ANALIZA STABILITĂȚII UNUI ECHIPAMENT DE DEMOLARE

STABILITY ANALYSIS OF DEMOLITION EQUIPMENT

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Rezumat: *În această lucrare ne propunem un model cu 2 grade de libertate pentru un sistem dinamic al unui echipament de demolare. Folosind datele experimentale din [4], prin intermediul software-ului Simulink, se construiește diagrama bloc, cu scopul de a simula mişcarea sistemului dinamic, iar diagramele de fază sunt trasate prin utilizarea Matlab. Din interpretarea acestor diagrame rezultă, pentru un set de parametri (m, c, k, F_O, ω), stabilitatea mişcării pentru sistemul dinamic maşină de bază-ciocan hidraulic.*
Cuvinte cheie: *stabilitate, sistem dinamic, echipamente de demolare, Simulink, Matlab*

Abstract: *In this paper we propose a model with 2 degrees of freedom for demolition equipment dynamic system. Using experimental data from [4] by means of the Simulink software is built block diagram to simulate the dynamic system motion and phase diagrams are drawn by using Matlab. From the interpretation of these diagrams result, for a set of parameters (m, c, k, F_O, ω), stable motion for the basic engine-hydraulic hammer system.*
Keywords*: stability, dinamic system, demolition equipment, Simulink, Matlab*

1. THE DYNAMIC MODEL PROPOSED

For the hydraulic hammer demolition equipment from figure 1 a two degree of freedom dynamic model is proposed shown in figure 2.

Fig. 1. The hydraulic hammer demolition equipment [5]

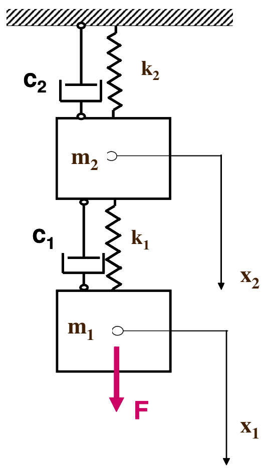


Fig. 2. Dynamical model

2. DETERMINATION OF DIFFERENTIAL EQUATIONS OF MOTION

Using Lagrange's equations (II), the differential equations of motion in matrix form are:

$$[M]\{\ddot{x}\}+[C]\{\dot{x}\}+[K]\{x\}=\{F\} \tag{1}$$

Matrix differential equation (1) is developed being obtained the system:

$$\begin{cases} m_1\ddot{x}_1 + c_1\dot{x}_1 + k_1x_1 - c_1\dot{x}_2 - k_1x_2 = F \\ m_2\ddot{x}_2 + c_1\dot{x}_1 + k_1x_1 - (c_1+c_2)\dot{x}_2 - (k_1+k_2)x_2 = 0 \end{cases} \tag{2}$$

To determine the motion and speed laws, in order to analyze the dynamic stability of the system, will use Simulink.

For this purpose the differential equations system (2) to rewrite as follows.

$$\begin{aligned} \ddot{x}_1 &= \frac{1}{m_1}\left[-c_1\dot{x}_1 - k_1x_1 + c_1\dot{x}_2 + k_2x_2 + F\right] \\ \ddot{x}_2 &= \frac{1}{m_2}\left[c_1\dot{x}_1 + k_1x_1 - (c_1+c_2)\dot{x}_2 - (k_1+k_2)x_2\right] \end{aligned} \tag{3}$$

3. USING SIMULINK SOFTWARE

For each of the two differential equations of the system (2), will compose one subsystem with predefined blocks from Simulink library.

For example, the differential equation:

$$\ddot{x}_2 = \frac{1}{m_2}\left[c_1\dot{x}_1 + k_1x_1 - (c_1+c_2)\dot{x}_2 - (k_1+k_2)x_2\right] \tag{4}$$

in Simulink have a block diagram shown in figure 3.

