ISSN 1066-369X, Russian Mathematics, 2020, Vol. 64, No. 5, pp. 56–65. © Allerton Press, Inc., 2020.
Russian Text © The Author(s), 2020, published in Izvestiya Vysshikh Uchebnykh Zavedenii. Matematika, 2020, No. 5, pp. 62–73.

Refined Orthotropic Plate Motion Equations for Acoustoelasticity Problem Statement

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Received May 7, 2019; revised May 7, 2019; accepted June 19, 2019

Abstract—The formulation of the acoustoelasticity problem is given on the basis of refined motion equations of orthotropic plates. These equations are constructed in the first approximation by reducing the three-dimensional equations of the theory of elasticity to the two-dimensional equations of the theory of plates, where the approximation of the transverse tangential stresses and the transverse reduction stress is made with the help of trigonometric basis functions in the thickness direction. Wherein at the points of the boundary (front) surfaces, the static boundary conditions of the problem for tangential stresses are satisfied exactly and for transverse normal stress — approximately. Accounting for internal energy dissipation in the plate material is based on the Thompson–Kelvin–Voigt hysteresis model. In case of formulating problems on dynamic processes of plate deformation in vacuum, the equations are divided into two separate systems of equations. The first of these systems describes non-classical shear-free, longitudinal-transverse forms of movement, accompanied by a distortion of the flat form of cross sections, and the second system describes transverse bending-shear forms of movement. The latter are practically equivalent in quality and content to the analogous equations of the well-known variants of refined theories, but, unlike them, with a decrease in the relative thickness parameter, they lead to solutions according to the classical theory of plates. The motion of the surrounding the plate acoustic media is described by the generalized Helmholtz wave equations, constructed with account of energy dissipation by introducing into consideration the complex sound velocity according to Skudrzyk.

DOI: 10.3103/S1066369X20050060

Key words: *orthotropic plate, refined theory, trigonometric function, energy dissipation, Thompson–Kelvin–Voigt model, longitudinal-transverse form, transverse bending-shear form, acoustoelasticity problem, generalized wave equation.*

INTRODUCTION

It is known that the frequency of incident or emitted acoustic wave is considered to be low if it does not exceed 150–200 Hz, high — above 3–5 kHz, and the frequencies between the mentioned ranges are considered middle. At low frequencies, it is quite acceptable to describe the process of dynamic deformation of thin-walled elements in structures, made of traditional constructional or composite materials, by the motion equations based on the Kirchhoff–Love hypotheses for the whole package of layers altogether. The studies, conducted in the framework of the project no. 14-19-00667 of Russian Science Foundation (2014–2018, see, for instance, [1]–[3]), showed that already

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