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VIBRATION ANALYSIS OF FUNCTIONALLY GRADED MATERIAL SANDWICH STRUCTURES WITH PASSIVE DAMPING

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Summary: In this work a finite element model is developed for vibration analysis of pure Functionally Graded Material (FGM) structures, and for passive damped sandwich structures, with a soft viscoelastic core between the FGM layers. The FGM layers are modeled using the classical plate theory and the core is modeled using Reddy's third-order shear deformation theory. The finite element is obtained by using specific assumptions on the displacement continuity at the interfaces between layers. The dynamic analysis of these types of structures is conducted in the frequency domain to obtain the natural frequencies and, for the case of a viscoelastic core, the respective modal loss factors. It is also conducted in the time domain for steady state harmonic motion. For both analyses, the finite element code is implemented. The model is applied in the solution of some illustrative examples and the results are presented and discussed.

1 INTRODUCTION

The concept of Functionally Graded Material (FGM) was introduced by Koizumi [1] and Yamarouchi et al.[2] in an effort to develop super heat resistant materials and to avoid the shortcomings of the multilaminated composite materials with respect to stress concentration between layers that can lead to delamination failures.

Structures made of composite materials have been widely used to satisfy high performance demands. In such structures, stress discontinuities may occur at the interface between two different materials. In contrast, in FGM plate-shell structures the smooth and continuous variation of the properties from one surface to the other eliminates abrupt changes in the stress and displacement distributions.

Typical FGM plate-shell type structures are made of materials which are characterized by a continuous variation of the material properties over the thickness direction, by mixing two different materials, metal and ceramic. Metal–ceramic FGM plates and shells are used in aircraft, space vehicles, reactor vessels, and other engineering applications.

Research in FGM structures has been carried out intensively in the recent years, in static, buckling and vibration analyses. In what follows we cite a selection of papers that are more related to the present work. Some of the cited works will be used for benchmarking the results of the present model. Reddy and Chin [3] analyzed the

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