CROMWELL PROPERTY GROUP

TIMBER BUILDINGS: COST-COMPETITIVE SUSTAINABLE REAL ESTATE

H1 2023

Source: Waugh Thistleton Architects

TIMBER BUILDINGS: THE STORY SO FAR

In 2022 we released our report on timber construction titled "Timber Buildings - Truly Sustainable Real Estate". This demonstrated the many benefits of construction using mass timber (short for massive timber) when compared to traditional steel and concrete.

To recap, the benefits of using mass timber include:

- **Energy efficiency**: manufacturing mass timber materials uses significantly less energy than steel and concrete production;
- **Faster construction**: prefabricated timber panels enable shorter construction timetables than building with steel and concrete thereby reducing construction-based emissions;
- **Less disruptive**: fewer delivering trucks are needed resulting in less disruption to communities around building sites;
- **Resistant**: mass timber is fire-resistant and avoids moisture damage when built correctly; and
- **Financially attractive**: rising occupier demand for greener buildings led to a 9% rental premium for timber buildings.

This report seeks to look more closely at the amount of carbon reduction during the building development and lifecycle. It also explores how the cost implications of timber buildings compare to steel and concrete.

KEY TAKEAWAYS

Lower embodied carbon

Construction using timber instead of steel and concrete can lead to a 73% embodied carbon reduction.

Financially competitive

The financial cost of timber development is becoming increasingly competitive: our analysis suggests 3% more than concrete, and 1% cheaper than steel.

Comparable insurance costs

Our analysis shows insurance premiums for timber buildings on a holistic basis are comparable to other materials and are only likely to fall.

PHOTOSYNTHESIS: NATURES CARBON CAPTURE

Mass timber is a natural carbon removal technique that involves using specialised wood products to construct buildings. As such, it has the potential to play a key role on the road to net zero.

Manufacturers use products such as cross-laminated timber (CLT), laminated veneer lumber (LVL), and glue laminated timber (glulam) to produce wood panels and beams, which are strong enough to replace concrete and steel as primary building materials. Because steel and concrete are emissions-intensive, swapping to mass timber can reduce these emissions and significantly reduce the embodied carbon in buildings.

Figure 1 shows how wood stores the carbon dioxide (CO2) that was captured from the atmosphere via photosynthesis. Photosynthesis is the process that enables the storage of carbon, by converting and sequestering carbon dioxide, thereby helping to mitigate climate change by reducing carbon-related emissions. While a very basic concept, this means that in a biobased economy, meaning the use of natural resources, our construction products are grown instead of mined and created using heavy industrial processes.

Mature trees have limited ability to absorb additional carbon emissions, but young trees do absorb additional carbon in order to grow faster, a process known as carbon fertilisation. When mature trees have reached their growth limit, any extra carbon they absord is quickly cycled through the soil and released back into the atmosphere by the trees themselves or through fungi and bacteria in the soil. Harvesting mature trees for the use of mass timber construction and replacing with tree saplings in a sustainable managed fashion therefore provides a mutually beneficial form of carbon removal and construction practice (figure 2).

CARBON: SEQUESTERED AND DEVELOPED

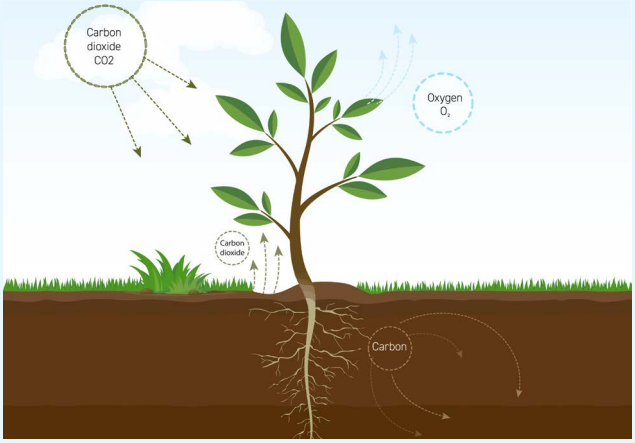
230 billion sqm of new building stock is forecast to be built over the next 40 years - the equivalent of the city of Paris every week[1]. That powerfully demonstrates the importance of increasing the use of sustainable building materials.

