Gradient-enhanced damage model for ductile failure

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It has been widely accepted that the conventional local definition of damage is unable to utterly describe the behaviour of materials under softening regimes. Such difficulties arise from the mesh-dependency issues, leading to the loss of ellipticity/hyperbolicity of the governing equations. Introducing the gradients of variables in the structure of the boundary value problem has been proved to efficiently attenuate the dependency of failure behaviour modelling on the spatial discretization size and orientation, see [1-2].

The phase-field method [3-4] share similarities with gradient nonlocal models namely in terms of the utilization of second order spatial gradients of field variables and a 'diffusion'-like equation- This promotes a flattening of sharp meso-crack topologies and, simultaneously, it reduces numerical costs, when compared to continuous-discontinuous approaches like the XFEM [5], and enables to avoid difficulties in the solution of complex crack patterns. However, most of the failure-based phase field models to date have been focused on brittle continua and research is still progressing on ductile materials [6-7]. The main concern of the present work is to establish a bridge between the continuous damage mechanics and the phase field concept of brittle fracture by describing the order parameter of phase field as a localization limiter to the coupled elastoplastic local damage model. In order to quantify the ability of the proposed model in evasion of mesh topology dependence as well as the prediction of crack paths, the progression of new order parameter over different mesh sizes will be assessed and the influence of the different model parameters will be clarified.

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