DIAGNOSIS OF WINDING ENGINE BRAKE MECHANISM IN BLIND SHAFT No. 15 IN PETRILA MINE

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ABSTRACT**:** *Diagnosis of winding engine brake mechanism in mines is important to provide normal extraction vessel movement in the shaft, or stopping machines in a certain position of the vessels in disturbances or failures. The paper presents the calculus of theoretical and real safety coefficients in the use of safety and maneuver brakes. Experimental measurements were made in Blind Shaft No. 15 in Petrila Mining Plant in view of examination and adjustment of the winding engine.*

KEYWORDS: loads, tower, strain, displacements, structure

1. INTRODUCTION

The development in safe conditions of the extracting process continuously imposes the need of optimal functioning of the extracting installations as important links in the transport flow. The fundamental elements of an extraction installation placed on the mining surface are: the extraction tower, the countrafort, the extraction pulleys, the extraction cable, the extraction vessels and the extraction-machine consisting of the wrapping device of the cable, the reducing-gear and the action engine. If the installation is meant for a blind shaft, the extraction vessels are lifted from the inferior ramp of the lower level to the ramp level of a superior level. The upper part of the shaft, over the ramp of the superior level, has the role of a winding tower.

Every extraction machine is foreseen with a stop–gear whide ensure the right movement of the extraction vessels, or allows to stop the machine in a certain position of the vessels (brake tests) and the automatic stopping machine, independently of the operator will, in one of the following situations, considered to be perturbations or damages: tension absence, pressure diminution of the working fluid for the braking action, the over raising of the extraction vessels, exceeding the accepted speed, overloaded etc. (safety–braking) [1]. Speed reducing made by the brake system mist be included between 1,5–5 m/s2 and the answer length of the brake (from the action release till the effective application) at the most 0,7 s. Constructive, the brake system consists of two components: the implementation mechanism and the action system. Depending on the implementation system, the common engineering brakes can be with disk or with shoes, and from the point of view of actuation, can be with weights and, spring assembly, pneumatics, hydraulics and combined.

2. INSTALLATION CONSIDERED

The installation considered equipping the blind shaft no. 15 in Petrila Mine, meant [5] to supply materials and machines and man travel from and between levels -18 (level - 15, (Fig.1), -200 (level -214,898) and -250 (level -254,871).

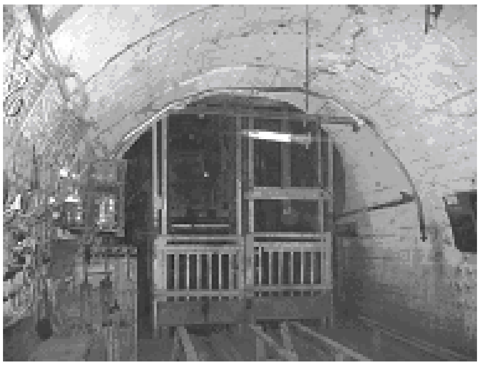

Fig. 1. Shaft ramp - 18 horizon (level - 15,744)

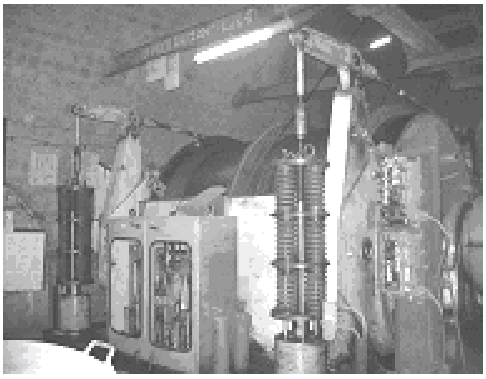

Fig. 2. 2T-3 1,5 type winding engine

The installation meant for the shaft is unbalanced and equipped with an 2T-3 x 1,5A type winding engine (Fig. 2) fitted with an MIP 3X-450Y-110-6 type, 630W power, 990 rpm nominal rotation asynchronous machine (Fig. 3). The machine's reducer is 2 TS-880 type, of 30 transmission ratio (Fig. 4). Φ 34 mm diameter and 4,15 kg/m weight (per linear meter) winding cables wind over the two Φ 3000 mm extraction pulleys, at a 20,46 m height (pulley axes) as to the winding part.

