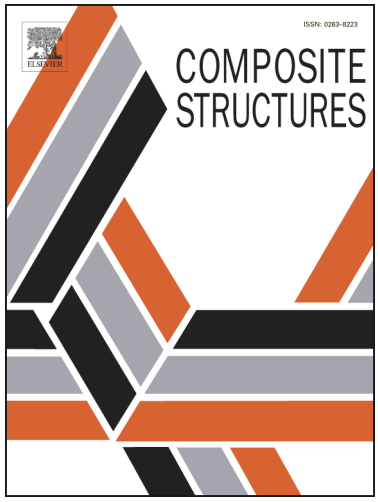

Free vibration analysis of thin functionally graded rectangular plates using the dynamic stiffness method

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Free vibration analysis of thin functionally graded rectangular plates using the dynamic stiffness method

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Abstract

In this paper, free vibration behavior of thin functionally graded rectangular plates is investigated by using the dynamic stiffness method (DSM). Classical plate theory along with the concept of physical neutral surface of the functionally graded plate is used to formulate the dynamic stiffness matrix. The dynamic stiffness matrix is finally solved by using the Wittrick-Williams algorithm to compute the natural frequencies. DSM frequencies are compared with those available in the literature. Some inaccurate published results are pointed out and possible reasons for these inaccuracies are discussed. Results for several plate parameters are given and the influence of these parameters on natural frequencies of the functionally graded plate is highlighted. The present study shows that the dynamic stiffness method provides very accurate results for vibration analysis of thin functionally graded plates and these results can be used as benchmark solutions for comparison purposes.

Keywords: free vibration, dynamic stiffness method, rectangular plate, functionally graded material, classical plate theory, physical neutral surface

1. Introduction

The idea of functionally graded material (FGM) was first conceived by Japanese scientists in 1984 during the development of thermal barrier materials for aerospace applications [1]. Functionally graded materials are heterogeneous composites in which the material properties vary smoothly in one or more than one desired directions [2, 3]. The variation of properties in the thickness direction is the most preferred design in plate like structures. Quite often, functionally graded plates are made from a mixture of metals and ceramics such that the ceramic constituent provides high thermal resistance whereas metal constituent provides high fracture resistance and strength [4, 5]. Due to both high stiffness and strength to weight ratios, FGM plates are advantageously used as light-weight structural components bearing

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