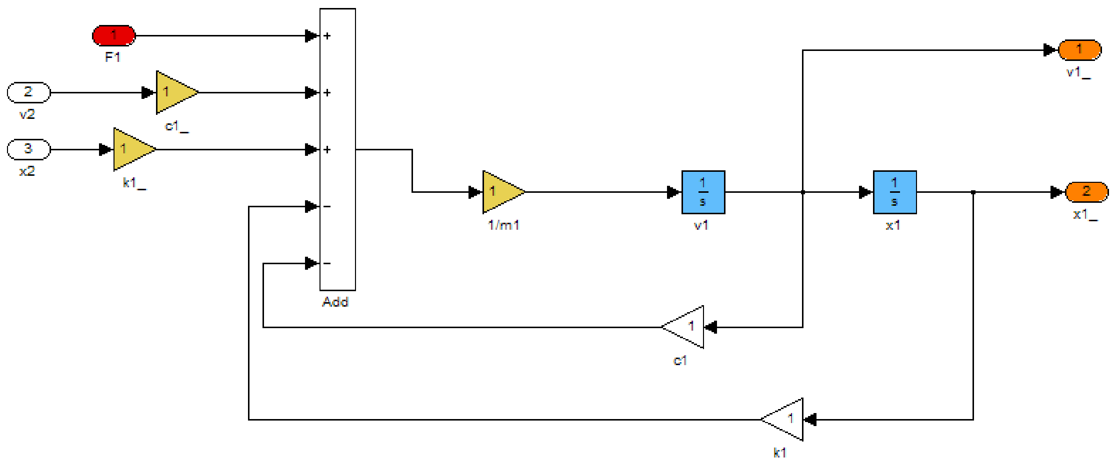


Fig. 3. Block diagram for demolition equipment

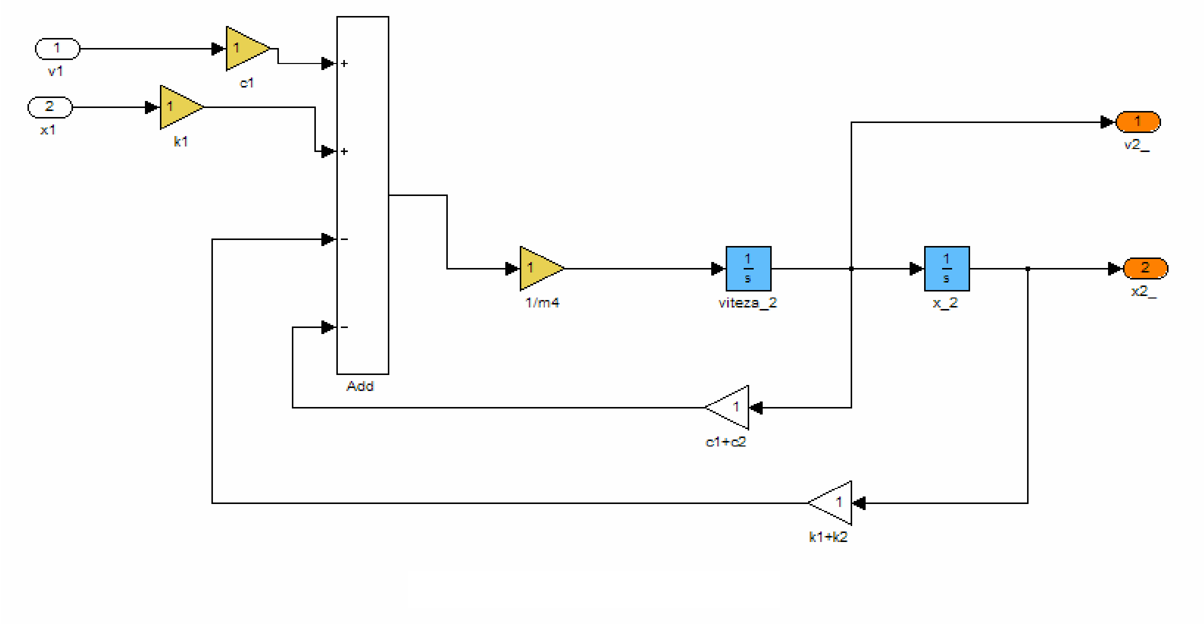


Fig. 4. Block diagram for the basic engine

All these block schemes it encapsulates and connects in a block diagram of the whole demolition equipment, shown in figure 5.

