Risks and Rewards of Mass Timber

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As the design and construction industry moves toward more eco-conscious systems to construct the buildings we work and live in, mass timber has made it to the forefront of this change in direction. It is currently a favored building material for many leading architectural firms and is being strongly marketed by the wood industry.

While wood construction has never gone away, its use in large buildings was easily replaced by steel and concrete in the last two centuries. Now with its rediscovery, it is important to remember the reasons why it originally lost its place in large building construction, and more importantly, how to overcome those shortcomings to ensure a successful project.

Three top reasons why mass timber lost out to other materials.

1. During its construction, a mass timber structure is exposed to weather and can remain exposed for a very long time. The wood species used in mass timber are classified as "softwood" which are hydroscopic, meaning they absorb water and can also lose water. This causes mass timber to swell and shrink, often warping as it does so. Given continuous exposure to relatively small amounts of liquid water, or even high humidity, softwood will grow mold, rot, and decay[1]. (Many types of mushrooms grow on decaying wood.) We can now counteract that condition, but only by adding chemicals to the natural product, and manufacturers of mass timber simply don't use such chemicals.

   In addition, sealers and vapor-permeable membranes are needed to protect mass timber components from weather-related water exposure during construction. However, even with the addition of these products, the need to monitor and maintain the moisture content of the wood extends well beyond the construction period and throughout the lifecycle of the building.

2. Wood is combustible, which means it readily burns. So, exposure to fire, if not thick enough, can completely release the wood's sequestered carbon into the atmosphere with some residue ash. If thick enough, mass timber will only char, but will produce vast quantities of smoke which is the main cause of death in most building fires. But at least the structure remains standing. However, the cost of repairing charred structural members may well exceed the cost to replace the building[2]. Fire suppression/protection systems are required for most facilities. Mass timber producers currently do not use fire-treated wood. In the future, maybe we can counteract that capacity, but only by adding some more chemicals to the natural product.

3. While the exposed wood of mass timber can be beautiful in appearance, it is easily stained by construction activities, and some stains are very difficult to remove. Because of this, its installation is much more of an art than other structural materials.

To put it more bluntly, "If someone invented wood today it would never be approved as a building material[3]."

Due to these and other more minor reasons, wood was basically abandoned for structural construction of large commercial and institutional buildings, with a preference toward steel and concrete. Once the building was fully enclosed and conditioned, wood was reintroduced as part of the building's interior design. Even so, most of this reintroduced wood was in the form of hardwoods, and the only softwoods were primarily concealed and either pressure-treated or fire-treated to protect from its shortcomings.

The New Wood

As a response to climate change concerns improving availability, speed on construction, and biophilic considerations, wood in "mass timber construction" is being quickly reevaluated for such buildings' structures. Its implementation has moved beyond the few pioneering designers, manufacturers, and constructors, and into mainstream with much excitement and fanfare.

But is mass timber construction ready to be used by the entire design and construction industry?

Some see the construction of mass timber projects and harken back to images of barn-raising by low-tech and sometimes religiously no-tech constructors. It all seems so simple and easy to build, but adding today's technological advancements, it should now be a piece of cake to build.

However, as noted previously, the properties of softwood have not changed. The major components of the mass timber family include cross-laminated timber (CLT), dowel-laminated timber (DLT), nail-laminated timber (NLT), and mass plywood panels (MPP), which are all composed of softwoods. While barns may have had heavy timber post and beam structures, they didn't have fire-rated floors, roofs, and wall systems, and many were built from hardwoods. They also did not enclose air-conditioned spaces for human inhabitation.

Both the old softwood-heavy timber and today's mass timber remain hydroscopic and combustible. (Note: Neither preservative treated, nor fire-retardant treated wood are currently being used in mass timber panels.)

While softwood is not a new structural material, its use in today's design of mass timber buildings should be considered new. The number of designers and constructors using mass timber is quickly growing; however, very few are well experienced with the nuances of the system's means and methods.

Concerns with Means and Methods

One part of the construction industry that most architects and engineers tend to ignore are the means and methods of construction. They can't be blamed, as back in 1909, the AIA's Owner-Architect Agreement first excluded designers from the responsibility, and their professional liability insurers remind them of this at the start of every policy period!

But a major concern with mass timber pertains to the means and methods: mass timber is exposed to elements and usually for a longer duration than any other materials that have the same type of reactions to the changes in weather/moisture. Rainwater seeping between joints, wall openings, and protrusions can flow down from floor to floor and even into wall systems. Seepage through wall system joints can run both vertically and horizontally, causing other trades multiple problems. This moisture causes the wood to swell and shrink and can then warp the wood as it tries to dry out. Protection systems and methods that are not vapor-permeable can cause more harm than good, especially when encapsulating moisture in permanent weather barriers and roofing, leading to mold and rot.

It's equally important to consider the methods used to stabilize the indoor environment once the building is enclosed. Expecting an inexperienced constructor to understand all these nuances and protect mass timber components is quite the ask, and specifications for mass timber, like most construction products, state little about how the product is to be protected from the elements, rather just that they should be protected.

Pioneers vs Settlers

The initial mass timber design and construct pioneers did their research and planning to have a successful outcome, avoiding swelling, shrinking, warping, rot, decay, mold, and mushrooms.

The settlers that follow these pioneers need to address these concerns with equal proactivity. Mass timber is in a remarkably similar place as Exterior Insulation Finish Systems (EIFS) was in the North American construction industry during the early 1980s. Though proven in Europe, there are few standards to reference when specifying mass timber, with no defined MasterFormat name or Section number. Manufacturers have various levels of services and types of products they provide designers and constructors. Unlike what has unfortunately happened to the reputation of EIFS, we want to see the implementation of mass timber and its environmental benefits succeed for all involved in its use.

