Mass Timber Moisture Protection

Considerations for CLT Construction

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This document focuses on the potential of moisture impacts on a type of mass timber construction called Cross-Laminated Timber (CLT). CLT is a series of plies of dimensional lumber perpendicularly oriented, glued, and pressed together to create structural panels that are similar to plywood, but on a larger scale. The primary aim of this document is to raise awareness regarding the importance of considering construction-phase moisture impacts. Photos of installed material follow the commentary. This document does not discuss assembly design or in-operation moisture impacts to CLT. Although this content is specific to CLT, many of the considerations also apply to other mass timber products, such as glued laminated timber (glulam), Mass Plywood Panels (MPP), and Dowel Laminated Timber (DLT). This document presents a summary of issues encountered in a quickly evolving industry; thus, engaging an enclosure consultant familiar with the weather protection and construction practices of mass timber is recommended.

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BACKGROUND

One aspect that differentiates mass timber from dimensional lumber in building construction is the way mass timber is affected by liquid water exposure. In the Pacific Northwest, dimensional lumber frequently gets wet during construction, and in most cases can be dried sufficiently once a building is weather protected. This drying process typically utilizes heat, fans, and dehumidification to reduce the moisture content of wood framing and sheathing to an acceptable level (below 19% moisture content) before finishes are installed. If the wood is sufficiently dried, the construction period moisture exposure does not cause harm or negative long-term structural implications. Aesthetics are not an issue because the wood is covered by finishes.

Conversely, if a CLT building is exposed to similar moisture levels during construction, significant damage and negative structural impacts can occur beyond those experienced in traditional stick-framed buildings. Although outer portions of mass timber members can be dried to acceptable levels, inner portions may remain at unacceptably high levels, leading to mold growth, decay, significant expansion of panel thickness, and construction that is severely out of plane and out of dimensional tolerances, thus requiring expensive and exhaustive efforts to correct. Drying out the CLT core is possible, but takes a long time compared to traditional stick-framed buildings. The drying process can take even longer if one or both faces are covered by vapor-impermeable materials. For this reason, it is necessary to limit the amount of time that CLT—or any other type of mass timber panels—is exposed to wetting during the construction process. Moisture content of dry materials should also be limited to 16% instead of the recommended 19% for dimensional lumber products.

Drying CLT panels in a manner typically used for dimensional lumber can also cause significant checking or cracking in the surface of the CLT panel. This is an issue because CLT typically has portions left exposed to take advantage of the biophilic benefits of expressing natural materials in interior spaces. In addition, water that drains around and between CLT panels will bring with it dirt, construction debris, and oxidized metal shavings, staining the exposed panels and requiring time-consuming and costly remediation before the project is finished.

Properly drying CLT panels requires a careful, slow, and expensive process to limit differential moisture contents, which is necessary for limiting checking and other negative aesthetic and structural impacts.

