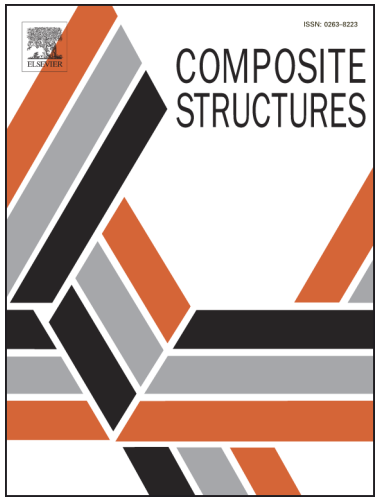

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Free vibration analysis of laminated cylindrical panels using discrete singular convolution

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Abstract

Based on three-dimensional theory of elasticity, semi-analytical solutions for free vibration of cross-ply laminated cylindrical panels are derived applying the state space approach (SSA) and discrete singular convolution (DSC) algorithm. One pair of opposite edges are assumed to be with simply supported and the other pair of edges arbitrary boundary conditions. The thickness direction of panels is chosen as the transfer direction in SSA, and the DSC is employed to discretize the axial direction of panel. Hence, the original partial differential equations are transformed into a state equation consisting of first-order ordinary differential equations. The application of DSC can deal with various boundary conditions, which cannot be solved in the conventional SSA. Accuracy and convergence for laminated cross-ply panels are validated through numerical examples.

Keyword: state space method, discrete singular convolution, laminated cylindrical panels, free vibration

1. Introduction

Due to the properties of high strength-to-weight and stiffness-to-weight ratios, advanced composite materials have been applied increasingly in modern industries. Cylindrical panels composed of laminated composite materials are widely applied in the aerospace field. Therefore, mathematical and mechanical models for predicting static and dynamic behavior of composite laminates have received much attention during the past decades.

Laminated composite shells and panels have been studied by many elasticity solutions. Srinivas [1] presented a Frobenius' series solution for free vibrations of a laminated orthotropic cylindrical shell. Ren [2] studied the cross-ply cylindrical panel with simply supported and infinitely length, undergoing plane-strain deformation due to transverse loading. Solution of finite-length cylindrical shells under two-dimensional surface loading has been obtained by Ren [3]. Three-dimensional solution of the free vibration problem of homogeneous isotropic cylindrical panels was obtained by Soldatos and Hadjigeorgiou [4]. Hawkes et al. [5] used the successive approximation method to analyze three dimensional axisymmetric vibration of orthotropic and cross-ply laminated cylinders with simply supported boundary conditions. Varadan and Bhaskar [6] obtained elasticity solution for a simply supported, infinitely long and transversely loaded cylindrical panel with off-axis layers. Ritz method was applied to study the free vibrations of laminated anisotropic cylindrical shells by Heyliger and