AXA

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Risk considerations in mass timber construction

AXA XL North America
Construction Property
whitepaper

Mass timber is trending, and statistics show it is not likely to slow down anytime soon.

Many factors are driving this popularity: owners like it for the speed and potential cost savings, the higher rents it commands, and its alignment with their sustainability and other corporate social responsibility goals. Architects and designers love its beauty and the potential for new and exciting forms. Builders are enthused about the apparent simplicity of construction. Builders considering pursuit of a mass timber project, need to account for many factors and make plans to take the right steps to deliver the project on time, on budget, and meet the owner's expectations.

This paper discusses some of the key factors that assist in the successful execution of a mass timber project. Let's start by defining some terminology.

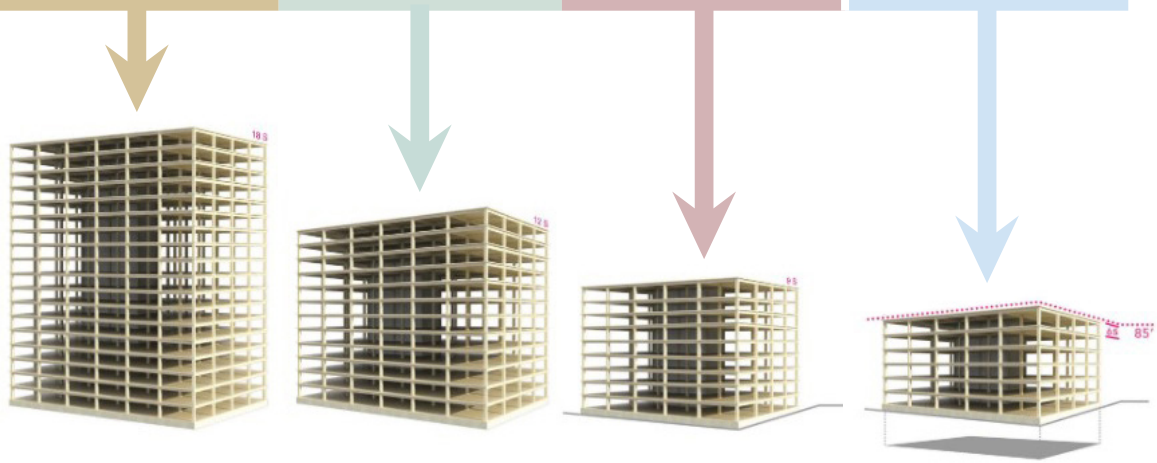
What is a mass timber project?

A mass timber project is defined as a building construction project that incorporates structural elements of engineered wood products, as defined in the 2021 International Building Code (IBC), that meet minimum cross section dimensions for Type IV construction. This includes hybrid systems that also utilize concrete and/or steel elements along with mass timber structural elements.

As the proposed 2021 revisions to the IBC are adopted by local jurisdictions, the IBC designations will become more commonly used. The 2021 IBC classifies mass timber as Type IV construction, with three sub-types that require varying amounts of timber encapsulation depending on building height:

- **Type IV-A** (all mass timber elements fully encapsulated and up to 18 stories)
- **Type IV-B** (protected exterior, partially exposed interior mass timber elements and up to 12 stories)
- **Type IV-C** (protected exterior, exposed mass timber interior and up to nine stories)
- The code also retains **Type IV-HT** (No non-combustible protection required. 324,000 sf, six story maximum)

	IBC 2021			IBC 2015
	TYPE IV-A	TYPE IV-B	TYPE IV-C	TYPE IV-HT
Type of combustible protection required	▪ fully encapsulated	▪ protected exterior ▪ partially exposed interior	▪ protected exterior ▪ exposed timber interior	▪ none
Maximum # of stories	18	12	9	6
Maximum building height	270	180	85	85
Allowable building area	972,000 sq. ft	648,000 sq. ft	405,000 sq. ft	324,000 sq. ft
Average area per story	54,000 sq. ft	54,000 sq. ft	45,000 sq. ft	54,000 sq. ft



Building floor-to-floor heights are shown at 12'0" for all examples for clarity in comparison between 2015 to 2021 IBC codes.

