Wood Studio Workshop

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Wood Studio Workshop

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and

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UMass, Amherst

UMass STEM Ed Science and Engineering Saturday Seminars

Thompson Community Center, Richmond, British Columbia
Photo courtesy: Henriquez Partners Architects
21st century timber engineering

“high-tech”

“eco-friendly”

“revolutionary”

“bold and beautiful”

“new”

Prince George Airport, British Columbia
Photo credit: McFarlane Green Biggar (MBG) Architects

17 TALL WOOD BUILDINGS HAVE BEEN BUILT IN THE PAST 5 YEARS AND COUNTING

42 stories proposed!
TIMBER TOWER PROJECT by SOM

See: http://www.som.com/ideas/videos/rethinking_tall_building_design_the_timber_tower_research_project
Go UMass!

The Design Building is the most technologically advanced CLT structure in the US

Primary drivers

Sustainability & Innovation
Building: one of the biggest culprits of climate change

Green Building

Why Build Green?

In the United States, buildings account for:

- 39 percent of total energy use
- 12 percent of the total water consumption
- 68 percent of total electricity consumption
- 36 percent of the carbon dioxide emissions

A list of additional statistics on buildings and the environment (PDF) (7 pp, 66K, About PDF) is available.

The built environment has a vast impact on the natural environment, human health, and the economy. By adopting green building strategies, we can maximize both economic and environmental performance. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if the design and construction team take an integrated approach from the earliest stages of a building project. Potential benefits of green building can include:

Green Building Awards

Office Building for GlaxoSmithKline Inc., Quebec Nordic CLT. Photo credit © Stéphane Groleau

“Wood can help to earn points in categories typically found in green building rating systems—including certified wood, recycled/reused/salvaged materials, local sourcing of materials, waste minimization, indoor air quality, advanced building techniques and skills and life cycle impacts” ...

Quote source: ReTHINK Wood
Carbon sequestration and storage

- Wood and wood products store carbon until they burn or biodegrade.

Wood products are carbon negative

Image courtesy of Joseph Mayo of Mahlum | Architects Inc.
Life Cycle Assessment (LCA)

Image source: ReTHINK WOOD® – Building Green with Wood (Module 2)

Healthy Indoor Environment

- Stress reducing effects
- Humidity control
- Advanced adhesives with minimal to no off-gasing
UMass Design Building

Carbon Summary

- Volume of wood products used (m³):
  - 2081 m³ (73482 ft³) of lumber and sheathing
- U.S. and Canadians forests grow this much wood in:
  - 6 minutes
- Carbon stored in the wood:
  - 1463 metric tons of CO₂
- Avoided greenhouse gas emissions:
  - 1218 metric tons of CO₂
- Total potential carbon benefit:
  - 2681 metric tons of CO₂

Equivalent to:

- 512 cars off the road for a year
- Energy to operate a home for 228 years

Primary drivers

Sustainability
&
Innovation
Mass Timber

- Cross Laminated Timber (CLT)
- Glulam
- Parallel Strand Lumber
- Wood Concrete Composites

Photo credit: A. Schreyer
Fire Safety with Mass Timber

Char protects the inner core

Large trees remain after forest fire

Let’s make some Glulam beams!
Why is Glulam strong?

1) Defects are dispersed

Wood knots
Stress grades

Select Structural  No. 1  No. 2  No. 3

Why is Glulam strong?

2) Layup is engineered
Different species have different strengths

<table>
<thead>
<tr>
<th>Wood Species</th>
<th>Bending Strength (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Ash</td>
<td>103,000</td>
</tr>
<tr>
<td>Black Spruce</td>
<td>74,000</td>
</tr>
<tr>
<td>Douglas-Fir</td>
<td>85,000</td>
</tr>
<tr>
<td>Eastern Hemlock</td>
<td>61,000</td>
</tr>
</tbody>
</table>

Design Building Tour
- 87,500 ft² (8,200 m²), 4 stories
- Project cost: $52M (construction only: $36M)
- Architect: Leers Weinzapfel Assoc.,
- Engineer: Equilibrium / SGH

Design Building, UMass, Amherst

Building Layout
FAST glulam column installation
Design Building in Construction: 1 work day

The Design Building Floors are Special
CLT-Concrete Composite Flooring
• Why go to all the extra trouble to connect the concrete to the wood?

• Because it’s much stronger and stiffer that way

• And it all has to do with Composite Action
## Composite Action ... in action!

<table>
<thead>
<tr>
<th>Case</th>
<th>Measurements</th>
<th>Calculations</th>
<th>Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height from floor to top UNLOADED (mm)</td>
<td>Height from floor to top LOADED (mm)</td>
<td>Deflection, Δ (unloaded height – loaded height)</td>
</tr>
<tr>
<td>A</td>
<td>One wood plank only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Two wood planks unconnected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Two wood planks laid side by side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Two wood planks connected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Two wood planks with HardiePlank unconnected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Two wood planks with HardiePlank connected</td>
<td></td>
<td></td>
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</tbody>
</table>