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A modified Gurson-type plasticity model at finite strains: Formulation, numerical analysis and phase-field coupling

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The modeling of failure in ductile metals must account for complex phenomena at the micro-scale, such as nucleation, growth and coalescence of micro-voids, as well as the final rupture at the macro-scale, as rooted in the pioneering works [1,2]. Within a top-down viewpoint, this can be achieved by the combination of a micro-structure-informed elastic-plastic model for a porous medium with a concept for the modeling of macroscopic crack discontinuities. The modeling of macroscopic cracks can be achieved in a convenient way by continuum *phase-field approaches to fracture*, which are based on the regularization of sharp crack discontinuities as outlined in [3,4,5]. This avoids the use of complex discretization methods for crack discontinuities, and can account for complex crack patterns. In this work, we develop a new theoretical and computational framework for the phase-field modeling of ductile fracture in conventional elastic-plastic solids under finite strain deformation. It combines modified structures of Gurson-Tvergaard-Needelman GTN-type plasticity model with a new evolution equation for the crack phase field. The modeling capabilities and algorithmic performance of the proposed formulation is demonstrated by representative simulations of ductile failure mechanisms in metals.

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