Performance of axially loaded self-tapping screw in mass timber subjected to moisture content change

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ABSTRACT

Self-tapping screws (STS) are a popular fastener in mass timber construction due to several advantages over traditional fasteners such as bolts and lag screws. The advantages include ease of installation, increased strengths and stiffness in connections, and availability in a wide range of length and diameter. However, their performance is impacted by several parameters. Due to their potential large penetration length, a particular concern of designers and builders is unintended stress in the screw when wood member is subjected to moisture content change. The increase in moisture content effects negatively on the strength of timber members and components, and also results in swelling (in-plane and out-of-plane deformations), which influences the level of tensile stress through the length of the screw, potentially resulting in premature failure which has been often overlooked or neglected in the past. The aim of the research is to analyze the failure possibility of STS with different penetration lengths used in glue-laminated timber (glulam) subjected to different initial axial load due to torquing and moisture content change. A 2D axisymmetric finite element model (FEM) has been developed using ABAQUS commercial software to evaluate the stress distribution along the length of the STS. Analyses were performed by varying the overall moisture content of the glulam, but it was assumed that the moisture content remains uniform inside the glulam, i.e. no moisture gradient through the member dimension. The results of this study provide valuable information about the critical points on the STS based on the maximum principal stress theory and indicate damage areas that may happen under different loading conditions. These results can be used to improve the design and performance of self-tapping screws in mass timber construction.