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# NATURAL FREQUENCIES AND OSCILLATIONS FORM SPECTRUM DEPENDING ON GEOMETRY AND INHOMOGENEITY OF PLATES

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***Abstract.*** *The influence of the variable concentrated mass, which's moves along the radius of the circular plate, on the spectrum of its own frequencies and the shape of oscillations, is considered in the paper. The effect of the holes of various radii and their position relative to the center of the plate on its frequency and oscillation forms is also investigated. Calculations were made by the finite element method for the plate of aluminum alloy D16T.*

***Key words:*** *finite element method, spectrum of eigenfrequencies, oscillation forms.*

## Introduction.

The design of modern structures is closely related to the previous ones calculations to assess the strength, stiffness and stability of plates that are under action of static and dynamic loads. Plates with design features, such as cutouts, concentrated masses, perforations, are widely used in instrument making, mechanical engineering and construction [1]. The calculation of inhomogeneity plates with using the simple analytical solutions is too complicated. In this regard, the solution of such problems is carried out by using numerical methods. One of the most promising methods for studying the problems of stability and natural oscillations of plates with inhomogeneities is the finite element method [2].

## Statement and solution of the problem

This work is devoted to the study of the influence of inhomogeneity, namely concentrated mass, and nonlinearity of geometry on the spectrum of natural frequencies and oscillations of a circular plate.

We studied a round plate with a radius $R$ = 1.2 m, 0.015 m thick, made of aluminum alloy D16T with the corresponding properties:

Young's modulus $E$ = 71000 MPa, Poisson's ratio $\nu$ = 0.34, density $\rho$ = 2700 kg / m$^3$. The plate rests freely on its own contour.

The following questions were studied:

1. The influence of holes on the frequency and the natural oscillations shapes of a round plate.

A hole with radius $r$ = 0,01..0,5$R$ at a distance $x$ = 0,1… 0,8$R$ from the center of the plate was considered (Fig. 1).

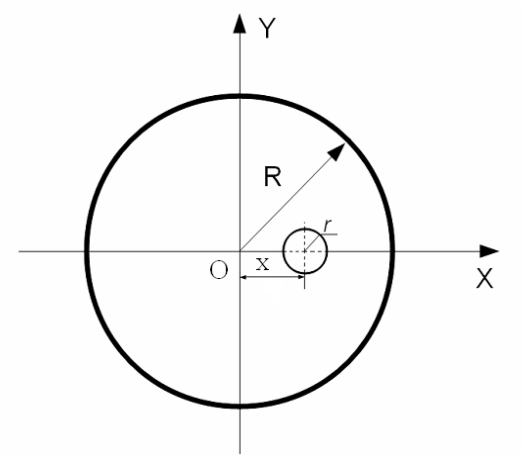


Fig.1. Calculation scheme for determining natural frequencies and oscillations forms of plates with a hole

2. Influence of concentrated mass on the frequency and natural oscillations shapes of a round plate. The location of the concentrated mass varies along the radius at a distance from 0 R (center of the plate) to 0.8R from the center of the plate. The weight varies from 10% to 50% of the weight of the plate.

The calculation scheme is shown in Fig.2.

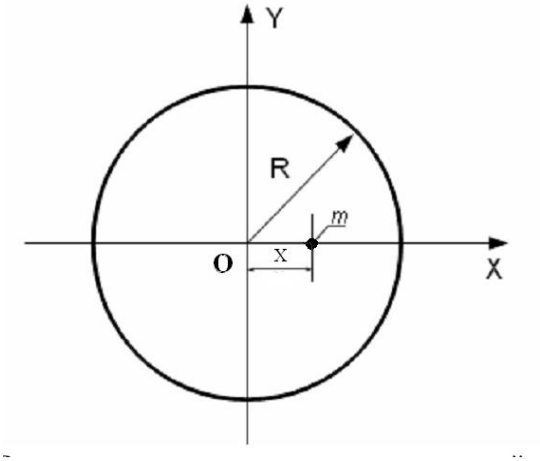


Fig.2. Calculated scheme with concentrated mass

**Summary and conclusions**.

It is shown that holes of small radius (r = 0.01R - 0.15R) have little effect on the natural frequency of a solid round plate and do not have any significant effect on their shape. Differences are observed for plates with a hole of large radius ($r \geq 0{,}25R$), when it is shifted to the edge of the plate. But even the forms of oscillations in general repeat the form of oscillations of the plate without a hole. Holes of radius more than 35% from the radius of the plate are lead to a significant changes in the shapes of the oscillations and increase, starting with the third, the values of the frequencies of natural oscillations. These numerical solutions are confirm the received Chizhevsky analytical results [3].

The location of the concentrated mass in the center of the plate, regardless of its size, reduces the amplitude of oscillations, but does not change shape. When the concentrated mass is displaced along the radius, asymmetric forms of oscillations are occur; in the locations of the concentrated mass there is the appearance of nodal lines, which are not typical for the oscillations of the plate without the concentrated mass. The concentrated mass, which is located in the center of the plate, is on the nodal lines and does not affect the shape of the natural oscillations, but only reduces the frequency.

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