Home for the Homeless using Cross Laminated Timber (CLT) Waste Stream

**Introduction**
Homelessness has been a rapidly growing social crisis in our city. To address this in a humane manner, a local architect has started a program where a 125 sq. ft accessory dwelling unit (ADU) is built in the backyard of a willing homeowner; the surrounding community provides support to help the resident to get back on their feet. Since 2010 about 10 ADUs have been built using traditional light timber frame construction using volunteer labor. A student team, as part of its capstone project, improved the existing design with the use of waste stream from a Cross Laminated Timber (CLT) manufacturing process.

**Project Scope**
- Explore using waste material from Cross Laminated Timber (CLT) for ADU construction
- Develop design that is easy to assemble and disassemble by unskilled volunteer labor force
- Improve current design to incorporate sustainable features and Living Building Challenge

**Health, Safety and Welfare Issues of Project**
- Homelessness is a social problem involving public health, safety and welfare
- Fire safety of timber structures was addressed
- Vibration of timber floors for user comfort was studied

**CLT Production and Construction**
3, 5, 7 or 9 layers of lumber bonded together with adhesives to form 10ft x 40 ft panels

- Building components (walls, roofs, beams and columns) pre-cut in factory using CNC machines and shipped to site for construction
- CLT wall panel with windows and doors pre-cut being installed on site
- Cut outs and waste CLT discarded

**Modular CLT Slat - Construction Sequence**
- two rows of four Diamond Pier foundations are installed
- two foundation beams placed on top
- beam connected to foundations with 5/8" x 5 1/2" ASTM A325 structural bolts
- Floor slats connected with 3/8" x 2" dowels
- floor connected to foundation beam with 5/8" x 6" flat head screws
- Wall slats assembled and connected...
- to each other with LTP4 Simpson Strong-Tie®
- to floor with ABR 9020 Simpson Strong-Tie® angle brackets
- at corners with 1 1/8 inch SDWS Timber screw

**Professional Engineers and Allied Professional Participation**
- A faculty member (SE) advised the team
- A faculty member (PE) taught the capstone course
- An Architect served as the project sponsor and owner representative
- A professional engineer from industry mentored the team on current ADU building practices.
- CLT factory personnel met with team to explain the manufacturing process and waste stream generation
- Diamond pier (foundation) manufacturer met with team to explain product and construction practices
- Team worked with unskilled volunteers to understand the challenges to be aware of in the design process

**Comparison of Cost**

<table>
<thead>
<tr>
<th>Home Element</th>
<th>Light Frame</th>
<th>CLT Waste Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Lumber</td>
<td>2,390</td>
<td>760</td>
</tr>
<tr>
<td>Structural Hardware</td>
<td>760</td>
<td>1,130</td>
</tr>
<tr>
<td>Finished Carpentry</td>
<td>5960</td>
<td>1,660</td>
</tr>
<tr>
<td>Coatings</td>
<td>840</td>
<td>400</td>
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<tr>
<td>Envelope²</td>
<td>3530</td>
<td>4,160</td>
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<tr>
<td>Transportation</td>
<td>-</td>
<td>1,350</td>
</tr>
<tr>
<td>Common Materials³</td>
<td>30,700</td>
<td>30,700</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>44,200</strong></td>
<td><strong>40,600</strong></td>
</tr>
</tbody>
</table>

1. TRimming of openings, cabinetry inside ADU
2. architectural finishes and materials for a weather tight enclosure (sealant, insulation, rainscreen
3. foundation, metal roof and siding, doors, windows, interior work, plumbing, HVAC, electrical/soilair, landscaping, utilities and permits

**Knowledge and Skills Gained**
- Working knowledge of various design codes
- AutoCAD for drafting and Sketchup 3D modeling software for presentation
- Exposure to sustainable design features, hardware and connection design, concept of Living Building Challenge and cost estimation

**Professional Skills**
- Ability to interact with engineers, allied professionals and volunteers
- Communicate effectively orally and through writing
- Project management and leadership skills: running meetings with an agenda and following up action items, managing schedules and budgets; working as a team
- Ability to work in virtual environment
- Awareness of ethical and social responsibility of engineers