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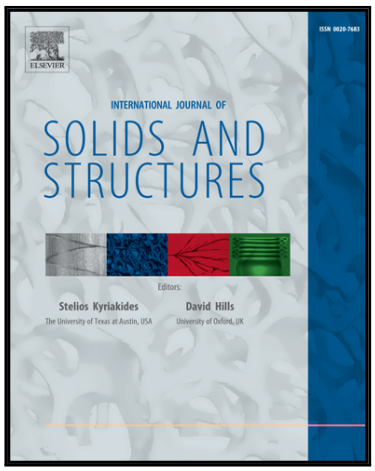

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Dispersion of elastic waves in a strongly inhomogeneous three-layered plate

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Abstract

Elastic wave propagation in a three-layered plate with high-contrast mechanical and geometric properties of the layers is analysed. Four specific types of contrast arising in engineering practice, including the design of stiff and lightweight structures, laminated glass, photovoltaic panels, and electrostatic precipitators in gas filters, are considered. For all of them the cut-off frequency of the first harmonic is close to zero. Two-mode asymptotic polynomial expansions of the Rayleigh-Lamb dispersion relation approximating both the fundamental bending wave and the first harmonic, are derived. It is established that these can be either uniform or composite ones, valid only over non-overlapping vicinities of zero and the lowest cut-off frequencies. The partial differential equations of motion associated with two-mode shortened dispersion relations are also presented.

Keywords: Vibration, sandwich plate, asymptotic, contrast.

1. Introduction

Multi-layered engineering structures, in particular three-layered symmetric plates and shells, also known as sandwich structures, have been manufactured since long ago. Sandwich structures, due to their light weight combined with relatively large flexural stiffness, are in a great demand for modern aerospace, automotive, and civil engineering, e.g. see Vinson (1999) and references therein.

Recent technological developments intensively exploit structures with high contrast in material and geometrical properties of the layers, including, for example, laminated glass beams and plates widely used in glazing and photovoltaic applications. Laminated glass is usually designed as a three-layered plate, with two stiff

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