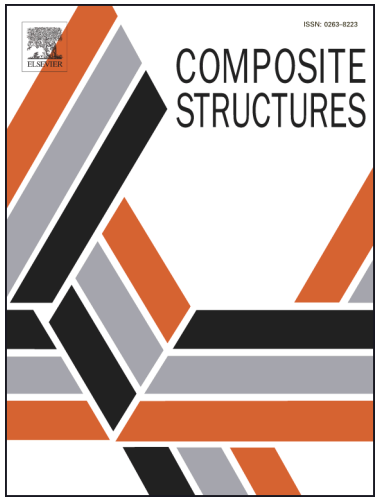

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Dynamics of a functionally graded Timoshenko beam considering new spectrums

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Abstract

Dynamics of a functionally graded (FG) beam were studied using Timoshenko and Euler-Bernoulli (EB) beam theories. Wave propagation of infinite beams and vibration analysis of simply supported FG beams were investigated. Variation of the material properties were assumed in the power law form. It was obtained that unlike isotropic beams, axial and transverse waves are coupled in FG beams due to unsymmetric material variation in the thickness direction of the beam. Two and three dispersion curves were obtained for EB and Timoshenko beam theory, respectively. All of these modes are axial-flexural coupled modes and coupling degree depends on material distribution with respect to mid-surface of the beam. The spectrums of different beams may be classified considering corresponding mode shapes. Wave propagation and vibration properties were discussed considering their mode shapes. It is seen that, unlike isotropic beams, pure shear mode is not possible for FG beams.

Keywords: Functionally graded beam, coupling, Timoshenko beam, vibration, wave propagation.

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1. Introduction

Beam type structures are generally used in different applications such as civil, mechanical and aerospace engineering. Dynamics of these structures has great importance in their design process. In the last three-four decades functionally graded materials (FGMs) are used in beam forms. It is well known that FGM provides some opportunities such as continuous stress distribution, thermal stiffness and optimization. They have temperature resistance, high strength, corrosion resistance and toughness. In the analysis of beam structures the simplest theory is EB theory. In this theory, it is assumed that normal to the beam mid-plane before deformations are normal after deformation. The use of EB theory is