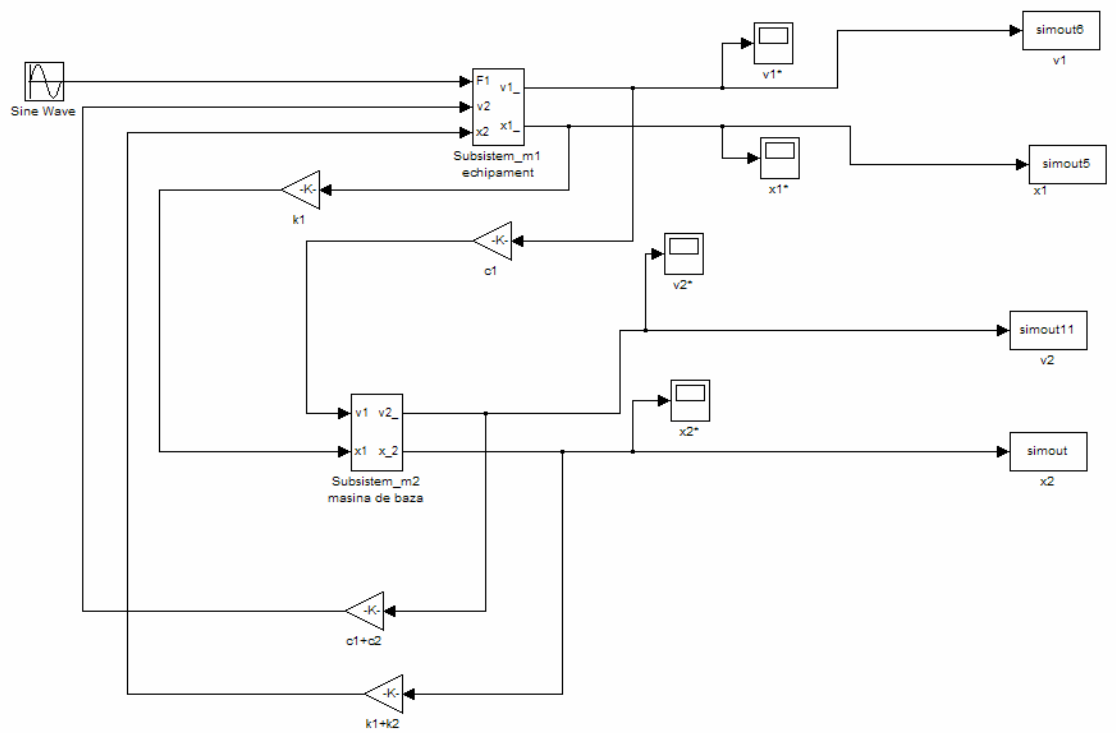
