Abstract

The problem of stability and natural vibrations of slender systems is the subject of many scientific and research works. This subject is still inexhaustible and the interest in these issues is still observable.

In this study, the problem of stability and nonlinear free vibrations of a column were considered, taking into account the additional heat load. The system was loaded by the use of a mass element. The thermal load is defined as the local heat source. The boundary-initial problem of heat flow in a column was formulated on the basis of the classical heat flow equation - the Fourier equation. An original program, based on the Finite Element Method was used to solve the problem. Based on the performed calculations, discrete distributions of material properties and temperature were obtained in individual segments of the column depending on the exposure time to the heat source.

The problem of stability and free vibrations of the system was formulated using the Hamilton principle, taking into account the Bernoulli-Euler theory and the von Karman theory in the case of the deformation - displacement relation. Due to the nonlinear factors appearing in the equations of motion, the problem was solved by use of the small parameter method. Based on the mathematical model, computational programs were prepared in the Wolfram Mathematica software.

A series of numerical simulations were carried out, taking into account both the parameters of the system and the parameters of external loads. Taking into account the results concerning the heat flow, the characteristics of the column capacity were determined depending on the time of its heating. The influence of the thermal load parameters: position, intensity and height on the stability and vibrations of the considered structure were determined. Additionally, the work takes into account the influence of the longitudinal inertia of the mass element loading the column.

In order to validate the obtained results of numerical calculations, experimental studies were carried out. A stand for testing columns has been designed and made, by means of which the load is carried out with the use of weights. Experimental research was carried out with the use of a heating chamber in order to realize the thermal load. A good convergence of the results of numerical calculations and experimental tests was obtained, which confirmed the correctness of the formulated mathematical models.