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ANALYZING THE OPERATION OF ROTOR EXCAVATORS IN THE E.M.C. JILȚ OPEN PIT MINES

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Abstract: The increase of the working efficiency of the excavator depends of its selection in concordance with the concrete working conditions and in correlation with the other equipments from the operation lines for lignite and waste extraction from the lignite seams roof. The mining equipment used at Jilt quarry was monitored for a certain period and based on the data gained during that period we have drawn up Pareto charts that highlight the subassemblies of those installations which have to be considered with the view to increasing the main indices which allow to calculate the reliability of rotor excavators.
Keywords: technologic flow, open pit, Pareto chart

1. GENERALS

An increased efficiency in the working of the excavator shall depend on which type of excavator is being selected, in accordance with the actual mining conditions and in correlation with all the other equipment on the technological flow for mining of lignite and sterile rocks from the roof of the lignite beds. The safety in operation of a machine or engineering system represent the extent to which these machines shall fulfill their tasks and depends on their accessibility, reliability, capability and maintainability.

2. MINING TECHNOLOGY USED AT THE E.M.C. JILT OPEN PIT MINES

2.1. Jilț–Sud open pit

The method of mining out used in an open pit considers mainly the use highly output equipment such as:

- EsRc – 1400 30/7·630 and SchRs – 1400 30/7· 630 type rotor excavators;
- BRs 1600· 60 type distribution equipment;
- Belt conveyors with the width of the carpet between 1000 and 2000 mm;
- IH 6500· 90 and IH 4400· 170 type waste dumping plants;

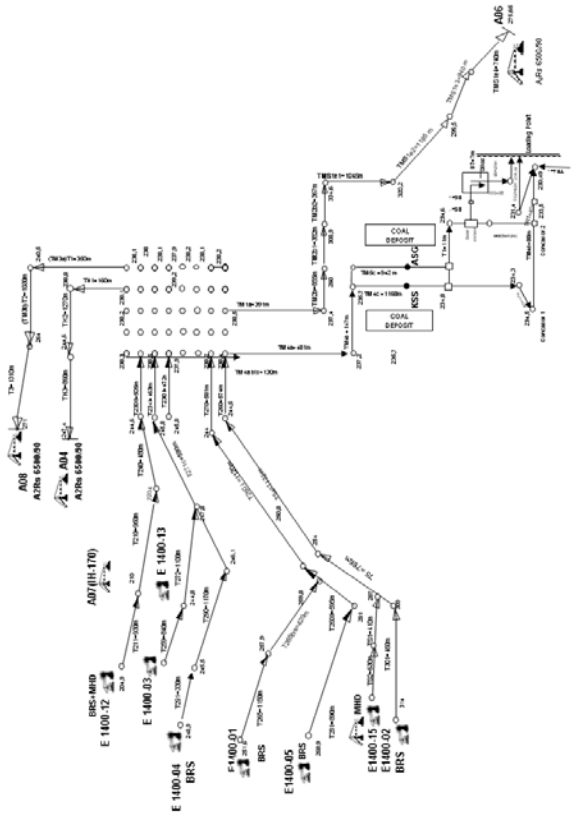

Fig.1. *The technologic flow at Jilț-Sud open pit*

- MHD 4400· 50 waste dumping and distribution machines;
- As – G 6000· 40 and Ks – S 5600/3800· 40 type stowing equipment.

At present the activity at the open pit is being performed on seven excavation levels with the use of seven EsRc – 1400 30/7·630 rotor excavators and one SchRs – 1400 30/7· 630 rotor excavator (E-01).

The technologic flow at Jilț-Sud open pit (Fig. 1 on 01.02.2006) involves a parallel advance of faces; afterwards the advance is made by a rotation up to the borders of the open pit.

