Mass Timber: Knowing Your Options

Presentation to the Architectural Institute of BC & the American Institute of Architects

24 October, 2013

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• Overview
• Design process + case studies
• Future
• Useful tools
Overview |

• Definition of Mass Timber
• Structural Building Systems
• Products
• Sizes and Design Characteristics
• Comparison
Mass timber construction uses large and ideally prefabricated wood for wall, floor, and roof construction. [...] Because of their high strength and dimensional stability, they can be used as alternatives to concrete, masonry and steel in many building types.

Quote from MassTimber.com
Building Systems

Light Wood Frame (Stick Frame)
Building Systems

Post + Beam (with Mass Timber or light wood frame floors)
Building Systems | Mass Timber (100%)
Building Systems | Light Wood Frame
Institutional Post + Beam
Residential Mass Timber (100%)

Mass Timber Floors (and Shearwalls)
Mass Timber Walls and Floors
Building Systems |

Light Wood Frame

Institutional Post + Beam

Residential Mass Timber (100%)

Mass Timber Floors (and Shearwalls)

Mass Timber Walls and Floors

LOTS OF VARIATIONS AND HYBRIDS ARE POSSIBLE
Nail Laminated Timber
**Alternative Names:** nailed timber, nail-up, edge-lam, brettstapel

**System:** regular framing members (2x, 3x) on edge + fastened together

**Suppliers:** a good carpenter

**Basic Info:**
- material/fibre used: S-P-F / Douglas Fir or any other
- harvesting cycle: 80 years
- floor, roof (and wall) with Plywood sheathing for lateral loads
Comments:

- Non-standardized panel product
Comments:

- Non-standardized panel product
  - base material covered with grading rules
Comments:

- Non-standardized panel product
- Specifications
Comments:

- Non-standardized panel product
- Specifications
- Requires care with regards to swelling / shrinkage perpendicular to grain
2. SHRINKAGE / SWELLING GAP
   TYP. GRIDS B, C, F AND G ONLY
Overview | GLT

Glue Laminated Timber
Alternative Names: glued edge laminated timber, edge laminated timber, edge-lam

System: “glulam beams on edge”

Suppliers: Structurlam (Penticton), Western Archrib (Edmonton), Nordic (Montreal) or any other glulam supplier

Basic Info:
- material/fibre: S-P-F / D. Fir / Black Spruce / …
- harvesting cycle: 80 years
- adhesive: Phenol Resorcinol (black) or Melamine (clear)
- adhesive amount: 1% by weight
- floor, roof (and wall) with Plywood sheathing for lateral loads
Comments:

- Standardized product
Comments:

- Standardized product
- Requires care with regards to swelling / shrinkage perpendicular to grain
D. FIR PLY OVER GLT PANELS
AS PER PLAN, U.N.O.
GLUE PLY TO GLT PANELS &
FASTEN WITH 76mm COMMON
NAILS @ 75mm AT ALL PLY
PANEL EDGES.

1 ROWS 76mm COMMON NAILS @ 300mm
EACH WAY THROUGHOUT INTERIOR OF
PLY SHEET. USE 1 ROW EACH SIDE OF
PLY PANEL JOINT

GLT PANEL
AS PER PLAN

625
PANEL JOINT C/C SPACING

619

6 GAP

6 GAP
Comments:

- Standardized product
- Requires care with regards to swelling / shrinkage perpendicular to grain
- Glulam beam ≠ GLT
Overview | Products
Cross Laminated Timber
Alternative Names: cross laminated timber, x-lam

System: cross laminated timber panels → 2x members glued together

Suppliers: Structurlam (Penticton, BC), Nordic (Montreal, QC), Smartlam (Whitefish, MT)

Basic Info: - material/fibre: S-P-F / Black Spruce
- harvesting cycle: 80 to 100 years
- adhesive: Polyurethane
- adhesive amount: 4% by weight
- floor, roof and wall with joints detailed for lateral loads
Comments:

- Standardized product
Comments:

- Standardized product
- Dimensionally very stable
Comments:

