RESEARCH in Progress

Forest Products Laboratory

Laboratory Investigation of Cross-Laminated Timber (CLT) Decks for Bridge Applications

The use of cross-laminated timber (CLT) has gained popularity over the past decade, with many advances stemming from completed research and construction projects in Europe. Many inherent advantages of CLT (such as, it is prefabricated, relatively lightweight, dimensionally stable, and environmentally sustainable) have been utilized in vertical construction projects. Despite these advances, the use of CLT in bridge structures has been limited, and the adoption of CLT into governing design codes has been slow. However, CLT shows promise as a complementary or alternative construction material in bridge decks, and additional research would help characterize the structural attributes of CLT decks to guide their use in bridge projects.

Background

CLT was first introduced in Europe in the 1990s to provide an alternative to commonly used building materials, such as concrete, masonry, and steel. Since that time, CLT, its production, and distribution have greatly improved, allowing for rapid growth in its use. The building industry has seen hundreds of projects completed using CLT, predominately for mid-rise and high-rise buildings.

The bridge industry has seen its share of CLT projects but not nearly as many as in the building industry. The few notable bridge projects include the Mistissini Bridge in Quebec, Canada, constructed in 2014 and the Maicasagi Bridge, north of Quebec, constructed in 2011. In each case, CLT was selected for its locally sourced material and shorter lead time than more commonly used materials. Both projects were considered successes and provide an example of CLT capabilities. Despite this, CLT is rarely considered for use, even with several inherent advantages. Additional research and proof of concept are required to bring CLT to the forefront of construction materials selected by bridge designers and engineers.

Cross-laminated timber panels.

Objective

The objective of this project is to conduct a laboratory investigation on the feasibility of CLT as a primary structural material for highway bridge applications. CLT bridge deck performance will be compared with equivalent glulam bridge systems on both structural and serviceability bases.

Approach

Several work phases will help us better understand the structural performance of CLT. A literature review will provide data related to CLT bridges. Design details of existing CLT bridges and laboratory CLT bridge specimens will be compiled, either in the laboratory or in the field. Because most CLT bridges and specimens have been constructed and tested in Europe, we will rely on analytical and experimental performance. The existing U.S. CLT bridge design specification will be adhered to for construction of a full-scale laboratory test bridge. The AASHTO-LRFD Bridge Specifications requires waterproof adhesives and preservative treatments for all primary structural components in timber bridges. We will identify a CLT manufacturer to help identify a suitable waterproof adhesive and to help assess the size limits of CLT panels that can be pressure-treated for the laboratory bridge testing.

The most challenging task of the project will be to construct and test full-scale bridges in the Iowa State University Structures Laboratory. Two bridges with similar dimensions (30 ft long and 16 ft wide), one with a CLT deck and one with a glued laminated deck, will be load tested to compare structural characteristics. Multiple girder spacings will be tested, range from 4 to 8 ft. Deflection and strain data will be collected using various load positions on the decks to simulate highway vehicle traffic.

Additional laboratory testing will include construction and load testing of two 20-ft-long, single-span CLT and glulam panels. The structures will be instrumented with strain and deflection gages to gather data for structural characterization. The loading will occur at several locations on the deck to simulate highway vehicle traffic.

We will also assess the serviceability of CLT panels under highly variable moisture contents from top to bottom of the panel, and the geometric behavior of the panel will be documented.

Expected Outcomes

The expected outcomes from this project are (1) a structural characterization of CLT panels used in bridge applications, (2) a comparison of CLT and glulam panels used in similar configurations, and (3) recommendations for the use of CLT in highway bridge applications. A comprehensive final report will document the literature review, design details, laboratory tests, data analysis, and results.

Timeline

This project began in January 2020, with technical literature searches underway. Lab testing and data analysis will be completed by early 2021, with a final report being completed by late spring 2021.

Cooperators

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