

Chapter 7

Development of Mathematical Models for Gapless Motion in Mechanical Systems

ABSTRACT

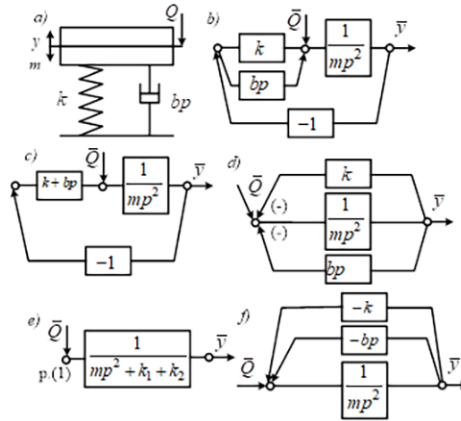
Methods of structural mathematical modeling are being developed in applications to solving problems of estimating, forming and correcting dynamic states of mechanical oscillatory systems that allow the implementation of unilateral interactions of elements. The purpose of the study is to determine the motion parameters of the system, at which there is no break in contact between the elements of the solid. The equations of static and dynamic equilibrium of the system are presented, as well as the contact conditions of the elements. The D'Alembert principle is used to determine the dynamic component of the reaction. Particular attention is paid to assessing the range of change in the dynamic component of the contact reaction and constructing an estimate of the parameters at which the contact between the elements of the composite solid is not disturbed during the period of steady motion.

INTRODUCTION

A composite solid is considered, formed by two elements with masses m_1 and m_2 in accordance with the scheme in Figure 1. Composite solid is placed on flexible element with rigidity k_1 and length in unloaded state l_{01} . It is assumed that composite solid features have only one degree of freedom, being able to move only in the vertical direction. Elements of a composite solid with masses m_1 and m_2 form an irrepressible contact.

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Figure 1. Composite solid on elastic oscillating base Z_1 ; P_i - viscous friction forces, Q_i -gravity forces, F_i - constant forces, N_{12} , N_{21} -full contact reactions, a_2, b_1 - contact surfaces



It is assumed that the supporting surface performs harmonic vibrations $Z_1 = A_1 \sin \omega_1 t$, causing movements of the composite solid. At low amplitudes and frequencies, the components of a solid move gaplessly.

X_i The solid coordinate m_i is the surface coordinate of the mass a_i solid, m_i where $i = 1, 2$. The vertical dimensions of the elements are respectively d_1 and d_2 . In the process of movement, each composite element of a solid body is affected by a viscous friction force P_i from a stationary medium, weight Q_i and some constant force that F_i does not depend on the mass of the solid:

$$P_i = -p_i \dot{X}_i, Q_i = -m_i g, F_i = f_{0i} \text{ where } i = 1, 2 \quad (1)$$

The composite solid features have a non-retaining link of the form:

$$X_1 + d_1 \leq X_2 \quad (2)$$

The contact condition is:

$$X_1 + d_1 = X_2 \quad (3)$$

The condition for determining the critical state, which in some cases may mean the occurrence of a gap, is equal to zero of the complete contact reaction N_{21} .

To determine the conditions of a continuous mode at steady-state oscillations, the positive of the full contact reaction is used as a criterion for the absence of a

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