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Phase Field Model for Brittle Fracture in Random Heterogeneous Elastic Media : Forward Numerical Simulations and Sensitivity Analysis

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Within the framework of linear elasticity theory and fracture mechanics, this work addresses the forward numerical simulation of a phase field model [1] for brittle fracture in random heterogeneous elastic materials. Such a phase field model is classically parameterized by the fracture toughness (or critical energy release rate in the sense of Griffith) and the regularization parameter (corresponding to the actual width of the smeared/diffusive crack representation) which are considered as deterministic and homogeneous parameters. At a given mesoscale, the material is considered as random and heterogeneous with apparent elasticity properties. Various classes of stochastic models and associated random generators for non-Gaussian tensor-valued random elasticity fields with statistical fluctuations in a given material symmetry class and in the (purely) anisotropic class have been proposed [2]. In the present work, we focus on two particular classes of stochastic models, namely (i) the class of random elasticity fields exhibiting almost surely isotropic symmetry properties, and (ii) the class of purely anisotropic random elasticity fields with an isotropic mean elasticity field and anisotropic statistical fluctuations (around the isotropic mean function). A sensitivity analysis is carried out to study the influence of the (hyper)parameters of the aforementioned stochastic models on some statistical quantities of interest related to the force-displacement curve for identification purposes. The proposed approach is illustrated on a classical benchmark problem for brittle fracture, namely a two-dimensional single-edge notched/cracked specimen under pure shear loading.

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