

## **VERIFY OF THE WINDING ENGINE BRAKE MECHANISM IN AUXILIARY SOUTH SHAFT IN LUPENI MINING PLANT**

**RĂZVAN BOGDAN ITU<sup>1</sup>, IOSIF DUMITRESCU<sup>2</sup>,  
MIHAI CARMELO RIDZI<sup>3</sup>, BOGDAN ZENO COZMA<sup>4</sup>,**

**Abstract:** Verify 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 brakes. Experimental measurements were made in South Shaft in Lupeni Mining Plant in view of examination and adjustment of the winding engine.

**Keywords:** verify, brake mechanism, winding engine

### **1. INTRODUCTION**

The normal 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 miningsurface 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 which ensure the right movement of the extraction vessels, or allows to stop the machine in a certain position

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<sup>1</sup> *Eng. Ph.D., Cooperating professor, University of Petroșani*

<sup>2</sup> *Eng. Ph.D., Associate Prof., University of Petroșani*

<sup>3</sup> *Eng. Ph.D., Associate Prof., University of Petroșani*

<sup>4</sup> *Eng. Ph.D., Lecturer, University of Petroșani*

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 must be included between 1,5–5  $\text{m/s}^2$  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.

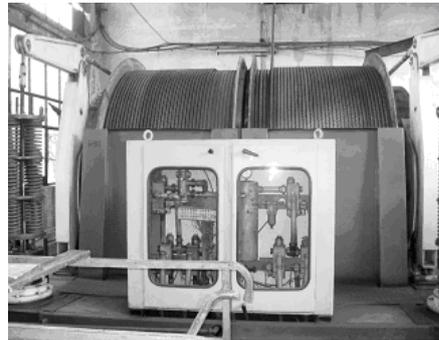
Depending on the implementation system, the common engineering brakes can be with disk or with shoes, and from the point of view of actuation, can be with weights and, spring assembly, pneumatics, hydraulics and combined.

## 2. THE EXTRACTING INSTALLATION TAKEN INTO STUDY

The auxiliary well South Shaft, from Lupeni Mining Plant (Fig. 1), is destined for the underground supply with materials and tools as well as for transporting personal. The personal and materials transport is done to and among levels 650, 400 and 300 (pump stations for the evacuation of waters from the underground) [7] The extracting installation that supplies the well (Fig. 1) is unbalanced (without a balance cable) and has an extracting machine type 2T-3,5 1,7 A. (Fig. 2) The extracting cables are wrapped onto two layers (rows) on each of the two pulleys from which one is fixed and one is mobile, and are tied at one end at the outer border of each pulley.



**Fig. 1.** Extracting installation



**Fig. 2.** Extracting machine

Cables are wound 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-bridge, with two cars per deck, of 5390 kg

weight (its own plus C.L.D.)

The right cage 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.

### 3. THE MECHANISM OF IMPLEMENTATION

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. 3), pneumatics, hydraulics and combined.

The implementation mechanism of the brakes with sabots and levers (Fig. 4) 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).

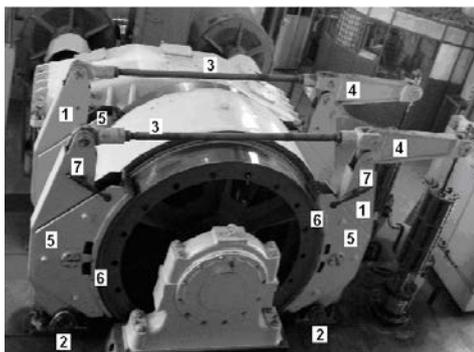


Fig. 3. Winding engine brake mechanism

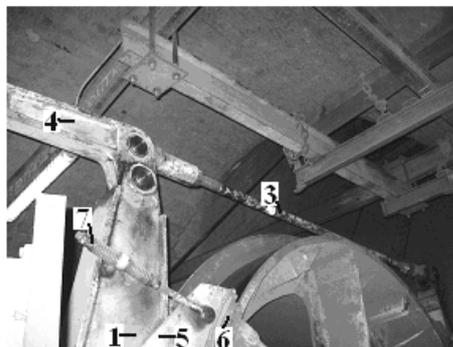


Fig. 4. Tyrant wit tension meters marks

### 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:

$$M_{fr} \geq 3M_{st} \text{ [Nm]} \tag{1}$$

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

$$M_{st} = g(Q_u + qH)R \quad [\text{Nm}] \quad (2)$$

Where:  $g$  is gravitational acceleration,  $g = 9,81[\text{m/s}^2]$ ;  $Q_u$  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):

