Building Enclosures for Mass Timber Buildings

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The Building Enclosure

Mass Timber Structure
Mass Timber Integrated into Building Enclosures

→ Mass timber elements often a part of the building enclosure
  → Above Grade Walls & Roofs
  → Wood or parts of wood desired to be left exposed – serves both functional and aesthetic purpose
→ Requires protection from moisture during construction & in-service
→ Assemblies with wood, membranes, insulation & accessories control heat, air, and moisture transfer along with noise and fire
→ Designed to accommodate building movement, structural loads, initial & seasonal wood movement
What Makes Mass Timber Buildings Unique?

- Use of engineered mass timber components
  - Alternate structural systems (post/beam, engineered panels, infill components)
  - Unique & new connections, interfaces & details
  - Hybrid steel-wood-concrete components & connections
- Longer & heightened exposure of large wood components to rain and weathering during construction
- Is not the same as stick built mid-rise wood-frame, but is also different from high-rise steel or concrete structures
Mass Timber Structures

→ Potentially fast
→ Sensitive to moisture
→ Greater movement (shrinkage & drift)
→ Fire code challenges
→ Mixed steel, concrete & wood components & connections
Tall Wood Building Enclosures

→ **Need for Speed**
  → Erect and seal as fast as possible to protect the wood structure
  → Preference for offsite prefabrication & minimal site preparation
  → Be accommodating of inclement weather

→ **Ensure Durability**
  → Robust materials – high-rise appropriate
  → Be more tolerant of movement
  → Thermally efficient
  → Non-combustible
Building Enclosures for Mass Timber Structures

→ Tall Structures
  → More repetitive, more exposed, need for more speed – *ideal for prefabrication*
  → Less focus on roof and more on walls for weather protection

→ Low-rise structures
  → Less repetitive? Less exposed
  → Greater focus on roof for weather protection than walls
Facades for Mass Timber Buildings?
Load Bearing versus Hung “Curtain-wood” Exterior Enclosure Walls
Good vs Bad Use of Mass Timber

**Good** – Warm, dry and protected by the building enclosure 😊

**Bad** – exposed to weathering 😞
CLT Wall Considerations

Best Placement & Insulation Type? – It Depends!
CLT Walls – Exterior Insulated Is Better in the North
CLT Wall Considerations - Movement
Strategies to Address Differential Movement

→ Relative Humidity & Moisture changes in wood cause swelling/shrinkage of tangential & radial grain

→ Dimensional lumber within CLT and Glulam are prone to movement

→ Not so much a building height issue, but a differential movement issue between components that don’t move as much (like curtainwall or infill walls)

Plywood over end grain

Larger movement joint at curtainwall & SIPs panel head

Horizontal wood kept relatively dry during construction to minimize swelling
CLT Panel Interface Air Tightness?
CLT Interface Air Barrier Detailing Considerations
Air Barrier/WRB Membranes for CLT Panels

Liquids

Vapor permeable self-adhered sheets

Liquids
Roofs – Exterior Insulated (Conventional or PMR)
CLT Roof Considerations

Roof Assembly:
- Roof Membrane
- Protection Board
- Exterior Insulation
- Air Barrier Membrane
- Plywood
- Furring/ Vented Space
- CLT Roof Structure
Venting Above Mass Timber Panels in Roofs
Why Prefabrication & Mass Timber Fit
UBC Tall Wood House – Façade Challenge
UBC Tall Wood House - Façade Design Criteria

- Fast installation – 1 floor/day & water tight to protect structure
- Durable & high-performance
- Thermally efficient, >R-16 effective walls
- Inexpensive, <$50/sqft installed & finished
- Installed without access to exterior – no sealing or finishing
- Resistant to water & able to install in rain
- Pre-installed cladding & windows
Façade Prefabrication - Small Panel with Separate Windows
Façade Prefabrication - Large Panel with Pre-installed Windows
UBC Tall Wood - Prefabricated Panel Competition
Wall Panel Laboratory Mockup & Physical Testing
Wall Panel Prefabrication
Site Installation
Site Installation – at Pace with Structure – 2 floors/week
Where Next? “Curtainwood”
Mass Timber Building Lessons Learned
Nuances of Different Mass Timber Products
CLT is Not Airtight - Don’t Forget the Membrane
CLT is Not Airtight - Don’t Forget the Membrane
NLT Panel Shrinkage Considerations

