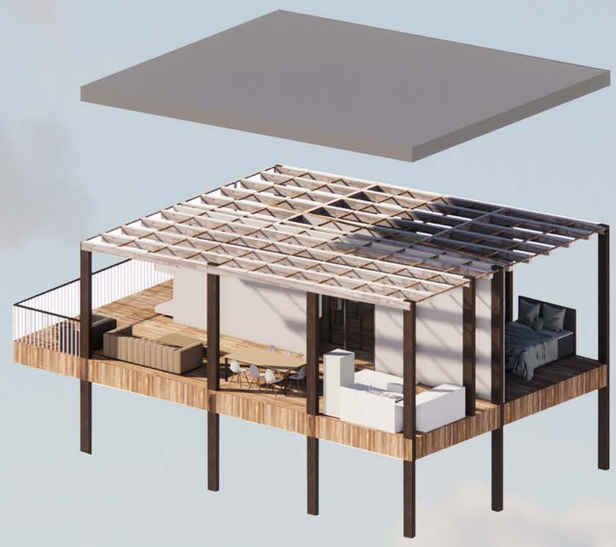
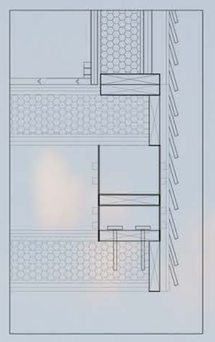
CONNECT

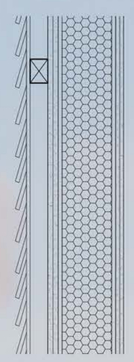


The design unleashing the potential for new technologies through the Stirrup brackets, Passive design, floor plate connections, and materiality. The click in, click out features allow for the design to be re-orientated. The stirrup brackets allow for ease of construction and stability allowing for multiple connections. The clip on features such as the window frames and the click in flooring allow for modular design.

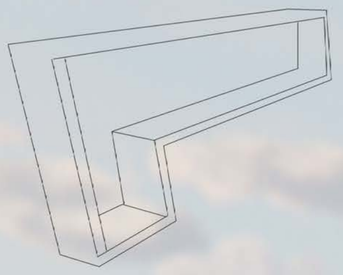
Potential For New Technologies:



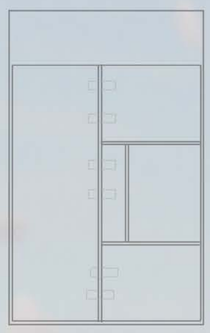
The modules are connected similar to an "I Beam" connection, with the connection being made through a stirrup bracket. This means the modules are easily accessible and connected



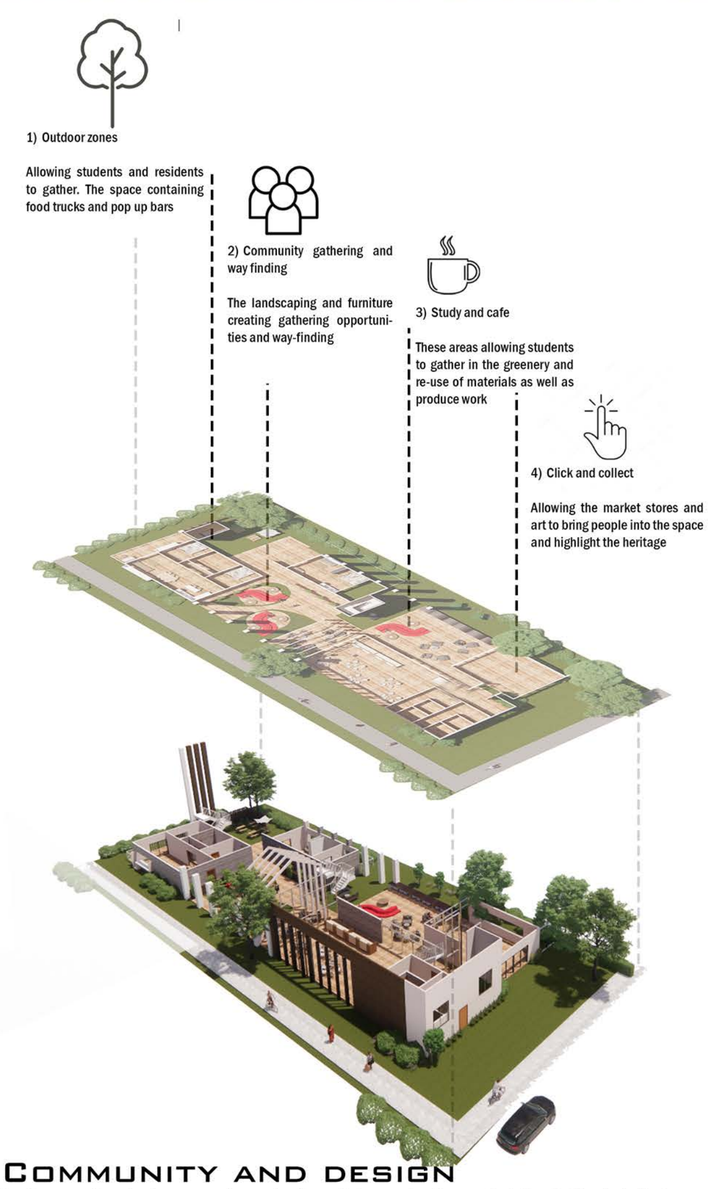
Sips internal and external walls that make up the modules. Sips panels, gypsum and plasterboard make up the external layer. The exterior wall with gyprock frychek moisture resistant plasterboard.



The modules have a alucobond frame in order to cater for the winter and summer sun when it is too harsh. The summer sun angles at 81 degrees and winter at 34 degrees. The timber frame is on all sides of the building.



The floor plates have a unique way of being connected allowing for future expansion. The timber framing being cut in half this way.



Connect: Community and design

Occupant wellbeing, community value as well as circular economies are fundamental concepts of our project. The design aiming to focus on community engagement as well as privacy when desired. The heart of Fremantle and its characteristics being kept true on site through the integration and play of materials as well as occupancy. Through the wrapping of the design in an open grid, vegetation grows freely through the site, acting as a way-finder and creating peaceful community spaces. The construction of the apartments being modular and robust as well as focusing on adaptive re-use, construction speed and the ability to fit on any site. As the modules have clip on, clip off facades, they are able to be adjusted no matter the stie. The sites approach begins with a large open café with the stripped warehouse down to a large open Skelton. The design also providing features such as study spaces, and click and collect to allow for the fresh café produce as well as items from the café which can partially transform into a community market space.

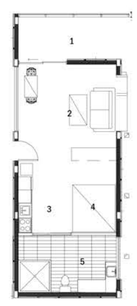
The modular apartments aiming to be as environmentally sustainable as possible, focusing on the lifecycle of materials. The modules are produced out of CLT timber frame and weathertex cladding. The red brick on site alongside the timber are used to re-new the warehouse as well as create timber facades and flooring. The plates of the terraces being modular, allowing the terraces and outdoor spaces to be moved around if need be. The site staying true to the context of Fremantle with the remaining heritage and enhancement of materials near site.

Two Bedroom Apartment: Scale 1:100

This apartment is the two bedroom apartment made of sips panels and weather text cladding. The bedrooms being orientated East and living rooms North to optimise the natural daylight. The sliding doors and windows optimising on space and natural light and ventilation

1) Living room
2) Dining room
3) Kitchen
4)Bedroom
5) Bathroom with laundry facilities
6) Balcony

N 0m 2 4 6 8 10
1:200 scale bar

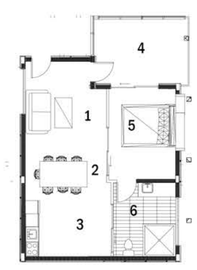


Student accommodation: Scale 1:200

This apartment is the student accommodation made of sips panels and weather text cladding. The bedrooms being orientated East and living rooms North to optimise the natural daylight. The sliding doors and windows optimising on space and natural light and ventilation

1) Balcony
2) Living/ dining
3)Kitchen
4) Bedroom
5) Bathroom with laundry facilities

N 0m 2 4 6 8 10
1:200 scale bar



One bedroom apartment: Scale 1:200

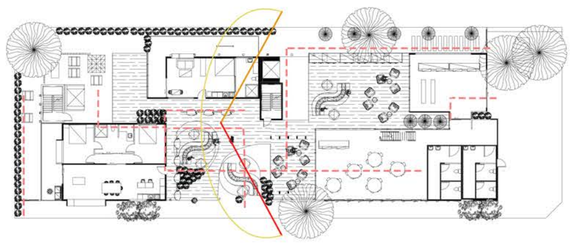
This apartment is the one bedroom apartment made of sips panels and weather text cladding. The bedrooms being orientated East and living rooms North to optimise the natural daylight. The sliding doors and windows optimising on space and natural light and ventilation

1) Living Room
2)Dining room
3) Kitchen
4) Balcony
5) Bedroom
6) Bathroom with laundry facilties

N 0m 2 4 6 8 10
1:200 scale bar

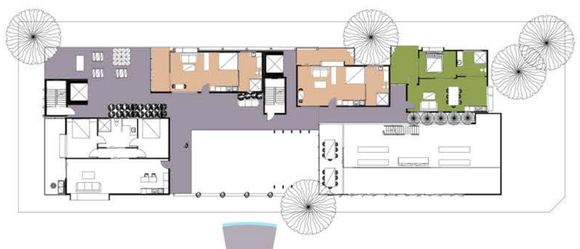
Advanced Design That delivers Community and Client Value:

The creation of such a design delivers community and client value due to the community and warm environment created in Fremantle. The design optimises circulation, daylight, the separation and ease of transition from private to public whilst also providing for ventilation and views. The design being advanced due to the selection of sips walls for panels and using weathertex as exterior cladding, giving the design a 90/90/90 fire rating



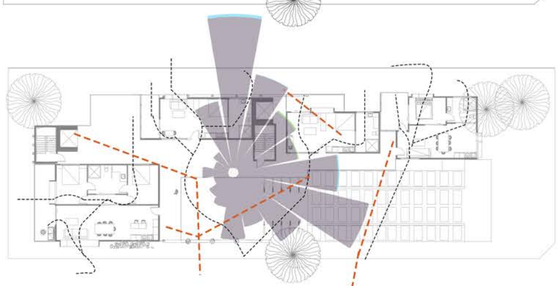
Circulation and daylight:

The circulation through the space being made evident through the timber terracing and timber decking. The site being accessible from mainly from the West. As the summer sun is at a 81 degree angle and winter sun is at a 31 degree angle this being optimised through the placement of balconies and living rooms as well as shading devices



Private and public and terracing:

Each of the modules has a balcony on either the North or East, meaning the main circulation and public spaces occur around the atrium.The purple outlining the terraces which are more so for the occupants and the yellow highlighting the public area which is present on the levels below



Ventilation and views:

The ventilation throughout the space optimising the "Freo Doctor" meaning that the South-West wind in the summer and North Eastern wind in the winter will be utilised.The design being done in such a way that from all areas of the apartment there is surveillance, aiding to the safety as well as here is being longitudinal views.

West Elevation

0m 2 4 6 8 10
1:200 scale bar

East elevation

0m 2 4 6 8 10
1:200 scale bar

The North and East elevation illustration. The Weathertex exterior that all of the modules will have. This material being both sustainable and also has a high fire rating. The site aiming to be as vegetated as possible to increase the community value and the wellbeing of its residents. The internal walls being produced out of sips panels and clad with gypsum board. All connections being produced out of cross- laminated timber and partial elements of steel. The cross laminated timber being used as the load bearing element

North elevation

N 0m 2 4 6 8 10
1:200 scale bar

South elevation

N 0m 2 4 6 8 10
1:200 scale bar

SECTION A-A

N 0m 2 4 6 8 10
1:200 scale bar

APPROACH

The design involves the re-use of old red bricks and weathertex giving the approach a warm subtle entrance.

WELCOMING

The greenery within the design and the large open courtyard allows one to easily navigate through and feel welcomed and safe.

COMMUNITY FACILITIES

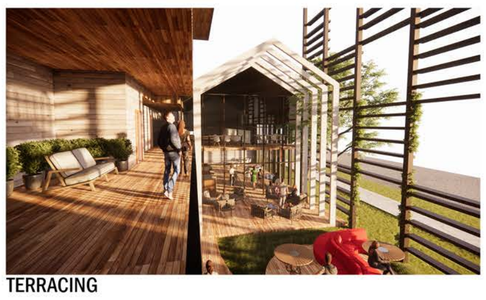
The large open cafe serving as a meeting point for those apartments creating a sense of community

STUDY FACILITIES

The design has study areas amongst the greenery, reducing travel time for those who work

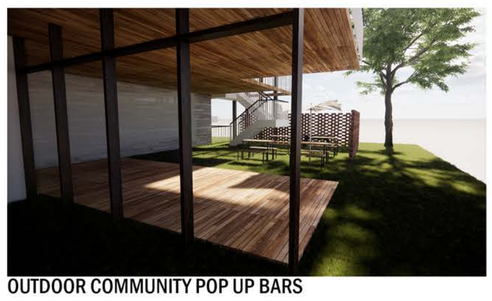
OUTDOOR COURTYARD

The outdoor courtyard allows for peace and tranquillity through community engagement whilst benefiting from the larger architectural features



TERRACING

The terracing provides community and client value as it allows for 24/7 surveillance and views

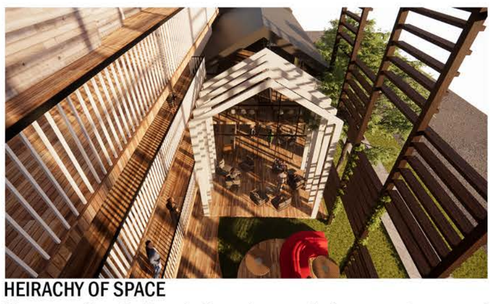


OUTDOOR COMMUNITY POP UP BARS

The space is flexible to allow elements such as pop-up bars and shops to function

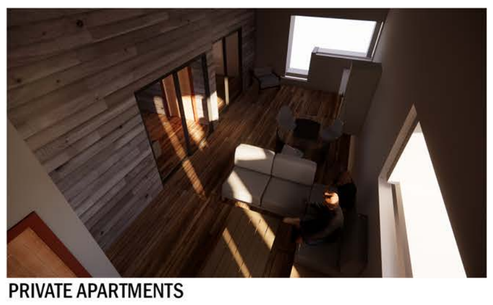
SEMI-PRIVATE TERRACING

The semi- private terracing allows those in the apartments more functional space to use



HEIRACHY OF SPACE

The space allows for those in the environment to have a greater sense of community due to the facilities provided



PRIVATE APARTMENTS

The apartments allow for those who live there to permanently be within the space and enjoy the views, natural light and facilities

PRIVATE BALCONIES

The private balconies mean that all users can engage with the surroundings and have private times

VIEWS

The space progressing from private to public to create a community orientated modular design

Smart materials:

The use of weathertex on sips panels being considered a smart material due to the air tight design it creates along with the weathertex creating a

Gypsum Board:

This being used internally for walls but also the fire escape staircases

CLT:

Cross laminated timber being used for the timber structure to allow for strength and also use a sustainable material with reduced lifecycle costs

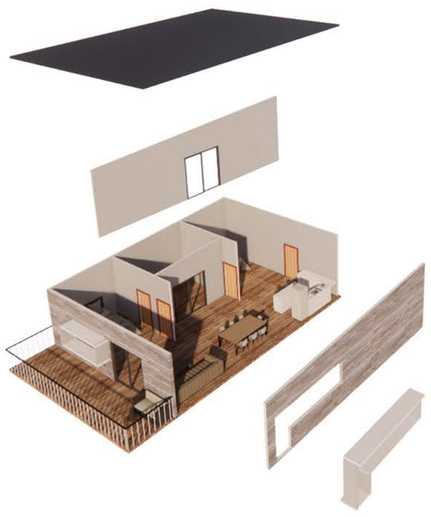
Sips:

Sips being used for the external walls as well as some of the internal to produce an air tight design and use a local manufacturer

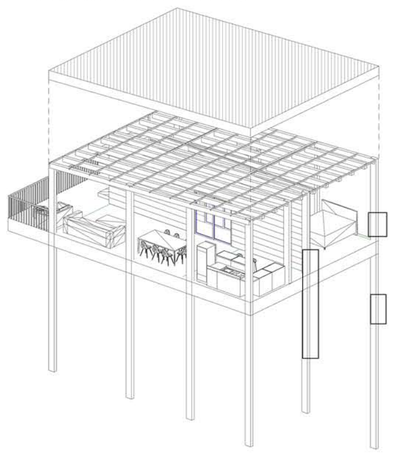
Weathertex:

This being used externally due to its fire rating, appearance and also sustainability

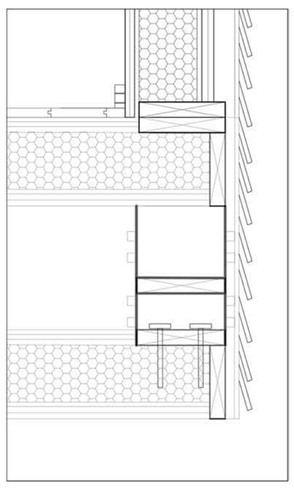
Design for Manufacture and Assembly (DfMA)



The module is designed for ease of assembly and disassembly due to the way in which the module is crafted. The splitting of the modules into two parts with a CLT load bearing wall allows for strength and stability when being transported. The minimising of material types allows for the design to be easily constructed and deconstructed. Reuse of red brick on site will therefore reduce the assembly process and will take into consideration the circular economy.



