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Aspects Regarding Data Processing Obtained from Measurements for Braking System Verification of Winding Installation Machines

The paper presents aspects on data processing obtained following measurements and recordings made in view of verification of braking system of winding installation machines. To exemplify these aspects, braking system verification of winding installation machine at Shaft 2 in Lupeni Mining Plant and the braking system of winding installation machine of Central Shaft at Petrila Mining Plant were studied.

***Keywords**: data processing, winding installation machines*

1. Introduction

According the exploitation norms and occupational safety standards, each winding engine shall be fitted with a braking device (Fig. 1 and Fig. 2) providing normal running of hoisting vessels, or stopping the engine in a given position of vessels (maneuver braking) and automatic stopping of the engine, irrespective of the operator's will, one of the following cases being considered disturbance or malfunctioning: de-energizing, dropping working fluid pressure for brake actuation, over height of hoisting vessels, exceeding admitted speed, overcharge etc.(safety braking).

The calculus of the real safety coefficients of safety brake application and is given in the paper. To assess the real safety coefficient, results obtained by tensiometric measurements were used.

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.

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.

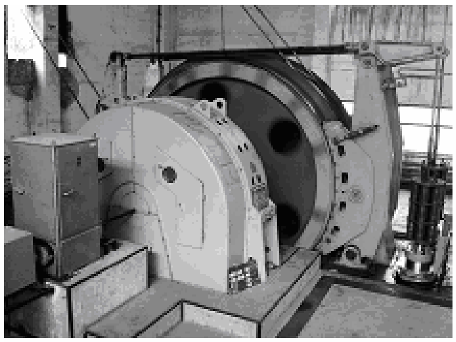

Figure 1. Winding machine
Petrila Mine „Shaft with new skip”

Figure 2. Winding machine
Lupeni Mine „No. 12 auxiliary shaft"

2. The Mechanism of implementation

The braking mechanism is designed in two parts: the execution mechanism and the actuation mechanism.

Depending on the execution mechanism, the common design brakes can be with band and with shoes, and actuation wise, through weights and arches (Fig. 1 and Fig.2), pneumatic, hydraulic and combined.

Brake execution mechanisms are made up of braking shoes and transmission by levers connecting shoes to the actuation device.

Execution mechanisms are common (in most of the cases) for maneuver braking and safety braking.

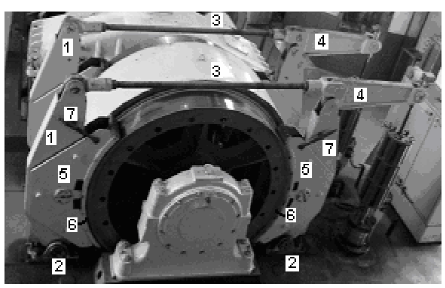

Figure 3. Braking system of „MK 2,5x4 Shaft with skip‟ type winding machine with driving wheel
Livezeni Mine

The implementation mechanism of the brakes with sabots and levers (Fig. 3) 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).

3. 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::

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

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

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

where g is gravitational acceleration, g=9,81[m/s^2]; Qu 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)::

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

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.

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

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.

As mentioned above, movement of the cable and of the load is initiated due to the force of friction between the cable and the driving wheel.

Therefore, the deeper the extraction, the higher the safety for cable sliding on the driving wheel.

To avoid cable sliding on the driving wheel, a certain ratio of the cable winding and unwinding tensions will be maintained. In this sense, both starting acceleration and delay in case of braking are limited.

4. Measuring efective forces in braking mechanism tyrants

Besides the winding instalation equipment with braking device providing normal extraction cycle , winding installation is also eqipped with indicator and recording control apparatus, as well as with safety devices which should provide the possibility of a rational control, change of work regime and obtaining information regarding information on the operation state and regime of the winding installation

Thus, the speed indicator indicates in any moment the speed of the extraction vessels.

When variation in time of the speed is also recorded, the apparatus is called tachograph.

The tachogram recorded allows the control of the instalation operation(number and duration of winding cycles, halts etc.). In modern winding installations electrical tachographs are used based on tachogenerators and selsines with no contact, having as visualization apparatus an indicator –recorder voltmeter scaled in speed units, mounted on the control desk.

In view of verification of the braking system, effective forces of the tyrants of the braking mechanisms (rods 3) were determined in the case of application of the safety brake, which actioned by lifting and lowering the levers(4) entails the support rods on which the brake slides supports are fixed (Fig. 4).

