

## Development of Seismic Performance Factors for Cross Laminated Timber—Phase II

Cross laminated timber (CLT) is a wood technology for structural applications that was developed in Europe over 15 years ago and is beginning to make its way into the North American market as a green building alternative. CLT is a multilayer wooden panel made of lumber. Each layer of boards is placed cross-wise to the adjacent layers and connected with either mechanical fasteners or adhesives for increased rigidity and stability. CLT use in both low and mid-rise commercial construction (Figure 1) is expected to become more viable as a conventional building system when seismic performance factors, applicable for seismic design of CLT, are developed.

### Background

A collaborative project between the Forest Products Laboratory and Colorado State University to develop seismic performance factors for cross laminated timber is underway. The project requires application of the FEMA P-695 methodology, which is purposely robust and detailed and requires that the project team follow specific procedures. Failure to develop these seismic performance factors would severely limit the acceptance of the CLT building systems in the United States, underscoring the need for application of the FEMA P-695. The FEMA P-695 document, “Quantification of Building Seismic Performance Factors,” was published in 2009 and defines a number of steps, all of which will be taken to develop the seismic performance factors for seismic design of CLT buildings.

### Objective

The objectives of this research are (1) to develop seismic performance factors for CLT subject to a peer review panel process that includes an independent

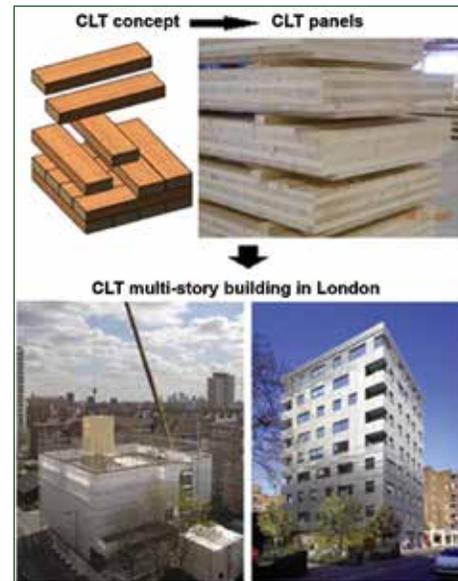


Figure 1—CLT concept and use in a nine-story mid-rise building in London.

peer review committee report and (2) to have the resulting seismic performance factors recognized in ASCE 7 Minimum Design Loads for Buildings and Other Structures.

### Approach

The P-695 methodology is an integrated process (Figure 2) that includes several key elements:

- Seismic ground motions
- Analysis methods
- Test data requirements
- Design information requirements
- Peer review

Current work is in the first of two years. A peer review committee was formed, and the numerical model

development has begun. As the P-695 methodology specifies, a number of archetype designs will be developed over the next months, and approximately 20 to 30 CLT panels of various lengths will be tested at the Colorado State University structures laboratory. These results will provide the calibration of the numerical models of the archetypes, allowing the project team to apply the methodology outlined in P-695.

This process requires monthly update meetings of the peer review panel via web conferencing, and several in-person meetings are needed to ensure the expert opinions of the panel are incorporated in the the process in a timely manner.

### Expected Outcomes

The ultimate outcome of the project will be broadly accepted seismic performance factors for CLT in the United States, which will then be available for use by engineering designers in seismic regions where seismic guidelines are mandated. A secondary outcome will be the methodology to follow on how future component changes can be incorporated into the design of CLT.

### Timeline

Starting in September 2012, total project duration will be 18 months. Component wall testing will be undertaken in the fall of 2013. Analysis of a suite of building types will be conducted in winter of 2013. A final report summarizing the analysis and testing is expected by July 2014.

### Funding Status

Funds for year 1 of the project are in place. Funds needed for year 2, which would include the majority of the peer review panel budget, are \$220,000.

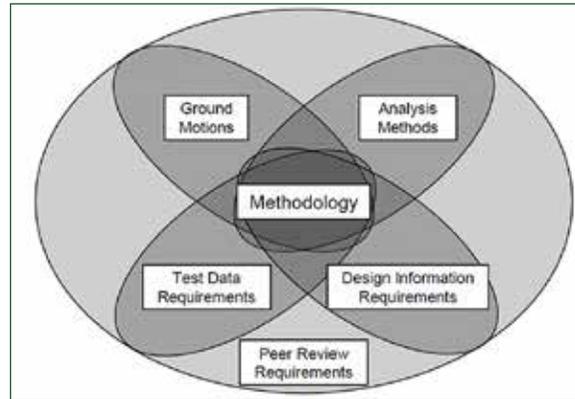


Figure 2—Conceptual view of the P-695 process and keys elements.

### Cooperators

Colorado State University  
 USDA Forest Service, Forest Products Laboratory  
 South Dakota State University  
 American Wood Council  
 FPInnovations

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