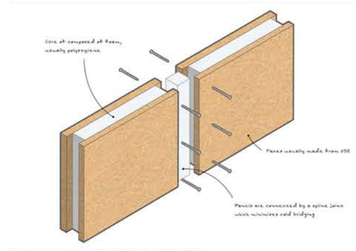
The design being built for assembly and disassembly as it reduced the amount of chemical connection and rather focuses on a mechanical connection. The stirrup brackets mean the design has structural integrity whilst reducing the amount of chemical connections. The weathertex and bamboo timber flooring also reduces the amount of chemical connectors. The points of assembly are highlighted above. The three main points of connection from one module to the next, its connection to the roof, and the CLT panel which is used, is a load bearing wall in the centre



Working alongside engineers allowed for deeper understanding into the construction systems and the structural integrity behind the built form. This resulted in the use of connections such as the stirrup bracket as seen above and the use of a spine joint connection as seen below. The further use of elements such as glulam beams had allowed for a more environmentally sustainable and durable design.

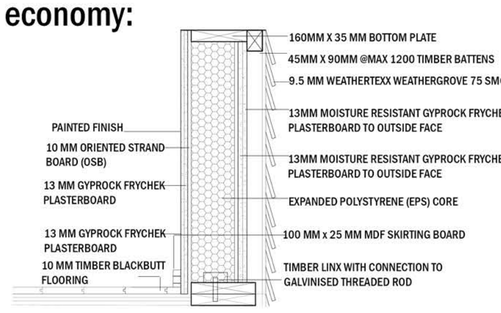
Transdisciplinary design approaches:

Working alongside engineers allowed for deeper understanding into the contrcution systems and the strucutral integrity behind the built form. This had meant the use of a connection such as the striup braket as seen above and the use of a spine joint connection as seen below. The further use of elements such as glulam beams had allowed for a more environmentally sustainable and durable design.

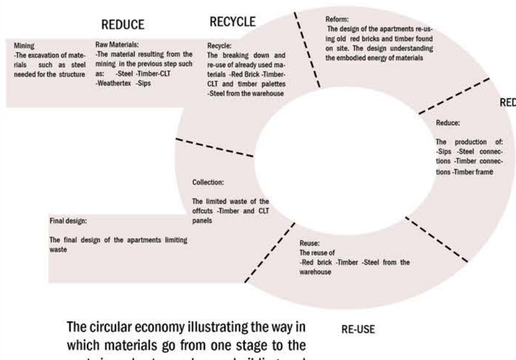


Spline joint connection (Connection of two SIP panels)

Climate emergency and ciruclar economy:

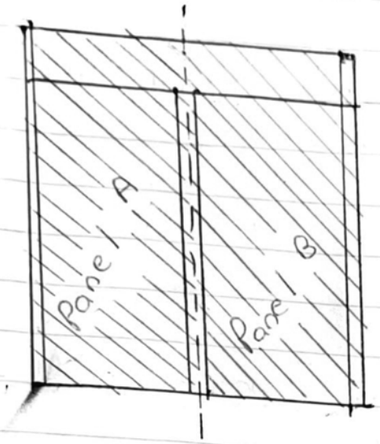


As the design layers gyprock panels with sips panels and weathertex, this results in high durability and fire resistance, creating a 90/90/90 design. The sips panels allow for easy construction together with the glulam beams and stirrup connections



The circular economy illustrating the way in which materials go from one stage to the next, in order to produce a building and cater for stages that occur thereafter.

Panel ①



Calculations for selfweight, Superimposed dead load & Imposed load.

L4 1 B

Level 4 Panel 1 – B

Density of Glue lam. timber = 650 kg/m³

Glue lam. self weight = [4 × 0.13 m] × 650 kg/m³ × 3m × 0.165m × 9.81×10⁻³

= 1.64 kN

CLT self weight = 12m × 1.2 kPa × 0.085m

= 1.224 kN

SIP Self weight = [(12 − 0.13×4)m + (3.6×2)m + (1×2)m + (4.5×2)m] × 0.26 kN/m² × 0.165m

= 1.273 kN

Total self weight of the panel = 4.137 kN

Total area of the panel = 57.6 + 9.27 = 66.87 m²

Self weight of columns, beams & walls on the floor = $\frac{4.137 \text{ kN}}{66.87 \text{ m}^2}$ = 0.062 kPa

Self weight of the floor (SLT) = 1.2 kPa

Total self weight = 1.262 kPa

Super imposed dead load for the panel ①

Finishes = 1 kPa

Services = 0.5 kPa

1.5 kPa

~~Super impos~~ Calculation for Imposed load (Q)

Roof used floor activities = 1.5 kPa (AS1170.1 Table3.1)

Imposed action on the floor = 2 kPa (AS1170.1 Table3.1)

Total imposed load = 3.5 kPa.

L4 1 A

Level 4 – Panel 1 – A

Self weight of Glue lam columns = 4 × 0.13m × 6.37 kN/m³ × 3m × 0.165m

= 1.64 kN

Self weight of CLT Partition = 1.2kPa × 12m × 0.085m

= 1.224 kN

Self weight of SIP walls = 0.26 kN/m² × [[12 − (0.13×4)] + 28.1] × 0.165m

= 0.711 kN

Total self weight on the panel = 3.575 kN

Total area of the panel including Verandah

= 47m² + 8.59m²

= 55.59 m²

Self weight of columns, beams & walls = ~~0.064 kPa~~

$$\frac{3.575\,kN}{55.59\,m^2} = 0.064\,kPa$$

Self weight of of the floor (CLT) = 1.2 kPa

Total self weight = 1.264 kPa.

Super imposed dead load for the panel ①

Finishes = 1. kPa.

Services = 0.5 kPa

1.5 kPa

Calculation for Imposed load (Q)

Imposed ~~load~~ action for roof = 1.5 kPa (AS 1170.1 Table 3.2)

Imposed action on the floor = 2 kPa (AS 1170.1 Table 3.1)

Total imposed load = 3.5 kPa

Assumption : Wind pressure acts only on the windward wall side columns, wall & beam

Net x-direction wind pressure = 0.943 kPa

Load on wind ward wall $= \frac{0.943\,kPa\,(12 \times 3)\,m^2}{55.59\,m^2}$

= 0.61 kPa

Level 4 Summary

	A	B	Total (kPa)
Self weight	1.264 kPa	1.262 kPa	2.526
SIDL	1.5 kPa.		1.5
Imposed (Q)	3.5 kPa	3.5 kPa	7
Wind	0.61 kPa	–	

} G = 4.026 kPa

L3 1B and L3 1A

Since, Gluelam columns, CLT partitions, SIP walls & CLT floor are the same for this unit in each level,

~~Per~~ Total self weight = 2.526 kPa

SIDL = 1.5 kPa

Permanent load, G = ~~3~~ 4.026 kPa

No roof action, ∴ Imposed load due to floor

Q = 2 kPa (AS 1170.1 Table 3.1)

Wind action only on L3 1A = 0.72 kPa

Total imposed action on Level 3 = 2 kPa (A) + 2 kPa (B) + 7 kPa (L4)

Q = 11 kPa

Total permanent action on Level 3 = 4.026 + 4.026 kPa

~~G = 8.052 kPa~~

L21B and L21A

G = 4.026 kPa
Q = 2 kPa
Wind on L21A = 0.72 kPa

Total Q = 11 + 2 + 2 = 15 kPa
Total G = 8.052 + 4.026 = 12.078 kPa

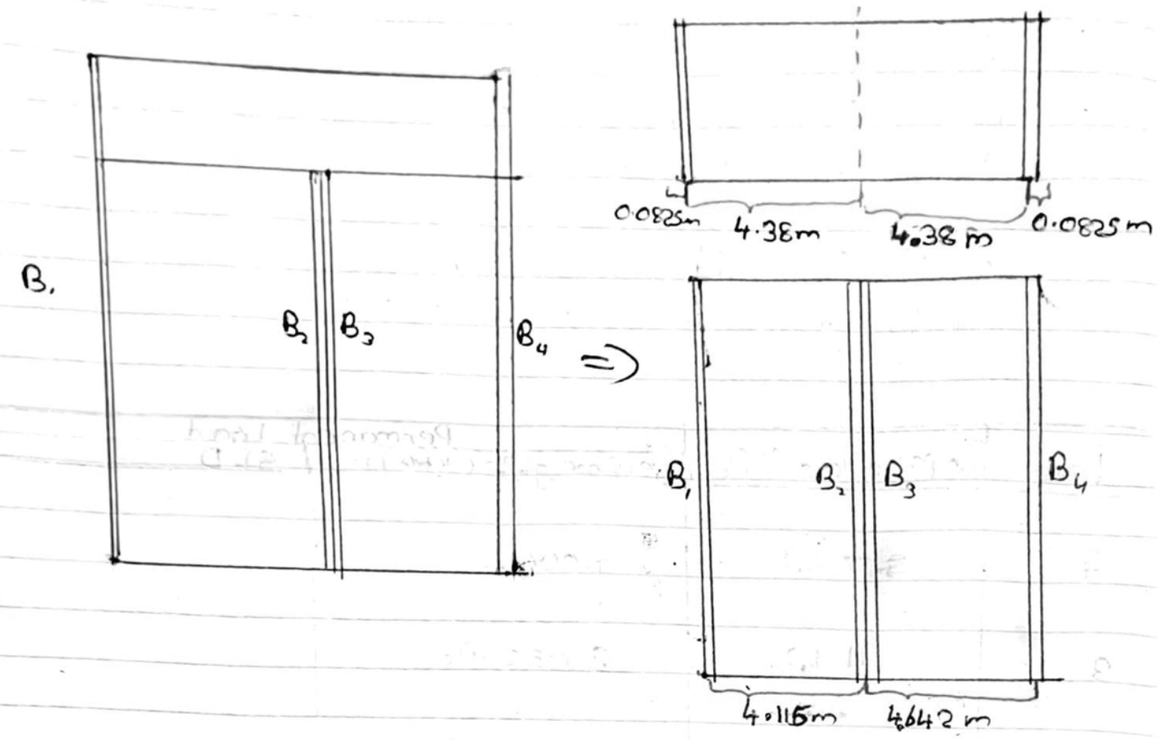
Level	Imposed load Q (kPa)	Permanent Load G (kPa)
4	7 kPa	4.026 kPa
3	11 kPa	8.052 kPa
2	15 kPa	12.078 kPa

For level ①

Loads on beams, columns, walls
G = 12.078 kPa
Q = 15 kPa.

Load Combinations (AS 1170.0 Cl 4.2.2)
a) $E_d = [1.35G] = 16.3053$ kPa
b) $E_d = [1.2G + 1.5Q] = 36.9936$ kPa
c) $E_d = [1.2G + 1.5 \times \psi_1 Q] = 23.4936$ kPa

Critical load $\omega = 36.9936$ kPa.



Tributary width

Bottom Part
$B_1 = 0.0825 + \frac{4.116}{2} = 2.1405$ m
$B_2 = 2.058$ m
$B_3 = \frac{4.642}{2} = 2.321$ m
$B_4 = \frac{4.642}{2} + 0.0825 = 2.4035$ m

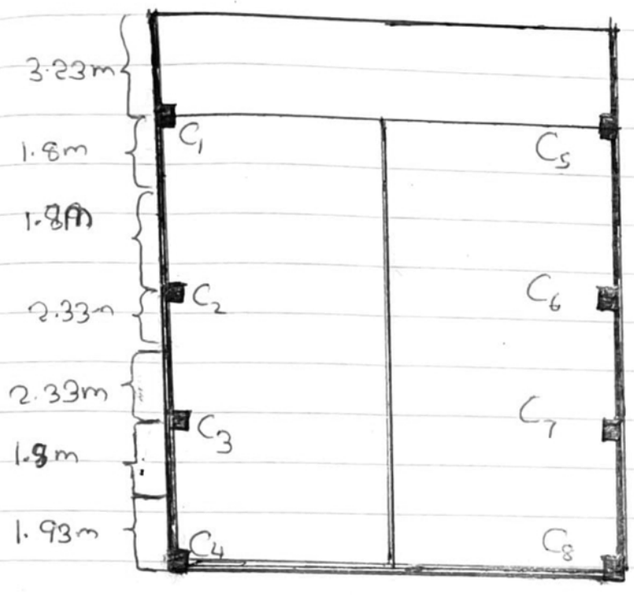
~~Uniformly distribu~~

Upper part
$B_1 = 0.0825 + 4.38$m $= 4.4625$m
$B_4 = 4.38 + 0.0825 = 4.4625$ m

Uniformly distributed loads

Bottom part
- $B_1 = 79.185$ kN/m
- $B_2 = 76.133$ kN/m
- $B_3 = 85.862$ kN/m
- $B_4 = 88.914$ kN/m

Upper part
- $B_1 = 165.084$ kN/m
- $B_4 = 165.084$ kN/m



B_1 & load acts on C_1, C_2, C_3 and C_4

B_4 load acts on C_5, C_6, C_7 and C_8

B_2 & B_3 Loads acts along CLT Panel towards ground

Concentrated axial loads

$C_1 = 165.084 \times 3.23$ kN $+ 79.185 \times 1.8$ kN $= 675.75$ kN

$C_2 = 79.185 \times (1.8 + 2.33)$ kN $= 327.03$ kN

$C_3 = 79.185 \times (2.33 + 1.8)$ kN $= 327.03$ kN

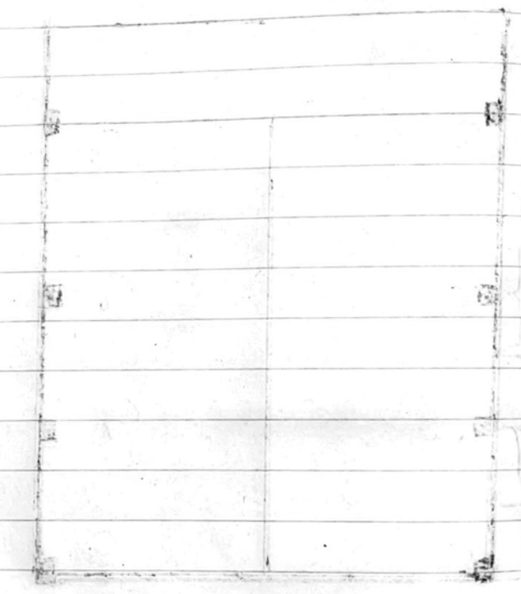
$C_4 = 79.185 \times (1.93)$ kN $= 152.83$ kN

$C_5 = 165.084 \times 3.23$ kN $+ 1.8 \times 88.914$ kN $= 693.27$ kN

$C_6 = (1.8 + 2.33) \times 88.914$ kN $= 367.215$ kN

$C_7 = (2.33 + 1.8) \times 88.914$ kN $= 367.215$ kN

$C_8 = 1.93 \times 88.914$ kN $= 171.604$ kN



Beam Selection.

