THE BALEEN, WADJEMUP, WESTERN AUSTRALIA

**ALWAYS WAS
ALWAYS
WILL BE
WADJEMUP**

I would like to acknowlege that this project was was researched and put together on Wadjuk Noongar Country. I would like to pay my deepest respects to those whose Ancestors were imprisoned on Wadjemup.
I would like to pay my respects to the Wadjuk Noongar Elders. past present and emerging.

CONSTRUCTION MATERIALS

DURRA PANEL

Made entirely from straw the panels are used for floor, wall and ceiling systems.

Requires no water, gas, additives, glues or chemicals to create or bind the material and produces no toxic waste.
It is 100% biodegradable and recyclable

HYDRATED MAGNESIUM CARBONATE BOARD (HMC)

Sequesters 90% of the Carbon used to manufacture product in the curing stage.
Current Supplier: Fire-Crunch

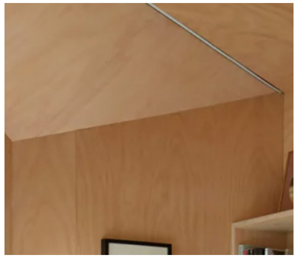
Future Supplier: EcoMag Limited & UNSW are developing building board using magnesium waste from the Pilbara salt industry, West Australian Agricultural waste and CO_2 Waste from nearby resource industries.

WOOD STONE

Wood stone by the Natural brick company recycle waste wood chips, glass and rice hulls with recycled masonry to create new brick and stone products. Bricks are made low tech and dried naturally in Australia.

MARMOLEUM BY FORBO

97% Natural Raw Materials where 70% is rapidly renewable and 43% of the product is recycled
This Vinyl alternative uses raw materials such as linseed oil, wood flour, and jute. All the materials used in its production renew in 12 months time.
Marmoleum is biodegradable, and after
30 years time can be scrapped or recycled. .
Timber look for inside the modular apartments
Commercial range comes in a variety of colours that can be used together to help way finding and categorizing large areas

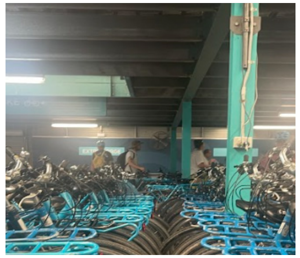


AUSTRALIAN MADE STRUCTURAL PLYWOOD

Made by Austral Plywoods, Queensland Hoop pine plywood in both structural, marine and appearance grade.
Structural ply has a Super E0 formaldehyde emissions rating

THERMO JUTE INSULATION

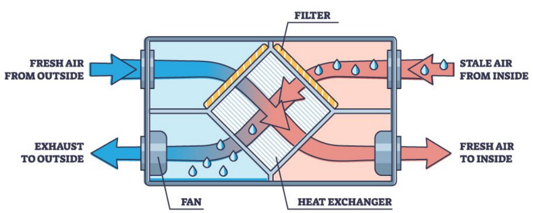
85-90% Jute
8-10% Biopolymer Fibres
2-5% Soda
Thermal conductivity
Rated value: D (23.80)
= 0.039 W / (m · K)

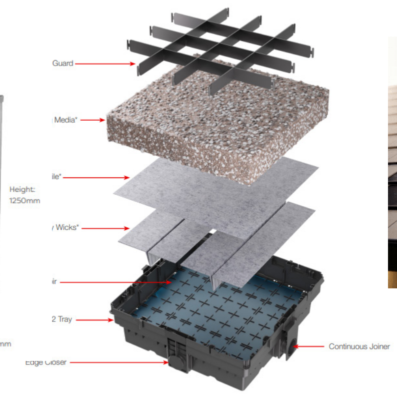


RECYCLED STEEL

As The original Pedal and Flipper is a large shed, with approval from a structural engineer the steel columns, beams and cladding are to be reused in low load areas, the bicycle mechanic and the Flipper hire building

INNOVATIVE TECHNOLOGIES





MECHANICAL VENTILATION AND HEAT RECOVERY

The continuation of removing and refreshing the building with comfortable filtered air reduces energy load on HVAC systems

CLOSED LOOP COMMERCIAL COMPOSTING

Giving residents the opportunity to compost their food. Designated bins and chutes are available for 24/7 food waste composting.
This system will not only provide nutrients to the landscaping at the Pedal and Flipper but will give back to the whole island with excess compost and allowing similar businesses to dispose of their food waste here.

PREPLANTED MODULAR ROOFTOP GARDEN

With the ability to extend the size of the rooftop garden while still gaining the insulating benefits of a built in system.
The Roof top gardens will be fixed to the flat roofs of level 2 a of level one and two with additional areas throughout the building.
These gardens have a simple joining plumbing system where excess water can be collected or returned to lanscaping on the site.

VOLT SOLAR TILES

Designed in Australia and currently the highest performer in solar tiles in the world. Made from 100% recycled materials and at end of life can be reycled via local photovltaic recyclers. Works on the Bristle Roofing system and individual tiles can be removed and replaced without distrupting the whole system.
Supplier : Volt

EVACUATED TUBE SOLAR HOT WATER COLLECTORS

A collection of cylinder tubes that contain a vacuum sealed space which acts as insulation. They have an energy efficiency rating of up to 80%, and are effective on overcast days. Tubes collect sunlight from multiple angles unlike solar panels. They can also be used off grid if a booster is not needed.
Supplier: Ureco Perth

02

WIKIHOUSE

MODULAR OPENSOURCE BLOCKS

Wikihouse is an open source, free to use building system Initially developed by Architect Alastair Parvin and Nick Lerodiaconou of 00 Architects London. Wikihouse is now owned by no one and developed by a worldwide community of contributers.

The design stems from Korean Architecture that relies on tight jigsaw connections, requiring very little to no carpentry skill from its builders.
The core of a Wikibuild requires only an internet connection, a computer , 18mm Ply or OSB and a cnc router.

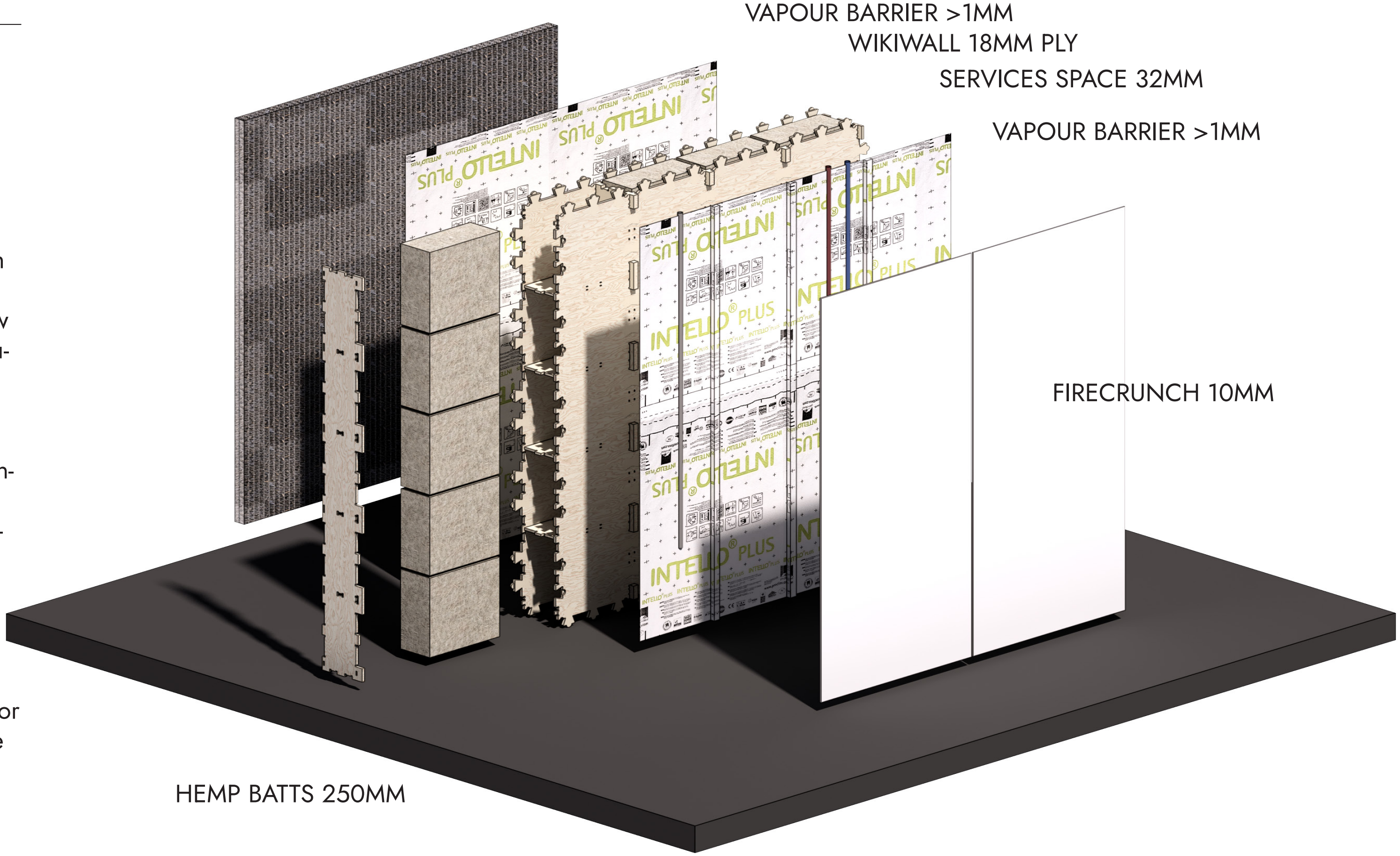
Building a Wikihouse requires very little space, and the modules can be reused or repurposed if not needed.

