Building Enclosures for Nail-Laminated Timber Buildings

NAILED IT! – INTRODUCING THE DESIGN GUIDE FOR NAIL-LAMINATED TIMBER WOODWORKS – MARCH 2019

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Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
Outline

→ The Building Enclosure & Considerations for NLT
→ Energy Codes & Insulation Requirements
→ NLT Roof Assemblies
→ Site Moisture Management for Roofs & Floors
→ NLT Floor Assemblies
→ Air-Barriers and NLT Detailing
Building Enclosures for NLT

Focus for NLT Guidelines for Building Enclosures is on NLT Roofs and Exposed Floors/Soffits + Construction Moisture Considerations for Roofs and Floors
Building Enclosure Design Fundamentals

→ Primary function of the Building Enclosure/Façade: Separate the exterior & interior environments
  → Protect mass timber during construction & in-service
  → Serves functional and aesthetic & purpose
  → Controls heat, air, and moisture transfer along with noise and fire
→ Designed to accommodate building movement, structural loads, initial & seasonal wood movement
→ Key passive design element for a sustainable & energy efficient building
Building Enclosure Design Fundamentals

- **Water**
  - Building Form & Features
  - Water Shedding Surface (WSS)

- **Air**
  - Water-Resistive Barrier (WRB)

- **Heat**
  - Air Barrier System

- **Vapor**
  - Thermal Insulation

- **Sound**

- **Fire**
  - Vapor Retarder/Barrier

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1 – Water is defined here as precipitation (rain, snow, hail, etc.) and ground water
2 – Vapor is separately defined here as the water vapor in air, as well as condensate moisture
NLT as Part of the Building Enclosure
NLT as Part of the Building Enclosure
NLT Construction & Floors
Properties of NLT & Building Enclosures

→ Water Control
  → Protect NLT from wetting and condensation: Dry = Durable

→ Thermal Control/Insulation
  → Wood provides some thermal resistance, but additional insulation still needed in assemblies/details

→ Vapor Control
  → Wood is a vapor barrier, no supplemental VB needed
  → Consider drying by design & material placement in NLT assemblies

→ Air Flow Control
  → NLT is not an airtight material supplemental materials & details needed for air barrier system
Properties of NLT and Building Enclosures

Lamination expansion due to swelling

Lamination position after NLT has returned to lower moisture
US Energy Codes & NLT Building Enclosures

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<tr>
<td>8</td>
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Based on Maximum Effective Assembly U-value Tables (402.1.4 (2015)), Group R, Residential Building R-values if different shown in brackets (higher)  
*Assumed “Mass” definition, NLT w/ concrete topping

**Note:** Confirm state by state & municipal requirements depending on year of energy code adoption
### Insulation Contribution of NLT Panels

#### B. TYPICAL NLT LAMINATION R-VALUES

<table>
<thead>
<tr>
<th>WOOD LAMINATION NOMINAL DIMENSION</th>
<th>ACTUAL THICKNESS MILLIMETERS (INCHES)</th>
<th>THERMAL RESISTANCE – RSI (R-VALUE) m²K/W (ft²°Fhr/Btu)</th>
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<td>2x4</td>
<td>89 (3.5)</td>
<td>0.61-0.75 (3.5-4.3)</td>
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<td>2x6</td>
<td>140 (5.5)</td>
<td>0.97-1.18 (5.4-6.7)</td>
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<td>184 (7.25)</td>
<td>1.26-1.56 (7.2-8.8)</td>
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<tr>
<td>2x10</td>
<td>235 (9.25)</td>
<td>1.61-1.99 (9.2-11.3)</td>
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</tbody>
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Minimum R-values for Roofs ~R-20 to R-35+

Minimum R-values for Floors ~R-9 to R-20, except Zone 1 (N.R.)
Roof Assembly Design Considerations

Conventional Roof Assembly

Protected Membrane Roof Assembly (Inverted Roof)
Conventional Roof – Sloped NLT Panels

SLOPED STRUCTURE

- Roof membrane
- Coverboard
- Rigid insulation
- Air/vapor control membrane/TMMS
- Structural Plywood/OSB
- NLT
- Sloped roof support (beyond)
Conventional Roof – Sloped/Tapered Insulation

