Phase-field modelling of void growth using micromechanical damage law

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ABSTRACT

Utilization of the phase-field diffusive crack approach in prediction of crack evolution in voided material is investigated herein. It has been established that the ductile failure is predominantly production of nucleated and grown micro-voids, which is followed by the formation of the micro-cracks from void coalescence mechanism. Development of modelling strategies that studies both the material internal degradation and its transition to discrete crack modelling is a topic of interest in both fracture and damage communities.

In this study, the damage growth modelling is performed via the Rousselier micromechanical law [1], in which the void volume fraction evolution is suggested as a precursor to the meso-crack initiation. In the light of proved ability of phase-field diffusive crack approach in dealing with arbitrary and intricate crack patterns and following the recent developments on its application in the context of ductile fracture [2]–[5], an attempt is made to obtain a meaningful relation between the two frameworks. In this regard, the void growth mechanism is embedded into the diffusive phase-field energy, and a crack initiation criterion is proposed based on the critical void volume fraction that principally is not considered in the damage model under study. As the crack development is mainly driven by accumulation of internal damage, the coupling of the mechanical problem to the crack diffusion mechanism necessitates the employment and use of the phase-field degradation function in the material constitutive description. The numerical implementation is performed using the commercial Software ABAQUS implicit analysis, whereby a fully-staggered integration of the mechanical and diffusive fields is considered. Benchmark testing is carried out and a good correspondence with the results from literature is observed.

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