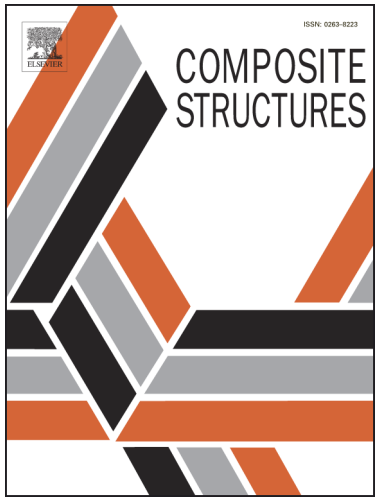

An exact Spectral Element Method for free vibration analysis of FG plate integrated with piezoelectric layers

Farhad Abad, Jafar Rouzegar

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An exact Spectral Element Method for free vibration analysis of FG plate integrated with piezoelectric layers

Farhad Abad, Jafar Rouzegar*

Department of Mechanical and Aerospace Engineering, Shiraz University of Technology, Shiraz, P.O. Box-71555-313, Iran.

* (Corresponding author) Tel. and Fax: +9871 37264102, Email: rouzegar@sutech.ac.ir

Abstract

In this paper, the Spectral Element Method (SEM) is employed for free vibration analysis of smart functionally graded (FG) plate. Two piezoelectric layers are attached to the upper and lower surfaces of moderately thick FG substrate. Considering first-order shear deformation theory assumptions, governing equations are derived using the Hamilton's principle and Maxwell's equation. Using discrete Fourier transform, differential equations of Levy type smart FG plates are transformed into frequency-domain and then a closed-form solution in the frequency-domain is proposed. The accuracy and performance of proposed approach is confirmed by solving several benchmark problems and comparing the obtained natural frequencies with existing results in the literature. Effects of different parameters such as piezoelectric thickness ratio, thickness-to-side ratio, power law index and type of boundary conditions on the results are investigated, too. Number of required element in the SEM to achieve acceptable results is much fewer than other numerical methods like the FEM and the consequent saving in computational cost is one of the most interesting features of the SEM.

Keywords: Free vibration; FG plate; Piezoelectric; Spectral Element Method.