Timber as a construction material can help in two ways. Firstly, the carbon captured whilst the timber is growing will be locked into the building rather than released back into the atmosphere. Secondly, the carbon used to manufacture mass timber is significantly less than with steel and concrete.

It is estimated that high-rise buildings made from mass timber would provide carbon removal benefits equivalent to roughly 150–250 kgCO2e/sqm of floorspace. For context, that would mean that building a city with as much floorspace as Manhattan would sequester something in the order of 25–40 million metric tonnes of CO2[2], offsetting 8.6 million petrol cars in a year[3]. This is in addition to the mitigation benefit from displacing steel and cement production.

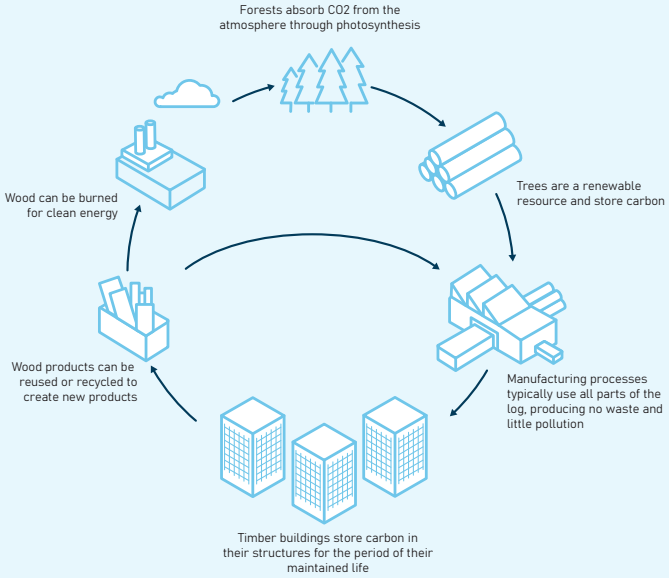
1 United Nations, 2019
2 American University Washington, Mass timber construction, Q1 2020
3 Connected World, 2022

Figure 1: Atmospheric carbon removal from via photosynthesis

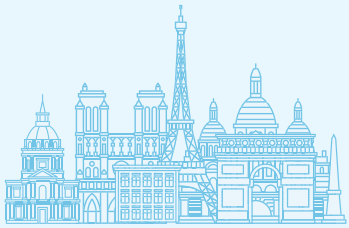


Source: Cromwell Property Group, Q1 2023

Figure 2: Circularity of timber



Source: Waugh Thistleton Architects, Cromwell Property Group, Q1 2023



Over the next 40 years we are expected to build
230 billion sqm of new buildings, globally
The equivalent of the city of Paris every week[1]

Building a timber city with as much floorspace as Manhattan could **sequester approximately 25–40 million metric tonnes of carbon dioxide[2]**

Offsetting the emissions from **8.6 million petrol cars** in a year[3]

Figure 3 shows the carbon footprint of a six-storey residential building in central London. The carbon cost of constructing this building from concrete would be over 1,000 kgCO2e/sqm. The equivalent building constructed using mass timer would use roughly 600 kgCO2e/sqm. This equates to a cost saving of 42% less carbon.

In addition, the timber building would have sequestered a further 350 kgCO2e/sqm by capturing the carbon through photosynthesis. When this is subtracted from the overall figure above, the timber buildings carbon footprint is 258 kgCO2e/sqm, a massive 61% less carbon than the concrete equivalent (figure 3).

