HYBRID TIMBER: HOW CAN LESS TIMBER BE MORE?

WOODSOLUTIONS – 28TH JUNE 2023

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COMMERCIAL TIMBER CONSTRUCTION IN AUSTRALIA

Commercial (non-residential construction) in Australia was **16.3million sqm** GFA (Commercial Building Baseline Study 2022)

Largest timber buildings in Australia to date include:

- 25 King St – 15,000 sqm
- Murdoch Uni – 16,000 sqm

Based on this we could estimate a generous annual GFA of timber commercial buildings for a single year of **80,000 sqm**, or about **0.5%** of the construction market.

How do we get this to 1%?

… 5%?

…10%?!

Table 1: Overview – Key Findings

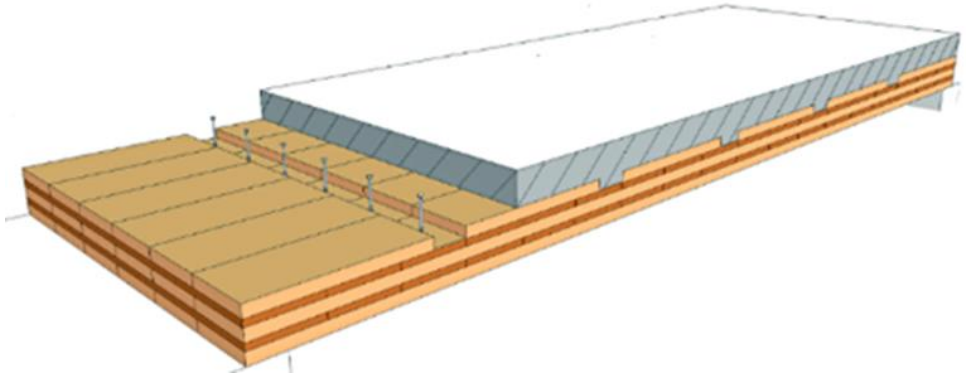
How many non-residential buildings are there in Australia?	~1,040,000 at the end of FY2020.[2]
How much floor area do they contain?	~830 million square meters (sqm) gross floor area (GFA) on a primary purpose basis, or ~820 million sqm GFA on a space-use basis[3]
What is the annual rate of new construction?	16.3 million sqm GFA were constructed in FY2020, equivalent to 2% of the total floor area.[4]
What is the annual rate of demolition and major refurbishment?	Not known, but the floor area demolished in FY2020 is estimated at 1.8 million sqm.

GOALS FOR MORE TIMBER

My thoughts on how we can start to push for more timber in commercial buildings:

- Normalise mass timber in construction
- Accept and embrace the limitations of timber
- Find ways to utilise timber resources more effectively
- More standardisation across our buildings