TAPERED INSULATION

Roof membrane
Coverboard
Tapered rigid insulation
Air/vapor control membrane/TMMS
Structural Plywood/OSB
NLT
Roof support (beyond)
Conventional Roof – Sloped Over-Framing

- Roof membrane
- Coverboard
- Rigid insulation
- Air/vapor control membrane/TMMS
- Structural Plywood/OSB
- Sloped over-framing, Air cavity, vented to interior. (Refer to section 5.4.1)
- NLT
- Roof support (beyond)
Protected Membrane/Inverted Roof – Sloped Structure

Overburden/ballast
Extruded polystyrene insulation
Drainage composite
Roof membrane/TMMS
Structural Plywood/OSB
NLT
Structural support (beyond)
Protected Membrane/Inverted Roof – Sloped Over-Framing

Overburden/ballast
Extruded polystyrene insulation
Drainage composite
Roof membrane/TMMS
Structural Plywood/OSB
Sloped over-framing
Air cavity, vented to interior
NLT
Structural support (beyond)
Protected Membrane/Modified Inverted Roof Membrane – Tapered Insulation

- Overburden/ballast
- Extruded polystyrene insulation
- Drainage composite
- Roof membrane
- Coverboard
- Tapered rigid insulation
- Air/Vapor Control Membrane/TMMS
- Structural Plywood/OSB
- NLT
- Structural support (beyond)
Managing Site Moisture – Temporary Moisture Management Systems (TMMS)
Site Conditions Where TMMS Systems Are Beneficial
NLT Considerations – Panel Sheathing & Joints

Figure 7.4: Installed roof panels with gaps for expansion. (Photo courtesy of StructureCraft Builders Inc.)

Figure 7.5: NLT install of prefabricated presheathed panels. (Photo courtesy of StructureCraft Builders Inc.)
Site Moisture Management Fundamentals

→ **Divert**
  - Keep NLT as dry as possible during shipping and construction
  - Consider site tarping and other means to keep NLT dry during inclement weather
  - Have a moisture management plan!

→ **Deflect**
  - Protect NLT with appropriate temporary moisture management system (TMMS) – *next section*

→ **Drain**
  - Keep water from ponding on NLT panels, drain or squeegee/vacuum standing water from panels onsite

→ **Dry**
  - Promote drying with natural or mechanical means when NLT does get wet
  - When covered with impermeable materials – may need to remove to accelerate drying
Selecting Temporary Moisture Management Systems (TMMS) – By Climate Risk

Figure 7.7: Scheffer Climate Index as updated by Morris and Wang [6] and modified by RDH Building Science Inc.
Temporary Moisture Management Systems – High Protection, All Climates/All Seasons

Field Membrane:
- Factory applied, fully-adhered, vapor impermeable waterproof membrane on sheathing
- Serves as temporary roof and later Air Barrier/Vapor Barrier

Joint Treatment:
- Fully adhered/torched or welded field membrane laps immediately onsite
Temporary Moisture Management Systems –
Moderate Protection, Climate Index ≤70/ All Seasons

Field Membrane:

→ Pre-coated moisture-resistant bonded water-repellent coating in sheathing

Joint Treatment:

→ Taped with flexible flashing membrane or tape

Other Considerations:

→ Proprietary coated sheathing
→ May have limited exposure time to ponding water
Temporary Moisture Management Systems – Moderate Protection, Climate Index ≤70/ All Seasons

Field Membrane:
→ Fully adhered “ponding water resistant” vapor-permeable membrane applied to sheathing

Joint Treatment:
→ Taped with flexible flashing membrane or tape

Other Considerations:
→ May have limited exposure time to ponding water
→ May be susceptible to damage or adhesion failure during construction
Temporary Moisture Management Systems – Moderate Protection, Climate Index $\leq 35$/ All Seasons

**Field Membrane:**
→ None – Exposed OSB or plywood sheathing

**Joint Treatment:**
→ Taped with flexible flashing membrane or tape

**Other Considerations:**
→ Limited exposure time to ponding water
→ Joint treatment may be damaged or non-bond during construction
→ Water sealers could improve water resistance of sheathing
Temporary Moisture Management Systems – Low Protection, Climate Index ≤35/ Dry Seasons

Field Membrane:
→ None – Exposed OSB or plywood sheathing

Joint Treatment:
→ None – Exposed Sheathing joints

Other Considerations:
→ System permits water between sheathing joints into NLT in wet weather
Temporary Moisture Management Systems – Low Protection, Climate Index ≤35/ Dry Seasons