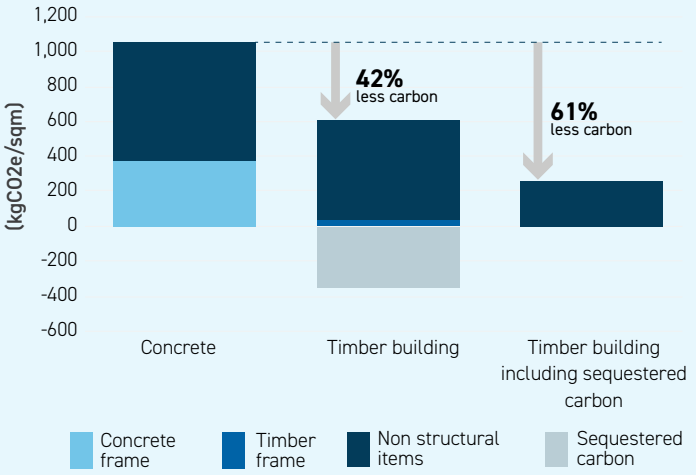
Figure 4 demonstrates the carbon performance over a 50-year lifecycle. Due to the amount of carbon sequestered, the timber building again has a far lower carbon footprint than its concrete equivalents.

Towards the end of the building lifecycle, Figure 4 shows that there is a significant spike in the carbon footprint of timber buildings. This assumes that the building is taken down and the timber is burnt as fuel, thus releasing the previously captured carbon back into the atmosphere. However, given physical climate impacts and legal developments around climate and CO2 burning materials at end of life is increasingly unlikely and, in 50 years' time, may well be illegal.

In the meantime to address this issue, modern mass timber buildings are accounting for sustainable ways to deconstuct them at the end of their life. The emphasis is on recycling the timber for other purposes thereby keeping the carbon out of the atmosphere.

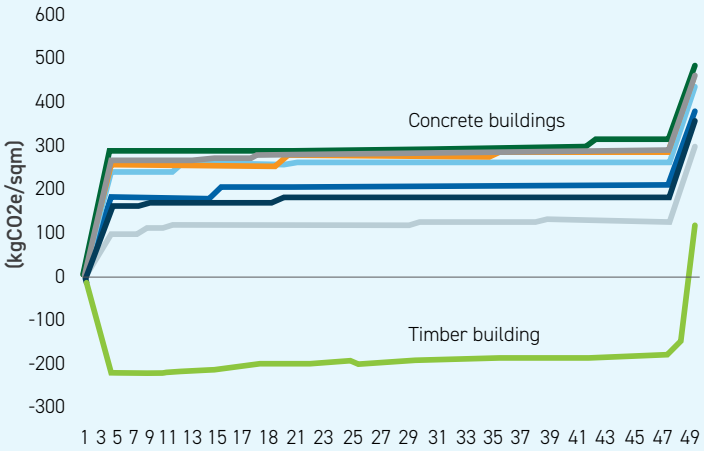
The ability to do this successfully is critical in maximising the environmental benefits of mass timber. Figure 5 shows the amount of carbon used in the lifecycle of the same six-story residential building in central London in two scenarios. Under Scenario 1 the timber is burnt at the end of life, under Scenario 2 to the timber is recycled at the end of life. Scenario 1 would emit over 2,000 tons of carbon throughout its lifecycle. By comparison, Scenario 2 would generate less than 1,000 tons, a 55% reduction.

Figure 3: Carbon footprint of a six-storey residential concrete and timber building



