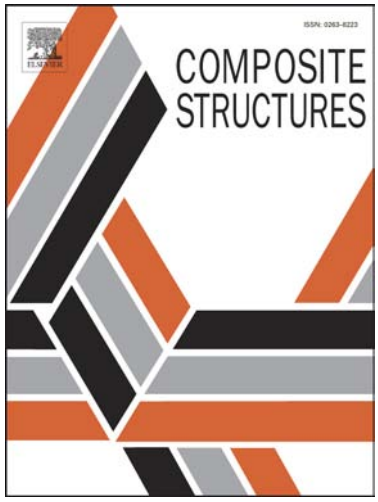

Free vibration analysis of rotating functionally graded rectangular plates

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Free vibration analysis of rotating functionally graded rectangular plates

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Abstract: A dynamic model of a functionally graded rectangular plate undergoing large overall motions is presented in this paper. The material properties of the FGM plate are assumed to vary continuously in its thickness direction according to a power-law distribution. The dynamic model with the dynamic stiffening effect included is used to study the free vibration characteristics of various kinds of rotating cantilever rectangular FGM plates. Simulations results from the present dynamic equations are verified to have higher accuracy than those from the previous method in literature, which induces different frequency variation phenomena for the same case. Phenomena of frequency loci veering rather than crossing can be observed in either rotating homogeneous plates or rotating FGM plates. Complicated frequency loci veering and associated mode shift phenomena occur in a rotating hub-FGM plate system, where a frequency locus may veer more than once due to different types of modal coupling between the bending and torsional vibrations of the FGM plate. The effects of dimensionless parameters such as the hub radius ratio, the aspect ratio, and the volume fraction exponent on the variations of the natural frequencies of rotating FGM plates are also investigated.

Keywords: Rotating FGM plates, free vibration, frequency loci veering, mode shapes

1. Introduction

Functionally graded materials (FGMs) are one kind of advanced materials usually made from a mixture of metal and ceramic constituents with continuous changes in the composition of them. The concept of FGMs was proposed in 1984 by materials scientists in the Sendai area as a means of preparing thermal barrier materials [1]. In recent years, FGMs are widely used in aerospace engineering and mechanical structures and have gained widespread attention of mechanics researchers due to their excellent thermo-mechanical advantages over traditional composites.

The dynamic modeling and analysis of rotating blades made of FGMs have been studied extensively over the last decade. Most studies involving blades made of FGMs are devoted to beams. Birman and Byrd [2] presented a review of the principal developments in FGMs with an emphasis on the recent work published since 2000. They reviewed the works on functionally graded material blades