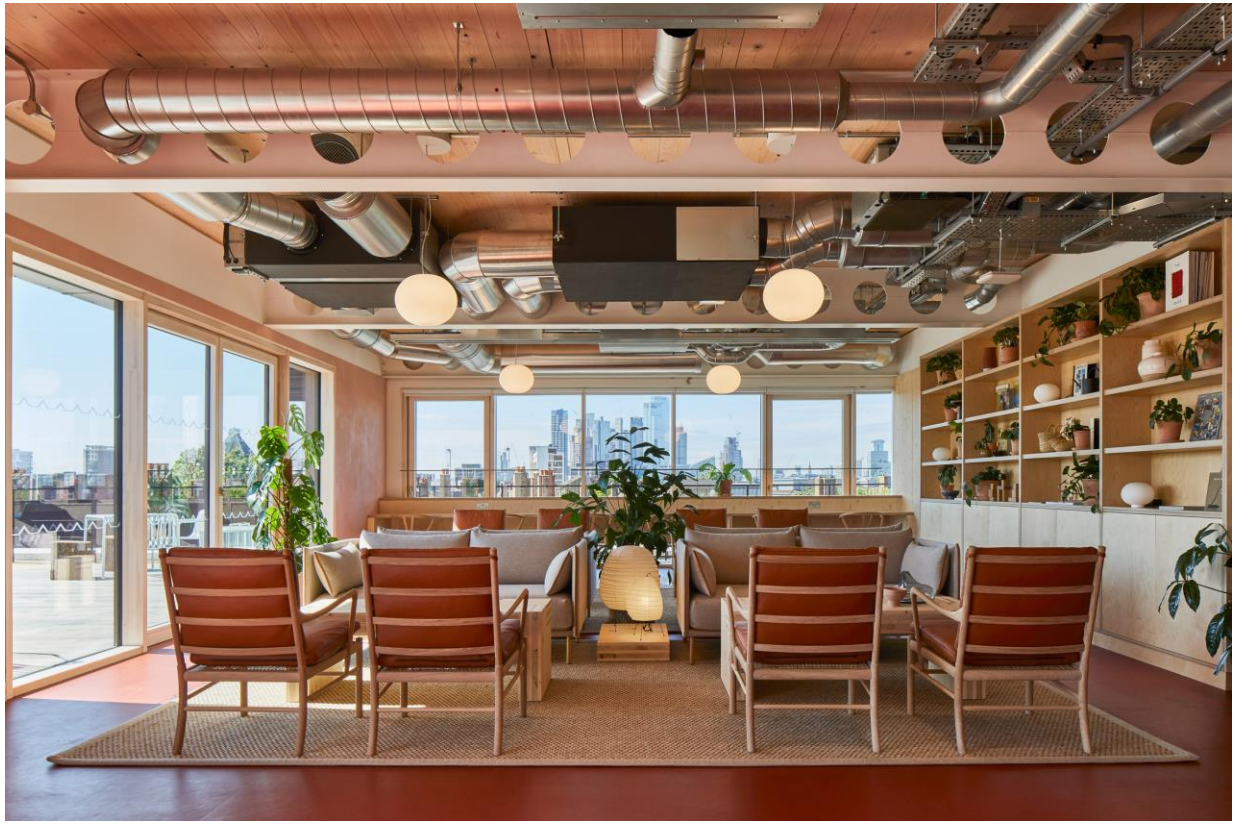
HYBRID STRUCTURES AND HYBRID MATERIALS



HYBRID STRUCTURES – STEEL AND TIMBER

276 Flinders St, Melbourne

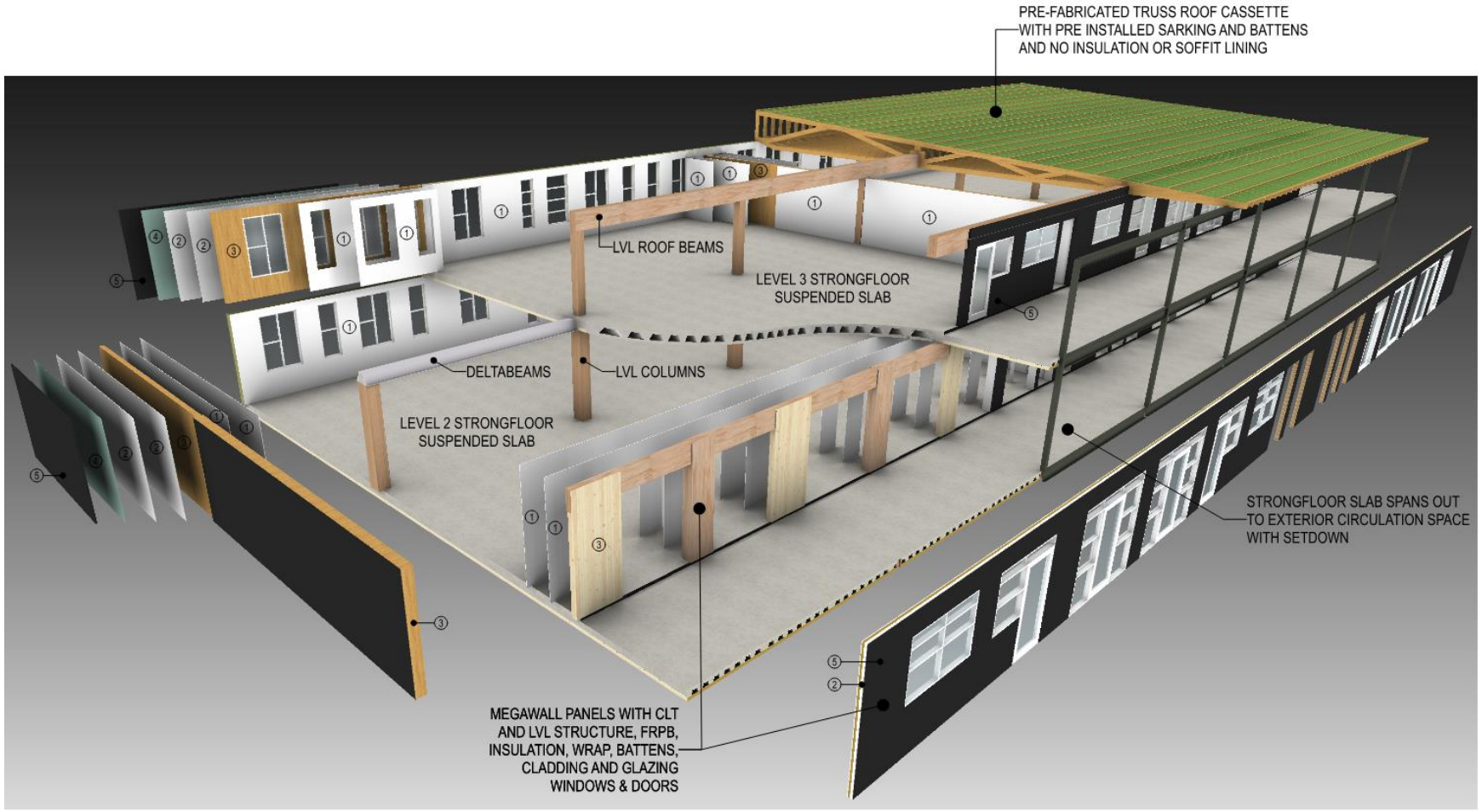
5 levels of steel frame and CLT floors



6 Orsman Road, London

6 levels of steel frame and CLT floors

HYBRID STRUCTURES – KIT OF PARTS (KOP)



Combination of materials/systems

- Mass timber
- Composite floors
- Lightweight framing
- Steelwork
- Precast
- Pre-cladding/finishing components

HYBRID STRUCTURES – KIT OF PARTS (KOP)

