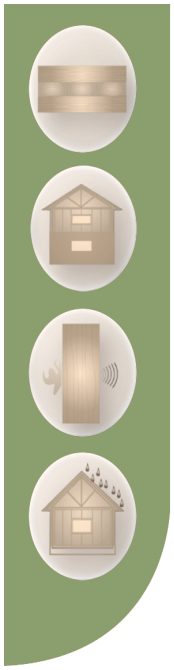
NEWBuildS

Technical Note 13

December 2013



MEASUREMENT OF ROLLING SHEAR MODULUS AND STRENGTH OF CROSS LAMINATED TIMBER

KEYWORDS: Cross laminated timber, Rolling shear modulus, Rolling shear strength

OVERVIEW OF PROJECT

Rolling shear properties are particularly important in design of cross laminated timber (CLT). CLT used as panel or diaphragms in floor and wall structure are made from several layers of single small dimension planks connected by adhesives. If a CLT panel is loaded perpendicular to its plane, rolling shear stresses occur. Due to the weakness of radial-tangential (RT) plane in wood, in comparison with longitudinal-radial (LR) and longitudinal-tangential (LT) planes, the rolling shear modulus is very low, leading to rolling shear failure in the cross layer. Shear strain significantly affects the overall out-of-plane deflection of a CLT panel and may influence the normal stress distribution on each layer. Basically, this influence is dependent on the magnitude of the rolling shear modulus of the cross layers. The design of CLT floor systems with low span-to-depth ratios is often governed by the rolling shear capacity of CLT panels. Therefore, the design and application of CLT products require knowledge of rolling shear modulus and strength.

The test method for determining rolling shear properties of CLT has not been systematically investigated and standardized. Various methods have been employed such as short-span bending, and two-plate shear. This study was designed to identify and evaluate an appropriate test method for evaluating rolling shear properties of CLT. It contained two phases. In Phase I, the variable-span bending tests and two-plate shear tests were conducted on three types of downscaled specimens, including wooden cross layer (WCL), steel-wood-steel (SWS) and 3-layer downscaled CLT (WWW), to identify an appropriate method for assessing the rolling shear properties. In Phase 2, the method proposed in Phase 1 was evaluated using the full-size WCL and 3-layer CLT.

KEY RESULTS

Key conclusions from this study were:

- The two-plate shear test was recommended to be used as a test method for measuring the rolling shear modulus of a cross layer, which could be used to calculate the deflection of a 3-layer CLT beam using the shear analogy method at a given span-to-depth ratio ranging from 6 to 50;
- An adjustment factor (α) was proposed to predict the deflection under the centre-point bending tests at various span-to-depth ratios (Figure 1);
- The two-plate shear test method could also be used to measure the rolling shear strength, and could provide a reasonable estimate of the load-carrying capacity of a

Researchers: Qinyi Zhou[1], Meng Gong[1], Y.H. Chui[1], Mohammad Mohammad[2]
Affiliation: [1]University of New Brunswick, [2]FPInnovations
Contact email address: meng.gong@unb.ca,

3-layer CLT beam at a relatively large span-to-depth ratio, but a conservative estimate at a small span-to-depth ratio; and

- Figures 2 and 3 show the rolling shear failure of WCL under the two-plate shear test (Figure 2) and 3-layer CLT beam under bending test (Figure 3). Crack(s) initiated within the earlywood zone near the boundary between two growth rings, propagated along the growth ring or wood rays. Finally, specimens failed at the bonding surface or delaminated due to shear.

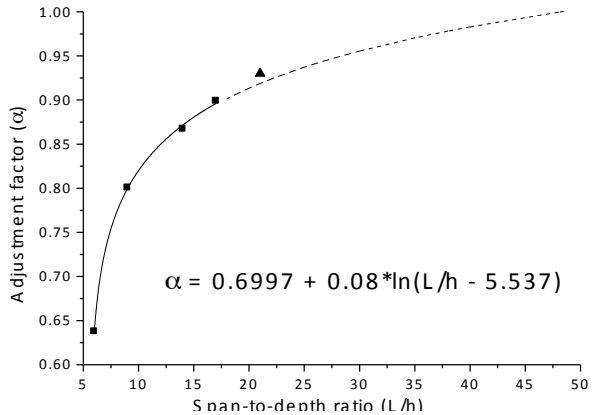


Figure 1 Adjustment factor (α) values versus span-to-depth ratio (L/h)

Figure 2 Failure mode of WCL under 2-plate shear test

Figure 3 Failure mode of 3-layer CLT beam under bending test

FUTURE WORK

The following future work is recommended:

- To investigate the influence of cross layer without edge gluing at the narrow faces on the rolling shear properties of CLT panels;
- To examine the rolling shear properties of full-size CLT panel made of cross layer thinner than 38mm with an aim at fabricating stronger CLT products;
- To conduct bending tests on 3-layer CLT beam with span-to-depth ratios larger than 21 (in particular from 28 to 48), which are commonly adopted in CLT buildings; and
- To expand research to evaluate the behaviour of CLT products with more than 3 layers.

THESIS

Zhou, Q.Y. 2013. Development of evaluation methodology for rolling shear properties in cross laminated timber (CLT). MScFE thesis. University of New Brunswick, Fredericton, NB.