Source:
Images obtained from dci-engineers.com

What are mass timber materials?

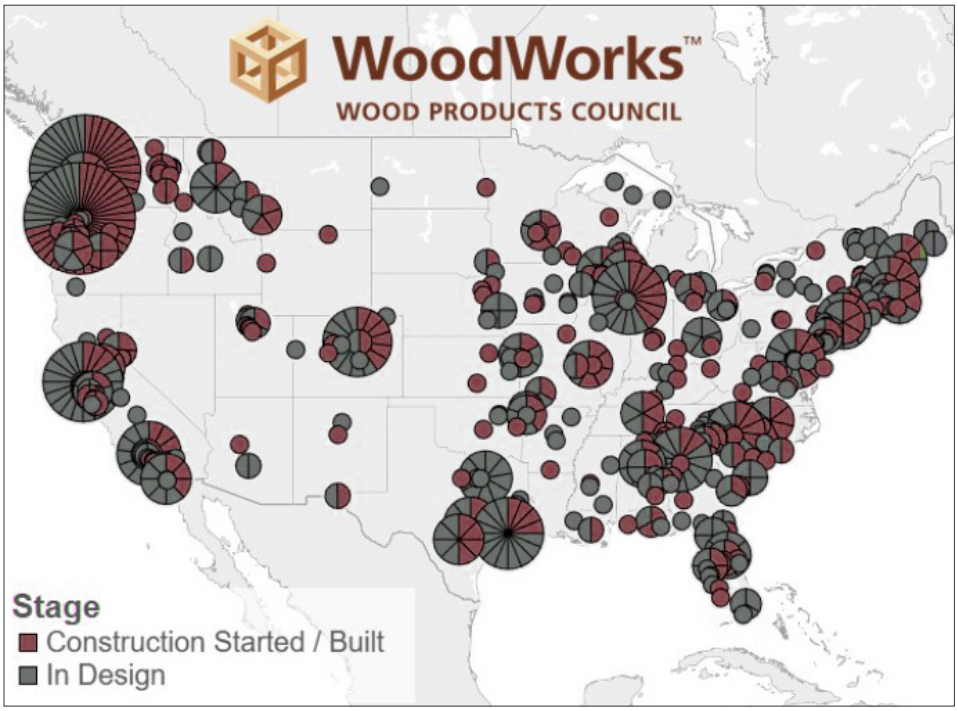
There are a variety of material types that fall under the mass timber umbrella, including Cross Laminated Timber (CLT), Nail Laminated Timber (NLT), Dowel Laminated Timber (DLT), Glue Laminated Timber (GLT), and more – with more types in development all the time. These materials all share many risk factors, and therefore all have similar planning and construction considerations.

CLT

GLT

NLT

DLT



Mass Timber Projects in Design and Constructed in the US (December 2020)

Source: Images obtained from StructureCraft

What are the risks and benefits?

The risks and benefits of mass timber construction will vary depending on a variety of factors, including the project's intended use, location, and structural components. If the structure is all mass timber, there will be a different risk profile than if the structure is a hybrid of mass timber combined with steel and/or concrete, where tolerances between the materials must be carefully managed. If a project sits in a geography near a reputable mass timber manufacturer, that is obviously going to be a far different risk than a project that is getting their materials from across the country – or across the globe. There is no "one size fits all" guidance for mass timber project risks, but there are certain consistent themes, and this paper is focused on those themes.

When considering the construction of a mass timber project, undergo serious thought about the following.

