A numerical study on phase field diffusive fracture approach in ductile failure analysis

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ABSTRACT

This study addresses the incorporation of phase field diffusive fracture methodology in modelling ductile failure of metallic materials. Recent development of phase-field-based fracture models in ductile material description [1,2] has shown the robustness and versatility of this approach in the solution of intricate crack patterns, such as intersecting or branching cracks, in which it bypasses the need to introduce *ad hoc* criteria for nucleating cracks as it is processed in an original mesh. Besides, it is noteworthy to highlight its structural similarity with the nonlocal gradient damage models, as in both methods a Helmholtz type gradient equation appears, despite the fact that each of them come from different contexts [3,4], namely fracture mechanics in the case of phase field and continuous damage mechanics in the case of the gradient-enhanced damage approach.

In line with this, the present contribution gives an insight into the prediction of initiation and propagation of meso-cracks, in which micro-void growth is the main failure-induced mechanism. This entails the introduction of a damage evolution law and a crack initiation criterion, in which the latter defines the location where phase-field diffusive crack starts to propagate. This essentially involves an interplay between the internal damage, which may come from phenomenological constitutive description [5], and the phase field diffusive parameter.

As for the numerical implementation, the regularization of the internal degradation is performed using a modified phase field driving force and the integration of the mechanical and diffusion equations is conducted in a fully staggered manner within the finite element framework. Numerical benchmarking examples are tested and relevant comparisons are made with the existing literature.

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