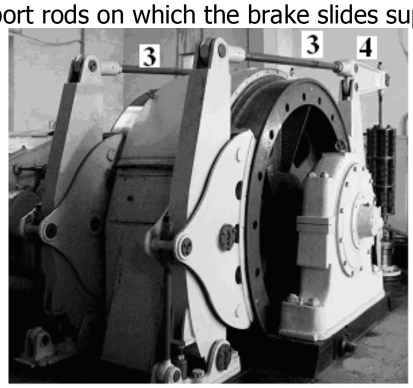

Figure 4. Braking device of MK 2,5x4 winding machine with driving wheel "Auxiliary shaft No. 1" Livezeni Mine

In view of verification of the braking system, effective forces in tyrants were determined.

Measurements were made to determine effective forces in tyrants in case of application of the safety brake, with empty moving extraction vessels(in dynamic regime), by simulating a case considered distubance or failure.

Simultaneously with measuring forces in tyrants in a complete movement of the extraction cycle, speed was measured.

To determine by measurements the forces in tyrants as experimental investigation method, electroresistive tensionmetry was applied, which by the simplicity of its use and accuracy of data supplied, proved to be especially efficient.

MM-USA made EA-06-250 BG-120 type tensionmetric stamps were applied, of 120 'Ω nominal resistance, and 2.06 sensitivity factor, with which a Wheatstone bridge was made, with two active branches and two passive ones(Fig. 5).Thus, on each of the two tyrants two tensionmetric stamps were attached, diametrally opposed, in view of eliminating the bending factor, and other two tensionmetric stamps of compensation (Fig. 6).As signal amplifier, a SPIDER 8 type measuring amplifying apparatus was used, with four modules for the measuring channels, whose scheme of principle is shown in Fig. 7. The outlet signal from the amplifier was recorded with the help of a data acquisition system (Fig. 8).

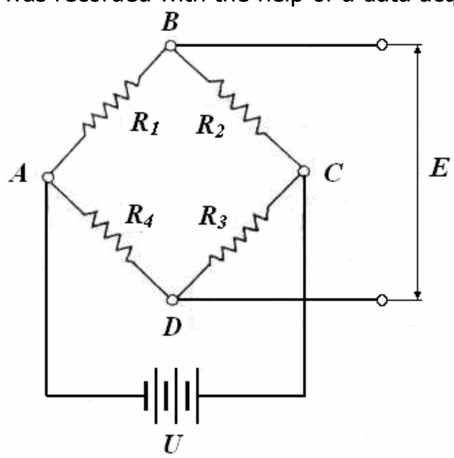

Figure 5. Wheatstone bridge

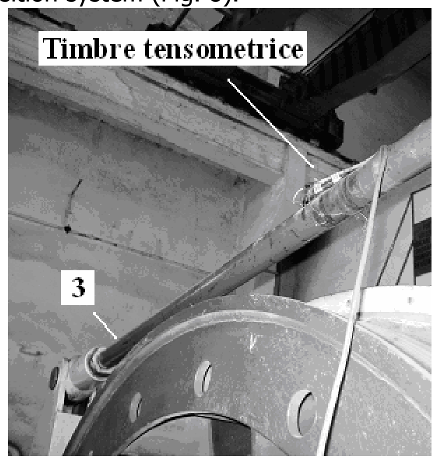

Figure 6. Stamps mounted on the tyrant

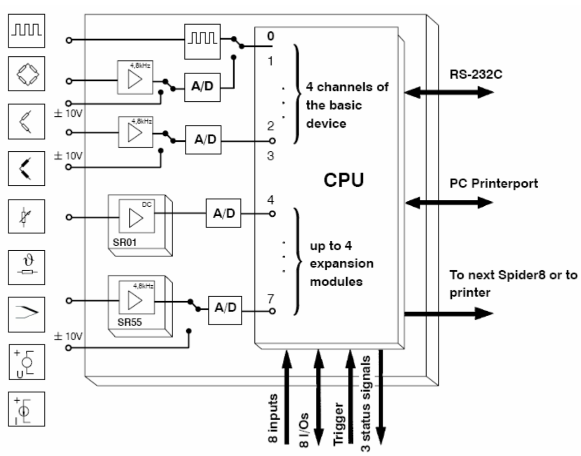

Figure 7. SPIDER 8 Scheme of principle

Figure 8. Acquisition system

5. Data processing obtained as a result of measurements

To be processed by a computer, analogical information perceived by the technical measuring devices(transducers), had to be converted in digital form, digitalization of analogical information showing advantages, such as fidelity of record, memory (stocking) and transmission.

