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STRUCTURAL PERFORMANCE OF BOX BASED CROSS LAMINATED TIMBER SYSTEM USED IN FLOOR APPLICATIONS

KEYWORDS: Cross laminated timber, Floor system, Box cross section

OVERVIEW OF PROJECT

Cross Laminated Timber (CLT) was first developed as a proprietary product by individual companies aimed at servicing specific markets in Europe. There is a need to investigate different ways of making CLT and to define its structural performance applicable to North America. The main focus of this study was to develop three-dimensional finite element models, which can be used to analyze the mechanical and vibration behavior of box-type CLT structures used in floor applications, and verify the models by comparing predicted results with measured data obtained from experimental studies.

Comprehensive three-dimensional finite element models, which can be used to analyze the mechanical and vibration behavior of the solid plate and box-type CLT structures, were developed (Figure 1). Four prototype box elements, each having five replicates, were designed and manufactured locally (Figures 2 and 3). Third point bending tests were conducted on the specimens. The numerical analysis results agreed well with experimental data in terms of vertical deflection and bending stiffness. Vibration, which is critical to floor serviceability, was also studied. Three types of excitation were applied to measure the fundamental frequency of the twenty specimens. Finite element analysis provided good predictions of fundamental frequency values comparing to the experimental results.

KEY RESULTS

- Comprehensive three-dimensional computational models were developed. Measurable parameters, such as CLT panel layout and dimensions, lumber dimensions and material properties and effects of glue/nail bond between lumber wide faces, were considered as input data for the simulation. These models are capable of predicting mechanical properties, such as deflection, stress, strain, etc., of CLT systems under different load scenarios in static environment.
- In dynamic situation, the above mentioned models were modified and could be used to predict the fundamental natural frequency of the box-type structures.
- In applications where large spans are required, the gravity load of structures increases with the thickness of the structure which can limit the efficiency of such system. Box-type CLT structures may be able to reduce structural weight without significant loss of strength or stiffness in some loading scenarios, such as out-of-plane bending.

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Future research

- One future direction would be to investigate the in-plane behavior of box-type CLT floor/ceiling. This knowledge would be critical for seismic design of buildings using CLT elements.

- In this study, CLT plates and dimension lumber rib frame in the box-type elements are connected with self-tapping screws. It would be interesting to investigate box systems, where wood plates and rib frame are connected by both adhesives and mechanical fasteners.

- Another possibility would be to study concrete topped CLT products, which can be used as floor components and have a real potential of competitiveness in terms of service life and an environmentally friendly material.

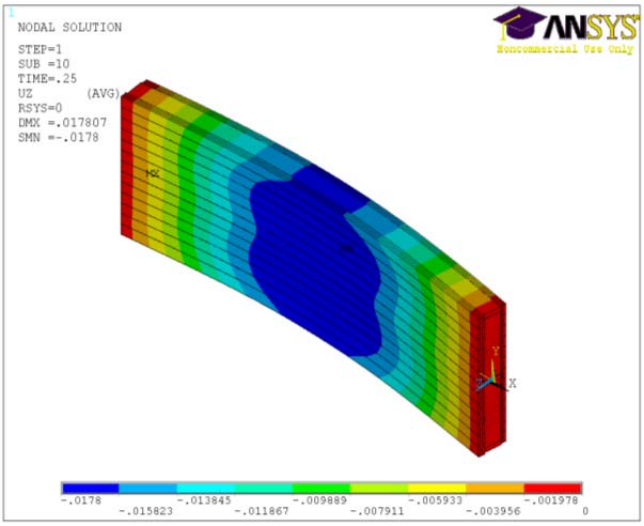

Figure 1 – Finite element model of a CLT plate.

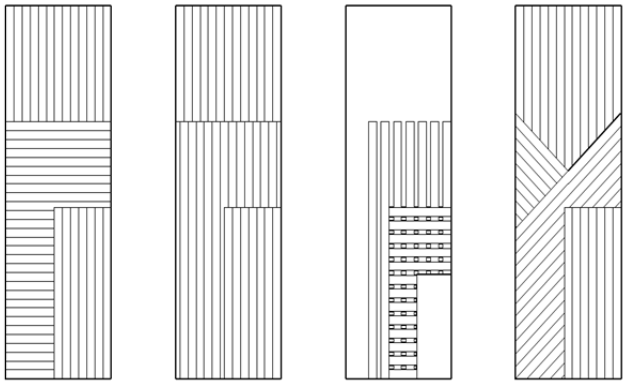

Figure 2 – Four different laminated plate layups.

Figure 3 – A box system consisting of 45° laminated plates.