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"Vibrations of Mechanical System with Self-excited and Parametric Excitation"

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Both theoretical and experimental analyses of the wibrations in mechanical system with two excitations: parametric and self-excited-the latter induced by nonlinear friction, were made. The scheme of the model stand is presented on Fig. 1, and the variation of the friction coefficient vs relative velocity in Fig.2.

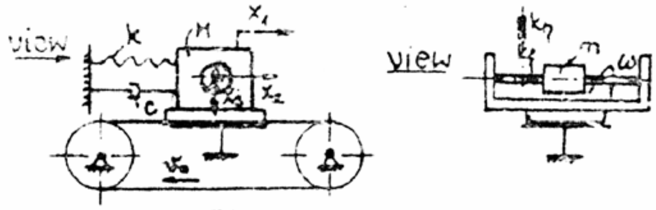

Fig. 1

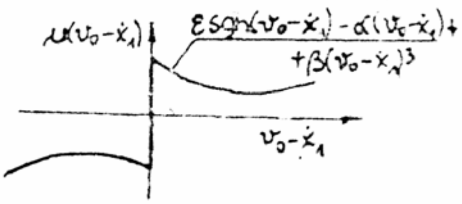

Fig. 2

The equations for motion are:

$$\ddot{x}_1=-x_1(\Omega^2+A+B\cos 2\omega t)-Hx_1+(A+B\cos 2\omega t)x_2-x_3 B\sin 2\omega t+[g-Bx_2\sin 2\omega t+$$
$$-(-A+B\cos 2\omega t)x_3+Bx_1\sin 2\omega t]\cdot(\varepsilon\,\mathrm{sgn}\,w_1-\alpha w_1+\beta w_1^3);$$
$$\ddot{x}_2=(x_1-x_2)(C+D\cos 2\omega t)+Dx_3\sin 2\omega t+a\omega^2\sin(\omega t+\varphi_0);$$
$$\ddot{x}_3=(x_2-x_1)D\sin 2\omega t+x_3(-C+D\cos 2\omega t+a\omega^2\cos(\omega t+\varphi_0)+g,\quad \text{where:}$$
$$A=\Omega_\xi^2+\Omega_\eta^2;\quad B=\Omega_\xi^2-\Omega_\eta^2;\quad C=\omega_\xi^2+\omega_\eta^2;\quad D=\omega_\xi^2-\omega_\eta^2;\quad \Omega^2=\frac{k}{M};\quad \Omega_\xi^2=\frac{k_\xi}{2M};$$
$$\Omega_\eta^2=\frac{k_\eta}{2M};\quad H=\frac{C}{M};\quad \omega_\xi^2=\frac{k_\xi}{2m};\quad \omega_\eta^2=\frac{k_\eta}{2m},\quad w_1=v_0-\dot{x}_1$$

a, φ_0 – parameters discribing the position of the geometric centre of the mass "m". The calculation analysis of the influence of parameters for vibrations was made by integrating the above equations, using Runge-Kutta-Gill method and simulate language. The experimental rig was designed and then the measure and registration of the vibrations was made, after the identyfication of the system.

References:

1. W.J.Cunningham "Introduction to Nonlinear Analysis" 1958.