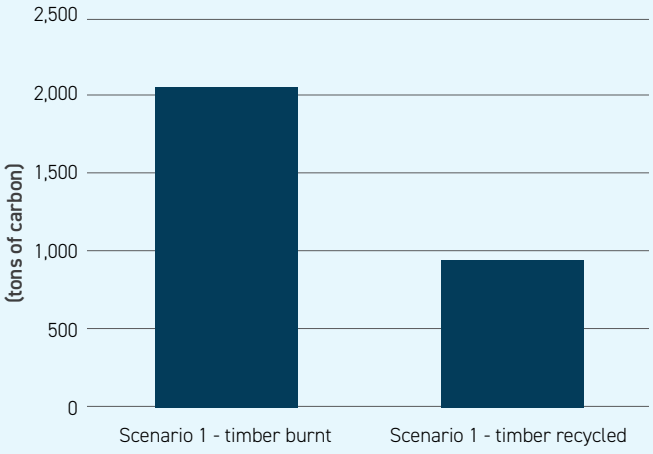
Source: Buro Happold, Q1 2023

Figure 4: Carbon performance of CLT and concrete buildings over 50 years



Source: Ramboll, February 2020

Figure 5: Carbon footprint of a timber building life cycle



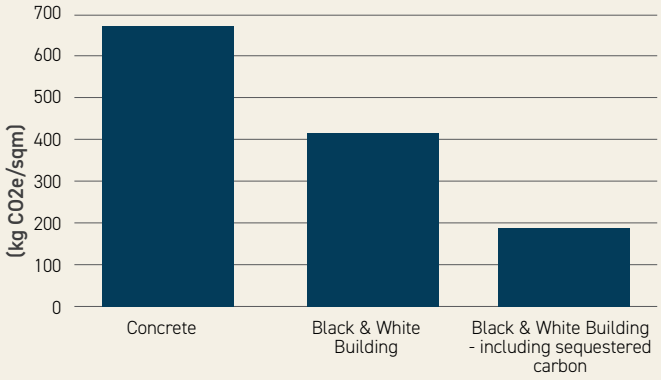
Source: Buro Happold, Q1 2023

CASE STUDY: BLACK & WHITE BUILDING, LONDON, UNITED KINGDOM

The Black & White Building was completed in Q1 2023. At 18m in height, it is the tallest timber office building in London. Like all timber buildings, the foundation utilises concrete, and the rest of the framework is made up of mass timber products compirsing CLT and LVL.

In comparison to using steel, iron or cement, constructing the building with mass timber allows the building to generate 63% less carbon than a concrete structure of the same size. When the sequestered carbon is subtracted, the saving rises to 73% (figure 6).

