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ON CRITERIA FOR TIMBER FRACTURE SIMULATIONS

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Numerical simulations of fracture processes can be conducted using various methods (interface elements, node splitting, phase field, XFEM) and using various criteria (stress-based, energy-based, damage-based). Throughout this contribution, several criteria with certain adaptions for wooden material are presented and compared towards an identification of a reliable and realistic criterion with a focus on a simple usability based on available material parameters for common wood species.

The XFEM (Extended Finite Element Method) is employed within this contribution to allow an automatic crack propagation without the necessity of mesh adjustments during crack growth [1]. Along the XFEM, cohesive zone models including a contact formulation are added to the discontinuity of the displacement field.

Utilising the cohesive zone model, a stress based criterion is easily applied. The averaged stress at the crack front is evaluated using a Tsai-Wu based anisotropic failure criterion, which governs the intensity and direction of the crack growth. A fully coupled cohesive zone with an initially rigid formulation is used. Simulation results have shown good agreement with experimental results. Moreover, an energy-based approach is adapted, employing the so-called material forces. Material forces are the driving forces on defects resulting from the imbalance of physical forces. The magnitude of material forces surrounding a crack front is identical to the energy release rate, which can be used as a criterion for the crack propagation. The orientation of the material forces yields the direction of the crack growth. Additionally, a damage-based criterion is introduced. The direction of crack growth it determined by the distribution of damage values of the integration points around the crack front.

The different criteria are tested by numerical simulations of common wooden constructive elements, like beams with kinks or holes [2] and face staggered joints [3].

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