ISSN 0021-8944, Journal of Applied Mechanics and Technical Physics, 2018, Vol. 59, No. 4, pp. 733–746. © Pleiades Publishing, Ltd., 2018.
Original Russian Text © V.N. Paimushin, R.K. Gazizullin.

ACOUSTIC WAVE PROPAGATION THROUGH A PLATE FIXED ON A RIGID FRAME VIA ELASTIC SPACERS AND LOCATED BETWEEN TWO BARRIERS

V. N. Paimushin[a,b] **and R. K. Gazizullin**[a]

UDC (539.3+629.7.01) : 534.1

Abstract: The propagation of a stationary acoustic wave through an infinite thin plate stiffened on two sides by a system of absolutely rigid, crossed ribs and located between two absolutely rigid barriers. It is assumed that the plate and the ribs evenly distributed along rectangular Cartesian axes are connected through elastic spacers (supports) without slip. The dynamic deformation of the plate is described by the linearized Kirchhoff–Love equations of the classical theory of plates, the dynamic deformation of the spacers is described by two-dimensional and one-dimensional relations based on linear approximations of displacements of points of the coating and spacers along the thickness and taking into account only transverse compression and transverse shear, and the motion of acoustic media by the well-known wave equations. The solution of the problem is obtained using the Ritz method. The constructed solution was used to investigate how the physico-mechanical and geometric parameters of the mechanical system and the frequency of acoustic waves incident on the plate influence the sound-insulating parameters and the stress–strain state of the plate.

Keywords: thin plate, rigid frame, spacer, periodicity cell, barrier, energy-absorbing coating, Kirchhoff–Love model, transversely soft material, acoustic medium, vibration frequency, exact analytical solution.

DOI: 10.1134/S0021894418040211

INTRODUCTION

The tightness of structures for various applications is provided (if necessary) using special types of joints of elements (glue layers, buffer layers of polymer materials such as Mylar, rubber, sealant, etc.). Among such structures, products of structural optics (portholes, fairings, canopy covers in aircraft, etc.) form a special group due to their functional purpose and the physico-mechanical properties of materials from which they are made. Articles of structural optics are manufactured used Plexiglas, quartz and silicate glasses, which can be destroyed under the action of contact stresses (see [1–3] and others). This motivates the development of special units for their connection to other elements of structures.

When solving problems of mechanics for the class of structural elements considered, it is of great importance to formulate boundary conditions that adequately take into account the way they are fixed. Studies have shown that the results obtained in modeling fixing conditions by setting the traditional boundary conditions of the theory of plates and shells (rigid clamping, hinged support, etc.) differ substantially from experimental data. Therefore, systematic studies have been performed to investigate problems of interaction of plates and shells with thin layers

[a]Tupolev Kazan National Research Technical University, Kazan, 420111 Russia; vpajmushin@mail.ru; gazizullin.rk@yandex.ru. [b]Kazan Federal University, Kazan, 420008 Russia. Translated from Prikladnaya Mekhanika i Tekhnicheskaya Fizika, Vol. 59, No. 4, pp. 179–194, July–August, 2018. Original article submitted September 12, 2017; revision submitted November 22, 2017.