<AS 1170.0 Table C1>

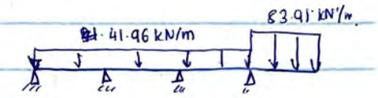
$\delta_{allowable} = L/500$

maximum span = 4657 mm.

$\therefore \delta_{allowable} = 4657/500 = 9.3$ mm.

From space gass analysis.

- Short term loading $\psi_l = 0.4$



$G + \psi_L Q = [12.08 + 0.4(15)] \times 4.64$

$= 83.91$ kN/m.

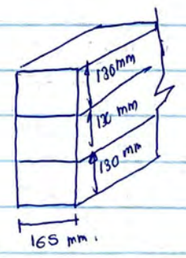
$G + \psi_L Q = [12.08 + 0.4(15)] \times 2.321$

$= 41.96$ kN/m

Based on space gass analysis, Three glued 165×130 (GL17) will be used

Max deflection = 8.91 mm (space gass analysis). < allowable deflection (9.3mm).

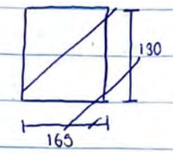
$\therefore$ Suitable.



$\boxed{\text{Section size (beam)} = 165 \times 390}$

Column Selection

Capacity of GL17



$N_{d,c} = \phi k_1 k_4 k_6 k_{12} f'_c A_c$

$= 0.85 \times 0.57 \times 0.7 \times 0.9 \times 1 \times 33 \times (295 \times 260)$

$= 772.5$ kN < Max actual load on the column = 693 kN.

For Seasoned timber k_4 is greater of,

$k_4 = 1 - 0.3\,\frac{E_{mc} - 15}{10}$ = and $k_4 = 0.7$

to be conservative $k_4 = 0.7$ <AS 1720.1, 2.4.2.3>

For covered timber structures under ambient conditions,

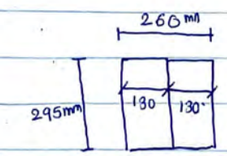
$k_6 = 1$ <AS 1720.1, 2.4.3>

Permanent and long-term imposed action $k_1 = 0.57$

Stability factor = 1.0.

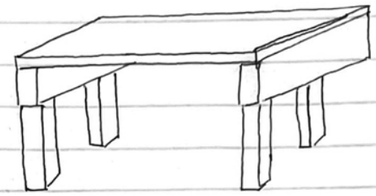
In order to create this section, Two × 295×130 beams will be laminated.

Thus suitable section $\boxed{295 \times 130 \text{ GL17}}$



Floor CLT (Cross Laminated Timber Floor]

<XLam design guide>



- Simply supported floor
- Imposed action on the floor (Q_k = 2kPa)
- Super imposed dead load (G_{SDL} = 0.5 kPa).
- Max span between support < 5.5m)

Selected CLT Floor – CLS/175

CLT wall

<XLam design guide>

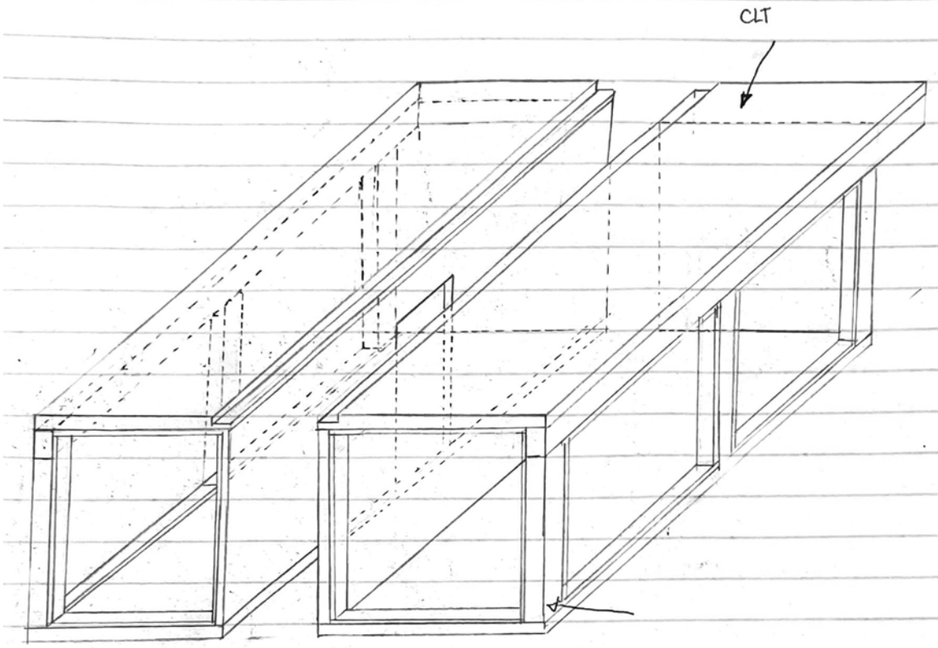
UDL on CLT wall = 78.9 kN/m

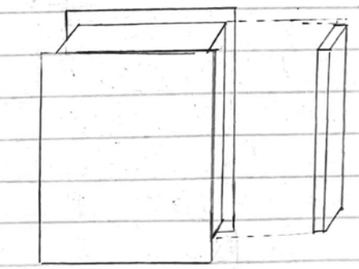
Imposed Load on a floor (Q_k) = 2kPa.

Selected CLT wall section CL3/85

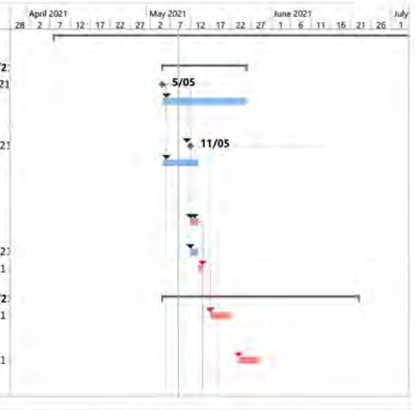
[3m height

Designed capacity = 115 kN/m]





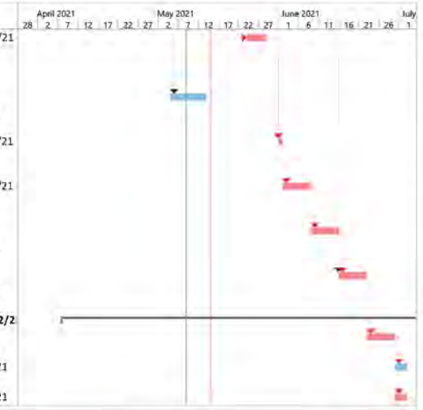
ID	Task Mode	Task Name	Duration	Start	Finish
1		**Fleetwood Cup Appartment Project**	**198 days**	**Thu 8/04/21**	**Mon 10/01/22**
2		**Preliminaries**	**15 days**	**Wed 5/05/21**	**Tue 25/05/2**
3		Contract Award	0 days	Wed 5/05/21	Wed 5/05/21
4		Procurement of materials and delivery	15 days	Wed 5/05/21	Tue 25/05/21
5		Kick-Off Meeting	0 days	Tue 11/05/21	Tue 11/05/21
6		Dilapidation surveys and liaison with residents	7 days	Wed 5/05/21	Thu 13/05/21
7		Environment Inspection	2 days	Wed 12/05/21	Thu 13/05/21
8		Soil testing	2 days	Wed 12/05/21	Thu 13/05/21
9		Identify existing services	1 day	Fri 14/05/21	Fri 14/05/21
10		**Management Plans**	**35 days**	**Wed 5/05/21**	**Tue 22/06/2**
11		Prepare Draft Management Plans	5 days	Mon 17/05/21	Fri 21/05/21
12		Draft Management Plan assessment	5 days	Mon 24/05/21	Fri 28/05/21



Project: Project1
Date: Sun 9/05/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

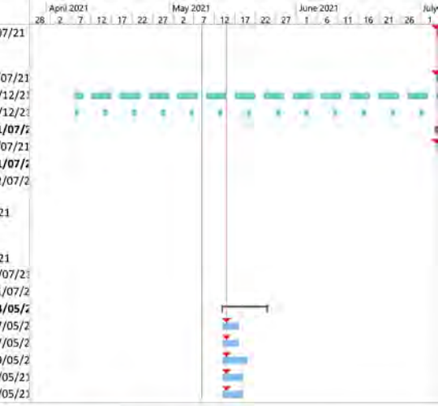
ID	Task Mode	Task Name	Duration	Start	Finish
13		Construction Risk awareness workshop notification	5 days	Mon 24/05/21	Fri 28/05/21
14		Traffic management plan preparation	7 days	Wed 5/05/21	Thu 13/05/21
15		Construction Risk awareness workshop	1 day	Tue 1/06/21	Tue 1/06/21
16		Finalise management plans	5 days	Wed 2/06/21	Tue 8/06/21
17		Approval of management plans	5 days	Wed 9/06/21	Tue 15/06/21
18		Clearance to work - Application and approval	5 days	Wed 16/06/21	Tue 22/06/21
19		**Pre-works**	**191 days**	**Thu 8/04/21**	**Thu 30/12/2**
20		Secure site and erect singage	5 days	Wed 23/06/21	Tue 29/06/21
21		Clear and Grub site	3 days	Wed 30/06/21	Fri 2/07/21
22		Site investigation	3 days	Wed 30/06/2	Fri 2/07/21



Project: Project1
Date: Sun 9/05/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

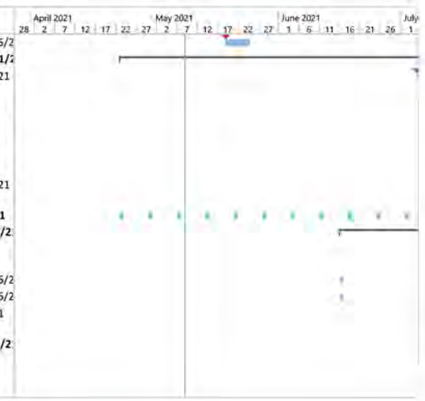
ID	Task Mode	Task Name	Duration	Start	Finish
23		Temporary facilities installation	2 days	Mon 5/07/21	Tue 6/07/21
24		Removal of trees	1 day	Mon 5/07/21	Mon 5/07/21
25		Prestart meeting	191 days	Thu 8/04/21	Thu 30/12/2
217		Toolbox meeting	191 days	Thu 8/04/21	Thu 30/12/2
257		**Mobilisation**	**13 days**	**Mon 5/07/21**	**Wed 21/07/2**
258		Mobilise to site	3 days	Mon 5/07/21	Wed 7/07/21
259		**Survey**	**10 days**	**Thu 8/07/21**	**Wed 21/07/2**
260		Benchmarking	3 days	Thu 8/07/21	Mon 12/07/2
261		Pickup underground services	3 days	Thu 8/07/21	Mon 12/07/21
262		Setout lay down area	1 day	Tue 13/07/21	Tue 13/07/21
263		Stake levels	3 days	Tue 13/07/21	Thu 15/07/21
264		Site set out	4 days	Fri 16/07/21	Wed 21/07/2
265		**Induct trades**	**7 days**	**Fri 14/05/21**	**Mon 24/05/2**
266		Electricians	2 days	Fri 14/05/21	Mon 17/05/2
267		Labourers	2 days	Fri 14/05/21	Mon 17/05/2
268		Operators	4 days	Fri 14/05/21	Wed 19/05/2
269		Plumbers	3 days	Fri 14/05/21	Tue 18/05/21
270		Carpenters	3 days	Fri 14/05/21	Tue 18/05/21



Project: Project1
Date: Sun 9/05/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

ID	Task Mode	Task Name	Duration	Start	Finish
271		Landscapers	4 days	Wed 19/05/2	Mon 24/05/2
272		**Site Establishment**	**187 days**	**Fri 23/04/21**	**Mon 10/01/2**
273		Fencing	4 days	Mon 5/07/21	Thu 8/07/21
274		Install temporary power systems	3 days	Fri 9/07/21	Tue 13/07/21
275		Set-up the site office	4 days	Wed 7/07/21	Mon 12/07/21
276		Set-up site facilities	4 days	Wed 7/07/21	Mon 12/07/21
277		Install water services	2 days	Wed 7/07/21	Thu 8/07/21
278		**Progress meeting**	**121 days**	**Fri 23/04/21**	**Fri 8/10/21**
304		**Mobilise**	**22 days**	**Wed 16/06/2**	**Thu 15/07/2**
305		General Materials	2 days	Wed 14/07/21	Thu 15/07/21
306		Franna cranes	1 day	Wed 16/06/2	Wed 16/06/2
307		Bobcat	1 day	Wed 16/06/2	Wed 16/06/2
308		Tools and equipment	1 day	Fri 9/07/21	Fri 9/07/21
309		**Construction**	**30.5 days**	**Thu 8/07/21**	**Thu 19/08/2**
310		Locate and protect existing services	3 days	Thu 8/07/21	Mon 12/07/21



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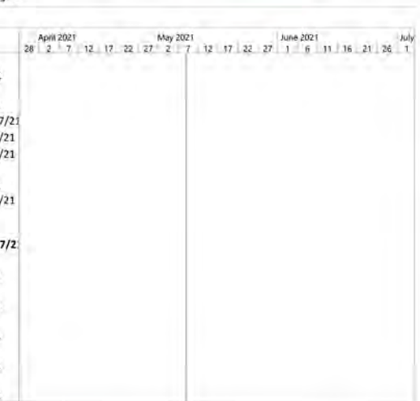
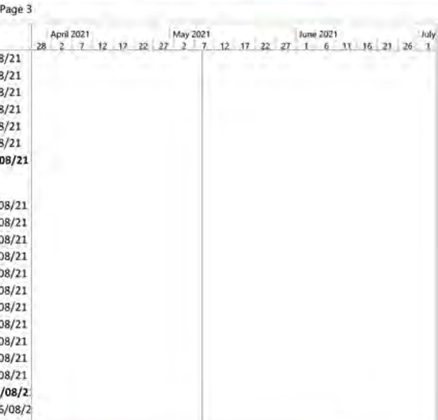
ID	Task Mode	Task Name	Duration	Start	Finish
311		**Clearing and Earthworks**	**7 days**	**Mon 12/07/21**	**Tue 20/07/21**
312		Clearing the site	2 days	Mon 12/07/21	Tue 13/07/21
313		Cut & fill	5 days	Wed 14/07/2	Tue 20/07/21
314		Drainage	3 days	Wed 14/07/2	Fri 16/07/21
315		Compaction	3 days	Wed 14/07/2	Fri 16/07/21
316		General Excavation	0 days	Tue 13/07/21	Tue 13/07/21
317		Excavation for utility trenches	3 days	Wed 14/07/21	Fri 16/07/21
318		**Install Services**	**4 days**	**Mon 19/07/2**	**Thu 22/07/2**
319		Installing utilities	3 days	Mon 19/07/21	Wed 21/07/21
320		Installing waste lines	2 days	Mon 19/07/21	Tue 20/07/21
321		Rough-in plumbing	2 days	Mon 19/07/21	Tue 20/07/21
322		Rough-in electrical	3 days	Mon 19/07/21	Wed 21/07/21
323		Rough in HVAC	4 days	Mon 19/07/21	Thu 22/07/21



