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An improvement to motion equations of rotating truncated conical shells

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Abstract

In this paper, an improved formulation has been presented to study the vibrations of a truncated conical shell under rotating condition. This formulation considers the Coriolis and centrifugal forces and the initial hoop tension resulting from rotation. The conical shell discussed in this paper is the shell of revolution modeled by the Novoshilov theory. The equations which have been derived in the present paper differ from and are more complete than the equations in the existing papers published on the vibrations of conical shells under rotating condition. For validation, first, the solution method used in this paper was evaluated and then the conditions that highlight the difference between the equations obtained in the present paper and the former equations were considered. In this way, it was demonstrated that when the cone angle and rotation speed have large values, the backward frequencies obtained from the two equations differ from each other, and this difference becomes more pronounced as the circumferential wave number increases. After validating the presented equations and the solution method, the effects of different important parameters such as the rotation speed, cone angle and the circumferential wave number on the forward and backward waves' frequencies have been evaluated. The results reveal that with increase in the rotation speed of the cone, the discrepancy between the frequencies of the forward and backward waves gets larger. Also, the difference between the forward and backward waves' frequencies diminishes with the increase of the cone angle.

Keywords: rotating conical shell; free vibration; forward wave; backward wave.

1. Introduction

Due to having a high strength-to-weight ratio, cylindrical and conical rotating shells are extensively used in various industries. Drive shafts of gas turbines, rotating satellite structures and rotor systems are some typical applications of these types of shells.