CLT & Builder's Risk

Erik G. Olsen, CSP, CFPS
Executive Property Specialist
Chubb Insurance

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This is what we are talking about.

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North American Projects Underway

18 storey wood, Vancouver, BC

12 storey wood, Portland, OR

10 storey wood, New York

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“Good Thing Wood is a Renewable Resource – It Needs to Be!”

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GlaxoSmithKline, Carbon Neutral Laboratory of Sustainable Chemistry, 2014 (Glulam & CLT)

Before

After

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Recent Press

- "I'm sorry, but I'm very reluctant to endorse anything made out of sawdust and glue," says fire marshal….
- "if we are having a hard time tackling some of these low-rise wood-building fires, how are we going to deal with something taller? They have a lot of selling to do to make us feel comfortable."
- "admits that the interior wood exposure in tall wooden buildings can increase the fire duration because the wood is adding fuel to itself"
- "For buildings with exposed CLT, there is now overwhelming evidence that compliance with the existing fire resistance framework is not necessarily sufficient to guarantee that legislative fire safety goals will be met"
- "as timber buildings get ever taller, the consequence of failing to design for burnout will become greater, and the risk to life, property and the environment will also become greater"
- "it has also been identified that whilst buildings of this nature do meet these (BC) requirements and offer increased design features, they are vulnerable from fire during the construction phase."

What is Mass Timber?

- Mass timber refers to **composite wood** systems combining multiple pieces of wood to increase their compressive and tensioned strength
- They are essentially really big wood-based products
- Competing with concrete, masonry and steel construction
- Allow for reduced foundation sizes (due to lighter weight)
- Industry Selling Point - Shortened construction cycles.
- **Fire performance** and **burn out** is a key hurdle
- Building code limitations on height & area (quickly being overcome with 2015 IBC)
- Need for general system connection and design guidance
- **NFPA FPRF (Fire Protection Research Foundation) Phase II study ongoing research underway – focusing on fire performance and full scale testing.**

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CLT Fundamentals

- The CLT panels are useful in prefabricated structures and are made up of multiple layers of lumber.
- Each layer of boards is placed perpendicular to adjacent layers for increased rigidity and strength. The boards are then glued and pressed together.
- The adhesives used to assemble CLT panels are usually thermoset resins like those used in plywood, oriented strand board (OSB), and other wood products.
- CLT can be used for long spans and all assemblies, e.g. floors, walls or roofs. Walls typically consist of 3-5 layer panels, whereas floors consist of 5 or more layers for greater stability.

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Lots of Sell Points

- Market Leadership & Innovation
- Current Code – 85 ft (IBC). Alternate Means is the means to get any higher.
- 2015 IBC formally recognizes CLT, Glulam, and SCL
- Smaller carbon footprint than steel and concrete -i.e. CO_2 emission during concrete manufacturing process.
- Sustainability
- Green/LEED
- Good thermal performance
- Durable
- Lightweight. A fraction of the weight of concrete.
- Economy & Jobs
- Federal Support (USDA)
- Prefabrication allows for **Speedy** Construction.
- Aesthetics
- Fire Resist***ant*** (NOT Fire Resist***ive***)

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Tall Wood Buildings in the U.S.

- Most common materials include cross laminated timber (CLT), and glulam.
- Benefits include reduced building weight, precise offsite prefabrication of the component parts (panels), faster construction times.
- CLT has the advantage of faster construction times as the panels are manufactured and finished off site and supplied ready to fit and screw together as a flat pack assembly project.
- Holes and notches in CLT panels can be pre-cut before arrival to the site. This minimizes work onsite, reduces construction time and costs and increases the accuracy of structural components.

Waugh Thistleton Architects

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IBC 2015 & CLT

- It's a lot to do about the glue and heat performance testing of these laminated products
- Minimum requirements for the CLT panels and associated adhesives are that they comply with ANSI/APA PRG 320 Standard for Performance –Rated Cross-Laminated Timber and ANSI 405, Standard for Adhesives for Use in Structural Glued Laminated Timber.
- In Canada, CLT adhesives must meet the requirements of CSA O112.20. In both the U.S. and Canada, CLT adhesives must meet ASTM D7247 for heat durability and be evaluated for heat performance based on PS 1.
- You can **verify the compliance of the panel** to this standard by requesting the OEM cut sheet for the construction material and by referencing construction plans as well.

