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Free Vibration of Conical Shells with Intermediate Ring Support

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Abstract

Free vibration behaviour of a shear deformable conical shell with intermediate ring support is analysed in this research. It is assumed that the conical shell is made from a linearly elastic isotropic homogeneous material. To capture the through-the-thickness shear deformations and rotary inertia effects, first order shear deformation theory of shells accompanied with the Donnell type of kinematic assumptions are adopted to establish the general equations of motion and the associated boundary conditions with the aid of Hamilton's principle. The resulting system of equations are discreted using the semi-analytical generalised differential quadrature (GDQ) method. The shell is divided into two sections, where the continuity conditions are satisfied at the ring position. Considering various types of boundary conditions for the shell ends and continuity conditions at the ring position, an eigenvalue problem is established to examine the natural frequencies of the shell reinforced with an intermediate ring support. After proving the efficiency and validity of the present method for the case of thin isotropic homogeneous cylindrical shell with intermediate ring support, parametric studies are carried out for the case of shear deformable conical shells with intermediate ring support.

Keywords: Conical shell; Intermediate ring supports; Free vibration; Generalized differential quadrature; Intersection Continuity conditions.

1 Introduction

A conical shell with intermediate ring supports has increasing application in refinery, civil, and power plant engineering. Long conical shells are frequently supported at various intermediate locations to increase their stiffness. Without these intermediate supports, these structures may undergo large deformation due to their low stiffness, and will eventually lead to failure.

Free vibration characteristics of cylindrical or conical shells under different conditions has been the subject of many studies for a long period of time. In an early work, Breslavskii [1] theoretically and experimentally studied the natural frequencies of freely supported complete conical shells. Grigolyuk [2] studied the free vibration of freely supported truncated and complete conical shells, by using the energy method. Free vibrations of truncated conical shell are also discussed in a number of papers, see e.g. [3, 4, 5]. However, in comparison with such works less attempt is devoted to shells with intermediate supports or stiffened shells.

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