1 storey

2 storey

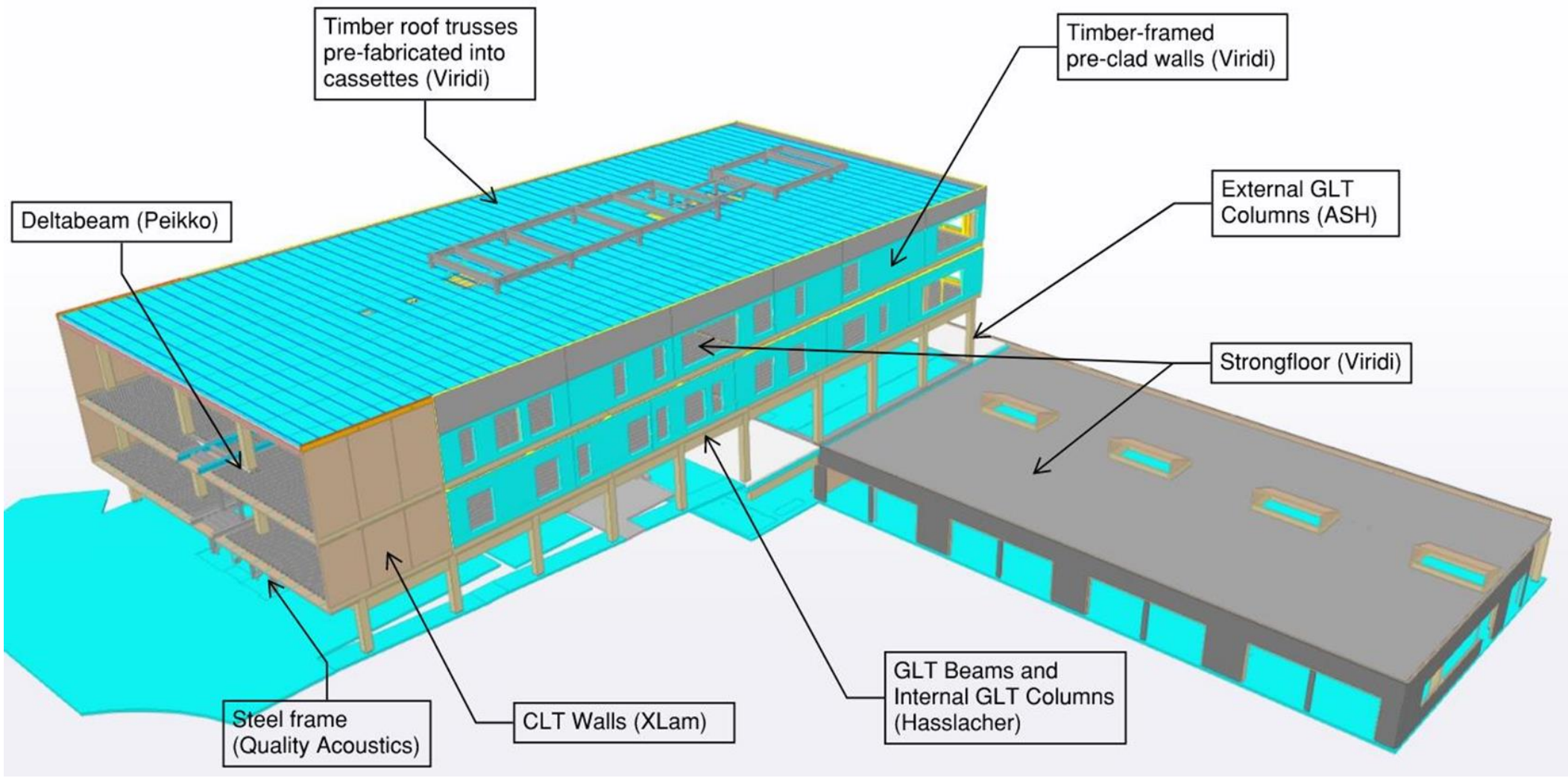
3 storey

HYBRID STRUCTURES – OAKHILL COLLEGE

CONCEPT

COMPLETION

OAKHILL COLLEGE



OAKHILL COLLEGE

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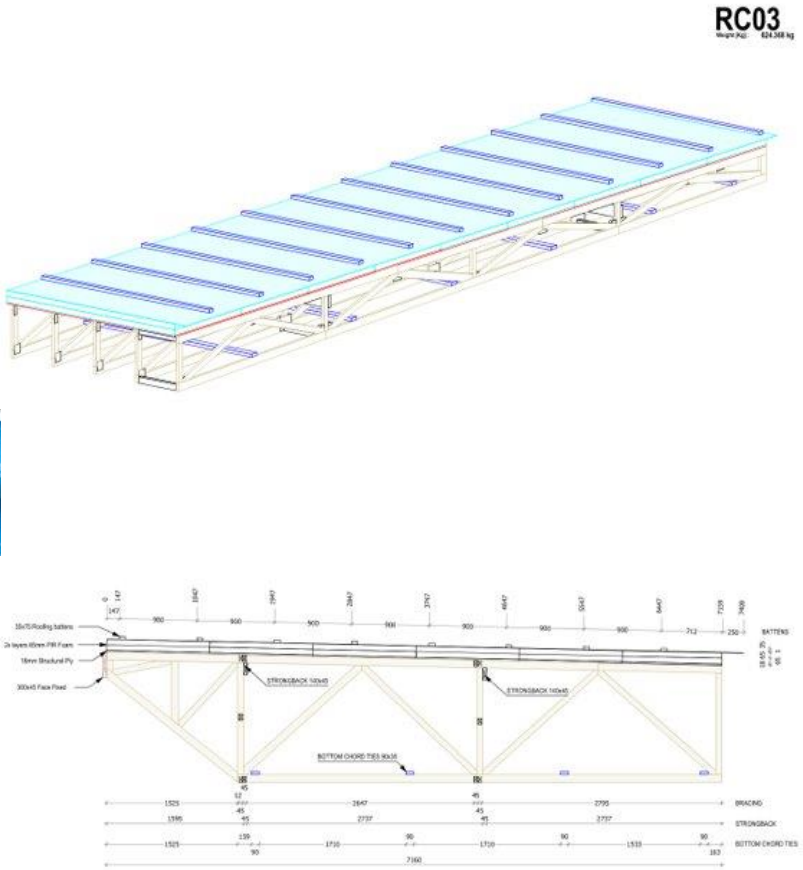
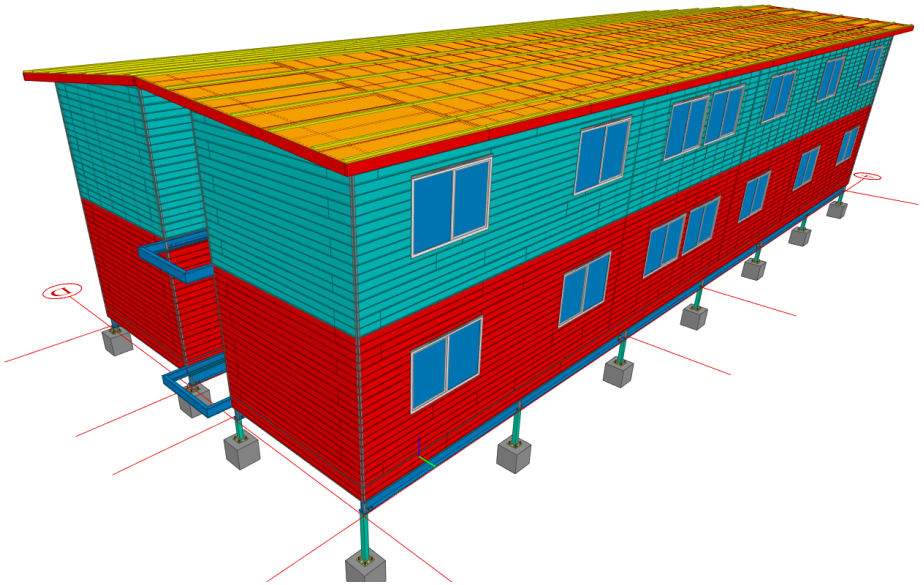
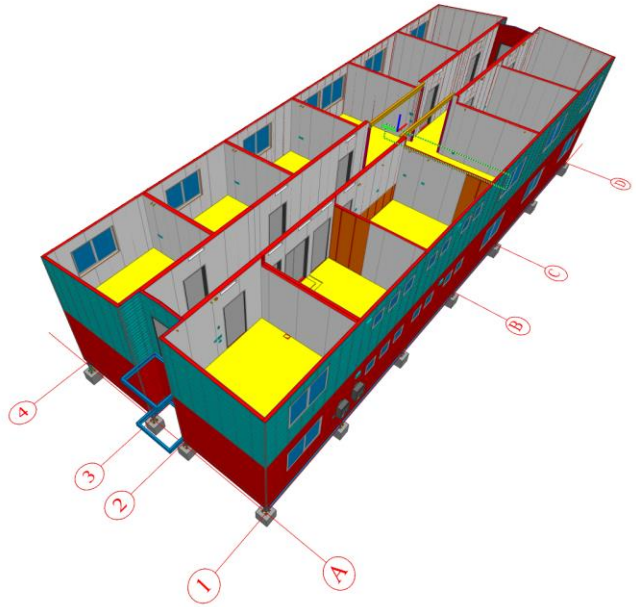


HMAS CRESWELL





Hybrid can be lightweight timber and mass timber too...

