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Establishing Proper Pulsation and Perturbation Couple of the Drill System

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Abstract

The goal is to establish proper pulsation of the drill system of the drilling rig with diesel-hydraulic actuators and disturbing variation when the time determined by the average engine torque developed by the action during operations to extract the useful load.

Key words: *proper pulsation, drill system, numerical simulation*.

The methodology for determining the proper pulsation operating system installations drilling

Determination of mathematical equations for determining proper pulsation operating system is done by writing equations of motion. Elastic-dynamic scheme of calculation is shown in fig. 1.
The system of equations of motion of the operating system used to establish their proper pulsation is:

$$\begin{gathered}
I_1 \ddot{\varphi}_1 - c_{12}(\varphi_2 - \varphi_1) = 0 \\
I_2 \ddot{\varphi}_2 - c_{23}(\varphi_3 - \varphi_2) + c_{12}(\varphi_2 - \varphi_1) = 0 \\
I_3 \ddot{\varphi}_3 - c_{34}(\varphi_4 - \varphi_3) + c_{23}(\varphi_3 - \varphi_2) = 0 \\
I_4 \ddot{\varphi}_4 - c_{45}(\varphi_5 - \varphi_4) + c_{34}(\varphi_4 - \varphi_3) = 0 \\
I_5 \ddot{\varphi}_5 + c_{45}(\varphi_5 - \varphi_4) = 0
\end{gathered} \qquad (1)$$

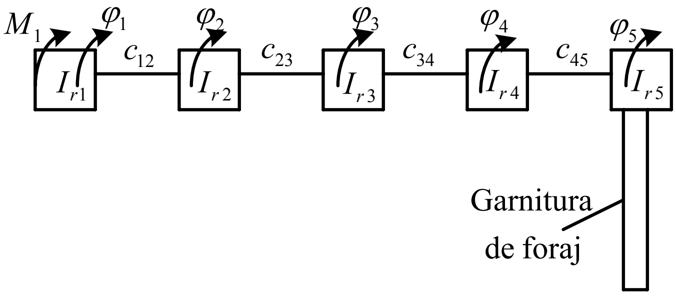

Fig. 1. The scheme of calculation elastic-dynamic.

where: I_i are the moments of inertia of the elements in moving the tree $i = 1,2,3,4$ the tree reduced drum for manoeuver;

I_i - moment of inertia of the masses in the circle moving between hook and tree drum for manoeuver;

c_{12} - elastic constant elements of the first tree ("contribute" to the first speed) reduce to the speed to the tree drum for manoeuver. Similar constants are determined c_{23} (the tree 2) and c_{34} (the tree 3); constant c_{45} is the constant branch of the cable assets for manoeuver.

Power flow diagram of the drill system (Fig. 2) is the basis for determining their moments of inertia and reduced the elements are in motion on the coupling considered, also will determine the values and reduced elastic constants ([1], [2]).

System (1) is resolved as a system of equations for free vibration, with solutions form $\varphi_i = a_i \sin(pt + \alpha)$. From the condition that the system of equations to be uniform to determine the proper pulsation. After replacing these system solutions (1), to obtain:

$$\begin{cases} -I_1 p^2 a_1 - c_{12} a_2 + c_{12} a_1 = 0 \\ -I_2 p^2 a_2 + c_{12} a_2 - c_{12} a_1 - c_{23} a_3 + c_{23} a_2 = 0 \\ -I_3 p^2 a_3 + c_{23} a_3 - c_{23} a_2 - c_{34} a_4 + c_{34} a_3 = 0 \\ -I_4 p^2 a_4 + c_{34} a_4 - c_{34} a_3 - c_{45} a_5 + c_{45} a_4 = 0 \\ -I_5 p^2 a_5 + c_{45} a_5 - c_{45} a_4 = 0 \end{cases} \tag{2}$$

