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Interlocking Assembled 3D Auxetic Cellular Structures

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Abstract

As promising metamaterials, 3D periodic auxetic cellular structures (PACSs) have attracted great interest. However, they usually consist of intricate geometries which make their fabrication a significant challenge. The present paper is focused on introducing the interlocking assembly concept into the fabrication of 3D PACSs. There are distinct advantages of the interlocking assembly method compared with the additive manufacturing methods mainly used before. Based on the interlocking assembly method, the dependences of mechanical properties mainly including the Poisson's ratio and the Young's modulus of the structure on the re-entrant angle were investigated through a combination of uniaxial compression experiments and numerical simulations, excellent qualitative and quantitative agreement was found. Using the experimentally verified numerical model, the effects of the strut thickness and the ratio of the vertical strut length to oblique strut length on the mechanical properties of the structure were investigated. Results show that the compression modulus of the structure will increase with the structure becomes more re-entrant, but there exists an extreme value for Poisson's ratio with the re-entrant angle around 45° which differs from former studies. With the thickening of the struts the compression modulus of the structure monotonously increases and the Poisson's ratio of the structure will gradually changes from negative to positive then gradually approaches to the Poisson's ratio of the parent material. The vertical strut length to oblique strut length ratio plays fewer roles on the mechanical properties

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