HMAS CRESWELL

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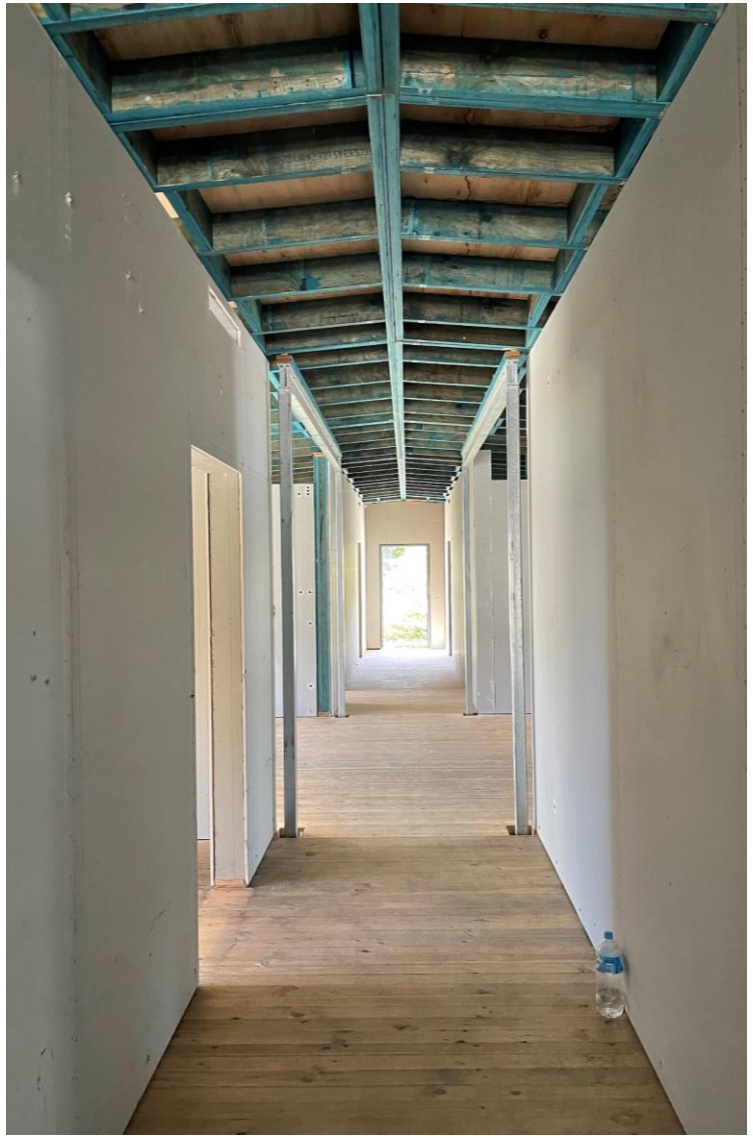
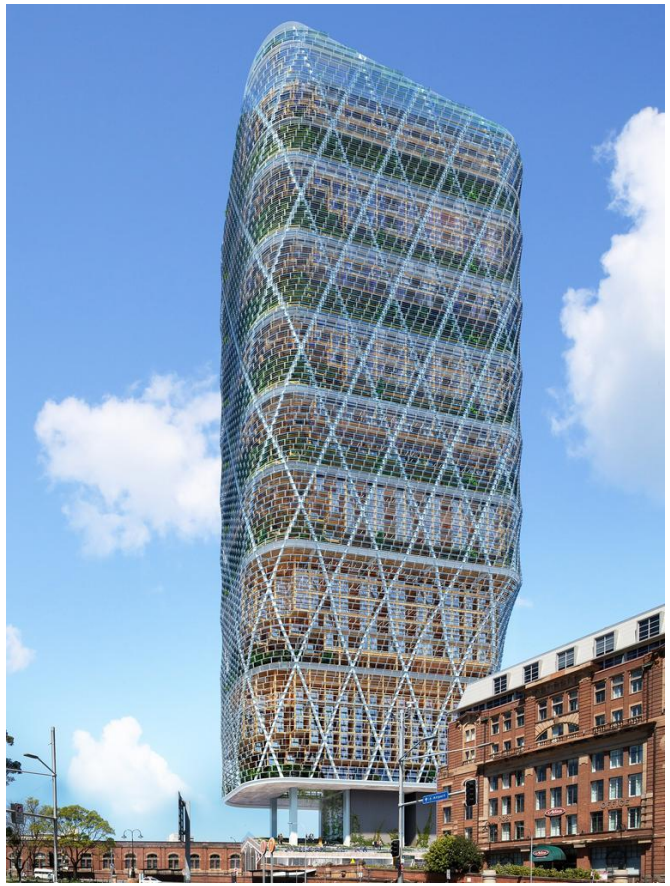


HYBRID STRUCTURES – SKYSCRAPERS




The sky is the limit!

Limitations on structural capacity or fire performance of timber can be mitigated by utilising other materials

HYBRID MATERIALS

Why Use Timber?

Lightweight

Sustainable (low embodied carbon)

Aesthetics

Fast to install

Why Not Use Timber?

Combustible!

Lower acoustic performance

Diaphragm action difficult to achieve

Lower floor dynamic performance

What about concrete?

Definitely non-combustible

Heavyweight so performs well, particularly at low frequency

Often simple to achieve

Heavyweight materials help to dampen vibration

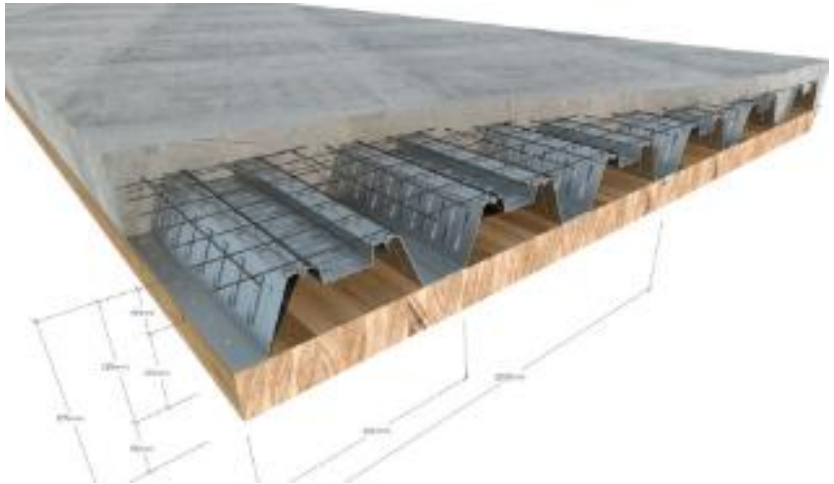
Timber Concrete Composite Floor

Viridi Group's sister company - Composite Systems

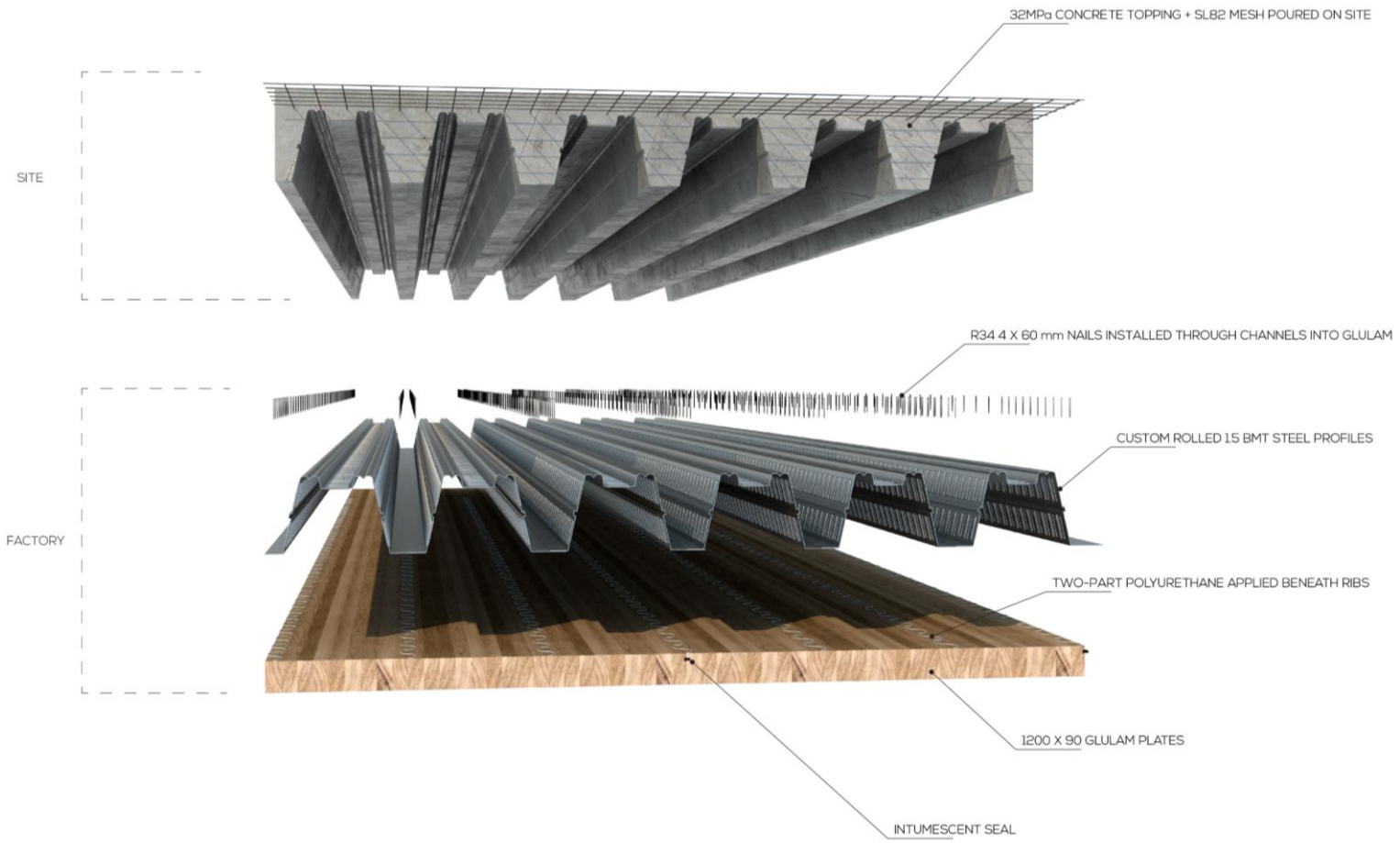
- Mission: to take timber and add other materials to make it better!