It put the condition that system (2) to be homogeneous:

$$\begin{cases} a_1\left(-I_1 p^2 + c_{12}\right) - a_2 c_{12} + 0 + 0 + 0 = 0 \\ -a_1 c_{12} + a_2\left(c_{23} + c_{12} - I_2 p^2\right) - a_3 c_{23} + 0 + 0 = 0 \\ 0 - a_2 c_{23} + a_3\left(c_{23} + c_{34} - I_3 p^2\right) - c_{34} a_4 + 0 = 0 \\ 0 + 0 - a_3 c_{34} + a_4\left(c_{45} + c_{34} - I_4 p^2\right) - c_{45} a_5 = 0 \\ 0 + 0 + 0 - a_4 c_{45} + a_5\left(c_{45} - I_5 p^2\right) = 0 \end{cases} \tag{3}$$

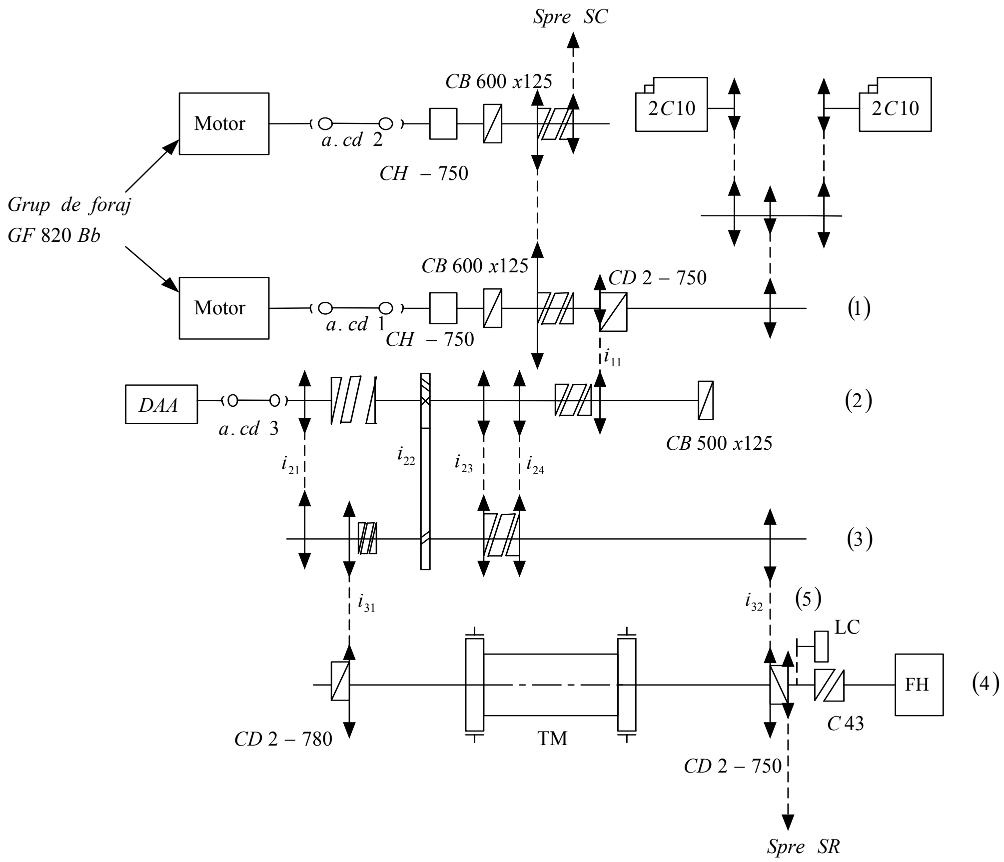

Fig. 2. Power flow diagram for drilling rig type F200-2DH.

The system of equations (3) is resolved through software developed in Matlab.

The perturbation moment

The most important *disturbance (perturbation)* acting on the drill system is produced by the (system) which claims to feature depends on the vibrator regime (the action is hydraulic with diesel engine, fig. 3). Perturbation couple is determined by average time engine torque developed by the action during operations to extract the payload. This perturbation couple will be reduced to tree of the drum for manoeuver.

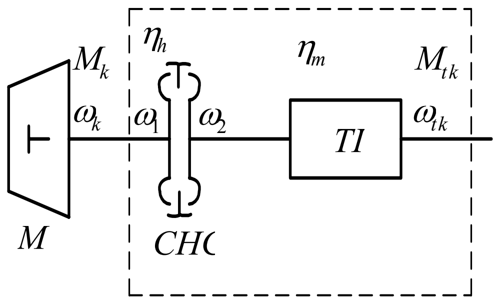

Fig. 3. The action term hydraulic.

