Architect: Michael Green Architects; photo courtesy of naturally:wood

With six stories plus a penthouse and mezzanine, the Wood Innovation and Design Centre in British Columbia is (for the moment) North America's tallest contemporary wood building.

Tall Wood Takes a Stand

Examining North America's evolution toward taller wood buildings

Sponsored by reThink Wood

There is a quiet shift on the horizon—one that has the potential to change North American skylines.

Heightened awareness of the environmental benefits of wood combined with advances in wood technology and manufacturing have aligned to make tall wood buildings not only possible but safe and cost effective.

While the increasing number of code-approved, light-frame wood construction projects reaching five and six stories has helped North American building professionals raise their comfort level with wood, a number of forward-looking architects, engineers, and developers have been actively pursuing more.

In 2012, *The Case for Tall Wood Buildings*[1] outlined a compelling argument for building taller wood structures, showing that mid-rise (six to 12 stories) and tall buildings (up to 30 stories) could be safely, efficiently, and economically built using mass timber construction techniques.

Now, the *Survey of International Tall Wood Buildings*[2] demonstrates how these techniques have been successfully used in "tall wood" projects worldwide. Design approaches range from conventional platform-based systems made from cross laminated timber (CLT) to glued-laminated (glulam) timber framing to composite wood-concrete and wood-steel building systems. Examples include (among others) a 10-story CLT apartment building in Australia, a 14-story timber-frame apartment in Norway, and an eight-story CLT apartment in the U.K. Closer to home, a six-story wood building (plus mezzanine and penthouse) was recently completed in British Columbia—becoming, for a moment, the tallest contemporary wood building in North America.

This continuing education course explores the evolution toward taller wood buildings, including motivating factors, fire and life safety, structural performance, and relevant changes to the *International Building Code* (IBC). Examples

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Learning Objectives

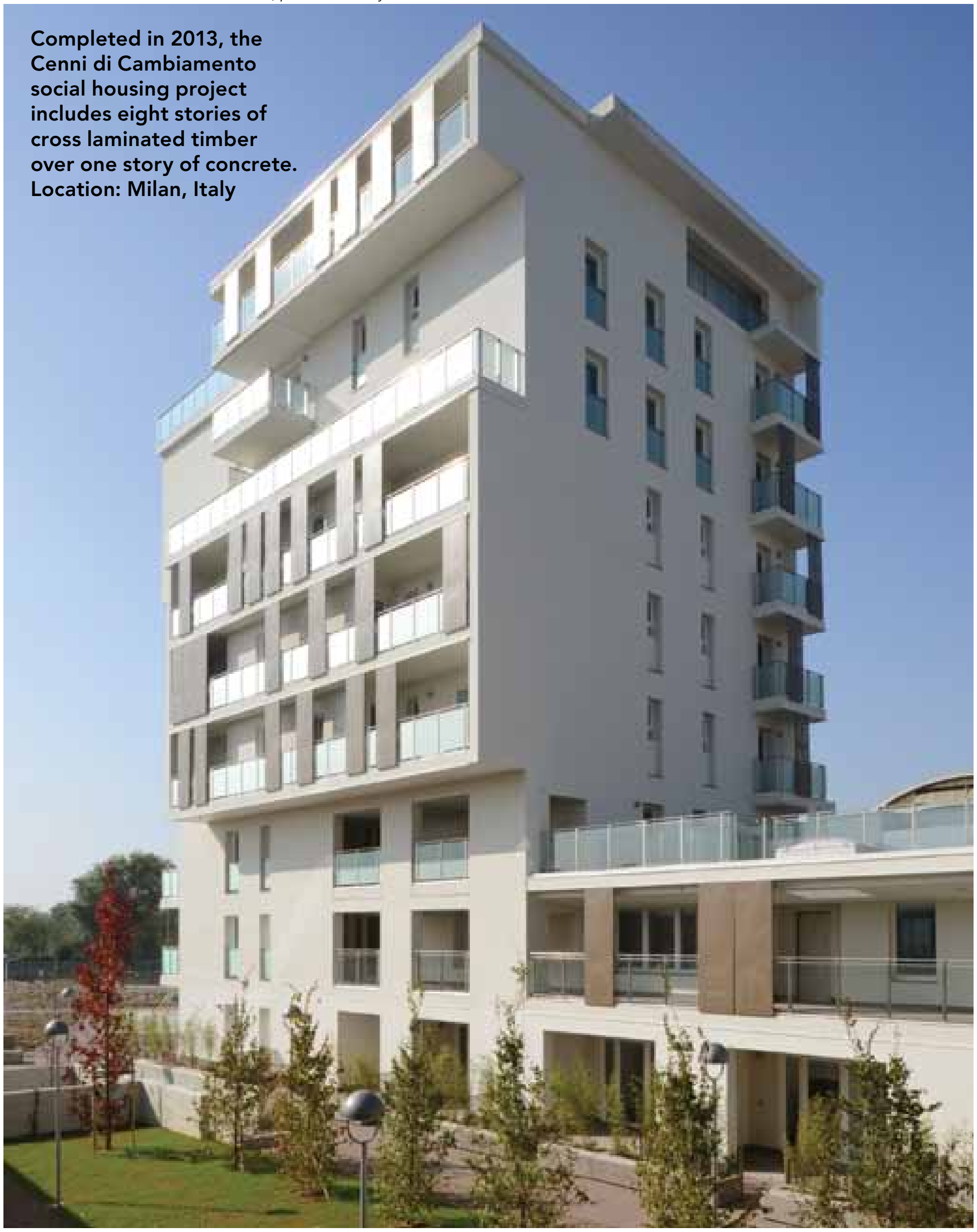
After reading this article, you should be able to:

1. Recognize that mid-rise and taller wood buildings can be safely, efficiently, and economically built using mass timber construction techniques.
2. Discuss different design approaches to mass timber construction for tall wood buildings.
3. Explain similarities and differences between the structural composite panel and lumber products that allow building professionals to design and construct tall wood buildings.
4. Distinguish the differences between design approaches to achieving the acceptable structural passive fire protection measures in a mass timber building.

To receive ICC credit, you are required to read the entire article and pass the test. Go to **www.awc.org** for complete text and to take the test for free.

AWC COURSE #MAT241-A
ICC COURSE #4779

Architect: ROSSIPRODI ASSOCIATI srl; photo courtesy of Riccardo Ronchi



Completed in 2013, the Cenni di Cambiamento social housing project includes eight stories of cross laminated timber over one story of concrete. Location: Milan, Italy

of tall wood buildings are featured throughout, with an emphasis on design approaches and materials used.

THE INSPIRATION BEHIND TALL WOOD

What's driving the move to use wood in taller buildings? While cost effectiveness is usually cited as the number one reason to specify wood-frame construction, the recent *Survey of International Tall Wood Buildings*—undertaken by architecture firm Perkins+Will on behalf of the Binational Softwood Lumber Council and Forestry Innovation Investment—found that designers pushing boundaries with taller wood buildings are doing so because of innovation, market leadership, and carbon reduction. Energy efficiency and healthy indoor environments that promote a sense of well-being were found to be complementary objectives.

From an environmental perspective, wood grows naturally and is renewable. Its carbon benefits derive from the fact that wood products continue to store carbon absorbed by the trees while growing, and wood manufacturing requires less energy and results in less greenhouse gas emissions than the manufacture of other materials. Life cycle assessment studies consistently show that wood outperforms other materials in terms of embodied energy, air and water pollution, and global warming potential.[3]

However, while designers are increasingly driven by the need to find safe, carbon-neutral, and sustainable alternatives to steel and concrete, these new systems must be cost competitive in order to achieve any real market traction over the long term.

WOOD IS ...

- Strong, lightweight, and versatile
- Sustainable, natural, recyclable, renewable
- Carbon efficient, since it sequesters carbon and reduces greenhouse gases in the atmosphere
- Cost effective and abundant—easy to source locally
- Reliable, providing proven performance for seismic, wind, and other loading conditions
- Energy efficient, with lower thermal conductivity
- Warm, visually appealing, and inviting

Cost Competitive

The IBC allows five stories of wood-frame construction (plus a wood mezzanine) for most occupancy types, including multi-residential, and six stories for business. These buildings, which utilize dimension lumber and structural wood panels as well as engineered lumber components, have proven themselves to be cost-effective alternatives to light-gauge steel and concrete.[4]

Taking wood to the next level, mass timber construction uses large prefabricated wood members such as CLT, laminated veneer lumber (LVL), and laminated strand lumber (LSL) for wall, floor, and roof construction. Glulam can also be used in column and beam applications. (For more details on these products, see the online version of this course.)

From a cost perspective, mass timber products cannot compete with light wood-frame construction for most low- and mid-rise projects. Rather, engineered for strength and dimensional stability, mass timber offers an alternative to steel and concrete where light wood framing may not be applicable.

