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Tall Wood Buildings Are Gaining Attention in the Construction World

Dating back centuries, mass timber construction—or **tall wood buildings**—could be making a comeback. Today, tall wood buildings use **engineered wood products** and are generally considered comparable in strength and performance to structures built using materials such as steel and concrete. Additionally, this type of construction is often a more economical choice over steel or concrete, due to a shorter construction time frame, and is attracting interest from green building advocates because of the carbon sequestration benefits of trees. However, due to unclear building codes and concerns over fire safety, construction of tall wood buildings in the U.S. is currently limited.

Tall wood buildings can be constructed using several building systems including all-wood, wood-hybrid, wood-concrete and wood-steel.

Engineered wood products such as nail-laminated timber, glued laminated timber (glulam), cross-laminated timber (CLT), laminated veneer lumber (LVL) and laminated strand lumber (LSL) are made by combining multiple wood pieces, veneer sheets or strands with adhesives. These products can be used for several building applications such as floors, walls, and long-spanning beams. They also have higher allowable design values than traditional sawn lumber and are used as main load-carrying structural members.

Built in 1056, in the Shangxi province of China, the Yingxian Pagoda is a nine-story, 221-foot-tall pagoda completely designed with wood components on a deep stone foundation. It has withstood years of seismic activity, high winds, and extreme moisture with minimal damage.

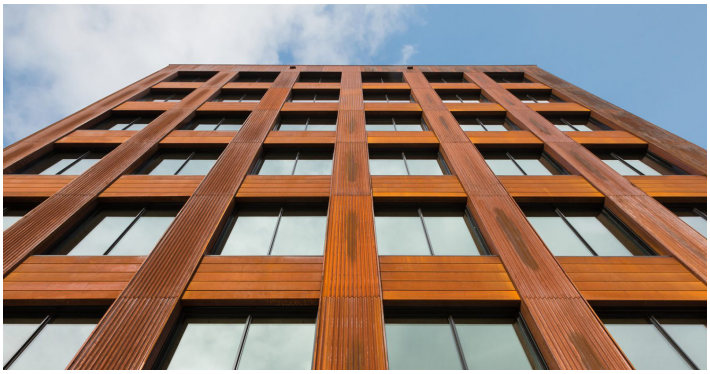
MODERN DEVELOPMENTS

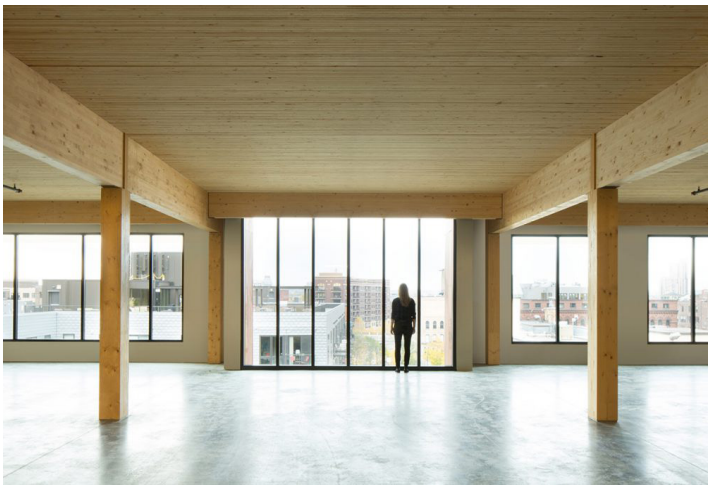
In the early 1990s, designers in Canada began constructing tall wood buildings using a combined structural system of masonry, brick and wood. The exterior walls were constructed of masonry and brick, while larger timber was used for the interior structure. More than a dozen buildings have been built in Canada using this system, with a maximum height of nine stories.

During the last decade, combinations of engineered wood products and hybrid systems have provided designers with alternative wood-based construction practices that provide comparable performance to concrete and steel. Additionally, tall wood buildings can now be built up to 18 stories—such as the University of British Columbia's Brock Commons student residence.

Changes in building codes have also contributed to the design and safety of high-rise wood construction. Along with structural performance, designers and fire safety engineers have been studying fire safety and generally believe that with proper design and fire safety strategies, tall wood buildings can be built to be safely occupied.

