

MODELLING OF INFLUENCE OF LOCAL VIBRATION ON OPERATOR' HANDS

Professor Anatoly V. Zinkovsky (1), Dr. Vyacheslav V. Potekhin (1)
Prof. Dr. Koos Jaap Van Zwieten (2)

1. St. Petersburg State Polytechnical University, Russia
2. Limburg University, The Netherlands

INTRODUCTION

Operation of machines and mechanisms, which installed power per employee constantly grows, connected also influence of local vibration on the operator. As a result of long and uncontrolled influence lines of operators have proof vibrating illness, and instant influence may result in a trauma. Computer modelling of reactions of the person at influence on him vibrations allows to study mechanisms of such interaction and further at designing machines and mechanisms to lower a level of vibration influence.

Vibrating protection of the man represents a complicated problem which can be decided with using of biomechanical examinations and build-ups of mathematical models. Limits of safe and permissible vibrating action on man now set.

From the point of view of a mechanics a human body only a mechanical system having particular natural frequencies. However, making of adequate mathematical model of a human body is complicated that the parameters featuring dynamic properties change in time. Having presented a human body as the composite dynamic structure with parameters varied in time, it is possible to spot resonant frequencies which cause growth of vibration amplitudes both all body and separate parts.

STUDYING OF OSCILLATIONS IN SYSTEM HUMAN HAND - MACHINE

Complexity of studying of a problem is bound to a series of the reasons, namely: the system is nonlinear, stochastic, non-stationary, with variable parameters in time, has the composite dynamic structure.

The most effective method of build-up of models of a human body of operators is the method of a mechanical impedance or a method of definition of transfer functions of system for manifold working poses and standings.

On the basis of experimental dates with application of analytical methods of a mechanics it is possible to construct proved enough mathematical and mechanical models of a human body. *The mathematical model is meant as analytical expression of observationally found mechanical gear impedance of a human hand:*

$$z_{12}(s) = F_1 / v_2 \quad (1)$$

where F_1 is the force on an inlet of system (on a vibrant platform or the handhold), v_2 is the velocity on an output of system (for example, on a forearm).

As *mechanical* model understand such mechanical system with the concentrated (or the distributed) parameters which gear impedance coincides with the found impedance of a human body. Thus, the problem of synthesis is stated as a problem of build-up of a mechanical system with the given properties.

The mechanism of change of resonant frequencies of a human body at action of vibration. Viewing a hypothesis about self-control of dynamic properties of osteomuscular structure of a human body, it is necessary to note, that the resonant frequency automatically changes eventually activities of vibration. If at system vibration with frequency operates $p > \omega$, that a resonant frequency $\omega(t)$ decreases, and if $p < \omega$, that occurs the return phenomenon. Thus, what would not be frequency of effective vibration, the odds between a resonant frequency and frequency of action eventually grows.

If

$$\Omega(t) = |\omega(t) - p|, \quad (2)$$

that the estimation of activity of the mechanism of change of a resonant frequency is reduced to a prime inequality:

$$\frac{d}{dt} \Omega(t) > 0. \quad (3)$$

As is known, the main principle of build-up of systems of vibrating protection is reduced to make system of a cushion suspension bracket of machine or mechanism such that the natural frequency of new system would be as more as possible removed from frequency of exterior vibrating action. From the technical point of view it is the most simple expedient of protection against vibration. There is, that a mechanism of regulation of dynamic properties of a human body, automatically carrying out change of the resonant frequency, is compounded with rules of vibrating protection in techniques.