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Theoretical investigation on impact resistance and energy absorption of foams with nonlinearly varying density

Hu Liu[1], Zhiqiang Zhang[1], Hua Liu[1,*], Jialing Yang[1], Hong Lin[2]

[1]*Institute of Solid Mechanics, Beihang University, 100191Beijing, PR China*

[2]*Beijing Institute of Astronautical Systems Engineering, 10076 Beijing, PR China*

Abstract

Compared with traditional uniform foams, the density-graded foam exhibits more excellent impact resistance and energy absorption capacity. In order to exploit its full potential for improved dynamic performance, the density profile should be designed properly. However, the effect of the nonlinear density gradient profile on the impact resistance and energy absorption characteristics is still unclear. The aim of this paper is to study the dynamic response of a nonlinear density-graded foam rod impinged by a mass projectile. The density in the foam rod varies along the longitudinal direction in a power-law exponent form and the coupling effect of density gradient on material properties of foam rods is taken into account. Both the negative and positive density gradients are investigated. The dynamic stress at the impinging and support ends and the energy absorption capacity for different power-law exponents are compared. The present nonlinear gradient model can be degenerated into the previous linear gradient model when the exponent is equal to 1. To validate the theoretical analysis, the finite element simulation is also carried out and a good agreement is achieved. The results indicate that the impact resistance and energy absorption capacity of the foam rod can be improved by using proper nonlinear density-graded profiles.

Keywords： A. Foams; B. Impact behavior; C. Analytical modeling; Density graded foam

*Corresponding author.
E-mail address: liuhuarui@buaa.edu.cn (Hua Liu).