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The structure of steady shock waves in porous metals

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Abstract

The paper aims at developing an understanding of steady shock wave propagation in a ductile metallic material containing voids. Porosity is assumed to be less than 0.3 and voids are not connected (foams are not considered). As the shock wave is traveling in the porous medium, the voids are facing a rapid collapse. During this dynamic compaction process, material particles are subjected to very high acceleration in the vicinity of voids, thus generating acceleration forces at the microscale that influence the overall response of the porous material. Analyzing how stationary shocks are influenced by these micro-inertia effects is the main goal of this work. The focus is essentially on the shock structure, ignoring oscillatory motion of pores prevailing at the tail of the shock wave. Following the constitutive framework developed by Molinari & Ravichandran [J. Appl. Phys. **95**, 4 (2004)] for the analysis of steady shock waves in dense metals, an analytical approach of steady state propagation of plastic shocks in porous metals is proposed. The initial void size appears as a characteristic internal length that scales the overall dynamic response, thereby contributing to the structuring of the shock front. This key feature is not captured by standard damage models where the porosity stands for the single damage parameter with no contribution of the void size. The results obtained in this work provide a new insight in the fundamental understanding of shock waves in porous media. In particular, a new scaling law relating the shock width to the initial void radius is obtained when micro-inertia effects are significant.

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