RESEARCH in Progress

Forest Products Laboratory

Fire Risk with Different Adhesives in Cross-Laminated Timber (CLT)

Cross-laminated timber (CLT) is a mass-timber composite that is being used to construct tall timber buildings (Jakes et al. 2016). CLT is a panel product made from layers of dimensional lumber where the long axis of each layer is rotated 90° from the previous layer. CLT panels can be manufactured up to 500 mm thick and 18 m long and can be delivered to the jobsite with fenestrations already precut (Mohammad et al. 2012). CLT is the major structural component of many tall wood buildings that have been constructed or are in the planning process including, but not limited to, 24 Murray Grove in London, Brock Commons in Vancouver and the Carbon12 building in Portland.

CLT specimen exposed to the standard time–temperature curve from ASTM E 119.

Background

Fire safety is frequently cited as a concern with tall wood buildings—specifically that the buildings are more vulnerable to fire than concrete and steel buildings and/or do not provide an adequate level of life-safety during a fire (Green and Karsh 2012). However, the reality is that the charring of wood is well understood and an adequate level of fire resistance can be calculated and designed for from these char rates. One big question with CLT buildings is the performance of adhesive at high temperature. In preliminary research, differences in fire resistance and char rate were found between different adhesives (Hasburgh et al. 2016). Understanding and quantifying these differences are key to furthering the use of CLT in construction.

Objective

The objective of this research is to quantify differences in structural failure risk of CLT panels manufactured with different adhesives.

Approach

The approach will combine experimental data on char rate with finite element (FE) models. CLT panels will be made at the USDA Forest Products Laboratory using different adhesives. Char rates will be measured in an intermediate scale horizontal furnace following the ASTM E 119 time–temperature curve without loading. Char rates as a function of time for CLT constructed with different adhesives will be modeled using these small specimens. Nonlinear FE models of different CLT structural components (mainly floor diaphragms and bearing walls) will be constructed and analyzed. Material behavior from sample fire tests will be incorporated in the FE modeling. Differences in probability of failure for different loading and fire scenarios will be calculated and used to quantify differences in risk among CLT construction using different adhesives.

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CLT specimen being removed from furnace.

Expected Outcomes

This work will quantify the performance of CLT structural components with different adhesives under fire. A set of FE models for analyzing CLT components fire performance will be developed. A simplified approach to assess fire-related strength loss will be developed that can guide component level structural design. The project will quantify differences in risk of failure between adhesive types.

Timeline

The project is expected to start September 2016. Experimental work will be conducted in 2017, and the project will be completed by August 2018.

Cooperators

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