

Influence of the material thickness and microstructure on the mechanical properties and the pressure distribution in timber constructions

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Wood is widely used as construction material due to its mechanical efficiency and damage tolerance [1]. Typically, construction sizes are large, i.e. buildings or bridges, and to realize glued joints between components, vacuum or hydraulic presses are used, to get a sufficient pressure in the joining area. Screw-press-bondings (SPB) give the opportunity to apply pressure, where an external pressure application cannot be realized [2]. However, the resulting pressure distribution is significantly lower and strongly dependent on parameters like the used base material, planking, adhesive and type of screw [2], so optimizations are necessary to reach conditions set by the adhesive industry. To create safe and resistant constructions with SPB in future, it would be desirable, if the resulting pressure distribution in the glue line can be predicted and estimated over numerical methods.

In this study, the mechanical properties, i.e. strength and stiffness, of spruce and beech were determined over quasi-static tensile, compression and bending tests to describe the material behavior and implement it in a finite element model (FEM). To assess the effect of external influences, like component size and microstructure, specimen geometries and orientations were varied. To calculate input parameters for FEM, like elastic modulus E , shear modulus G and Poisson ratios ν , total strain was measured by using digital image correlation (DIC) as a contact free method, excluding the influence of extensometer edges on the surface [3]. In addition to the DIC, to characterize damage visible on the surface, acoustic emission (AE) measurement was used to get information about internal damage.

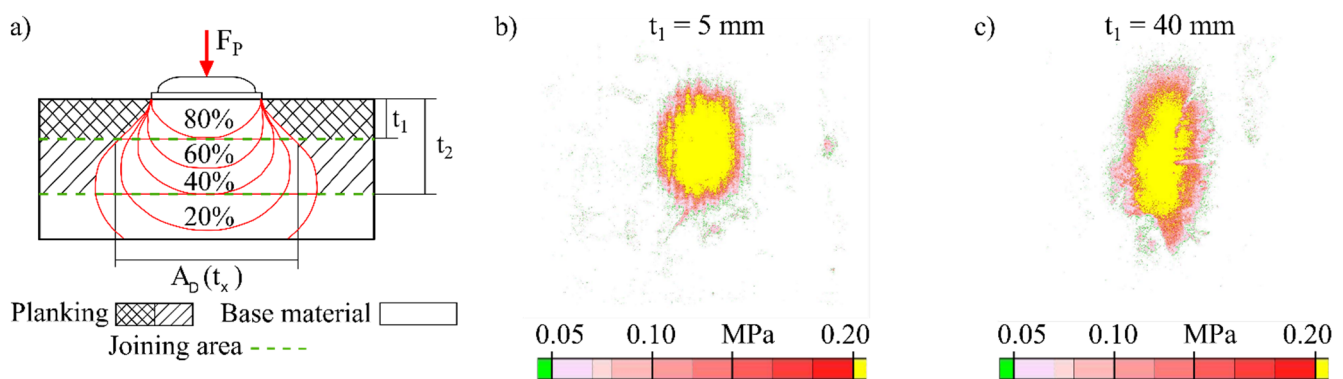


Figure 1: a) Scheme of pressure distribution, and experimental results for spruce with b) $t_1 = 5$ mm and c) $t_2 = 40$ mm

To enable a qualitative characterization of pressure distributions in glue lines, resulting from specific combinations of the above mentioned parameters, special pressure measurement films (PRESCALE, Fujifilm Europe) were used by placing them between the wooden components during mechanical loading. Figure 1 a) shows a scheme of pressure distribution to explain the material behavior under pressure, where the pressure area increases with material thickness, whereas the joining zone pressure decreases. Figures 1 b) and 1 c) show the corresponding results of the measurement films for different material thicknesses t_x determined in quasi-static compression tests.

In further steps, material behavior will be implemented in FEM to realize a validation between numerical and experimental results. Further, screw forces and their effects on the resulting glue lines will be included. The aim of the project is the direct numerical calculation of efficient screw arrangements dependent on the existing screw force and needed joining zone pressure according to the adhesive.

References

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