Theoretical and experimental analysis methods applied to hand-arm system subjected to mechanical vibrations

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Introduction

Mechanical vibrations from the medical point of view [BOVE98], [PEL99] body had sent a complex physiological effect such, mechanical and thermal energy, leading to functional and physio- logical changes in the body.

Mechanical modelling

Theoretical method

The human hand—with one arm is a highly complex, heteroge- neous, continuously properties visco-elastic muscles, bones and skin. The dynamic characteristics in terms of biomechanical analysis model [CHE95] require the identification of mechanical properties, visco- elastic and model inertia, typical operating conditions. The human arm movement there are many factors that relate to their behaviour, these factors are classified as static factors behave and dynamic behaviour factors (e.g. passive moments of the joints (the joints), depending only on the angles of these joints).

Differential equations of motion corresponding mechanical model (Fig. 1) is integrated twice, resulting the solutions of the system of equations, respective velocities and displacements for the masses m1, m2 and m3. Harmonic solutions are solutions millimetres and are therefore reliable in terms of reality.

Experimental method _ hand—arm vibration measurement system

To achieve the measurement system of mechanical vibrations trans- mitted from the machine—tool (lathe) human operator hand choose a piezo-electric transducer. This type of transducer is commonly used in such applications. Measurements of mechanical vibrations to the hand—arm were performed with noise and vibration meter and 958

SVAN have made measurements vibration (Fig. 2) on your wrist, elbow and shoulder.

Figure 2a–c show only mechanical vibration measurements (accelerations Peak, Peak to Peak, Max, and R.M.S—Root Mean Square) carried on your wrist studied for frequencies of the lathe,

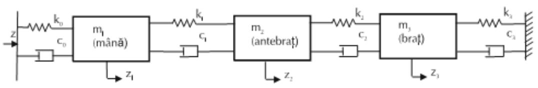

Fig. 1 A simplified linear mechanical system of hand-arm assembly with three degrees of freedom

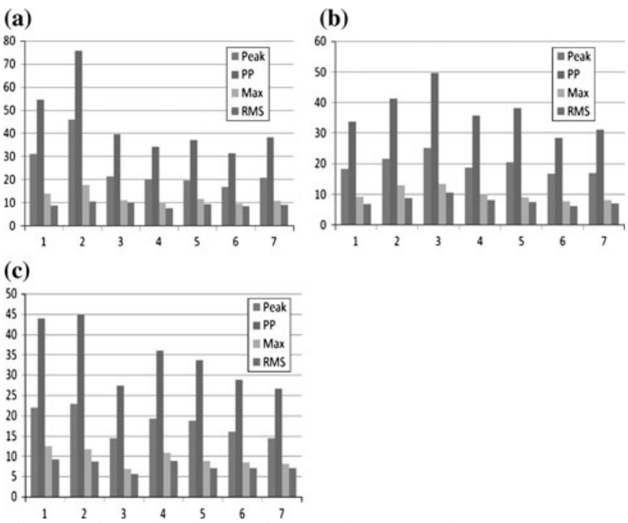

Fig. 2 Peak acceleration, Peak to Peak, Max, and R.M.S. [m/s2] frequencies obtained for machine—tools: 4.16 (1), 5.25 (2), 6.66 (3), 8.33 (4), 10.50 (5), 13.33 (6) and 16.66 (7) Hz, corresponding vibration measurements at the wrist axes: a Ox, b Oy, c Oz

where the directions Ox (2a), Oy (2b) and Oz (2c). These measure- ments were carried out vibration and elbow and wrist to shoulder. Conclusions

Throughout the boom, high acceleration values are obtained in trans- mission axis wrist Ozh for lathe frequency of 4.16 Hz (250 rpm = rotation per minute) and measurements showed that the frequency of shoulder 16.66 Hz (1,000 rpm).

Analysis of acceleration spectra (axis Ox) for anatomical locations
wrist, elbow (above and below the joint) and shoulder indicated that they generally have higher values of the frequency of lathe 16.66 Hz (1,000 rpm) compared to those obtained in 4.16 Hz (250 rpm), were compared with. We studied mainly the transmission of mechanical vibrations from the excitation source (machine-tool) human operator's hand, along the hand-arm system (Oz axis, according to the ISO 5349/2003) and not by the Ox axis that is perpendicular to the hand.

Discussions

Results obtained from measurements of mechanical vibrations, vibra- tion from the machine—tool to hand-arm system, are consistent with previous theoretical research results and the literature data. It namely those that vibrations along the arm (Ozh) is transmitted more strongly to low frequencies (\20 Hz), and transmission of vibration at fre- quencies above 20 Hz are felt especially, after Oxh axis anatomical coordinate system.

Acknowledgement

This paper was supported by the project ''Develop and support multidisciplinary postdoctoral programs in primordial technical areas of national strategy of the research—development—innovation''
4D-POSTDOC, contract nr. POSDRU/89/1.5/S/52603, project co-funded from European Social Fund through Sectorial Operational Program Human Resources 2007–2013.

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