Project: Project1
Date: Sun 9/05/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

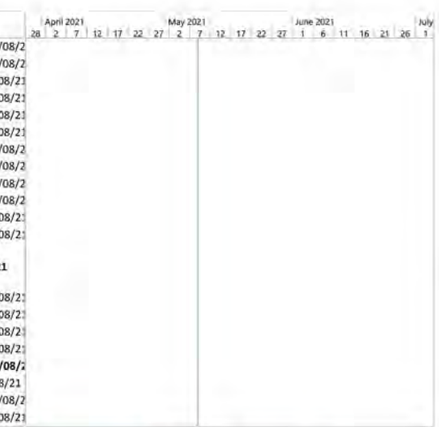
ID	Task Mode	Task Name	Duration	Start	Finish
338		B6	0.5 days	Fri 6/08/21	Fri 6/08/21
339		B8	0.5 days	Fri 6/08/21	Fri 6/08/21
340		B9	0.5 days	Fri 6/08/21	Fri 6/08/21
341		B10	0.5 days	Fri 6/08/21	Fri 6/08/21
342		B12	0.5 days	Fri 6/08/21	Fri 6/08/21
343		B14	0.5 days	Fri 6/08/21	Fri 6/08/21
344		**Assemble the modules on-site**	**5 days**	**Fri 6/08/21**	**Fri 13/08/21**
345		B1	5 days	Fri 6/08/21	Fri 13/08/21
346		B2	5 days	Fri 6/08/21	Fri 13/08/21
347		B3	5 days	Fri 6/08/21	Fri 13/08/21
348		B4	5 days	Fri 6/08/21	Fri 13/08/21
349		B5	5 days	Fri 6/08/21	Fri 13/08/21
350		B6	5 days	Fri 6/08/21	Fri 13/08/21
351		B8	5 days	Fri 6/08/21	Fri 13/08/21
352		B9	5 days	Fri 6/08/21	Fri 13/08/21
353		B10	5 days	Fri 6/08/21	Fri 13/08/21
354		B12	5 days	Fri 6/08/21	Fri 13/08/21
355		B14	5 days	Fri 6/08/21	Fri 13/08/21
356		**Install modules**	**4 days**	**Fri 13/08/21**	**Thu 19/08/2**
357		B1	1 day	Fri 13/08/21	Mon 16/08/2
358		B2	1 day	Fri 13/08/21	Mon 16/08/2



Project: Project1
Date: Sun 9/05/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

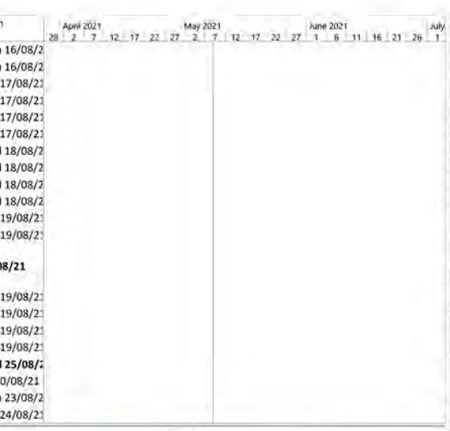
ID	Task Mode	Task Name	Duration	Start	Finish
359		B3	1 day	Fri 13/08/21	Mon 16/08/2
360		B4	1 day	Fri 13/08/21	Mon 16/08/2
361		B5	1 day	Mon 16/08/2	Tue 17/08/21
362		B6	1 day	Mon 16/08/2	Tue 17/08/21
363		B7	1 day	Mon 16/08/2	Tue 17/08/21
364		B8	1 day	Mon 16/08/2	Tue 17/08/21
365		B9	1 day	Tue 17/08/2	Wed 18/08/2
366		B10	1 day	Tue 17/08/2	Wed 18/08/2
367		B11	1 day	Tue 17/08/2	Wed 18/08/2
368		B12	1 day	Tue 17/08/2	Wed 18/08/2
369		B13	1 day	Wed 18/08/2	Thu 19/08/21
370		B14	1 day	Wed 18/08/2	Thu 19/08/21
371		**Deliver the modules of staircase**	**0.5 days**	**Thu 19/08/21**	**Thu 19/08/21**
372		Lvl 1	0.5 days	Thu 19/08/2	Thu 19/08/21
373		Lvl 2	0.5 days	Thu 19/08/2	Thu 19/08/21
374		Lvl 3	0.5 days	Thu 19/08/2	Thu 19/08/21
375		Lvl 4	0.5 days	Thu 19/08/2	Thu 19/08/21
376		**Install the stairs**	**4 days**	**Fri 20/08/21**	**Wed 25/08/2**
377		Lvl 1	1 day	Fri 20/08/21	Fri 20/08/21
378		Lvl 2	1 day	Mon 23/08/2	Mon 23/08/2
379		Lvl 3	1 day	Tue 24/08/21	Tue 24/08/21



Project: Project1
Date: Sun 9/05/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

ID	Task Mode	Task Name	Duration	Start	Finish
359		B3	1 day	Fri 13/08/21	Mon 16/08/2
360		B4	1 day	Fri 13/08/21	Mon 16/08/2
361		B5	1 day	Mon 16/08/2	Tue 17/08/21
362		B6	1 day	Mon 16/08/2	Tue 17/08/21
363		B7	1 day	Mon 16/08/2	Tue 17/08/21
364		B8	1 day	Mon 16/08/2	Tue 17/08/21
365		B9	1 day	Tue 17/08/2	Wed 18/08/2
366		B10	1 day	Tue 17/08/2	Wed 18/08/2
367		B11	1 day	Tue 17/08/2	Wed 18/08/2
368		B12	1 day	Tue 17/08/2	Wed 18/08/2
369		B13	1 day	Wed 18/08/2	Thu 19/08/21
370		B14	1 day	Wed 18/08/2	Thu 19/08/21
371		**Deliver the modules of staircase**	**0.5 days**	**Thu 19/08/21**	**Thu 19/08/21**
372		Lvl 1	0.5 days	Thu 19/08/2	Thu 19/08/21
373		Lvl 2	0.5 days	Thu 19/08/2	Thu 19/08/21
374		Lvl 3	0.5 days	Thu 19/08/2	Thu 19/08/21
375		Lvl 4	0.5 days	Thu 19/08/2	Thu 19/08/21
376		**Install the stairs**	**4 days**	**Fri 20/08/21**	**Wed 25/08/2**
377		Lvl 1	1 day	Fri 20/08/21	Fri 20/08/21
378		Lvl 2	1 day	Mon 23/08/2	Mon 23/08/2
379		Lvl 3	1 day	Tue 24/08/21	Tue 24/08/21



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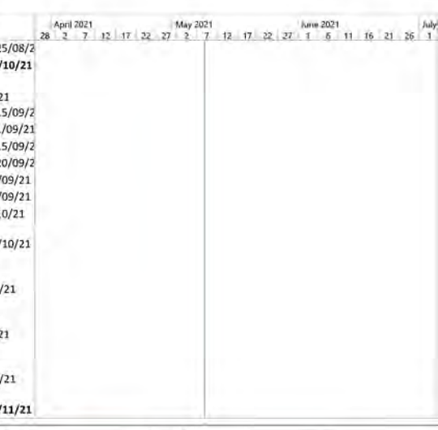
Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

ID	Task Mode	Task Name	Duration	Start	Finish
380		Lvl 4	1 day	Wed 25/08/2	Wed 25/08/2
381		**Building Finishes**	**42 days**	**Thu 26/08/2**	**Fri 22/10/21**
382		Interior finishes	30 days	Thu 26/08/21	Wed 6/10/21
383		Plumbing	15 days	Thu 26/08/2	Wed 15/09/2
384		Electrical	5 days	Thu 26/08/2	Wed 1/09/21
385		Roofing	15 days	Thu 26/08/2	Wed 15/09/2
386		Install AC	3 days	Thu 16/09/2	Mon 20/09/2
387		Hang doors	7 days	Thu 16/09/2	Fri 24/09/21
388		Hang windows	7 days	Thu 16/09/2	Fri 24/09/21
389		Install window frames	10 days	Mon 27/09/21	Fri 8/10/21
390		Cladding finishes	10 days	Mon 11/10/21	Fri 22/10/21
391		Install triangular arches	4 days	Thu 26/08/21	Tue 31/08/21
392		Install open area wood frames	10 days	Thu 26/08/21	Wed 8/09/21
393		Landscaping and ground works	15 days	Thu 26/08/21	Wed 15/09/21
394		**Commissioning**	**12 days**	**Mon 25/10/2**	**Tue 9/11/21**



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See appendix for more

Table 03 - Wind Pressure Summary

However, the critical load combination was 0.3G+0.5Q which does not include the force applied by the wind, leaving the forces/loads acting on the first level to be as following:

Level	Imposed Load	Dead Load	SDL
1st level floor	9.45kPa	4.1kPa.	5kPa.

Table 04 - Loading on first level floor

4.2 Design Calculations

Following will be the order of design calculations:

Appendix C: Wind Load Calculations
Appendix D: Load Calculation on each floor
Appendix E: CLT Floor Design Calculations
Appendix F: Glulam Beams Design Calculations
Appendix G: Glulam Column Calculations
Appendix H: Internal CLT Wall Design Calculations
Appendix I: Design for Connections

Following will be the Summary of Design sections determined after the Calculations:

- **CLT floor- CL5/175**
- **Glulam Beam- G17 165mmx260mm**
- **Glulam Column- G17 165mmx325mm**
- **External SIP wall- 165mm thick SIPs**
- **Internal CLT wall- CL3/85**

4.2 Connections

Purpose of using connections is to provide strength and stability to the structural elements along with stiffness and ductility. For the elements to bear the applied load and maintain its integrity, the connections should be strong enough to hold them in place.

Connections are used along with fasteners (nut and bolt, welding, etc.) to adjoin two panels together or two members together. They are available in all sizes and types and it is up to the Engineer to design the correct connection to each elemental connection to bring up an efficient design.

Types of Connections used in the Accommodation Building.

1) CLT panel to panel on the floors

For this purpose, the most suitable connection type is Half-Lap joint connection where a half-lapped joint is milled at a plant. Fastener type used is self-tapping screws.

This connection supports normal and transverse loads but do not support moment resistance (Augustine 2008). It does a quick job at connecting CLT panels on site or off site but with a risk of splitting of the cross section due to concentration of tension perpendicular to grain stresses in the notched area.

Figure 8 - Half-Lapped joint close up

2) CLT floor to CLT wall

As metal brackets are used along with screws or nails to connect walls in transverse direction, it is the best option for wall to floor connection of CLT panels. It has high strength, but fire resistance quality is very poor.*Figure 9- Metal Brackets connection system*

3) SIP panel to panel on external walls

Spline joint connections are used as they are inserted into matching grooves or plows, along the edges of two boards (SIPs). It provides mechanical strength and offers mating face-grain-toface-grain contact, which gives glue something to hold onto (Woodcraft 2009).

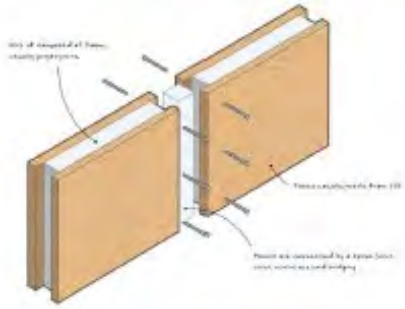


Figure 10- Spline Joint Connection

4) Glulam Column to Glulam Beam

A **fin plate connection** consists of a length of **plate** welded in the workshop to the supporting member, to which the supported beam web is bolted on site which is ideal for the connection between the Glulam column and beam. Even though it is relatively inexpensive, often far away from a lateral and torsional restraint.

