Chapter 2
Peculiarities of Structural Mathematical Modeling Method

ABSTRACT

Methods of evaluating the dynamic state of mechanical oscillatory systems and the possibility of changing their dynamic characteristics are investigated. Particular attention is paid to the search for new approaches to the development of protective systems against vibrations, based on the use of structural interpretations of mathematical models of systems. A method for determining static and dynamic reactions based on transformations of the initial structural model of an oscillatory system is proposed. The idea of the method is that an elastic element in an oscillatory system is considered as a feedback circuit for an object making periodic movements relative to static equilibrium. Methodological bases of reaction determination method using Dalembert principle are considered. The idea of constructing compact systems including standard links, lever mechanisms and other devices forming a quasi-element or a system of quasi-elements interacting according to the rules of structural transformations is proposed.

INTRODUCTION

Determination of static and dynamic characteristics in interactions of elements and parts of machines and equipment is an important step in solving the tasks of ensuring reliability of operation and safety of operation. In this regard, the issues of assessing the reduced parameters of systems with mass-inertial, elastic and dissipative elements are of great importance. Particular attention is paid to the possibilities of identifying various dynamic effects that may arise when establish-

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ing non-traditional forms of communication between individual types of system movements and their elements, as well as during interactions of disturbing factors. The structural approaches developed in the proposed studies may be useful due to their visibility and the ability to obtain integral estimates associated with the use of mathematical models in the form of structural schemes and transfer functions.

COMPACTS IN STRUCTURAL DIAGRAMS OF MECHANICAL OSCILLATORY SYSTEMS

As shown in the previous sections, structural approaches in the dynamics of mechanical oscillatory systems are based on ideas about the possibility of comparing the physical initial model of a dynamically equivalent structural scheme of an automatic control system. The identity of the description of processes is predetermined by the fact that a mathematical model in the form of a linear system of differential equations is common. Structural transformations of models allow you to obtain the transfer functions of systems. This is used in design details to solve many machine dynamics problems. As for the ideas about the elementary base of mechanical oscillatory systems, its expansion, first of all, due to the introduction of an elementary link with a second-order differentiating link transfer function, significantly expanded the possibilities of changing the dynamic properties of systems. Equally important in this regard is the use of leverage, which is reflected in the development of ideas for building compacts. The essence of such representations lies in the fact that blocks or structures of elementary links obtained on the basis of the rules for transforming structural schemes can also be further included in subsequent transformations according to the same rules, forming in a sense megastructures in which typical elementary links are replaced by compacts. Such transformations can be considered as quasi-springs, which allows, when building mathematical models of complex mechanical oscillatory systems in solving a number of specific problems (for example, vibration protection) related to the allocation of an object with a controlled dynamic state, to obtain. At the same time, the structures of complex systems can be considered as the results of transforming compacts or quasi-structures according to the rules of transformation and connection of typical elementary units.

Features of Building Compacts

We consider a mechanical oscillatory system with three degrees of freedom, making small vibrations in the absence of friction forces (Figure 1*a*, *b*).

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