M – diesel engine; CHC - hydraulic torque converter, TI - intermediate transmission.

Feature diesel engine should be correlated with characteristic hydraulic torque converter. The operation to be covered is the regime tasks maximum rated power P_n (corresponding system tasks continue maximum), which contains the minimum field strength P_m (corresponding system of partial tasks maximum) - the maximum power P_M (corresponding system tasks intermittent maximum) and feature tuned $M_{tk}(\omega_{tk})$ for a degree injection constant (maximum) ([4]).

In fig. 4 is presented to the functioning of the couple *pf* diesel-hydraulic torque converter (it should be in the best area of the engine and the actual minimum specific consumption, to ensure a high efficiency).

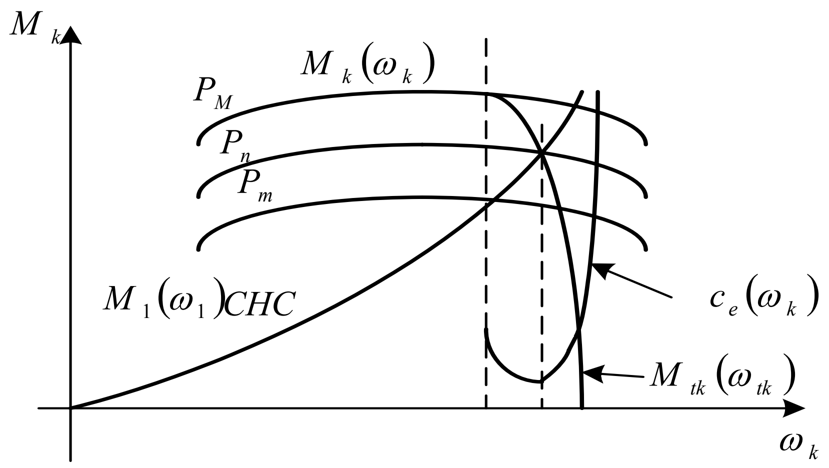

Fig. 4. Correlation operation of motor-hydraulic torque converter.

From the experimental determination has been established that when disturbing M_1 is dependent on the size hydraulic torque converter and speed are appropriate timing of the secondary $M_2^{'}$ ([5]) on the first tree reduced engine drum for manoeuver (it is considered that the other engine idle).

$$M_1 = M_2^{'} \frac{\omega}{\omega_1}$$
$$M_2^{'} = K_{M2} \left(n_1^{'}\right)^2 D^5 \tag{4}$$

where, for CHC750, $D = 0{,}750$ m. For the drill system is examined ω is the angular speed tree engine, ω_1 the angular speed the tree drum first step of speed and $n_1^{'}$ speed to the primary of the hydraulic torque converter. The K_{M2} coefficient depends on the rate of transmission of hydraulic torque converter. Fig.5 obtained from the experimental [5], depending on the speeds of primary and secondary hydraulic torque converter *x* is K_{M2} established ([5]).

Calculation proper pulsation and perturbation couple

Proper pulsation is determined using a program developed by the authors in Matlab language. The three own vibration modes are determined by three pulsations of oscillations own: $p_1 = 2161.5\ \text{s}^{-1}$, $p_2 = 868.8\ \text{s}^{-1}$ şi $p_3 = 631.6\ \text{s}^{-1}$.

Perturbation couple is determined use the Simulink package to the Matlab program. The scheme is carried out simulation shown in Fig. 6, and the result is a simulation in Fig. 7.

