Abstract

In the beginning of the twenty-first century, the largest mountain pine beetle (MPB) outbreak ever recorded struck western Canada. A huge volume of MPB-attacked lodgepole pine is expected to hit the BC forest industry in the next decade. Technologies to convert MPB-attacked lumber into engineering wood products are urgently required. Cross laminated timber (CLT) is a technology that can produce massive timber members as an engineered wood product for timber structures.

In this study, the duration-of-load and size effects on the rolling shear strength of CLT manufactured from MPB-afflicted lumber were evaluated. The study of the duration-of-load effect on the strength properties of wood products is typically challenging; and, additional complexity exists with the duration-of-load effect on the rolling shear strength of CLT, given the necessary consideration of crosswise layups of wood boards, existing gaps and glue bonding between layers.

In this research, short-term ramp loading tests and long-term trapezoidal fatigue loading tests (damage accumulation tests) were used to study the duration-of-load behaviour of the rolling shear strength of CLT. In the ramp loading test, three-layer CLT products showed a relatively lower rolling shear load-carrying capacity. Torque loading tests on CLT tubes were also performed. The finite element method was adopted to simulate the structural behaviour of CLT specimens. Evaluation of the rolling shear strength based on test data was discussed. The size effect on the rolling shear strength was investigated.

A stress-based damage accumulation theory was used to evaluate the duration-of-load effect on CLT rolling shear. The model was first calibrated against the test data and used to investigate the long-term CLT rolling shear strength. A reliability-based method was then applied to assess the CLT rolling shear performance. Finally, a duration-of-load adjustment factor for CLT rolling shear strength was established. The duration-of-load adjustment factor for the three-layer and five-layer CLT is different from that for lumber. The results suggest that the rolling shear duration-of-load strength adjustment factor for CLT is more severe than the general duration-of-load adjustment factor for lumber, and this difference should be considered in the introduction of CLT into the building codes for engineered wood design.