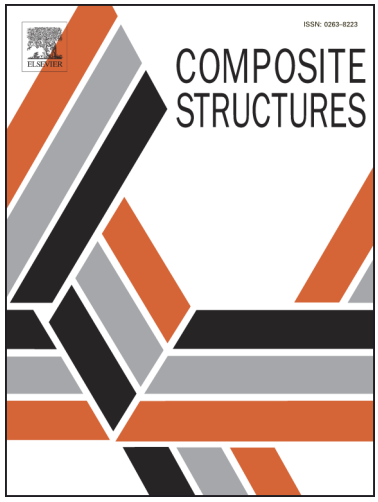

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A simple four-unknown shear and normal deformations theory for functionally graded isotropic and sandwich plates based on isogeometric analysis

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Abstract

This paper presents a new simple four-unknown shear and normal deformations theory (sSNDT) for static, dynamic and buckling analyses of functionally graded material (FGM) isotropic and sandwich plates. The fully three-dimensional material matrix is used in the relation between stress and strain. The present theory uses only four independent unknowns although it is additionally accounted for a deformation in the axial direction. In comparison with the first and higher order shear deformation theories, the number of independent unknowns of the present theory retains four degrees of freedom per node. The shear stress free surface conditions are naturally satisfied so that the shear correction factors are no longer required. The discrete system of equations is derived from the Galerkin weak form and numerically solved by isogeometric analysis (IGA). This discrete form requires the C^1-continuity of the displacement field. Therefore, NURBS basis functions in IGA can easily satisfy this condition. Several examples are given to demonstrate the efficiency of the present method.

Keywords: Simple four-unknown shear and normal deformations theory (sSNDT), Functionally graded material (FGM), Isogeometric analysis (IGA).

1. Introduction

Thanks to outstanding properties such as high stiffness and strength-to-weight ratios, long fatigue life, wear resistance, lightweight, composite materials have been extensively applied in many industries, especially in aerospace, automotive, civil, etc. However, the classical composite materials are incapable to use under the high-temperature environments. To overcome these disadvantages, advanced composite materials or functionally graded materials (FGMs) have been devised. FGMs are made, for example, from a mixture of ceramic and metal with continuous variation from the rich-ceramic to rich-metal surfaces. Due to continuous variation of material properties from one surface to another, it, therefore, overcomes the phenomenon of the strength reduction of the metal in high-temperature environments and low toughness of the ceramic material.

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