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APPLYING RELIABILITY ANALYSIS METHODS TO SHEARER BIT CONSUMPTION ASSESSMENT

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***Abstract**: In this paper are presented the results obtained at bit consumption that equipped the working part at different utilized types of shearer in mining exploitation from Jiu Valley, Romania .*
***Key words**: bits, reliability, wear, shearer*

The main synthetic indicator, which reflects the bit quality from their wear resistance point of view, is the specific bit consumption, expressed in pieces/unit of mining product quantity.

The establishment of bit consumption presents a distinctive importance because it is an indicator on their quality and on the economical efficiency of rock winning operation.

In the paper are presented the results of some in situ determination of realized bit's consumption at two mining exploitation from Jiu Valley (E.M. Valea de Brazi and E.M. Lupeni) for the CMR – 4 bits case, which equipped ANDERSON AM – 500, KS-3M and KWB – 3RDU shearers. From these data analysis, it can find that exist a large dispersion of specific consumptions in bits per 1000 tones produced, respectively of daily average consumption rate for the same shearer and the same kind of bit.

There were made observations in time about bits behavior in exploitation, for determining their durability, their wear resistance and the main causes of their output from use.

The CMR-4 bits are radial type, in hard construction and they have two distinctive parts: the body and the tail. The bit's body is a wedge-like piece. The peak is ended through a sharp cemented carbide tip.

The main effect of wear is defined through the rake angle reduction until 0^o. The different forms of wear manifestation which find at CMR-4 bits are showed in figure no. 1.

In figure no. 1 is presented a bit with the tip used-up less than 1/3 from its volume. At a number of 22 bits, alongside this wear type, there are also registered cracks and fractures in tipped weight. At the bits placed on bit disk prevailed the wear manifested through cracks and fractures in tipped body, through broken the tipped on junction outline, also through tipped unsoldering. At same bits assembled both on cutting disk and on the blades, the tipped was

unsoldering before the wear registering. At the bits with advanced wear, the body isn't protect by the tipped, it consumed on.

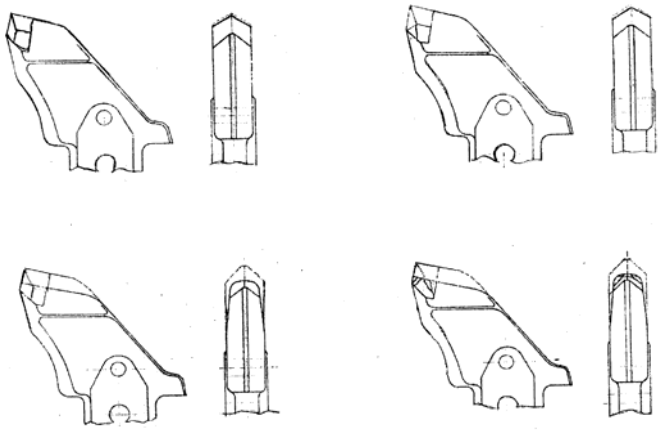

Fig. 1. The main wear types of CMR – 4 bits

At the bits placed at the beginning of blades, the wear couldn't study; all the bits thus assembled were broken due their impact with the conveyor frame and with the support section shield.

The bit's consumption was determined taking into consideration the bits at which the tipped is consumed over 1/3 from its volume and the losing and broken bits.

The specific bit's consumption is given by the number of consumed bits reported at output and it is expressed in pieces/1000 tones.

In table no. 1, there are given the bit's consumption on three months of following, with the output, the price of one bit being of 10,3 Euro/piece (up-to-date).

Table 1. The bit consumption

No	Month	Output (t)	Consumed bits (pieces)	Bit's consumption (pieces/1000 t)	Bit's cost (EUR)	Specific cost afferent bit's consumption (EUR/1000 t)
1	June	2185	40	18,223	414	188,71
2	July	10195	10	0,980	98	10,14
3	August	24680	230	9,300	2381	95,79
TOTAL		37060	280	7,550	2893	77,165

The observations were made directly on 112 bits, assembled in the same period, for which were settled the bit's consumption on wear types, given in table no. 2. The corresponding Pareto diagram is given in figure no. 2.

In the following period of cutting head don't registered losing bits.