2.2. Jilț–Nord open pit

The method of mining out used in an open pit considers mainly the use highly output equipment such as:

- EsRc – 1400 30/7·630 type rotor excavators;
- CBS 1200· 60 and BRs 1600· 60 type distribution equipment;
- Belt conveyors with the width of the carpet between 1000 and 1800 mm;
- IH 6500· 90 and IH 4400· 170 waste dumping plants;
- MHD 4400· 50 waste dumping and distribution machines;

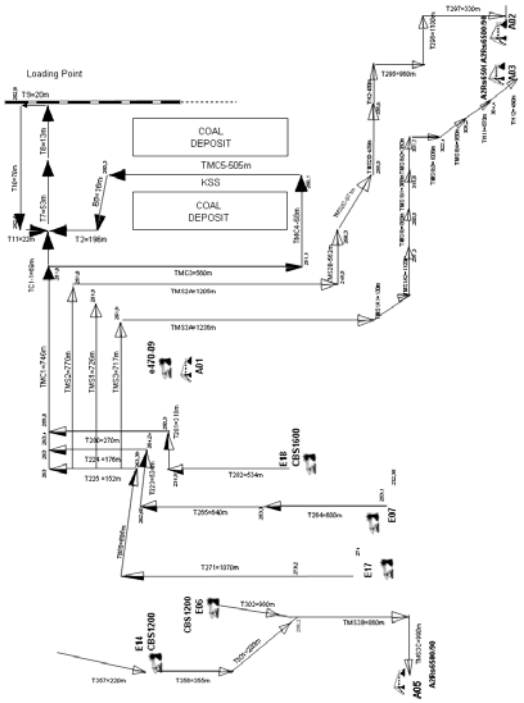

Fig.2. *The technologic flow at Jilț-Nord open cast*

- Ks–S 5600/3800·40 combined equipment for making deposits and loading activities and As – G 6000·40 type stowing equipment.

At present the activity at the open pit is being performed on six excavation levels with the use of five EsRc – 1400 30/7·630 rotor excavators. The output is being excavated and then discharged on the conveyor belts located at the face.

Fig. 2 shows the technologic flow at Jilț-Nord open pit on 01.02.2006.

3. MAIN ASPECTS REGARDING THE USE OF THE EXTRACTION SYSTEM

An analysis of the operation manner of the extraction system used at Jilț-Sud and Jilț-Nord open pits (belonging to S.C. Complexul Energetic S.A. Turceni) relies mainly on the information which already exists at Jilț Open Pit Mining Unit in the document entitled "Situation on the use of rotor excavators and of the waste dumping machines" valid for the period situated between 2001 – 2005. Also, this analysis relies on the observations and the measurements carried out on the site as well as on the experience gained all through the years during the studying of the aspects related on the mechanized extraction of lignite at open pits. One of the most important problems related to this extraction system is the pause scheduled for: the engineering operations (engineering pauses), revision and repairing operations (non – engineering pauses). Another reason for the impossibility to reach the scheduled output is the accidental interruption. Among the most often interruptions of the total accidental

interruptions occurred at Jilț Open Pit Mining Unit between 2001 and 2005 are the interruptions due to mechanical reasons, for vulcanization purposes, etc.

4. THE INFLUENCE OF THE EQUIPMENT IN OPERATION ALONG THE TECHNOLOGICAL FLOW OVER THE GOOD OPERATION OF EXCAVATORS

An analysis of how the transportation and waste dumping or stowing equipment influences the good operation of excavators with rotor is being made based on the database which exists at E.M.C. Jilț. Consequently, Table 1 shows the situation regarding the use of the equipment at Jilț-Sud and Jilț-Nord open pits in 2005. Based on the information above we have developed pie charts which present (in percentage) the influence of interruptions due to the decommissioning of damaged waste dumping (stowing) machines and belt conveyors or due to several other causes such as the clogging of containers, the sliding of the conveyor belts and the impossibility that the sterile be dumped, problems in the operation of the rotor excavators.

Table 1. Situation of the use of the equipment at Jilț-Sud and Jilț-Nord open pits in 2005

No.	Year	Open pit	Equipment	Total hours of engineering interruptions	Total hours of non-engineering interruptions	Total hours of accidental interruptions	Total hours of general purpose interruptions
1	2005	JILȚ-SUD OPEN PIT	E1400-01 M	1171	1118	1152	4521
2			E1400-02	2210	686	2184	6256
3			E1400-03	1508	1484	1502	5574
4			E1400-04	1227	1020	1584	5007
5			E1400-05	1325	964	2103	5664
6			E1400-12 M	1289	1440	898	4707
7			E1400-13	2016	1304	360	4856
8			E1400-15	2897	1032	1906	6987
9			Total J-S	13643	9048	11689	43572
10		JILȚ-NORD OPEN PIT	E1400-06	1333	1284	877	4694
11			E1400-07	1305	1586	836	4807
12			E1400-14	1413	1136	1209	5030
13			E1400-17	1253	1512	1345	5286
14			E1400-18 M	1293	1136	1020	4529
15			Total J-N	6597	6654	5287	24346

The above said pies are shown below: Fig. 3 for Jilț-Sud open pit, Fig. 4 for Jilț-Nord open pit covering the information valid for 2005.

