Chapter 6
Free Vibration Corrugated Open Cylindrical Shells

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Abstract The problem of the free vibrations of the thin circular corrugated open cylindrical shells are presented. The finite element method was used. The frequencies and forms of free vibrations of the in circular corrugated open cylindrical under conditions of different longitudinal bisecting and different boundary conditions shells are calculated. The dependence of the frequency of free vibrations on the variant of longitudinal bisecting is analyzed.

Key words: Free vibrations, Corrugated circular cylindrical shell, Different boundary conditions, Rigid fixes, FEM

6.1 Introduction

The problem of the free vibrations of corrugated open cylindrical shells is very important for further basic research and for various practical problems. Solving such problems is associated with great computational difficulties. Therefore, the current problem of the mechanics and the applied mathematics of the free vibrations of corrugated open cylindrical is proposed to be solved based on FEM.

Cylindrical shells, due to their high strength and stability with relatively low weight, are widely used in various industries. Increasing the strength characteristics while maintaining mass can be achieved by changing the wall thickness of the shell or changing the shape of the cross section, for example, using corrugation. The

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design of the frames of various machines and mechanisms, and the shell elements of buildings, structures, and other constructions is dependent on a number of prior calculations. One of the important calculations is to determine the frequencies and forms of free vibrations, since when the frequency of the external force coincides with the frequency of free vibrations, resonance occurs, which can be destructive. In modern science, these problems of dynamics are commonly solved using a variety of computer-aided design software systems, which are based on various numerical methods such as the finite element method (FEM). One such software system is FEMAP with the NX Nastran solver. There arises an urgent problem of mechanics and applied mathematics about the extension of FEM to the study of frequencies and forms of free vibrations of corrugated open cylindrical shells.

Determination of the frequencies and forms of free vibrations of shells of a simple geometric shape is possible within the framework of the theory of thin shells (Arnold and Warburton, 1953; Baron and Bleich, 1954; Greenspon, 1959; Grigorenko et al, 2018b; Grigorenko and Rozhok, 2004; Grigorenko and Efimova, 2008). In the case of shells of a complex shape, which have non-circular cross-sections of constant (Budak et al, 2016) or variable (Budak et al, 2017) thickness, or open contours (Grigorenko et al, 2020a,b), or thick walls (Grigorenko et al, 2018a), it is advisable to use the FEM. In addition to numerical methods, there is the use of experimental methods for determining the frequencies and forms of free vibrations of shells of complex shapes, for example, the method of holographic interferometry (Grigorenko et al, 2013; Budak et al, 2014).

Let us consider some of the literature. In Puzyrev (2013), a study was carried out using the spline collocation method in combination with the method of discrete orthogonalization of resonance frequencies of noncircular cylindrical shells with an elliptical corrugated cross section. (Mousa Khalifa, 2015)) investigates the influence of the parameters of corrugation and material homogeneity on the vibration frequencies of isotropic and orthotropic oval cylindrical shells with a sinus-like contour. In Kim (2016), the free vibrations of longitudinally corrugated cylindrical shells are theoretically investigated, and the frequencies are calculated using the finite element method implemented in the ANSYS program. Nguyen et al (2021) present a semi-analytical approach to the study of vibration of corrugated functionally graded sandwich cylindrical shells. In Semenyuk et al (2005) investigates the influence of the length and amplitude of the corrugations on the fundamental frequency of corrugated non-circular cylindrical shells both while unloaded and while compressed along the axis. Xu et al (2008, 2010) investigate the dynamic characteristics of coupled longitudinal and bending vibrations of corrugated cylindrical piezoelectric shells. Yang et al (2015) study the vibration characteristics of corrugated composite cylindrical sandwich shells with free boundary conditions. Yuan and Liu (2007) investigate, on the basis of the equations covering the dynamics of large deflections of axisymmetric shallow shells in revolution, nonlinear forced vibrations of a corrugated shallow shell under a uniform load.

The purpose of this work is to determine by the finite element method (FEM) the frequencies and forms of free vibrations of thin circular open corrugated cylindrical