An adaptive global-local approach for phase-field ductile fracture

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ABSTRACT

This work outlines an efficient global-local model augmented with predictor-corrector adaptivity applied to the phase-field modeling of ductile fracture in elastic-plastic solids at finite strains. Following the recent work [1], the variational phase-field formulation to ductile fracture is considered based on a triple multiplicative decomposition of the deformation gradient. Triple multiplicative decomposition of the deformation gradient consists of plastic-, compression- and tension-deformation gradient results from the principle stretches obtained from elastic part of deformation gradient. Accordingly, an exponential update scheme for the return map in the time is used. Also, the critical fracture energy density is considered to associate the ductile behavior to fracture, which depend on the equivalent plastic strain.

Clearly, the formulation of elastic-plastic solids at large strains is strongly non-linear and requires sufficiency small length-scale, to "approximately" predict the sharp crack resolution. So, an idea of multi-scale approach that enables to send the multi-field problem to the local scale, and accordingly upscale the effective solution to the global scale, seems particularly appealing. In line with [2], we propose an adaptive global-local approach applied to phase-field modeling of fracture in elastic-plastic solids. In particular, a predictor-corrector global mesh adaptivity scheme, according with [3], is developed, which does not require any a priori-knowledge of the crack path. Evidently, a non-matching finite element discretization of an interface between the two nested scales becomes feasible. In order to handle non-matching grids, a dual mortar method [4] is implemented for improving the regularity of the corresponding FE meshes.

With several numerical examples, we show that the proposed approach indeed yields results similar to the reference single-scale solution yet they are obtained with much superior efficiency.

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