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RESEARCH PAPER

Investigating the Influence of Material Composition on Bending Analysis of Functionally Graded Beams Using a 2D Refined Theory

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Abstract

This study attempts to shed light on the analysis of the static behavior of simply supported FG type property gradient material beams according to an original refined 2D shear deformation theory. Young's modulus is considered to vary gradually and continuously according to a power-law distribution in terms of volume fractions of the constituent materials. The equilibrium equations are obtained by applying the principle of virtual work. The governing equilibrium equations obtained are thus solved by using the analytical model developed here and Navier's solution technique for the case of a simply supported sandwich beam. Moreover, Using the numerical results of the non-dimensional stresses and displacements are calculated and compared with those obtained by other theories. Two studies are presented, comparative and parametric, the objective of which is the first to show the accuracy and efficiency of the theory used and the second to analyze the mechanical behavior of the different types of beams under the effect of different parameters. Namely boundary conditions, the material index , the thickness ratio and the type of beam.

Keywords: Mechanical behavior; beams; Property Gradient Materials; Principle of virtual work; Navier's solution.

1. Introduction

Functionally graded materials (FGMs) are a class of advanced composite materials that have continuous gradation in composition and structure over volume, resulting in corresponding changes in the properties of the material [1, 2]. The concept offers the potential to optimize material response or functionality by tailoring the microstructure. FGMs eliminate the stress concentrations and singularities that often occur in laminated composites by providing smooth transitions in material properties [3].

Beams are a common structural element analysed in FGM research. A wide variety of analytical and numerical

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