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# DYNAMICS BRAKING OF THE LIFT

***Miorita UNGUREANU[1], Ioana TAŞCU[2]***
*[1]Lecturer Eng. PhD., [2]Lecturer Mat., PhD.,*
*North University of Baia Mare, Romania*

***Abstract:*** *In this paper it is presented an approaching method of the dynamic process regarding to the lift mechanic brake with friction wheel.*

***Key – words****: lift, brake moment, generalize co-ordinates, generalize speeds, kinetic energy, and potential energy.*

## 1. INTRODUCTION

For the theoretical establishment of the dynamic characteristics of the lift's elastic system at brake, it is presented the gravel scheme in figure 1.

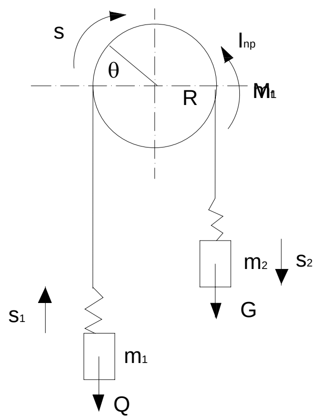

Fig. 2.

When the wording problem take place (when the gravel algorithm is elaborated) there are accepted the next assumptions:[1][2][4]

- the actuation engine is stopped, in conclusion the moment engine is null.
- the reduced mass at the periphery of brake rim for all elements which execute a rotation movement it's considered as an inertia moment reduced $I_{np}$ – to he drum's axis of all the elements in the rotating movement (of the engine, the redactor, the ropes , the pulleys).
- because the moment of braking apply directly on the friction wheel, the rigid/stern of branches cables and the rigid of the action system have a considerable influence on the mechanic system

In the figure 1:

- m1, m2 means the cabin and the counterweight's masses;

- $s_1$ , $s_2$ şi $s$ represents the masses movements and the adequate movement of the rotation angle $\theta$ of the friction wheel in the applying moment of braking till the movement stops;
- $c_1$ and $c_2$ the rigidity coefficients of the two branches of cables.

## 2. MATHEMATIC MODEL

The equation of the lift' s movement , regarding the braking is written under the general equation, with the help of Lagrange equation . [3]

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \rho_i}\right)-\frac{\partial T}{\partial \rho_i}=-\frac{\partial \Pi}{\partial \rho_i}-\frac{\partial D}{\partial \rho_i}+Q_i\left(t\right), \tag{1}$$

in which:

- $T$ is the kinetic energy of the mechanic system
- $\Pi$ - potential energy
- $\rho_i$ - generalize coordinates;
- $D$ - dissipation function;
- $Q_i\left(t\right)$-generalize forces.

In our case we consider $q_1 = s$, $q_2 = s_1$, $q_3 = s_2$, and the generalize forces are:

$$\begin{cases} Q_1\left(t\right)=Q-G+F_f\left(t\right) \\ Q_2\left(t\right)=-Q \\ Q_3\left(t\right)=G \end{cases} \tag{2}$$

In which $F_f$ is the result of braking forces, Q weight forces of cabin, G weight forces of counterweight.

The generalize speeds are: $\frac{ds}{dt}=\dot{q}_1$, $\frac{ds_1}{dt}=\dot{q}_2$, $\frac{ds_2}{dt}=\dot{q}_3$ .

- $\dot{\theta}=\dot{q}_3$ - the angular speed;
- $\frac{ds}{dt}$ -speed of the cabin;
- $\frac{ds_1}{dt}$ -speed of the counterweight.

