Grigorovitch, Marina; Gal, Erez; Waisman, Haim

Embedded unit cell homogenization model for localized non-periodic elasto-plastic zones.

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Summary: We extend the embedded unit cell (EUC) homogenization approach, to efficiently and accurately capture the multiscale solution of a solid with localized domains undergoing plastic yielding. The EUC approach is based on a mathematical homogenization formulation with non-periodic domains, in which the macroscopic and microscopic domain are concurrently coupled. The formulation consists of a theoretical derivation and the development of special boundary conditions representing the variations of the local displacement field across the unit cell boundaries. In particular, we introduce a restraining band surrounding the local domain in order to support the consistency of the solution in the transition layer between the micro and macro scales. The method is neither limited to a specific plasticity model nor to the number of localized features, thereby providing great flexibility in modeling. Several numerical examples illustrate that the proposed approach is accurate compared with direct finite element simulations, yet requires less computational cost.

MSC:

74Q05 Homogenization in equilibrium problems of solid mechanics
74C05 Small-strain, rate-independent theories of plasticity (including rigid-plastic and elasto-plastic materials)

Keywords:

multiscale analysis; concurrent; localization; non-periodic zones; plastic yielding; mathematical homogenization

Software:

HYPLAS

Full Text: DOI

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