Figure 6: Carbon footprint of the Black & White Building

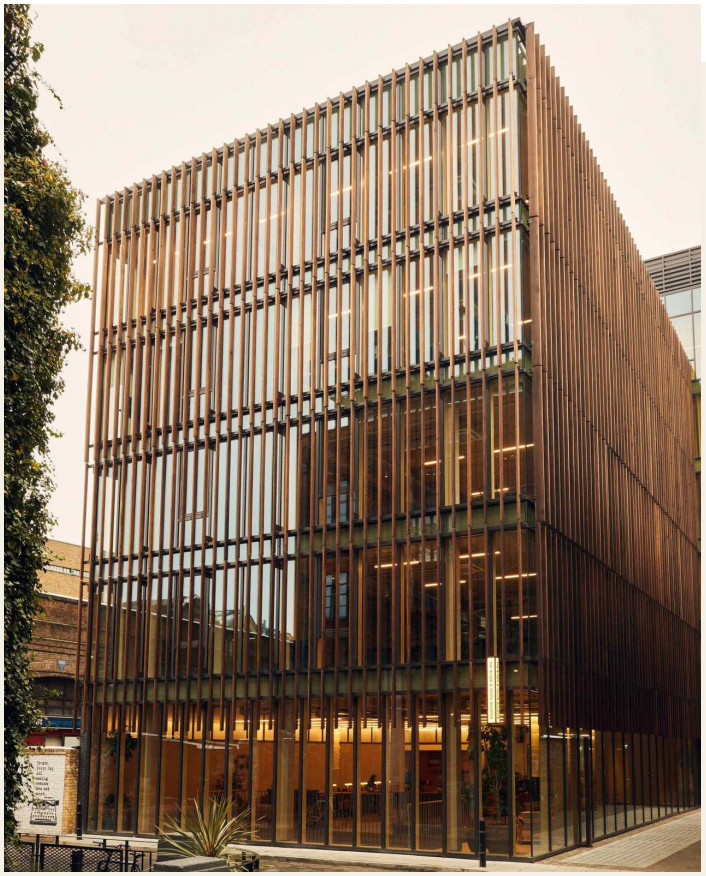


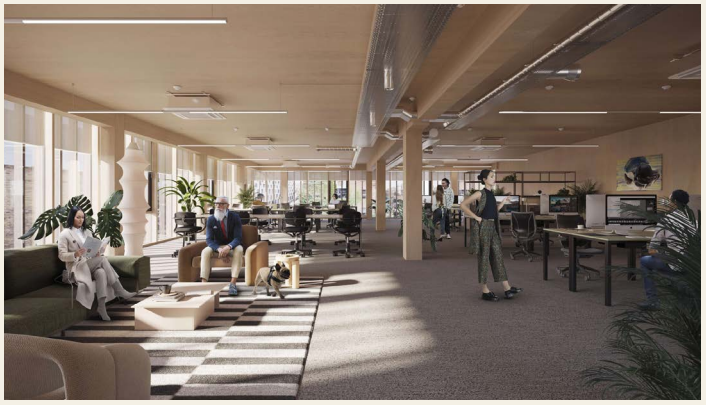
Source: Waugh Thistleton Architects, Q1 2023

Figure 7 analyses the carbon generated during the development process based on the different aspects of construction. The greatest proportion of the total carbon footprint, almost a third, was generated in the substructure (the basement and foundations), which even on an all-timber building uses concrete. By comparison, the much larger above ground superstructure, which is the timber frame of the building, only accounted for 12%.

The disparity between these two data points once again highlights the huge benefits that the adoption of timber could have on the built environment.

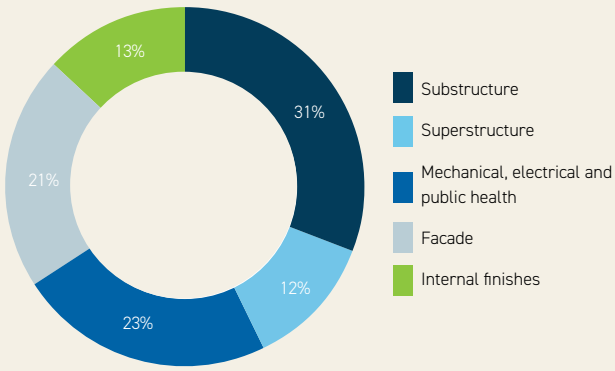
Removing the basement altogether would have significantly reduced the carbon footprint of the building. This raises the question of how important basements will be in the future to office design when carbon footprints are even more closely scrutinised.





Source: Waugh Thistleton Architects

Figure 7: Proportion of carbon by building section



Source: Waugh Thistleton Architects, Q1 2023

COSTS: INCREASINGLY COMPETITIVE

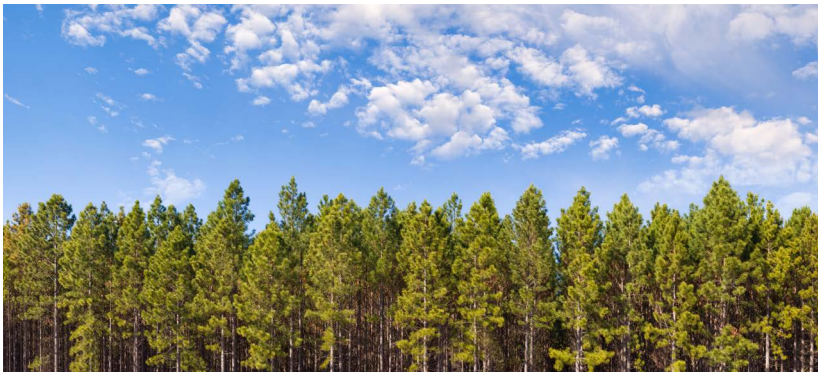
The environmental benefits of timber construction can clearly be seen when compared against equivalent buildings made from steel and concrete. However, one of the potential hurdles to mass timber becoming the gold industry standard is financial. Inevitably the cost of building using newly developing more specialised techniques is greater than traditional methods.

