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Enhanced out-of-plane crushing strength and energy absorption of in-plane graded honeycombs

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Abstract: Introducing gradient into cellular materials has been envisioned as an effective way to improve their performance. In this study, a novel in-plane graded honeycomb is proposed and its dynamic behavior under out-of-plane compression is investigated using numerical simulation and theoretical analysis. The in-plane gradient is introduced by changing the thickness of each cell wall of honeycomb unit cell along its side length. Numerical results show that the crushing strength and energy absorption capacity of honeycombs with positive gradient are substantially enhanced compared to those of honeycombs without gradient. To explore the enhancement, theoretical and numerical analyses on the energy absorption mechanism of honeycombs are performed. It is found that severe plastic deformation is mainly concentrated near the intersecting edge of cell walls, and the energy absorption can be further improved by distributing more material near the intersecting edge when the total mass remains constant. In addition, analytical formulas for the crushing strength and energy absorption of graded honeycombs are developed, and good agreement is obtained with numerical results.

Keywords: Honeycomb; Out-of-plane compression; In-plane gradient; Crushing strength; Energy absorption.

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