Variational formulation of damage in rock mechanics and fracture dynamic

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Abstract

An important problem is to describe the propagation of seismic waves in heterogeneous rock masses and models of fracture and damage. The first ones are used to try to identify the zones in a sector of a mine in which the rock masses have been weakened by the exploitation of the galleries (in particular by hydraulic fracturing) starting from the recording data of the geophones network. The second should allow, considering the estimated rate of damage, to determine the areas of concentration of the stresses likely to generate seismic activity.

In terms of damage, we are interested in to understand the dynamic of the damage in rock mass. Our approach is based on the variational models developed by G. Frankfurt and J.-J. Marigo. As in the classic Griffith's models, the variational models of rupture postulate that the dissipated energy, when creating and propagating a crack, is proportional to the length of this crack, and a crack is created only if it is advantageous from an overall energy point of view. The energy functional that governs the evolution of the material depends on two fields, that is, the elastic displacement and the geometry of the crack. To overcome these difficulties (especially the numerical difficulties) induced by the different nature of these fields, some regularization techniques have been developed, which aim to consider a crack as a diffuse interface described by a regular function rather than a characteristic function. From a mathematical point of view, the functional of Ambrosio–Tortorelli resultant generalizes the approach of Mumford–Shah originally invented in the context of image segmentation, thus, from a mechanical point of view, this regulation technique can be interpreted as a damage model. In this talk we will present some recent results and numerical simulations which give us important results in the understanding of this phenomena.