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GRADIENT DAMAGE MODELS FOR LARGE DEFORMATION

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In 1998, Francfort and Marigo proposed a variational approach to fracture “[1]” in which the damage or crack evolution is governed by a least energy principle. They constructed damage models that were regularized via the introduction of a spatial gradient of damage weighted by a parameter called characteristic length. Although these models were thoroughly developed and enriched in the past few years “[2]”, they stayed in the framework of small deformation.

The aim of this work is therefore to show the relevance of these gradient damage models in a finite deformation framework. To this end, both an analytical and numerical study were conducted. The damage evolution (homogeneous and localized) of a 1D hyperelastic bar submitted to traction was first studied. The results were then compared with the ones obtained after the numerical implementation of the damage gradient models in the FEniCS library, in a hyperelastic setting.

Once the 1D analytical and numerical results have been shown to be in agreement, simulations in higher dimensions were performed with a finite element academic code. Compressible or quasi-incompressible Mooney-Rivlin laws were used on different 2D and 3D geometries. Theses numerous tests lead to the study of the cavitation phenomenon, which is a well-known damage process for elastomers. A critical load for the onset of cavitation was established for compressible neo-hookean solids, and compared with the critical load for which the damage occurs. Moreover, simulations on a 2D plate with rigid inclusions were carried out to reproduce the results disclosed in the experience of Gent and Lindley.

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