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Numerical simulation of crushing processes in metallic open-cell foam

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The aim of the paper is to presents a description of viscoplastic deformation of open-cell metallic 96% porosity foam under dynamic compression, which accounts for the crushing phenomena.

The geometry of the foam is obtained from the computed tomography scans, [1], [2], [3]. The CT scans made the basis for the formulation of computational model of the foam and are transformed into a finite element tetrahedral mesh with Scan IP+FE software [4].

The Cowper-Symonds material constitutive equation for the elasto-viscoplasticity overstress power law model is used. In numerical simulations the metallic foam sample is a cube of dimensions 2.5 x 2.5 x 2.5 mm of the following skeleton material properties: Young's modulus 110 GPa, Poisson's ratio 0.296 and density 8960 kg/m^3. We assume elastic-viscoplastic material with isotropic hardening and the initial yield stress of the material is 50.0 MPa. To simulate the impact deformation processes the finite element program ABAQUS is used. In numerical simulation of dynamic compression of foam sample it is considered a rigid-wall impact scenario in which the cellular specimen is sandwiched between two rigid wall to impose compression under two different normal initial velocities V_0=50 and 300 m/s on the top wall and the bottom wall displacements in the impact direction are fixed. General contact (the steel rigid wall surfaces and the surfaces of foam, and self-contact between the surfaces of foam) with friction 0.35 is assumed. The material definition include failure model with damage. The ductile criterion is specified in terms of the strain. Failure is assumed to occur when the damage parameter exceeds 0.9.

Crushing force, the energy of impact and impact velocity histories of the open-cell foam in wall impact with different initial velocities 50 m/s and 300 m/s are presented. 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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