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DYNAMIC FORCES IN RUNNING WHEELS TAKING INTO ACCOUNT A FLEXIBLE SUSPENSION OF THE LOAD

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A large number of works by well-known scientists is devoted to the study of dynamic load modes of cranes and the development of methods for their dynamic calculation, as evidenced by the importance of this issue [1-3].

Particular attention is paid to the dynamics of cranes moving on rail tracks in steady state [4-6].

A great contribution to the theory of dynamics of bridge cranes was made by S.A. Cossack. He considered the case of the movement of the mechanism of movement with a flexible suspension of the load without taking into account the collisions in the toothed joints. The S.A. Cossack rightly proposes to use a three-mass calculation scheme with two elastic connections (Fig. 1) [7].

For small load oscillations, the stiffness coefficient of the second elastic bond is determined by the formula [7]:

$$C_2=Q/l \ , \qquad (1)$$

where Q – the weight of the cargo;
l – suspension length.

The horizontal component of the rope tension at small oscillations is determined by this expression:

$$H=Q\varphi, \qquad (2)$$

where φ – the angle of deviation of the center of gravity of the load from the vertical.

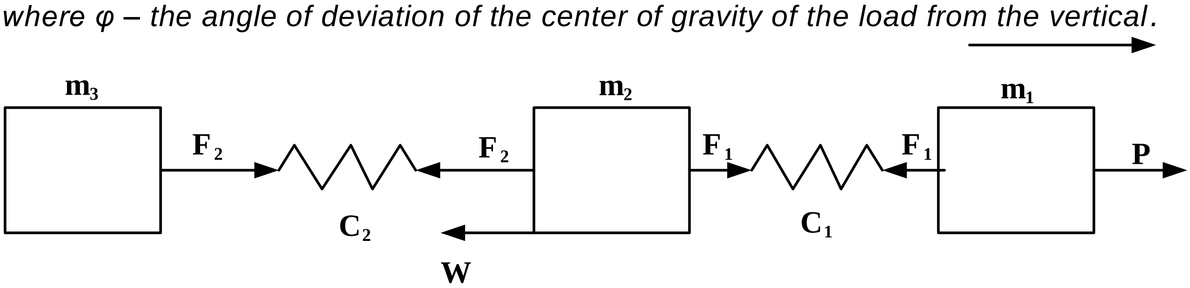

Fig. 1. **Three-mass scheme of flexible load suspension:**
m_1 – mass of rotating parts (mass of the engine motor and other parts, mainly the motor

clutch and brake pulley) m_2 – reduced mass of parts that move forward; m_3 – cargo weight; C_1 – coefficient of stiffness of the low-speed transmission shaft; C_2 – stiffness of another elastic connection

Move horizontally $x_3=l\varphi$, because $x_3=H/C2$.
The equations of motion of each mass will have the form [1]:

$$m_1\ddot{x}_1 = P - F_1,$$
$$m_2\ddot{x}_2 = F_1 - F_2 - W, \quad (3)$$
$$m_3\ddot{x}_3 = F_2.$$

Efficacy in elastic bonds:

$$F_1=W+C_1(x_1-x_2), \quad (4)$$
$$F_2=C_2(x_2-x_3).$$

Solving the system (3) the S.A. Cossack received an equation for loads:

$$F_1=A_1\cos w_1t+A_2\cos w_2t+D_1, \quad (5)$$
$$F_2=A_3\cos w_1t+A_4\cos w_2t+D_2,$$

where frequencies are determined by the formula:

$$\omega_{1,2}^2 = \frac{1}{2}\left(\frac{C_1}{J_1} + \frac{C_1+C_2}{J_2} + \frac{C_3}{J_3}\right) \mp \quad (6)$$
$$\mp \frac{1}{2}\sqrt{\left(\frac{C_1}{J_1} + \frac{C_1+C_2}{J_2} + \frac{C_3}{J_3}\right)^2 - \frac{4C_1C_2}{J_1J_2}\frac{J}{J_3}},$$

where

$$J=J_1+J_2+J_3. \quad (7)$$

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