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

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:

$$M'_{fr} \geq 1,2M_{1st} \quad [\text{Nm}] \quad (4)$$

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

$$M_{1st} = g(Q_c + qH)R \quad [\text{Nm}] \quad (5)$$

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  $1,5 \text{ m/s}^2$  and at most  $4 - 5 \text{ m/s}^2$  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. 3), and the estimation of the real safety coefficients, two tension meters marks have been stuck together on each tyrant (Fig. 4 right tyrant), 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 Wheatstone bridge was balanced with a compensator, in various states of the brake, and specific deformation of the material was determined. MM-SUA made EA-06-250BG-120 type tensiometric marks were applied, nominal resistance 120 ohms, actual sensitivity factor 2,06 and SPIDER 8 type measuring amplifier. Measurements were effected in a static regime to determine absolute magnitudes. To find the dynamics of the phenomena, output signal from the amplifier was recorded

with a data acquisition system.

The experimental measurements have been made at the Auxiliary South Shaft at Lupeni Mining Plant [4] in order of examination and regulation the extraction – machine. The values forces from the tyrants, by means of 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 5 and 6.

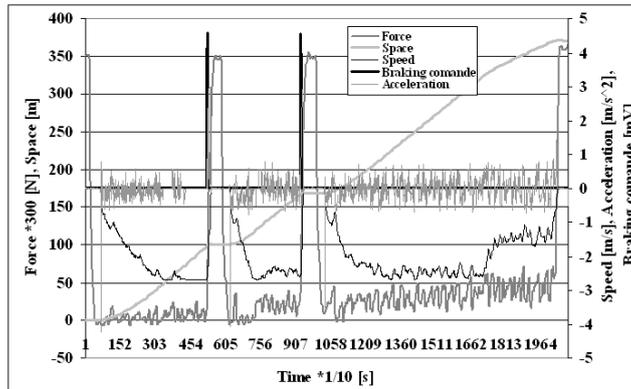


Fig. 5. Right tie bar, right skip going down

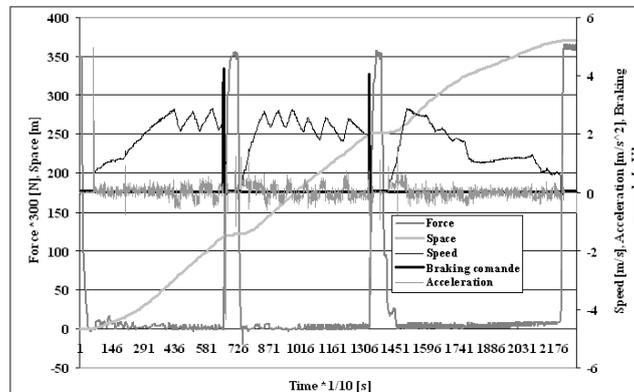


Fig. 6. Right tie bar, right skip going up

### 6. DETERMINATION OF BRAKING MOMENTUMS AND SAFETY COEFFICIENTS

Left brake  
 $F_{Si}$   
 $\Delta mV_s = 0,176$   
 $F_{Mi}$

$\hat{i}$  – Closed

Right brake  
 $F_{di}$   
 $\Delta mV_d = 0,178$   
 $F_{Mi}$

$\epsilon$  – specific measured deformation  $\mu\text{m/m}$

$$\varepsilon_s = \frac{4000\Delta m V_s}{2.2,06}$$

$$\varepsilon_d = \frac{4000\Delta m V}{2.2,06}$$

Stretching forces in tie bars F (N)

$$F_s = \varepsilon_s E_o S_s 10^{-6} \quad F_s = 1,119 \times 10^5 \quad F_d = \varepsilon_d E_o S_d 10^{-6} \quad F_d = 1,131 \times 10^5$$

$D_j$  – Diameter of braking rim (m)

$$D_j = 3,08$$

$i_2$  – Partial amplification ratio (post shoe holder)

$$i_2 = 2,877$$

Left brake braking momentum (N·m)

Right brake braking momentum (N·m)

$$M_{F_s} = \frac{F_s i_2 D_j 2\mu\eta}{2}, \quad M_{F_s} = 2,825 \times 10^5, \quad M_{F_d} = \frac{F_d i_2 D_j 2\mu\eta}{2}, \quad M_{F_d} = 2,857 \times 10^5$$

Total braking momentum:  $M_t$  (N·m)

$$M_t = M_{F_s} + M_{F_d}$$

$$M_t = 5,682 \times 10^5$$

$c_s$  – Experimentally determined actual safety coefficient

$M_{st1}$  – Maximum static momentum (N m)

$$M_{st1} = 165310$$

$$c_s = \frac{M_t}{M_{st1}}$$

$$c_s = 3,437$$

## 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.

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