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Analytical and Numerical Study of Crushing of Syntactic Foams under uniaxial Compression

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Abstract

Syntactic foams are a class of particulate composites made with hollow microspheres dispersed uniformly in a matrix. By the inclusion of hollow spheres in the matrix, the bulk mechanical properties are improved by limiting the bending of cell edges and localization of inelastic deformation, which is the cause of failure in the case of low-density foams. For the general class of cellular materials, several analytical and experimental methods are available in the literature to characterize the material. In the case of syntactic foams, relatively few methods exist for the computation of effective elastic properties and methods for analyzing the crush behavior of the syntactic foams are rather limited.

In this research, the quasi-static crushing behavior of syntactic foam under uniaxial compression is investigated using analytical and numerical methods. To better understand the bulk behavior of syntactic foam, a micromechanical study is conducted to analyze the crushing of hollow spheres in dilute concentration. Initially the stress fields around dilute concentration are derived using continuum mechanics principles and subsequently a limit analysis is performed.

To gain further insight into the deformation fields and deformations of cell walls leading to densification, a finite element (FE) analysis is performed. Assuming a periodic repetition of a representative volume of the material would correspond to the bulk material, axisymmetric and 3D finite element models are developed. The numerical computations are compared with the analytical results obtained in this study, and with experimental data reported in the literature. Using the FE models, a parametric study is conducted to investigate the influence of microsphere strength and elastic mismatch between the matrix and the inclusions on the crush behavior of syntactic foam.

References:

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