For example, the U.S. CLT Handbook says that CLT becomes more cost competitive at higher building heights or sizes, indicating that mass timber products may be an attractive choice for mid-rise, industrial, retail (one to two stories), and educational (two to three stories) buildings.

To assess the potential for taller wood structures, a recent *Study of Alternative Construction Methods in the Pacific Northwest* by Mahlum Architects compares the cost of using CLT, concrete, and steel for a 10-story building in Seattle, which the authors refer to as "low high-rise." According to the report, "Common assumptions for the Seattle market dictate that concrete is too expensive for building only slightly above midrise. Consequently, lots in certain zones may not get built out to their maximum zoning height potential."

The report concludes that a 10-story CLT building in Seattle offers an estimated 4 percent cost savings compared to a concrete alternative and a 2 percent savings over steel. However, these estimates are conservative as the study assumed cost premiums associated with the newness of CLT in the North American market and lack of familiarity among contractors.

Adding to their cost advantage, mass timber structures can generally be erected much more quickly than structures made from other materials. For example, development company Lend Lease estimates that the 10-story Forté apartment building in Melbourne, Australia (see sidebar), was built 30 percent faster because the CLT was prefabricated. Off-site panelization saves money by speeding installation, which leads to faster occupancy. Wood structures also tend to weigh less than other materials, which can reduce foundation requirements and thus foundation costs. This feature is especially important in areas with poor soil where foundation costs are already high, as was the case with the Forté project.

Project: Forté
Location: Melbourne, Australia
Architect/Developer/Contractor: Lend Lease
Completed: 2012

Rising 10 stories, Forté is Australia's first CLT building and first timber high-rise.

The developer, Lend Lease, chose a conventional platform-based system for the $11-million project, which includes 23 apartments and four townhouses. Speed of construction was a huge priority. Construction began in February 2012, installation of the CLT began in May, and the wood portion of the structure was completed in August—a timeline Lend Lease estimates as 30 percent faster than concrete.

While CLT's ability to meet safety and quality requirements was fundamental to the project, Lend Lease cites its environmental benefits as a key motivation for its use. Forté is expected to be the first 5 Star Green-Star As Built-certified residential building in Australia. By using CLT, the structure is also expected to reduce carbon dioxide (CO_2) equivalent emissions by more than 1,400 metric tons when compared to concrete and steel—the equivalent of removing 345 cars from Melbourne's roads.[5]

Photo courtesy of Lend Lease

Mark Menhinnitt, chief executive officer for Lend Lease's Australian business, says, "CLT will transform the construction industry by introducing a more efficient and environmentally friendly construction process that has never been undertaken in Australia before. By adopting green technologies, materials, and construction processes, we are closer to creating livable, sustainable cities that are climate positive."

Lend Lease reported that costs to build Forté with CLT were comparable to concrete. Going forward, the company plans to develop 30 to 50 percent of its Australian apartment projects using CLT.

SAFETY AND PERFORMANCE

While there are many advantages driving the increased use of wood in tall buildings, it is a fundamental requirement that these buildings meet the same standards for safety and performance as buildings made from other materials.

Tall Wood Fire Safety

Although fire safety is often cited as a barrier to building tall structures with wood, research shows otherwise. Mass timber buildings behave very well in fire, primarily because the wood's thick cross-section chars slowly. Once formed, char protects the structural integrity of the wood inside and prevents further degradation. In addition, mass timber systems are similar to concrete slab, solid wall, and heavy timber systems in that they tend to limit combustible concealed spaces. The solid wood panels themselves essentially form the fire-rated assemblies between building compartments, reducing a fire's ability to spread undetected.

There are two design approaches to achieving the acceptable structural passive fire protection measures in a mass timber building. Encapsulation is used to provide fire-resistance rating to timber structures, but charring is increasingly accepted around the world as a valid means of realizing reliable and safe structural performance in fire.

Encapsulation – Designers can apply one or two layers (depending on the fire assembly required by code) of fire-rated gypsum board to the underside of floors and throughout the building to reach the desired protection level. This method is similar to standard construction techniques used to construct fire-rated floor, roof, and wall assemblies in both combustible and noncombustible building types.