Field Membrane:
→ None – Exposed NLT

Joint Treatment:
→ None – Exposed NLT

Other Considerations:
→ System permits water into NLT laminations in wet weather conditions
Temporary Moisture Management Systems – Avoid – Isolated Conditions

Field Membrane:
- Loose laid sheet over sheathing

Joint Treatment:
- Tape/flashing membrane

Other Considerations:
- Low durability, difficult to seal effectively, slippery to walk on
- Use in isolated conditions for short term only
Temporary Moisture Management Systems – Avoid

Field Membrane:
→ Loose laid sheet over NLT under sheathing

Joint Treatment:
→ Tapes/laps

Other Considerations:
→ Membrane will trap moisture in sheathing, laps and joints in membrane likely to leak into NLT laminations
Remember – The TMMS also needs to tie into drains (if present) and all other penetrations such as tie off anchors, strong-backs etc.
Consideration for Venting Above NLT Framing

Figure 5.5: Venting options for NLT roof assemblies.*

*In all cases venting occurs between the NLT laminations and sheathing and is vented to the building interior.
Venting Above Mass Timber Panels in Roofs
Other Water Management Approaches – Tenting
Floor/Soffit Assemblies - Air Impermeable Insulation

Interior finish and acoustic components
TMMS
Structural Plywood/OSB
NLT
Air- and vapor-impermeable thermal insulation (structure beyond)
Exterior vented soffit panel
Floor/Soffit Assemblies - Air Permeable Insulation

Not recommended for Hot-Humid Climates
NLT Floor Water Management Considerations – Concrete Toppings
Air Barrier Systems
Air Barrier Considerations for NLT

→ Air Barrier Systems Must Be:
  → Air Impermeable
  → Continuous
  → Durable
  → Stiff
  → Strong

→ Unique to NLT Assemblies:
  → NLT is not air-impermeable due to gaps between laminations
  → Adhered membranes or sheathing fixed over the NLT panel overcomes stiffness

Figure 5.2: Potential Deformation or Deflection of Air Barrier System from Forces of Air Pressure.
NLT Air Barrier Detailing Example - Parapets
NLT Air Barrier Detailing Example – Floors & Soffits
Air Barrier Detailing Example – Overhangs
Air Barrier Detailing Example – Overhangs
NLT Panel Air-Sealing in Factory
## NLT Panel Air-Sealing Options

<table>
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<tr>
<th>Method</th>
<th>Materials</th>
<th>Schematic</th>
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<tbody>
<tr>
<td>Double Gasket Weave</td>
<td>2-side adhesive foam gasket</td>
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<tr>
<td>Single Gasket Weave</td>
<td>2-side adhesive foam gasket</td>
<td><img src="image2.png" alt="Diagram" /></td>
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<tr>
<td>Sealant</td>
<td>Compatible high modulus sealant</td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Butyl Tape</td>
<td>Butyl tape</td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Expanding Foam w/ drilled holes</td>
<td>Low expansion, flexible spray foam</td>
<td><img src="image5.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
Woven Gasket Method
Drilled Gap & Sprayfoam Method

- Challenges with effectiveness and implementation
- Very difficult to seal along sheathing effectively with sprayfoam
Sealant Method – Two Stage Joint
Sealant Method – Two Stage Joint & Panel Gap
Considerations for Staggered NLT Laminations

Figure 2.10: Uniform Depth Cross-Section.

Figure 2.11: 1:1 Alternating Staggered Depth Cross-Section.

Figure 2.12: 2:1 Alternating Staggered Depth Cross-Section.
Alternate Approaches for Overhangs
Summary

→ NLT Roofing Applications
  → Supplemental insulation needed for energy code – insulate on top in conventional or protected roof membrane application
  → Protect NLT roofs from construction moisture with appropriate temporary moisture management system – also provides air barrier

→ NLT Floor Applications
  → Supplemental insulation may be needed for energy code – insulate underneath floor after structure closed-in
  → Protect NLT floors from construction moisture with appropriate temporary moisture management system given protection from above

→ Details
  → Strategies for NLT lamination air-sealing at interfaces
Questions?

This Concludes The American Institute Of Architects Continuing Education Systems Course

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