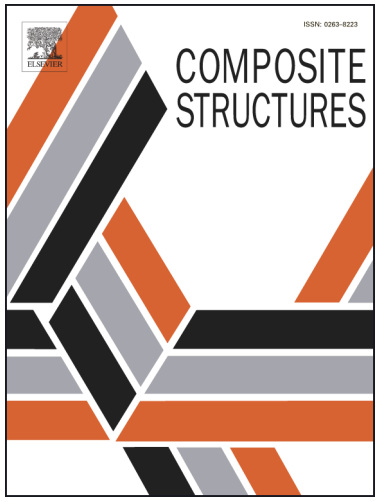

General analytical sensitivity analysis of composite laminated plates and shells for classical and first-order shear deformation theories

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General analytical sensitivity analysis of composite laminated plates and shells for classical and first-order shear deformation theories

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Abstract

The paper describes a general analytical sensitivity analysis method for the composite laminated plates and shells, which is applied to both classical and first-order shear deformation theories and based on the finite element methods. The first derivatives of engineering constants of lamina with respect to fibre volume fractions are computed based on the micromechanics theory. The first derivatives of extensional, bending and bending-extensional coupling stiffnesses of laminate with respect to fibre volume fractions and fibre orientations are derived using classical and first order theories of laminate. Computational methods for the first derivatives of total stiffness and mass matrices are proposed based on finite element method. The analytical sensitivity analysis methods for static responses, eigenvalues and eigenvectors are described using the total stiffness and mass matrices, and their first derivatives. Sensitivity analyses of composite laminated plate and shell are demonstrated. The merits and disadvantages are also discussed.

Keywords: Composite structures; laminate; plates; shells; Finite element; Analytical sensitivity

1. Introduction

The fibre-reinforced composite materials are widely used in the military and civil aircraft, spacecraft, automobile, naval and defence industries because they have high performance characteristics, for example, high strength-to-weight ratio, high stiffness-to-weight ratio, superior fatigue properties and high corrosion resistance [1-3]. The composite laminated plates and shells are generally employed in engineering design. In order to improve the performance of the composite

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