Begin at the beginning: Design and planning stage

Prequalify everyone – not just subcontractors

Prequalification is often thought of as related to subcontractors, but, with mass timber, it is critical to prequalify all parties involved. It is important to enter into these projects with partners who are prepared to contribute to its success. Before pursuing a mass timber project, start with some self-reflection. Assess the experience level of your organization and team members. Beyond that, it is important to understand the experience level of all parties involved. Work to acquire a complete picture of the experience level of the owner, design team, and consultants with the proposed type of system. Determine the experience (length of time in business, number of completed projects), capabilities, and capacity of the proposed manufacturer fabricating and supplying the intended system.

It is important to understand the Owner's level of experience with Mass Timber and assess their expectations for the project. From overall goals and defining parameters for a successful project, down to the details of variations in the appearance of different types of wood, visibility of defects, and visibility of accessories (back boxes, light switches, surface mounted conduit). It is impossible to meet unrealistic expectations, so it is important to start those discussions early.

As always, it is necessary to consider the capacity and capability of the company and crew(s) that will actually install the mass timber materials. Ensure that the prequalification process asks the right questions to gain a full understanding of their experience and approach to the installation. This is a particular challenge; in most markets, subcontractors will not have much experience with mass timber. An effective prequalification strategy must take that into account. In addition, almost all the trade subcontractors in consideration for the entire project will need to have BIM capability because all trades and systems must be coordinated with the mass timber before fabrication starts. The prequalification process should serve as a tool to vet this capability in all necessary subs.

Plan the placement strategy

Give some thought to the available strategies to place the materials. There are several options: It is possible to subcontract this work as typical or place it with internal forces. The manufacturer may also subcontract to their own installer or use their own crews. It may also be possible and advisable to take advantage of manufacturer's technical representative (or other qualified consultant) to help guide the construction process, particularly if the mass timber installation is a builder's first or is a very specialized design. Walk all potential subcontractors through the planning and placement of these materials, so that they will have the information they need to price and plan the work accurately.

Think about the design

Consider the completeness of the design, and the overall commitment to it, because changes can mean major delays getting materials manufactured and to the site. Since mass timber buildings are essentially a prefabricated kit of parts, the design should be finalized and approved before the parts are fabricated. If there is any indication from the owner or designer that there could be changes down the road, make sure to explain the amount of time, difficulty, and costs that any change will impose on the project. A lack of commitment to the design could be a signal to decline the contract.

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Understand the challenges of permitting and AHJs

Before deciding to undertake a mass timber project, talk to the local Authorities Having Jurisdiction (AHJs) and Building Officials to understand their familiarity with mass timber projects, and assess the challenges that will be involved in the permitting and construction process. If other, similar mass timber projects have been completed within the intended jurisdiction, the process will be easier, especially if the proposed project is within existing codes. If the proposed project is the first mass timber project in this jurisdiction, the permitting process will take longer. In addition to the normal application data, be prepared to educate the Code Officials, Fire Marshall, and possibly others, regarding the properties and benefits of mass timber. Understand the process, its likely timing, and its requirements and factor that information into your analysis.

Plan for extended quality management

On a mass timber project, the need and importance of a robust quality program will extend beyond the boundaries of the project site. As the builder, the quality program should extend to and incorporate the manufacturer's quality practices. Assess the track record and management methods that the manufacturer will have in place during fabrication. Devise a plan to monitor production and quality at the point of manufacture; this might mean repeated shop visits by a quality consultant or a staff member, or even an embedded staff member at the production facility. The goal is to facilitate real-time coordination and communication with all parties throughout the manufacturing process as well as reporting that fully verifies materials status.

Take a hard look at transportation

There are several elevated concerns related to the transport of mass timber that should be considered. It is important that the complete path and all modes of transport required to move the materials from the plant to the project site are understood, including any constraints on the size (length, width, height, total weight) of the load and have a method for tracking its progress. Research whether there are limiting bridges, utility crossings, narrow highways or streets that will require special planning or permitting to navigate.