Currently, the tallest wood building in the U.S. is the T3 Tower in Minneapolis, Minnesota. Designed by Michael Green Architecture and DLR Group, the seven-story, 220,000-square-foot, wood-hybrid building has a concrete pedestal main floor, concrete core and timber framing from levels 2–7. Having complete commercial occupancy, the design allows for exposed wood ceilings and exposed wood columns.



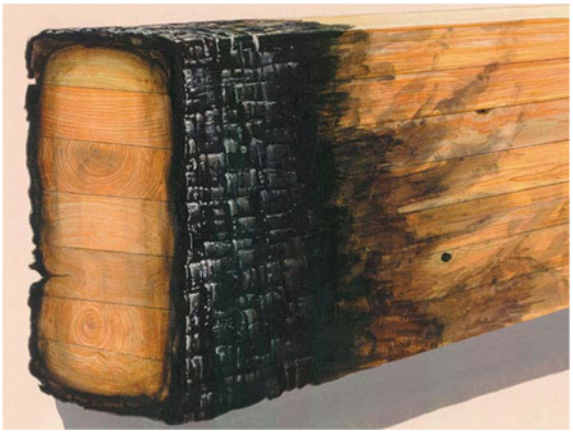


T3 Tower in Minneapolis, Minnesota. Photos by Ema Peter courtesy of MGA | MICHAEL GREEN ARCHITECTURE

OBSTACLES AND CONCERNS IN THE U.S.

Although tall wood buildings have been constructed in Asia, Europe and Canada, they are relatively new to the U.S., in part due to the lack of specificity in building codes regarding safety requirements. Additionally, despite maintaining their structural integrity in fires, flames spread rapidly across the surfaces of wood-based materials, which has historically resulted in the codes' severe regulations and limitations[1]. The International Code Council (ICC), the organization that publishes model building codes in the U.S., has established an ad hoc committee to explore the feasibility and development of proposed changes to the International Building Code® (IBC) to include provisions for tall wood buildings. This group is a cross-disciplinary team consisting of architects, engineers, code officials and manufacturers.

Another big obstacle is that model building codes in the U.S.—the IBC and the National Fire Protection Association's NFPA 5000®—limit maximum height and area of wood-framed structures up to six stories and 202,000 square feet. The building codes' maximum allowable building sizes (i.e., number of stories above grade, building height and floor area) are permitted to be increased depending on whether wood structural members are protected/covered with noncombustible/limited combustible material or if the building is protected with an automatic sprinkler system. With advances in research and new testing that is to be conducted on the fire resistance and structural applications of assemblies made of engineered wood products, as well as new fireproofing and firefighting practices, the requirements of model codes for tall wood buildings are being reevaluated. The ICC ad hoc committee is currently running full-scale mock-up fire tests which evaluate multiple issues such as connection strength after exposure to heat. These tests will serve as the basis for changes to the codes as they apply to fire protection design of engineered wood products and their application in tall wood buildings.



Char layer on glued laminated timber (glulam) beam exposed to fire.

Several highly publicized fires in low-rise wood construction have raised similar concerns for tall wood buildings. If an ignition occurs during construction, the mass timber creates a "char layer" that acts as an insulation and prolongs the fire's penetration into the wood. This layer of char does not significantly reduce the structural stability due to the inherent factor of safety added by the structural engineer. These components will continue to slowly burn until an outside source eliminates the fire. Fire watches, fire extinguishers, hot work permit systems, documented fire emergency plans, temporary fire protection systems and removal of combustible materials help minimize the risk of construction fires.

CONCLUSION

Loss control experts and risk managers should be aware of the construction industry's interest in tall wood buildings. Their popularity is increasing with continued urbanization of cities and the high demand for sustainable design and materials. Tall wood buildings are also attractive to some owners and designers because their lighter weight contributes to a smaller square footage foundation, and the use of pre-fabricated engineered wood products allows for a relatively fast and efficient construction process.

Tall wood buildings are also becoming more popular among architects and designers, but more work is needed to determine their place in the built environment. Full consideration of fire safety and structural integrity should always be part of the decision of whether and how to move forward.

[1] Smulski, Stephen. 1997. Engineered wood products: a guide for specifiers, designers and users. Madison, WI: PFS Research Foundation.