THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XIV MECHANICAL ENGINEERING, ISSN 1224-5615
2002

THE DYNAMIC STUDY OF THE CRANE "MT – 40" IN THE PROCESS OF GYRATIONS

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ABSTRACT

This work proposes the determination of the dynamic behavior of a tower crane in the process of gyration in sight of a move burdens in the most disadvantageous conditions and namely: in the crane's hook it is a solid body who has the weight equal with the maximum admissible burden of erect found out at the maximum ray of act. The determination of the dynamic arid behavior is made using a mathematical model which has as base a simplified physical model.

1. Introduction

The crane's architecture is as in figure 1, with: 1- tower; 2 - arm; 3- counterarm; 4 - cable; 5 - rotating platform.

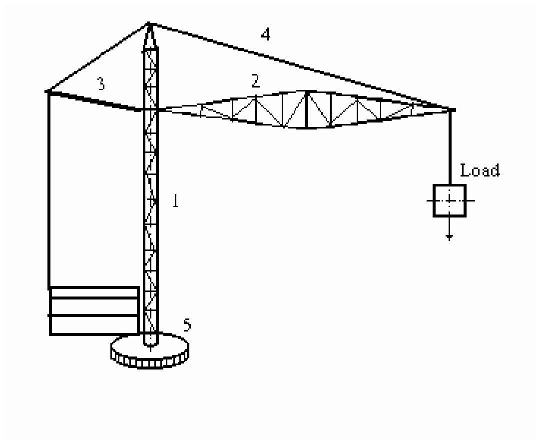

Figure1 The simplified model of the Crane MT - 40

The structure is solicited to pressure and flex in static conditions and twist gave by the forces of inertia on gyration move in dynamic conditions. The pressure, the flex and the twist are determinative solicitations; the wind solicitation is aleatory. The metallic building must be resistant under the solicitations and must confer stability during in the moving.

2. The determination of the elastic constants

For the determination of the elastic constants is used a specialized software application, who resolves this problem using the finite element method, named RDM.

For the study of the phenomenon is defined the real model, followed by the physical model, on which base is defined the mathematical model. This last model is accompanied by the numerical model, on which base the solutions are found.

The physical model is presented in the figure 2.

On the base of this model we write the differential equations of the moving:

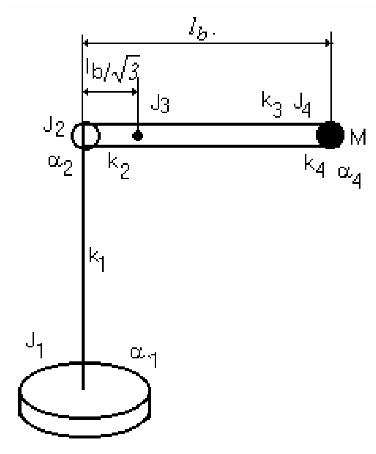

Figure2 The physical model of the crane

$$J_1 \cdot \ddot{\alpha}_1 + k_1 \cdot (\alpha_1 - \alpha_2) + M_{fr1} \cdot sgn(\omega_{mot} - \dot{\alpha}_1) =$$
$$= M_{mot} \cdot sgn(\omega_{mot} - \dot{\alpha}_1)$$

$$J_2 \cdot \ddot{\alpha}_2 + k_2 \cdot \frac{l_b}{\sqrt{3}} \cdot (\alpha_2 - \alpha_3) + k_3 \cdot l_b \cdot (\alpha_2 - \alpha_4) +$$
$$M_{fr2} \cdot sgn \dot{\alpha}_2 = k_1 \cdot (\alpha_1 - \alpha_2)$$
$$J_3 \cdot \ddot{\alpha}_3 + \left(l_b - \frac{l_b}{\sqrt{3}} \right) \cdot (\alpha_2 - \alpha_3) + Mfr_3 \cdot sgn \dot{\alpha}_3 =$$
$$= k_2 \frac{l_b}{\sqrt{3}} (\alpha_2 - \alpha_3)$$
$$J_4 \cdot \ddot{\alpha}_4 + Mfr_4 \cdot sgn \dot{\alpha}_4 = k_4 \cdot \left(l_{b-} \frac{l_b}{\sqrt{3}} \right) \cdot (\alpha_3 - \alpha_4)$$

where:

- J_1, J_2, J_3, J_4 - inertia moments;
- $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ -the angular space;
- $\dot{\alpha}_1, \dot{\alpha}_2, \dot{\alpha}_3, \dot{\alpha}_4$ angular speeds;
- $\ddot{\alpha}_1, \ddot{\alpha}_2, \ddot{\alpha}_3, \ddot{\alpha}_4$ angular accelerations;
- k_1, k_2, k_3, k_4 - elastic constants;
- l_b - the arm's length;
- $M_{fr1}, M_{fr2}, M_{fr3}, M_{fr4}$ - the friction moments;
- M_{mot} - moving moment;
- sgn - the mathematical function "the sign of ..";
- M - the weight of the load;

The presented equations are resolved with a program made in the BORLAND-PASCAL language. The elastic constants and the weight of the structure were determined with the RDM program, and they are:

- $k_1 = 2758620 Nm/rad$ - (the elastic constant at twist solicitation);
- $k_3 = 410959 Nm/m$ - (the elastic constant at flex of the arm as ratio between moment in *Nm* and deplacement in *m*);
- $k_2 = k_3/\sqrt{3};$;
- $k_4 = k_3 \cdot (1 - 1/\sqrt{3});$;

As initial data we had:

$$l_b = 9m; M = 1000kg; J_1 = 800 Kg\, m^2;$$
$$J_2 = 50 Kg\, m^2; J_3 = m_0 \cdot l_b^2/3;$$
$$J_4 = m l_b^2; m_0 = 1500\, kg;$$
$$M_{fr1} = 500 N\, m; M_{fr2} = 50 N\, m;$$
$$M_{fr3} = 50 N\, m; M_{fr4} = 50 N\, m;$$
$$M_{mot} = 20000 N\, m; n_{mot} = 2 rot/min;$$

On the base of the resolving the differential equation system is the Runge-Kutta degree IV method. The real linear deformation of the arm at load goes into a approximate deformation $x \approx l_b \cdot \theta$.

After the program's running on a during of 2 seconds result the moving diagrams, as in figure 3.

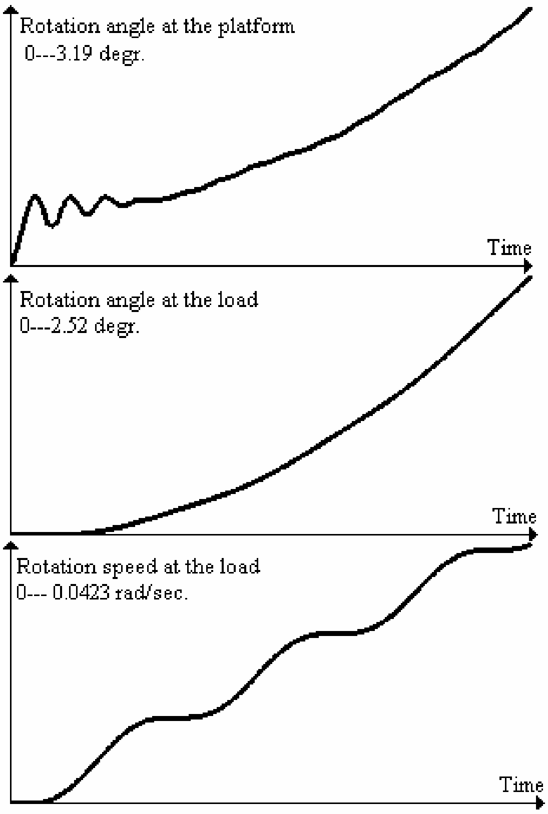

Figure 3. The movings diagrams

In diagrams is to show the dynamic behavior of the crane in first times from the start of the moving. The speed's diagram show clear the oscillant moving, respectively the unstability at the load.

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