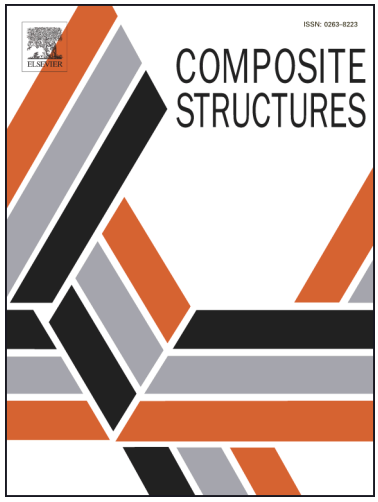

Three-layered plate exhibiting auxeticity based on stretching and bending modes

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Three-layered plate exhibiting auxeticity based on stretching and bending modes

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Abstract

The effective elastic properties 3-layered plates consisting of auxetic and nonauxetic cubic crystals are investigated based on stretching and bending modes. In many cases effective Young's modulus is higher than Young's modulus of the stiffest layer with sufficiently thick auxetic layers. In stretching, 3-layered nonauxetic-auxetic-nonauxetic plates exhibit positive out-of-plane Poisson's ratio. In-plane Poisson's ratios are negative in the case of relatively soft nonauxetic layers and positive for stiffness nonauxetics. The effective Young's moduli can exceed original Young's moduli of all three layers also for the auxetic-nonauxetic-auxetic category. For this category, both effective Poisson's ratios are negative more often and in-plane Poisson's ratio increases with Young's moduli of the original nonauxetics.

In addition to well-known Poisson's ratio under stretching, the concept of Poisson's ratio under pure bending is introduced. There is a large difference between them in the case of 3-layered plate. Effective in-plane Poisson's ratio for symmetrical 3-layered plates are different depending on the loading mode, i.e. the outer layers exert a greater influence under bending mode in comparison to stretching mode. Therefore, nonauxetic-auxetic-nonauxetic cubic plates exhibit an overall auxetic and nonauxetic behaviour under stretching and bending modes, respectively, while the reverse is true for auxetic-nonauxetic-auxetic cubic plates.

Keywords: Auxetics; Poisson's ratios; mode-dependency; stretching; bending; Young's modulus

1. Introduction

Auxetic materials are solids that exhibit negative Poisson's ratio [1-3]. By this it means that the application of axial stretching on an auxetic rod leads to radial expansion. This response is the opposite from that of conventional rods. By similar argument, the application of bending moment on two opposing sides of a square auxetic plate transforms it into a