On fracture in finite strain gradient plasticity - DTU Orbit (09/11/2017)

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In this work a general framework for damage and fracture assessment including the effect of strain gradients is provided. Both mechanism-based and phenomenological strain gradient plasticity (SGP) theories are implemented numerically using finite deformation theory and crack tip fields are investigated. Differences and similarities between the two approaches within continuum SGP modeling are highlighted and discussed. Local strain hardening promoted by geometrically necessary dislocations (GNDs) in the vicinity of the crack leads to much higher stresses, relative to classical plasticity predictions. These differences increase significantly when large strains are taken into account, as a consequence of the contribution of strain gradients to the work hardening of the material. The magnitude of stress elevation at the crack tip and the distance ahead of the crack where GNDs significantly alter the stress distributions are quantified. The SGP dominated zone extends over meaningful physical lengths that could embrace the critical distance of several damage mechanisms, being particularly relevant for hydrogen assisted cracking models. A major role of a certain length parameter is observed in the multiple parameter version of the phenomenological SGP theory. Since this also dominates the mechanics of indentation testing, results suggest that length parameters characteristic of mode I fracture should be inferred from nanoindentation.

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