Our first product:

StrongFloor



STRONGFLOOR – A TRUE HYBRID FLOOR SYSTEM



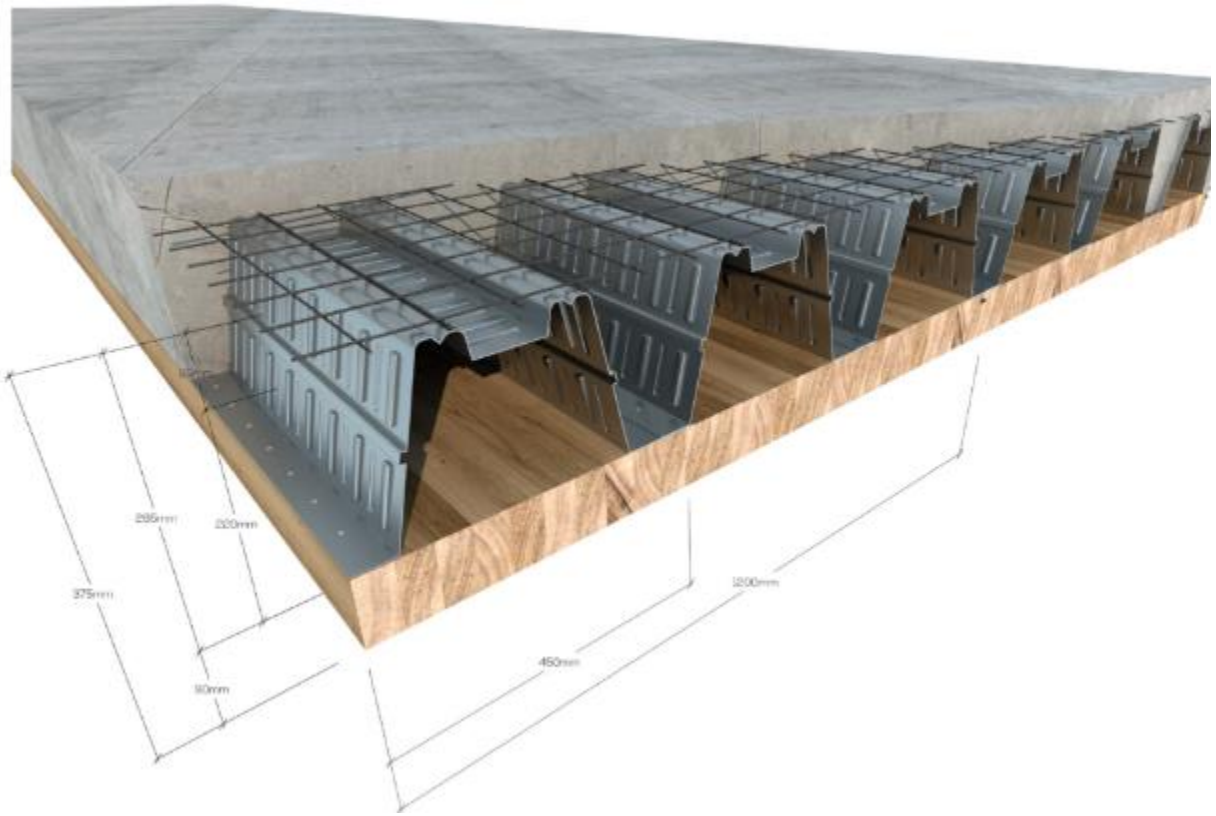
The genesis of StrongFloor came from earlier experiences with mass timber

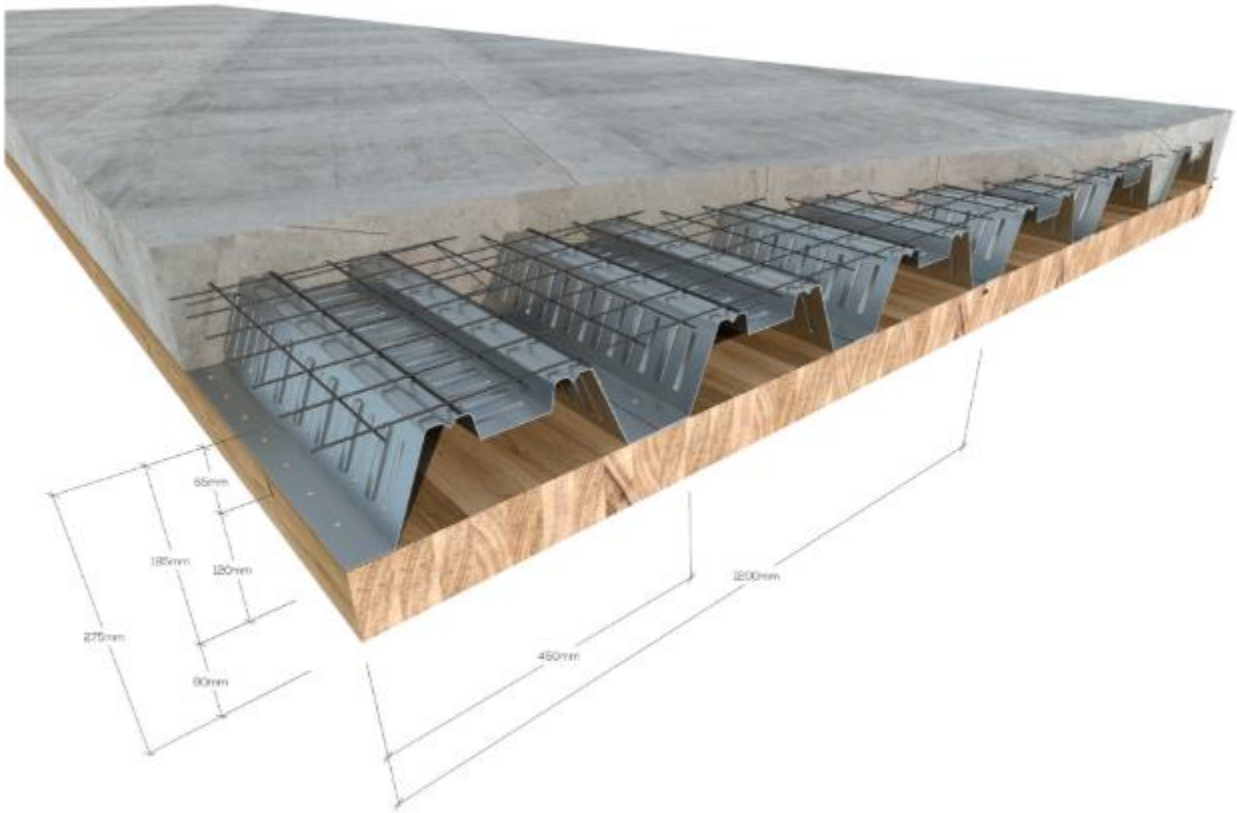
- Many floors were requiring screed for acoustics/vibration, which was just adding weight
- Spans were limited to around 6m

