Comparative analysis of methods of hand-arm system subjected to vibration by mechanical modeling and simulation

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1. Introduction

Is there more data that shows the effect of vibration on humans depending on the size of one frequency and a characteristic kinematic [DAR68], [DAR88], [HAR69], [HAR02]. Such data introduced by Dieckmann and collecting a coefficient denoted K, taken as unit the effect of vibration on humans. The effects of vibration on man, often producing damage to health by hand-arm system (in time). These effects are affected the dexterity of Vibration White Finger disease— (VWF).

2. Mechanical modelling

2.1 Linear mechanical model of hand-arm vibration attenuator mounted on the forearm

Consider a linear mechanical model with four degrees of freedom, representing the hand-arm system and having no cylindrical hinge to wrist, elbow and shoulder. The four degrees of freedom are given by z1—m1 mass displacement (hand), z2—m2 mass displacement (forearm), z3—m3 mass displacement (arm) and z4—m4 mass dis- placement (vibration damper device).

Oz direction of transmission of vibrations is taken according to the anatomical coordinate system given by the literature and ISO 5349. The system is powered by a disruptive force shaped harmonic signal given by z and it is retrieved from the machine-tool.

The equations that characterize the mechanical model shown in Fig. 1 will be double integrated with Runge–Kutta method of order 4, for 5 s and the results respective velocities and the mass displace- ments of the system are obtained.

2.1.2 Stability of linear system with hand-arm vibration attenu- ator mounted on the forearm

To determine the stability of the system is replaced by the generalized coordinates z1, z2, z3 and z4 of the system of equations character- izing the model aert, bert, cert, dert. Solving the characteristic determinant of the system of equations, it resulted from the roots notated r. The system has eight roots, but all real or complex con- jugate with negative real part, their frequencies are represented by the imaginary part, and values are: 363.968, 527.056 and 692.855. This demonstrates that the system is stable and/or the range of stability.

2.2 Simulation of mechanical vibration transmitted from hand- arm system

To simulate the movement and determination of kinematic parameters of simplified model hand—arm has developed a model using software Simulink—SimMechanics of Matlab [MAT08], whose results are shown in Fig. 2. This scheme has restored the Matlab mathematical model in the preceding paragraph and has the same parameters (mass, length, stiffness, damping and initial conditions) with it.

Simulated results were obtained for system integration using the Runge—Kutta of order 4 (ODE45) and integration was performed to 5 s. All movements have been reported to the centre of mass for the element of the whole hand-arm study. Harmonic results were obtained, proving that the system retains the stability that the scale values in millimetres, which is comparable to results obtained by theoretical methods.

3. Conclusions

The results obtained by both methods (theoretical and simulation) have shown that value, they are comparative, and regardless of the method are harmonic and whatever method you choose, if the initial conditions, visco-elastic parameters are the same, the results may vary.

It is important to remember that when installing a vibration damper on the forearm, the vibrations transmitted along the arm decreased significantly by about approximately 70 % compared to the case when not using such a vibration damper (mass m4). Acknowledgement

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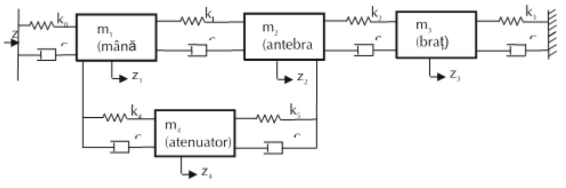

Fig. 1 Linear mechanical hand-arm assembly with four degrees of freedom and vibration attenuator mounted on the forearm (between wrist and elbow imaginary joints)

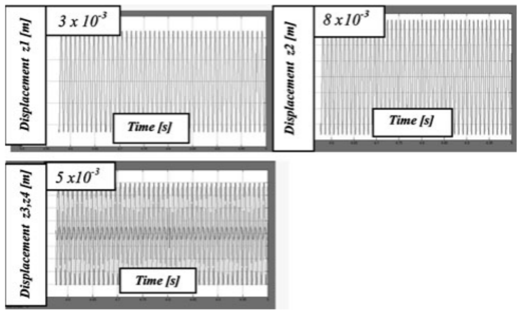

Fig. 2 Displacements z1, z2, z3,z4 corresponding to n = 1,000 rpm, which is moving the hand (m1), forearm (m2), arm (m3) and vibration damper (m4)

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