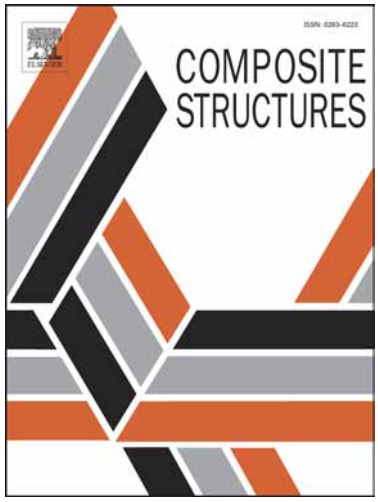

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Hygrothermal effects on vibration characteristics of viscoelastic FG nanobeams based on nonlocal strain gradient theory

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Abstract

This paper investigates damping vibration characteristics of hygro-thermally affected functionally graded (FG) viscoelastic nanobeams embedded in viscoelastic foundation based on nonlocal strain gradient elasticity theory. The modeling of nanobeam is carried out via a higher order refined beam theory which captures shear deformation influences needless of any shear correction factor. The viscoelastic foundation is consists of Winkler-Pasternak layer together with a viscous layer of infinite parallel dashpots. Power-law model is adopted to describe continuous variation of temperature-dependent material properties of FG nanobeam. The governing equations of nonlocal strain gradient viscoelastic nanobeam in the framework of refined beam theory are obtained using Hamilton's principle and solved implementing an analytical solution for different boundary conditions. To validate the presented model, the results are compared with those of elastic nanobeams. The effects of linear, shear and viscous layers of foundation, structural damping coefficient, hygro-thermal environment, nonlocal parameter, material characteristic parameter, power-law exponent, mode number, boundary conditions and slenderness ratio on the frequency response of viscoelastic FG nanobeams are investigated.

Keywords: Damping vibration, Hygro-thermal loading, FG nanobeam, Visco-Pasternak foundation, Nonlocal strain gradient elasticity.

1. Introduction

The remarkable benefits offered by functionally graded materials (FGMs) compared to conventional materials and the demand for overcoming technical challenges involving intense hygro-thermal environments have prompted an increased application of FGM structures. FGMs are heterogeneous materials in which the hygro-thermo-elastic properties vary from one surface to the other, continuously and gradually. Humidity and temperature changes may lead to failure of FGM structures by reducing the rigidity of structure. Therefore, hygro-thermal analysis of FGM structures is an important case of study in research community. To this purpose, post-buckling response of FG plates in hygro-thermal environment is researched by Lee and Kim (2013). Also, Zenkour (2013) investigated static response of exponentially graded plates under uniform and hygro-thermal loadings. Bouderba et al. (2013) analyzed thermomechanical bending response of FGM thick plates resting on Winkler-Pasternak elastic foundations. Khateeb and Zenkour (2014) analyzed bending of advanced plates embedded in elastic foundation under hygro-thermal environments according to a refined plate theory. They mentioned that the bending response of the plate deteriorates considerably with the increase in temperature and moisture concentration. Zidi et al. (2014) performed bending analysis of FGM plates under hygro-thermo-mechanical loading using a four