RESEARCH in Progress

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Development of Cross-Laminated Timber for Seismic Regions of the United States

The increasing density of modern urban populations demands building that are taller and safer, resilient to natural hazards, and sustainable by having a low carbon footprint. Cross-laminated timber (CLT) is a bioproduct that can achieve all three objectives while utilizing low-value lumber stock emanating from beetle kill trees, small-diameter stock, and waste peeler core material, further reinforcing its sustainability.

Background

CLT is a multilayer wooden panel made of lumber. Each layer of boards is aligned perpendicular to adjacent layers and connected with either mechanical fasteners or adhesives for increased rigidity and stability. CLT—developed in Europe as an environmentally friendly building product—has been used successfully in multistory applications, such as a nine-story apartment tower in London's East End and four- and seven-story buildings in Växjö, Sweden (Fig. 1). However, those buildings were designed without the need to consider earthquake loading.

CLT is making inroads in North America, but more information is needed on its behavior when subjected to natural hazards, such as earthquakes (seismic loading). Recent changes to U.S. seismic building codes require that new building systems meet higher modeling and performance levels prior to utilization.

Objective

The objectives of this proposed research are to

- develop analytical models to evaluate the seismic performance of CLT systems to supports,
- evaluate ways to increase the seismic performance of CLT systems, and
- use developed analytical models to evaluate the seismic performance of a suite of CLT building types (Fig. 2).

Figure 1. Mid-rise CLT building in Växjö, Sweden.

Approach

A numerical model specifically designed to assess CLT systems under seismic loading does not currently exist. In the past decade, a new numerical tool, SAPWood, was developed and validated with full-scale shake table test results for wood-frame seismic simulation. Using the existing seismic simulation framework of SAPWood, the computational engine will be modified to enable CLT subassembly and whole-building nonlinear dynamic analysis. In addition, a mixed formulation including both traditional light-frame wood system and CLT system will be developed.

To understand how CLT wall lines behave under seismic loading, a series of wall line tests will be conducted. Wall line tests will both generate and validate

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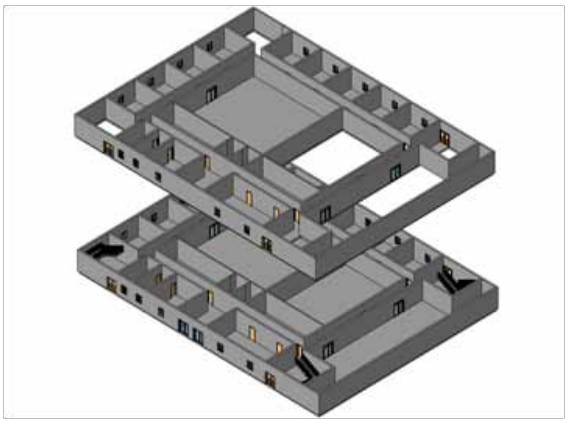

Figure 2. Typical commercial CLT building archetype for seismic analysis.

seismic parameters needed for the numerical modeling of CLT buildings.

Finally, using the numerical model developed in SAPWood and calibrated using the wall line tests, a representative suite of CLT building types will be analyzed to determine which designs are most feasible for use in seismic zones.

Expected Outcomes

The research project will develop both analytical tools and methods to enable the use of CLT in seismic regions of the United States for new buildings and make CLT wall systems a viable seismic retrofit option for commercial wood structures.

Timeline

The project will begin September 2011 and is planned for completion in 12 months. Analysis of a suite of CLT building types will be conducted in fall 2011, and component wall testing will be begin in spring 2012. A final report summarizing the analysis and testing is expected by January 2013.

Cooperators

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