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A DISPERSIVE COMPUTATIONAL HOMOGENIZATION SCHEME FOR MODELING QUASI-BRITTLE MATERIALS UNDER IMPACT LOADING

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Heterogeneous quasi-brittle materials under impact loading are modeled using a multi-scale method. Among different multi-scale techniques, computational homogenization is considered in the present work in which the overall properties at the global-scale can be obtained by solving a boundary value problem for a representative volume element (RVE) assigned to each material point of the global-scale model.
Available standard computational homogenization methods require the strain/stress field to be homogeneous over the RVE. However, when strain localization occurs or/and high frequency loading conditions take place, this assumption breaks down and the standard homogenization method cannot be used.
In the present work, a computational homogenization scheme for modeling cracking under high frequency impact loading is developed. The cohesive macro-cracking is modeled using XFEM and the gradient enhanced damage model is used to model damage at the local-scale. A continuous-discontinuous computational homogenization method [1] is employed to obtain the traction-separation law for macro-cracks using averaged properties calculated over the damaged zone in the RVE. In the multi-scale model, a dynamic analysis is performed for the global-scale model and the local-scale model is solved as a quasi-static problem [2]. The dispersion effects at the bulk material caused by reflection of the wave at the interface of different materials are captured by accounting for the inertia forces at the local-scale model via a so-called dispersion tensor which depends on the heterogeneity of the RVE [3].
Numerical examples for various loading frequencies and loading rates are given and the multi-scale model results are compared to direct numerical simulation results which show a good agreement. Furthermore, the objectivity of the multi-scale scheme with respect to the RVE size is examined.

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