Charring – The solid wood members used in mass timber construction allow a char layer to form during a fire situation. This, in turn, helps insulate the remaining wood from heat penetration. The fire-resistance rating of large-size members can be calculated based on minimum structural thicknesses and the remaining sacrificial thickness available for charring. By combining modern fire suppression systems and compartmentalization, structures can be detailed to safely resist fire without encapsulation, using charring calculation methods. This eliminates the need for the gypsum board, reducing building weight and cost while showcasing the natural beauty of the exposed wood.[6]

For the WIDC project (see the online version of this course), fire protection is provided through a fully engineered approach based on charring. Rather than protecting the wood structure from exposure to fire by covering it with noncombustible material, the wood is left exposed and the required structural sections

CLT FIRE TESTING RESULTS

In October 2012, the American Wood Council (AWC) conducted a successful fire resistance test on a load-bearing CLT wall at NGC Testing Services in Buffalo, New York. The test, conducted in accordance with ASTM E-119-11a (*Standard Test Methods for Fire Tests of Building Construction and Materials*), evaluated CLT's fire-resistance properties. The five-ply CLT wall (approximately 6-7/8 inches thick) was covered on each side with a single layer of 5/8-inch Type X gypsum wallboard and then loaded to 87,000 pounds, the maximum load attainable by the NGC Testing Service equipment. The 10 x 10 foot test specimen lasted three hours, five minutes, and 57 seconds (03:05:57)—well beyond the two-hour goal.

are oversized. As a result of their increased size, these members have a "sacrificial" layer of wood; they've been calculated to char at a predictable rate in a fire in order to provide the needed level of protection.

Similarly, the fire design for the 14-story Treet (see sidebar) was based on the cross-section method of the Eurocode, which determines the residual cross-section after charring. The main load bearing system was required to resist 90 minutes of fire without collapse, and secondary load bearing systems such as corridors and balconies were required to resist 60 minutes of fire exposure. In addition to the charring calculations, fire protection measures for this project include fire painting of wood in escape routes, sprinkler systems, and elevated pressure in stair shafts.

Performance

Wood has a number of properties that make it well-suited for tall structures.

Structural/seismic – In terms of their strength-to-weight ratio, engineered wood products generally match and, in some cases, exceed the performance of reinforced concrete.[7] In addition, timber's weight is just 25 percent of reinforced concrete, placing less gravity and seismic loads on the structure and foundation.[8] Mass timber building components are dimensionally stable and rigid, creating an effective lateral load-resisting system. Extensive seismic testing has found that CLT panels perform well in multi-story applications, with no residual deformation. Tested buildings have shown ductile behavior and good energy dissipation, mainly influenced by their mechanical connections.

In one study, for example, researchers tested a seven-story CLT building on the world's largest shake table in Miki, Japan. Even after 14 consecutive seismic events, the building suffered only isolated and minimal structural damage.[9] Assuming an actual building performs the same as the test building, the rehabilitation and repair required following an earthquake would also be minimal.

This aspect of CLT's performance is also relevant in the context of sustainable design and, in particular, the growing emphasis on disaster resilience. As noted in the U.S. CLT Handbook, "There is a considerable advantage to having a building with the ability to quickly return to operation after a disaster and in the process minimizing the life cycle impacts associated with its repair. Based on full-scale seismic testing, it appears that CLT structures may offer more disaster resilience than those building with other heavy construction materials."

Thermal – From an energy-efficiency perspective, different materials and exposure conditions for taller buildings will dictate different—and likely more rigorous—approaches to heat, air, and moisture control than for buildings up to six stories. However, it is worth noting the unique characteristics of mass timber building systems that lend them to the design of energy-efficient structures.

Like all wood products, mass timber offers excellent thermal performance. Wood's thermal properties are determined by U-value, or coefficient of heat transfer, which relates to panel thickness. Thicker panels have lower U-values; they are better insulators and therefore require less insulation. The way in which mass timber buildings are constructed also improves its thermal performance. CLT, LVL, and LSL can be manufactured using computer numerical control (CNC) equipment to precise tolerances, so panel joints fit tightly, which can improve energy efficiency. However, while panels may offer an inherent level of air tightness, an additional air barrier is recommended. It is also critical that panel joints

Photo courtesy of Sweco/Artec/3Seksti

Project: Treet (The Tree)
Location: Bergen, Norway
Architect: Artec
Completion: Fall 2015

While Forté has held the "tallest wood building" record since 2012, Treet—a 14-story timber-frame project in Norway—is under construction and scheduled for occupancy in the fall of 2015.

The luxury apartment building, which includes 62 residential units, a fitness center and rooftop terrace, consists primarily of load-carrying glulam trusses and prefabricated building modules made from traditional timber framing. To address potential wind loads, it also includes concrete decks on floors 5 and 10, and on the roof.