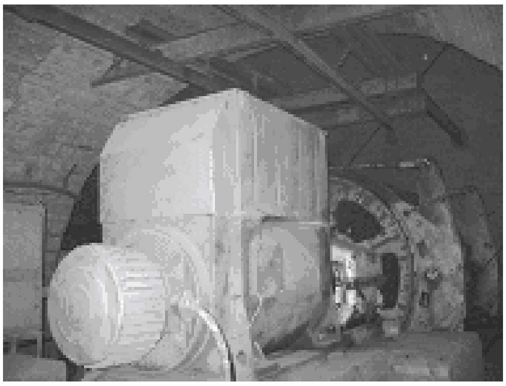

Fig. 3. Winding engine motor

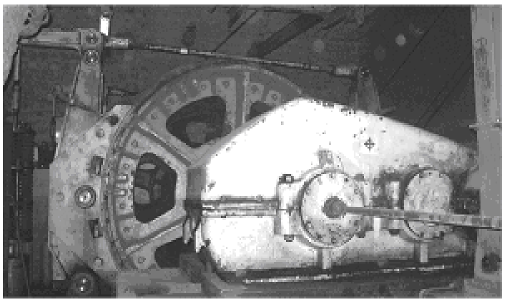

Fig. 4. Reducer

Cables are winded in one layer over each of the two drums of the engine, one of which is fixed and one mobile, and of which they are fixed with one end at their outside extremity.

The other end of the cables is fixed of the winding engine by means of the cable linking device (C.L.D.) Extraction vessels are non-tilting cages.

The left cage is with decked bascule-bride, with two cars per deck, of 5390 kg weight (its own plus C.L.D.)

The right cage (Fig.5) is one decked, with two cars per deck, of 4748 kg weight (its own mass plus C.L.D.). The weight of a car is 650 kg, and its useful load is 1600 kg/car.

Fig. 5. Extraction vessel in ramp

3. INSTALLATION CONSIDERED

Constructive, the brake system consists of two components: the implementation mechanism and the action system. Depending on the implementation system, the common engineering brakes can be with disk or with shoes, and from the point of view of actuation, can be with weights and, spring assembly (Fig.6), pneumatics, hydraulics and combined.

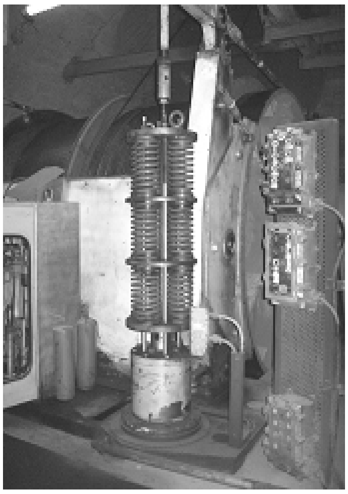

Fig. 6. Spring battery

The implementation mechanism of the brakes with sabots and levers (Fig.7) consists of two support bras (1), articulated in mainstays (2) connected each other through the rod (3) actuated by raising or lowering the lever (4).On the support bars there are fixed the prop (5) of the brake sabots (rigid in case of angular movement and articulated in case of parallel motion).

On the inner side surface of the props have been fixed the sabots (6) whit action straight about the brake system.

The sabots motion during the braking time is stopped by the mainstays (7) at the ends of the props (5).

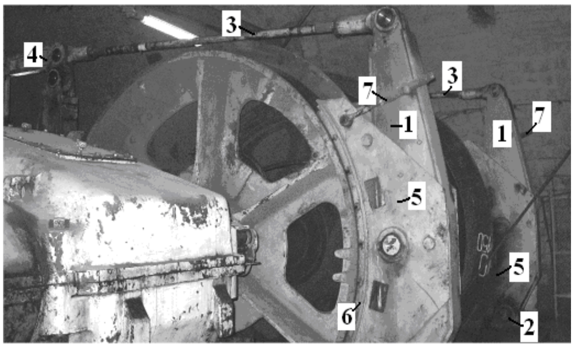

Fig. 7. Spring battery

4. OPERATING CONDITIONS REQUIRED FOR THE BRAKING DEVICE

Braking momentums, both for maneuver and for safety braking should be at least three times the static momentum:

$$M_{fr} \geq 3M_{st} \text{ , Nm} \quad (1)$$

In case of an unbalanced winding engines (no compensation cable (balance)), static momentum is:

$$M_{st} = g\left(Q_u + qH\right)R \text{ , Nm} \quad (2)$$

Where g is gravitational acceleration, g = 9,81 m/s^2;

Q_u useful mass of extraction vessel, kg; q weight per linear meter of extraction cable, kg/m; H extraction depth, m; R is radius of the winding part, m.

For a statically or dynamically balanced installation (with compensation cable):

$$M_{st} = g\left[Q_u + \left(q - q_1\right)H\right]R \quad \text{, Nm} \tag{3}$$

where q_1 is mass per linear meter of compensation cable, kg/m.