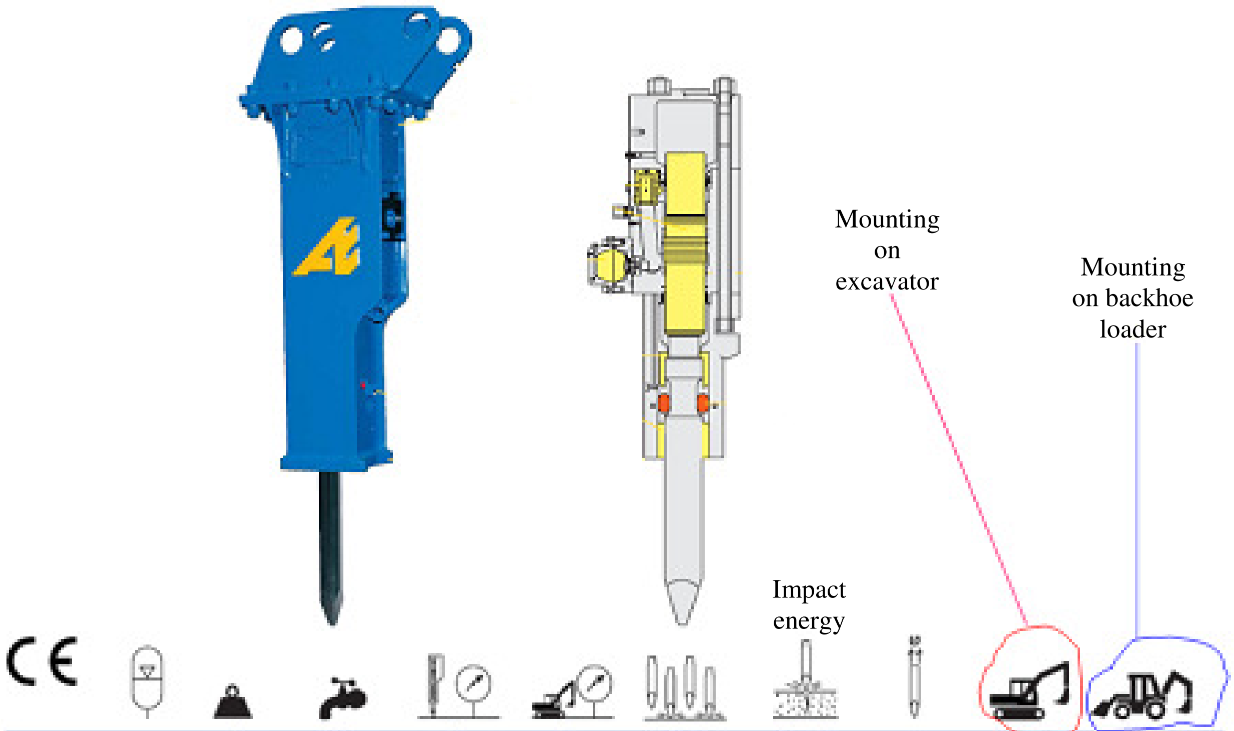


