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Dynamic equations for solid isotropic radially functionally graded circular cylinders

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Abstract

A hierarchy of dynamic equations for solid isotropic functionally graded circular cylinders is derived based on the three dimensional elastodynamic theory. The material parameters are assumed to vary in the radial direction. Using Fourier expansions in the circumferential direction and power series expansions in the radial direction, equations of motion are obtained for longitudinal, torsional, flexural and higher order motion to arbitrary Fourier and power orders. Numerical examples for eigenfrequencies and plots on mode shapes and stress distributions curves are presented for simply supported cylinders for different material distributions. The results illustrate that the present approach renders benchmark solutions provided higher order truncations are used, and act as engineering cylinder equations using low order truncation.

Keywords: Series expansion, Cylinder, Beam equation, Functionally graded, Eigenfrequency

1. Introduction

Functionally graded (FG) materials are non-homogeneous composites in which the properties change gradually in one or several directions. This continuous variation may be used as an alternative to laminated structures, and may thus eliminate the risk for delamination failures. The FG composites are usually made of a mixture of metal and ceramic phases, where the strength of the metal and the heat resistance of the ceramic make these materials popular in many different fields of engineering [1, 2].

The majority of work on FG structures considers basically two dimensional structures such as plates and shells, where the material parameters in most cases vary over the thickness. Of particular interest for the present work is the special case on FG cylindrical shells,

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