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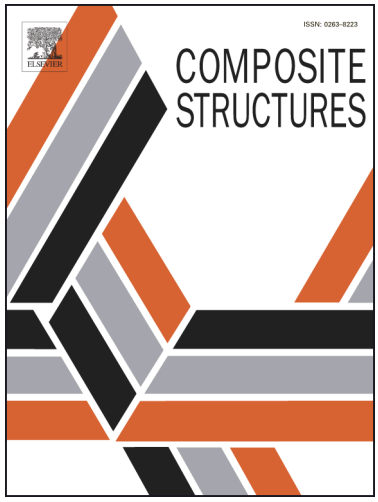

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A size-dependent zigzag model for composite laminated micro beams based on a modified couple stress theory

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Abstract: This study developed a new composite laminated size-dependent beam model based on a re-modified couple stress theory and a refined zigzag theory. Unlike the classical theory, the proposed model only includes one internal material length scale parameter and can capture the scale effects. In addition, the current model satisfies a priori interlaminar continuity conditions and can accurately predict the displacements and stresses, particularly the interlaminar stresses. Reissner's Mixed Variational Theorem is employed to derive the equilibrium equations and related boundary conditions. Numerical examples of simply supported cross-ply beams subjected to transverse sinusoidal loads are analytically solved by directly applying the derived formulas. The results prove that this model can be applied to investigate the scale effects, which increase the stiffness and decrease the displacements and stresses. Moreover, the results obtained with present model are compared with the exact solutions to validate the present formulation.

Key words: modified couple stress theory; scale effects; composite laminated beam; interlaminar transverse shear stresses; zigzag functions

1. Introduction

The extensive use of composite laminates in the civil, mechanical, and aeronautical engineering industries, among others, has stimulated interest in the accurate prediction of the structural behavior of these laminates. These composite laminates are typically used to obtain a low ratio of the transverse shear modulus to the high in-plane tensile modulus in the engineering applications. Hence, the transverse shear deformation plays an important role in predicting the structural behaviors. Moreover, the interlaminar transverse shear stresses (ITSSs) caused by these transverse shear deformations may make the laminates delaminate, which is the main damage form of the composites. Therefore, related theories and models to analyze such structures should be developed to investigate their delaminated behaviors [1-8].

Various theories have been developed for laminated composites. These theories can be classified into Equivalent Single Layer (ESL) theories [9-12] and Discrete Layer (DL) theories

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