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Issue 2

timber UPdate

THE RISE OF THE PLYSCRAPERS

Timber buildings are reaching towards the skies, thanks to breakthroughs in super-strong wood.

IMAGE ABOVE COURTESY OF PLP / ARCHITECTURE

Left: Sydney's first timber office block, International House at Barangaroo, due to open next year.

Right: A proposed 34-storey tower in Stockholm.

IMAGE COURTESY OF C.F. MØLLER ARCHITECTS

If there's one way to get people talking, it's to draw up plans for a new skyscraper and plonk it smack in the middle of an iconic skyline like London's, overlooking majestic St Paul's Cathedral. Londoners have nifty nicknames for the crop of eccentrically shaped skyscrapers that have popped up over the last decade or so – the Gherkin, the Cheese Grater and the Walkie-Talkie – but if a small group of British architects and engineers has their way, the historic skyline may be welcoming a bold geometric addition with a new moniker: the Toothpick. This sleek, 80-storey tower will soar 300 metres above the Barbican Centre, a gloomy, grey concrete slab of residential and arts buildings that was opened by the Queen in 1982.

But there's something very different about this proposed tower, something pointing to the possible rebirth of the skyscraper itself: the Toothpick, as its name suggests, will be made almost entirely from wood. Thanks to significant breakthroughs in super-strong engineered timber products over the past decade, making them as tough as structural steel or concrete, the stage is now set for the construction – for the first time in human history – of tall timber buildings.

"Mass timber" is the collective term used to describe this new suite of structural materials, which include cross-laminated timber or "CLT" (multiple layers of wood glued together at right angles under extreme pressure to form giant wall, ceiling and floor panels) and "glulam" (layers of wood jointed together along the same grain for beams and posts). And here's another nickname for these woody high-rises: plyscrapers.

Just as steel, glass and concrete revolutionised super-tall construction in the 20th century, it's now likely that timber, which has been shown to be vastly kinder to the environment, faster to build with, with next-to-zero waste and far healthier to live with, will do the same as the new century marches on, leading to burgeoning new high-rise profiles in Europe, the US and parts of Asia. British architect Andrew Waugh, whose company Waugh Thistleton is building the largest timber housing development in the world in Hackney, London, goes as far as to call this "the beginning of the timber age".

At present, the tallest wooden building in the world is Treet ("the Tree"), a 14-storey apartment block in Bergen, Norway, which last year surpassed Australia's first trailblazing timber high-rise, the 10-storey Forté apartment building in Melbourne, built in 2012. But the Treet will soon be dwarfed by the 24-storey HoHo tower in Vienna, due for completion late next year, an 18-storey building at the University of British Columbia, which will open next year, and a 34-storey tower in Stockholm, earmarked for completion in 2023. Earlier this year French architect Jean-Paul Viguier won a design competition for Hypérion, a woodenframed residential tower in Bordeaux featuring hanging gardens, to be finished in 2020. In Sydney there's International House, a striking timber office complex in Barangaroo, to open next year.

But if it's a super-tall, iconic skyscraper you're after, Michael Ramage, director of Cambridge University's Centre for Natural Material Innovation and an internationally recognised expert in building big with wood, is your man. He insists that the timing is right for projects like the Toothpick, which he designed with engineers from London's PLP Architecture. While the latest steel-and-concrete skyscrapers may look sleek and cutting-edge, most come with old-world energy bills, insists Ramage. "Timber has a very important place in the future construction of medium- and large-scale buildings," says Ramage, in his soft American accent (he grew up in New York state), in a phone interview from his office at Cambridge University. "It can be cost-effective, faster to build, and result in more attractive high-rises."

Timber is our only renewable construction material. Absorbing CO_2 from the air, forests – from wilderness to crop plantations – are huge carbon stores or "sinks", and a tree's wood continues to store carbon when it becomes a timber beam holding up a ceiling, a process known as carbon sequestration. It's been estimated that a timber beam of one cubic metre stores close to one tonne of CO_2. Compare that to steel, concrete or plastics: not only do their manufacturing processes require large quantities of electricity and water, but instead of storing carbon, steel and concrete emit it. For the equivalent one cubic metre beam, concrete releases two tonnes of industrial emissions (steel releases even more). By the time a concrete skyscraper has been erected, it has produced tens of thousands of tonnes of CO_2; it has been estimated that as a whole, the concrete industry has five times the carbon footprint of the world's airline industry.

