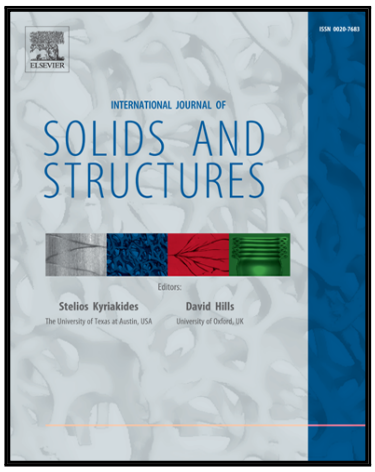

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Accurate characterization of 3D dispersion curves and mode shapes of waves propagating in generally anisotropic viscoelastic/elastic plates

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Abstract

We investigate wave propagation in generally anisotropic viscoelastic plates. The generally anisotropic material system has 21 independent complex coefficients in its stiffness matrix when viscoelasticity is taken into account. The dispersion equation is obtained in the form of determinant vanishing in the complex domain based on the straightforward derivation. An accurate root-searching in the dispersion equation for arbitrary ranges of frequencies and complex wavenumbers, however, is very difficult, if not impossible. In this paper, a novel algorithm is introduced to calculate the 3D dispersion curves. An approximate solution in the low attenuation range via the semi-analytical finite element (SAFE) method is also used to compare and validate the introduced algorithm. Using this algorithm, various peculiar wave features are then investigated in details. These includes the attenuation jump and branches exchange in viscoelastic model caused by conversion of wave mode shapes, and the veering of dispersion branches in the corresponding elastic medium. The general anisotropic (viscoelastic/elastic) models are further compared with the isotropic ones to identify the similarity and difference on wave features between them. The proposed accurate algorithm along with the observed features should be particularly useful in nondestructive evaluations via waves in viscoelastic/elastic plates and structures.

Keywords: Wave propagation; anisotropic viscoelasticity; dispersion curves; mode shapes; branch switch; analytical solution.