Fortunately, the technical information on mass timber has been proactively addressed by the leaders in the subject. Pioneering organizations such as WoodWorks, RDH, and Mass Timber Group have provided extensive open-source and free documentation on the many technical aspects to consider when designing and constructing with mass timber. Additionally , building codes are being quickly updated to address mass timber in multiple construction types.

While there is much research on this subject, there is no CSI 3-part formatted guide specification Section for all the types of mass timber that addresses the concerns noted above. We believe the Section 061710 – Mass Timber can provide a starting point for designer and constructors to confidently use when implementing it in their projects.

Additional Considerations

Since not all conditions can be covered in a specification guide, please address the following in your design's documentation:

- Mass timber construction has unique regulations related to fire resistance, height restrictions, and seismic requirements. Construction and design novices must research regulations to ensure they are meeting these requirements.

- Mass Timber is noted for its greater speed in construction (+/-25%) and subsequent reduced labor compared to traditional construction. That speed assists in limiting moisture exposure.

- Verify mass timber can be used per the building code's construction type, especially exterior wall systems.

- There are currently few UL-rated top-of-wall firestopping systems for the underside of mass timber floors/roofs above. Verify firestopping manufacturer's engineering judgements are acceptable to the Authorities Having Jurisdiction.

- Structural design of mass timber is prevalently performed by the manufacturer, requiring close coordination with the building's other structural component engineering. Connections from mass timber structure to other structural framing systems require close coordination between engineers of record.

- The thickness of components can vary from manufacturer to manufacturer. Consider this when detailing and dimensioning mass timber components for competitive bids.

- Provisions and materials used for moisture protection of components can vary from manufacturer to manufacturer.

- Close coordination of exposed-to-view conduits, pipes, ducts, and wiring is required, especially when openings are needed in mass timber components. Consider visible routing of wiring and connections of low-voltage fixtures.

- The "wood" components can be multiple species of trees of multiple grades. Ensure the aesthetics align with your vision.

- Less than 13% of forests in the U.S. have certifications from the Forest Stewardship Council, the Sustainable Forestry Initiative, or the American Tree Farm Systems[4]. Verify the manufacturer uses wood only from certified forests.

- When specifying mass timber, although it may appear to have similarities, consider separate specification Sections for Heavy Timber, Laminated Veneer Lumber, Wood I-Joists, Rim Boards, Shop-Fabricated Wood Roof and Floor Trusses, and Glue-Laminated Beams and Columns.

- AXA/XL Insurance's "Risk considerations in mass timber construction" guideline identifies additional risks to be addressed when using mass timber.

- As with any wood construction, fire protection responsibilities existing during construction. Contractors/owners are required to provide active fire protection systems during construction per Chapter 33 of the International Fire Code (IFC).

- Fire protection system design: fire flow requirements in Chapter 5 of the International Fire Code (IFC) should be provided based on Appendix B of the IFC for a Type IV building. Tall Mass-Timber buildings, Type IV-A, may use provisions for Type I and II buildings with approval of the Authority Having Jurisdiction.

The attached 3-part Guide Specification "Section 061710 - Mass Timber" is a collaborative effort between RDH Building Sciences Inc, Jensen Hughes, and Mead & Hunt to assist in the proper implementation of mass timber construction.

Acknowledgements:

RDH:

Leaders in the building enclosure space, like Portland-based firm RDH Building Science, are true collaborators to architects, building owners, and developers during Concept Design. Their ability to help designers navigate decision-making around moisture management, megamall facade panel design, and modular/pre-fab are integral to leveraging mass timber correctly—for durability, user comfort, and carbon-emissions impact. Particularly critical to success is developing a comprehensive moisture management plan.

"When build methods evolve, we keep pace," Casey McDonald, RDH Senior Project Engineer, says. "Our expertise and knowledge must be timely and continue reflecting what's happening to our changing climate and landscapes—all through the lens of the user needs. RDH is proud to be at the forefront of these nuanced shifts and innovative edge."

Jensen-Hughes:

Across our global partnership of experts, clients, and communities, we are recognized worldwide for our leadership in fire protection engineering, a legacy of responsibility we have advanced with pride since 1939. Today, our expertise extends broadly across closely related risk management fields—from accessibility consulting, risk and hazard analysis, process safety and forensic investigations to security risk consulting, emergency management, and digital innovation. As we champion best practices, set industry standards, and support communities with innovative solutions, we are making the world a better place.

"The tool, or building material, is only used if the process is clear and complete," Tom Jaleski, Director at Jensen Hughes, says. "Continually looking at new and evolving technologies, evaluating how they affect people's lives, and working to create simple and effective processes is our daily drive."

Mead & Hunt:

Our planning, design, and construction services are available to clients across a wide variety of sectors. From architecture, food/beverage processing, and federal to transportation, water infrastructure, and more, our unique methodologies deliver innovative, cost-effective solutions that elevate clients and communities.

"As we seek new ways to reduce greenhouse gases in our facility designs, it is imperative their implementation is addressed properly in construction documentation," Donald Koppy, Mead & Hunt's Master Construction Specifier, says. "This is a global design construction industry concern, and we need to share our knowledge to benefit the entire world."

[1] Sinha, Udele, Cappellazzi, and Morrell, *A Method to Characterize Biological Degradation Of Mass Timber Connections* (2020)
[2] Chorlton, B., Gales, J. York University. American Society of Civil Engineers. (2020). *Structural Repair of Fire-Damaged Glulam Timber.*
[3] Lstiburek, Joseph, Building Sciences Inc, (2009) BSI-023: *Wood Is Good . . . But Strange.*
[4] **Certified Forests*, M. Alvarez, U.S. Endowment for Forestry & Communities (2019)