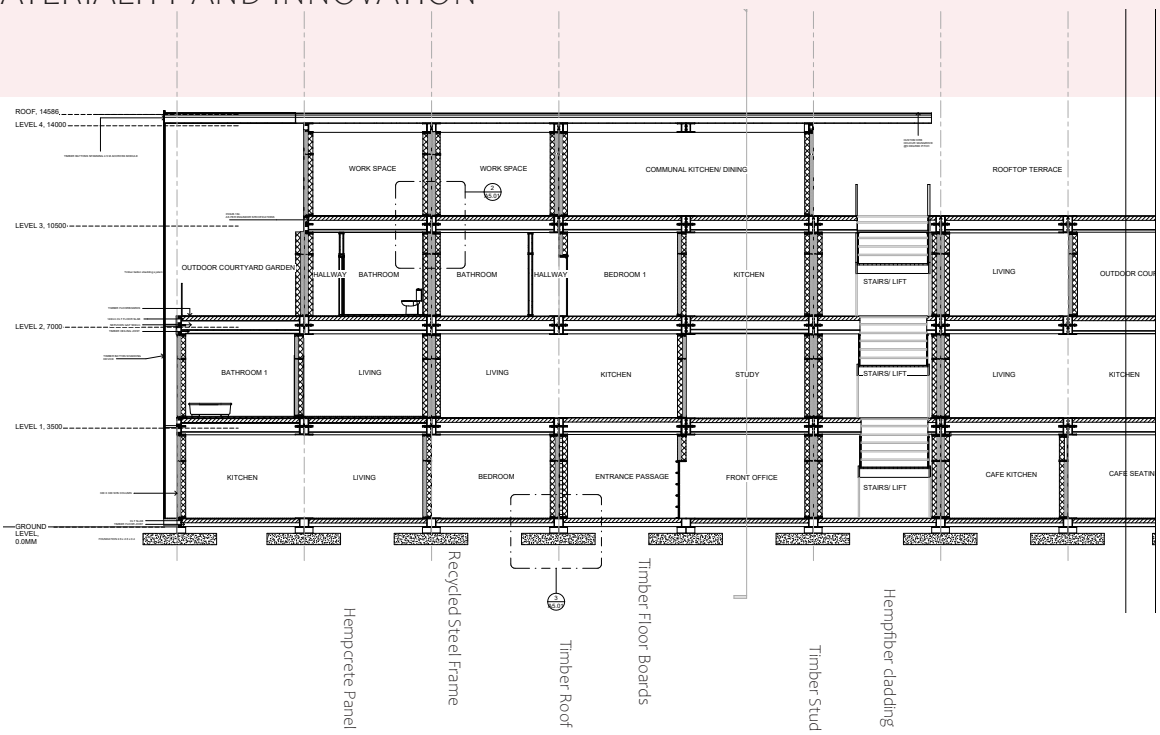
3 **FOOTING**
1 : 20

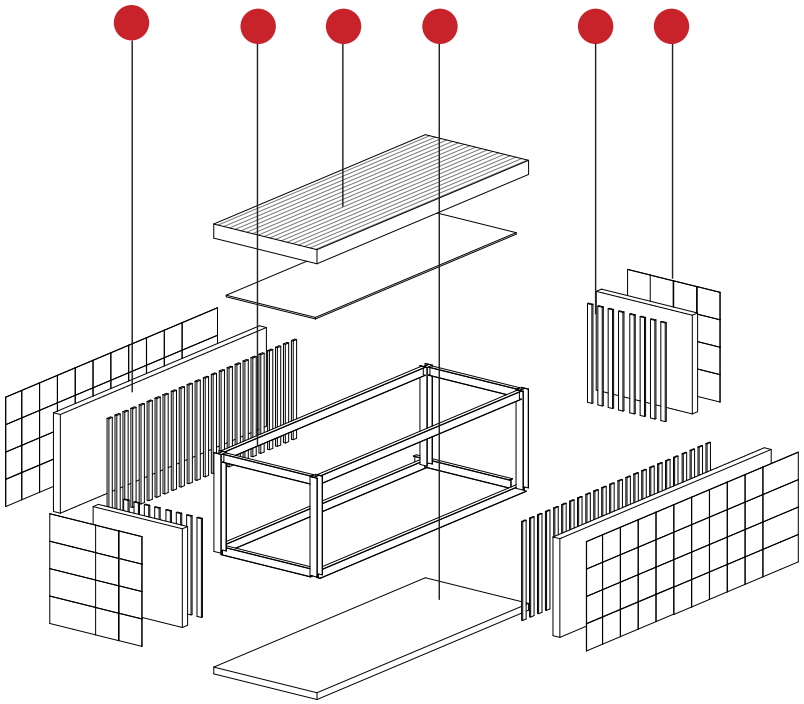




5 **PLAN WALL DETAIL**
1 : 20

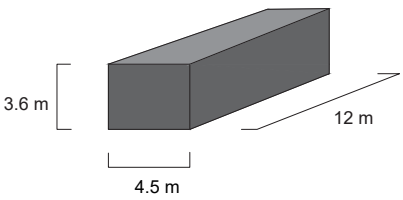
0.3 MATERIALITY AND INNOVATION

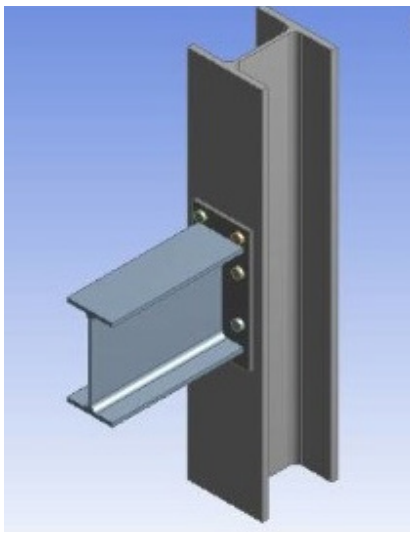


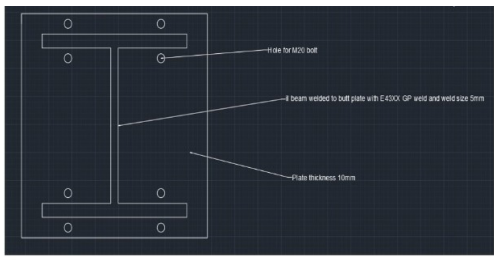


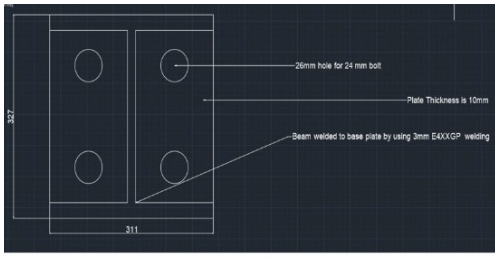
Design for Disassembly

The design follows a simple construction method. Using Steel frame, timber stud walls with Hemp insulation panels and Hemp Cladding.









