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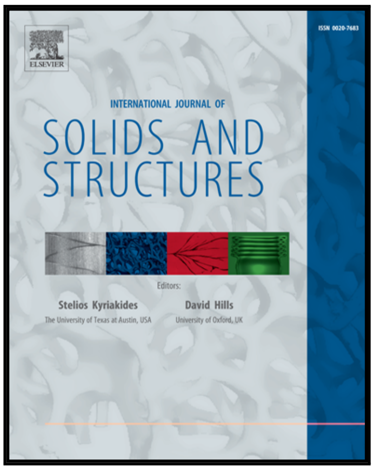

Shear wave propagation in finitely deformed 3D fiber-reinforced composites

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Shear wave propagation in finitely deformed 3D fiber-reinforced composites

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Abstract

We investigate the propagation of shear waves in finitely deformed 3D fiber-reinforced composites. We employ a micromechanics based approach and derive explicit expressions for the phase and group velocities of the shear waves in the long wave limit. Thus, we obtain the important characteristics of the shear waves in terms of the volume fractions and material properties of the constituents. We find that the phase and group velocities significantly depend on the applied deformation and direction of wave propagation. To account for interactions between the elastic waves and microstructure in finitely deformed 3D periodic fiber-reinforced materials, we employ the Bloch wave analysis superimposed on large macroscopically applied homogeneous deformations, and we implement the technique into a finite element code. The Bloch wave numerical analysis reveals the essential dispersion phenomenon for the shear waves propagating along the fibers in the finitely deformed 3D periodic fiber-reinforced materials. We find that the appearance of the dispersion phenomenon and the corresponding wavelengths can be tuned by material composition and deformation.

Keywords: Fiber-reinforced composites, Wave propagation, Finite deformations, Dispersion, Transversely Isotropic, Micromechanics

1. Introduction

Nature actively exploits sophisticated microstructures to achieve remarkable material properties and functionalities. In particular, the fiber-reinforced deformable composites, possessing a light weight, high strength and flexibility at the same time, are widely present in nature [43]. However, natural materials are biodegradable and poorly resistant to moisture, and not always they can provide desirable properties; therefore, synthetic composite materials are of

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