What if we could use the concrete topping in conjunction with the timber? We'd get:

- Better acoustic performance
- Longer spans and better feel under-foot
- Better fire performance with the concrete as a "backstop"

STRONGFLOOR





StrongFloor 375 – Spans up to 9.5m

- 90mm glulam
- 220mm deep custom rolled steel channels
- 65mm concrete cover

StrongFloor 275 – Spans up to 6.5m

- 90mm glulam
- 120mm deep custom rolled steel channels
- 65mm concrete cover

STRUCTURAL PERFORMANCE

We have completed

- ✓ Full scale panel testing
- ✓ Cyclic testing
- ✓ Composite & Non-composite testing to failure
- ✓ Long-term deflection testing
- ✓ Lifting & anchoring test
- ✓ Load slip tests for adhesive and nails

FIRE PERFORMANCE

Full tests and assessments to AS1530.4 with FRL up to 120/120/120.

Testing of typical floor penetrations for up to 120/120/120

Good results in self-extinguishment / burnout

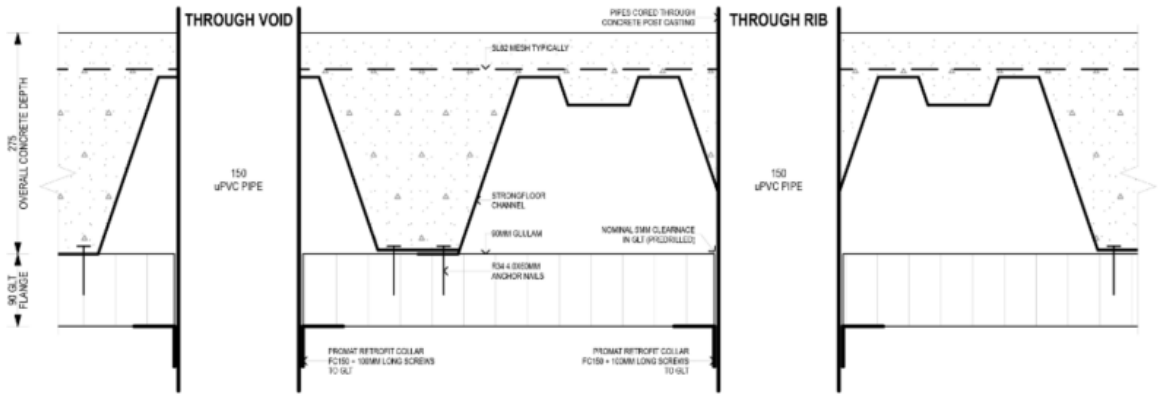


Figure 12 - Typical fire-stopping details through Strongfloor

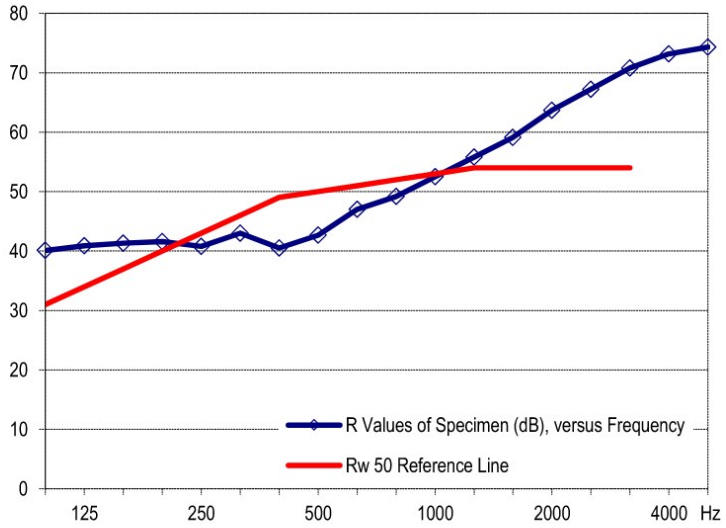
ACOUSTIC PERFORMANCE

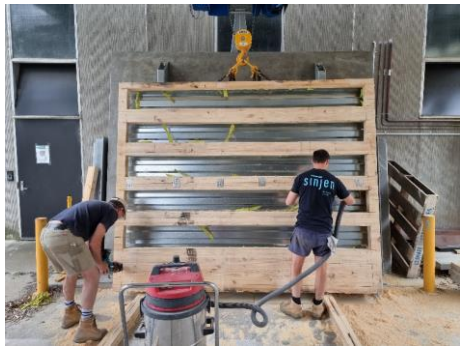
Completed on a bare floor and even with the timber cut out to help future predictions

Excellent performance, particularly at the lower frequency end of the spectrum where timber alone performs poorly

Measurement Details & Results[2]

Frequency (Hz)	Specimen R Value (dB) 1/3 Octave	Whole Octave	95 % Conf δ (dB)
100	40.1		1.2
125	40.9	40.8	1.9
160	41.3		1.0
200	41.6		1.7
250	40.8	41.7	1.0
315	43.0		1.0
400	40.5		0.9
500	42.7	42.6	0.6
630	47.0		0.6
800	49.2		0.4
1000	52.5	51.7	0.5
1250	55.8		0.3
1600	59.1		0.3
2000	63.7	62.1	0.3
2500	67.2		0.4
3150	70.8		0.5
4000	73.2	≥ 72.5	0.6
5000	≥ 74.3		N/A





Performance Index Numbers
R_w (C; C_{tr}) = 50 (-1; -3) dB
STC = 50

Confidence Intervals (AS 1191, App B, 95 % Confidence)
Measurement was carried out in both directions through the test specimen, using 3 loudspeaker positions in each chamber; giving 6 spatially independent sets of R values, from which average R values and confidence intervals have been calculated (confidence intervals rounded up to 1 decimal place).