0.4 NET ZERO CONSIDERATIONS

Photovoltaic Panels

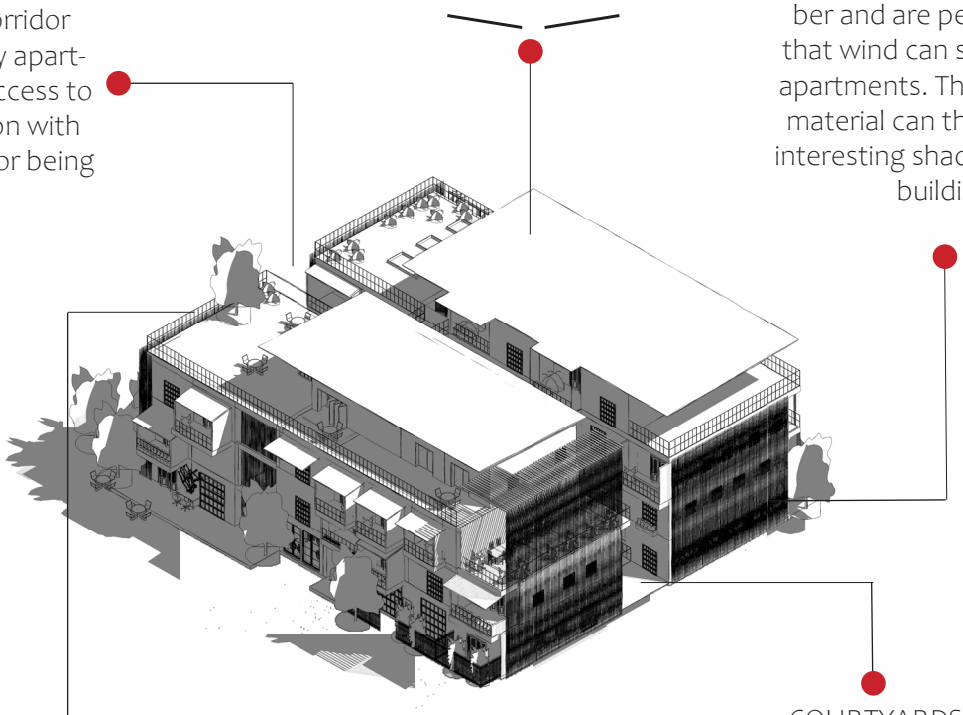
The roof has been designed as a butterfly roof with two tandem pieces sloping down into the central courtyard. This design element allows sunlight to be captured from multiple angles. exess solar energy gained during the day is then stored in a battery, one for each appartment. This solar energy can then be used at night time.

