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ABOUT NONLINEAR CHARACTERISTIC OF VISCOELASTIC SYSTEMS IN THE BEHAVIOUR DYNAMIC'S OF THE FOUNDATION OF TECHNOLOGICAL EQUIPMENT

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ABSTRACT

Mounting the foundation of the technological equipment on antivibrating system to the current moment, don't have an optional character she becoming a must, because noxious effects of transmitted vibrations the environment, essentially peoples who stand nearest, then the machines, equipments, and buildings. In this paper, is distinguishing the influence of nonlinear characters of elastic and damping forces about amplitude frequency plot of vibrations of the machine foundation. The characterization of the influence nonlinear behaviors of mounting elements was make on based of a quantitative criteria of appreciation vibration carry consisted in the evaluation response systems in time and frequency. Present study has based of a physical model with prevalence, which in he considered a machine foundation, as rigid system mount on viscoelastic elements trirectangular. Consequently, the movement of the rigid system has been characterized by dint of six degree of freedom. The physical model considers has a covering prevalence for the many maul real situation, be beyond personalize to according as of analyze characteristic situation.

1. The physical model

For analyze dynamic behavior of the foundation of technological equipment was considered a rigid mount on four identical viscoelastic support trirectangular (fig. 1).

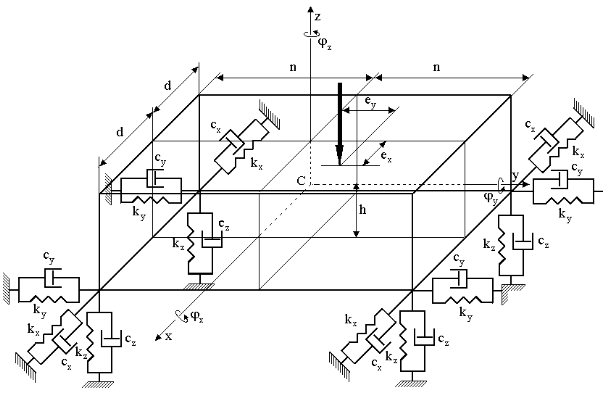

Fig. 1 Physical model

The rigid body was consider is solicits eccentric by signal semi-sinusoidal excitation (semi-sinusoidal shock) presented in fig. 2. Considered as one two coordinate symmetry plane: XOZ, YOZ, situation which in:

$$\sum k_{iy}x_i = 0;\ \sum k_{iz}x_i = 0;\ \sum k_{iy}x_i y_i = 0;$$

$$\sum k_{iy}x_i z_i = 0;\ \sum k_{ix}y_i = 0;\ \sum k_{iz}y_i = 0;$$

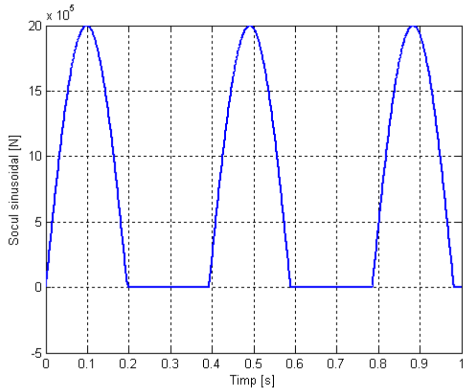

Fig. 2 Semisinusoidal signal

Considered as one two coordinate symmetry plane: XOZ, YOZ, situation which in:

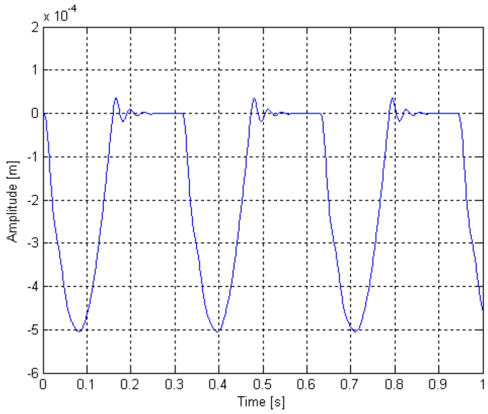

Fig. 3

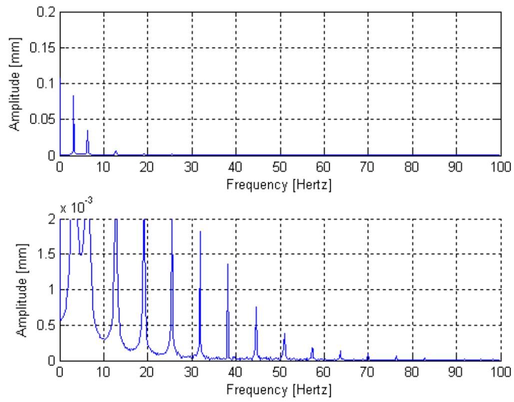

Fig. 4

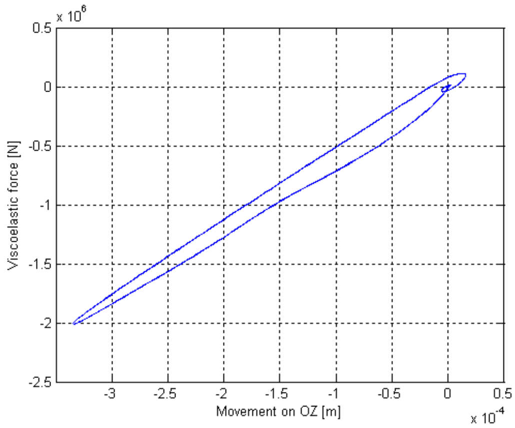

Fig. 5

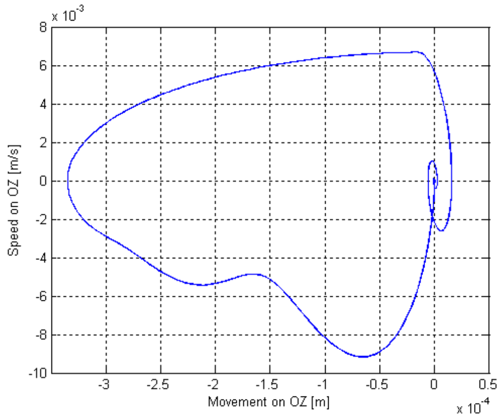

Fig. 6

$$\sum k_{iy}x_i = 0;\ \sum k_{iz}x_i = 0;\ \sum k_{iy}x_iy_i = 0;$$

$$\sum k_{iy}x_iz_i = 0;\ \sum k_{ix}y_i = 0;\ \sum k_{iz}y_i = 0;$$

$$\sum k_{iz}y_iz_i = 0;$$

$$\sum k_{ix}y_iz_i = 0;\ \sum c_{iy}x_i = 0;\ \sum c_{iz}x_i = 0;$$

$$\sum c_{iy}x_iy_i = 0;\ \sum c_{iy}x_iz_i = 0;\ \sum c_{iz}y_i = 0;$$

$$\sum c_{ix}y_i = 0;\ \sum c_{iz}y_iz_i = 0;\ \sum c_{ix}y_iz_i = 0;$$

In this situation the system of differential equations which describes rigid body movement becomes:

$$\begin{cases} m\ddot{X} + 4c_x\dot{X} - 4hc_x\dot{\varphi}_y + 4k_xX - 4hk_x\varphi_y = 0 \\ m\ddot{Y} + 4c_y\dot{Y} + 4c_yh\dot{\varphi}_x + 4k_yY + 4k_yh\varphi_x = 0 \\ m\ddot{Z} + 4c_z\dot{Z} + 4k_zZ = -F_z \\ J_x\ddot{\varphi}_x + 4hc_y\dot{Y} + 4\left(c_yh^2 + c_zn^2\right)\dot{\varphi}_x + 4hk_yY + \\ \qquad + 4\left(k_yh^2 + k_zn^2\right)\varphi_x = -e_yF_z \\ J_y\ddot{\varphi}_y - 4hc_x\dot{X} + 4\left(c_zd^2 + c_xh^2\right)\dot{\varphi}_y - 4hk_xX + \\ \qquad + 4\left(k_zd^2 + k_xh^2\right)\varphi_y = e_xF_z \\ J_z\ddot{\varphi}_z + 4\left(c_xn^2 + 2c_yd^2\right)\dot{\varphi}_z + 4\left(k_xn^2 + 2k_yd^2\right)\varphi_z = 0 \end{cases}$$

2. The analyze of vibrations in hypothesis: elastic and damping forces, functions with linear expression

Considering elastic and amortization forces, functions with linear expression the temporal response is presented in fig. 3, in hypothesis of digital values: $F_z=2\cdot10^6$ N; m=45000 kg; $k_z=1.5\cdot10^9$ N/m; $c_z=3.5\cdot10^6$ Ns/m.

