The Evolving Metropolis
2019 IABSE Congress
New York City

IABSE 90 YEARS

Failure Prediction Model for 3-Ply CLT Panels

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1 Abstract

Mass production of cross-laminated timber (CLT) lends itself to cost efficient and sustainable building solutions and is an effective solution for affordable residential housing. Currently, most panel research focuses on longer span, thicker (i.e., 5-, 7-, 9-ply) panels. However, 3-ply panels are important both for residential construction and as a post-fire strength model for 5-ply. As a first step in developing a failure prediction model, 15 three-ply V2 CLT specimens were tested using four-point bending and characterized by ultimate strength, stiffness and shear utilization for comparison to PRG 320 values. The shear and flexure utilization were 350% and 615%, respectively, indicating significant residual strength beyond allowable design values. Results were analyzed to examine correlation between ultimate strength and material defects, suggesting that the ultimate strength of the V2 CLT tested was governed by the shear strength of the middle (perpendicular) layer and that flaws within lumber grades did not noticeably impact the ultimate stresses for the aspect ratios considered.

Ultimate failure loads were used to develop a failure prediction model. The minimum required out of plane third point load for probability of failure (POF) of 1:1000 is 17.1kN. The loads associated with a 50:1000 and 100:1000 POF are 24.1kN and 31.3kN, respectively. The POF curve was best-fit to obtain a design equation.

Keywords: cross-laminated timber, composite, wood, flexure, failure prediction model.

2 Introduction

Increasingly, engineers reduce environmental impact, construction time and project cost by selecting engineered timber, a renewable and often local resource, as a primary structural component. In particular, cross-laminated timber (CLT) is increasingly used as a structural material in mid- and high-rise construction. However, CLT adoption is still relatively inchoate in North America and ongoing research often focuses on 5-, 7- and 9-ply applications with the North American Standard for Performance Rated CLT (PRG 320) establishing minimum required ultimate strengths for CLT under typical load conditions (axial, shear, and flexure) [1]. Yet, CLT, especially 3-ply, lends itself to single-family residential use particularly well due to the combination of: lighter loads, shorter spans and less stringent fire requirements. As a result, this research investigates performance of 3-ply CLT to determine a failure prediction method both for residential use and as a post-fire strength model for 5-ply panels.

The experimental results of this research suggest that the ultimate strength of shear and flexure

https://doi.org/10.2749/newyork.2019.0663
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