"Even though the glulam trusses are incredibly stiff, the lightness of the wood building meant that it would move more than was acceptable in high winds," says Rune Abrahamsen of the structural engineering firm Sweco. "By adding mass, the total system restricts accelerations to a maximum of 0.04 m/s^2, which is in compliance with the comfort criteria given by the ISO standard."

According to Abrahamsen, the design concept can be explained using the analogy of a cabinet filled with drawers. The glulam trusses represent the cabinet itself, and the modules are the drawers. The modules are stacked in multiples of four, or singly on the strengthened levels—i.e., on stories 1-4, 5, 6-9, 10, and 11-14.

While the interior walls, corridors, elevator shaft, and balconies are CLT, CLT is not part of the main load-bearing system. The building will be clad in glass and metal sheeting to protect the structural timber from rain and sun.

Sweco has previously done feasibility studies on two tall timber buildings in Norway—a 20-story office building and a 15-story apartment building.

"We have found that timber high-rises are perfectly feasible from an engineering point of view," says Abrahamsen. "They also address the need for sustainable building in urban areas."

According to the project owner, the Bergen and Omegn Building Society, the wood products used in Treet will store approximately 1,000 metric tons of CO_2.

Architect: Arkitektbolaget Kronoberg; photo courtesy of Midroc Property Development

The Limnologen includes four buildings, each with seven stories of CLT over one story of concrete. Location: Vaxjo, Sweden

Photo courtesy of IVALSA

Seven-story CLT building being tested on the world's largest shake table in Miki, Japan

and interfaces as well as penetrations such as windows and doors be properly air sealed.

Acoustics – Tall buildings are often used for apartments or condominiums, where noise control is critical. Because the mass of a wall contributes to its acoustic performance, mass timber building systems provide appropriate noise control for both airborne and impact sound transmission, often without the need to add additional acoustical layers. However, as noted in the U.S. CLT Handbook, a large part of achieving acceptable acoustic performance is simply giving adequate attention to details in the design and construction of the project. This includes proper use of sealants or caulking to seal sound leaks, avoiding rigid contact between building elements where the transfer of vibrational energy between spaces is possible, and using appropriate materials (e.g., materials with sufficient mass).

Building Height Considerations

Because they use engineered wood products, mass timber buildings have minimal shrinkage over time because the moisture content of the wood used in engineered wood is typically just 8 to 10 percent. Therefore, mass timber products experience little shrinkage along the main axis of the material during the life of a building. Slightly more shrinkage can be found across the thickness of CLT material than with LSL or LVL due to CLT's solid wood composition. Therefore, platform-based CLT construction (which includes CLT floors and walls) can result in slightly more accumulative shrinkage over the height of the building than systems that rely more heavily on LVL or LSL, requiring additional consideration in the detailing of the exterior envelope.

Wood-frame structures can also shorten vertically due to loading, so designers must include design considerations to accommodate this, particularly as the buildings get taller. Possible solutions include the use of a continuous rod tie-down system with a shrinkage compensation device to limit lateral deflection and avoid wall separation under wind and seismic forces. Designers can also include expansion joints in the cladding and provisions in the mechanical systems to allow for movement. There are many design support materials that help simplify these calculations for tall wood buildings.

Code Approvals

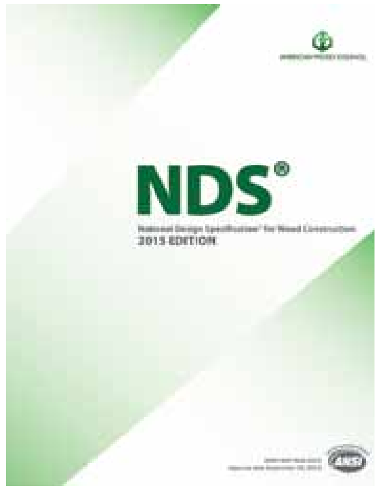
Code-allowed height for combustible buildings varies around the world. Currently, U.S. and Canadian building codes do not explicitly recognize mass timber systems, but this does not prohibit their use under alternative method provisions.

In the next edition of the IBC, recently approved changes will streamline the acceptance of CLT buildings. In May 2012, APA published *ANSI/APA PRG 320-2011 Standard for Performance-Rated Cross-Laminated Timber*, which details manufacturing and performance requirements for qualification and quality assurance. The 2015 edition of the IBC will recognize CLT products when they are manufactured according to the standard. CLT walls and floors will be permitted in all types of combustible construction, including use as exterior bearing walls in Type IV buildings.