Strategize and establish effective communication methods between the manufacturer, shipping and/or trucking company, and installer to monitor the progress of movement towards the site. Do not rely on second-hand information. Determine if there are any special considerations in getting materials through customs, any import tariffs, or concerns with the Authorities Having Jurisdiction (AHJs). If any of these are present, move early to work through the challenges. Discuss how the material will be protected from damage during transport with all concerned parties.

Another potential transportation complication is insurance coverage; consult with insurance professionals to ensure that the material is adequately covered by insurance during shipping; the shipping company's policy may not be sufficient for the value.

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Consider on-site materials management

Strategize lay down logistics

Well before the materials arrive at the site, define and establish a logistics plan to minimize the number of times materials must be handled and moved before being installed in the building. Determine the number of loads that can be received each day and where each load will be placed on the site. Anticipate the amount of time the materials will stay in storage, and the sequence in which they will be required for construction. It is possible in many cases to have the manufacturer sequence the loads to optimize these factors, and that is something to discuss and consider. Consider the specific safety risks for the handling of the materials on site and make a relevant Safety Plan for unloading and handling it.

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Define a plan for receipt of materials

The process for receiving and accepting each delivery of mass timber materials should be detailed, down to the smallest detail, to document that all expected materials have been received and that all material received is in good condition. There should also be a clear, documented, and implemented process to sign for the materials, document any damage, identify shortages, and track any issues through rectification. This process should establish who is responsible for inspecting all shipments. If the material is procured through a subcontract, the contractor's staff should partner with the subcontractor's staff in this effort rather than solely relying on the subcontractor's efforts.

All responsibilities for the initial inspection for damage, correctness, and quantity should be clearly defined and assigned, with signoffs and documentation as they occur, with photos of materials and stickers / tags attached. Any damage observed during the initial inspection should be noted on the Bill of Lading and in the Quality Log with photos taken of the damage, and a firm plan to communicate the damage to the manufacturer to cure it. Engage the manufacturer to understand how materials that are wrapped – and which need to stay wrapped – may be inspected for damage.

Understand the logistics for storage of materials

Define where and how the materials will be stored once unloaded. Specifically, how will individual beams, columns, and panels be supported so they are off the ground and protected from damage? The materials manufacturer will have requirements for dunnage and storage that should be followed, but additional measures may also be needed; for example, blowing debris should be considered and a plan made to keep it from piling up under and around the material, so that water does not wick up through a buildup of leaves or other debris. There should also be a plan for ongoing inspections and maintenance of panels and protective wraps on stored panels, which includes any additional or special handling requirements to preserve and protect visually exposed panels. Ensure that security measures are adequate to prevent vandalism and damage to exposed members.

Ensure implementation

Through the considerations above, there should be a defined plan for materials receipt and storage on site that identify how materials will be unloaded, stored, and moved into the structure, along with who will be responsible; the implementation of that plan is crucial to the success of the Site Logistics plan. To ensure consistency, it is wise to have dedicated crews for unloading, inspection, and materials maintenance. A clear responsibility matrix with signoffs and audits is also recommended.

Establish a plan for construction

Construction coordination

Coordinate with the manufacturer and project consultants to determine if there are details related to the mass timber that vary from conventional construction and where these details occur. This may include different sequencing, connection details, an air gap at the roof installation, waterproofing before wet applications like concrete, managing connections when hybrid systems result in tolerance differences between materials, etc. Ensure that project management and supervision understand them and that the crews who will place the materials do too.

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Construction quality

Because some requirements may be different than the typical practices on a construction site, make sure to plan for any quality practices specific to mass timber that may be over and above the norm; clarify the expectations and train the responsible parties on them, and assign responsibility for implementation. These practices may include new or unfamiliar activities like installing the connections, additional inspections, more photography, additional checklists, more robust signoffs, additional mockups, etc. Plan to make full use of mockups and give preference to functional mockups that can be used for trade coordination, testing in advance of in-place construction, and as a reference during construction, in addition to aesthetic concerns.

