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Investigation of dynamic fracture of elastomers: On the role played by viscoelasticity

Résumé

This study aims to investigate the propagation of a dynamic crack through an elastomer membrane. The crack propagation in polyurethane elastomers was studied experimentally in earlier studies. In that study, under certain loading conditions, crack speeds exceeded the shear wave speed. Such cracks are called transonic cracks. Two main hypotheses were put forward in literature to explain the observation of Transonic cracks. One of them relies on the hyperelastic stiffening of the material in the vicinity of the tip, while the other relies on the viscoelastic stiffening. This study examines these two hypotheses and determines that viscoelastic stiffening is the necessary (and sufficient) ingredient. Finite Linear viscoelasticity has been used in the first instance. Once this has been established, a rate-dependent cohesive model has been used to predict the crack propagation speed. The crack speed was found to be independent of the specimen height starting from a certain threshold. A nonlinear viscoelastic model has also been implemented assuming plane stress conditions to prevail. Using this, the energy dissipated in the bulk because of viscoelastic effects, and the energy consumed by the fracture processes has been explicitly computed. The majority of the strain energy was observed to be consumed as the viscoelastic dissipation in the bulk material. The rest is taken up by the fracture processes.

Mots-clés : Dynamic fracture, Viscoelasticity, Transonic cracks, Elastomer, Cohesive zone