The 2015 IBC will also recognize the 2015 *National Design Specification® (NDS®) for Wood Construction*, which is published by the American Wood Council (AWC) and has been approved as an American National Standard by the American National Standards Institute. Available as of December 1, 2014 on the AWC website (www.awc.org), the 2015 NDS includes a number of changes relevant to mass timber, such as a new product design chapter for CLT and new provisions that explicitly permit the use of structural composite lumber (e.g., LVL and LSL) to meet fire protection requirements.

One of the primary challenges facing tall wood designers is the fact that residential buildings over six stories (and exceeding a certain total building area) are required to be of noncombustible construction; taller projects will require well-proven fire performance. Fire resistance testing confirmed that CLT exterior walls exceed the requirements for heavy timber construction. Because CLT construction typically eliminates concealed spaces, this enhances its ability to meet Type IV construction requirements.

See endnotes in the online version of this article.



TALL WOOD AROUND THE WORLD: LESSONS LEARNED

For the *Survey of International Tall Wood Buildings*, architecture firm Perkins+Will examined 10 tall wood building projects in several countries. The goal was to learn from early adopters and present common lessons based on the experiences of four key stakeholder groups: the developer/owner, design team, authorities having jurisdiction, and construction team. Topics included project insurance, project financing, and building operations and performance.

The majority of the building projects were located in Europe, and the results revealed some important distinctions about building construction practices. Among other things, Europe has a strong regulatory grounding that supports the use of low-carbon materials, renewable resources, and energy efficiency in construction. These policies directly and indirectly encourage tall wood and mass timber construction. For the buildings surveyed, there was also significant blending of professional roles across related sectors, creating a strong ethos of collaboration between developers, designers, timber fabricators, and researchers. These nuances appear to be significant for potential designers of tall wood buildings in North America. Among the lessons learned:

Commitment – All stakeholders stressed the importance of committing to a timber solution at the start of a project.

Planning – All stakeholders indicated the importance of pre-planning and investing significant effort early in the design development process to identify and resolve issues and conflicts.

Collaboration – Stakeholder groups were directly linked to or had strong collaborative ties with each other, researchers, and timber fabricators. In several cases, engaging early with the authority having jurisdiction and directly involving that person in the development process was key to gaining approvals for fire protection and acoustic performance.

Holistic innovation – Most stakeholders emphasized the need to approach mass timber/tall wood projects as wholly innovative rather than with a focus on just an application, a component, or a system that is related to wood elements.

Experiences regarding financing and insurance costs or conditions suggest very little deviation from typical requirements for conventional tall reinforced concrete or steel buildings or for low-rise wood structures. No owner/developer experienced challenges obtaining financing attributable to the use of mass timber. In all cases, stakeholders reported they managed to overcome any approval, design, or construction obstacles without exceeding the projected budgets. No owner/developer indicated any irregularities regarding building operations or performance.[10]

Project: Bridport House
Location: Hackney (London), UK
Architect: Karakusevic Carson Architects
Completed: 2011

Built using a conventional platform-based CLT system, Bridport House includes 41 homes in two joined buildings; one with eight stories of wood construction and the other with five. All elements from the ground floor up are made from CLT, including the elevator shaft. As is typical of these buildings, the below-ground level is made of reinforced concrete.

Developers chose to use wood for Bridport House for several reasons—namely, the structural capabilities of CLT, speed of construction, and environmental advantages. The project was built over an old sewer line that runs through London; the line is big enough to drive a double-decker bus through but could not sustain the loads of a heavy concrete building above. Wood's light weight allowed the developer to maximize use of the site while still meeting below-ground requirements. In fact, the structure was twice as high as the previous building, while the weight increased by only 10 percent.

On-site assembly took just 12 weeks, primarily because the CLT panels were prefabricated off-site and then lifted into place. EURBAN, the project's timber engineer, estimates that on-site assembly time was 50 percent faster than conventional reinforced concrete.

