Concrete Reinforcing Steel Institute

ENGINEERING
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Technical Note

Cost Comparison of Cross Laminated Timber (CLT) and Cast-in-place Reinforced Concrete Structures

Overview

This Technical Note provides a summary of a recent study that compares the cost of the structural frame of a hypothetical 10-story residential building located in the Pacific Northwest using cross laminated timber (CLT) and cast-in-place reinforced concrete. The study was performed by the structural engineering firm Cary Kopczynski & Company, Seattle, WA (see the Reference section below for the report that was generated from this study).

Axonometric and plan views of the CLT option are given in Figures 1 and 2, respectively. Similar views for the reinforced concrete option are given in Figures 3 and 4. A typical floor to ceiling height of 9 ft-0 in. was assumed in both options.

Additional cost data for some actual CLT projects are also provided.

Structural Design

Design loads for the buildings were determined in accordance with the 2015 edition of the International Building Code (IBC) and the 2010 edition of Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-10). It was assumed that wind loads governed the design. Members of the gravity and lateral force-resisting systems were designed for strength and serviceability using the latest material design standards.

CLT Option

The CLT option utilizes a bearing wall system where the walls resist both gravity and lateral loads (see Figure 2). Walls are 6-7/8-in.-thick 5-lam assemblies, assuming 1-3/8-in.-thick laminations of structural grade softwood timber (a standard size for U.S.-manufactured CLT). The floor panels are typically 6-7/8-in.-thick 5-lam assemblies, with 9-5/8-in.-thick 7-lam assemblies at the corner units where floor spans exceed 16 ft-0 in.

Spans selected for the CLT option are shorter in some areas than those for the cast-in-place concrete option due to the vibration potential for CLT floor systems. Floor vibration can typically be mitigated with a concrete topping slab, which may also be utilized for fire resistance.

Steel angle clips fastened with structural screw anchors were used between floor and wall panels to transfer lateral loads. Wall openings were assumed to be either integrated into the wall assemblies, or resolved with a structural composite lumber (SCL) beam. Exterior walls on the north and south sides of the building were considered to be non-load bearing, and do not require CLT framing. Balconies were assumed to be pre-manufactured components attached to the building frame.

Cast-in-place Concrete Option

In the cast-in-place reinforced concrete option, normalweight concrete and Grade 60 ASTM A615 reinforcement are utilized throughout the structure. The flat plate system consists of 9-in.-thick slabs ($f_{c'}=5,000$ psi) and 16 in. by 24 in. columns ($f_{c'}=6,000$ psi), which are spaced at a maximum of 25 ft-0 in. on center (see Figure 4).

The lateral force-resisting system consists of 12-in.-thick concrete shear walls ($f_{c'}=6,000$ psi) around the stair and elevator cores. Except for the shear walls, all interior and exterior walls were assumed to be non-load bearing and non-structural. Balconies were assumed to be either an extension of the floor slabs or pre-manufactured components attached to the building frame.

Cost Comparison

Based on a survey of contractors knowledgeable in CLT construction, the cost of the structural frame in the CLT option was estimated to be $48 to $56 per gross square foot excluding costs for acoustical dampening and fire protection. Acoustical and fire protection costs are expected to range from $2 to $6 per square foot.

The cost of the structural frame in the cast-in-place reinforced concrete option is
Figure 1 – Axonometric View of the CLT Option.

Figure 2 – Plan View of the CLT Option.
Figure 3 – Axonometric View of the Reinforced Concrete Option.

Figure 4 – Plan View of the Reinforced Concrete Option.
estimated to range from $42 to $46 per gross square foot. Additional cost for acoustical dampening may be required, which is estimated to be in the range of $1 to $2 per square foot.

*It is evident from the results of this study that the cost of the structural frame for the CLT option is about 16 to 29% greater than that of the cast-in-place reinforced concrete option.*

**Additional CLT Cost Data**

Cost information for the structural frame of CLT projects located in North America is given in Table 1.

Typical bay sizes in the Brock Commons Student Residence are 9.4 ft by 13.1 ft. Floor framing consists of 6.7-in.-thick CLT members. It is assumed that these bay sizes were used so that beams would not be required; using beams would have significantly increased floor-to-floor heights and overall cost. Seismic forces are resisted solely by 18-in.-thick reinforced concrete walls in the cores, and the wood superstructure is supported by a reinforced concrete podium slab at the first elevated level.

**Conclusion**

The results from this study clearly show that CLT structures cost significantly more than cast-in-place reinforced concrete structures. Square foot costs of some actual CLT projects are also greater than comparable reinforced concrete structures based on national average structure costs. It is expected that the costs would be even greater for CLT projects outside the Pacific Northwest where the majority of CLT production facilities are located.

**Reference**


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### Table 1 - CLT Cost Data

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Location</th>
<th>Cost Information</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-story industrial building</td>
<td>Rockwood, TN</td>
<td>$55/square foot</td>
<td>Square foot cost does not include cost for fireproofing</td>
</tr>
<tr>
<td>Two-story commercial building</td>
<td>Whitefish, MT</td>
<td>$60/square foot</td>
<td>Square foot cost does not include cost for fireproofing and acoustical damping</td>
</tr>
<tr>
<td>Four-story commercial building</td>
<td>Eugene, OR</td>
<td>$54/square foot</td>
<td>Square foot cost does not include cost for fireproofing, acoustical damping, and concrete topping slabs</td>
</tr>
<tr>
<td>18-story college dormitory (Brock Commons Student Residence)</td>
<td>Vancouver, BC</td>
<td>CLT framing cost approximately $26 / square foot (US) more than cast-in-place reinforced concrete framing</td>
<td>Square foot cost for CLT framing includes cost for fireproofing</td>
</tr>
<tr>
<td>12-story mixed-use building (Framework)</td>
<td>Portland, OR</td>
<td>$65/square foot</td>
<td>Some of the mass timber structure is unprotected</td>
</tr>
</tbody>
</table>

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**Keywords:** Buildings, CLT, cost, cost comparison, reinforced concrete

**Reference:** Concrete Reinforcing Steel Institute – CRSI [2018], “Cost Comparison of Cross Laminated Timber (CLT) and Cast-in-place Reinforced Concrete Structures”; CRSI Technical Note ETN-D-5-18, Schaumburg, Illinois, 4 pp.

**Historical:** None. New Technical Note.

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