After an analysis of the situation regarding the accidental interruptions and their influence on the utilization level of rotor excavators in Jilț-Sud open pit in 2005, one can notice that the longest periods of interruption occur due to the stagnation of excavators, to the clogging of containers and the belt jamming; also problems occur due to the lack of locations for coal storage, due to some stops in the waste dumping process because of lack of priorities, etc. All these aspects are grouped in the previously said statistics under the category "other causes". The weight of the interruptions produced by this category of causes reach a peak of 87% for the E – 15 excavator and a dip of 58% for the E – 13 excavator. The standstill of excavators due to personal accidental interruptions situate between 1% at the E – 15 excavator and 35% at the E – 13 excavator. The waste dump installations may hold 2% of the accidental interruptions at the E – 02 and E – 15 excavators and 10% at the E – 13 excavator. The accidental interruptions produced by the high capacity belt conveyors weigh between 10% for the E – 13 and E – 15 excavators and 21% for E – 01M and E – 03 excavators.

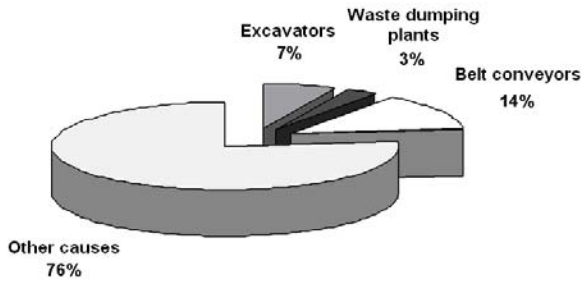

Fig. 3. *Weight of accidental interruptions at Jilț-Sud open pit in 2005*

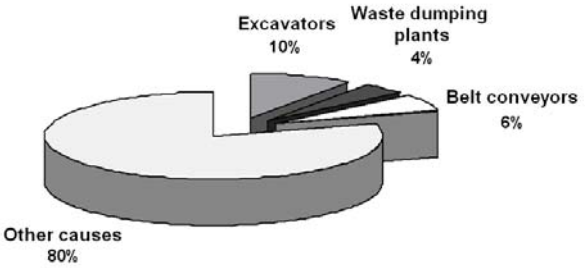

Fig. 4. *Weight of accidental interruptions at Jilț-Nord open pit in 2005*

For the case of Jilț-Nord open pit, the peak values regarding the accidental interruptions from the category "other causes" situate between 71% at the E – 14 excavator and 84% at the E – 17 excavator. The stop of the excavators due to personal reasons situates between 4% at E – 18M excavator and 22% at E – 14 excavator. The influence of waste dumping equipment situates between 3%…6% at the E - 14 excavator and at the E – 06 excavator, respectively. The belt conveyors have a weight of accidental interruptions between 4% at the E – 06 excavator and 18% at the E – 18M excavator. As a whole one can notice that the weight of accidental interruptions is higher because of causes which are not related to the excavator.

Consequently, with the view to increasing the utilization level of excavators one

should focus energy and take into consideration all the component parts both at the technical level, i.e. a renewal and an updating of the current technology and all the other aspects related to a good management, an optimization of the processes, a solid motivation of the working staff, a good professional training, etc.

5. PARETO CHARTS USED TO ANALYZE THE OPERATION OF THE ROTOR EXCAVATORS

It is very important that any analysis on the reliability of equipment underlines the occurrence of certain types of failures come up during operating period. As a rule Pareto charts are being used to show all these information. Pareto charts show that 20% of causes can explain 80% of failures and that 80% of failures emerge from 20% of causes. These figures shall focus attention on these particular causes and neglect, for the moment being, those causes which are less important. Considering the aspects said above, there has been produced a Pareto charts which underlines the rate of failures occurred on EsRc-1400 excavators at Jilt Mining Unit. All the 13 excavators in operation were monitored between 20.06.2005 and 02.05.2006.The types, the incidence and the total number of failures occurred in this period have all been summed up in table 2.