According to one study, the cost of constructing mass timber buildings can be up to 4% greater than the cost of using concrete[4]. Another study found that for a six-story building in New Zealand, the predicted construction cost of a timber building would be approximately 6% greater than its steel and concrete counterpart[5].

Although most studies illustrate that the construction cost of mass timber buildings is more expensive than traditional concrete and steel buildings, there are also studies which supports mass timber as a cheaper option overall[6].

These inconsistencies demonstrate that it is difficult to accurately compare the costs of construction using different materials as there are many variables, and each building is unique. Even within timber buildings, there can be significant overall cost differences based on the type and amount of mass timber used. For example, CLT is a larger and heavier timber product when compared to LVL. As such, projects using CLT require more trips to the construction site than those using LVL and this will have a significant impact on cost calculations.

Source: Waugh Thistleton Architects



Financial benefits: The advantages of timber over steel and construction

Lighter weight – timber reduces the building weight. This usually results in reduced foundation requirements and therefore lower substructure construction costs. It allows the building to be constructed over restricted load areas such as railway stations and tunnels. Lighter-weight wood elements can also be installed with smaller cranes, such as mobile cranes, instead of heavy and expensive tower cranes.

Offsite manufacturing – the ability to build timber sections offsite results in shorter construction schedules, lower site overheads and financial holding costs compared with conventional construction. Offsite manufacturing reduces on-site labour need which diminishes health and safety risks as well as costs.

Logistics – timber elements are transported in a preassembled panel configuration and optimised for load capacity. Due to the lower loads, the total number of trucks to a site is reduced which means not only lower transportation costs, but also more sustainable transportation (particularly when using LVL as noted above).

Reduced construction times – due to the materials being prefabricated offsite, construction times are far less compared with more site-intensive construction projects using steel and concrete.

Aesthetically pleasing – the benefit of exposing timber elements is that the main frame itself can be produced and erected with a finished visual quality, eliminating the expensive façade works required with traditional buildings.

4 Chubb Construction Risk Engineering, Mass Timber Construction, 2021
5 ibid
6 Construction Engineering Oregon State University, 2021

Despite the many variables to consider, figures 8 and 9 compare hypothetical buildings to examine overall cost changes due to the use of different construction materials.

Figure 8 considers a six-storey residential building in Greater London. Overall, the costs for a timber frame building are only 5% greater than the equivalent building made from concrete. When the benefits above are applied (such as a lesser labour requirement and overall quicker construction schedules), timber could be a cheaper option.

Figure 9 compares the development cost of three office buildings in the UK.

- Building 1 – 4 storeys, 11,000 sqm
- Building 2 – 7 storeys, 13,000 sqm
- Building 3 – 3 storeys, 2,000 sqm

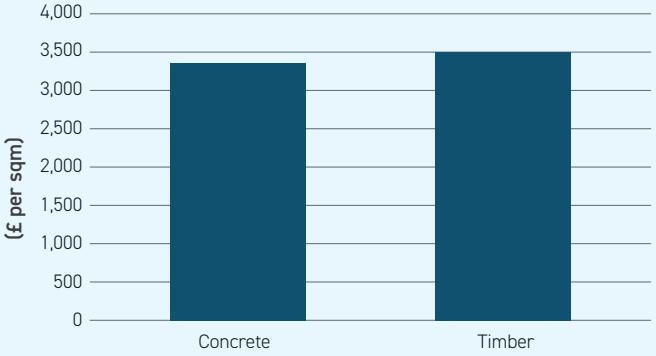
Across the three examples, timber as a construction material is competitively priced. On average, it is 3% more expensive than a concrete equivalent, and 1% cheaper than using steel.

