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On Accurate Stress Determination in Laminated Finite Length Cylinders Subjected to Thermo Elastic Load

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Abstract

In this paper, we analyze the boundary value problems (BVPs) of a finite length laminated cylinders under thermoelastic loads using a semi analytical cum numerical approach. Exact elasticity equations are used in the analysis without any assumptions to determine the accurate stresses. Examples covered are diaphragm supported isotropic, orthotropic and laminated composite cylinder under symmetric thermal load which is considered as a two dimensional (2D) plane strain problem of thermoelasticity in (r, z) direction. The boundary conditions are satisfied exactly by taking an analytical expression in axial (z) direction in terms of Fourier series expansion. Fundamental (basic) dependent variables are chosen in the radial coordinate of the cylinder. First order simultaneous ordinary differential equations are obtained as mathematical model which are integrated through an effective numerical integration technique by first transforming the BVP into a set of initial value problems (IVPs). The numerical results obtained are also first validated for their accuracy with 1D solution of an infinitely long cylinder.

Keywords: A. Laminate; B. Thermal properties; C. Computational mechanics; C. Deformation; C. Structural composites.

Introduction

Thermal stresses are of great practical importance, especially in large composite cylinders such as steam-turbine rotors, heavy shafts and large turbine discs. In all these cases, heating or cooling must be gradual in order to reduce the temperature gradient in the radial direction. Moreover, determination of the stresses and