

ACCOUNTING FOR THE FREQUENCY-DEPENDENT DYNAMIC ELASTIC MODULUS OF DURALUMIN IN DEFORMATION PROBLEMS

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Abstract: The flexural vibrations of D16AT Duralumin specimens have been investigated, showing that the dynamic elastic modulus of D16AT Duralumin is significantly dependent on frequency. It has been found that the dynamic elastic modulus significantly reduces in the frequency range 0–20 Hz, and at high frequencies, it is practically constant. A general method has been developed to determine the modes and frequency of free vibrations of a structure taking into account the dependence of the dynamic elastic modulus of the material on its deformation frequency. Numerical experiments on impulsive loading of an elongated plate have been performed, showing that the frequency dependence of the dynamic elastic modulus of Duralumin should be taken into account in structural analysis.

Keywords: specimen, dynamic elastic modulus, frequency dependence, identification, finite element.

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INTRODUCTION

Duralumin is the general name for high-strength aluminum-based alloys with additions of copper, magnesium, and manganese, including D16, D16T, D16AT, D18, and other alloys. Currently, these alloys are the basic structural material in aviation rocket-space engineering, where stringent requirements are imposed on the strength and weight of designed structures. In structural design, regardless of the loading condition (static or dynamic), it is common to use the elastic modulus obtained in static tests of specimens.

The most reliable information about the elastic characteristics of material is provided by the dynamic method based on the results of experimental measurements of the cyclic frequency of flexural vibrations of specially prepared specimens and comparing it with the calculated frequency of a perfectly elastic specimen. Currently, the experimental determination of the elastic and damping properties of materials is specified by the ASTM E-756 international standard [1], according to which the dynamic behavior of cantilevered specimens of different structure in resonant modes is investigated in the frequency range 50–5000 Hz using an acoustic method. However, this standard has a number of limitations which narrow the region of its application, the main of which is that it is impossible to determine the elastic and damping properties of materials at frequencies less than 50 Hz, the closest to the real conditions of operation of most structures.

To implement this possibility, an experimental setup [2] has been developed to study the elastic and damping properties of a wide class of materials by processing experimental vibrograms of damping flexural vibrations. In particular, to study of the elastic and damping properties of rubber in tension-compression and shear, one must

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