Thus the information obtained following the measurements was converted in numerical data, in five columns in the form of a table, the first column being for the measurements performed, the second and the third representing time base for the measurements performed, the forth column being tension values for safety brake control, indicating the moment when this was applied to stop the extraction vessels in motion along the shaft, and the last column (the fifth) representing the speed variation recorded from the winding machine's tachogenerator.

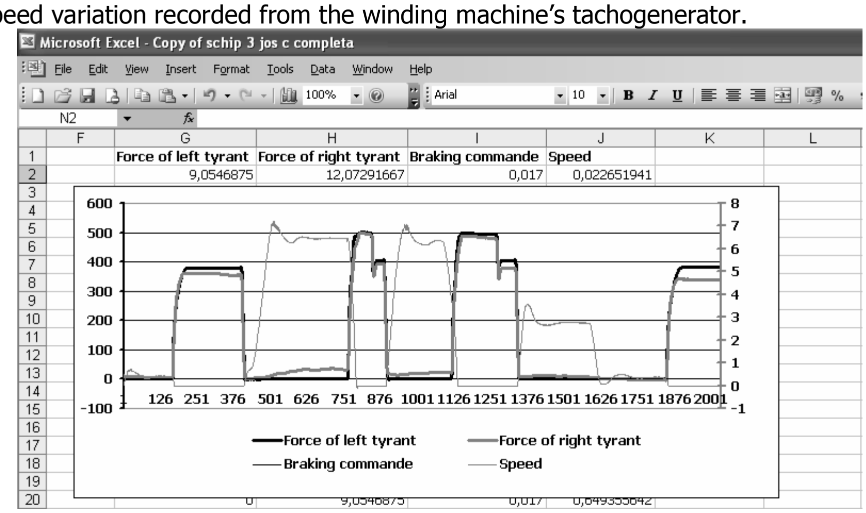

Figure 9. Calculation sheet with representation of measured magnitudes.