Lamination expansion due to swelling

Lamination position after NLT has returned to lower moisture
NLT Considerations – Design for Movement
The Biggest Challenge with NLT - Overhangs
NLT Panel Air Sealing in Factory
Managing Water Effectively During Construction
Keep Wood Dry & Use Appropriate Materials in Contact with Damp Wood
Take Care with Impermeable Roof Membranes – Can Be Double Edged Sword
Protect NLT from Excessive Wetting But Not Too Late
…Or Just Plan Ahead & Take Advantage of the Protection

Finland – use of climbing roof and overhead cranes – high degree of modular moisture sensitive components
Mass Timber Can Be Dried Out… Albeit Slowly
Protection of Mass Timber Panels During Construction

→ Pre-applied torch applied roofing membranes applied to horizontal panels in factory

→ Laps torched onsite immediately after installation
Lots of Protection Options for Mass Timber Panels During Construction – Just Pick One!
Just Don’t Pick None..
Coating Lessons - CLT

→ Primary purpose for temporary moisture protection to reduce wetting to avoid drying and keep construction on schedule

→ Factory Coatings
  → CLT end grain/panel edge coatings are effective
  → CLT surface coatings are useful though not always needed

→ CLT will benefit with a coating below wet concrete floor toppings
Site Moisture Management Fundamentals

→ Divert
  → Keep mass timber as dry as possible during shipping and construction
  → Use site tarping and other means to keep wood dry during inclement weather
  → Have a moisture management plan!

→ Deflect
  → Protect mass timber with appropriate temporary moisture management system

→ Drain
  → Keep water from ponding on mass timber panels, drain or squeegee/vacuum standing water from panels onsite

→ Dry
  → Promote drying with natural or mechanical means when wood does get wet
  → When covered with impermeable materials – may need to remove to accelerate drying
Moisture Management Planning for Mass Timber

→ Step 1: Risk Evaluation - Consider Climate, Rainfall, Construction Schedule, Length of exposure of all mass timber floors/roof etc. Type of mass timber

→ Step 2: Factory applied coatings to wood?

→ Step 3: Pre-applied or field applied temporary or permanent membrane protection?

→ Step 4: Active water management team onsite to reduce uptake (small tarps, squeegees/vacuums etc.)

→ Step 5: Whole building tarping & protection systems

→ Step 6: Environmental drying

→ Step 7: Mechanical drying contingency
How-to: Moisture Management Plans

→ Start planning early – starts with design and assemblies
  → Impact to architecture, structural design, building enclosure design, possibly fire separation and acoustics
  → Consider multi-function materials (ie temporary roof later becomes functioning air barrier/vapor barrier or acoustic underlayment)
  → Consider schedule impacts of wet wood on design
→ Include requirement in specifications for GC/mass timber sub-contractor to provide & follow written a Moisture Management Plan
  → Responsibility of contractor or sub-trade
  → Plan for regular reviews of implementation by (3rd party and/or BE Consultant, Architect, Structural Engineer)
  → Ask for mock-ups
Some Considerations
The Future of Tall Wood Facades/Enclosures

→ Facades/enclosures erected at same pace as structural systems for tall wood buildings – build fast & dry

→ Growing local market opportunities for various prefabricated wall & window assemblies
  → Will see a combination of steel, concrete, wood framing or wood panel structural systems used
  → Systems will borrow technology from precast concrete and aluminum curtainwall industry, evolve and adapt for mass timber structures
  → Use of hung “curtainwall” facades instead of load-bearing exterior walls
Discussion & Questions

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