

Advanced Quality and In-Service Condition Assessment Procedures for Mass Timber and Cross-Laminated Timber Products

Cross-laminated timber (CLT) is a type of large-scale, prefabricated, engineered wood panel. Panels are composed of multiple perpendicularly oriented layers of face-laminated lumber. Layers are bonded with structural adhesives. Once manufactured, the panels are lightweight, esthetically pleasing, and robust. They achieve favorable fire, seismic, and thermal performance. CLT and other engineered wood building systems, collectively referred to as mass timber, have been used for more than 20 years. In the United States, CLT is a novel engineered wood building material that is gaining acceptance in both residential and commercial structural applications, particularly in tall timber building construction.

Background

With the rapid development of CLT manufacturing capacity around the world and the increasing architectural acceptance and adoption, there is a current and pressing need regarding adhesive bond quality assurance in manufacturing. As with other engineered glued composites, adhesive bondline performance is critically important. Bondline assessment requires technology in the form of sensors, ultrasonics, load cells, or other means of reliable machine evaluation.

Objective

The objectives of this cooperative study are to develop quality assurance procedures for monitoring the quality of mass timber and CLT during and after manufacturing and to develop assessment techniques for CLT panels in-service.

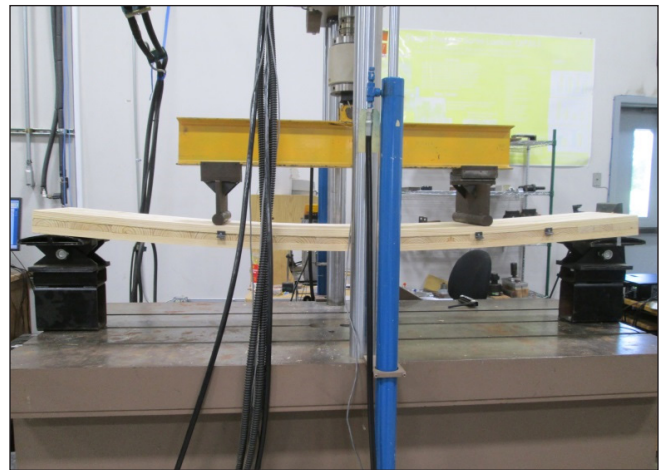


Figure 1. CLT bending test at Mississippi State University mechanical test laboratory.

Approach

- Review literature and technology regarding candidate nondestructive evaluation (NDE) techniques and equipment.
- Obtain or fabricate CLT/mass timber products with various bond qualities, to include products made from one or more currently commercialized species (Douglas fir, Spruce–Pine–Fir, southern yellow pine) and one or more commercially viable adhesives
- Propose additional work on preservative-treated material for use in buildings, timber bridge decks, or environmental access mats
- Conduct testing on pilot- or full-scale panels to collect performance data and analyze results

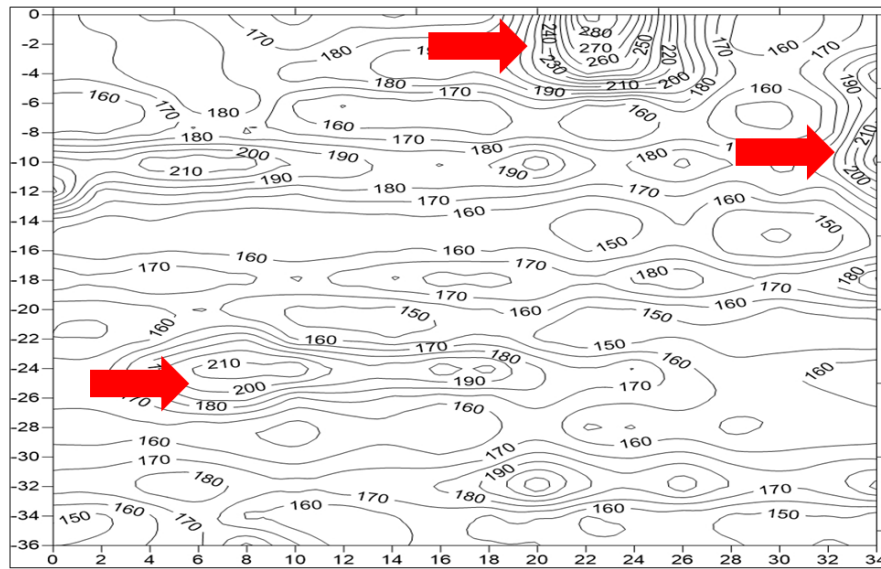


Figure 2. Delamination map generated from ultrasonics (Wang 2019).

- Develop strategies for adapting equipment to manufacturing setting for quality assurance
- Conduct additional testing with large panels in a plant setting, time permitting
- Develop an inspection procedure for using equipment to analyze condition of in-place CLT/mass timber products
- Prepare final report and disseminate information as appropriate

Expected Outcomes

Information generated in this study will be valuable for manufacturers, contractors, and building inspectors. It will help manufacturers assess the quality of their products before shipping. It will help contractors assess the condition of the materials they receive and potentially track them through manufacturing, if needed. It will be important to building inspectors, providing them with an additional tool to evaluate the integrity of wood structures, both during construction and over time. Information will be disseminated as a USDA Research Note or Paper, in the peer-reviewed literature, and in presentations at international symposia.

Timeline

The project started in June 2019 with development of a formal study plan. Nondestructive evaluation of specimens will begin in 2020, with analyses to follow. The project will be complete in June 2022.

Cooperators

Mississippi State University

USDA Forest Service, Forest Products Laboratory

Contact Information

Frederico França

Mississippi State University

Starkville, Mississippi

fn90@msstate.edu

Robert J. Ross

USDA Forest Service, Forest Product Laboratory

Madison, Wisconsin

robert.j.ross@usda.gov

Reference

Wang, X.; Ross, R.J.; Brashaw, B.K.; Yue, X.; Liu, F.; Wu, X. 2019. Delamination detection in cross-laminated timber panels using ultrasound and resistograph tools. In: Wang, X.; Sauter, U.H.; Ross, R.J., eds. Proceedings: 21st International Nondestructive Testing and Evaluation of Wood Symposium. General Technical Report FPL-GTR-272. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. p. 642–649.