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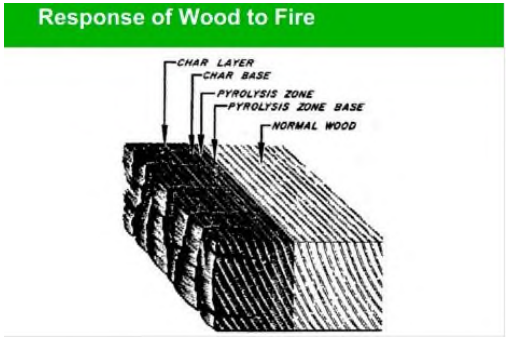
Fire Related Design Considerations



- Oversized timber elements to include char layer.
- Encapsulation of timber elements and connections with gypsum
- Full sprinkler protection is key (**remember how well 13R systems performed in Edgewater NJ stick construction?**)
- Intumescent Paint applied to exposed timber
- No wood cladding on exterior – most opt for non combustible facades
- Fire protection strategies for wood facades are more challenging and complex

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Fire Performance of CLT Panelized Structures

- CLT panels are promoted as having excellent fire resistance, comparable to that of noncombustible materials and to heavy timber construction.
- After testing CLT panels to the standard fire resistance test (CAN/ULC S101 (Canada), ASTM E119 (USA), and ISO 834 in other countries), manufacturers propose that a five-layer CLT floor panel can receive a 1.5-hour rating; and a three-layer wall panel can receive a 45-minute rating.
- ***There is a lack of conclusive fire testing involving "delamination," various types of adhesives and their impacts on char rates, etc.***
- Fire resistance of the CLT panel is based upon the insulating properties of the char layer that develops during the exposure to the fire, and *assumes that a thermoset resin adhesive has been used, rather than a thermoplastic resin*.
- The greater the depth of the section (3, 5 or 7 layers), the greater the fire resistance.
- A 5/8-inch (15.9mm) layer of Type X gypsum board on the exposed side of the panel adds 30 minutes of fire resistance; and two layers add 60 minutes of fire resistance to the assembly

Connections

- Performance of timber connections exposed to fire can be quite complex based on type of fastener, geometry of connection, different failure modes
- Most building codes, including the IBC, do not provide specific fire design methodology for determining the fire performance of timber connections.
- **When a fire resistance rating is required by the IBC, connections and fasteners are required to be protected from fire exposure by wood, gypsum board or other protection approved for the required rating.**
- Connections for mass wood buildings are not uniformly manufactured as they are for steel or concrete construction
- **Connections is an area that requires further research, testing and verification.**
- **During construction, connections will be exposed.**

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Part II – Builders' Risk Nuances

- Fire
- Water Damage (especially roofs)
- Material Replacement

Construction Class from a Builder's Risk Perspective

- How will it burn during construction?
- Exposed structural?
- Any compartmentalization?
- Details on encapsulation
- Any functional fire protection?
- Exposed Connectors?

Figure 3—Mass wood primary structural frame for Framework, Portland, Oregon (image: Lever Architecture)

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Fire Performance During Construction Phase

- Chubb expects it to be **somewhat better** than low rise light wood frame from a fire standpoint during construction phase.
- It will probably perform better from a life safety standpoint (fire with impaired FP systems) than regular wood frame because it will probably burn slower and resist progressive collapse better.
- In the event of a fire, the assessment of what is damaged versus what needs to be replaced for aesthetic or potential unknown structural considerations is something we anticipate may be a difficult issue.
- If steel or concrete gets smoke, fire and/or water damage it can typically be assessed for structural concerns cleaned, painted and returned to service. Not sure that the exposed wood surfaces would be treated the same or if they will perform the same.

Critical Risk Factors for Emerging Construction Methods

- Chubb Experience - CLT in the Pacific North West
- Commonly being brokered as less fire exposed.
- GC Experience & Design Review
- On the projects we have seen with CLT the schedules have not been that compressed when compared to similar FR and NC projects
- Has CM or PM Spent Time at other Mass Timber Sites?
- Experience of the timber erection crew
- Systems integration – are prefab components and penetrations. Included in early design or done onsite? Impact on housekeeping?
- Penetrations should be performed during prefabrication (cut in at factory)
- Cutting onsite can be complex

Critical Risk Factors… During Construction

- Multi-story CLT type projects and large Glulam (long span) structures may have more of an erection/collapse exposure compared to load bearing MNC type projects
- Raised floors and drop ceilings accommodate most systems
- Moisture protection considerations (tent structures). Taller Buildings = more wind & rain.
- Are structural wood exposed or inside bldg envelope? Weathering of wood during construction.
- Water damage exposure is elevated. Avoiding Moisture during Construction.
- Any ventilation systems to address moisture?
- Avoiding staining during construction is unrealistic
- Apply final finishes at the end of construction