In hypothesis of these digital values for all characteristic parameters systems, frequency characteristic in of movement on OZ directions is represented in fig. 4. Rate of hysteretic curve and the characteristic speed-movement is presented in fig. 5 and fig. 6. Dissipation energy on one period is: W= 52. 36J.

3. The analyze of vibrations in hypothesis: elastic forces, functions with nonlinear expression

In this case is considered the expression force of an elastic element having form:

$$F_z = k_{z0}(x + \beta x^3)$$

In hypothesis of next digital values of the characteristic what interfere in the equation system: $F_z=2\cdot10^6$ N; m=45000 kg; $k_{z0}=1.5\cdot10^9$ N/m; $c_z=3.5\cdot10^6$ Ns/m; $\beta=3.6\cdot10^7$ $1/m^2$, was presented in the next figures temporal and frequency responses (fig. 7, 8).

Rate of hysteretic curve and the characteristic speed-

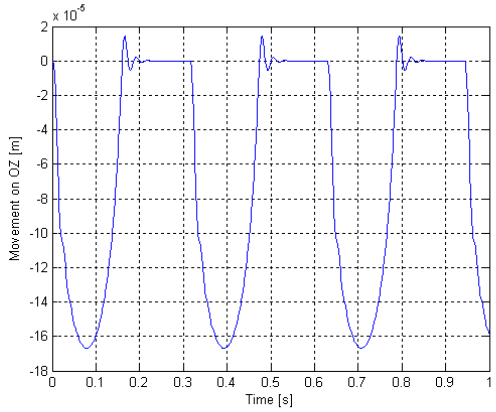

Fig. 6

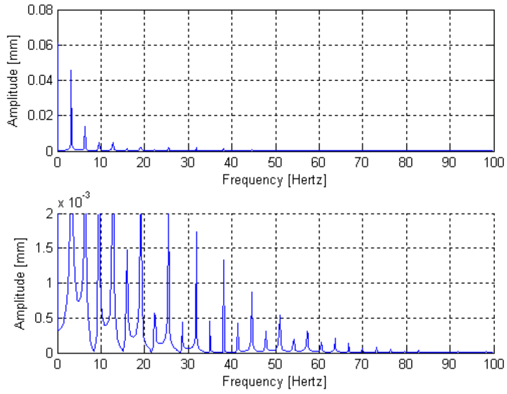

Fig. 7

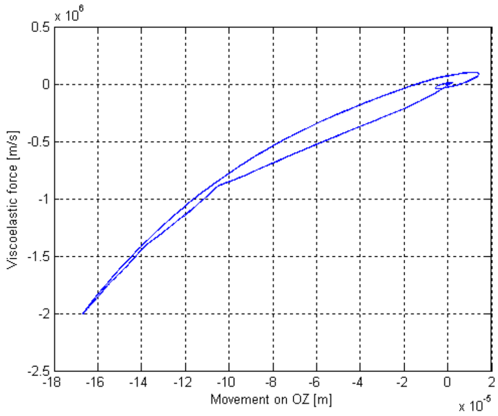

Fig. 8

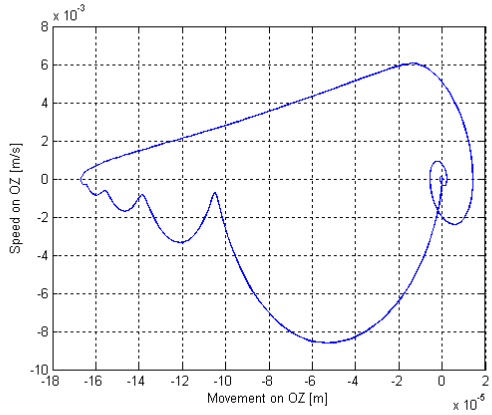

Fig. 9

movement are presented in figures 9 and 10. Dissipation energy on one period is: W= 181. 34J