Shading devices

The shading devices on the North Elevation are operable, allowing users to open and close them as they please. These operable devices are made from timber and are perforated so that wind can still enter the apartments. The perforated material can then also cast interesting shadows into the building.

Cross Ventilation

The central corridor allows for every apartment to have access to cross ventilation with this wind corridor being created.



ROOF TOP TERRACE

Acts as a water buffer
Helps with stormwater runoff
Combating heat waves and urban heat island effect
Green roof absorbs CO_2 and sunlight, essential in regulating climate

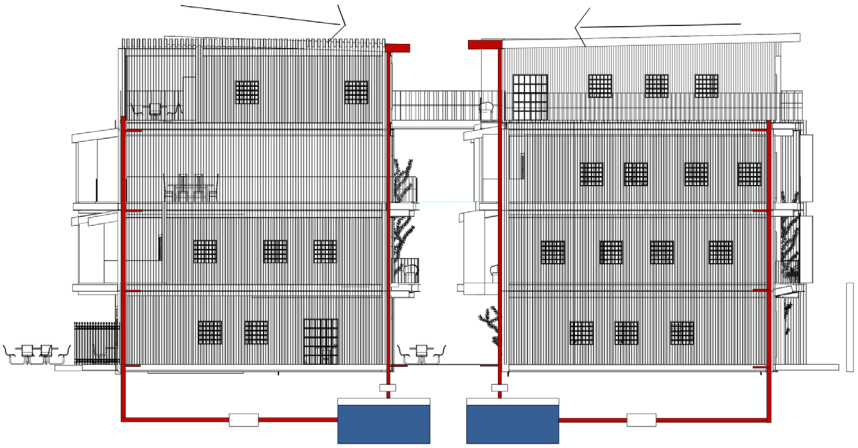
Energy conservation:
Decreases temperatures inside by up to 8% in hotter weather
Reduces greenhouse gas emissions

Improving health and wellbeing:
Provides a community hub space
Encourages biodiversity
Users can grow their own vegetables and fruits

COURTYARDS

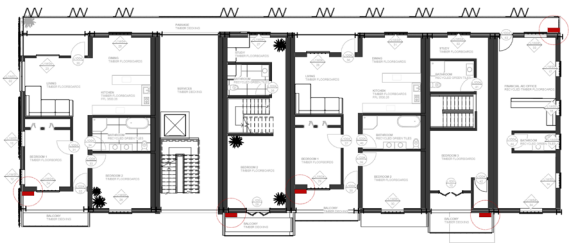
These allow for users to have a scenic space to look into from their rooms, with the back block closest to the train line able to see greenery too as their view to coal dam may be blocked by the front apartment block. The courtyard also provides some privacy as well as shading from the sun, and provides a space for social interaction.

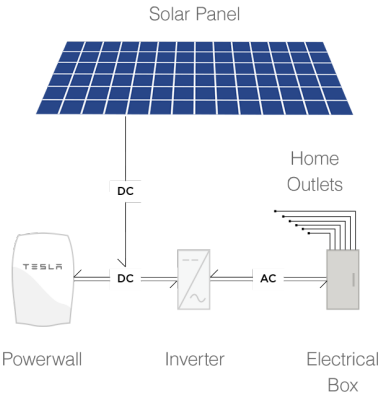
RAINWATER SYSTEM



BATTERY SYSTEM

The Midland Bio-Base will store solar energy captured by the photovoltaic panels on the roof of the building during the day, ready to use for nighttime or electricity outages. these are a key net zero design element as solar energy is often not used during the day as lighting is often provided naturally through the sun. My project has high quality insulation in the walls, roof and floors and the building has been orientated and shaded adequately to reduce thermal absorption from the sun and insulated against cool air from the outside in winter. The orientation of the building, where most windows face north or south, ensures each apartment receives adequate sunlight. Due to these design choices, electricity usage during the day should be dramatically reduced, therefore the use of solar panel energy is not essential or the day, but when the sun sets this energy becomes an important function of the building. By implementing a Tesla home battery system in each apartment, these modules and homes can essentially run off grid. In say thirty years these modules are rearranged or relocated; this battery system can move with them with the rearranging of modules not affecting this system. Each tesla battery is about the size of a suitcase and would therefore be placed on each private outdoor balcony or courtyard.