And here's the scary part: more than 70 per cent of energy-related carbon dioxide emissions, says *Scientific American*, come from the planet's vast new mega-cities. It's estimated that China has poured more concrete in the past six years than the US has in its entire history.

Yes, concrete and steel buildings have become far more energy-efficient in recent years, thanks to better insulation, solar panelling, vegetated roofs, waste-water recycling and low-watt lighting, but in the battle for green supremacy, nothing touches timber. Masses of large-scale buildings sourced from timber plantations would provide a carbon sink in any heavily developed city.

Left: Bordeaux's Hypérion, named after the world's tallest living tree, to be completed in 2019.

Right: The 14-storey Treet building in Bergen, Norway, currently the world's tallest wooden building.

Right now, agroforestry may not form a major part of international climate-change policy, but that's likely to change in the next decade or so, says Vancouver architect Michael Green, an internationally-recognised expert in building big with wood. While timber plantations are no substitute for continued deforestation – virgin rainforests have irreplaceable ecological value – it's one way to reduce manmade greenhouse gases.

"European crop forests are expanding, while the use of trees is declining because we're using less paper," explains Michael Ramage. "We're actually cutting down far less than we are growing, at a time when timber as a structural material is achieving a higher value. Timber plantations would also provide struggling farmers in industrialised countries with a new source of income."

A greater use of timber in construction – together with more trees, parks, green roofs and vertical gardens – will also reduce the urban heat island effect: the phenomenon of higher temperatures experienced in cities due to concrete and tar soaking up thermal energy and radiating it back into the atmosphere.

More timber buildings and large, shadebearing trees would mean a lower gauge on the thermometer – and cleaner air in cities (a mature tree removes 60 to 70 times the pollution of a sapling). A report by the UN Food and Agriculture Organisation released in July called for more wood and wood-based materials to be used in construction instead of non-renewable materials like concrete, brick and steel.

Wooden buildings are, of course, nothing new. Japan's five-storey Horyuji Buddhist temple in Nara, built more than 1400 years ago, has survived earthquakes, fires and floods. But in most countries, timber lost its allure – especially for the construction of monumental buildings – once the art of stonemasonry and, later, bricklaying took hold. Even today, there is a resistance to large-scale timber construction for three age-old, common-sense reasons. It rots. It's a fire risk. It's not rigid or heavy enough for high-rise construction. The challenges are certainly real, but those at the forefront of engineered wood construction insist most are being swiftly overcome – if they haven't already.

Many are betting their careers and money on a big future for high-rise "big timber". And the good news is that some of those at the cutting edge of this new timber wave are in Australia.

On a crisp, sunny morning in late July, as droves of office workers scurry across Sydney's new City Walk Bridge to their jobs in Barangaroo's gigantic glass towers opposite, architect Jonathan Evans grabs my arm, stopping me in my tracks. We're only 50 metres from the site of Evans' latest project, International House Sydney, a seven-storey timber office building now under construction at the gateway of Barangaroo. Evans is keen for me to get a first glimpse – from this elevated vantage point – of a design flourish on its façade.

It turns out to be a dazzlingly elegant two-storey-high wooden colonnade stretching the entire length of the building; it will be the first thing pedestrians see as they cross into Barangaroo from the city side. "The colonnade links all of Barangaroo from north to south," says the tall, soft-spoken Evans, eyeing his handiwork, which he designed with veteran architect Alec Tzannes. "If you have a front door, you want it to be inviting and attractive, right?"

What strikes me first as we enter the site of International House, fitted out in our regulation high-vis jackets, hard-hats and steel-capped boots, is the faint woodsy smell of the three storeys already completed. Not only do the exposed CLT ceilings and walls, made from pine and spruce, feel warm and inviting, but they exude a pleasant resinous scent (a change from the acrid smell of freshly poured concrete). But it's when you see the core of the construction – the timber lift shaft and load-bearing walls – that you realise this is a building (apart from its concrete foundations) built entirely of CLT (for floors, ceilings and walls), and glulam (for beams and posts).

I'm the first journalist to visit the site, and I notice something else besides the absence of concrete odour: no thundering din. Because the mass timber panels, prefabricated in Austria, are craned, slotted and screwed into position with next to no waste, there's far less construction noise – and, I'm told, much less back-and-forth of cement trucks and other heavy vehicles, thus lightening traffic congestion in local streets and reducing noise.

