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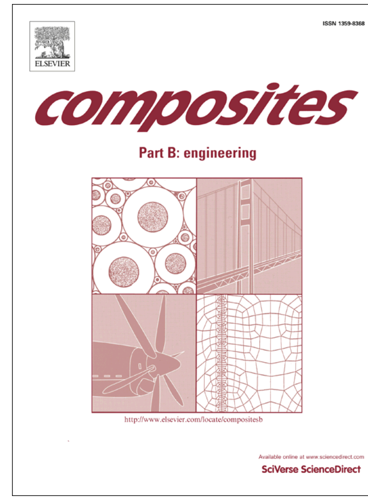

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Quasi-static energy absorption of hollow microlattice structures

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Abstract: We present a comprehensive modeling and numerical study focusing on the energy quasi-static crushing behavior and absorption characteristics of hollow tube microlattice structures. The peak stress and effective plateau stress of the hollow microlattice structures are deduced for different geometrical parameters which gives volume and mass densities of energy absorption, D_v and D_m, scale with the relative density, $\bar{\rho}$, as $D_V \sim \bar{\rho}^{1.5}$ and $D_m \sim \bar{\rho}^{0.5}$, respectively, fitting very well to the experimental results of both 60^0 inclined and 90^0 predominately microlattices. Then the strategies for energy absorption enhancement are proposed for the engineering design of microlattice structures. By introducing a gradient in the thickness or radius of the lattice members, the buckle propagation can be modulated resulting in an increase in energy absorption density that can exceed 40%. Liquid filler is another approach to improve energy absorption by strengthening the microtruss via circumference expansion, and the gain may be over 100% in terms of volume density. Insight into the correlations between microlattice architecture and energy absorption performance combined with the high degree of architecture control paves the way for designing high performance microlattice structures for a range of impact and impulse mitigation applications for vehicles and structures.

Keywords: B. Plastic deformation; B. Buckling; C. Finite element analysis; B. Mechanical properties; A. Microlattice structures

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