RESEARCH in Progress

Forest Products Laboratory

Effect of Notches on the Performance of Cross-Laminated Timber

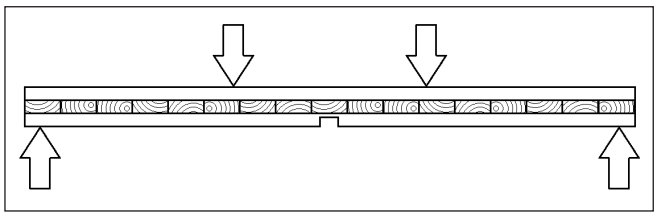

Figure 1. Schematic of CLT specimen, notched at midspan, to be loaded in third-point flexure (not drawn to scale).

Over the past few decades, the use of cross-laminated timber (CLT) for low- to mid-rise construction has expanded in Europe. Now this product is being slowly incorporated in the United States. Engineered wood products such as CLT provide builders with a unique opportunity to renew the way we construct and see our everyday spaces. Compared with other common construction practices, building with prefabricated CLT is cleaner, faster, and requires less intensive labor. One limitation of CLT panels is the application of notches for construction purposes. Notches are often employed as construction details to facilitate mechanical interlocking and placement of adjacent members, which can improve and facilitate building design.

Background

Notches, particularly when incorporated on the tensile face, influence the ultimate capacity of members, such as beams and floor panels. Understanding and quantification of failure modes, ductility, and strength of notched CLT floor panels can allow the safe application of notches on building construction. Despite wood's ductility, notches are known areas of stress concentration. The 2018 International Residential Code for one- and two-family dwellings (International Code Council 2017) restricts the use of notches on engineered wood products by requiring structural calculations instead of elucidating the ways notches might be used. To employ CLT to its maximum potential, there is a current and pressing need for better knowledge regarding the influence of notches on flexural performance.

Objective

This research seeks to review the literature regarding notches in solid and engineered beams, review typical CLT design details that employ or utilized notched panels, and conduct pilot-scale testing of notched CLT panels.

Approach

Literature and design review will be conducted in the library. Extant references will be consolidated such that designers, engineers, architects, and other interested parties can readily find and use them. Pilot-scale testing will be conducted as follows:

1. Procure approximately 20 CLT panels, each three ply, approximately 8 by 16 ft
2. Label the panels and crosscut each panel such that both long-span (approximately 28:1 to 30:1 span to depth) and short-span (approximately 12:1 to 15:1 span to depth) bending specimens can be produced from each panel
3. Rip five specimens from each panel, one for control and four for treatments:
   a. Notch (all notches produced by sawkerf) approximately 1/3 through the thickness of the tension lamina

Figure 2. Stack of short-span CLT specimens prepped for mechanical testing.

b. Notch approximately 1/3 through the thickness of the tension lamina with stitching (long screws applied to the tension face, near the notch)

c. Notch approximately 2/3 through the thickness of the tension lamina

d. Notch approximately 2/3 through the thickness of the tension lamina with stitching as described in treatment b

4. Statistically analyze the influence of notches on bending properties of matched specimens—In this case, master panels will be considered statistical blocks, thus it is a randomized complete block design.

Expected Outcomes

This research will generate a better understanding of the extent to which flexural properties of CLT are reduced due to notches and the extent to which stitching can mitigate the deleterious impact of the notch.

Timeline

This project was initiated in June 2019. During 2019, a study plan was developed, a literature review at the FPL library was initiated, and suppliers of CLT were identified. In 2020, the 20 CLT panels will be received, marked, processed, and tested. By May 2022, data will be analyzed and publications will be written.

Cooperators

USDA Forest Service, Forest Products Laboratory

Mississippi State University

Contact Information

Robert J. Ross
USDA Forest Service, Forest Products Laboratory
Madison, Wisconsin
robert.j.ross@usda.gov

Rubin Shmulsky
Mississippi State University
Starkville, Mississippi
rshmulsky@cfr.msstate.edu

Reference

International Code Council. 2017. IRC: International residential code for one- and two-family dwellings. Country Club Hills, IL: International Code Council. 962 pp.