Measurement Conditions
Date of measurement: 23 November 2021
200 m³ chamber (upper): 19 °C, 63 % R.H.
100 m³ chamber (lower): 15 °C, 81 % R.H.
Atmospheric pressure: 1004 mBar

ACOUSTIC COMPLIANCE

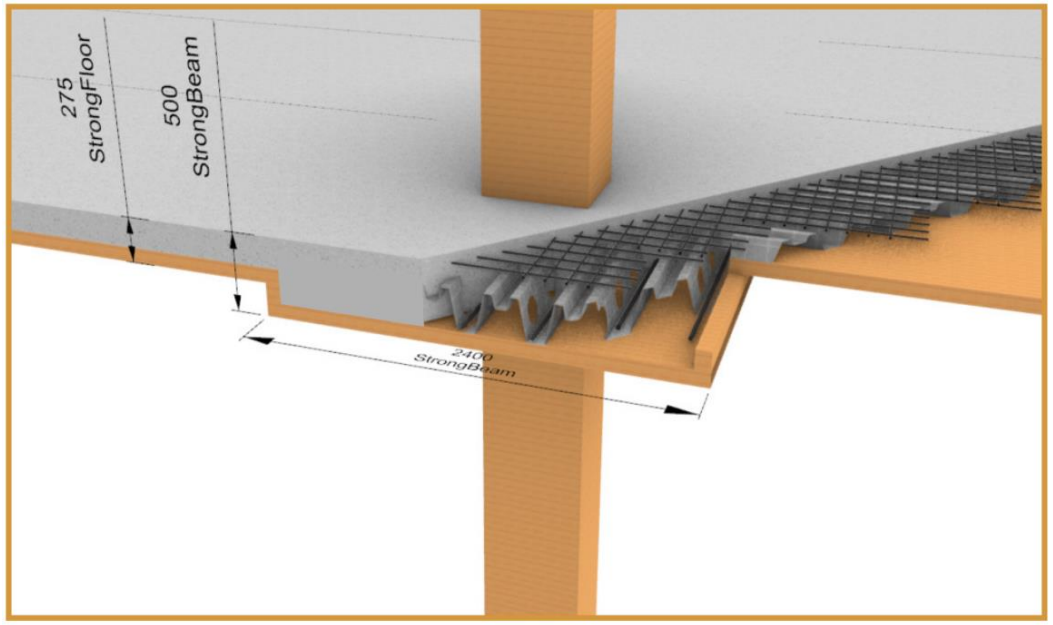
Bare StrongFloor starts at Rw = 50, only improves with linings & floor finishes

Bare StrongFloor 375 will achieve airborne sound attenuation for an apartment floor on its own

Additional simple finishes with a resilient layer will meet footfall requirements

Basic floor data available or calculated values for typical finishes from PKA

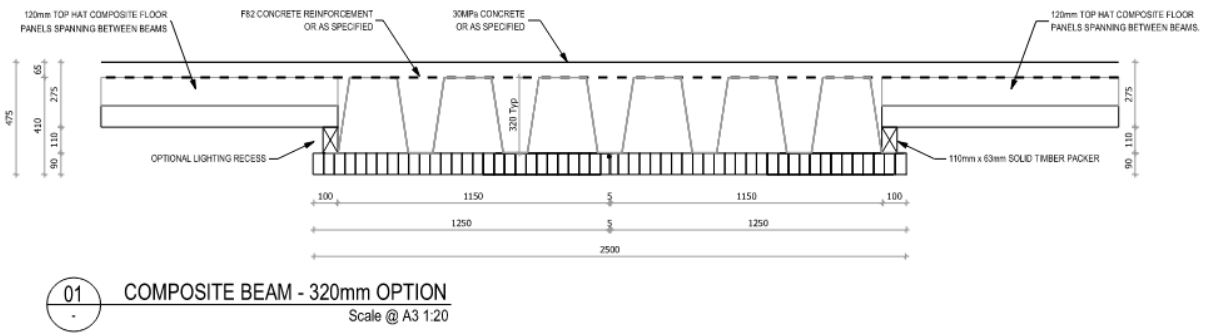
Strongfloor	Ceiling	Floor finish	R_w	$R_w + C_{tr}$	$L_{n,w}$
275	None	Bare	50	47	79
		10mm rubber underlay and 2x9mm FC Sheet (13kg/m2 each)	54	50	55
		Tiles (10mm ceramic) + 8mm adhesive bed			
		Timber (7mm laminate), 5mm rubber underlay	50	47	62
		Carpet (12mm quality) + Chip foam underlay	50	47	<45
		Carpet tile (4.5mm), vinyl back	50	47	65
		Carpet tile (6mm), cushion backed underlay	50	47	50
	150mm ceiling -Suspension rods -Resilient mounts -28mm furring channels -75mm glasswool (11kg/m3) -13mm standard plasterboard (8.4kg/m2)	Bare	62	53	62
		10mm rubber underlay and 2x9mm FC Sheet (13kg/m2 each)	63	54	48
		Tiles (10mm ceramic) + 8mm adhesive bed	62	53	61
		Timber (7mm laminate), 5mm rubber underlay	62	53	55
		Carpet (12mm quality) + Chip foam underlay	62	53	<35
		Carpet tile (4.5mm), vinyl back	62	53	58
		Carpet tile (6mm), cushion backed underlay	62	53	<45
375	None	Bare	54	50	73
		10mm rubber underlay and 2x9mm FC Sheet (13kg/m2 each)	57	51	52
		Tiles (10mm ceramic) + 8mm adhesive bed	55	50	71
		Timber (7mm laminate), 5mm rubber underlay	54	50	59
		Carpet (12mm quality) + Chip foam underlay	54	50	<40
		Carpet tile (4.5mm), vinyl back	54	50	61
		Carpet tile (6mm), cushion backed underlay	54	50	47
	150mm ceiling -Suspension rods -Resilient mounts -28mm furring channels -75mm glasswool (11kg/m3) -13mm standard plasterboard	Bare	64	55	59
		10mm rubber underlay and 2x9mm FC Sheet (13kg/m2 each)	65	56	<45
		Tiles (10mm ceramic) + 8mm adhesive bed	64	55	58
		Timber (7mm laminate), 5mm rubber underlay	64	55	53
		Carpet (12mm quality) + Chip foam underlay	64	55	<35
		Carpet tile (4.5mm), vinyl back	64	55	55
		Carpet tile (6mm), cushion backed underlay	64	55	<45



StrongBeam + StrongFloor will provide a cost-effective floor system for a project with long-spans