In case of adjusting drum position as to another, in changing the hoisting level, braking momentum will be developed on the fixed drum rim:

$$M'_{fr} \geq 1{,}2M_{1st} \quad \text{, Nm} \tag{4}$$

where M_{1st} is static momentum of a cable branch, generated by the weight of the empty extraction vessel and the extraction cable, Nm

$$M_{1st} = g\left(Q_c + qH\right)R \quad \text{,Nm} \tag{5}$$

where Q_c is mass of the empty extraction vessel, kg.

Maximum distance between shoes and braking rim should be no more than 2 mm. A deceleration of at least 1,5 m/s^2 and at most 4…5 m/s^2 is also required during braking, but the critical magnitude when driving wheel winding installation cables slide shall not be exceeded.

5. THE MECHANISM DIAGNOSIS

Braking–mechanism diagnosis for the mining extraction–machines consists in establishing the real safety coefficients when the safety–brake is applied and shunting–brake is applied too [1], [2].

For the experimental checking of the effective forces of stretching from the tyrants (in the rods 3 Fig.7), and the estimation of the real safety coefficients, two tension meters marks have been stuck together on each tyrant (Fig.8 and Fig.9), diametrically contrariwise, in order to eliminate the bending–effect and by means of other two compensation–marks has been made up a Wheatstone–deck with two active branches and two passive ones [2], [3]. The experimental measurements have been made at the Auxiliary blind shaft number 15 at Petrila Mining Plant [4] in order of examination and regulation the extraction –machine.

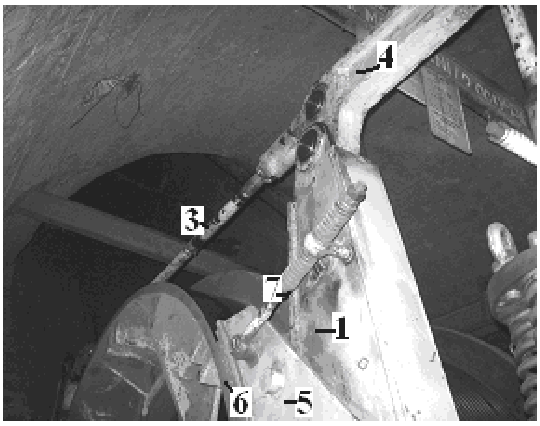

Fig. 8. Left tyrant with tensiometric marks

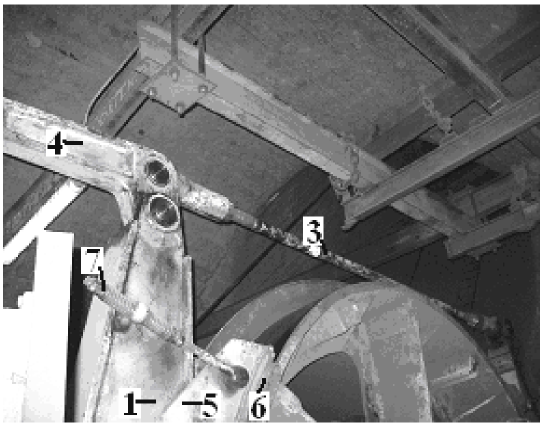

Fig.9. Right tyrant with tensiometric marks

The values forces from the tyrants, by means of which the safety coefficients have been calculated obtained as following the measurements performed during the extraction cycle, together with cinematic elements of the vessels motion movement on the shaft – raising have been rendered in Fig 10 and 11.