Table 2. Data summation sheet for the production of Pareto chart

Code	Subassemblies with faults	Incidence of faults	Total number of faults
A	Driving system of the bucket wheel	𝍸 𝍸 𝍸	15
B	Conveyance system	𝍸 𝍸 ///	13
C	BRS	𝍸 𝍸 𝍸	15
D	Belts system	𝍸	5
E	Other subassemblies	////	4
	Total		52

Table 3 shows the faulty subassemblies, the total number of faults, the weight of these faults for each subassembly; Figures 5 and 6 shows Pareto charts in relation to the absolute and cumulated incidence of faults.

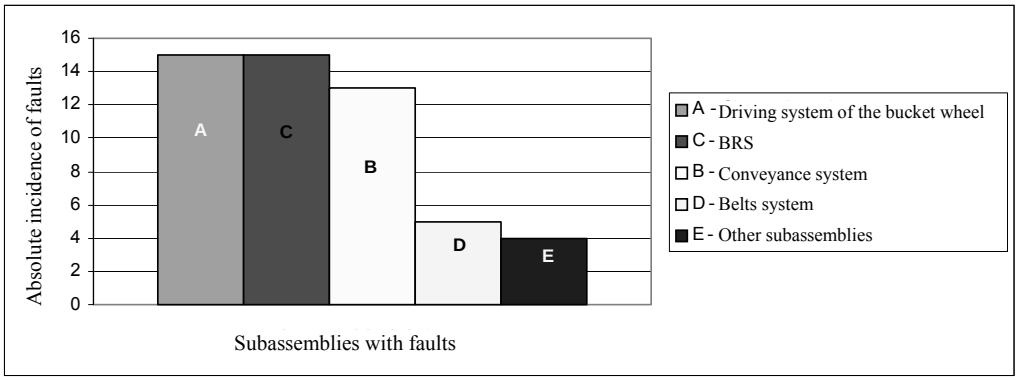

Fig.5. *Pareto chart depending on the absolute incidence of faults for rotor excavators*

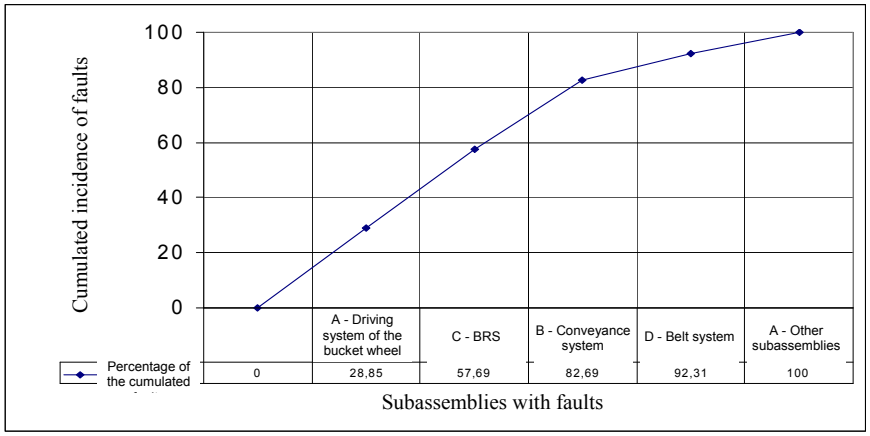

Fig. 6. *Pareto chart depending on the cumulated incidence of faults for rotor excavators*

Table 3. Data necessary for the production of Pareto charts

Code	Subassemblies with faults	No of faults	Total cumulated faults	Percentage of total	Percentage of the cumulated faults
A	Driving system of the bucket wheel	15	15	28,85	28,85
C	BRS	15	30	28,85	57,69
B	Conveyance system	13	43	25,00	82,69
D	Belts system	5	48	9,62	92,31
E	Other subassemblies	4	52	7,69	100
	Total	52	-	100	-

6. CONCLUSIONS

So, according to the above charts, it results that 82.61% of faults occur due to the deterioration of three subassemblies: the driving system of the bucket wheel (28.85%), the BRS (28.85%) and the conveyance system (25%).

Consequently, for increasing the utilization rate of these excavators, the three said above subassemblies shall have to be updated. The study regarding the influence of the equipment used for transportation, waste dumping or stowing purposes over the utilization level of the rotor excavator underlines both from a qualitative and a quantitative point of view that there is still a lot of place for improving this process. An analysis of Pareto charts shows that this equipment needs an up-to-date of the rotor excavators (rotor with the driving system, motion system, distribution carriage (BRS)).

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