Modules can be built off site and transportated as boxes or stored, or can be built in a factory and transported to site prebuilt.

Limitations:

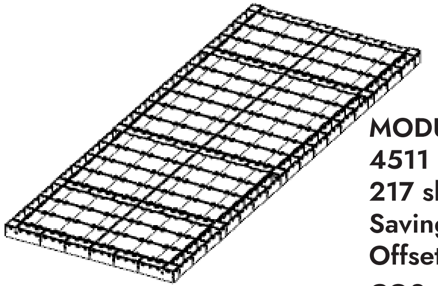
Wikihouse is not structurally able to support more that 4 levels at this stage.

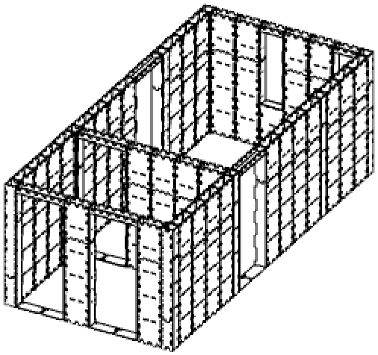
Costs, Structural Ply has been the best tested material for the panels but can be costly. Teams and indivudals are constantly testing materials that are easy to cnc or laser cut that are available to everyone.

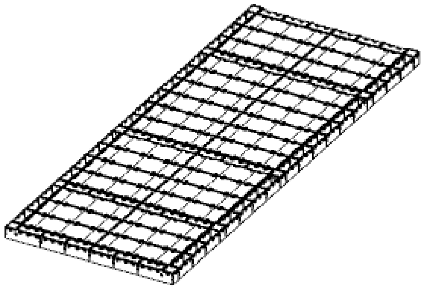


Wikihouse wall system for Modular Apartments

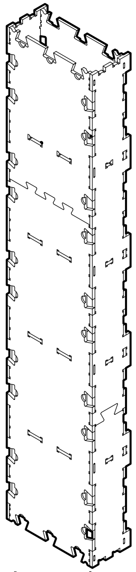
KIT OF PARTS



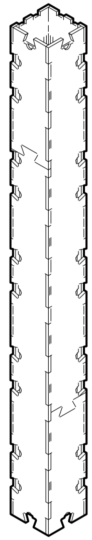




MODULE ONE
4511 kg
217 sheets of ply
Saving 7641.8 kgCO2
Offsetting the average
CO2 yearly usage per Australian

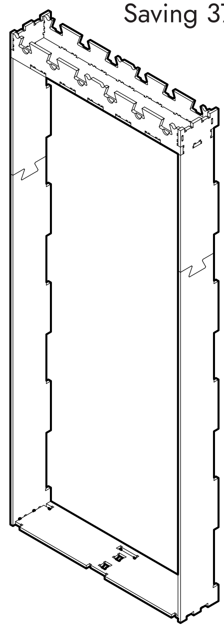


Wall 31 pieces
1426 kg
68.2 pieces of plywood
Saving 2420.17 kgCO2

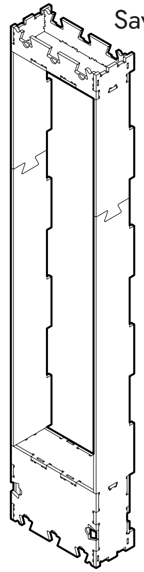


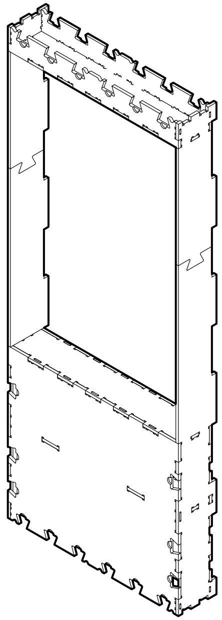
Wall column 8 pieces
240 kg
10.4 pieces of plywood
Saving 374.48 kgCO2

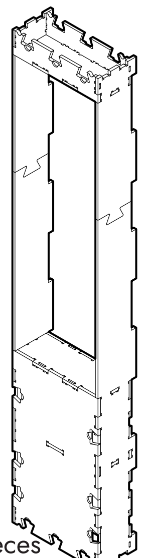
Large doors and windows 5 pieces
210 kg
10 pieces of plywood
Saving 374.05 kgCO2



Service Duct Door 1 pieces
23 kg total
1pieces of plywood
Saving 37.2 kgCO2

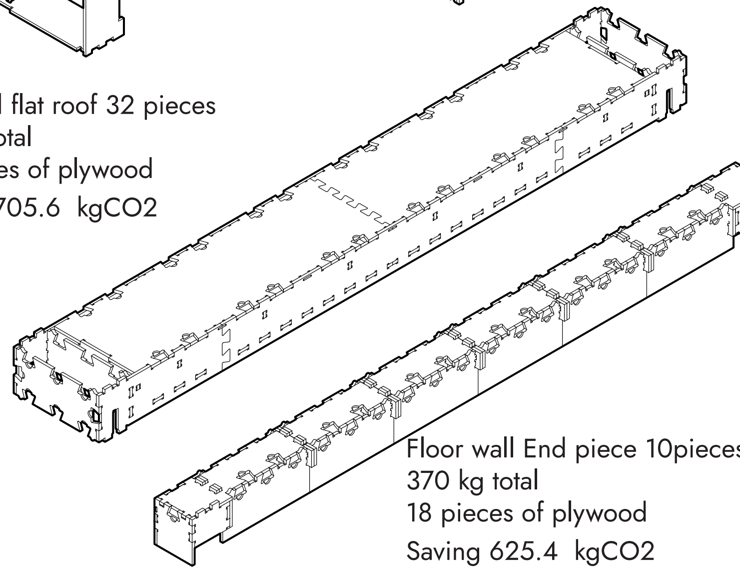






Long Window 1 pieces
66 kg
2.8 pieces of plywood
Saving 104.90 kgCO2

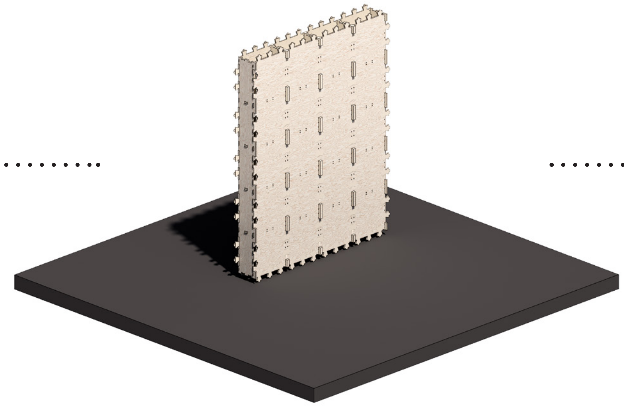
Floor and flat roof 32 pieces
2176kg total
106 pieces of plywood
Saving 3705.6 kgCO2