This data is compelling and shows that the development cost is similar between the materials. When the potential of more stringent government requirements around accounting for carbon in development, which seems increasingly likely, the argument for timber is even greater when considering the substantial environmental benefits. For example from 1 January 2023, Denmark became the first Nordic country to introduce embodied carbon limits into building regulations. These include:

- All new buildings applying for a building permit (from January 2023), must document the climate impacts through Life Cycle Assessments (LCA).
- New buildings above 1,000 sqm must comply with the limit value of 12kg CO2e/sqm per annum, including operational carbon.
- New construction under 1,000 sqm requires LCA calculation without the threshold limit values

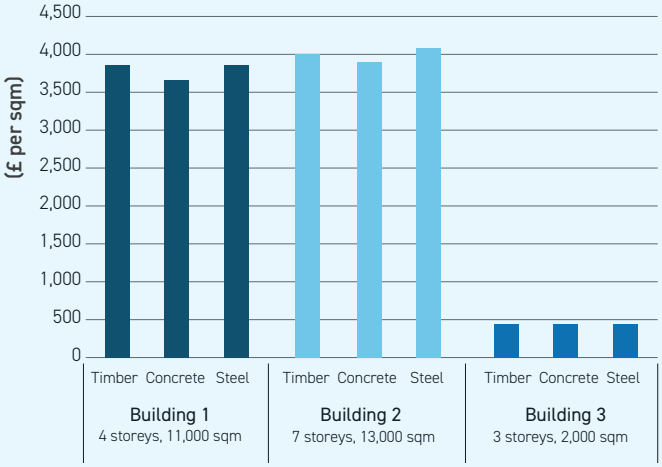
Other countries can be expected to adopt similar legislation.

Figure 8: Six storey residential block construction costs, concrete vs timber



Source: Gardiner and Theobald, Q4 2022

Figure 9: Office cost comparison (£ per sqm)



Source: Stora Enso, Cromwell Property Group, Q1 2023

INSURANCE: BRINGING PREMIUMS DOWN

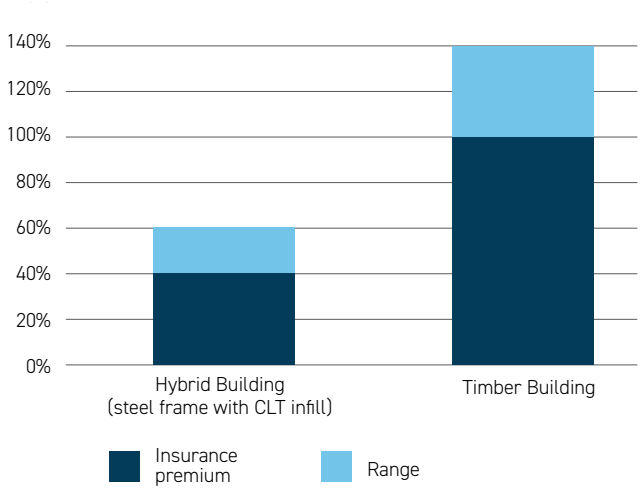
The price of insuring timber buildings has historically had a significant impact on cost. Insurer concerns related to timber buildings centre on a lack of distinction between mass timber, which is the topic of this report, and old-style timber frame construction. Currently all timber is lumped into the same bucket. Mass timber is a different construction process and produces sturdier buildings, especially at height, meaning it is not comparable old-style timber. This misconception must be addressed by raising awareness and educating stakeholders throughout the real estate industry. A one size fits all approach to timber simply does not work and is a huge barrier to normalising use of mass timber in construction projects.

Such comparisons lead insurers to make false assumptions about timber construction. The first is that a fire in a timber building means the total loss of asset value. This is simply not the case as discussed at length in our previous report. Other major insurance concerns focus on long-term moisture damage. While this is a valid concern, it can be addressed through good design and construction and the incorporation of risk mitigation measures. However, if there has been a fire or flood, as timber is pliable damaged materials can easily be replaced which is not always the case with steel and concrete buildings. Thus it offers superior resilience against flood, fire and moisture risk.