Fig. 5. Block diagram for the whole demolition equipment

Using the hydraulic hammers parameters from Arden papers (figure 6), we can simulate the dynamic system via the block diagram shown in figure 5.



		≈ kg	l/min	bar	bar	Nb/min	joule	mm	t	t
AB 152	-	145	20/30	90/110	180	700/900	343	57	1,3/3	-
AB 212	-	180	26/36	90/120	180	600/800	392	57	2,5/4,5	-
AB 282	X	250	30/40	90/120	180	700/800	696	70	3/6	4/7
AB 352	X	310	35/55	110/165	220	550/700	736	70	4/8	5/10

Fig. 6. Hydraulic hammers parameters (ARDEN company), according to the possibility of mounting on excavator or backhoe loader [4]

4. RESULTS

Next figure was drawn the speed variation depending on displacement under a sinusoidal disturbance forces acting on the hydraulic hammer, using data from fig.5.

We obtain the state-space diagrams for the hydraulic hammer (fig.7) and for the basic engine (fig.8).

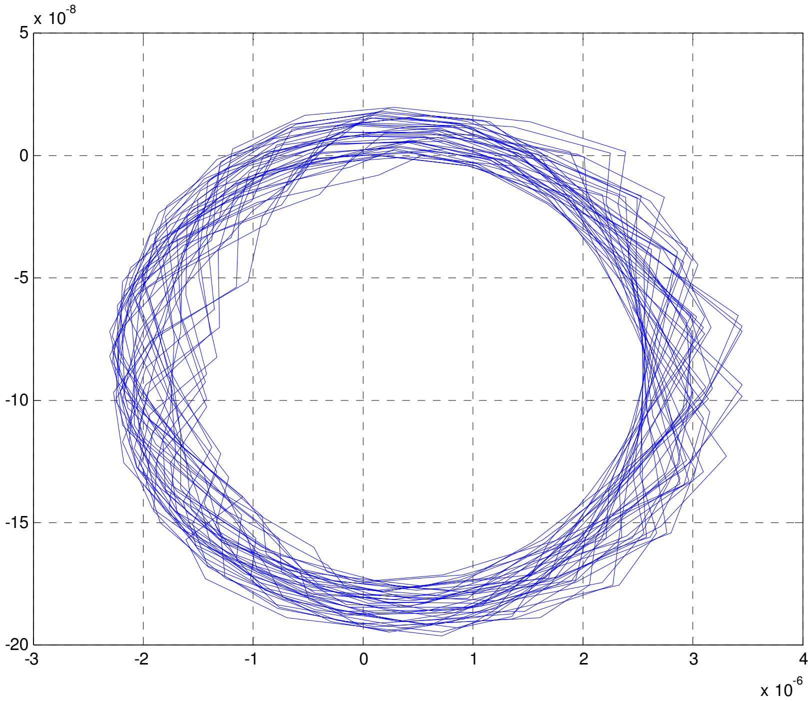


Fig. 7 The state –space diagram for hydraulic hammer

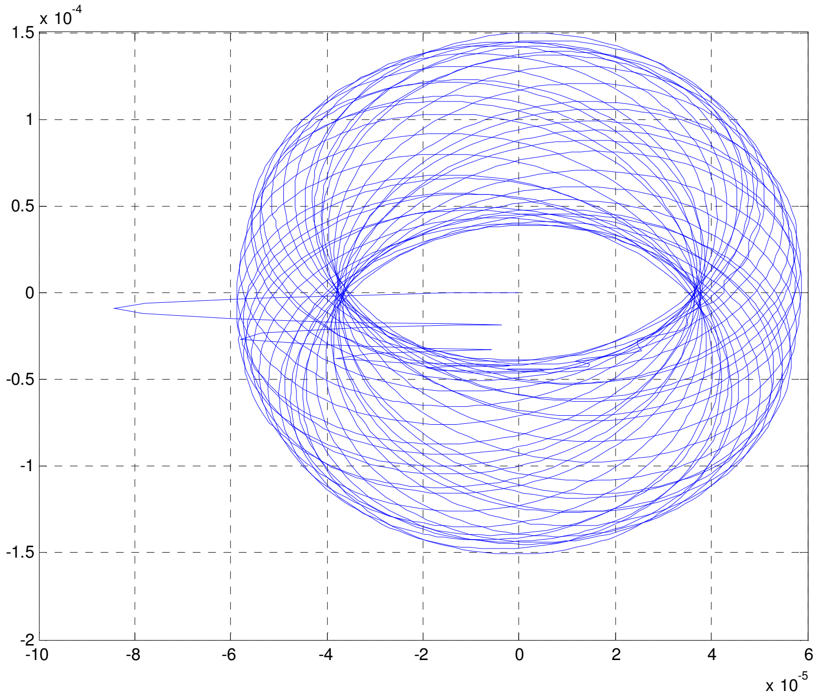


Fig. 8 The state –space diagram for basic engine

5. CONCLUSIONS

From the analysis of two state space diagrams under the force $F_0 \sin\omega t$ and considering into account all the elements that make up the damping system finds that all these representations are cyclic closed curves.

According to chaos theory, if a representation in state space (velocity, displacement) is a closed cycle curve, then the system is stable.

This method takes the advantage versus the classical stability analysis used for the choose of the demolition equipment with basic engine because this method offer a dynamic stability analysis taken care of the damping and the demolition forces.

References

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