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Features of Dynamic Damping in Linear Mechanical System with Additional External Excitation

N.K. Kuznetsov[a], V.L. Lapshin[a], A.V. Eliseev[b]*

[a]*Irkutsk National Research Technical University, 83, Lermontov Str., Irkutsk 664074, Russia*
[b]*Irkutsk State Transport University, 15, Chernyshevskiy Str., Irkutsk 664074, Russia*

Abstract

The possibilities of dynamic damping of fluctuations in mechanical systems with two degrees of freedom at simultaneous action of two forces are considered. The features of dynamic interactions of elements of system in the conditions of functional ties between external excitation are researched. It is shown that control modes of system elastic properties and the parameters of modes of dynamic damping of oscillations can be created in the case when the management of factors of linear relation between the forces is possible. The theorem of restrictions on possibilities of realization of modes of simultaneous dynamic damping of oscillations in linear mechanical oscillatory system with two degrees of freedom is proved. Mathematical models for the estimation of dynamic properties of systems at joint adjustable interaction of two harmonious external excitation are suggested.

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Keywords: mechanical chain system; dynamic vibration damping; interpartial transfer function.

1. Introduction

Dynamic vibration damping elements of machines, equipment and devices refers to the number of task dynamics that have received considerable attention. Theoretical and practical aspects of the characteristics of dynamic interactions are presented in recent works [1-4]. The development of ways and means to reduce vibrations of the object due to the formation of dynamic responses arising from the interaction of the additional massinertial element [5-10] (dynamic vibration absorber) to the object of protection, to which the external periodic (often harmonic) excitations are applied directly, have received greatest development.

* Corresponding author. Tel.:+7-983-407-1553.
E-mail address: eliseew_aw@irgups.ru

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At the same time, external excitation, creating a dynamic interaction, may take forms, ones are reflective a more complex scheme of interaction of elements. In particular, the object of protection can be under the excitation of several external forces, which for its part may have functional relations. Such situations arise, for example, at kinematic indignations of vehicles and technological machines [11-17].

In offered article the approach on the basis of methods of the structural mathematical modelling is developed. Actions of simultaneously several harmonic forces to object of protection are considered. In this case harmonic forces are creating the conditions for the coupling of the movement along several co-ordinates.

2. Basic provisions. Research problem statement

Linear system of N series connected mass-inertial elements, ones are performing small oscillations without friction under the action of external harmonic forces or kinematic excitation from the support surfaces is considered (see Fig.1).

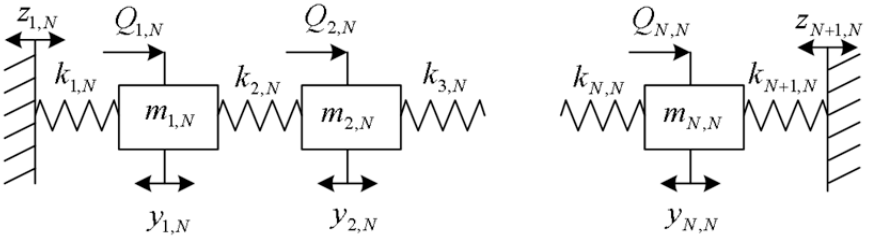

Fig. 1. The design scheme of chain system with *N* degrees of freedom.

Vibrational mechanical chain system of N material particles with masses $m_{1,N}$,.. $m_{N,N}$ united among themselves and with the bearing surfaces by means of elastic elements with stiffness $k_{1,N}$,.. $k_{N+1,N}$ is assigned to each N. It is assumed that the forces $Q_{1,N}$,.. $Q_{N,N}$ are applied to elements with lumped masses and the horizontal supports ($Z_{1,N}$ и $Z_{N+1,N}$) oscillate harmonically. Displacements $y_{1,N}$,.. $y_{N,N}$ of lumped masses in relation to the points of static equilibrium are considered as the generalized coordinates. In the coordinate system connected with motionless basis of expressions for kinetic and potential energy have the following form:

$$T_N = \sum_{i=1}^{N} \frac{1}{2} m_{i,N} (\dot{y}_{i,N})^2 \tag{1}$$

$$\prod_N = \frac{1}{2} k_{1,N} (y_{1,N} - z_{1,N})^2 + \sum_{i=1}^{N-1} \frac{1}{2} k_{i+1,N} (y_{i+1,N} - y_{i,N})^2 + \frac{1}{2} k_{N+1,N} (z_{N+1,N} - y_{N,N})^2 \tag{2}$$

Lagrange equation of type II for N degrees of freedom is used:

$$\frac{d}{dt}\left(\frac{\partial T_N}{\partial \dot{y}_{i,N}}\right) - \frac{\partial T_N}{\partial y_{i,N}} + \frac{\partial \Pi_N}{\partial y_{i,N}} = Q_{i,N}, \; i = 1...N \tag{3}$$

The objective of this research is to develop technology for the estimation of dynamical damping in several coordinates of the mechanical oscillatory system, which defined by the forms of external action.