FUTURE PRODUCT

StrongBeam

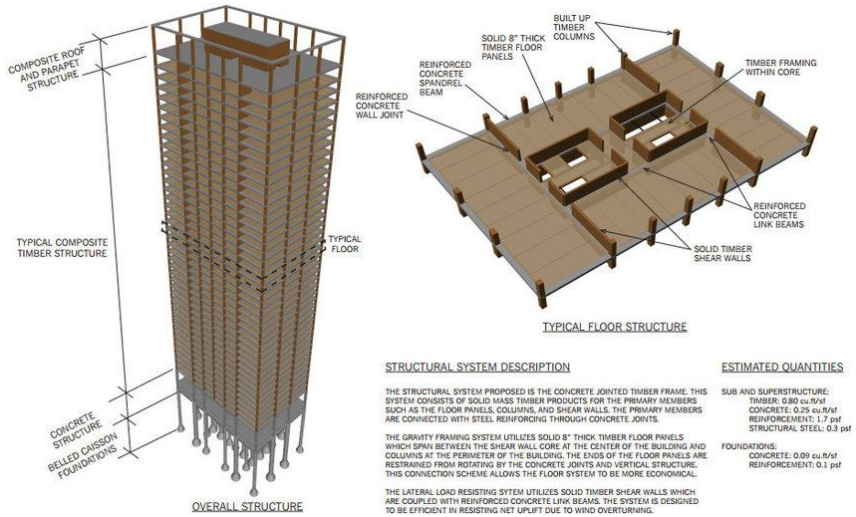


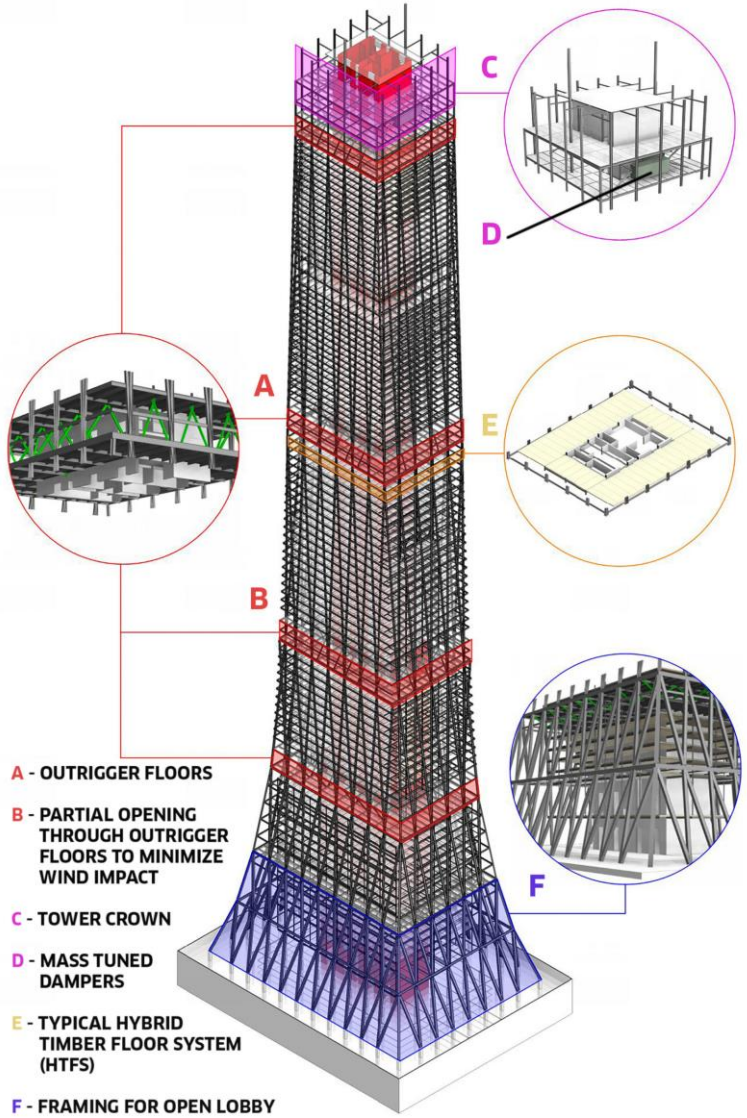
01 - COMPOSITE BEAM - 320mm OPTION
Scale @ A3 1:20

GOALS FOR TIMBER HYBRIDS

Normalise mass timber in construction

- Timber hybrids have the potential to get timber into more buildings
- Would it be better to have 1 pure timber building or 10 buildings with some timber in?
- Can we utilise timber where it is best suited?





GOALS FOR TIMBER HYBRIDS

Accept and embrace the limitations of timber

- We all love timber, that's why we're here!
- It doesn't need to be the answer to everything – other materials can help where timber struggles
- Structural, fire and acoustic performance can all be supplemented

GOALS FOR TIMBER HYBRIDS

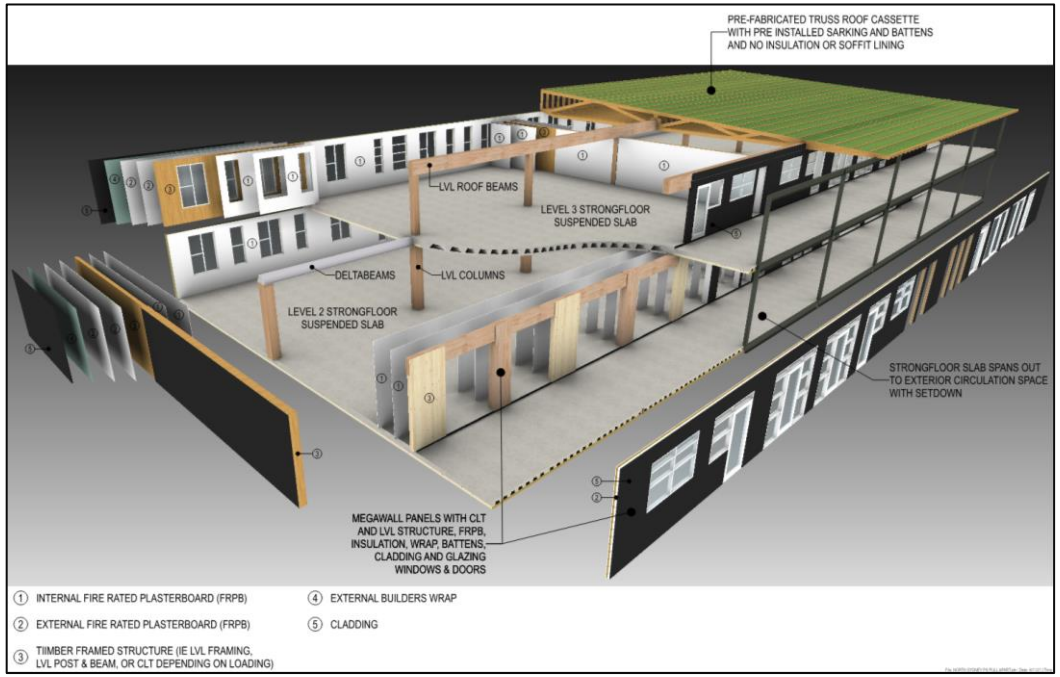
Find ways to utilise timber resources more effectively

- Covid taught us supply chains aren't very elastic
- To go from 0.5% market share to 5% means 10x the material is needed
- Can we find other timber fibre to use for construction products?
- Can we "upgrade" that low grade fibre by combining it with other materials?

GOALS FOR TIMBER HYBRIDS

More standardization across our buildings

- Embrace Kit of Parts (KOP) and Design for Manufacture and Assembly (DFMA)
- More standard components/systems = greater cost certainty + economies of scale



"Hybrid timber buildings combine the best of nature and innovation, offering a sustainable and inspiring future. They embrace the beauty and strength of timber while harnessing modern technologies, creating structures that are eco-friendly, versatile, and aesthetically captivating."

- ChatGPT

BARRIERS AND SOLUTIONS

BARRIERS	SOLUTIONS
Coordination risk increases	Establish tolerances and hierarchy early – which materials are the “primary” ones, and which fit around that
Procurement risk increases	Integrated suppliers/super-subs to supply as many components as possible
Design time may increase	Construction time will reduce (and it is more expensive time)
Lack of knowledge of options from designers	More education needed – early engagement with supply chain
Regulatory challenges (particularly around fire) for interfaces	Fire testing and assessments from suppliers/manufacturers/industry needed

SUMMARY

- Feel free to mix materials – at a project or product level
- Use the right material for the right job
- Carefully detail interfaces and consider tolerances
- Engage the supply chain early (call Viridi!)
- Hybrid buildings can be:
    - Faster to install (reduced components)
    - Cheaper (using the right material for the job)
    - Better performing (supplementing timber)