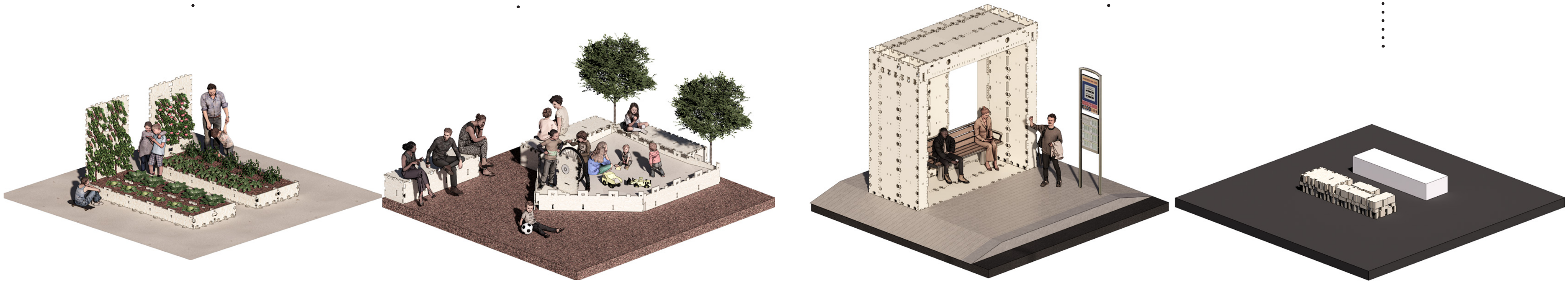


Floor wall End piece 10pieces
370 kg total
18 pieces of plywood
Saving 625.4 kgCO2

The Combination of these 8 parts is all that is needed for each of the 3 Modules designs that make up the core of the apartments

END OF LIFE





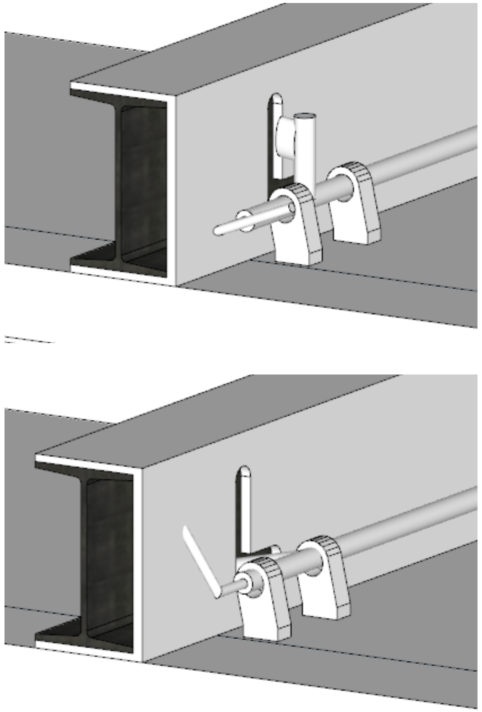
COMMUNITY
By donating the material to local groups it can be reused to benefit the community. With some slight changes modules can be reused as community garden beds, planter boxes, and even parklets, changing the urban environment and bringing the community together

CREATE
By donating the material to local groups it can be reused to benefit the community.

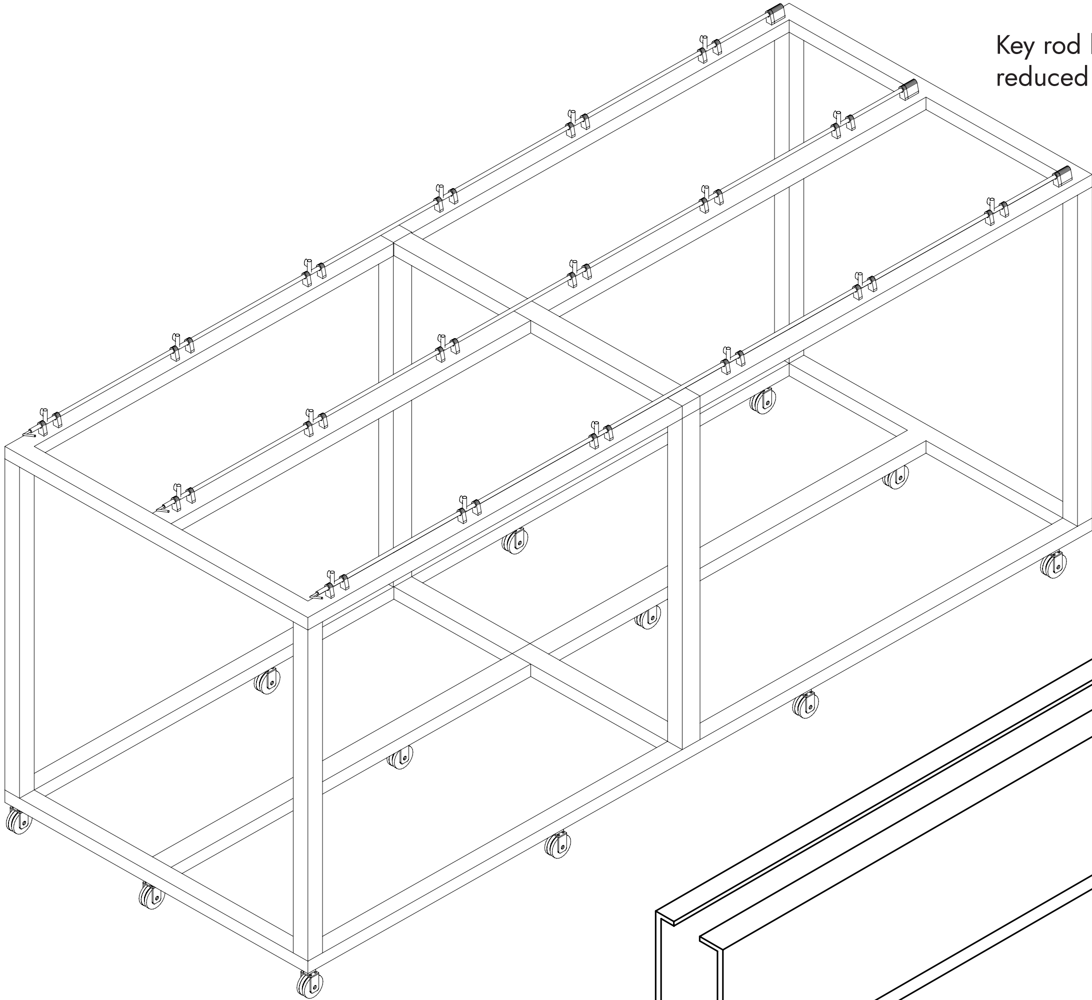
DOWNLOAD MORE PARTS
If the core blocks are in good condition they can be reused again and again. More block are always available to download.

STORE, SELL OR DONATE
A different way to sell your home.
Or store them until you have another project.
As long as they are laid flat and kept dry , they can be use indefinetly.
Donate them to charity. They can be used for small refuge homes, horse stables, playground houses or dog kennels.

MODULES

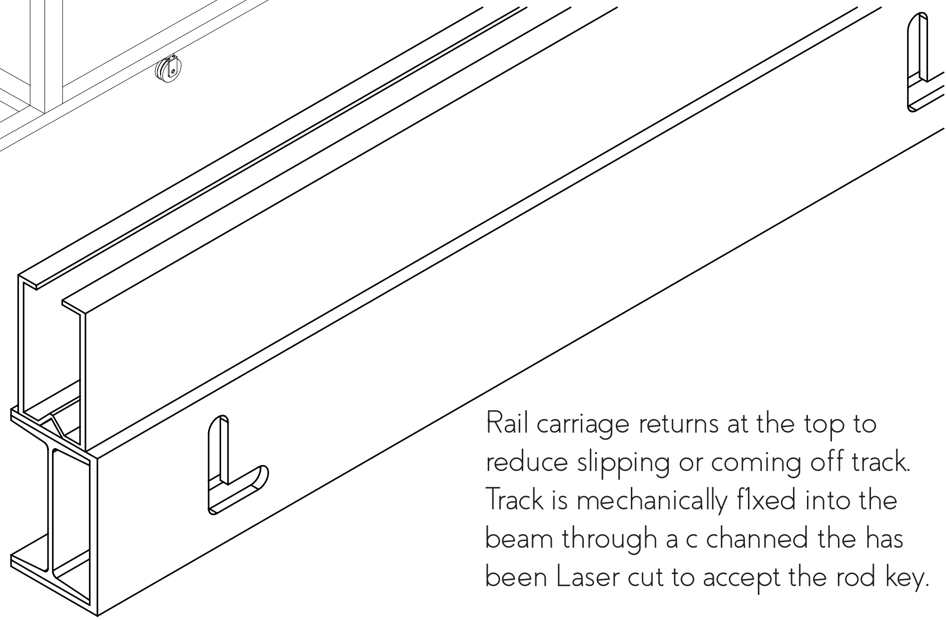


LOCKING SYSTEM
Turning steel rods Are fixed to the roof of each module
When the modules have slid into their place and the keys have lined up, The handle is turned and then pushed, an additional locking system before the modules are connected together.

