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Strength prediction of timber with different qualities based on stress concentration factors

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Natural defects and the structural heterogeneities of timber are affecting the uniform stress distribution inside the boards. Localized high stress concentrations around these defects may result. These stress concentrations are important factors, causing the initiation of the crack and collapse of the structure. Due to the anisotropy and 3D spatial variation of these defects, especially in softwoods, calculation of the stress concentrations is not an easy process. The aim of this study is to find the link between board tensile strength and these parameters for different quality boards. Simulations are run for 240 softwood boards, covering the full range of quality. This include 103 medium to high quality spruce and 137 low to medium quality douglas fir boards. ABAQUS and PYTHON programming language are used for the numerical analysis. The geometrical model of wood is generated by creating an automatic link to the knots and defects, measured on the board surfaces. The structural model is created based on the flow-grain analogy [1, 2, 3], and the mechanical model is created by considering wood as an orthotropic and heterogeneous material. The results of the multiple correlation analysis are presented in figure 1.

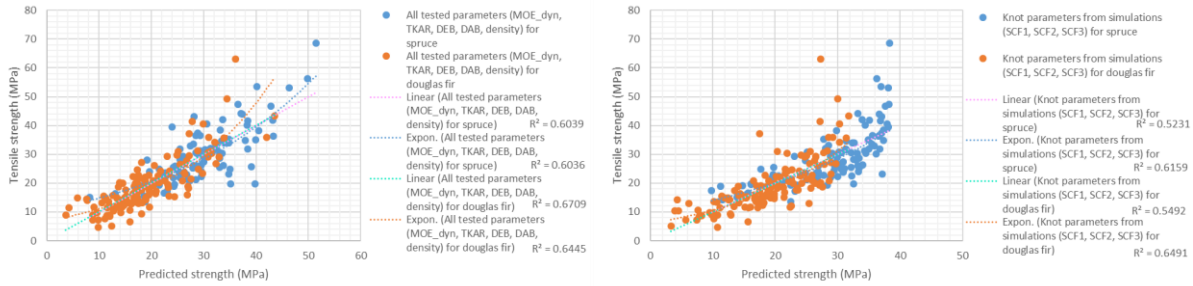

Figure 1: Comparison of the multiple regression results of the tests and the simulations

It can be concluded that three stress concentration factors are enough for strength prediction of the good quality spruce boards, whereas an additional parameter needs to be defined for performing more accurate predictions for low quality douglas fir boards, in order to cover the complete quality range of softwoods.

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