Figure 11- Fin Plate Connection

See appendix for more

Ref:	ITEM	UNIT	ADD.	DDT.	QTY	RATE($/UNIT)	COST	CUMULATIVE	NOTES
A	**GENERAL ITEMS**								
A100	Contractual requirement								
A120	INSURANCE								
	contract works insurance								
	project type - residential (TCV greater than $1,000,000 - Apartments)								
							$		
	Preliminary estimation:						6,774,437.52		
							$	$	
	Rate x TCV	%	0.09		0.09		6,096.99	6,096.99	Rawlinsons publishing 2021
							$		
	Deductable (excess)	$		13,000	13,000.00		(13,000.00)	-$6,903.01	Rawlinsons publishing 2021
		%	10		10.00		$ (690.30)	-$7,593.31	Rawlinsons publishing 2021
	Stamp duty								
		%	5.3		5.30		$ (365.86)	-$7,959.17	Rawlinsons publishing 2021
	Terrorism levy								
	State: Freemantle (Western Australia)							-$7,959.17	
	Current fire service levies and stamp duty charges to be added to any contract works premium							-$7,959.17	
							$		
	Fire service levy	%	0		-		-	-$7,959.17	
							$		
	Stamp duty (excl: GST)	%	10		10.00		677,443.75	$669,484.58	Rawlinsons publishing 2021
	Development/Planning fee							$669,484.58	
								$669,484.58	
								$669,484.58	
								$669,484.58	
A300	Method - Related Charges							$669,484.58	
A310	Accommodation and buildings							$669,484.58	
								$669,484.58	
								$669,484.58	
A311	office running cost - time related charges								
						$	$		
	one 6m x 3m office space	week	29		29.00	65.00	1,885.00	$671,369.58	Rawlinsons publishing 2021
						$	$		
	office equipment	unit/month	7		7.00	20.00	140.00	$671,509.58	Rawlinsons publishing 2021
						$	$		
	Delivery to site and return (up to 6m long)	item	1		1.00	225.00	225.00	$671,734.58	Rawlinsons publishing 2021
						$	$		
	Toilet - one 20-man unit	week	30		30.00	72.50	2,175.00	$673,909.58	Rawlinsons publishing 2021
						$	$		
	Delivery to site and return (up to 6m long)	item	1		1.00	225.00	225.00	$674,134.58	Rawlinsons publishing 2021
								$674,134.58	
						$	$		
A315	Lunch room - one 6m x 3m	week	29		29.00	90.00	2,610.00	$676,744.58	Rawlinsons publishing 2021
						$	$		
	cold water supply, sink, refrigerator & bins	unit/month	7		7.00	50.00	350.00	$677,094.58	Rawlinsons publishing 2021
						$	$		
	Delivery to site and return (up to 6m long)	item	1		1.00	225.00	225.00	$677,319.58	Rawlinsons publishing 2021
								$677,319.58	
						$	$		
A314	storage shed - one 4.8m x 2.4m	week	29		29.00	37.50	1,087.50	$678,407.08	Rawlinsons publishing 2021
						$	$		
	Delivery to site and return (up to 6m long)	item	1		1.00	225.00	225.00	$678,632.08	Rawlinsons publishing 2021
								$678,632.08	
A320	Services							$678,632.08	
A324	Hoardings							$678,632.08	
	Hire rate for foregoing hoardings/fences, including erection and dismantling, six-month min period							$678,632.08	
	Perimeter of the site = 2 x (22.19m + 63.05m) = 170.48m	m	170.48					$678,632.08	
		month	7					$678,632.08	
						$	$		
	Hire rate	m/month			24.35	7.50	182.63	$678,814.71	Rawlinsons publishing 2021
								$678,814.71	
A330	Plants							$678,814.71	
	2o tonne mobile crane (casual use)							$678,814.71	
	9 hrs/day, 5 days/week, 11 weeks	hrs	495		495.00	$ 160.00	$ 79,200.00	$758,014.71	Rawlinsons publishing 2021
	(Rate include operator and fuel cost)							$758,014.71	
								$758,014.71	
B	**GROUND INVESTIGATION**							$758,014.71	
B341	rotary drilled boreholes, depth with core recovery - in holes of maximum depth not exceeding 5m							$758,014.71	
B400	samples							$758,014.71	
B422	from bore holes - disturbed (after site clearing)							$758,014.71	
	(rate includes 3 boreholes to 1.5m and technician cost	nr	3		3.00	$ 490.00	$ 1,470.00	$759,484.71	Smolders Geotechnical
								$759,484.71	
D	**DEMOLITION AND SITE CLEARANCE**							$759,484.71	
D110	general site clearance							$759,484.71	
	Project area = A							$759,484.71	
	A = 22.19m x 63.05m = 1400 m2 = 0.14 ha							$759,484.71	
	D1 general clearance shall include the demolition and removal of all articles, objects and obstruction which are expressly required to be cleared those for which separate items are given as set out in this class	ha	0.14		0.14	$ 5,000	$ 700.00	$760,184.71	Rawlinsons publishing 2021
								$760,184.71	
E	**EARTHWORKS**							$760,184.71	
E211	excavation for cutting, removal of topsoil of average 150mm depth							$760,184.71	
	Site are = 22.19m x 63.05m = 1400 m2							$760,184.71	
	Area of the existing building = 887 m2							$760,184.71	
	Excavation area = 1400m2 - 887m2 = 513m2	m2	513		513.00	$ 2.27	$ 1,164.51	$761,349.22	Rawlinsons publishing 2021
								$761,349.22	
E324	Excavation for foundation, material other than topsoil, rock or artificial hard material maximum depth not exceeding 2m							$761,349.22	
	Average depth of cut = 1.5m							$761,349.22	
	Excavation area = 513m2							$761,349.22	
	Total excavation volume = 770 m3							$761,349.22	
	D1 general clearance shall include the demolition and removal of all articles, objects and obstruction which are expressly required to be cleared those for which separate items are given as set out in this class							$761,349.22	
	This includes cost of disposal of excavated material other than top soil, rock or artificial hard material, assuming disposal area located in a distance within 10km								
E532		cum	770		770.00	$ 20.00	$ 15,400.00	$776,749.22	Rawlinsons publishing 2021
								$776,749.22	
E810	Turfing the area based on the architecture requirement							$776,749.22	
	Site area = 22.19m x 63.05m = 1400m2							$776,749.22	
	Building area = 891 m2							$776,749.22	
	Area to be turf = 510 m2	m2	510		510.00	$ 7.00	$ 3,570.00	$780,319.22	Rawlinsons publishing 2021
								$780,319.22	
I	**PIPEWORK -PIPES**							$780,319.22	
	Assuming all the required underground services electricity, water, gas, communication and drainage and sewers are located outside site's south boundary							$780,319.22	
	All the pipes connections shall							$780,319.22	
								$780,319.22	
	Length of the service pipes for each module from the main lines,							$780,319.22	
	South right corner first modules = 6.9m							$780,319.22	
	second modules from south right corner to north = 3.13m							$780,319.22	
	Third modules from south right corner to north = 7.45m							$780,319.22	
	Fourth modules west, left corner = 16.41m							$780,319.22	
								$780,319.22	
	Total height of the building = 12.6m							$780,319.22	
	Length of the main line = 57.8m							$780,319.22	
	Total length of the pipe = 57.8+4(6.9+3.13+7.45+16.41) +12.6 x 4 = 243.76m							$780,319.22	
								$780,319.22	
	water							$780,319.22	
I512	32mm (PN/class 9) PVC pipes in trenches not exceeding 1.5m	m	243.76		243.76	$ 18.75	$ 4,570.50	$784,889.72	Rawlinsons publishing 2021
								$784,889.72	
	GASS							$784,889.72	
I712	40mm Polyethylene pipe in trenches not exceeding 1.5m	m	243.76		243.76	$ 23.00	$ 5,606.48	$790,496.20	Rawlinsons publishing 2021
								$790,496.20	
	Electricity & telecommunication							$790,496.20	
I712	Flexible Coregulates HD UPVC pipes in trenches not exceeding 1.5m	m	487.52		487.55	$ 9.60	$ 4,680.50	$795,176.70	Rawlinsons publishing 2021
								$795,176.70	
	Drainage pipes							$795,176.70	
I712	150mm SN 4 PVC pipes in trenches not exceeding 1.5m	m	243.76		243.76	$ 38.00	$ 9,262.88	$804,439.58	Rawlinsons publishing 2021
								$804,439.58	
								$804,439.58	
	Trench excavation							$804,439.58	
E223	300mm wide/1000mm depth trench excavation in sandy soil by machines (backhoe, small bucket)	m	91.69		91.69	$ 9.50	$ 871.06	$805,310.63	Rawlinsons publishing 2021
	Backfilling trenches with clean sand							$805,310.63	
	Length of Excavation = 91.69m							$805,310.63	
	Backfilling volume = 91.69m x 0.3m x 1m = 27.5 m3	cum	27.5		27.50	$ 16.00	$ 440.00	$805,750.63	Rawlinsons publishing 2021
								$805,750.63	
J	**PIPEWORK - FITTINGS AND VALVES**							$805,750.63	
	basin							$805,750.63	
J411		no	14		14.00	$ 420.00	$ 5,880.00	$811,630.63	Rawlinsons publishing 2021
	polypropylene basin (wall, hand rinse 3.5l)								
	Shower bath							$811,630.63	
J611		no	14		14.00	$ 1,470.00	$ 20,580.00	$832,210.63	Rawlinsons publishing 2021
	Porcelain enamelled steel (1540 x 750 x 2175) mm							$832,210.63	
	Toilet seat								
J411		no	14		14.00	$ 120.00	$ 1,680.00	$833,890.63	Rawlinsons publishing 2021
	Hard plastic (medium quality) - Double flap							$833,890.63	
J400	Bends, junctions other fittings (20% of cost of basin, shower and toilet and the cost of the pipes)	%	20		20.00	$ 2,010.00	$ 402.00	$834,292.63	Rawlinsons publishing 2021
								$834,292.63	
O	**TIMBER**							$834,292.63	
								$834,292.63	
	Two bed room apartments							$834,292.63	
									
	(CLT and Glu Laminated beams has been made of pine which is a softwood. Thus, pine wood attributes considered. Rates are consisting with labour cost)								
O276	Floor - CLT Panel (CL5/175mm)							$834,292.63	
	Floor area of one module = 151.7 m2							$834,292.63	
	No of floors = 5 (including roof)							$834,292.63	
	Total floor area = 151.7 m2 x 5 = 758.5m2	m2	758.5					$834,292.63	
O276	Partition wall - CLT WALL (CL3/135mm)							$834,292.63	
	wall area = 12m x 3m = 36 m2							$834,292.63	
	No of walls = 4							$834,292.63	
	Total wall area = 144 m2	m2	144					$834,292.63	
								$834,292.63	
	Total CLT panel area (unit rate includes cost of labour)	m2	902.5		902.50	$ 602.80	$ 544,027.00	$1,378,319.63	Cary Kopczynski & Company, 2020
								$1,378,319.63	
O242	Column - Glu laminated GL 17 (165 x 325) mm							$1,378,319.63	
	Column length = 2.74 m							$1,378,319.63	
	No of column = 40							$1,378,319.63	
	Total columns length = 2.74m x 40 = 109.6m	m	109.6		109.60	$ 125.00	$ 13,700.00	$1,392,019.63	Homeguide,2020
								$1,392,019.63	
O246	Beam - Glu laminated GL 17(165 x 260) mm							$1,392,019.63	
	Beam length = 15.2m							$1,392,019.63	
	No of beam = 8							$1,392,019.63	
	Total beam length = 15.2m x 8 = 121.6 m	m	121.6		121.60	$ 125.00	$ 15,200.00	$1,407,219.63	Homeguide,2020
								$1,407,219.63	
	SIP panel area (165 mm)							$1,407,219.63	
	SIP panel area of one floor = 2.74m x 39.23m = 107.5 m2							$1,407,219.63	
	No of floors = 4							$1,407,219.63	
	Total area of SIP panel = 107.5 m2 x 4 = 430 m2	m2	430		430.00	$ 253.00	$ 108,790.00	$1,516,009.63	
								$1,516,009.63	
O212	Sip panel wall frame (140 x 38) mm							$1,516,009.63	
	Length of timber frame = 194.6m							$1,516,009.63	
	No of floors = 4							$1,516,009.63	
	Total length of timber frame = 194.6m x 4 = 778.4m	m	778.4		778.40	$ 24.00	$ 18,681.60	$1,534,691.23	Rawlinsons publishing 2021
								$1,534,691.23	
	Student accommodation unit - 1							$1,534,691.23	
									
	(CLT and Glu Laminated beams has been made of pine which is a softwood. Thus, pine wood attributes considered. Rates are consisting with labour cost)								
								$1,534,691.23	
O276	Floor - CLT Panel (CL5/175mm)							$1,534,691.23	
	Floor area of one module = 104.6 m2							$1,534,691.23	
	No of floors = 5 (including roof)							$1,534,691.23	
	Total floor area = 104.6 m2 x 5 = 523m2 (including labour)	m2	523		523.00	$ 602.80	$ 315,264.40	$1,849,955.63	Cary Kopczynski & Company, 2020,
								$1,849,955.63	
O242	Column - Glu laminated GL 17 (165 x 325) mm							$1,849,955.63	
	Column length = 2.74 m							$1,849,955.63	
	No of column = 40							$1,849,955.63	
	Total columns length = 2.74m x 40 = 109.6m	m	109.6		109.60	$ 125.00	$ 13,700.00	$1,863,655.63	Homeguide,2020
								$1,863,655.63	
O246	Beam - Glu laminated GL 17(165 x 260) mm							$1,863,655.63	
	Beam length = 13.1m							$1,863,655.63	
	No of beam = 9							$1,863,655.63	
	Total beam length = 13.1m x 9 = 117.9 m	m	117.9		117.90	$ 125.00	$ 14,737.50	$1,878,393.13	Homeguide,2020
								$1,878,393.13	
	SIP panel area (165 mm)							$1,878,393.13	
	SIP panel area of one floor = 2.74m x 46.7 m = 128 m2							$1,878,393.13	
	No of floors = 3							$1,878,393.13	
	Total area of SIP panel = 128m2 x 3 = 383.9 m2	m2	384		384.00		$ 253.00	$1,878,646.13	
								$1,878,646.13	
O212	Sip panel wall frame (140 x 38) mm							$1,878,646.13	
	Length of timber frame = 150.94m							$1,878,646.13	
	No of floors = 3							$1,878,646.13	
	Total length of timber frame = 150.94m x 3 = 452.82m	m	452.82		452.82	$ 24.00	$ 10,867.68	$1,889,513.81	Rawlinsons publishing 2021
								$1,889,513.81	
	Student accommodation unit - 2							$1,889,513.81	
									
								$1,889,513.81	

	(CLT and Glu Laminated beams has been made of pine which is a softwood. Thus, pine wood attributes considered. Rates are consisting with labour cost)								
								$1,889,513.81	
O276	Floor - CLT Panel (CL5/175mm)							$1,889,513.81	
	Floor area of one module = 92.03m2							$1,889,513.81	
	No of floors = 4 (including roof)							$1,889,513.81	
	Total floor area = 92.03 m2 x 4 = 368.12m2 (Including Labour)	m2	368.12	368.12	$ 602.80	$ 221,902.74	$2,111,416.55	Cary Kopczynski & Company, 2020	
							$2,111,416.55		
O242	Column - Glu laminated GL 17 (165 x 325) mm						$2,111,416.55		
	Column length = 2.74 m						$2,111,416.55		
	No of column = 24						$2,111,416.55		
	Total columns length = 2.74m x 24 = 65.76m	m	65.76	65.76	$ 125.00	$ 8,220.00	$2,119,636.55	Homeguide,2020	
							$2,119,636.55		
O246	Beam - Glu laminated GL 17(165 x 260) mm						$2,119,636.55		
	Beam length = 11.8m						$2,119,636.55		
	No of beam = 8						$2,119,636.55		
	Total beam length = 11.8m x 8 = 94.4 m	m	94.4	94.40	$ 125.00	$ 11,800.00	$2,131,436.55	Homeguide,2020	
							$2,131,436.55		
	SIP panel area (165 mm)						$2,131,436.55		
	SIP panel area of one floor = 2.74m x 32.8 m = 90 m2						$2,131,436.55		
	No of floors = 3						$2,131,436.55		
	Total area of SIP panel = 90m2 x 3 = 270 m2	m2	270	270.00		$ 253.00	$2,131,689.55		
							$2,131,689.55		
O212	Sip panel wall frame (140 x 38) mm						$2,131,689.55		
	Length of timber frame = 125.88m						$2,131,689.55		
	No of floors = 3						$2,131,689.55		
	Total length of timber frame = 125.88m x 3 = 377.64m	m	377.64	377.64	$ 24.00	$ 9,063.36	$2,140,752.91	Rawlinsons publishing 2021	
							$2,140,752.91		
	One bed room unit for build-to-rent programme						$2,140,752.91		
							$2,140,752.91		

	(CLT and Glu Laminated beams has been made of pine which is a softwood. Thus, pine wood attributes considered. Rates are consisting with labour cost)								
								$2,140,752.91	
O276	Floor - CLT Panel (CL5/175mm)							$2,140,752.91	
	Floor area of one module = 95.2m2							$2,140,752.91	
	No of floors = 5 (including roof)							$2,140,752.91	
	Total floor area = 95.2 m2 x 5 = 476 m2 (Including Labour)	m2	476	476.00	$ 602.80	$ 286,932.80	$2,427,685.71	Cary Kopczynski & Company, 2020	
							$2,427,685.71		
O242	Column - Glu laminated GL 17 (165 x 325) mm						$2,427,685.71		
	Column length = 2.74 m						$2,427,685.71		
	No of column = 48						$2,427,685.71		
	Total columns length = 2.74m x 48 = 131.52m	m	131.52	131.52	$ 125.00	$ 16,440.00	$2,444,125.71	Homeguide,2020	
							$2,444,125.71		
O246	Beam - Glu laminated GL 17(165 x 260) mm						$2,444,125.71		
	Beam length = 19.4m						$2,444,125.71		
	No of beam = 12						$2,444,125.71		
	Total beam length = 19.4m x 12 = 232.8m	m	232.8	232.80	$ 125.00	$ 29,100.00	$2,473,225.71	Homeguide,2020	
							$2,473,225.71		
	SIP panel area (165 mm)						$2,473,225.71		
	SIP panel area of one floor = 2.74m x 51 m = 139.74 m2						$2,473,225.71		
	No of floors = 4						$2,473,225.71		
	Total area of SIP panel = 139.74m2 x 4 = 558.96 m2	m2	558.96	558.96	$ 253.00	$ 141,416.88	$2,614,642.59	Enercept SIPs, 2021	
							$2,614,642.59		
O212	Sip panel wall frame (140 x 38) mm						$2,614,642.59		
	Length of timber frame = 233.52m						$2,614,642.59		
	No of floors = 4						$2,614,642.59		
	Total length of timber frame = 233.52 x 4 = 934m	m	934	934.00	$ 24.00	$ 22,416.00	$2,637,058.59	Rawlinsons publishing 2021	
							$2,637,058.59		