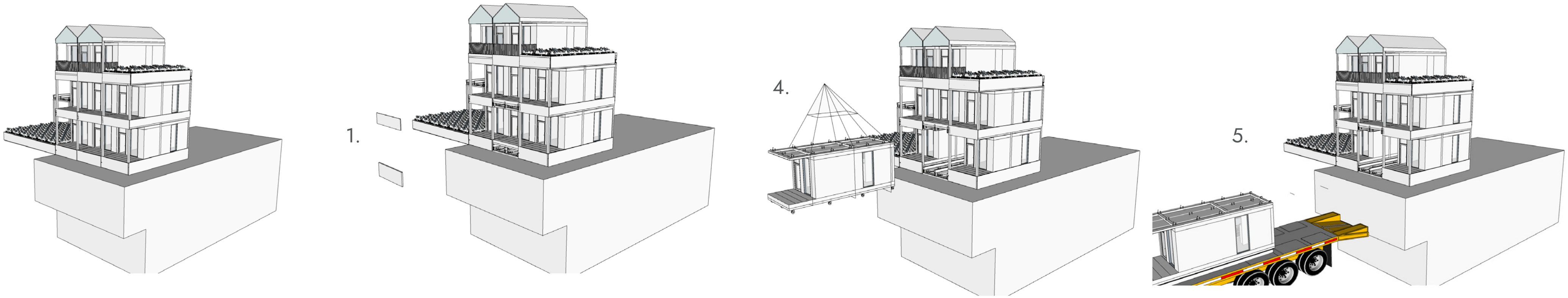


Key rod locking system. The stop at the end reduced slipping and unnessesary movement.

Industrial Iron fixed V-groove Castor wheel. Rated for 7 tonne per wheel. Wheel bolted to frame and flooring module sits on this frame and is mechanically fixed.



Rail carriage returns at the top to reduce slipping or coming off track. Track is mechanically fixed into the beam through a c channed the has been Laser cut to accept the rod key.



Disassemble

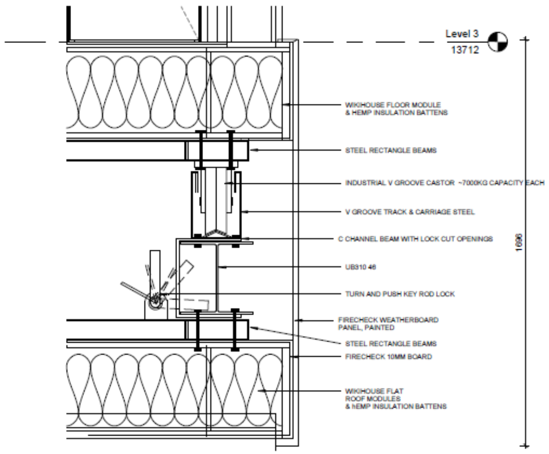
1 . Facade panels are mechanically removed.

2. Wheel lock is unbolted from the 3 tracks

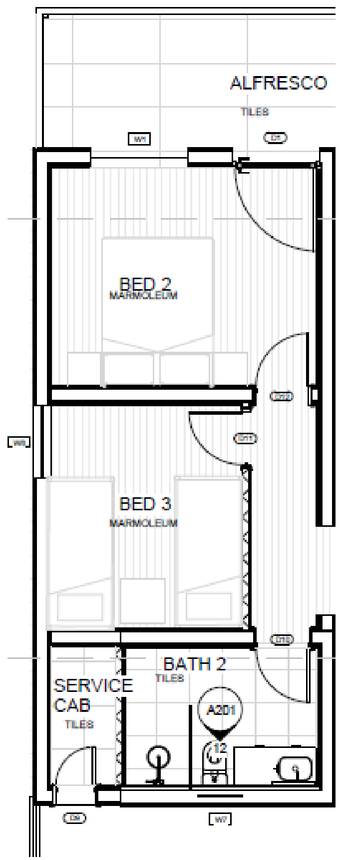
3. The key rod lock is pulled and turned open.

4. Crane hoist is attached to the steel frame bearer and pulled horizontal until released from track

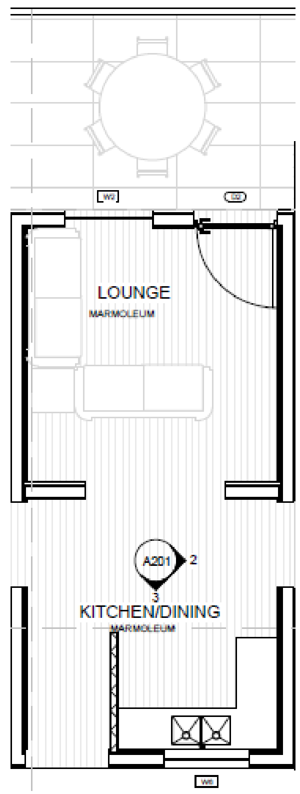
5. Module is placed onto flat bed trailer with wheel lock rails and transported to future site or factory where the next crane awaits



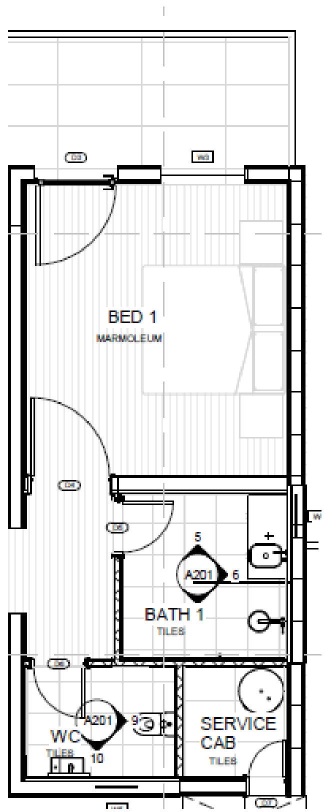
2 **MODULE RAIL CAST AND LOCKING SYSTEM**
1 : 10



MODULE ONE



MODULE TWO



MODULE THREE

APARTMENT MODULES

Column to Footings Connection Design
The capacity that is used for connection design for column to footings is 1002kN
Hence, the 8 Grade 8.8 bolts are selected to connect the column and footing.
The capacity of welding design for connecting plate to column is 1002kN.
The plate thickness of 15mm is designed.

5.0 Cost and Time Relationship

Project Task	Duration (weeks)	Total Cost (A$)	Weekly Cost (A$)	Project Duration (weeks) 1	2	3	4	5	6	7	8	9	10	11	12
Prefabrication															
Precast Square Pad Footings (including 12mm bar reinforcement)	2	109710.70	54855.35	■	■										
Precast Concrete Slab	4	585798.16	146449.54	■	■	■	■								
Precast Concrete Wall	4	450727.20	112681.80	■	■	■	■								
Steel Column, Steel Beam and Steel Joist	3	3603896.56	1201298.85	■	■	■									
WikiSips Panel for Modular units	4	1556913.34	389228.34	■	■	■	■								
Demolition and Site Clearance															
Demolition of Existing Building	1	671590.75	671590.75					■							
Site Clearance	1	575.00	575.00					■							
Earthwork and Site Preparation															
Temporary Accomodation, Office, Cabins and Scaffoldings	1	4734.40	4734.40						■						
Excavation for Square Pad Footings	1	191200.00	191200.00						■						
Filling with Excavated Materials to Footings	1	10412.44	10412.44							■					
Construction Stage															
Installation of Precast Square Pad Footings	1	27427.68	27427.68							■					
Installation of Precast Concrete Slab	1	146849.54	146849.54								■				
Installation of Steel Beam, Steel Column and Steel Joist (including bolts)	1	906724.14	906724.14									■			
Installation of Precast Concrete Wall	1	112681.80	112681.80										■		
Installation of WikiSipes Panel for Modular units	1	389228.33	389228.33										■		
Installation of Timber Staircase	1	120858.38	120858.38											■	
Installation of Roof Panel	1	53707.32	53707.32											■	
Installation of Door Panel	1	28657.20	28657.20											■	
Mechanical Installation (Piped building services, Ducted building services, gutters and downpipes)	1	595975.95	595975.95												■
Electrical Installation (Cabled building services)	1	144102.00	144102.00												■
Total Cost (A$)		9715374.89													
Weekly Cost (A$)				1904513.88	1904513.88	1849658.53	648359.68	674170.75	195934.40	37840.12	146849.54	906724.14	501910.13	203222.50	740078.95
Cummulative Cost (A$)				1904513.88	3809027.76	5658686.29	6307045.96	6981216.71	7177151.11	7214991.23	7361840.77	8268564.91	8770475.04	8973697.54	9715374.89

