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A quasi-3D refined theory for functionally graded single-layered and sandwich plates with porosities

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Abstract

The bending responses of porous functionally graded (FG) single-layered and sandwich thick rectangular plates are investigated according to a quasi-3D shear deformation theory. Both the effect of shear strain and normal deformation are included in the present theory and so it does not need any shear correction factor. The equilibrium equations according to the porous FG single-layered and sandwich plates are derived. The solution of the problem is derived by using Navier's technique. Numerical results have been reported, and compared with those available in the open literature for non-porous single-layered and sandwich plates. Effects of the exponent graded and porosity factors are investigated.

Keywords: Quasi-3D plate theory; functionally graded; porusity, sandwich plates.

1. Introduction

Functionally graded materials (FGMs), possessing spatially varying properties, have been improved for special components such as rocket engine, aerospace structures, turbine blades, etc. As it is well known, the earliest FGMs are introduced by Japanese scientists in the last four decades as ultra-high temperature-resistant materials for aerospace implementations. In recent years, these materials have found other applications in electrical appliances, energy transformation, biomedical engineering, optics, etc. [1]. However, in the manufacture of FGM, porosities may occur in the materials during the sintering process. This is due to the large difference in coagulation temperature between the components of the material [2]. Wattanasakulpong et al. [3] discussed the porosities that occur in lateral FGM samples made with a multistage sequential filtration technique. So, it is important to take under consideration the porosity effect when designing FG components under the effect of dynamic loadings.

On the basis of open literature, it seems that many investigators have paid their attentions on discussing analyses of FGM structures with porosities. Most of these investigations are concerned with vibration behavior of FG porous structures [4-28]. Additional researchers are restricted their attention to the buckling [29-38] or vibration and buckling [39-42] of many porous structures. The wave propagation in FG porous nanostructures have been discussed in many investigations [43-45]. Bîrsan [46] used a porous plate theory to propose field equations for bending thermoelastic plates. Behravan Rad [47] presented the static response of porous multi directional heterogeneous structures resting on developed gradient elastic foundations.

Many new exponential and power law relationships have been proposed, largely in analogy with effective porosity relationships. For theoretical background and a more detailed discussion of the

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