RESEARCH in Progress

Forest Products Laboratory

Engineering Performance Characteristics of Hardwood Cross-Laminated Timber

The hardwood industry in the Great Lakes region faces tremendous economic and competitive pressures that demand companies to focus on developing innovative and value-added products from undervalued hardwood materials (Fig. 1). Particularly in Michigan, there is an abundant supply of hardwood resource and there have not been many new applications for the low grades of hardwood materials (Ross and Erickson 2005). This project addresses the issues that are important to local sawmills and wood products manufacturers in reducing material waste and increasing profitability. It is also important to the economic growth and development in the region. The use of low-grade and undervalued hardwood materials in engineered wood products such as cross-laminated timber (CLT) will create new opportunities for many hardwood companies in the region. The technical information gained through this project will facilitate the development of new hardwood CLT products using local hardwood species.

Figure 1. Low-grade northern hardwood lumber obtained from a local company.

Background

The eastern forests of the United States hold 90% (357 billion cubic feet) of all hardwood resource of the nation, and most of the hardwood timber species are undervalued. The volume of hardwood sawn timber has increased significantly in the eastern forests because of decades of positive growth-to-removals ratios and diminished demand in the traditional markets for these hardwood species. There is a critical need to expand the use of these hardwoods, especially undervalued hardwoods, for value-added products. Current advances in the development of CLT have resulted in an increased interest in furthering the use of wood in engineering applications and more significantly, in construction of large, multi-story wood structures around the globe.

Traditionally, CLT panels are produced from softwood lumber. There has been an increasing interest in using CLT in commercial and residential construction in the United States and to fully develop a CLT manufacturing industry countrywide. This will require use of a variety of regional species, including hardwood. At this time, the product standard for CLT in the United States does not apply to CLT manufactured from hardwood lumber (APA 2018).

U.S. Department of Agriculture • Forest Service
Forest Products Laboratory
www.fpl.fs.fed.us

Michigan Tech
School of Forest Resources
and Environmental Science

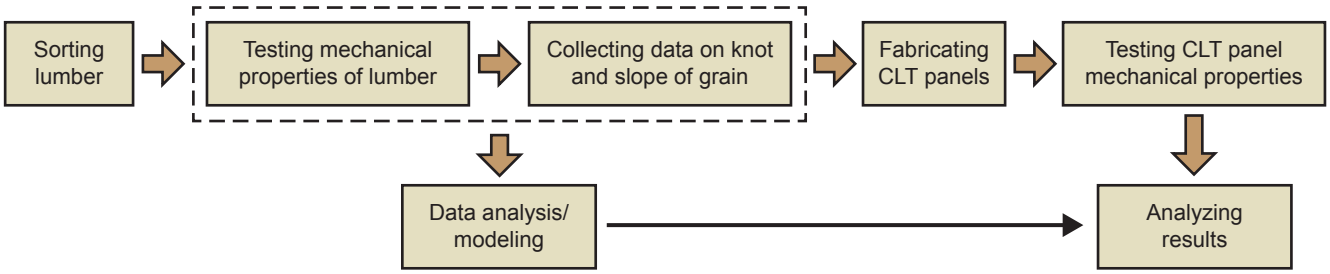

Figure 2. Schematic of the overall approach of the project.

Given this situation, further research is necessary to justify the inclusion of hardwood species into the standard.

Objective

The goal of this project is to examine whether CLT panels made from low-grade hardwood lumber can provide sufficient engineering performance needed for structural applications. Our specific objectives are to evaluate the baseline structural properties (mechanical strength and stiffness) of CLT panels manufactured from low-grade northern hardwoods and develop mathematic models for predicating hardwood CLT engineering properties and optimizing the layup of CLT panels for maximum performance.

Approach

Figure 2 shows the overall approach of this project with the following tasks: (1) obtain low-grade northern hardwood lumber and sort lumber on species and visual grades; (2) nondestructively E-rate the lumber to obtain basic wood properties; (3) characterize knot and slope of grain properties; (4) fabricate CLT panel specimens; (5) conduct qualification test on all the CLT specimens and determine the mechanical properties; and (6) analyze the results and write final report.

Expected Outcomes

Two major outcomes are expected. First is the establishment of a technical basis for developing allowable bending strength and stiffness of hardwood CLT panels. Second is the development of models for predicting the mechanical properties of CLT products made of log-grade hardwood lumber. The results will be shared with hardwood sawmills, adhesive suppliers, CLT manufacturers, hardwood loggers, and colleagues within the forest products community.

Timeline

The project will be conducted from September 2017 through April 2019. Material evaluation and fabrication of CLT panels will be completed by September 2018. Qualification tests of CLT panels are scheduled to be completed by December 2018. Data will be consolidated and analyzed, and a final report will be submitted by April 2019.

Cooperators

Michigan Technological University

USDA Forest Service, Forest Products Laboratory

Contact Information

Xinfeng Xie
School of Forest Resources and Environmental Science
Michigan Technological University
Houghton, Michigan
(906) 487-2294; xinfengx@mtu.edu

Xiping Wang
USDA Forest Service, Forest Products Laboratory
Madison, Wisconsin
608-231-9461; xwang@fs.fed.us

References

APA–The Engineered Wood Association. 2018. ANSI/APA PRG 320-2018: Standard for performance-rated cross-laminated timber. Approved February 2018.

Ross, R.; Erickson, J. 2005. Undervalued hardwoods for engineered materials and components. Madison, WI: Forest Products Society. 134 pp.