Progress income include profit (assuming profit margin of 10%)		4189930.34		2747820.02		957113.67		203158.63		1349497.70		1039389.84
10% retention		418993.03		274782.00		95711.37		20315.86		134949.77		103938.98
Client progress payment		3770937.49		2473038.02		861404.18		182842.76		1214547.93		935450.85
Cummulative progress payment	0.00	3770937.49	3770937.49	6243975.51	6243975.51	7105379.60	7105379.60	7288222.37	7288222.37	8502770.30	8502770.30	9438221.15

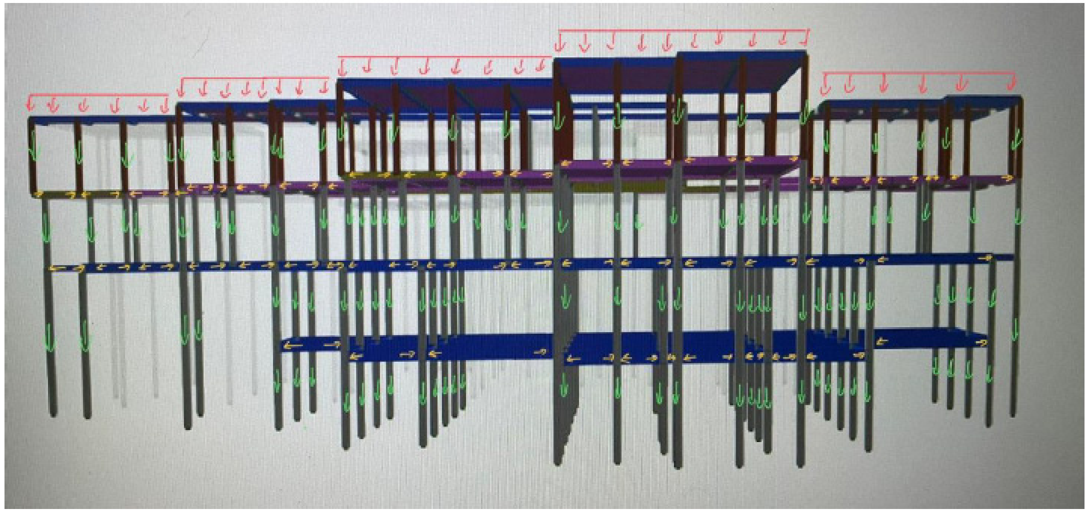


Figure 3: Load Path of the Entire Structure

Module 2 – 7.5m(L) x 2.2m(W) x 3.5m(W)

No.	Elements	kg/m	Length(m)	Unit	Load (kg)
1	310UB46.2	46.2	7.5	4	1386
2	310UB46.2	46.2	2.2	4	406.56
3	250UC72.9	72.9	3.5	4	1020.6
4	50x50x5EA	3.48	2.2	3	22.97
	Total				2836.13

Module 3 – 11.5m(L) x 2.2m(W) x 3.5m(W)

No.	Elements	kg/m	Length(m)	Unit	Load (kg)
1	310UB46.2	46.2	11.5	4	2125.2
2	310UB46.2	46.2	2.2	4	406.56
3	250UC72.9	72.9	3.5	4	1020.6
4	50x50x5EA	3.48	2.2	5	38.28
	Total				3590.64

Module 4 – 3.4m(L) x 1.5m(W) x 3.5m(W)

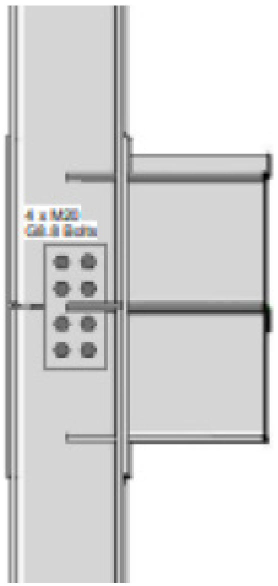
No.	Elements	kg/m	Length(m)	Unit	Load (kg)
1	310UB46.2	46.2	3.4	4	628.32
2	310UB46.2	46.2	1.5	4	406.56
3	250UC72.9	72.9	3.5	4	1020.6
4	Total				2055.48

The critical load calculated as shown in the table above is from Module 3 which has a total load of 3590.64kg. It has the longest structure of modular unit high contribute a dimension of 11.5m(L) x 2.2m(W) x 3.5m(W).

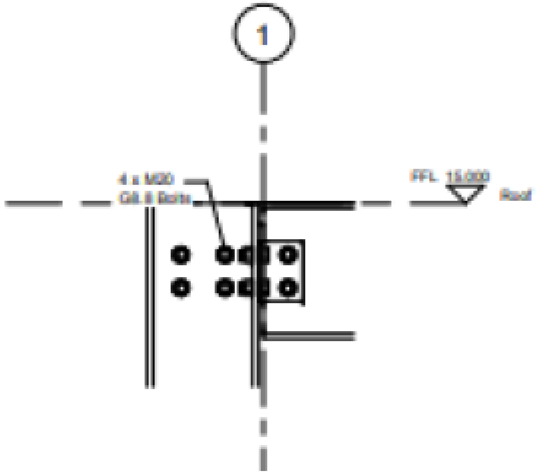
With the usage of spreader beam to lift the module, it will not experience an imbalance force at each edge of lifting but with a vertical force which could prevent the modular from swinging and tipping during lifting.

As for the mobile crane, the safety load of 1.5 will be applied to ensure the load will not exceed the capability of the crane maximum load. Therefore, a 6-ton mobile crane or higher load capacity crane will be used and the crane load chart which shows the radius and height of lifting will be examined.