0.9 ENGINEERING CALCULATIONS

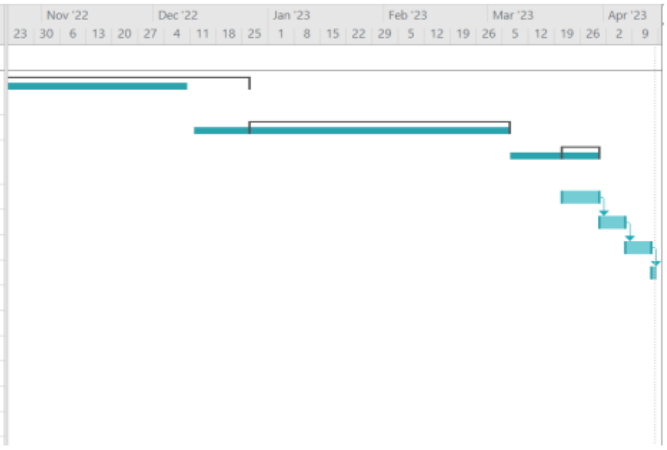
In this project there is a total of 55 modulars with an area of 54m2 each, 12 balconies with an area of 9m2 each and 4 balconies with an area of 4.5m2 each and the total area of the walkway of the building is 202.4 m2 and hence the approximate estimation building cost will be as shown below.
Total approximate estimation cost = cost per square metre x gross enclosed floor area
= (4028 x (54 x 55)) + (813 x ((9 x 12) + (4.5 x 4))) + (763 x 202.4)
= AUD$12,220,029.20

Element	Unit	Unit Price (Sydney) (A$/Unit)	Unit Price (Perth) (A$/Unit)	Dimension (Unit)	Preliminary Estimate (A$)	% of total cost
PRELIMINARIES	m^2	550.25	583.27	1044	608928.66	5.37
SUBSTRUCTURE	m^2	48.50	51.41	864	44418.24	0.39
SUPER STRUCTURE:						
COLUMNS	ton	65.25	69.17	259	17913.71	0.16
UPPER FLOOR	m^2	332.5	352.45	2106	742259.70	6.55
STAIRCASE	m	44.75	47.44	10.80	512.30	0.0045
ROOF	m^2	48.25	51.15	611.13	31256.24	0.28
WALL + WINDOW	m^2	456	483.36	6393.82	3090516.84	27.26
INTERNAL WALL	m^2	130	137.80	6393.82	881068.40	7.77
DOORS	m^2	58.5	62.01	140.18	8692.56	0.08
FINISHES:						
WALL	m^2	115.75	122.70	6393.82	754489.74	6.92
FLOOR	m^2	137.25	145.49	2970	432090.45	3.81
CEILING	m^2	82.75	87.82	2970	260513.55	2.30
FITTINGS:						
FITMENTS	m^2	294.25	311.91	1044	325628.82	2.87
SERVICES:						
PLUMBING	m^2	441	467.46	1044	488028.24	4.30
MECHANICAL	m^2	448	474.88	1044	495774.72	4.37
FIRE	m^2	64.5	68.37	1044	71378.28	0.63
ELECTRICAL	m^2	146.5	155.29	1044	162122.76	1.43
TRANSPORTATION	m^2	187	198.22	1044	206941.68	1.83
EXTERNAL SERVICES	m^2	1.5	1.59	1044	1659.96	0.01
CONTINGENCY		60	63.6	1044	66398.4	0.59
				SUBTOTAL	8720593.27	76.82
OVERHEAD	%			10	872059.33	7.69
PROFIT	%			10	872059.33	7.69
GST	%			10	872059.33	7.69
				TOTAL	11336771.26	100

The total preliminary estimation cost is AUS$12,115,872.82.

Critical Path of Gantt Chart

Task Mode	Task Name	Duration	Start	Finish	Predecessors
	Site Clearance	**10 days**	**Mon 9/5/22**	**Fri 20/5/22**	
	Installation of Modular Building	**53 days**	**Thu 13/10/22**	**Mon 26/12/22**	
	Mechanical Installtion	**50 days**	**Tue 27/12/22**	**Mon 6/3/23**	
	Installation of Windows and Doors	**8 days**	**Tue 21/3/23**	**Thu 30/3/23**	
	Door Installation	8 days	Tue 21/3/23	Thu 30/3/23	24,25,26,27
	Installation of Roof	5 days	Fri 31/3/23	Thu 6/4/23	30,29
	Prepare and Clearance	5 days	Fri 7/4/23	Thu 13/4/23	31
	Handover	1 day	Fri 14/4/23	Fri 14/4/23	32



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