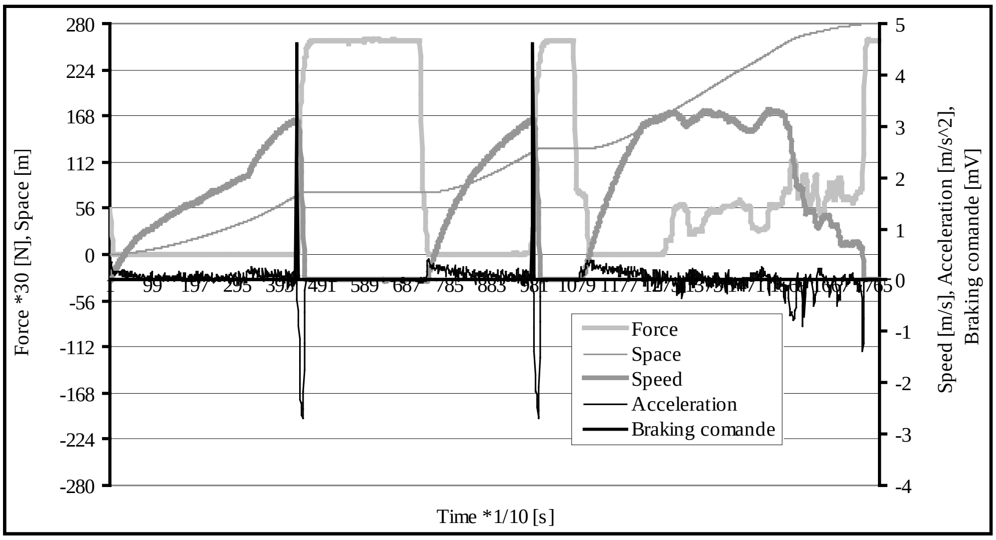

Fig.10. Left tyrant, left cage goes up

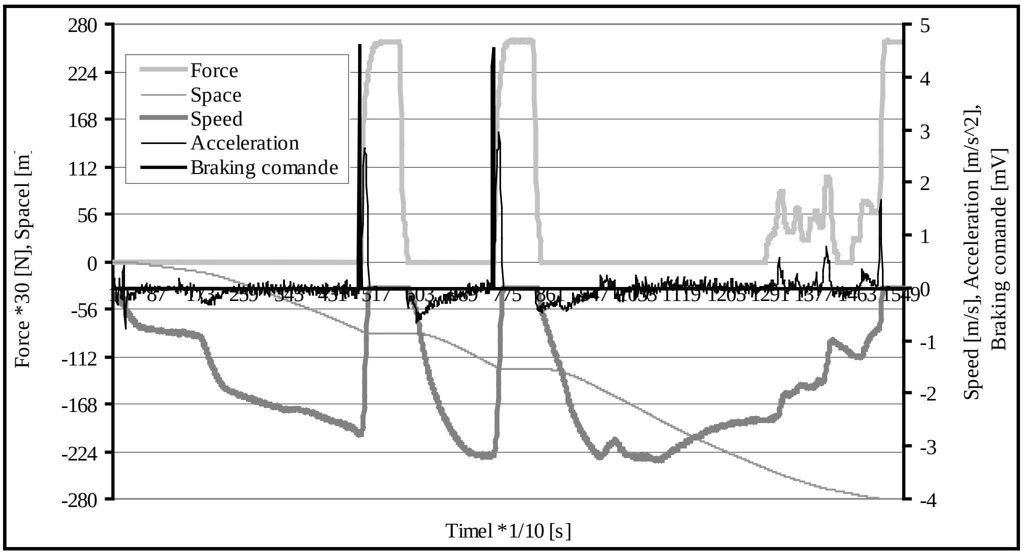

Fig.11. Left tyrant, left cage goes down

6. DETERMINATION OF BRAKING MOMENTUMS AND SAFETY COEFFICIENTS

Left brake .î – Closed Right brake

$F_{S\hat{i}}$ $F_{d\hat{i}}$

$\Delta mV_s = 0{,}085$ $\Delta mV_d = 0{,}085$

$F_{M\hat{i}.}$.$F_{M\hat{i}}$

ε – Specific measured deformation µm/m

$$\varepsilon_s = \frac{4000 \Delta mV_s}{2.2{,}06} \qquad \varepsilon_d = \frac{4000 \Delta mV}{2.2{,}06}$$

Stretching forces in tie bars F (daN)

$F_s = \varepsilon_s . E_o . S_s . 10^{-6}$ $F_s = 6{,}669x10^3$ $F_d = \varepsilon_d . E_o . S_d . 10^{-6}$ $F_d = 6{,}669x10^3$

D_j – Diameter of braking rim (m) $D_j = 2{,}9$

i_2 – Partial amplification ratio (post shoe holder) .$i_2 = 2{,}5$

Left brake braking momentum (daN·m) Right brake braking momentum (daN·m)

$$M_{Fs} = \frac{F_s . i_2 D_j 2.\mu.\eta.}{2} \quad M_{Fs} = 1{,}378x10^4 \qquad M_{Fd} = \frac{F_d i_2 D_j 2\mu.\eta}{2} \quad M_{Fd} = 1{,}378x10^4$$

Total braking momentum: M_t (daN·m)

$Mt = M_{Fs} + M_{Fd}$ $M_t = 2{,}756x10^4$

c_s – Experimentally determined actual safety coefficient

M_{st1} – Maximum static momentum (daN) $M_{st1} = 3{,}046$

$$c_s = \frac{M_t}{M_{st1}} \qquad c_s = 4{,}14$$

7. CONCLUSIONS

Mine winding engines brake mechanisms is important to provide normal extraction vessel movement along the shaft, or stopping the engine in a certain position of the vessel in disturbances or failures.

The calculus of the theoretical and real safety coefficients of safety brake application and maneuver brake application is given in the paper.

To assess the real safety coefficient, results obtained by tensiometric measurements were used.

After diagnosis, necessary information is obtained to improve present maintenance system and repair this category of machines in view of increasing safety in use of winding installations, with possibility of monitoring brake mechanism.

8. REFERENCES

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