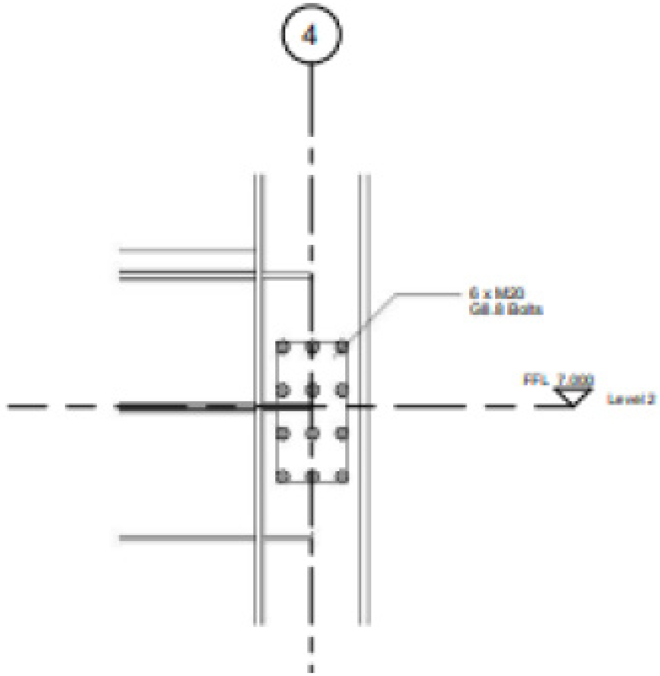
CONNECTION DRAWINGS



MODULE COLUMN TO MODULE COLUMN
CONNECTION SCALE 1:10

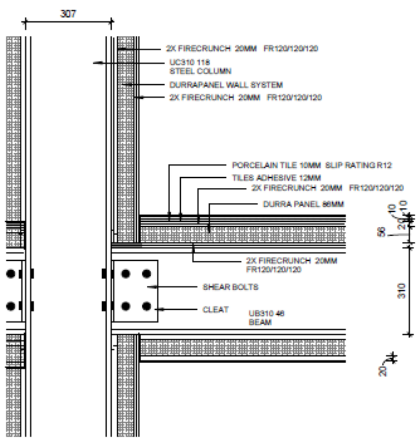


BEAM TO COLUMN CONNECTION 1:10

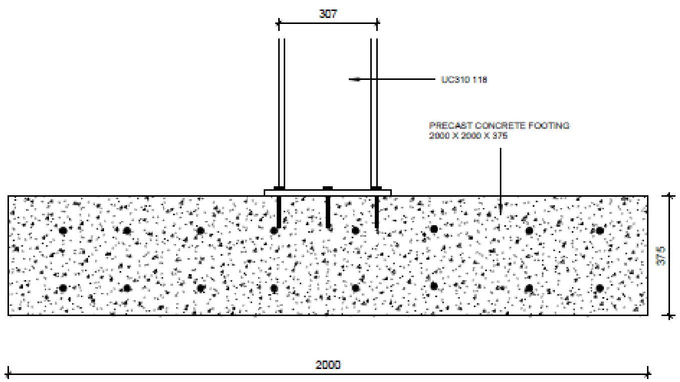


COLUMN TO MODULE COLUMN CONNECTION 1:10

MODULE BEAM TO MODULE
COLUMN CONNECTION 1:10



BEAM TO COLUMN CONNECTION AT FIREWALL 1:10



PRECAST CONCRETE FOOTING 1:10

Durapanel. 2023. Durpanel. durrapanel.com

Volt Tiles. 2023. Volt Tiles. www.volt-tile.com

Wikihouse. 2023. Wikihouse. www.wikihouse.cc

$= 0.166\ (> 0.15) \therefore k_v = 0.15$

$b_v = 1000mm$

$d_v = max[0.72D\ or\ 0.9d]$ **AS3600:2018<Clause 8.2.1.9>**

$= max[0.72(200)\ or\ 0.9(174)]$

$= 156.6mm$

$\emptyset = 0.7$ **AS3600:2018 Table 2.2.2**

$\emptyset V_{uc} = \emptyset k_v b_v d_v \sqrt{f'_c}$

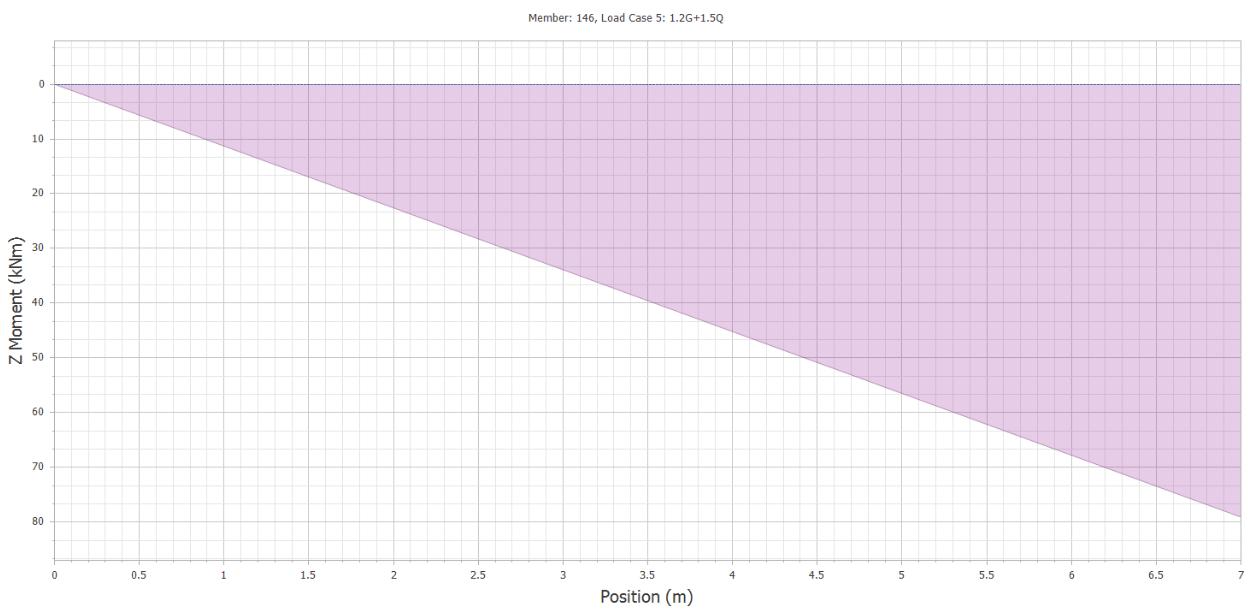
$= (0.7)(0.15)(1000)(156.6)\sqrt{32}$

$= 92.96kN/m$

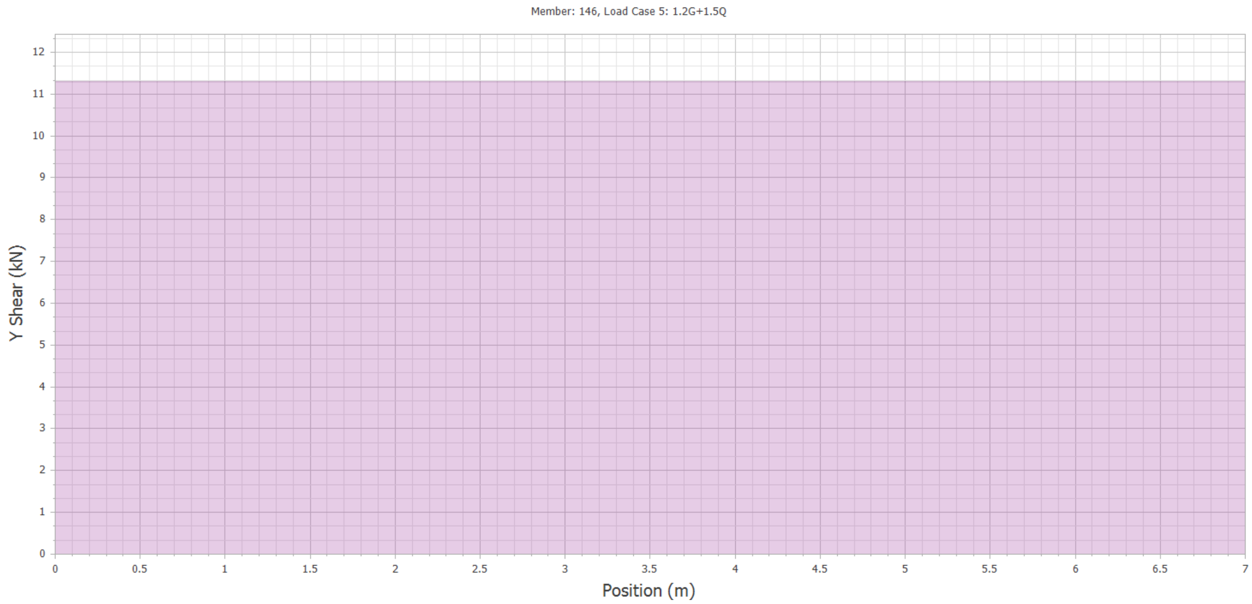
4.3 Double Story Column (7 meters)

In SpaceGass analysis, the member selection for 7.0m column for double story column is 310UC96.8. With the load combination of 1.2G + 1.5Q, the maximum moment, maximum shear force and maximum axial force is obtained as below.

