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Free vibrations of a rotating shell made of *p* joined cones

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Abstract

In this paper, a method has been presented to study the free vibration of a rotating shell consisting of *p* coupled conical shells. This method considers the Coriolis and centrifugal forces as well as the initial hoop tension resulting from rotation of the shell. Matrix transform and power series methods were employed to solve the equations. The advantage of using the matrix transform approach is that the dimension of the coefficient matrix, which is finally constructed to obtain the natural frequencies of a shell made of *p* cones, remains 8×8. The obtained results were validated with the help of existing special cases of the studied problem reported in the literature, and by means of FEM software programs. By verifying the presented equations and their solution method, the fundamental natural frequencies of a rotating shell made of two conical shells were obtained for different conditions.

Every thin-walled axisymmetric shell can be represented by a number of joined conical shells. So, as a practical example, the presented method was employed to analyze the vibrations of an automobile tire ring as a rotating thin-walled shell with a relatively complex geometry.

Keywords: rotating joined conical shell; free vibration; forward and backward waves; matrix transform.

1. Introduction

Structural shells are extensively used in different fields of engineering including aerospace, marine, and structural engineering. Since these structures are usually fabricated with a long length and small thickness, their vibration characteristics are highly important. For this reason, and in order to achieve a safe and secure design, the dynamic characteristics of these structures should be determined first.

The free vibration analysis of non-rotating conjoined shells has been mostly performed on cylindrical-conical shells. El Damatty et al. [1] conducted numerical and experimental studies on