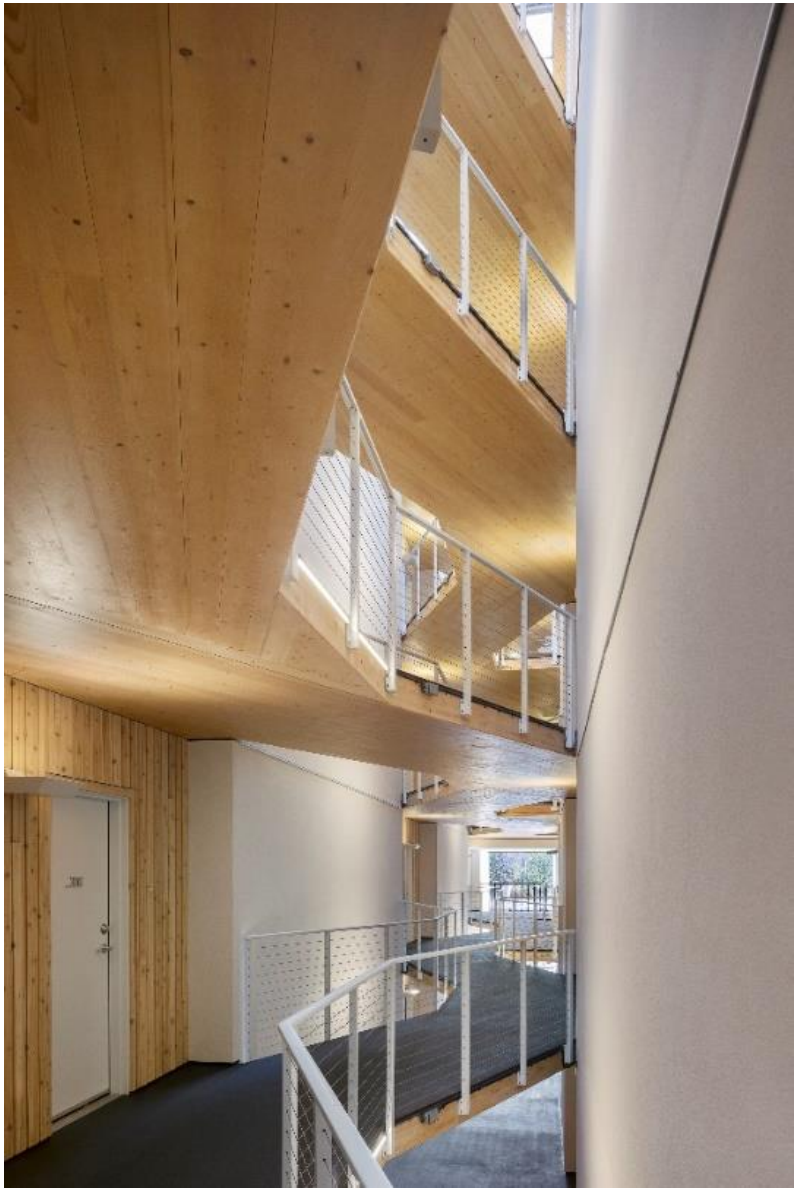

Photo 1: Example of exposed CLT installation at finished project. The Canyons, Portland, Oregon.

(Photo © Jeremy Bitterman)

CONSTRUCTION PROCESS

CLT is a manufactured product, typically shipped with a temporary moisture protection sheet that is loose laid and not intended for use once panels are installed. It is important to note that these temporary protection sheets can trap moisture and should not be relied on during construction. It is preferable to apply a coating, sealer, or permanent weather protective sheet at the factory that can act as moisture protection once panels are installed, but this may be a logistical challenge for manufacturers.

When CLT arrives on site, it is very important that it be protected from precipitation in order to prevent unnecessary wetting until temporary or permanent weather protection is placed on the building. Approaches to achieving this protection vary based on time of year, project size, construction schedule, site storage limitations, and other factors.

Some parts of the CLT panels are more sensitive to moisture than others, particularly the end grain. At a minimum, methods for mitigating water exposure to the end grain should be considered based on the project site and scheduling restraints. A combination of approaches may be necessary, such as applying a water repellent, covering panel edges with tape or sealant, and/or sealing panel joints and penetrations through panels. Approaches will vary from project to project and should account for the structural spline material used to join panels in the field. These materials are frequently metal or plywood.

Photo 2: Staining from corrosion of metal connectors.

Photo 3: End grain staining from an exposed CLT joint.

MOISTURE MANAGEMENT PLAN

Creating a moisture management plan is the best way to set expectations and ensure that the entire design and construction teams are on the same page regarding CLT protection. Frequently, the architect will first provide a performance specification and the management plan is then created by the general contractor. This plan should include the following:

1. The methods of protection from delivery until the enclosure is complete.
2. Criteria for removing water during and after rain events.
3. Defining which team member will be taking the moisture readings, when the readings will be taken, what instruments will be used to measure the moisture content, how the data will be recorded, and the parties this data will be shared with.
4. Defining acceptable moisture levels at varying depths of CLT panels prior to application of finishes or cementitious toppings.
5. Defining cleaning methods and the required level of final finish. These should include specifications for cleaning agents, sealers, and other materials to be applied to the CLT.

It is also important to consider the schedule and cost impacts of providing weather protection and/or drying before installation is finished, as well as any repair or remedial work needed to return wet materials to an acceptably dry condition.

Photo 4: Squeegee use on wet CLT panel.

Photo 5: Staining on exposed underside of CLT from end grain absorption.