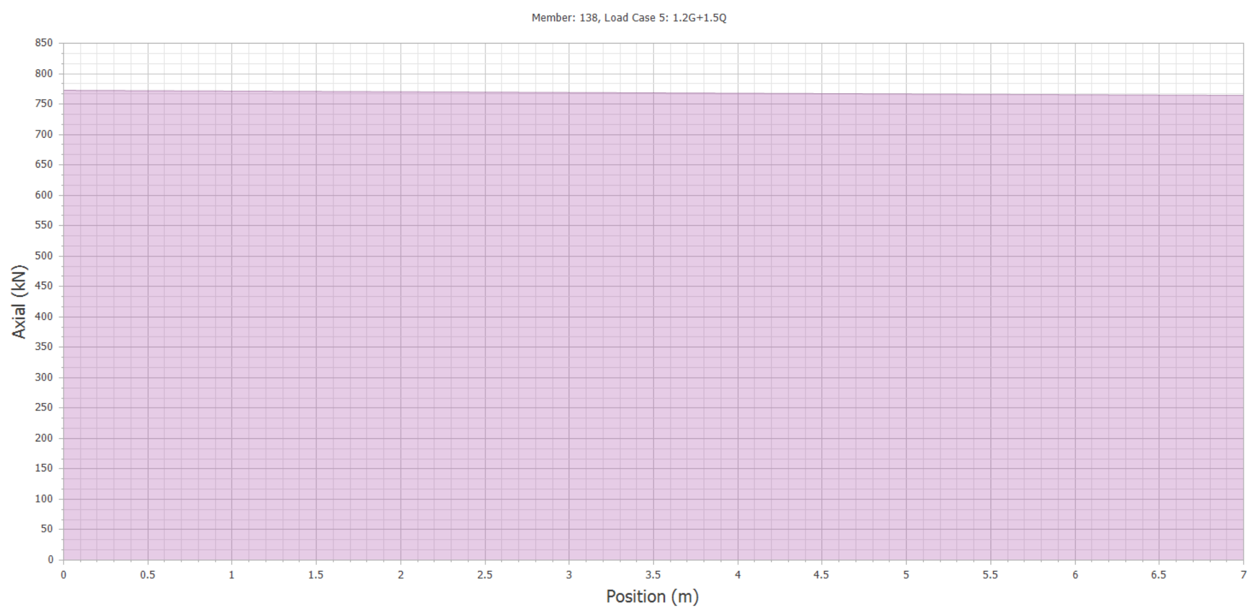
$M^* = 79.1kNm$



$V^* = 11.3kN$



$N^* = 772.8kN$



4.3.1 Moment Checking

a) Section Capacity

According to Table 5.3-4(A) in DCT, the design section moment capacities and design web capacities for 310UC96.8 can be obtained directly.

$\emptyset M_{sx} = 422kNm$ (>M*) $\therefore Satisfied$ **DCT Table 5.3-4(A)**

b) Member Capacity

The design member moment capacities can be obtained based on the member size and the effective length of the member selected in Table 5.3-3 (A) of DCT. Therefore, the effective length, L_e can be obtained using formula in AS/NZS 4100:2020 Clause 5.6.3 as below.

$L_e = k_t k_l k_r L$ **AS4100<Clause 5.6.3>**

$k_t = 1.0$ **AS4100<Table5.6.3(A)>**

$k_l = 1.0$ **AS4100<Table5.6.3(B)>**

$k_r = 1.0$ **AS4100<Table5.6.3(C)>**

$L_e = k_t k_l k_r L$

$L_e = (1.0)(1.0)(1.0)(7.0)$

$L_e = 7.0m$

For L_e = 7.0m, the design member moment capacities, $\emptyset M_b$ can be obtained as below.

$\emptyset M_b = 290kNm\ (<\emptyset M_{sx}) \therefore Satisfied$ **DCT Table 5.3-4(A)**

4.3.2 Shear Checking

a) Nominal Shear Capacity

$\emptyset V_v = 527kN\ (> V^*) \therefore Satisfied$ **DCT Table 5.3-4(A)**

b) Shear Bending Interaction

According to AS4100 <Clause 5.12.3>:

If $V^* > 0.6\emptyset V_v$ and $M^* > 0.75\emptyset M_{sx}$ is true, shear bending check is required.

$0.6\emptyset V_v = 0.6\ (527)$

$= 316.2kN\ (> V^*) \therefore Not\ True, Shear\ bending\ check\ is\ satisfied.$

4.3.3 Axial Compression Checking

a) Section Capacity (Compression)

The design member capacities in axial compression can be obtained based on the member size and the effective length of the member selected in Table 6-7 (A) of DCT. Therefore, the effective length, L_e can be obtained using formula in AS/NZS 4100:2020 Clause 5.6.3 as below.

$L_e = k_t k_l k_r L$ **AS4100<Clause 5.6.3>**

$k_t = 1.0$ **AS4100<Table5.6.3(A)>**

$k_l = 1.0$ **AS4100<Table5.6.3(B)>**

$k_r = 1.0$ **AS4100<Table5.6.3(C)>**

$L_e = k_t k_l k_r L$

$L_e = (1.0)(1.0)(1.0)(7.0)$

$L_e = 7.0m$

For L_e = 7.0m, the design member capacities in axial compression, $\emptyset N_{cx}$ can be obtained using interpolation.

$$\emptyset N_{cx} = 2891 + \frac{2598 - 2891}{8 - 6}(7 - 6)$$

$$= 2744.5kN\ (> N^*) \therefore Satisfied$$ **DCT Table 6-7 (A)**

For L_e = 7.0m, the design member capacities in axial compression, $\emptyset N_{cy}$ can be obtained using interpolation.

$$\emptyset N_{cy} = 1809kN\ (> N^*) \therefore Satisdied$$ **DCT Table 6-7 (B)**

$$\emptyset N_s = 3340kN\ (> N^*) \therefore Satisfied$$ **DCT Table 6-7 (A)**

$$\emptyset M_{rx} = 422(1 - n), n = \frac{N_c^*}{\emptyset N_s}$$ **DCT Table 8-4 (A)**

$$= 422\left(1 - \frac{772.8}{3340}\right)$$

$$= 324.36kNm\ (> M^*) \therefore Satisfied$$

b) Section Capacity (Tesion)

$$\emptyset N_t = 3340kN(> M^*) \therefore Satisfied$$ **DCT Table 7-7 (A)**

$$\emptyset M_{ry} = 422(1 - n), n = \frac{N_t^*}{\emptyset N_t}$$ **DCT Table 8-4 (A)**

$$= 422\left(1 - \frac{772.8}{3340}\right)$$

$$= 324.36kNm\ (> M^*) \therefore Satisfied$$

c) Member Capacity

$$\emptyset N_{cy} = 1809kN$$

In-plane capacity: $M^* \leq \emptyset M_i, M_i = M_s(1 - \frac{N^*}{\emptyset N_c})$ **AS4100:2020<Clause 8.4.2.2>**

$$79.1 \leq 422\left(1 - \frac{722.8}{1809}\right)$$

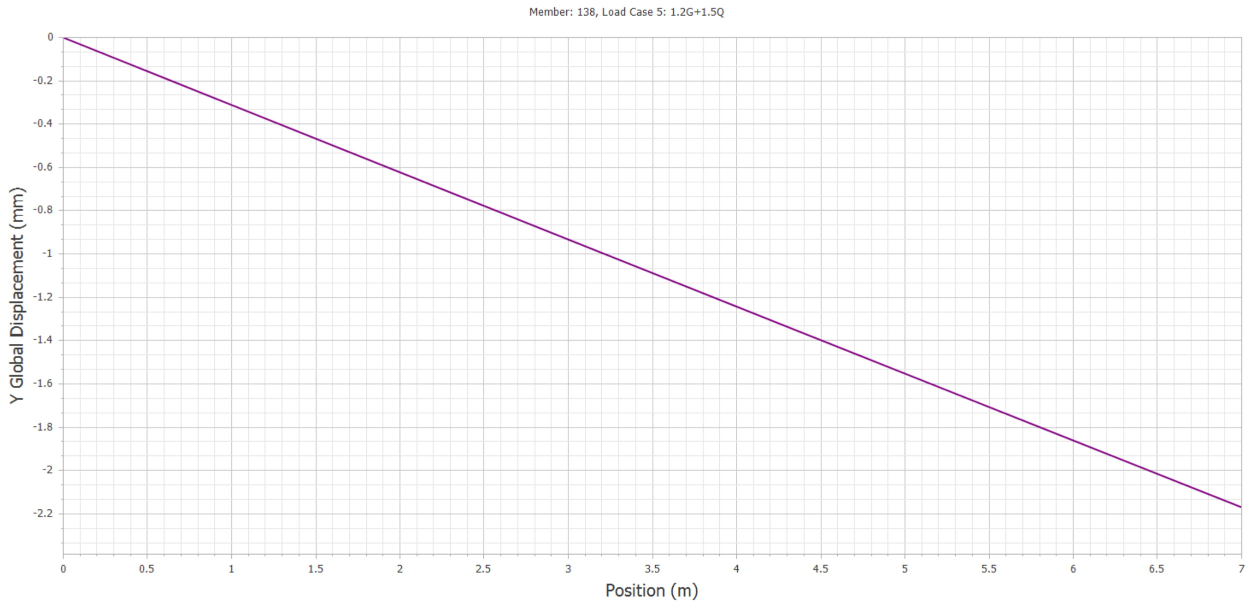
$$79.1 \leq 253.39 \therefore TRUE, Satisfied$$

Out-of-plane capacity: $M^* \leq \emptyset M_o, M_i = M_{bx}(1 - \frac{N^*}{\emptyset N_{cy}})$ **AS4100:2020<Clause 8.4.4.1>**

$$79.1 \leq 290\left(1 - \frac{722.8}{1809}\right)$$

$$79.1 \leq 166.11 \therefore TRUE, Satisfied$$

4.3.4 Deflection Checking



Based on the analysis as shown in Spacegass, the maximum deflection obtained is 2.17mm.