CLT and glulam structures of this size typically require only a handful of "timber installers" to build and are completed within a shorter time. International House Sydney will be finished next May, three months earlier than an equivalent concrete building. What's more, International House will have superior thermal and acoustic properties compared to most of its neighbours.

Evans is among a small club of architects in Australia who love designing with timber, especially on large-scale projects. He just loves its look and feel. In his inner-city Chippendale office a few weeks earlier, he lifted up a piece of CLT the size of at least two bread bins. "As architects, we like to touch and feel the materials," he explained. "Timber has a tactile quality like no other." Not all of the new generation of timber high-rises wear their wood-grain on their sleeve. The exterior of Melbourne's Forté, for example, is covered in cladding; International House, however, celebrates its timber structure from its colonnade to its roof.

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It turns out that timber buildings aren't just healthier for the environment but for the humans who live in them, producing benefits similar to those of being out in nature: lower blood pressure and heart rate. A 2009 study by Austria's Human Research Institute shows that children taught in timber buildings experience less stress and concentrate better; timberbuilt retirement villages promote tranquillity, according to studies in the UK and Finland; and in Japan, positive benefits have been noted in neurological clinics constructed from wood.

People are "innately drawn towards wood, which elicits feelings of warmth, comfort and relaxation ..." concludes a study by Planet Ark published last year.

Jonathan Evans says there is now a push in the UK and Germany for homes for the elderly to be built out of wood. "There is a strong belief that timber buildings provide a more serene environment; they feel more human," he says.

But wouldn't a wooden skyscraper risk turning into a towering inferno if a fire broke out? Not with mass timber technology, according to José Torero Cullen, a professor of fire safety engineering at the University of Queensland. He has been testing fireproofing in wooden buildings, including a prototype of a small apartment in which the furnishings are consumed by flame, but the walls and ceilings are not. "If a fire begins in the outer layers of the CLT, panels will only char, protecting the core," he says. This means that if a timber high-rise did ignite, the structural integrity of the building should be maintained (even steel buckles under extreme heat, turning to spaghetti at about 260˚C).

A construction challenge for all skyscrapers, but particularly lighter, timber ones, is swaying. Wind pushes against structures and accelerates upward in what's known as the stack effect. One solution to reduce sway is to add concrete elements in the middle storeys and roof.

"A timber high-rise of 25 storeys is manageable and feasible," says Andrew Nieland, an architect with Lend Lease, the company behind Melbourne's Forté and Sydney's International House. "Beyond that, you need a hybrid building, one with concrete or steel inclusions. Even so, you'll still save an enormous amount of carbon emissions if the bulk of the building is timber."

The beauty of timber is that it can work in multiple design languages, adds Nieland. A structure can be given curves, round corners, and virtually any form of embellishment. "Timber is a traditional building material that can be used in a 21st-century way," he says.

That very lightness of timber can be an advantage in seismically active areas if the buildings are well constructed (in Haiti, Nepal and Japan, many timber buildings remained standing amid a sea of grey rubble in the wake of major earthquakes). And timber high-rises may have a role to play in areas of soft soils (Shanghai, for example, has sunk 40 centimetres in the past 50 years, a legacy of its soft soils and global warming, possibly made worse by the weight of its vast mountain of skyscrapers).

"Timber buildings have the resilience of trees; they can creak and move. Concrete buildings have a cracking point; once they start to crumble, they have to be rebuilt," observes Dylan Brady, chief architect with Decibel Architecture in Victoria. Brady has designed an eight-storey CLT building in Punt Road, Melbourne, which he describes as "townhouses in the sky".

The other value of a timber high-rise, adds Brady, is that its materials can be recycled at the end of its lifespan (estimated at 150 years at least). "Timber buildings and timber hybrids are at the cutting edge, but it's important not to be over-zealous," he cautions. "They are perfect for a growing number of – but not all – situations."

Cambridge's Michael Ramage believes the most likely roadblock ahead for tall wooden towers is not engineering, but public attitude. He admits the idea of living in a timber skyscraper takes some getting used to. "It's difficult to get people out of the mindset that steel or concrete are intrinsically more secure," he says. "But isn't it great that the building material showing the most promise in the world today is the one that humans have had an affinity with since we started looking for shelter beyond the caves?"

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