Table 2. The bit's consumption on wear types

No	The wear type	Number of used-up bits(piece)	Number of used-up bits (%)
1.	Bits with tipped used – up till 1/3 from its volume	5	4,45
2.	Bits with broken tipped	22	19,65
3.	Bits with tipped used – up over 1/3 from its volume	1	0,8
4.	Bits with advanced wear tipped with cracks and fractures	28	25
5.	Bits with unsoldering tipped	12	10,72
6.	Bit with broken tipped on junction outline	15	13,39
7.	Bit with consumed body	13	11,61
8.	Bit with broken body	16	14,28

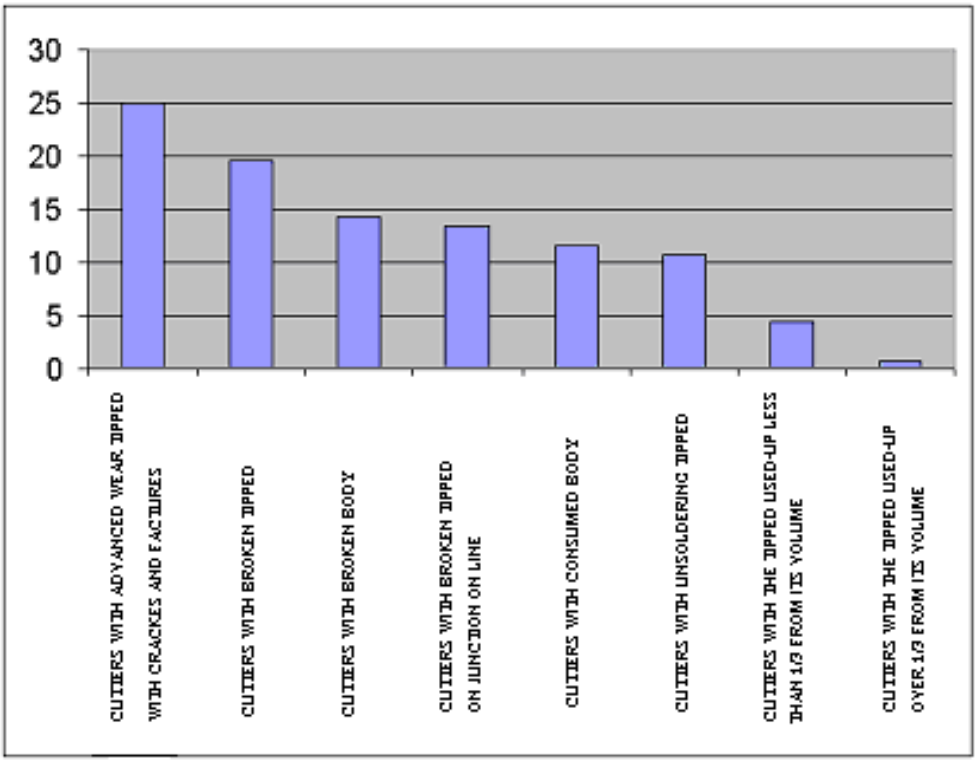

Fig. 2. The cause – frecvency diagram of bit wear types

Through comparison, in table no. 3 are given the bit's consumption registered for AM – 500 and AB – 16 shearer, shearers which worked in rocks with a hardness coefficient „f" between 2 and 4 according to Protodiakonov's scale.

The KS – 3M shearer works at E.M. Lupeni where registered a medium bit's consumption equal with 5 pieces/1000 t.

Table 3.

No	The shearer type	The hardness coefficient „f" f = /100	The bit's consumption (pieces/1000 t)	The unitary cost (EUR)	Cost (EUR/ 1000 t)
1.	AM – 500	3 ÷4	10,39	10,3	107
2.	AB – 16	2 ÷2,5	28,3	-	-
3.	AB –314	3 ÷4	5	5,73	28,65

The bit's consumption is negative influenced by the existence of hard inclusions between the 17 – 18 coal beds, and at the inferior drum by the necessity of cutting from floor, which is a sandstone with a hardness coefficient „f" by 6 – 9, as well as by accidental touch of drums by the metallic construction of support or the conveyor frame.

Based on results data from the following of bit's consummation realized at E.M. Lupeni in eight faces, it has made the table no. 4.

Table 4.

Face	Days no.	The shearer type	The bit symbol	The consumption on 1000 t	The daily medium consumption [pieces/day]
A	25	KS - 3M	CMR - 4	4,7	4,08
B	31	KS - 3M	CMR - 4	13,5	2,74
C	31	KS - 3M	3R4 - 80	11,74	3,25
D	31	KS - 3M	CMR - 4	24,64	6,54
E	31	KS - 3M	CMR - 4	29,86	6,35
F	31	KS - 3M	CMR - 4	23,76	6,48
G	31	KS - 3M	CMR - 4	12,88	3,19
H	31	2K - 52	CMR - 4	19,80	4,06

Analysis the data content in the above table it can find:

- A large difference of specific consumption on 1000 t, respectively the daily medium consumptions for the same shearer and the same type of bit;

- The medium value of specific consumption at those eight faces is 17,61 peices/1000 t respectively a daily medium consumption is 4,58 pieces/day;

- The medium value of consumption for the same type of bits (CMR - 4) is 18,44 pieces/1000 t, respectively 4,77 pieces/day.

