UNIVERSITY OF TRENTO - Italy
ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

EUROPEAN MECHANICS SOCIETY

ESMC 2018
10th European Solid Mechanics Conference
Bologna, July 2-6, 2018

Propagation of compaction waves in the open-cell copper foams

Zdzisław Nowak[1], Marcin Nowak[2], Ryszard B. Pęcherski[1]
[1] *Department of Theory of Continuous Media and Nanostructures, Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawinskiego 5b, 02-106 Warsaw, Poland*
E-mail:znowak@ippt.pan.pl, rpecher@ippt.pan.pl

[2] *Department of Mechanics of Materials, Institute of Fundamental Technological Research, Polish Academy of Sciences, Pawinskiego 5b, 02-106 Warsaw, Poland*
E-mail:nowakm@ippt.pan.pl

Keywords: dynamic compression test, open-cell copper foams, numerical simulation

The novelty of presented approach is based on the hypothesis that the propagation of compaction wave can be described theoretically as a propagation of strong discontinuity surface (shock wave) in a continuum. The subject of the study is the model of virtual metallic foam with the skeleton formed of convex or re-entrant cells. The computed tomography made the basis for the formulation of computational model of the foam and the finite element discretization of skeleton, [1], [2]. The goal of the presented investigations is to study the propagation of compaction waves, the impact limits and absorption energy of these two kinds of open cell metallic foams. To simulate the deformation processes the finite element program ABAQUS is used. From each reconstructed volume, a representative cubic volume element was extracted. For numerical simulations the constitutive elasto-viscoplasticity model is applied that defines the dynamic behaviour of oxygen-free high conductivity (OFHC) Cu using the experimental data reported in the literature, [2]. The chosen material description for the numerical simulation is based on the Cowper-Symonds model. In numerical simulations the bottom displacement in the impact direction is fixed and initial velocity V_0 on the top surface and general contact (steel wall-Cu foam and selfcontact Cu foam) with the friction coefficient 0.35 is assumed. The numerical analysis of dynamic compression test and prediction of axial force (crushing force) within the wide range of velocity: from 50 to 300 m/s are discussed. The state variables derived from Hugoniot relation for shock wave and the conservation laws are used for the comparison with the results of FEM simulations in order to verify the assumed hypothesis. The multiscale character of deformation process is discussed and the mechanisms of the deformation of skeleton struts in the compaction zone are visualised.

References

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