The environmental benefits of using wood for Bridport are also noteworthy. If the building had been constructed of conventional reinforced concrete, the materials required would have incurred an additional 892 tons of carbon; that's equivalent to 12 years of operational energy required to heat and light all of the project's residential units. When the carbon sequestered in this timber structure is added to the greenhouse gas emissions avoided, the total figure is 2,113 tons of carbon dioxide equivalent—which translates to 29 years of operational energy. Plus, because of the precise tolerances created during the CLT manufacturing process, the structure's airtightness measured three times better than that required by local building regulations.[11]

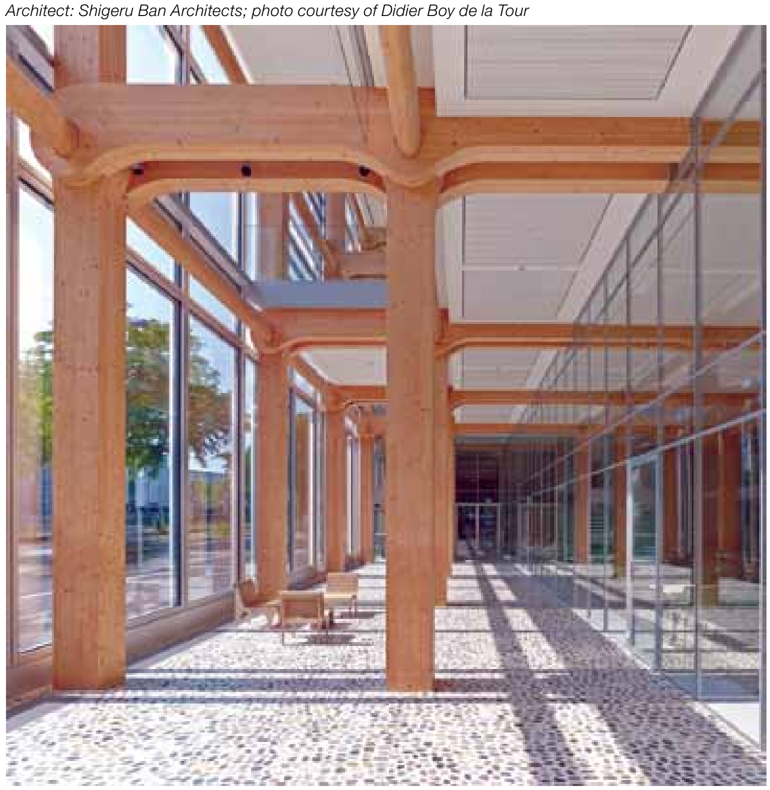
Photo courtesy of Karakusevic Carson Architects

RESPONSIBLE REVOLUTION

Tall wood buildings are capturing the imagination of architects, engineers and developers, who see them as a way to lessen the carbon footprint of the built environment while demonstrating ingenuity and meeting the same standards for safety and performance as any building type.

Although relatively new as a building category, examples of tall wood building to date are noteworthy for (among other things) their variation in design, from all-wood buildings made from CLT or a combination of dimension lumber and engineered wood products, to hybrid buildings of wood and other materials. Among the many accelerating aspects of the tall wood revolution—such as seismic and other testing that will form the basis of further building code developments—innovations in approach will be one of the most exciting to watch as some of North America's most creative minds embrace the challenge of designing tall wood buildings.

Architect: Shigeru Ban Architects; photo courtesy of Didier Boy de la Tour



For the six-story Tamedia, a post-and-beam structure was used to achieve large spans and open floor areas that can be easily customized and changed. Location: Zurich, Switzerland

COMMON MASS TIMBER PRODUCTS

Cross Laminated Timber (CLT) is an engineered wood panel typically consisting of three, five, or seven layers of dimension lumber oriented at right angles to one another and then glued to form structural panels with exceptional strength, dimensional stability, and rigidity. CLT is manufactured to customized dimensions; panel sizes vary by manufacturer. It is currently available in North America with dimensions up to 1.6 feet thick, 9.7 feet wide and 54.1 feet long. While length is usually limited by transportation restrictions, longer panels can be manufactured. CLT panels are typically installed like plywood in terms of grain orientation. Wall panels are oriented with the grain of the outside layers parallel to the vertical loads of the application. Floor and roof applications have the grain of their exterior layers oriented parallel to the span direction.

Since CLT panels resist high racking and compressive forces, they are particularly cost effective for multi-story and long-span diaphragm applications. Some specifiers view CLT as both a product and a system that can be used interchangeably with other wood products; it can also be used in hybrid applications.

Laminated Veneer Lumber (LVL) is produced by bonding thin wood veneers together using waterproof adhesives under heat and pressure and then sawn to desired dimensions. The wood grain of the veneers is oriented parallel to the length of the member. Since it is manufactured with kiln-dried wood veneers and because each veneer layer is oriented in the same direction, LVL has predictable structural performance and dimensional stability, being virtually free from warping and splitting. LVL can be manufactured in a broad range of widths, depths, and lengths.

