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Transmission of Sound Waves Through a Rectangular Plate Supported by a System of Cross Ribs

R. K. Gazizullin[1*] and V. N. Paimushin[1,2]**

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[1] *Kazan National Research Technical University, Institute of Aviation, Land Vehicles and Energetics, Kazan, 420111 Russia*

[2] *Kazan (Volga Region) Federal University, Institute of Computational Mathematics and Information Technologies, Kazan, 420008 Russia*

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Abstract—The stationary monoharmonic sound wave transmission through a thin plate of infinite extent, supported by a system of cross ribs on both sides is studied. It is assumed that the cross ribs are arranged with uniform steps along axes of Cartesian coordinate system related to the median plane of the plate and at the points of intersection centerlines plate rests on the ribs of finite length. Transverse loads acting on the plate cause only tension-compression deformation state on the ribs at zero displacement of their end sections. On cell of periodicity cut from the plate, concerned acousto-elasticity problem is formulated, which describes the interaction of the plate with acoustic environments located on both sides in the corresponding half-spaces. Dynamic deformation of the plate is described by the linearized equations of the classical theory of plates based on Kirchhoff–Love hypothesis, which take into account the internal friction of plate's and reinforcing ribs material by Thomson–Kelvin–Voigt hysteresis model, and the motion of acoustic environments—by well-known wave equations. On the basis of the Ritz method using trigonometric basis functions at the exact satisfaction of the periodicity conditions of solutions on the boundary points of the periodicity cell and in its corner points—the conditions of compatibility of strains of the plate and support ribs, exact analytical solution of the problem is constructed. It is shown that the plate of this class at frequencies that do not coincide with the resonance is characterized by less than the value of sound insulation parameter than simply supported at all edges rectangular plate, and introducing reinforcing ribs into the mechanical system and increasing their rigidity leads to a significant change in the resonance frequencies and the dependencies of the parameters of stress-strain state and sound insulation of plates on the incident sound wave frequency.

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INTRODUCTION

The amount of allowable vibration of any construction of any purpose is determined by its effect on the strength characteristics of the structure and its elements, on efficiency, well-being and health of people in one way or another connected with them, on work of equipment installed on it, etc. Among other things, it can be limited by the amount of allowable noise, emerging in acoustic environment of the construction as a result of its dynamic interaction with a deformable structure.

*E-mail: gazizullin.rk@yandex.ru

**E-mail: vpajmushin@mail.ru