	15% of total cost modules has been allocated for metal connections brackets	%	15		15.00	$ 2,637,059	$ 395,558.79	$2,637,058.59 $3,032,617.37	
W	**WATERPROOFING**							$3,032,617.37	
								$3,032,617.37	
W321	colorbond roofing trmdek sheets .42BMT	sqm						$3,032,617.37	
	Roof area of,							$3,032,617.37	
	two bed room apartments		108.4					$3,032,617.37	
	student accommodation unit -1		69.2					$3,032,617.37	
	student accommodation unit -2		53.3					$3,032,617.37	
	one bed room units		64.6					$3,032,617.37	
	total		295.5		295.50	$ 45.50	$ 13,445.25	$3,046,062.62 $3,046,062.62	Metalroofing
Z	**SIMPLE BUILDING WORKS INCIDENTAL TO CIVIL ENGINEERING WORKS**							$3,046,062.62	
								$3,046,062.62	
Z141	stairway and landing							$3,046,062.62	
	Two hardwood staircases located. Rate includes, traditional pattern 1000mm wide straight flight staircase with close treads and risers, simple balustrade on both side	m/rise	9.45		9.45	$ 1,610.00	$ 15,214.50	$3,061,277.12	Rawlinsons publishing 2021

	Element	Unit	Quantity	Unit Rate	Total	Information	References
Preliminary		sqm	2269.62	$ 247.50	$561,730.95	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
Substructure		sqm	903.5	$ 100.50	$90,801.75	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
Superstructure	External walls (SIP)	sqm	1342	$ 253.00	$339,526.00	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	Internal walls (SIP)	sqm	267	$ 253.00	$67,551.00	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	Roof	sqm	295	$ 118.75	$35,031.25	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	Staircase	m/rise	9.45	$ 44.75	$422.89	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	Wooden Columns	m	416.48	125	$52,060.00	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	Wooden Beams	m	421	125	$52,625.00	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	CLT wall	sqm	141	602.8	$84,994.80	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	CLT Floor	sqm	2269.62	602.8	$1,368,126.94	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
Fittings	Fitments	sqm	2269.62	139.75	$317,179.40	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
Service	Plumbing	sqm	2269.62	325.75	$739,328.72	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
	Electrical	sqm	2269.62	111.25	$252,495.23	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
External Services		sqm	2269.62	10	$22,696.20	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
Contingency		sqm	2269.62	55.5	$125,963.91	13.2.2.2 Apartments Max.3 Storeys Medium Std. (Rowlinsons 2021)	Architectural drawings
				Total	**$4,110,534.02**		

Total Material and Labour Cost		$4,110,534.02
Overheads	10%	$411,053.40
Markup	10%	$411,053.40
Sub Total		$4,932,640.82
GST	10%	$493,264.08
Total Project Cost		$5,425,904.90

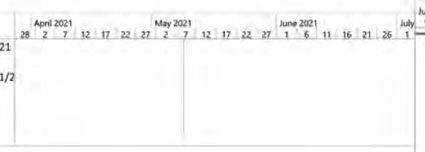
BELOW IS APPENDIX

ID	Task Mode	Task Name	Duration	Start	Finish
395		Inspections	7 days	Mon 25/10/2	Tue 2/11/21
396		Snag list	5 days	Wed 3/11/21	Tue 9/11/21
397		**Final inspection**	**38 days**	**Wed 10/11/2**	**Fri 31/12/21**
398		Perform architect's inspection	1 day	Wed 10/11/21	Wed 10/11/21
399		Complete Punch list items from all inspections	12 days	Thu 11/11/21	Fri 26/11/21
400		Obtain certificate	3 days	Mon 29/11/21	Wed 1/12/21
401		Issue final completion document	3 days	Thu 2/12/21	Mon 6/12/21
402		Complete final inspection for certificate of occupancy	3 days	Tue 7/12/21	Thu 9/12/21
403		Cleanup for occupancy	3 days	Fri 10/12/21	Tue 14/12/21
404		Perform final workthrough inspection	5 days	Wed 15/12/21	Tue 21/12/21

Project: Project1
Date: Sun 9/05/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Critical | Critical Split | Progress | Manual Progress

ID	Task Mode	Task Name	Duration	Start	Finish
405		Complete punch list items	8 days	Wed 22/12/21	Fri 31/12/21
406		**Final Clean-up**	6 days	Mon 3/01/22	Mon 10/01/2
407		**Issue final request for payment**	1 day	Mon 3/01/22	Mon 3/01/22
408		**Practical completion**	0 days	Mon 10/01/22	Mon 10/01/22



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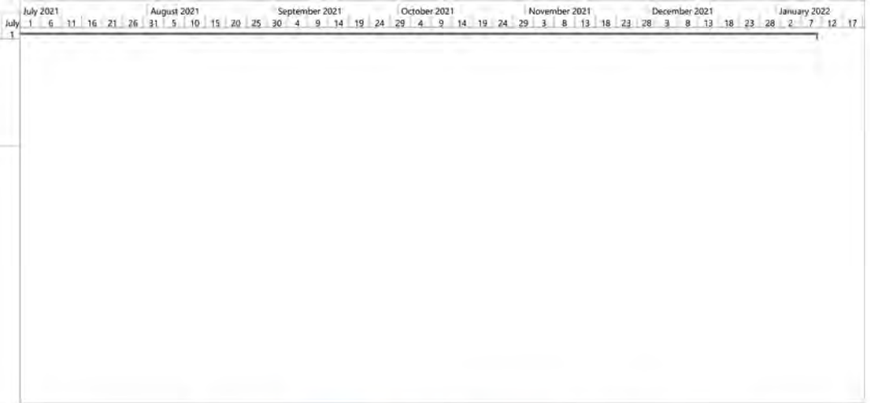

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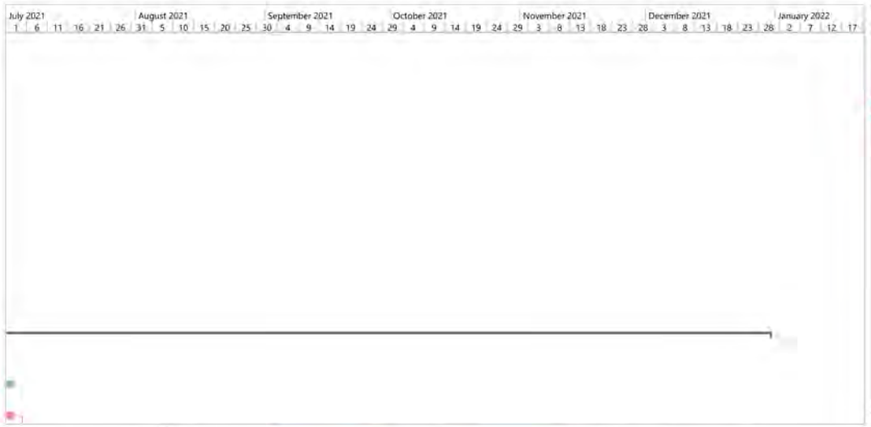

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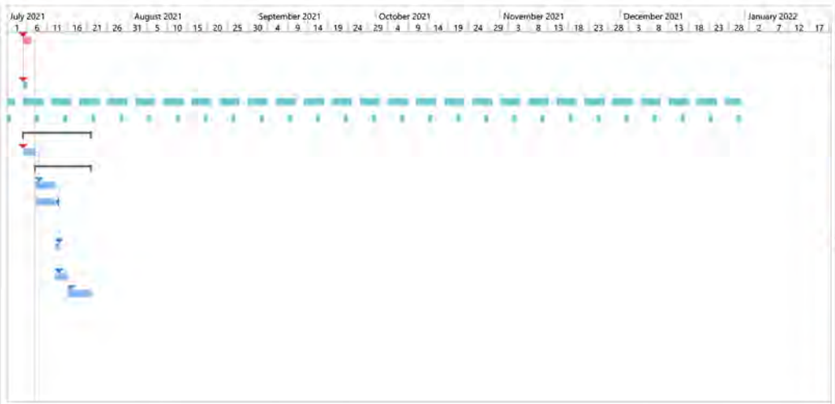

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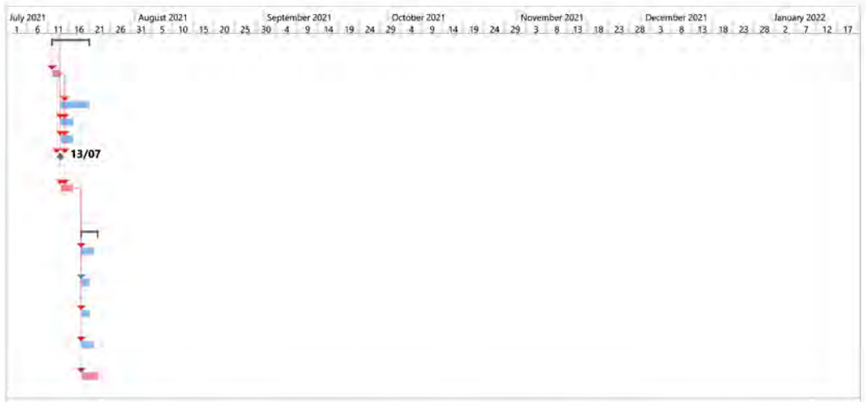

Project: Project1
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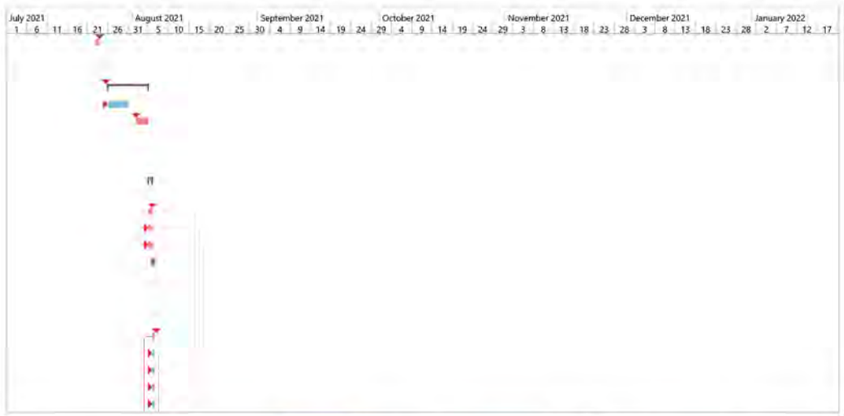

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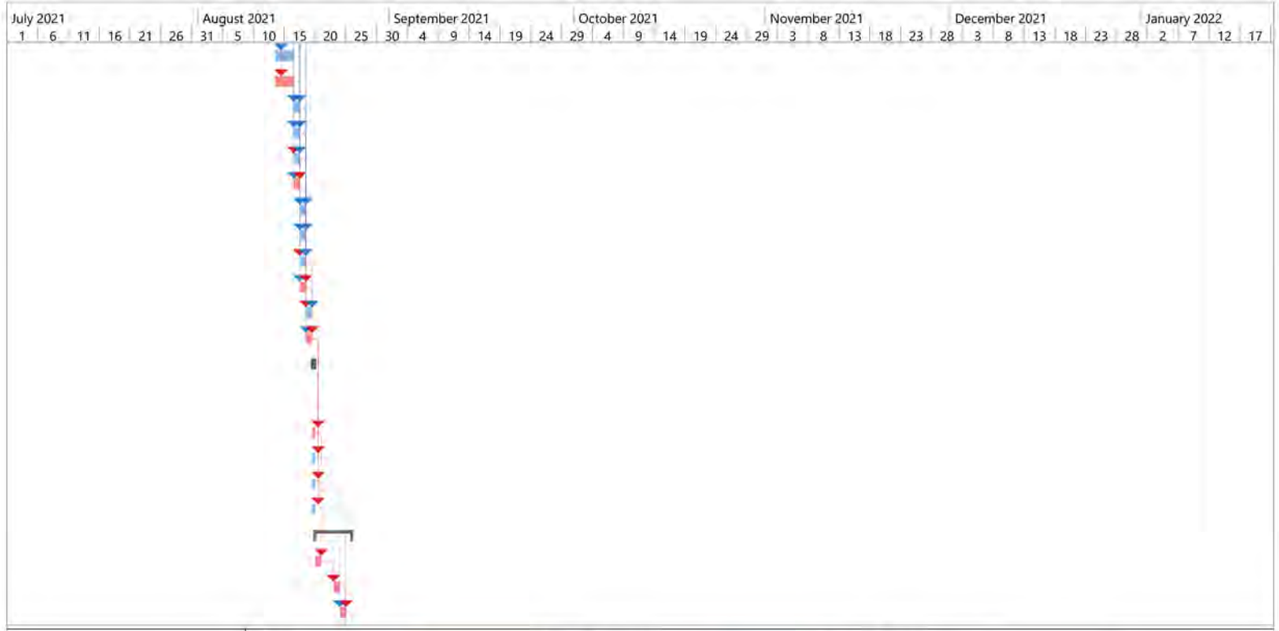

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Task	Inactive Summary	External Tasks	
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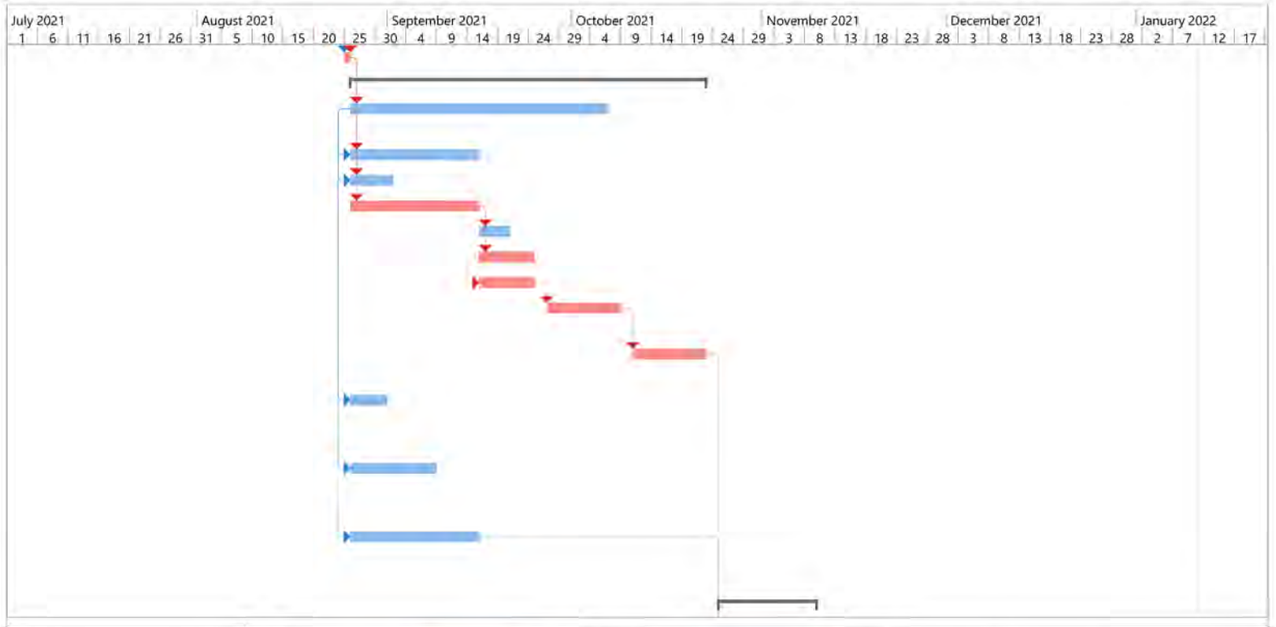