- Standardized product
- Dimensionally very stable
- Two directional span capabilities
CLT | Wayne Gretzky Centre

Courtesy of Structurlam Products
Overview | Solid LSL

Laminated Strand Lumber
Alternative Names: n/a

System: laminated strand lumber (timber strands glued together)

Suppliers: *Weyerhauser, Louisiana Pacific,

Basic Info*: - material/fibre: Aspen
- harvesting cycle: 60 to 70 years
- adhesive: MDI - Isocyante
- adhesive amount: 6% by weight
- floor, roof and wall with joints detailed for lateral loads (limited thicknesses!)
Solid LSL |

Comments:

- Standardized product
Solid LSL |

- ANSI
- CCMC Canadian Construction Materials Centre
- APA
Solid LSL |

Comments:

- Standardized product
- Dimensionally relatively stable
Solid LSL
Alternative Names: Microlam, Versalam

System: laminated veneer lumber (veneers stacked & glued together)

Suppliers: Louisianan Pacific*, Weyerhaeuser, Boise Cascade, West Fraser, Metsawood

Basic Info*: - material/fibre: D. Fir
- harvesting cycle: 80 years
- adhesive: Phenol Formaldehyde
- adhesive amount: 7% by weight
- floor, roof and wall with joints detailed for lateral loads (limited thicknesses!)
Comments:

- Standardized product
Solid LVL | ANSi | CCMC
Canadian Construction Materials Centre | APA
Solid LVL |

Comments:

- Standardized product
- Dimensionally relatively stable (can add cross layers)
Solid LVL
Overview | Brisco Fine Line LVL

Laminated Veneer Lumber
Alternative Names: N/A

System: laminated veneer lumber (veneers stacked & glued together)

Suppliers: Brisco

Basic Info:
- material/fibre: D. Fir
- harvesting cycle: 80 years
- adhesive: Phenol Formaldehyde
- adhesive amount: 7% by weight
- floor, roof and wall with joints detailed for lateral loads
Brisco Fine Line LVL |

Comments:

- Standardized product
Comments:

- Standardized product
- Dimensionally relatively stable
Brisco Fine Line LVL |
Wood – Concrete - Composite
Alternative Names: Timber – Concrete – Composite

System: Solid wood panel at bottom, concrete over top (acting as one unit)
Base layer can be nearly any solid wood panel
Connector supplied by wood panel supplier or general contractor
“Free”, stiff and strong diaphragm
- PSL (Parallam)
- Solid Decking / T&G
- Logs
Sizes and Design Characteristics
Sizes and Design Characteristics | Depth

- NLT: 89, 140, 184, 235, 286
- GLT-086: 80, 130, 175, 215, 235
- Westdek: 80, 130, 175, 215, 265
- Nordic Lam: 44, 86, 137, 184, 228, 279
- LVL: 44, 89, 78, 105, 131, 175, 220, 244
- CLT-Nordic: 99, 169, 239
- CLT-Structurlam: 80, 138, 175, 180, 190, 230, 276
- Brisco: 44, 64, 89
- LSL: 89, 102
Sizes and Design Characteristics | Width
Sizes and Design Characteristics | Length

<table>
<thead>
<tr>
<th>Material</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordic Lam</td>
<td>24.4</td>
</tr>
<tr>
<td>GLT-O86</td>
<td>24.4</td>
</tr>
<tr>
<td>Westdek</td>
<td>20</td>
</tr>
<tr>
<td>Timberstrand-LSL</td>
<td>19.5</td>
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<tr>
<td>CLT-Nordic</td>
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<td>LVL</td>
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<tr>
<td>Brisco</td>
<td>18.3</td>
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<tr>
<td>CLT-Structurlam</td>
<td>12.2</td>
</tr>
<tr>
<td>NLT</td>
<td>6.1</td>
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</tbody>
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16m (50') to 20m (66') basic transportation length.
Design is mostly governed by deflection (stiffness) and/or vibration.
Stiffness

- 184mm NLT
- 175mm Westdek
- 175mm Brisco
- 169mm CLT
- 140mm NLT
- 135mm Brisco
Comparison | Fire

