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Effect of porosity on fundamental frequencies of FGM sandwich plates

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Abstract. In this paper, the porosities effect on the dynamic analysis of the simply supported FGM sandwich plates is studied using a new refined shear deformation theory taking into account transverse shear deformation effects. This porosity may possibly occur inside the Functionally Graded Materials (FGMs) during their fabrication. Two common types of FGM sandwich plates are considered, namely, the sandwich with the FGM face sheet and the homogeneous core and the sandwich with the homogeneous face sheet and the FGM core. The results are presented for two constituent metal-ceramic functionally graded plates that have a power law through-the-thickness variation of the volume fractions of the constituents. The results obtained reveal that the dynamic response is significantly influenced by the volume fraction of the porosity, power law index, the thickness-side ratios and the thickness of the functionally graded layer.

Keywords: FGM sandwich plates; dynamic response; refined plate theory; porosity

1. Introduction

Functionally Graded Materials (FGMs) are microscopically inhomogeneous composites that are usually made from a mixture of metals and ceramics. FGMs are regarded as one of the most promising candidates for future advanced composites in many engineering sectors such as the aerospace, aircraft, automobile and defense industries, and most recently the electronics and biomedical sectors (Ichikawa 2000).

The term FGMs was originated in the mid-1980s by a group of scientists in Japan; where this new material concept was proposed to increase adhesion and minimize the thermal stresses. Since then, an effort to develop high-resistant materials using FGMs had been continued. FGMs have the properties that could vary in several suitable directions (Koizumi 1997, Benferhat *et al*. 2016b). The mechanical properties of these materials are often being represented in the form of a series (Shi and Chen 2004) and power-law index variations (Hassaine *et al*. 2016a, Abdelhak *et al*. 2016b, Adim and Hassaine 2016, Daouadji and Benferhat 2016, Abdedezak *et al*. 2016b, 2018, Adim *et al*. 2018, Benhenni *et al*. 2019a, b, Hadj *et al*. 2019, Hassaine Daouadji 2013, Belkacem 2016a). In these graded materials, there is a smooth and continuous variation of material properties across the thickness. This leads to no stress concentration and better fatigue life.

Sandwich structures are often found in aerospace application such as in skin of wings, vertical

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