Laminated Strand Lumber (LSL) is also an engineered structural composite lumber product manufactured by aligning thin chips or strands of wood up to 6 inches in length and gluing them under pressure. Like LVL, the wood grain of the strands is oriented parallel to the length of the member, and the wood member is then machined to consistent finished sizes. Common LSL sizes range up to 8 feet wide and 64 feet long. It is strong when either face- or edge-loaded, but typically has lower strength and stiffness properties than LVL.[12]

Glued-Laminated Timber (Glulam) is composed of individual wood laminations (dimension lumber), specifically selected and positioned based on their performance characteristics, and then bonded together with durable, moisture-resistant adhesives. The grain of all laminations runs parallel with the length of the member. Glulam can be used in horizontal applications as a beam, or vertically as a column. Glulam is available in depths from 6 to 72 inches or greater and in lengths up to 100 feet and longer. Glulam has excellent strength and stiffness properties (pound for pound, it is stronger than steel[13]), and is available in a range of appearance grades for structural or architectural applications.

Photos courtesy of: (CLT) FPInnnovations; (LVL, LSL and glulam) APA – The Engineered Wood Association

Project: Wood Innovation and Design Centre
Location: British Columbia, Canada
Architect: Michael Green Architecture
Completed: 2014

The 96-foot-tall Wood Innovation and Design Center (WIDC) is a gathering place for researchers, academics, design professionals and others interested in generating ideas for the innovative use of wood products. Designed to achieve LEED Gold certification, it includes eight levels—six 'stories' as defined in the building code plus a penthouse and mezzanine.

The design has an intentional simplicity, a choice made in the interest of seeing more architects, engineers and developers leverage the value of mass timber as an alternative to steel or concrete.

The concept is a "dry construction" design, which virtually eliminates the use of concrete above grade except at the penthouse level. Among the benefits, this allows the wood structure to be exposed as the ceiling finish; it also makes it easier to disassemble the building at the end of its functional service life, allowing re-use of the wood products.

The project consists of an innovative combination of glulam post and beam construction and built-up CLT floor panels.

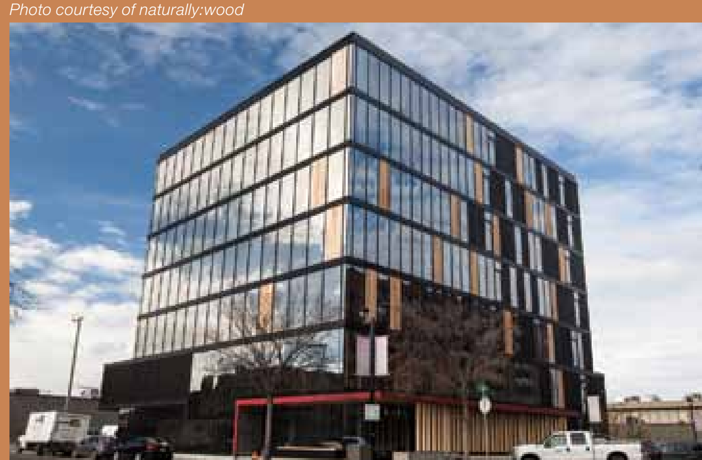
The beams frame into the columns using proprietary aluminum dovetail connectors, which allow the columns to run continuously from foundation to roof.

The all-wood floor system spans nearly 20 feet between the post and beam frames. Selected to minimize the use of concrete and thus weight, it also reduced construction time, which was a critical objective for the project. The innovative system consists of overlapping three-ply upper CLT panels on five-ply or seven-ply lower CLT panels; the upper and lower panels are connected with adhesives and mesh connectors, providing a fully composite corrugated structural section. Cavities created within this section accommodate services above and below the floor structure.

Lateral load resistance is provided mainly by the elevator and stair core walls, which consist of CLT panels connected vertically with self-tapping screws. The shear walls are anchored to the foundations using a combination of shear brackets connected to the panels with self-tapping screws and hold-down anchors connected to the panels using the ductile HSK system. (HSK is the German acronym for 'hollow taper shank.')

Wood also plays an important role in the building envelope. For the curtain wall system, high-strength LVL panels are used for window mullions instead of conventional aluminum—a unique and innovative use of wood that is unprecedented at this scale.

Photo courtesy of naturally:wood



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