APPROACHES TO PROTECTION

The following table summarizes several approaches to providing field protection to installed CLT, prior to installation of the permanent water protection (the “drying in” of a building). Descriptions in the table assume that panels are installed in a horizontal orientation rather than as vertical wall elements, though many considerations for horizontal orientation also apply to vertical panels. Keeping horizontal surfaces as free of water as possible reduces the risk and volume of wetting. This is especially true in the winter when freeze/thaw cycles can be very damaging to panels that are intended to be exposed.

Ideally, moisture protection materials intended for construction should be applied in the factory and joint treatment applied in the field. Because this is not always possible, however, methods of field applying moisture protection materials to dry CLT should be established. These methods may include tenting or timed delivery of materials.

As with all protection approaches, regular brooming or squeegeeing of any surface water is recommended to reduce the risk of absorption. Approaches for end grain treatment and horizontal surfaces may vary. Due to the end grain’s sensitivity to moisture, panel joint treatment and protection of panel edges should be a priority. Joints can often be shielded by tape application or by sealing splines. There are a variety of tapes with a range of vapor permeability that can be used in various climates and conditions.

Photo 6: Staining at end grain and panel joints with side grain.

Photo 7: Staining at panel edges from exposed joint above.

CLOSING

In conclusion, CLT and other mass timber products offer great benefits to a project, including carbon capture and storage, improved aesthetics, and reduction of construction time. Successful projects are not without challenges, however, and require careful planning by well-integrated teams of thoughtful designers, consultants, and contractors. Mass timber construction materials and practices are rapidly evolving, and historical construction practices are constantly being reevaluated and updated in response. Accordingly, keeping abreast of the latest guidance and advice on how to use mass timber successfully is a must. Some resources are provided at the end of this document.

MATERIAL CONSIDERATIONS FOR CLT PROTECTION:

Treatment	Benefits	Limitations	Notes
Fully Adhered Vapor-Permeable Sheet	• Generally keeps bulk water out • Water will not travel far in case of breaches • Generally spans checking or cracks	• May be slick for walking (depending on material used) • Liquid water sitting on upper surface for extended periods of time will migrate through as vapor • Limited duration	• Not to be considered waterproofing • Seams in sheets are the weakest point
Wood Sealers	• Inexpensive • Can be spray applied • Maintains wood appearance	• Weather and temperature application limitations • Requires drying time and multiple coats • Does not bridge cracks or checks	Decent dry climate/dry weather option
Edge Treatment Only	• Less labor to install • Inexpensive	• Only shields the end grain • Requires more diligence to keep untreated surfaces dry	Tapes or sealants are typically applied to supplement panel-to-panel joints
Vapor-Impermeable Adhered Sheet or Liquid (Field Applied)	• Allows for longer exposure to standing liquid water • Can act as a temporary roof	• Very difficult to dry without removing sheet or liquid if wood wets due to breach in material • Recommended for roof applications, not lower levels	Can be a reliable temporary roof if material can be installed in factory with completed in-field transitions or applied in the field to dry panels with clear weather to follow
Loose-Laid Sheet	• Inexpensive • Quick to install	• Potentially slick to walk on. May shift depending on material and attachment • Requires taping or sealing of all joints	May be useful in dry climate or extended dry weather periods, such as summers in PNW
Liquid-Applied Weather Barrier	• Generally keeps bulk water out • Water will not travel far in case of breaches	• Cannot span cracks or checks • Water and temperature application limitations • Application in factory is preferred • May be slick as a walking surface • Limited duration	Options have ranges in vapor permeability, including: • Silicone • STPE • Acrylic

REFERENCES FOR MOISTURE PROTECTION OF MASS TIMBER

The following links are good sources for currently available additional information. Since practices are evolving and research is ongoing, additional resources will available after issuance of this document.

Mass Timber general information (Think Wood)

Mass Timber Design Manual (Think Wood)

U.S. Design and Construction Guide (Think Wood)

Mass Timber Building Science Primer (Mass Timber Institute and the University of Toronto)

Moisture Management for Mass Timber Buildings (RDH Building Science)

Wetting and Drying Performance related to On-site Moisture Protection of Cross-Laminated Timber (FPInnovations)