From those exposed above, it can conclusion that the shearer bits reliability isn't guarantee by their constructive quality, the specific consumption values having a pronounce dispensations for the modern types of bits, from import. From this reason is required the theoretical and experimental study, on stands of wear requires of shearer bits.

The reliability parameters, in Weibull model case, it can determine through analytical and

graphical method.Through exemplifications, in table no. 5 it show the obtained results after calculation the reliability parameters through moments methods, for the bits CMR-4 type that equipped the cutting organs of KS-3M shearer.

Table 5.

M[x]	D[x]	σ[x]	c_v	θ	β	c_β	k_β	λ
274	162100	403	0,4606	800,04	1,8	0,5112	0,8893	$5{,}9\cdot10^{-6}$

The obtained values in Weibull biparametrical model are contained in table 6. The parameters determination of Weibull model with help of probabilities net Allan-Plait makes part from graphs methods of the reliability parameters. This probabilities net has on abscise the considered variable (the function time until the failure appearance), and on ordinates the appearance probability of failure in percents. The Weibull model parameters determined with probabilities relation help Allan-Plait, which isn't a high precision method, are content in table no. 7.

Table 6.

x (m)	0	200	400	600	800	1000	1200	1400	1600
R(x)	1	0,921	0,752	0,553	0,370	0,227	0,127	0,066	0,031

Table 7.

θ	β	γ	MTBF
850	1,9	0	754,2

It observes that the values are comparable with those obtained at moment's method.

Based on obtained data about the shearer bits exploitation requires, using Weibull model has determined the reliability indicators in table 8, for the bits used at the eight faces. Using the calculation relation of reliability, Weibull model, has determined the reliability variation in report with time is presented in table 9. In figure 3 are showed graphs of the reliability variations in report with the time as: A– for CMR – 4 bit, A face; B– for CMR – 4 bit, B face; C– for 3R4 – 80 bit, C face; D– for CMR – 4 bit, D; E– for CMR – 4 bit, E face; F – for CMR – 4 bit, F face; G– for CMR – 4 bit, G face; H– for CMR – 4 bit, H face.

In conclusion there were determined the main types of wear and statistics distribution of those. It was determined the specific bit's consumption. It can draw a conclusion that economical efficiency analyze of cuttier utilization in mines, must have in view the specific bit's consumption and, so the costs on which they introduced in output's costs.

Table 8.

Face	The bit symbol	η	γ	β	MTBF (days)	λ (days - 1)
A	CMR - 4	48	36	4,0	7,48	0,133
B	CMR - 4	56	38	5,7	12,53	0,079
C	3R4 - 80	9,5	0	1,1	9,16	0,109
D	CMR - 4	4,3	0	1,0	4,30	0,232
E	CMR - 4	4,7	0	1,3	4,34	0,230
F	CMR - 4	3,8	0	0,6	5,71	0,176
G	CMR - 4	12,5	0	1,0	12,50	0,080
H	CMR - 4	9,5	0	1,8	8,44	0,118

Table 9.

The time days	R(t), in %							
	The bit from face							
	A	B	C	D	E	F	G	H
1	70,2	88,0	91,9	79,2	87,4	63,8	92,3	98,2
5	58,7	80,1	61,0	31,2	33,8	30,7	67,0	72,9
12	36,7	59,2	24,7	6,1	3,4	13,6	38,2	21,8
16	25,2	44,3	16,9	2,4	0,7	9,3	27,8	7,7
22	11,8	22,7	8,0	0,6	0,06	5,6	17,2	1,0
27	5,1	9,6	4,2	0,18	-	3,9	11,6	0,1
31	2,2	3,7	2,6	0,07	-	2,9	8,3	0,02

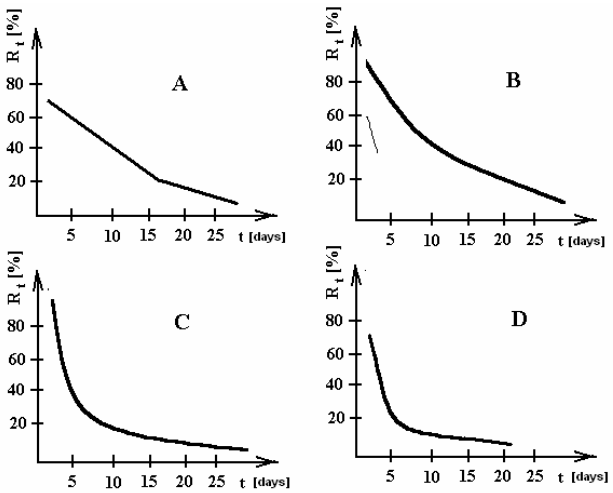

Fig. 3. Graphs of the reliability variations in report with the time

The reliability indicators knowledge permit taking some increase measures of reliability, respectively of their function period without failures through elimination the causes that lead to failure appearance and a better planning of repairing activities.

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