Fast + Epp structural engineers
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Southeast Mass Timber Symposium
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Fast + Epp

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2. Structural Properties of Wood
3. Products
4. Design Considerations
2. Structural Properties of Wood
3. Products
4. Design Considerations

Overview
LIGHT WOOD FRAME

POST + BEAM

MASS TIMBER PANELS

what is mass timber?
why use mass timber?
### Material Comparison

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume at 20’ (ft³)</th>
<th>Weight (lbs)</th>
<th>CO₂ per weight</th>
<th>CO₂ emissions (lbs)</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td>26.67</td>
<td>880.0</td>
<td>0.57</td>
<td>501.6</td>
<td>1</td>
</tr>
<tr>
<td>Steel</td>
<td>0.90</td>
<td>452.9</td>
<td>4.0</td>
<td>1811.8</td>
<td>3.6</td>
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<tr>
<td>Concrete</td>
<td>17.8</td>
<td>2666.7</td>
<td>1.15</td>
<td>3066.7</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Source: Alan Organschi, *Timber City*
speed
deck labor
construction traffic
site noise
aesthetics

why use mass timber?
1 Roofs (including long spans)
1. Roofs (including long spans)
2. Mid-rise office + residential
1. Roofs (including long spans)
2. Mid-rise office + residential
3. Tall structures?

Photo Credit: Skidmore, Owings & Merrill
overview
anisotropy
shrinkage and swelling

- Shrinkage greatest along the growth rings
- Shrinkage least across the growth rings

- Tangential cut ~ greatest shrinkage
- Radial cut ~ least shrinkage

Little shrinkage along length
<table>
<thead>
<tr>
<th>Stress Type</th>
<th>Parallel to Grain</th>
<th>Perpendicular to Grain</th>
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</thead>
<tbody>
<tr>
<td>Compression</td>
<td>600 - 2,000 psi</td>
<td>300 - 800 psi</td>
</tr>
<tr>
<td>Tension</td>
<td>400 - 2,000 psi</td>
<td>neglect</td>
</tr>
<tr>
<td>Bending</td>
<td>800 - 2,500 psi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,000 psi concrete</td>
<td>A36 steel</td>
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<tr>
<td>-------------</td>
<td>---------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>compression</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>tension</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>5,000 psi concrete</td>
<td>A36 steel</td>
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<td>----------------------</td>
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<td>-----------</td>
</tr>
<tr>
<td>stiffness to weight</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td>modulus of elasticity</td>
<td>1,000,000 - 2,000,000 psi</td>
<td></td>
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</table>
2. Structural properties of wood
3. Products
4. Design considerations

Overview
glulam panels (GLT)
nail-laminated timber (NLT)
plank decking
structural composite lumber (LSL, LVL, PSL)
CLT
wood-concrete composites
nail-laminated timber (NLT)

mass timber products
depths 3-1/2” to 11-1/4” (4” to 12” nominal dimensional lumber)

typical floor spans 8’ to 24’

typical panel dimensions 4’ to 8’ wide; up to 16’ long for continuous laminations, 40’ and up for butt-jointed or finger-jointed laminations

suppliers any competent carpenter

detailing considerations plywood layer over top for diaphragm, allow for shrinkage and swelling during construction
2x “joists” @ 1-1/2”

choose:
- depth, profile
- species, grade

continuous vs. butt-joined laminations
detail for swelling and shrinkage

2. SHRINKAGE / SWELLING GAP
   TYP. GRIDS B, C, F AND G ONLY
   1 : 10

38 mm 26
(1 OR 2 LAMINATIONS)
GAP TO BE FILLED IN AFTER
BUILDING IS ENCLOSED.
GLUE OR PIN NAIL.
design guide
rethinkwood.com

mass timber products
UniverCity Childcare
Samuel Brighouse Elementary School
glulam + GLT

mass timber products
**column sizes**  
3-1/8” x 4-1/2” to 14-3/8” x 18”

**beam sizes**  
3-1/8” to 14-3/8” wide, up to 7’ deep

**suppliers**  
20+ in North America

**detailing considerations**  
allow for shrinkage and swelling

**notes**  
- column layups are uniformly graded; beam layups have stronger laminations top and bottom
- multiple appearance grades available
- curved or cambered beams are possible
typical floor spans  8’ to 24’ 

typical panel dimensions (North American suppliers):  
2’ wide; 40’ to 60’ long

suppliers  any glulam supplier; 20+ in North America

detailing considerations  plywood layer over top for diaphragm, allow for shrinkage and swelling during construction
“beam on the flat”
detail for swelling and shrinkage
Grandview Heights Aquatic Centre
surrey, bc | canada
**depths**  approx. 4” (3-ply) to 12” (9-ply)

**typical floor spans**  10’ to 24’ in primary direction

**typical panel dimensions**
- North American suppliers: 8’ to 10’ wide; 40’ to 60’ long
- European suppliers: up to 16’ wide, 60’ long

**suppliers**  five certified to North American standard; 10+ in Europe

**detailing considerations**  no plywood layer required
- multiple splice options available
dimensional stability

APA PRG 320 defines structural grades (E1 - E4, V1 - V3)

panel sizes vary by supplier

cross-laminations reduce strength and stiffness in primary span direction
2-way span capability
Critical shear crack

Crack width correlated with $\psi \cdot d$

point-supported slabs
G ≈ 10 \times G_{\text{rolling shear}}
design guide
rethinkwood.com

mass timber
products
UHNBC Learning + Development Centre

CLT in action
UHNBC Learning + Development Centre

CLT in action
Brock Commons Student Residence
Vancouver, BC | Canada

CLT in action
1. mass timber: what and why?
2. structural properties of wood
3. products
4. design considerations

overview
5-ply CLT floor panel (bare):
STC 41, IIC 25

5-ply CLT floor panel with
3/4” recycled felt fiberboard and
1-1/2” concrete topping:
STC 59, IIC 42

Source: “Acoustics Summary – Sound Insulation in Mid-Rise
• Athena Sustainable Materials Institute (Life Cycle Assessment)
  www.athenasmi.org
• Wood Works
  www.woodworks.org
• American Wood Council
  www.awc.org
• Code Conforming Wood Design
  www.awc.org/codes-standards/buildingcodes/ccwd
• CLT Handbook
• NLT Handbook
  http://www.rethinkwood.com/webform/download-nlt-handbook
• Code consultant and local authorities
This concludes The American Institute of Architects Continuing Education Systems Course

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