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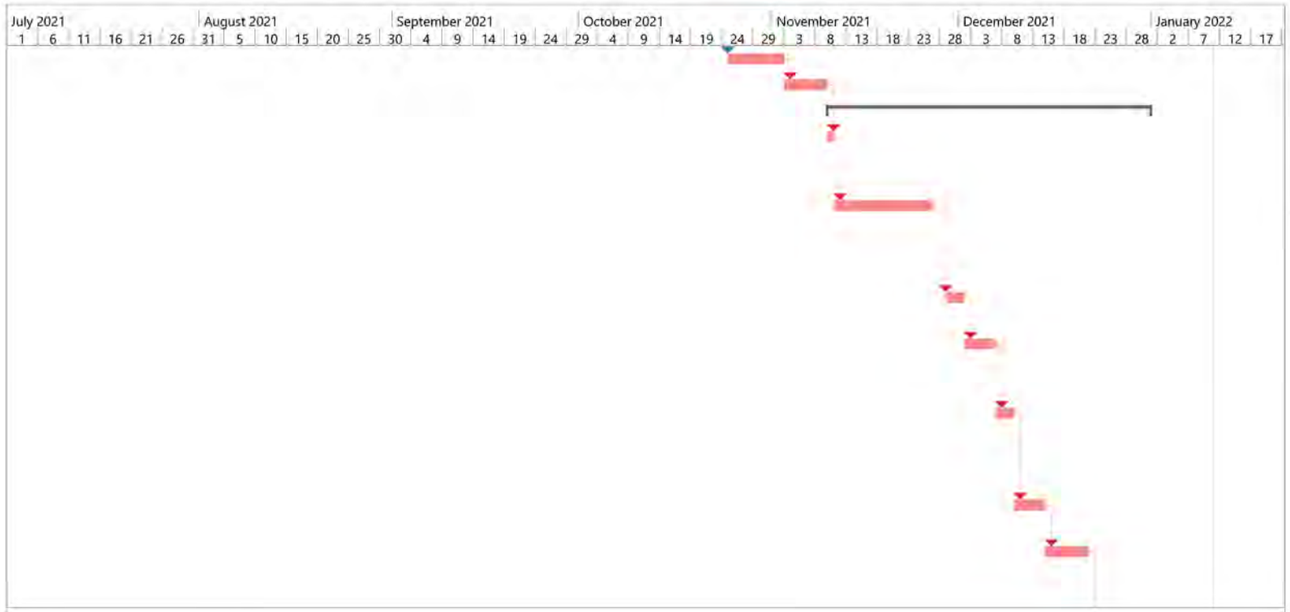

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Design For Connections

Connections for Glulam beams and Glulam columns

A bolted fin-plate connection is used at beam/Column joints.

Section: 165 x 475 mm

Assume: M12 bolts

Bolted Connection type: Type 1 - Shear in the bolt.

Capacity of the connection:

AS1720.1 Cl. 4.4.3.2 $N_{d,j} = \phi k_1 k_{16} k_{17} n Q_{sk}$

AS1720.1 Table 2.2 $\phi = 0.8$

AS1720.1 Table 2.3 $k_1 = 0.57$

AS1720.1 Cl. 4.4.3.2 $k_{16} = 1.0$

AS1720.1 Table 4.12 $k_{17} = 1.0$ (Assume: seasoned timber)

$n = 2$

Q_{sk} => Assumption: It is a two member configuration and the thickness of the plate is neglected

$\therefore Q_{sk1} = Q_{k1}$

Dimensions of the fin plate

The recommended finplate size is 160x10mm ("Structural Design of steel Fin Plate Connection - Structville" 2021)

$b_{eff} = 165mm$

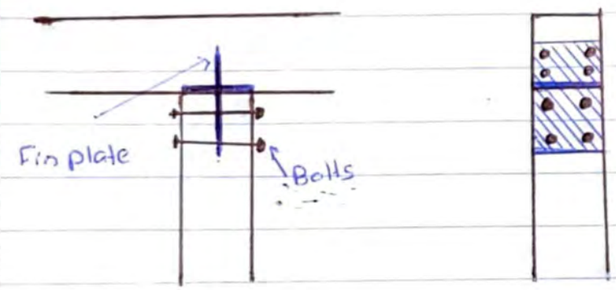
Group ID2

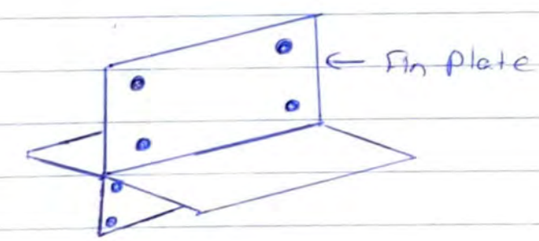
AS1720.1 Table 4.9(c) Q_{k1}, when $b_{eff} = 165$

$Q_{k1} = 14kN$

$N_{d,j} = 0.8 \times 0.57 \times 1 \times 1 \times 2 \times 14$ = 12.768 kN

$N_{d,j} > N^*$ Ok





Spacing

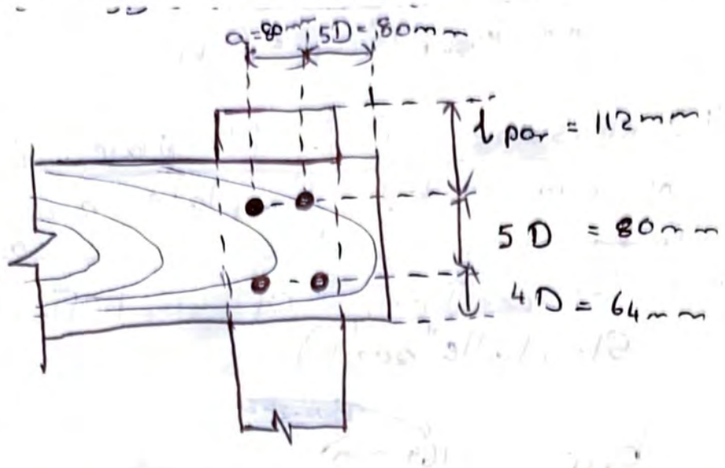
From the Edge => 4D = 4x16 = 16mm

Between bolts => 5D = 5x16 = 80mm

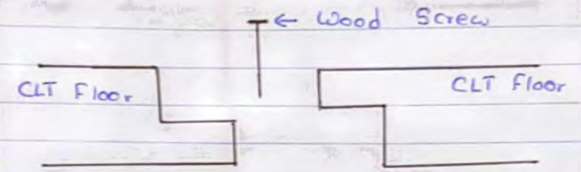
$l_{par} = 7D = 7 \times 16$ = 112mm

$\frac{b}{D} = \frac{165}{16}$ = 10.3125mm

AS1720.1 Cl 4.4.4.3 $\therefore a = 5D = 80mm$



Connection of CLT floor Panels



A Half-lap joint connection is to be used for this process.

A wood screw is used to strengthen the panels across the grain. The screw spacing at the joint shall be specified to resist the shear flow between the panels. Partially threaded screws are reccommended to be used to pull the panels tight together during the assembly.

x Lam design Guide

Assume :- M8 bolts are used (Thread type - Metric)

The details of the lapped joint connection as follows;

CLT Details :- 3-Ply S-P-F

Dimensions;

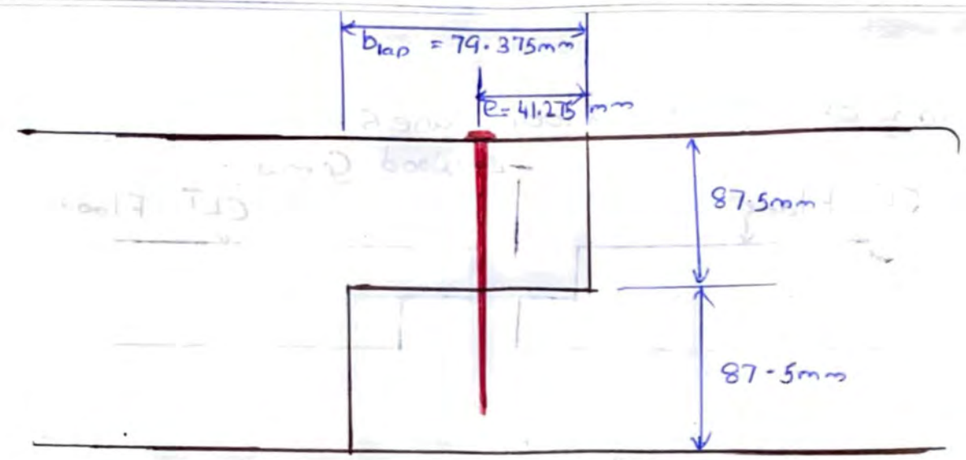
a_L = 76.2 mm

e = 41.275 mm

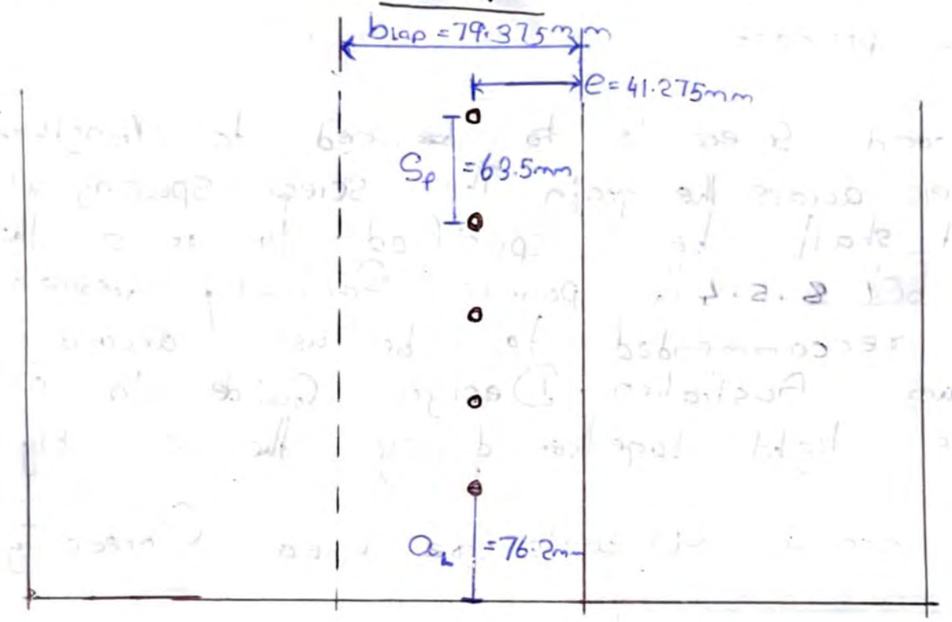
b_{lap} = 79.375 mm

S_p = 63.5mm

My TiCon Timber Connectors design Guide.

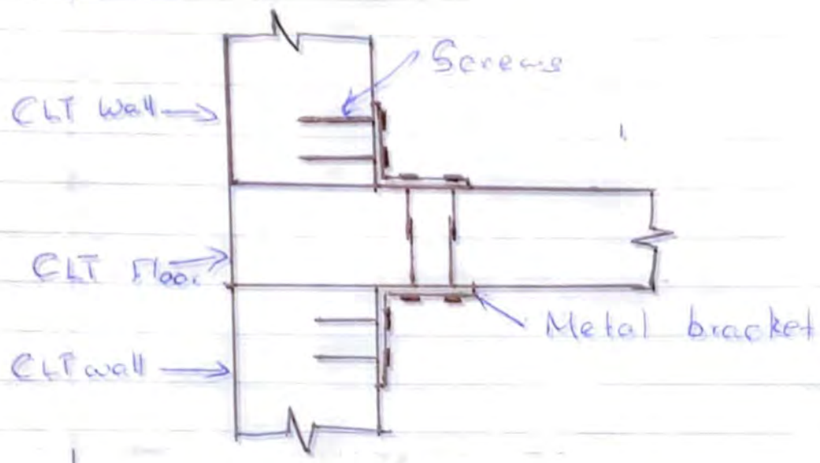


Side View



Connection of CLT floor with CLT wall

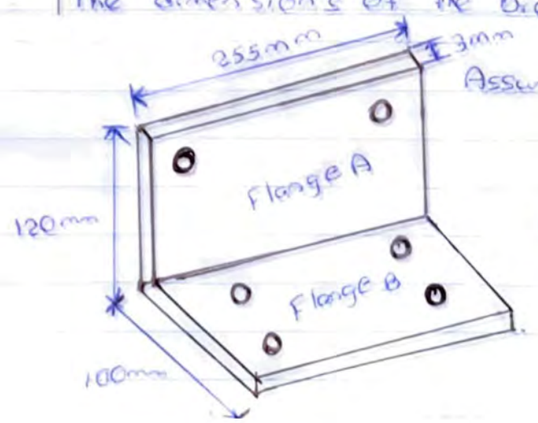
Metal bracket screw connection system is to be used to connect the CLT floor with CLT wall. The wall is connected to the floor with metal brackets screwed to them.



It is considered to be use ABR255 hold down brackets to fix CLT floor panel with CLT wall. It is particularly resistant to shear loads in accordance to its optimized geometry. The bracket is made out of mild steel.

C-CLT-AUN19 Design Guide

The dimensions of the bracket as follows:

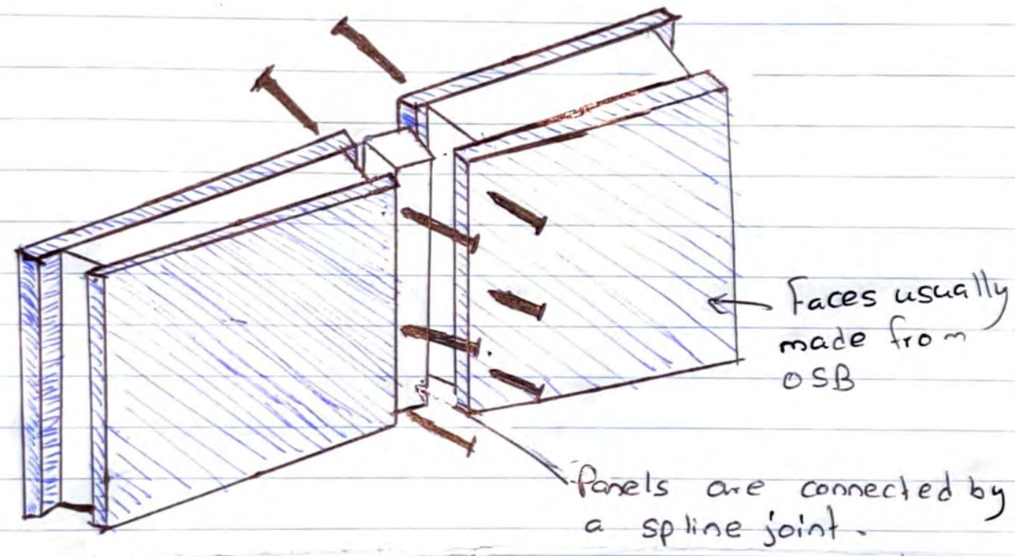


Assume: The diameter of holes = 14mm

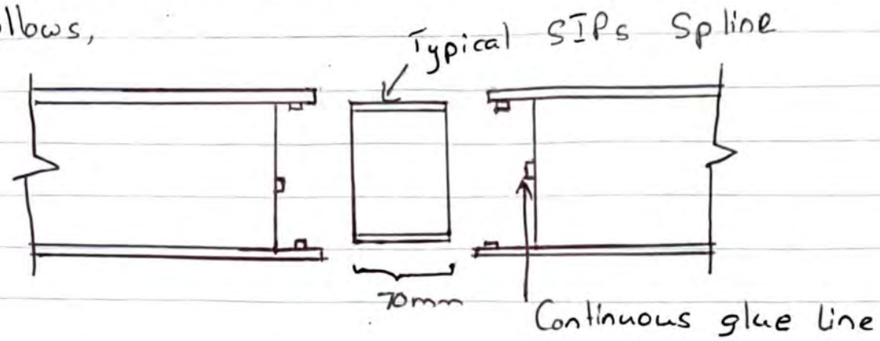
Quantity of holes:
Flange A = 2
Flange B = 4

Connection between SIP Elements

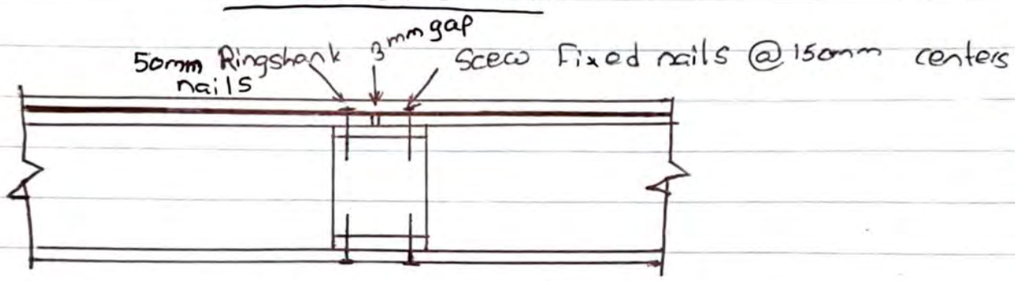
The spline joint method is used to join the SIP panels together in this project. This is a full-length spline that joins the panels together. ("Structural Design of Steel Fin Plate Connection - Structville" 2021). The connections and joints between SIP elements shall be adequately connected to transfer all forces acting parallel and perpendicular to the SIP surface.



