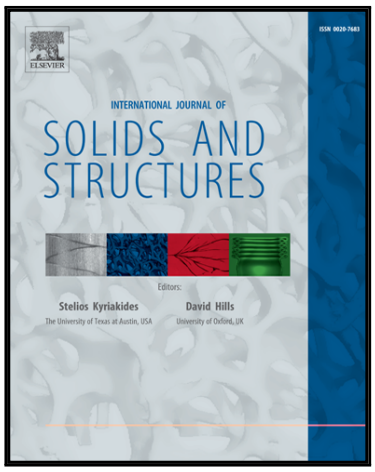

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An experimental evidence of the failure of Cauchy elasticity for the overall modeling of a non-centro-symmetric lattice under static loading

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Abstract

Materials with coarse inner architecture being easily made with modern additive or folding processes, the question of their overall behavior rises. Do they behave like classical elastic continua, or do they exhibit additional higher-order effects ? Further, if present are those effects stable with respect to imperfections (geometry, constitutive material, ...) ? In this view, the current work is an experimental investigation for the need, in static, of a higher-order overall description. It comes from noticing that such behaviors are up to now nearly exclusively studied from a theoretical and numerical point of view. In the present study a non-centro symmetric sample has been manufactured, based on an industrial honeycomb geometry used for aeronautic/aerospace composite materials. The geometrical anisotropy of the elementary cell and the scale separation ratio have been chosen in order to detect non-classical couplings. Samples are obtained by Fused Deposition Modeling (FDM), one of the most widespread 3D printing techniques. Simple experiments based on load controlled tests with full-field kinematic measurement have been performed. A distributed load control reveals that the overall behavior of the architectured material cannot be described within the realm of Cauchy elasticity.

Keywords: strain-gradient elasticity, Anisotropy, Boundary Conditions, Full-field measurement, Architectured materials, Non-centrosymmetric lattices, Generalized continua.

1. Introduction

Several scales are often use to model a material:

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