RESEARCH in Progress

Forest Products Laboratory

Expanding the Cross-Laminated Timber Market through Building Moisture Monitoring and Improved Modeling

Cross-laminated timber (CLT) is a recently developed heavy timber building material that has the potential to expand the wood building market. Although much has been studied on CLT building system structural and fire behavior, little is known about the construction and in-service moisture performance of CLT buildings. This project will address the dearth of knowledge and data on CLT building moisture performance and modeling by conducting on-site monitoring of CLT building projects in different U.S. climate zones using wireless sensors. The project will also utilize laboratory testing characterization and state-of-the-art numerical modeling methods to overcome the knowledge gap in CLT building moisture performance and help boost confidence in building more large commercial CLT buildings in the United States.

Background

As a massive timber material, CLT physical and mechanical properties are strongly dependent on its moisture content (MC). High levels of wood MC (calculated as the ratio of mass of water in the wood to dry mass of the wood) can lead to various practical difficulties with its use, such as dimensional instability, microbial attack, and fastener corrosion. Understanding wood-moisture interactions is essentially the starting point of wood building design. Lack of data on CLT moisture properties and limited data on CLT in-service performance in the United States lead to a high level of uncertainty in CLT durability. To date, field monitoring studies on CLT building performance have been very limited.

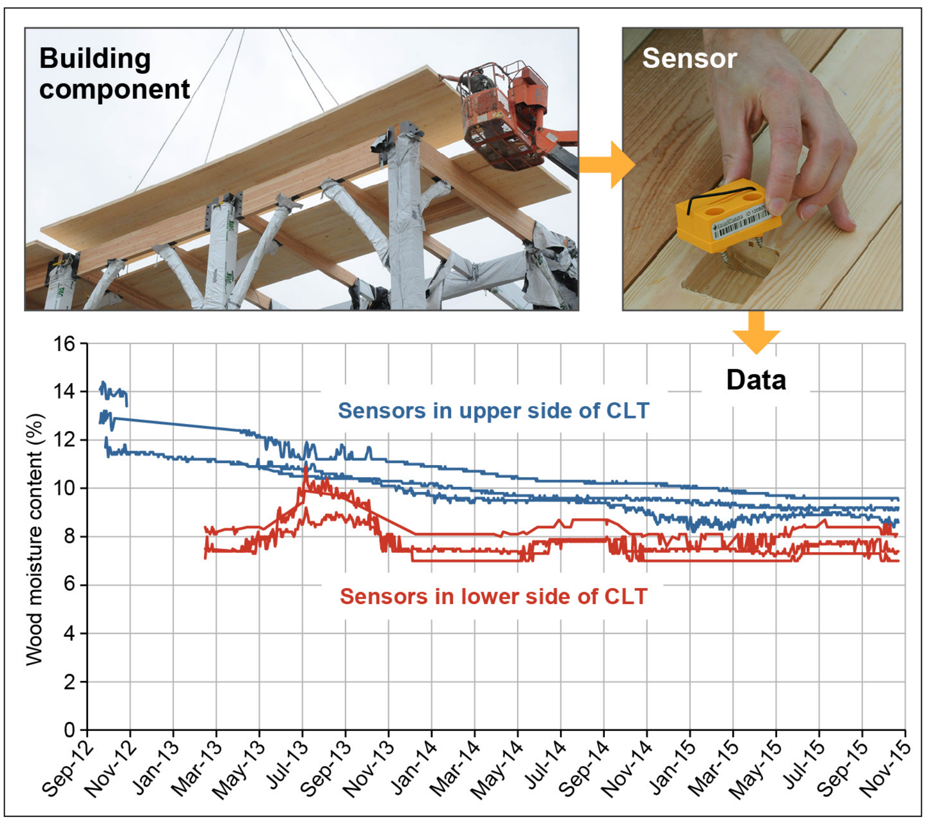

Figure 1. Easy-to-deploy wireless moisture sensor and example monitoring data.

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Objective

The two major goals of this research project are to (1) obtain a benchmark dataset for moisture levels in different components of CLT building envelope under different climate conditions and (2) develop and calibrate hygrothermal simulation models for CLT material in real building applications.

Approach

The project team will identify three multistory mass timber CLT building projects in different U.S. climate zones and monitor the MC of building components during construction and service (Fig. 1). Researchers will coordinate with the CLT manufacturer to obtain samples and conduct indoor material characterization tests at FPL (Fig. 2). By combining long-term moisture monitoring data and material characteristics obtained from testing, numerical models for evaluating large-scale mass timber building in-service moisture condition will be developed and calibrated.

Expected Outcomes

This project will generate three benchmark data sets for multistory CLT building moisture performance in different climate zones. Data will include moisture contents at key wood components and high moisture risk locations throughout the buildings. A relatively simple, but fully validated, numerical model for analyzing similar building moisture performance will be recommended. These results will be useful for structural engineers and architects to accurately consider moisture in their design of mass timber buildings. Outcomes from this project will fill the knowledge gap of realistic CLT building moisture transfer characteristics, and confidence in using CLT in large building projects will be boosted. Building owners and the public will look more favorably on CLT as a valid option for urban construction at large scale, thus creating new markets for biomass products and new jobs related to wood and forest industries.

Figure 2. Example laboratory testing facility and set up for CLT material characterization.

Timeline

The project began July 2016 and is planned for completion in 36 months. Monitoring of the first mass timber building will start in October 2016. Modeling and indoor laboratory testing will proceed together with the full building monitoring. The other two buildings will be identified in 2017 and monitored starting from construction. A final report summarizing the analysis and testing is expected by June 2019.

Cooperators

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