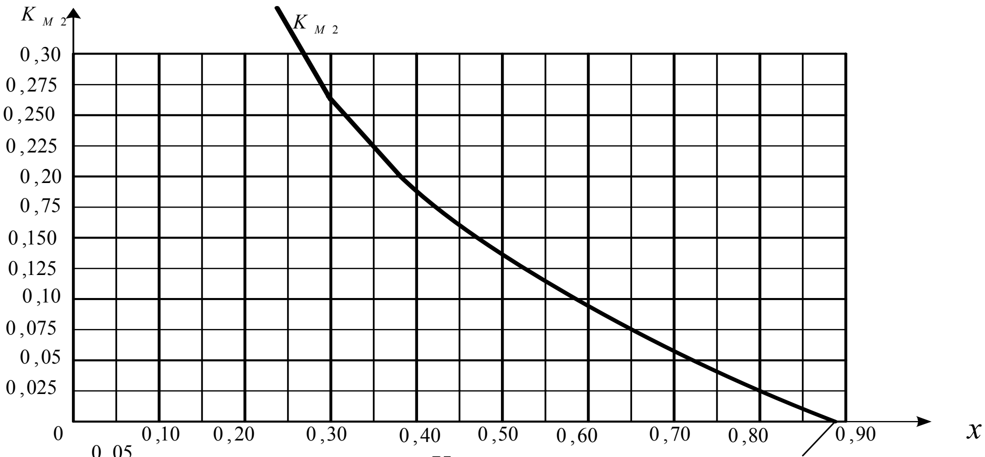

Fig.5. The K_{M2} coefficient.

Conclusions:

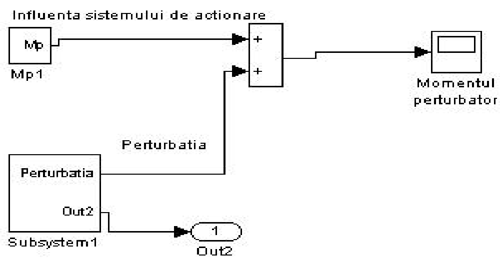

Fig. 6. Established the perturbation couple.

The Simulink of Matlab program is one of the most used programs in engineering simulations for dynamic processes. Models are studied systems that can build or develop knowledge of mathematical model that describes them. Also, the simulation system of equations that describe the existing mathematical models can be for any period of simulation and dynamic response or variations may be obtained for any length of simulation, and this alternative analysis provides a tool very easy managed. Dynamic responses obtained were compared with experimental data from paper [5], and concluded that break is that the results are similar, which makes us recommend using this type of analysis.

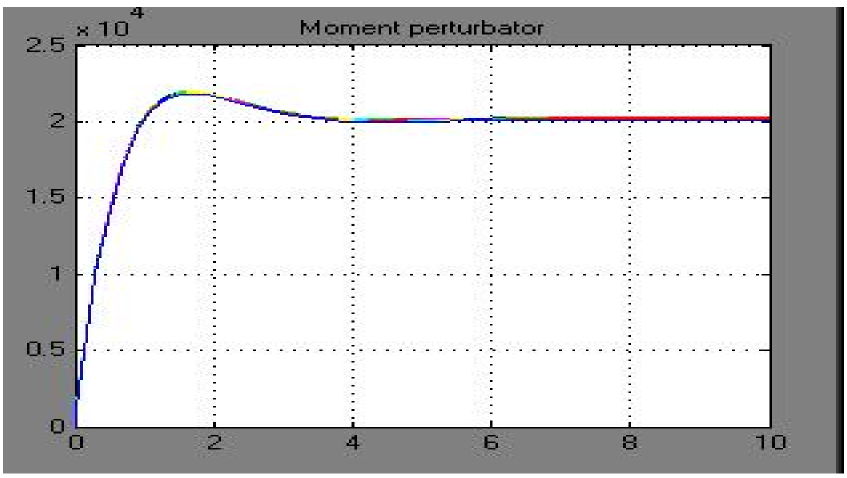

Fig. 7. The variation of the perturbation couple.

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Determinarea pulsaţiilor proprii şi a momentului perturbator a sistemului de manevră

Rezumat

Scopul lucrării este stabilirea pulsaţiilor proprii ale sistemului de manevră al instalaţiilor de foraj cu acţionare diesel-hidraulic şi a variaţiei momentului perturbator determinat de momentul cuplului motor mediu dezvoltat de sistemul de acţionare în perioada operaţiilor de extragere a sarcinii utile.