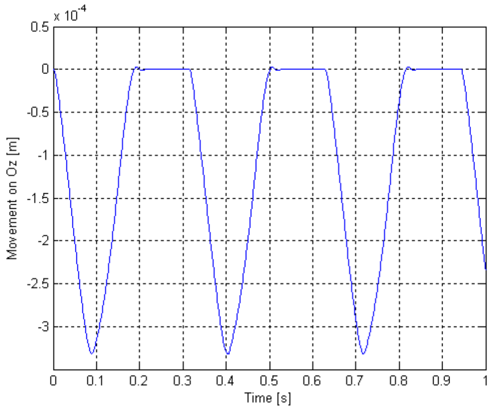

Fig. 6

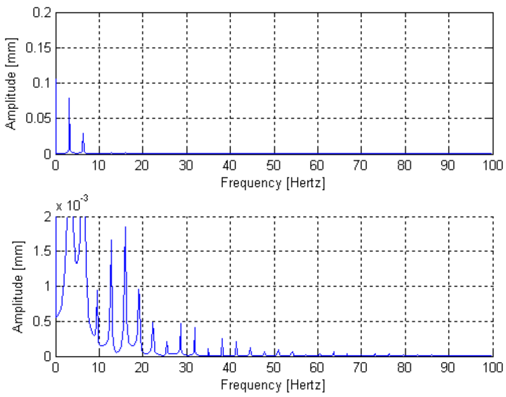

Fig. 7

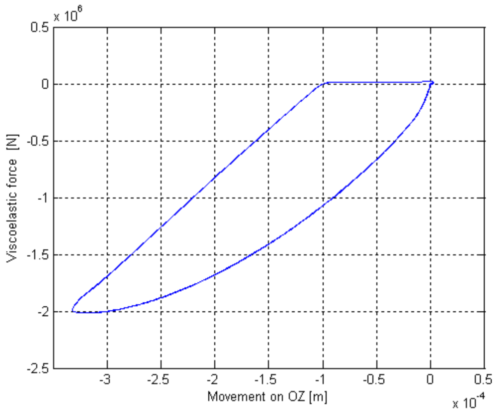

Fig. 8

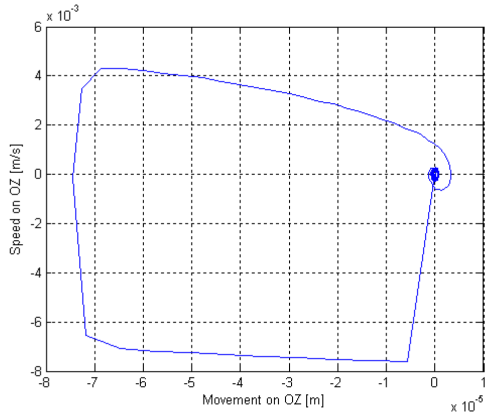

Fig. 9

4. The analyze of vibrations in hypothesis: damping forces are functions with nonlinear expression

In this case is considered the expression of damping force of an element having form:

$$F = c_z(\dot{x} + \gamma\dot{x}^3)$$

In hypothesis of next digital values of the characteristic what interfere in the equation system: $F_z=2\cdot10^6$ N; m=45000 kg; $k_{z0}=1.5\cdot10^9$ N/m; $c_z=3.5\cdot10^6$ Ns/m; $\gamma=3\cdot10^5$ s/m^2, was presented in the next figures temporal and frequency responses (fig. 11, 12). Rate of hysteretic curve and the characteristic speed-movement are presented in figures 13 and 14. Dissipation energy on one period is: W= 231. 25J

5. Conclusion

From the accomplish study, observe as in the cases of nonlinear elastic and damping forces, the frequency characteristic is characterized by appearance of new spectral values, by the of with first case which considered the force have linear expressions. Present these poliharmonic components is proven the value of dissipation energies on one period: in the case of nonlinear damping forces dissipation energies has greatest value.

The qualitative diagrams speed-movement argues the stability character of movements of rigid body on OZ direction.

6. Bibliography

[1] **Leopa Adrian** – *Influenta elementelor de amortizare vascoelastice asupra utilajului tehnologic* – A XXVIII- a Conferinta Nationala de Mecanica Solidelor, 28 -29 mai Targoviste, 2004, ISBN 973 – 86834 – 2 - 4, pg. 18-21;

[2] **Leopa Adrian** - *The model of forging hammers like system with three degree of freedom* - Analele Universitatii "Dunarea de Jos" din Galati, 2004, pg. 31-34, ISSN 1224-5615;

[3] **Leopa Adrian**, Silviu Nastac, Diana Anghelache, Carmen Bordea – *The influence of the visco-elastic dampers on forging presses*, April 2004 the 43nd International Seminar on Modelling and Optimisation of Composites - MOC'43, Odessa, ISBN 966-318-117-6, pg.208;

[4] **Leopa Adrian**, Nastac Silviu, Debeleac Carmen - *Influenta rigiditatii neliniare in functionarea utilajelor cu actiune dinamica*, Mai 2005, Tehnologii Moderne Calitate Restructurare - Chisinau, Editura UTM, ISBN 9975-9875-6-7, pg. 264-267.**1.**