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A MICROMECHANICAL MODEL FOR FAILURE ANALYSIS OF RUBBER-LIKE MATERIALS

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ABSTRACT

Rubber-like materials are modelled with hyperelastic material laws by which material attain either infinitely large stretches or a certain locking stretch value. In either type of hyperelastic models, the material possesses infinite energy. Classical fracture mechanical investigations are based on Griffith's theory which states that fracture occurs if surface energy exceeds a certain threshold value called critical energy release rate or fracture energy. In order to obtain new surfaces as crack propagates, either cohesive zone models or adaptive remeshing depending on material forces and G_c are commonly used. However, aforementioned methods are usually dependent on the finite element mesh and applications are limited to two-dimensional problems. Mesh manipulation in order to capture the crack path is computationally demanding and not appropriate for structural analysis since the problem should start with a pre-existing crack. In this contribution, material failure is embedded into the constitutive model and becomes an intrinsic property of the material. The model is based on a hyperelastic material law representing the energy stored in rubber network due to the chain conformations connected in series to an interatomic bond potential representing the energy stored in the polymer chain due to the interatomic displacement. For the representation of the ground state elastic response micro-sphere model of Miehe et al. [1] is utilized. Morse potential is used for the description of the interatomic bond, which governs the rupture of the polymer chain (see Volokh [2]). The presented formulation can be alternative to the interelement cohesive formulations as it circumvents some of the above mentioned inherent to such approaches.

References

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