The kinetic energy is written under the form:

$$:T=\frac{m_{np}}{2}\cdot\dot{q}_1^2+\frac{m_1}{2}\cdot\dot{q}_2^2+\frac{m_2}{2}\cdot\dot{q}_3^2, \tag{3}$$

We obtain the partial derivative:

$$\frac{\partial T}{\partial \dot{q}_1} = I_{np} \cdot \dot{q}_1, \tag{4}$$

$$\frac{\partial T}{\partial \dot{q}_2} = m_1 \cdot \dot{q}_2, \tag{5}$$

$$\frac{\partial T}{\partial \dot{q}_3} = m_2 \cdot \dot{q}_3 \tag{6}$$

and we have

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_1}\right) = I_{np} \cdot \ddot{q}_1, \tag{7}$$

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_2}\right) = m_1 \cdot \ddot{q}_2, \tag{8}$$

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_3}\right) = m_2 \cdot \ddot{q}_3. \tag{9}$$

Potential energy is written under the form:

$$\Pi = \frac{1}{2}(q_1 - q_2)^2 \cdot c_1 + \frac{1}{2}(q_3 - q_1)^2 \cdot c_2 \tag{10}$$

We obtain the partial derivative:

$$\frac{\partial \Pi}{\partial q_1} = (q_1 - q_2) \cdot c_1 - (q_3 - q_1) \cdot c_2 \tag{11}$$

$$\frac{\partial \Pi}{\partial q_2} = -(q_1 - q_2) \cdot c_1 \tag{12}$$

$$\frac{\partial \Pi}{\partial q_3} = (q_3 - q_1) \cdot c_2 \tag{13}$$

We consider that the extern forces are proportional with the speed than the dissipative function has this form [3]:

$$D = \frac{1}{2_1} k_1 \cdot \dot{q}_2^2 + \frac{1}{2} k_2 \cdot \dot{q}_3, \tag{14}$$

In witch $k_1$ and $k_2$ are dissipation coefficients.

The dissipation function has the partial derivative:

$$\frac{\partial D}{\partial q_1} = 0 \tag{15}$$

$$\frac{\partial D}{\partial q_2} = k_1 \cdot \dot{q}_2 \cdot \ddot{q}_2 \tag{16}$$

$$\frac{\partial D}{\partial q_3} = k_2 \cdot \dot{q}_3 \cdot \ddot{q}_3 \; . \tag{17}$$

Replacing the value of T, $\Pi$, D, in the equation (1) and in condition bases (2) results the following system of the differentiated equation:

$$\begin{cases} m_{np}\left(\ddot{q}_1 - \dot{q}_1\right) = \left(q_1 - q_2\right)\cdot c_1 - \left(q_3 - q_1\right)\cdot c_2 + Q - G + F_f\left(t\right) \\ m_1\left(\ddot{q}_2 - \dot{q}_2\right) = -\left(q_1 - q_2\right)\cdot c_1 - k_1\,\dot{q}_3\,\ddot{q}_2 - Q \\ m_2\left(\ddot{q}_3 - \dot{q}_3\right) = \left(q_3 - q_1\right)\cdot c_2 - k_2\,\dot{q}_3\,\ddot{q}_3 + G \end{cases} \tag{18}$$

The system can be solved trough numbering methods

**CONCLUSIONS**

Replacing in the system (18) the numbering values for the masses, for the coefficients and for the braking moment (for concrete cases of working), it's possible to determine the generalized coordinates which are the movements $s_1$ , $s_2$ end $s$ .Knowing these movements is very important to achieve the position of the cabin at the loading and unloading platform level.

**REFERENCES**


1. Belobrov,V. I.**,** Dinamika, nagrev i iznos tormozov şahtnâh podbemnâh maşin, Naukova dumka, Kiev, 1981.
2. Crăciunoiu V., ş.a., Ascensoare electrice, Editura Tehnică Bucureşti,1966.
3. Mihăilescu Ş. ş.a., Maşini de construcții, vol 3, Editura tehnică Bucureşti, 1986.
4. Spivacovschi, A., O. Rudenco N.F.**,** Maşini de ridicat şi de transportat, Traducere din limba rusă, Editura Tehnică, Bucureşti, 1953.
5. Teodorescu, N., Olariu V., Ecuații diferențiale şi cu derivate parțiale vol. I, II, Editura Tehnică, Bucureşti, 1979.
6. Vâță I., ş.a., Maşini de ridicat în construcții, Editura Tehnică Bucureşti 1989.