On the Finite Element implementation of higher-order Gradient Plasticity theories

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ABSTRACT

We focus on the Finite Element (FE) implementation of a theory of work-conjugate gradient plasticity, with emphasis on the effect of Nye's dislocation density tensor as sole higher-order primal kinematic variable entering the theory.

The proposed FE algorithm is an extension of a standard continuum element, in which, besides the displacement components, the relevant plastic distortion contributions are employed as nodal degrees of freedom. A notable efficiency of the proposed implicit (Backward-Euler) time integration algorithm is achieved by assuming a specific viscoplastic potential, which can accurately reproduce rate-independent material behavior without leading to convergence problems.

In particular, we study size effects in micro-indentation. The numerical analysis of such a demanding boundary value problem confirms the efficiency of the proposed FE algorithm.