According to ~~Sips~~ SIPs Industries design Guide line, the dimensions as follows,



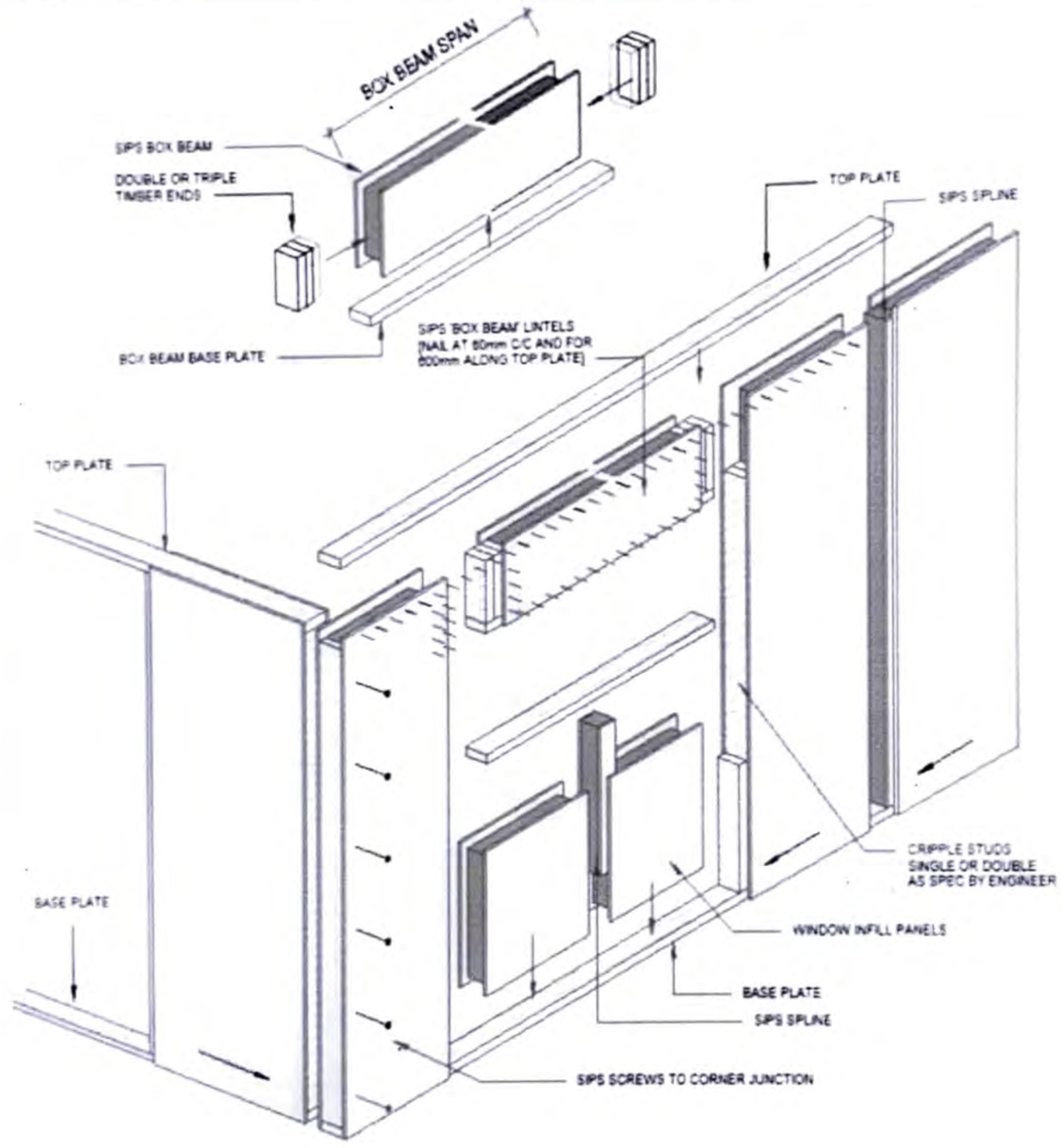
Pre assembled wall



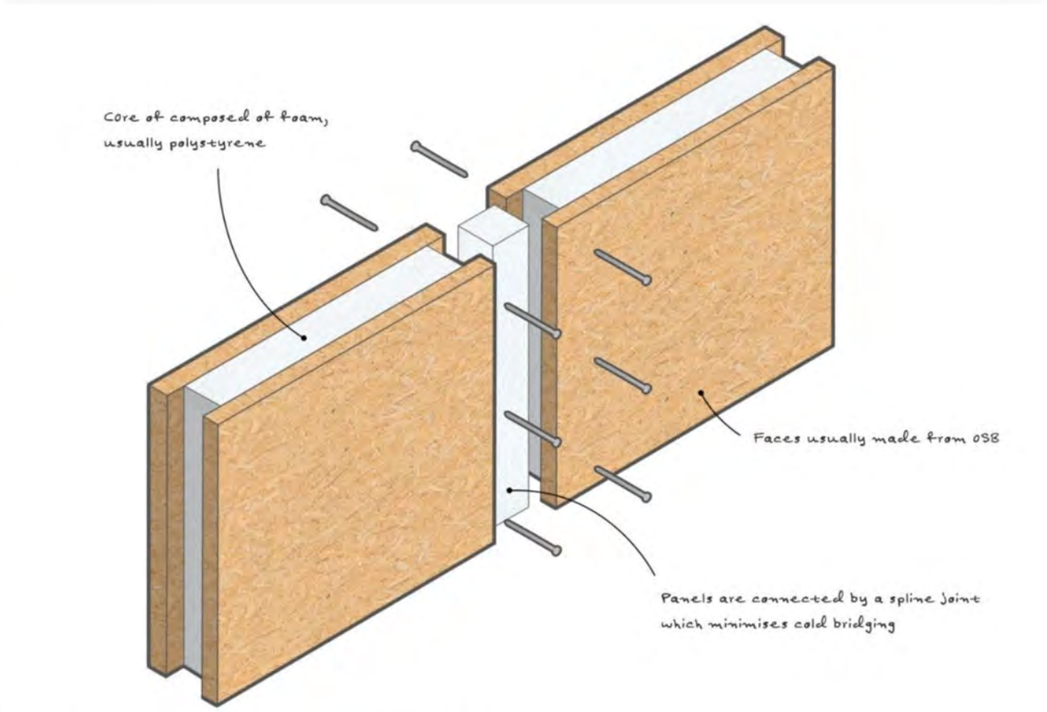
Finished wall

As Illustrated in the above figure, it is possible to visualize that the panels are joined with a spline fitted inside. Then the screws are fitted through the OSB of the panel and into the spline OSB to make the joint very strong and secure. Glue may be used to strengthen the joint more and to seal the joint. ("Structural Design Of Steel Fin Plate Connection - Structville" 2021).

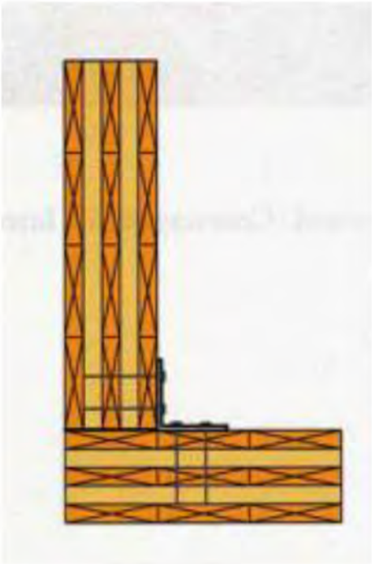
The SIP panels are constructed as to be covered by a timber frame from its surrounding. A base plate and a top plate comes from its top side and the bottom side and the two large surfaces are covered with two Oriented Strand Boards (OSB) as illustrated in the following figure.



Half-Lap joint connection (For the connection of CLT floors)



Spline joint connection (Connection of two SIP panels)



Metal bracket screw connection system (For the connection of CLT floor and CLT wall)

Fin Plate connection (For the connection of Glulam column and Glulam beam)

Executive summary and Research innovation:
The construction of the design focuses on the modularity being robust as well as creating spaces out of adaptively re-used materials that are constructed in a fast and timely manner as well as producing a design adaptable to any site in the most sustainable way.

Community and Client Value:
The design delivers community value with a large sprawl of vegetation throughout with vertical elements allowing the vegetation to spread. The clients have places for community gathering through the pockets on the terracing as well as large outdoor café and decking areas. There are areas being infilled with greenery and elements such as pop-up bars, food trucks and games such as ping pong to allow for the space to be forever changing. The design also allowing the occupants to retreat when need be, into their own private modules.

The potential for new technologies:
The design has the potential for new technologies through the floor plate connection. The connection of floor plates through clip-like figures allows the design to have rapid construction time frames. The design will also feature elements such as internal blind systems that adjust to the daylight, alongside clip on, clip off facades. Furthermore, through the use of connector types such as stirrup brackets it allows for ease of access and connection which has not been used a lot in industry. The stirrup bracket allows for the modules to connect easily and be rearranged to the manufacturers and client's needs. As the sips panels are being used and the fire rating must be considered, the idea of new technologies has been taken into consideration through the layering of materials. This allows the design to be aesthetically pleasing through the weathertex material, but once layered on the sips panels and gypsum board creates a fire resistant design. This therefore meaning the new technology or system which can be applied is through the layering of more sustainable materials to not only be aesthetic but also be fire rated and not have to use heavy materials and increase thickness.

Design for Manufacturer and Assembly:
The design will further be produced for manufacture and assembly through the CLT timber connections in the floor design, with the ceiling connection having fork like clips. The larger two-bedroom modules are spilt into two parts, whereas the one-bedroom module can be its own module allowing for the ease of construction. As the modules stack in an even manner, all services line up as well, as do the windows, allowing for the speed of construction due to the linear duplication. Design for manufacture and assembly has been considered further through the use of recycled materials and materials which can be recycled. The timber and red brick found on site being used to create walls and boundaries within the site in a pleasant architectural way. Furthermore, reducing the types of materials allows for simplicity and ease of construction and disassembly. This further reducing the need for different components to connect all modules. Once the modules are connected, they will further connect through mechanical and not chemical connections to create a modular design which reduces impact on the environment. The connections further being common and therefore require common tools and equipment, not specialist equipment making it easier to assemble and disassemble. As the stirrup bracket is being used it allows for minimum connection and access to all connection points is adhered too. The stirrup bracket allows for repeated reuse. The use of prefab further meaning it is lightweight and connection points can easily be identified for manufacturers.

New Construction system:
The new construction system therefore being the floor and roof clips allowing for ease of transportation. The smart materials which will be used will be solar panels to allow for the apartments to generate their own solar energy power. Secondly, the use of clip on and clip off facades allowing for the design to be altered and lastly; the use of smart building materials such as weathertex and sips. These materials allow for an airtight design which can before fire rated and also aesthetic. The building has a high building performance due to the use of CLT timber as the frame. The efficient manufacture of the modules being evident through the replication of each of the modules. This meaning the timber will be cut to the same sizes,

allowing for the speed of construction with the aid of robotics. The modules are highly efficient as the clip on façade shades the modules to not allow for an intense light. The sips keep the modules airtight and the blind allows for the light to be altered.

High building performance across the whole building lifecycle:
Building performance has been taken into consideration through the careful selection of materials and connection types. This therefore means that through the careful selection of timber such as CLT and glulam beams, the longevity of the building and its structural integrity has been greatly considered. The steel stirrup brackets allow the building to have high building performance through the material. The connections points having the ability to be connected and disconnected multiple types without issue. The timber is able to be recycled and reduced in the future. As for the sips panels, the waste during the production of panels is recyclable. The OSB board is from managed plantations and being produce from sustainable harvested spruce thinning. This therefore means all stages in the building lifecycle have been considered through the reuse of materials, careful selection of material and connection types.

Process and professions in transdisciplinary design approaches:
As the project entails the close relationship with engineers, construction techniques as well as elements such as plumbing, electrical and carpentry, etc, will be incorporated. The cross disciplinary approach is evident through the need for the engineering of elements as well as aspects such as the clip on, clip off facades. Through engagement with the engineers, the loads of the designing were able to be calculated to create a design which useslimited materials but also are able to load bear. As the modules are connected via stirrup brackets and some modules need to be brought to the site in two parts, the CLT load bearing wall acts as the main connection alongside the floor plates. Through the use of stirrup joints, this allows for structural integrity, multiple uses and through the weather text cladding can be hidden once easily arranged. Use of elements such as spline joint connections allows the CLT load bearing wall and other elements to easily connect to one another. The combination of the engineers and architectural knowledge has meant that structure is structurally strong whilst having a pleasant aesthetic design. The use of sips panels, stirrup connectors and CLT load bearing walls, means that the design produced a 90/90/90 fire rating wall which is being aesthetic, air tight and reduced the amount of materials used.

Innovation and circular economy
The circular economy has been considered with the adaptive re-use of the red brick and timber on site as well as the timber and brick blending with the site and characteristics of Fremantle. The sips panels will create an airtight design through a polymer foam and OSB3 board which is produced from spruce thinning and managed plantations. Furthermore, the climate emergency being considered through the use of fire rated gypsum where need be as well as the weathertex external façade. The circular economy is also considered through the reducing of materials and careful selection of materials. The re-use of red bricks and timber alongside use of sips walls creates a design which has the ability to be reused, and recycled whilst reducing impact.Resilience and sustainability response to the climate emergency:
The climate emergency is considered through the use of materials, connections and footings. The screw piles allow for a design which is heavily rooted into the ground allowing for the design to be structurally sound and allowing for window loads to be factored in. The climate emergency is further considered through the sips panelling and weathertex and gypsum board layering. The layering of weathertex onto sips panels has created at 90/90/90 fire resistant design. The sips panels together with the layering of gypsum board and weathertex reduces the spread of fire, even though there is little risk in the area.