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DETERMINATION OF THE LIFETIME OF ROPES USED IN MINING INDUSTRY BY STATISTICAL METHODS

Statistics made on the basis of the operation of a cable mining extraction

Analysis of rope breaking situations under normal operation conditions proved that the material fatigue is the most important factor. The method of specific mechanical work, which consists in comparing the performance aspects of different types of ropes to compare the mechanical work consumed, related to 1 kg of its own weight, taking into account the elapsed working time of the rope.

This criterion is not relevant, because one do not take into account the intensity of transport in the shaft, which is still a significant factor in rope fatigue and wear.

The method critical speed of growing number of broken wires, consist in the determination of a parameter which is particularly important for the assessment of the operation lifetime of the rope, the so called critical speed of growth of the number of broken wires. The practice has proved that the number of broken wires in the external layers, due to the fatigue, increases with the operating time is given by a relationship of the form:

$$n = B \cdot t^a \tag{1}$$

The speed of growth of the number of broken wires is defined by relationships:

$$v = \frac{d_n}{d_t} = a \cdot B \cdot t^{a-1} \tag{2}$$

where a> 1

The speed of growth in the number of broken wires in outer layer is not an index of fatigue comparable for all the ropes, because at the same degree of fatigue, the number of broken wires depends on the length of cable span considered , on the step of wiring, the number of cable wires in the outer layer.

For these reasons, the comparable number of broken wires defined by the relationship:

$$n_k = \frac{n}{i_p \cdot s_e} \tag{3}$$

where:

n_k - comparable number of broken wires, for all ropes, related to one wiring step and a wire from outer layer;

s_e - the number of wires in the outer layer;

n - the number of broken wires from outer layer;

i_p - the number of wiring steps on the trial span of the rope given by the relationship:

$$i_p = \frac{l_p}{p} \tag{4}$$

where:

l_p - is the length of the span the most charged

p - is the step of wiring p = (7.5 - 8) d

d – the rope diameter

It may noticed that:

$$n_k = \frac{p}{l_p \cdot s_e} n \tag{5}$$

The comparable speed of growth of the number of broken wires in outer layer is an index of the degree of fatigue of a rope and is expressed as follows:

$$v_k = \frac{d \cdot n_k}{d \cdot t} = \frac{p}{l_p \cdot s_e} v \tag{6}$$

Applying the logarithm to the relationship above we obtain:

$$\ln v_k = \ln \frac{p}{l_p \cdot s_e} + \ln v = (a-1) \cdot \ln t + (a_0 + b_0)$$

$$\ln v_k = C_1 \cdot \ln t + C_0$$

$$a_0 = \ln \frac{p}{l_p \cdot s_e}$$

$$C_0 = a_0 + b_0 = \ln \frac{p}{l_p \cdot s_e} + b + \ln a$$

$$C_1 = a - 1 \tag{7}$$

Based on this fatigue index it was formulated an effective method of the assessment of expected lifetime of the rope, which should follow many stages.

If the critical value v_{klim} is known for all ropes being into service, we calculate the allowable limit speed of growth of the number of broken wires from outer layer, of each rope, using the relationship:

$$v_{\lim} = \frac{l_p \cdot s_e}{p} v_{k\lim} \qquad (8)$$

The value of *ln*t corresponding for the value $ln v_{lim}$ on the horizontal axis of the diagram $ln\ v = \varphi\ (ln\ t)$, will represent $ln t_{lim}$ which is the maximum lifetime of the rope.

Given that the rate of increase in the number of broken wires might not have the expected shape during all the operation time of the rope , the value t_{lim} determined from the graphic will adjusted with a correlation coefficient les than 1.

This method, presents the advantage of a fair assessment of the progress over time of the fatigue of the rope and provides the opportunity, knowing t_{lim} to mitigate the cases of premature replacement of the rope .

As an example, we extracted from the survey register of a hoisting rope from Petrila Mine, equipped with a monocable hoisting device type DEMAG (D), whose technical characteristics and operating conditions are:

- Rope type BRINDON - England A ;
- External diameter of the rope 68 mm
- structure 6x60 wires ;
- vegetal sisal core impregnated with grease
- Operated 24/24 hours ;
- Shaft depth of 670 m :
- Rope length 820 m ;
- Extraction vessel cage 4x2 ;
- Hoisting Speed 4m / s.

Changes in the number of broken wires depending on length of service is given in the table below:

Analyzing the statistics of the two cables studied, we notice that until a period of 2 years of operation, the number of broken wires is moderate, at 3 years of operation, the number rises when the vertiginous and when 90 broken wires appear, which represents 25 % of the rope section, the rational limit for maintaining the rope in function is reached.

Table 1

Duration of operation (days)	Number of broken wires	Duration of operation (days)	Number of broken wires
0	0	884	42
152	1	886	45
295	2	893	47
462	3	897	48
546	4	913	49
600	5	950	50
653	6	971	51
685	7	974	52
691	8	985	54
703	9	1094	57
718	10	1104	58
758	11	1118	60
772	13	1129	86
776	14	1130	90
803	15	1131	92
804	16	1132	93
809	19	1138	94
814	22	1144	95
816	23	1178	99
835	27	1242	100
838	28	1268	101
851	29	1271	102
874	30	1275	103
878	33	1283	105
880	34	1299	106
883	39	1313	110

The analysis of perturbing factors which influence the quantitative and qualitative performance of rope operation, led to the following conclusions:

1. Durability of ropes is determined both by the manufacturing and operating conditions.
2. To ensure a proper durability for ropes working in corrosive environments, they must be made by coated wires.

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