- In general, all products have a similar char rate
- Approximately 38mm – 44mm / 60 minutes
  - Check with Code Consultant
- Be careful with CLT if required rating is between 45 and 90 minutes
  - Most of the time it’s not a problem for panels with 5+ layers
Fire
Practical Considerations | Location
Location

- Local trades
- Distance to suppliers (LEED, Living Building Challenge)
- Dry vs. wet climate
- Funding
- Season of construction (winter prefab)
Practical Considerations | Size of a Project
Sole Sourcing / Suppliers capacity

Sequencing on Site / Staging

Procurement
Procurement |

- Design - Bid - Build
- Construction Management
- Design Build
- ?
Depth

6m FLOOR SPAN  220mm – 260mm
5m FLOOR SPAN  160mm – 200mm
4m FLOOR SPAN  110mm – 150mm

DEPTHS ACCOUNT FOR VIBRATION
Practical Considerations | Decide Early
➤ Use the product to its fullest extent possible
➤ Work with supplier
➤ Economical solution
Practical Considerations | BIM
➢ CNC fabrication requires 3-D files

➢ Architectural 3-D models (REVIT) are not compatible with fabrication models

➢ 3-D shop drawing model including connections

➢ Successful projects using prefabricated systems rely heavily on integrated design (including fabricator & installer) and 3-D computer models to detect potential conflicts and fabrication/installation issues early in the process
Practical Considerations | Movement

CELL WALL LAYERS

FIBRILS

WOOD CELLS

S1 S2 S3

ML P

Hemicellulose

Cellulose

Lignin

CELLULOSE CHAIN MOLECULE

10 μm

1 nm

0.1 nm
Practical Considerations | Movement

NLT, GLT:
0.25% change in dimension for each 1% change in moisture content

• 12%MC when installed
• 14%MC during construction
• 50mm swelling in 10m

*38mm each 6m (1 ½” each 20’)

(1 or 2 lamination)
Gap to be filled in after building is enclosed. Glue or pin nail.
Practical Considerations | Connections

Wall
Floor
Wall
Foundation
Wall
Wall
Foundation
Practical Considerations | Connections
Galvanized or otherwise protected steel parts and fasteners to deal with moisture:
Mass Timber Design Process

• Case studies as a means to introduce concepts, uses and challenges:

  ➢ Case 1: Athabasca University Academic Research Ctr.
  ➢ Case 2: Mountain Equipment Co-op Head Office
Case Study One | Athabasca University
Design
Nail Laminated

- Standard & locally available
- Prefabrication
- Aesthetics
- Low-skilled labour
- Integrates mechanical & electrical systems
7 TYP. PANEL CONNECTION

NOTE:
CONTRACTOR IS RESPONSIBLE FOR ERECTION AND STABILITY OF PANELS DURING CONSTRUCTION. DISCUSS ERECTION PROCEDURE WITH ENGINEER PRIOR TO FABRICATION.
Case Study Two | Mountain Equipment Co-op
• 2x8 solid wood NLT panels
• 2x10 panels at snow drift zones and green roof
• Random stack pattern for long span
• ½” plywood and topping
• One hour fire rating (including char reduction)
The Future of Mass Timber
The Future | Innovative Products + Applications
The Future | Innovative Products + Applications
The Future | Procurement

Traditional Procurement:
- Design
- Shop Drawings
- Fabrication
- Installation

Time Savings:

Design Assist Procurement:
- Design
- Shop Drawings
- Fabrication
- Installation

Design Development
- Contract Documents
- Tender + Construction

Pre-Tender
The Future | Tall(er) Wood Buildings
CONCEPT App

- Idea calculator for architects
- Member calculator
- Material gallery
CONCEPT App | Depth Calculator Results

**Input Span**
- Wood Floor
  - Beam
    - Input length to calculate depth:
      - Beam: 1.5 – 15.0 m

**Results**
- Wood Floor Beam
  - Sawn Timber
    - 430 mm – 510 mm
  - Glue Laminated
    - 360 mm – 430 mm
CONCEPT App

Available on iTunes or visit www.fastepp.com for more information.
Thank You