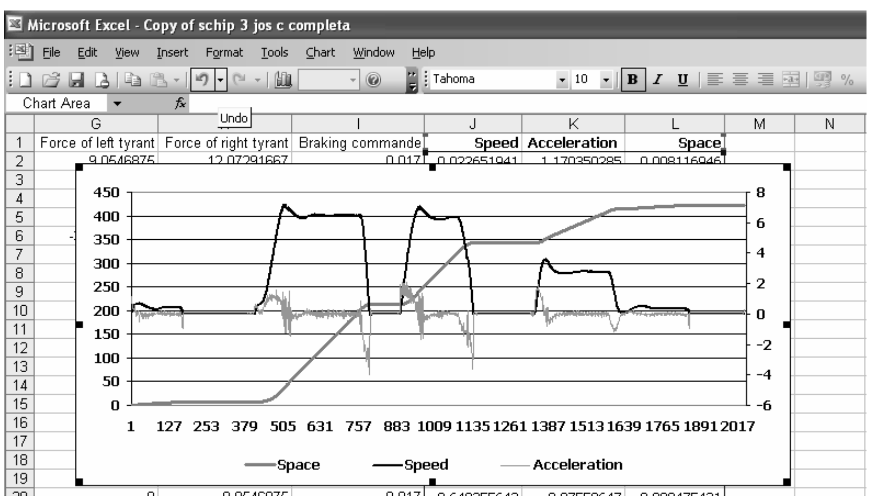

Figure 10. Calculation sheet with speed, acceleration and space representation

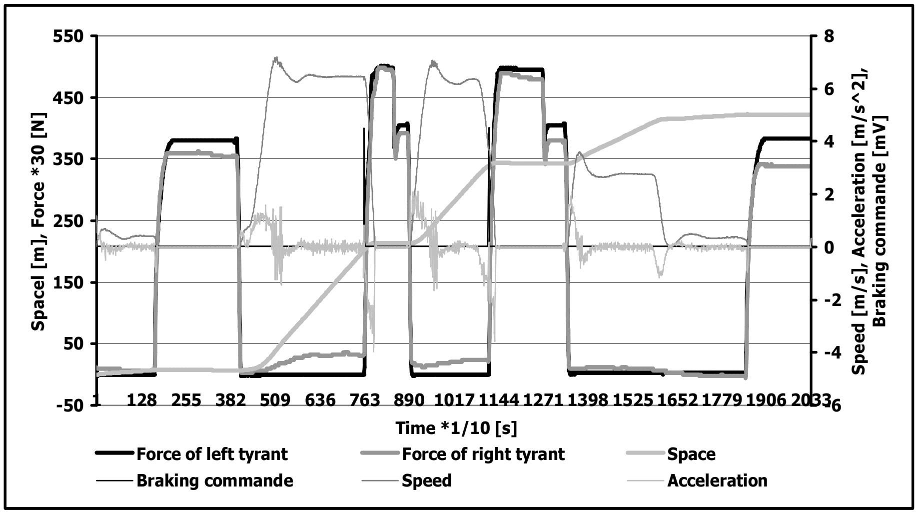

Figure 11. Left skip ascending Shaft with skip No. 2 , Lupeni Mine

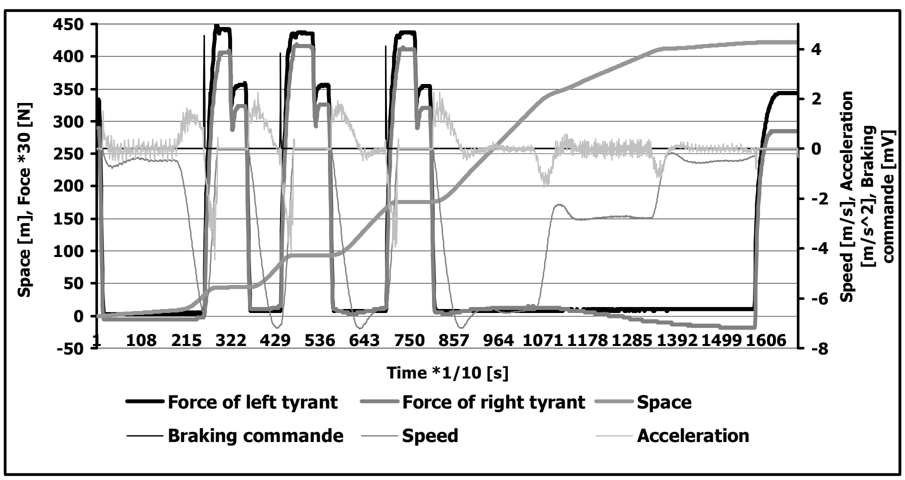

Figure 12. Left skip descending, Shaft with skip no.2,. Lupeni Mine

The data were organized in the form of electronic calculus sheets, being processed with excel soft, which even if it is a tabular calculation programme, it provides calculation facilities on data base, various processings, analyses, reports, , as well as particular graphic representations. Fig. 9 shows a calculation sheet with the data obtained following the measurements, together with the graphic representation of the magnitudes measured and recorded.

Fig. 10 shows a calculation sheet with the acceleration and space, calculated by derivation and integration of data obtained following the speed record along with its graphic representation.

The forces in the tyrants, with which the safety coefficients were calculated, obtained as a result of measurements performed during an extraction cycle, alonsid with kinematic elements of vessel movement along the shaft, nd the moment of application of the safety break, are shown in Figs. 11, 12, 13, and 14.