Tent Structures to Prevent Water

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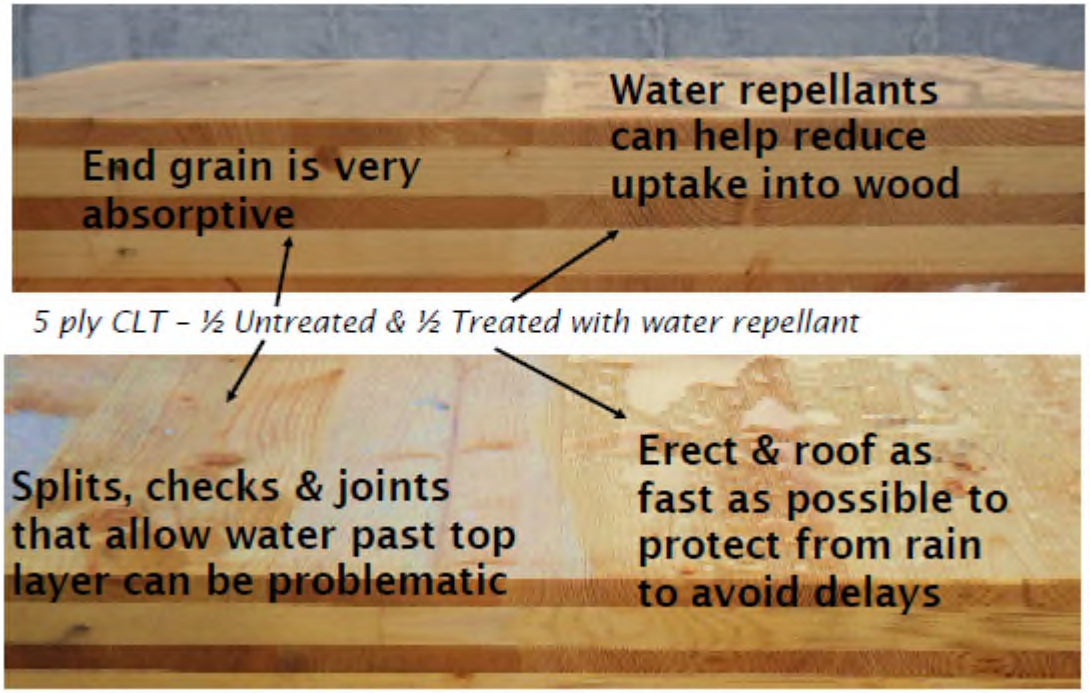
Protection of CLT from Wetting



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Material Replacement Considerations

- Aesthetic and the potential structural load bearing issues and material replacement associated with the interim BR fire exposure.
- If CLT or Glulam member is exposed to fire during project, what are the options as the project owner?
- Future heat performance of adhesives and structural load bearing capacity once damaged?
- As a “new” building owner, not sure I care whether a CLT or Glulam member is “structurally sound” after if it has been exposed to fire, I will probably want a “new” CLT or Glulam member.

Post Loss Considerations

- No guarantee supporting structure remains safe after fire even with restoration
- Combustible insulation use and reality of fire fighting challenges (inside wooden walls etc.) when installed over wood.
- Upon a pipe burst or leak, wood generally does not respond well. Mold & rot.
- Loss history for all types and dimensions of wooden buildings show increased loss potential closer to 100% MFL estimates.

Quick Summary of Advantages

- Reduced effect on the environment – i.e. CO_2 emission during concrete manufacturing process.
- Less energy consumption compared with concrete and steel manufacturing.
- Much less time to construct building – 10 weeks for Brock Commons Tower structure – not including interior finishings. This is about 4 months faster than typical structure of this size.
- Green product - natural, sustainable, lightweight.
- Aesthetically pleasing – for interior this will depend upon the percentage of allowable exposure - Will depend on panel thickness chosen.
- Good seismic features – flexibility/connections. Outstanding structural properties
- For Fire Safety during construction– much less congestion/fire loading, no hot work, very clean site. NOTE: prefabricated panels manufactured off site.
- Approximately 90% less construction traffic (trucks delivering materials) and requires 75 percent fewer workers on the active deck.

Quick Summary Disadvantages

- **Although 2 hour fire ratings being achieved and very slow rate of char, this is still a combustible product (will continue to burn –self sustaining but temperatures continued to decline under free-burn test).**
- May still be slightly more costly than concrete/steel. However, must take into consideration environmental impact, reduced construction, time, etc. Costs should be coming down.
- Mass Timber over 6 stories currently designated as "Alternate Solution" in the model building codes which must be accepted by the AHJ, involving numerous reviews, overdesigning, red tape, etc. to convince AHJ to accept project.
- Water!
- One CLT fire to date during COC – **GSK lab in England (2014)** – reportedly electric fire and unusual high plastic combustible loading in vicinity of fire origin. Rebuilt to same criteria – not a deterrent.
- Industry unfamiliarity- well established supply chains often not in place, engineers/architects sometimes less aware of the possibilities of designing with wood – slowly changing.
- Insurance industry unfamiliarity – many underwriters unaware of this construction – treated as frame.