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A piecewise shear deformation theory for free vibration of composite and sandwich panels

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Abstract

The new piecewise low and high order shear deformation models, which contain the in-plane rigidity and the transverse shear rigidity of the core and skins, are proposed in this paper. The partial differential governing equations are obtained by applying Hamilton's principle, aiming to attain the natural frequencies for the sandwich panel constituted of orthotropic materials. The frequency equation is explicitly expressed for simply supported rectangular sandwich panel. The effects of the thickness and elastic modulus of the core on the fundamental frequency are also discussed in this paper. The results obtained from the proposed models are compared with those obtained from the classical analytical models, FEM, low and high order shear deformation theory, which verifies the theories have theoretical accuracy and broad application.

Keywords: Sandwich panel, flexural vibration, piecewise low and high order shear deformation, free vibrations

1. Introduction

Sandwich panels are constituted of two high strength skins and one soft-light core which ensures that the two skins work together. The skins are normally made of stiff metal or composite laminate which can be utilized to resist the external load. And the core is composed of low-strength light materials such as foams which make the structure light enough. Sandwich structures have been extensively used in aerospace, marine, automotive and other industries because of its specific strength and stiffness, fatigue resistance and other advantages.

There have been a lot of intensive researches on modeling of the sandwich panels for calculating the natural frequencies during the past decades. Classical laminated plate theory is first applied to solve the sandwich panels. Since Mindlin [1] proposes a transverse shear model for an isotropic thick plate, transverse shear

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