Water management

Delamination, warping, and discoloration from uncontrolled exposure to water are primary concerns for mass timber construction. While the adhesives used have come a long way since those issues showed up on the radar, and it is well-understood how discoloration can be prevented or addressed, it is still important to avoid those issues in the first place.
To this end, design a water management plan that includes management of environmental and building systems water.
The contractor and subcontractor should create an active water management plan to keep the building as dry as possible during construction. Of course, any strategy that impacts the installation method should be coordinated with the manufacturer.
Potential strategies include:

- A designated rain crew to physically remove water from horizontal surfaces.
- Methods to prevent water migration. This may include temporary curbs/flashing at openings, caulking spline cover plates between panels, taping joints between panels and at columns, applying temporary waterproofing membranes, factory or site applied waterproofing to protect exposed wood, and temporary or permanent physical protection (e.g. temporary roofing or tenting of the structure).
- Envelope / dry in strategy – including acclimatization. Create an aggressive dry-in plan with a focus on walls for high-rise structures and the roof for low rise.
- Wet works permitting or other formal strategy to manage water used during construction with clear clean up protocols and equipment at hand for water releases.
- Control and monitoring of interior humidity levels.
- Monitoring and documentation of the moisture content of exposed timber members.
- Technology – There are a variety of technological solutions that can be leveraged to monitor conditions (for environmental or building systems water) and notify the project team or even shut off valves when a leak is detected. Some of these systems may be left in place after construction for ongoing monitoring, which ultimately increases your ability to proactively address problems and prevent defects.
- Site security (see below).

Fire prevention

Because wood is a combustible material, fire is typically the first concern raised with regards to mass timber structures, positive results from testing notwithstanding. These concerns have some basis in fact though, because – especially during construction – there is a higher level of diligence needed to manage fire potential. Be proactive about fire management with a robust plan that includes:

- A Hot Work Permitting Process.
- An extended fire watch after hot works in the structure.
- Portable Fire Extinguishers over and above what is required to meet OSHA standards.
- Coordinated Fire Department access, and fire service education / tours of the site.
- Use of a consultant/engineer experienced with fire suppression design in mass timber.
- Housekeeping protocols designed to prevent loading of building with combustible materials.
- Site security (see below).

Weathering/discoloration

Discoloration of mass timber panels may happen due to exposure to sun, water, or other building materials. Your plan should include coordinated measures to protect the materials from UV radiation, to control water migration and eliminate standing water, and contemplate connection strategies where galvanized or stainless-steel connection instead of un-treated steel or oil coated materials are recommended. You should also understand the options for repairs to the surface should discoloration occur and make sure the Architect and Owner also understand how these repairs will impact the final appearance.

Preventing vandalism

A huge mass of blank timber panels, beams, and columns are a very attractive canvas to local graffiti artists. Taking time out to resurface or refinish a panel that gets tagged is not going to be in anyone's schedule. A plan to employ a guard or watchman to monitor the site after hours should help with this - and other facets of the risks, like the water and fire concerns just discussed above.

Final thoughts

Mass timber is an exciting and promising construction type, and its apparent simplicity of construction is appealing. Some aspects of mass timber are relatively simple, but don't let that create a false sense of security in deciding to undertake one of these projects. Many of the typical planning activities that contractors go through must occur earlier in the construction process when dealing with mass timber, and most need to be completed well before the materials start to arrive on site. The pace of construction expected once they do arrive is so brisk that all activities need to be tightly choreographed to meet expectations and the schedule without any hiccups.

With forethought and planning, none of this is insurmountable. Take the time to understand the challenges and plan for them. Assign defined responsibilities for the practices required to individuals who really understand the importance of their roles in making a mass timber building happen. Most importantly, execute the plans consistently and without fail. This investment in forethought and planning before deciding to undertake a mass timber project, before subcontracting the work, and before construction begins, will pay off by keeping the project on the path to success in spite of the unfamiliar terrain.

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