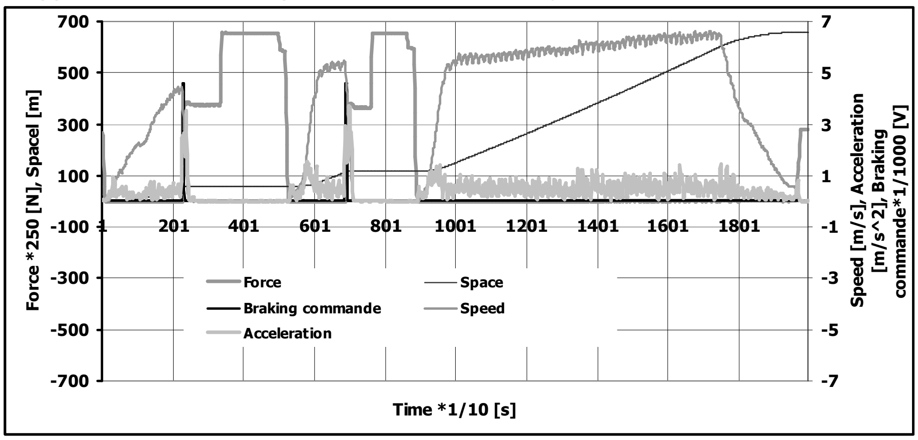

Figure 13. Right tyrant, left cage descending. Central Shaft, Petrila Mine

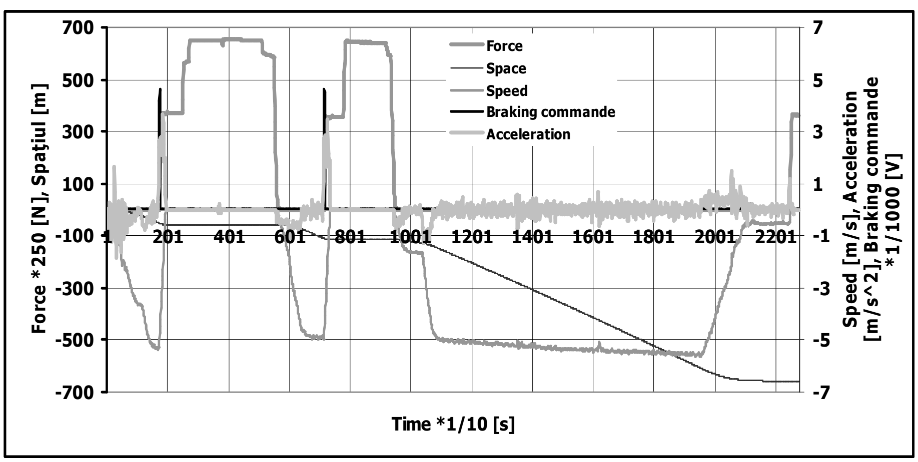

Figure 14. Left tyrant, left cage ascending, Central Shaft, Petrila Mine

6. Safety coefficients in safety braking

Real safety coefficient in safety braking is the ratio between the total braking moment and the maximum static moment given by the maximum unbalanced load and is given by the formula :

$$c_s=M_{F,T}/M_{st\ max} \quad (6)$$

For empty skip maneuvers, in Lupeni Mine new skip shaft, when the skip on the left branch ascends and on the right one descends, the safety coefficient is c_s=2,607, and when the left branch skip descends, and the right one ascends, the safety coefficient is c_s=2,866.

For empty cage maneuvres, in Petrila Mine Central Shaft, when the cage on the left branch ascends, and on the right one descends, the safety coefficient is c_s=3,023, and when the cage on the left bransh descends and on the right one ascends, the safety coefficient is c_s=3,364.

7. Real decelerations in safety braking

Table 1. Lupeni Mine Shaft with new skip

Nr. crt.	dQ [daN]	$V_{ef.}$ [m/s]	t_1 [s]	t_2 [s]	t_3 [s]	t_m [s]	a [m/s^2]
1	0	6,46	22,4	22,9	25,8	0,5	3,96
2	0	6,35	48,9	49,4	52,3	0,5	2,93
3	0	6,72	24,8	25,5	28,3	0,7	3,86
4	0	7,19	23,4	21,9	25,2	0,5	4,46
5	0	7,20	49,2	49,6	52,4	0,4	4,16

Table 2. Central shaft . Petrila mine

Nr. crt.	dQ [daN]	V_{ef} [m/s]	t_1 [s]	t_2 [s]	t_3 [s]	t_m [s]	a [m/s^2]
1	0	6,34	38,4	39	42	0,6	2,11
2	0	5,4	24	24,4	26,6	0,4	2,45

Real decelerations according to tables 1 and 2, are lower than those admitted.

8. Conclusions

Diagnosis of winding machine braking mechanisms is esse tial for the normal extraction vessels movement regime along the shaft, or halting the machine in a certain position of vessels, considered disturbances or failures.

The paper presents the calculation of the real safety coefficients in the application of thesafety brake.

To assess the real safety coefficients the results obtained by tensionmetric measurements were used, as well as information processing with the help of the calculator to obtain the data required for the calculation. Following the diagnosis, the required information is obtained in view of improving the present maintenance and repair system of this category of machines, and in view of increasing the safety in use of the winding installations, with monitoring possibilities of the braking mechanism.

Decelerations and delays in the application of the safety brake also have the values in the admitted range.

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