Determination of shear modulus (G_{LR}) for seven boreal species using a bending test and non-destructive methods (ultrasound and torsional resonance methods)

Wiem Jarboui †, Ahmed Koubaa†, and Besma Bouslimi†
† Université du Québec in Abitibi-Témiscamingue (UQAT), wiem.jarboui@uqat.ca

In general, a static bending test is used to determine either the modulus of elasticity (MOE) or the modulus of rupture (MOR) of materials. In the case of wood, this test is used to evaluate the shear modulus. This is mainly due to the complexity of performing a static shear test on wood. To overcome this complexity, empirical approaches and non-destructive testing could be used such as ultrasound and torsional resonance methods. This study aims to (i) present an alternative methodology for determining the shear modulus in the longitudinal-radial plane (G_{LR}) of wood using the three-point flexural test ($G_{f,LR}$) (ii) investigate the relationship between $G_{f,LR}$ and MOE as well as between $G_{f,LR}$ and MOR (iii) and predict the static shear modulus from dynamic modulus determined by the ultrasonic ($G_{u,LR}$) or the torsional resonance ($G_{r,LR}$) methods. Seven boreal species were studied: white spruce, white birch, hybrid poplar, trembling aspen, jack pine, eastern larch and eastern white cedar. The results showed a moderate correlation between $G_{f,LR}$ and MOE, with a correlation coefficient (R^2) of 0.50. A stronger correlation was found between $G_{f,LR}$ and MOR (R^2=0.66). These results proves the effectiveness of the static bending test to determine the shear modulus. An average correlation between $G_{f,LR}$ and $G_{u,LR}$ (R^2=0.55) is similar to that obtained between $G_{f,LR}$ and $G_{r,LR}$ (R^2=0.50). However, the torsional resonance method is the one that provides values closer to the static values of $G_{f,LR}$. These results show the usefulness of non-destructive methods for estimating $G_{f,LR}$, with an emphasis on the reliability of the torsional resonance method.

Keywords: Shear modulus, non-destructive methods, ultrasound, resonance method, static bending test

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