$\Delta = \frac{7000}{500} = 14mm\ (> 2.17mm) \therefore Satisfied$ **AS4100:2020 Table B.1**

4.3.5 Member Selection

The final member selection for column is 310UC96.8.

Module 2 – 7.5m(L) x 2.2m(W) x 3.5m(W)

No.	Elements	kg/m	Length(m)	Unit	Load (kg)
1	310UB46.2	46.2	7.5	4	1386
2	310UB46.2	46.2	2.2	4	406.56
3	250UC72.9	72.9	3.5	4	1020.6
4	50x50x5EA	3.48	2.2	3	22.97
	Total				2836.13

Module 3 – 11.5m(L) x 2.2m(W) x 3.5m(W)

No.	Elements	kg/m	Length(m)	Unit	Load (kg)
1	310UB46.2	46.2	11.5	4	2125.2
2	310UB46.2	46.2	2.2	4	406.56
3	250UC72.9	72.9	3.5	4	1020.6
4	50x50x5EA	3.48	2.2	5	38.28
	Total				3590.64

Module 4 – 3.4m(L) x 1.5m(W) x 3.5m(W)

No.	Elements	kg/m	Length(m)	Unit	Load (kg)
1	310UB46.2	46.2	3.4	4	628.32
2	310UB46.2	46.2	1.5	4	406.56
3	250UC72.9	72.9	3.5	4	1020.6
4	Total				2055.48

The critical load calculated as shown in the table above is from Module 3 which has a total load of 3590.64kg. It has the longest structure of modular unit high contribute a dimension of 11.5m(L) x 2.2m(W) x 3.5m(W).

With the usage of spreader beam to lift the module, it will not experience an imbalance force at each edge of lifting but with a vertical force which could prevent the modular from swinging and tipping during lifting.

As for the mobile crane, the safety load of 1.5 will be applied to ensure the load will not exceed the capability of the crane maximum load. Therefore, a 6-ton mobile crane or higher load capacity crane will be used and the crane load chart which shows the radius and height of lifting will be examined.

4 types of modular are as shown below.

5.0 Connection

Column to Footings Connection Design

$\emptyset N_t = 3340kN$ **AS4100:2018<Table 7-7(A)**

$N^* = 774.12kN$

Minimum design action: $max\ [N^*\ or\ 0.3\emptyset N_t]$ **AS4100:2018<Table 7-7(A)**

$= max\ [774.12\ or\ 0.3(3340)]$

$= max\ [774.12\ or\ 1002]$

$= 1002kN$

The capacity that is used for connection design for column to footings is 1002kN.

<u>Bolt Design</u>

Assume 8 G8.8 M20 bolts and 20% prying in the design of baseplate connection.

$Tension\ force, N_t = 1002kN$

$$Tension\ force\ per\ bolt, N_{tf} = \frac{1002kN}{8} = 125.25kN$$

With 20% prying occurs: $N_{tf} \times 1.20$

$= 125.25 \times 1.20$

$= 150.3kN$

$\emptyset N_{tf} = 163kN\ (> 150.3kN) \therefore Satisfied$

$Total\ \emptyset N_{tf} = 8 \times 163kN = 1304kN (> 1002kN) \therefore Satisfied$

<u>Combined Action Check</u>

$\left(\frac{V_f{}^*}{\emptyset V_f}\right)^2 + \left(\frac{N_{tf}{}^*}{\emptyset N_{tf}}\right)^2 \leq 1.0$ **AS4100:2020<Clause 9.2.2.3>**

$V^* = 43.1kN$

$$V_f{}^* = \frac{43.1}{8} = 5.39kN$$

$\emptyset V_f = 92.6kN$

$N_{tf}{}^* = 150.3kN$

$\emptyset N_{tf}{}^{*} = 163kN$

$$\left(\frac{5.39}{92.6}\right)^2 + \left(\frac{150.3}{163}\right)^2 \leq 1.0$$

$0.85 \leq 1.0 \therefore Satisfied$

Hence, the 8 Grade 8.8 bolts are selected to connect the column and footing.

Weld Design

Minimum design action: max$[N_t{}^{*} or\ 0.3\emptyset N_t]$

$= max[774.2\ or\ 0.3(3340)]$

$= max[774.2\ or\ 1002]$

$= 1002kN$

The capacity of welding design for connecting plate to column is 1002kN.

The width and length of plate is assumed to be 500mm and 600mm.

$Total\ welding\ length, l_w = 2(500) + 2(600)$

$= 2200mm$

For welding length between 1.7m and 8.0:

$k_r = 1.10 - 0.06(l_w)$ **AS4100:2020 Table 9.6.3.10(B)**

$= 1.10 - 0.06(2.2)$

$= 0.968$

$$V_w{}^{*} = \frac{N_t}{l_w}$$

$$= \frac{1002}{2200}$$

$= 0.455kN/mm$

Assuming the weld designed for general purposes (GP) with Grade 8.8 bolts, the $f_{uw} = 490MPa$

$\emptyset = 0.6\ (GP)$

$V_w{}^* \leq \emptyset V_w$ **AS4100:2020<Clause9.6.3.10>**

$V_w{}^* \leq (0.6)\emptyset f_{uw} t_t k_r$

$0.455 \leq (0.6)(0.6)(490)(t_t)(0.968)$

$t_t \geq 3.76mm \therefore Select\ 4mm\ E49XX\ fillet\ weld\ for\ general\ purpose\ (GP)$

$V_w{}^* \leq (0.6)\emptyset f_{uw} t_t k_r$ **AS4100:2020<Clause9.6.3.10>**

$0.455 \leq (0.6)(0.6)(490)(4)(0.968)$

$455 \leq 529.2 \therefore Satisfied$

<u>Combined Action Check</u>

$$\emptyset V_w = \emptyset \frac{N}{l_w}$$

$$= (0.6)\frac{1002}{2200}$$

$$= 273.27kN/mm$$

$$\emptyset V_w = \emptyset \frac{V}{l_w}$$

$$= (0.6)\frac{43.1}{2200}$$

$$= 11.75kN/mm$$

Total Resultant Load: $\sqrt{273.27^2 + 11.75^2} = 211.43kN/mm(< 529.2) \therefore Satisfied$

<u>Plate Thickness</u>

Assuming the steel grade of plate is 300MPa

$$Moment\ on\ plate, \emptyset M_{sx} = 150.3 \times \frac{50}{2}$$

$$= 3.76kNm$$

$\emptyset M_{sx} = \emptyset f_y \times z_e$

$f_y = 300MPa$

$$z_e = \frac{st^2}{6} = \frac{400t^2}{6}$$

$3.76 \ = (0.9)(300)(\frac{400t^2}{6})$

$t = 14.45mm \approx 15mm$

The plate thickness of 15mm is designed.

<u>Plate Bearing Capacity Check</u>

$V_b{}^* \leq \emptyset V_b$ **AS4100:2020<Clause 9.2.2.4>**

$V_b = 3.2 d_f t_p f_{up}$

$= 3.2(20)(15)(440)$

$= 422.4kN$

$5.39 \leq (0.9)(422.4)$

$5.39 \leq 380.16 \ \therefore Satisfied$

Minimum distance from edge of a hole to edge of a ply, a_e can be calculated as below.

$V_b \leq \emptyset a_e t_p f_{up}$ **AS4100:2020<Clause 9.2.2.4>**

$5.39 \times 10^3 \leq (0.9) a_e (15)(440)$

$a_e \geq 0.91$mm

Minimum edge distance for standard holes

$1.5 d_f = 1.5(20)$ **AS4100:2020<Table 9.5.2>**

$= 30mm$

Minimum Spacing

$2.8 d_f = 2.8(20)$

$= 56mm$

Minimum pitch

$2.5 d_f = 2.5(20)$ **AS4100:2020<Clause 9.5.1>**

$= 50mm$