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Experimental determination of the elastic-viscous characteristics of elastic ropes

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Abstract

The conducted analytical, numerical and experimental studies for waiving of the elastic-viscous characteristics of elastic ropes are presented in the current report. The analytical studies are related to the creation of a dynamic and mathematical model of a vibrating system, supported by such ropes. The numerical studies refer to the creation of a corresponding program and a simulation model. The experimental activities refer to the modification of an existing dynamic stand for the implementation of an experimental setting, corresponding to the initial dynamic model. Additional numerical activities are carried out in connection with the development of a programming module for receiving, processing and analysis of the results of the experimental studies. By applying of the combined procedure, the data for the resistance of randomly selected group of ropes, at different deformation in them, are received.

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Keywords: elastic ropes; dynamic model; numerical algorithm; experimental set; elastic-viscous characteristics

1. Introduction

Elastic ropes happen to be used in the practice to provide static and dynamic rest for various systems, even though this is not their purpose. Very often, however, there is no reliable data on the type and quality of the

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material from which they are made. This leads to difficulties in determining the elastic and damping properties related to the rest or systems' motion. For this problem to be overcome, experimental methods are employed.

The determination of the elastic-viscous characteristics of elastic ropes is required for solving a specific problem. Such ropes are used as external and internal elastic-viscous links in some bench units at the Laboratory for numerical and experimental dynamic modeling at the University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria. The experimental bases of the Laboratory consists of a Stand for study of the rectilinear vibrations of a particle [1], a Stand for study of the angular vibrations of a body in the vertical plane [2], and others. The support of the vibrations is performed through linear springs and their damping – through dampers with linear coefficient of resistance.

The springs, used in bench sets, are varied and very often their characteristics should be verified experimentally. Under normal circumstances they are produced to work under pressure or at tension. One can hardly find combined springs that most correctly comply with the relevant theoretical dynamic models where elastic links are bilateral. This is the reason why usually tensile springs are employed, which then get strained to a certain static situation until, due to the occurred vibrations around, they are regarded as bilateral links. The situation is similar with dampers – new or used ones from vehicles, household appliances, etc. are used. The resistance coefficients of the latter should be also calculated or verified experimentally.

The experimental determination of the elastic coefficients of linear springs are deduced via the Stand for the study of rectilinear vibrations of a particle in static mode. The same set is used to find coefficients of dampers in dynamic mode. During some of the experiments it is observed that the behaviors of springs and dampers, within certain limits of variation in the displacement and velocity of their moving points, are very similar to the behaviors of some elastic ropes. The latter includes also the elastic properties of the springs and the viscous properties of the dampers. Thus comes the idea in some mechanical systems, instead of separate, paralleled spring and damper, with certain characteristics, to employ an elastic rope with similar characteristics. In order to determine the elastic-viscous characteristics a modified version of the said stand is used.

A method for the carrying out of certain interrelated theoretical, numerical and experimental activities is developed for solving the problem under consideration.

Nomenclature

m	mass of a particle
c	stiffness coefficient of the spring (the elastic rope)
b	coefficient of linear resistance of the damper (the elastic rope)
ω	own circular frequency
n	damping coefficient
η	damping factor

2. Analytical, numerical and experimental procedure

Although the existing bench setting is being modified, it is necessary to implement the full sequence which is observed in the construction of a new stand.

2.1. Dynamic model