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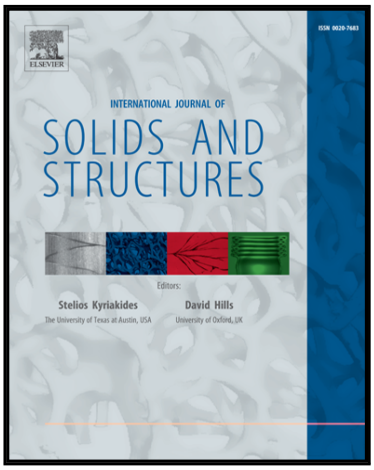

A micromechanical gradient extension of Gurson's model of ductile damage within the theory of microdilatational media

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A micromechanical gradient extension of Gurson's model of ductile damage within the theory of microdilatational media

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Abstract

Gurson's model and its numerous modifications are established for simulating ductile failure. However, this model is formulated within the theory of simple materials which is why it predicts a localization of deformation within an infinitesimally thin band for the softening regime. Corresponding FEM simulations exhibit a spurious mesh dependency. In order to overcome this problem, several heuristic extensions of Gurson's model to non-local or gradient theories were proposed in literature. Although these extensions are computationally effective, the particular implementation and interpretation of the additional terms and the corresponding constitutive parameters is problematic. In contrast, the extension of Gurson's model by Gologanu et al. [12] (GLPD model) towards strain gradient media by homogenization does not have these problems but its numerical implementation is considerably more complicated.

The present contribution aims in providing a gradient extension of Gurson's model which combines computational efficiency with a sound micromechanical basis. For this purpose a theory of homogenization towards unconstrained microdilatational media is developed. Based on this theory, a limit-load analysis is performed for a unit cell with void leading to a closed-form yield function of Gurson-type which contains additional terms of the microdilatational theory.

Keywords: ductile damage; micromorphic theory; homogenization; generalized continua

1. Introduction

Ductile damage and the associated failure of components is critical in many engineering applications. The ductile mechanism consists of the nucleation, growth and coalescence of microscopic voids during plastic deformations. The constitutive model of Gurson [14, 15] and its numerous modifications are established to simulate the ductile damage and failure of components.