Currently the benefits of mass timber are understood by a very niche community. Beyond this, misconceptions about timber buildings remain rife and present a significant hurdle to widespread adoption. This disconnect is a major obstacle to making progress with the insurance market. Ultimately it prevents greater mass timber investment as investors are deterred by the risk of the building being uninsurable.

Like the cost of construction, it is impossible to derive a single figure to reflect the insurance premium of timber buildings as construction projects are all different and have unique underwritten assumptions. As a broad indicator though, the construction risk-related insurance element of a mass timber construction project is typically 40%-60% higher for hybrid buildings, which have a steel frame with CLT infill, and 100%-140% higher for a full timber building (figure 10).

Figure 10: Construction-related insurance risk compared to traditional builds



Source: Gallagher Speciality, Q1 2023

Whilst this is a significant increase in insurance costs, the reality is that almost all reasonable sized construction projects also purchase most or all of the following.

- Third Party Liability and Non-Negligent Liability Insurance
- Delay in Start Up Insurance
- Terrorism Insurance
- Latent Defects Insurance

There is little evidence to suggest there is a variation in pricing for these lines of insurance when applied to a hybrid, or full timber scheme, with insurers charging the same for these covers irrespective of material. As a result, depending on the quantity of insurance bought the uplift in cost for the whole project is more likely to be in the region of 5%-7.5% for a hybrid building, and 25%-40% on a full timber scheme.

There is also action in progress to bring insurance premiums down. A new timber building guide, titled "The Mass Timber Insurance Playbook" is in development by the Alliance for Sustainable Building Products (ASBP) and Zurich Insurance Group, in a bid to reassure the insurance sector by setting down industry-accepted guidance for developers, investors and designers. The objective is to smooth the process of getting insurance for both construction and occupation of mass timber buildings. It will set out steps on how to engage insurers as early as possible to ensure that the correct questions are asked to ensure that appropriate timber is used with no impact on building resilience. This will demystify the insurance implications of timber buildings, increasing the acceptance of insurers towards the material and lower costs.

CONCLUSION: EDUCATION IS THE GREATEST BARRIER, NOT COST

The environmental benefits of using mass timber as a construction material are undisputable. However, whilst investors are increasingly conscious of their environmental footprint, timber construction also must be financially viable.

As the number of timber buildings globally rises, real estate stakeholders can better compare and benchmark data, and learn from each other. Much like the beginning of any new technology, the more widespread it becomes in the market the greater the achievable cost certainty. This will raise awareness of the costs associated with timber buildings and will encourage greater adoption of the material.

Associated industries, such as insurance, must be open-minded and willing to embrace the necessary changes needed to make the wide scale adoption of timber truly accessible. Bespoke insurance products which have tight controls over the type of timber used will be the key to unlocking the potential of the mass timber market. That is starting to happen and it is clear that there is growing momentum for enabling timber buildings through education, best practice and lowering costs.

As we have seen, using timber in real estate reduces carbon and produces more cost-effective, high-quality buildings. It also creates better working and living conditions for people to meet the growing investor and occupier demand for prime sustainable real estate across all asset classes, fulfilling all the criteria of ESG.

Figure 11: Timber buildings achieve all three aspects of ESG

Environmental	Social	Governance
Lower embodied carbon/emissions	Better working/living conditions for people and higher quality of life	Sustainably managed wood production/forestry

Source: Cromwell Property Group, Q1 2023

It seems inevitable that the insurance and financial market will adapt and bring costs down further. This presents an opportunity for vanguard investors who can start to build their industry networks, educate themselves on timber buildings, and secure standing assets or pipeline, before the market realises the potential of timber in mitigating climate change, supporting multiple ESG benefits and delivering rental outperformance. When the wider market sees the environmental and financial benefits of timber buildings, investor demand for such assets is likely to compress yields and increase capital values. Thus early investors who act now can benefit from a misplaced risk perception and capture sustained, long-term performance.

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