Author’s Accepted Manuscript

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PII: S0020-7403(15)00415-4
DOI: http://dx.doi.org/10.1016/j.ijmecsci.2015.11.031
Reference: MS3162

To appear in: *International Journal of Mechanical Sciences*

Received date: 13 October 2015
Revised date: 1 November 2015
Accepted date: 25 November 2015

Cite this article as: Chuanmeng Yang, Guoyong Jin, Xinmao Ye and Zhigang Liu, A modified Fourier-Ritz solution for vibration and damping analysis o sandwich plates with viscoelastic and functionally graded materials, *Internationa Journal of Mechanical Sciences* http://dx.doi.org/10.1016/j.ijmecsci.2015.11.031

A modified Fourier-Ritz solution for vibration and damping analysis of sandwich plates with viscoelastic and functionally graded materials

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Abstract

Most of the existing methods for sandwich plates are only suitable for a particular type of boundaries which typically require modifications in solution procedures to adapt different boundary cases. The main aim of this paper is to provide a unified yet accurate solution for vibration and damping analysis of viscoelastic and functionally graded (FG) sandwich plates with arbitrary boundary conditions. The two-parameter power-law distributions in terms of volume fractions are used for FG layer and a lamination theory is applied in composite laminated layers. The formulation is derived by the modified Fourier series in conjunction with Rayleigh–Ritz method according to the first-order shear deformation theory. The modified Fourier series is expressed in the form of the linear superposition of a double Fourier series and auxiliary functions which are introduced to ensure and accelerate the convergence of the series representations. The current method can be universally applicable to all classical boundaries, elastic boundaries and their combinations. New results about natural frequencies and loss factors of common and new types of sandwich plates are calculated, which may serve as benchmark solutions in future. The effects of some key parameters such as the boundary conditions, geometric properties and power-law indices on free vibration and damping characteristics of the plates are illustrated and analyzed. Effect of fiber orientation angle of composite facings on modal shapes is also investigated.