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FAILURE ENVELOPE FOR INTERACTION OF STRESSES PERPENDICULAR TO THE GRAIN WITH ROLLING SHEAR STRESS IN WOOD

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The orthotropic material property in combination with ductility in compression, brittleness in shear and tension, very low shear modulus in radial-tangential (RT) plane etc. requires anisotropic stress failure criteria, as well as their evolution with increasing strains. Three-dimensional failure criteria have been proposed for this purpose, but their validation in the RT plane with interaction of rolling shear stresses has attracted less attention. Corresponding stress interactions are however important for modelling of engineered wood-based products under compression perpendicular to the grain when taking into account influence of the annual ring structure.

The work aims at defining failure envelopes for stresses perpendicular to the grain with rolling shear stress interaction based on experimental investigations performed on Norway spruce. The experimental set-up was realized in a biaxial testing frame and consisted of stiff steel plates to transfer load from the testing machine to wood specimen. Mechanical grips prevented rotation and uplifting of the specimen in case of pure shear and tensile loading, respectively. In addition to conventional linear variable differential transformers, a digital image correlation system was used to measure strain fields on the surface of wood specimens and steel plates. Measurements of dog-bone shaped specimens were carried out along different stress interaction paths by displacement controlled loading.

The experimental dataset was then compared with commonly used phenomenological failure criteria, namely Tsai-Hill, Tsai-Wu [1], Norris [2] and Hoffman, as well as with regression equations from previous works [3].

Experiments revealed that the stress-strain relationship under compression, shear, and biaxial loading differs in radial and tangential directions. None of the three-dimensional stress failure criteria provided good prediction of experiments under compression and rolling shear, but experimental data was closer to the regression equation proposed in [3].

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