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STUDY OF IMPROVEMENT OF ROTATION MECHANISM BALL OF ESRC-1400 ROTOR EXCAVATOR

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Abstract. The paper presents the study of the possibility of improvement of EsRc-1400 rotor excavator's rotation mechanism ball.

1. Introduction

Increasing mechanization of lignite strata and sterile rocks extraction from their stripping, involves modernization processes, as well as technological systems used in specific extraction conditions and technical furbishing of quarries. Lignite quarries in Romania are equipped with technological flows provided with rotor excavators, conveyer belts, dumping machines, depositing and additional machines, providing a theoretical capacity of 200 000 m^3/h, and transportation and dumping of 300 000 m^3/h, respectively.

In Romanian lignite quarries 99 rotor excavators are in use, 53 dumping machines, 584 conveyer belts summing up 325 km and other depositing and additional machines.

EsRc rotor excavator is the basic machine in the lignite quarries in our country, approximately 70% of the excavations' volume being done with this type of machine.

Figure 1. Overall view of EsRc-1400 excavator

Fig. 1 shows an overall view of EsRc-1400 excavator where the rotation mechanism between the lower platform on the track and the upper part with the cutting part, the lifting mechanism and the related metal structure can be seen.

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The upper platform of the excavator is positioned over the basic shaft and can rotate by the Φ 8650 mm support and rotation ball, and by two gears that match with a toothed wheel.

The toothed wheel and the lower rolling path of the ball are interlocked with the basic shaft, and the upper rolling path is interlocked with the rotating platform. The platform rotation with all the upper structure leaning on it is made with the rotation mechanism.

2. Design of longitudinal ball bearing

Fig. 2 shows the overall solution for longitudinal ball bearings, which are the portent mobile structure that makes possible the rotation of the upper platform of the excavator as to the shaft and its handling mechanism, which stays fixed from a rotation point of view.

The lower rolling path, 3, made up of six segments fixed between them with bolts, is fixed, being mounted on the excavator shaft, and the upper rolling path, 10 fixed to the upper structure of the excavator, rotates along with it.

A solution was adopted by which the rolling paths are obtained from segments, due to the large sizes.

The marks in this figure mean: 1 – longitudinal ball bearing, 8650 mm rolling diameter, made up of six segments; 2 – rolling segment; 3 – lower rolling path segment, fixed; 4 – outside chute to collect greasing oil; 5 – baffle; 6 – outside sleeve doubling; 7 – outside sleeve; 8 – outside spacing ring; 9 – Φ150 mm ball, 109 pieces; 10 – mobile segment for upper rolling path; 11- M30x100 special screw with Grower nut, 207 pieces; 12 – M12x30 screw with safety washer; 13 – inside ring; 14 – inner sleeve; 15 – inside spacing ring; 16 – cage for 3 balls, 35 pieces and a cage for 4 balls; 17 – inside chute to collect greasing oil; 18 – M30x85 special screw with Grower washer, 108 pieces; 19 – inspection part, 2 pieces; a - four M12x1,5 holes on each segment to supply oil under pressure; b – a G $1^1/_4{}''$ hole on each segment to remove oil.

3. Proposals to improve the design of longitudinal ball bearing

Following the analysis of the pressure longitudinal bal bearing presented above, it results that both operation life and static load are improved by increasing the number of balls of the bearing, without modifications of the rolling path and ball sizes.

Fig. 4 shows the modified bearing with 143 balls, made up of: 1 – lower ring, made up of 6 segments; 2 – cage with 4 balls; 3 – cage with 3 balls; 4 – 150 mm diameter ball. The number of cages were maintained for this bearing (35+1), only that the 3 ball were transformed in 4 balls cages, and the cage with 4 balls in 3 balls cage.

Fig. 5 shows the variation of the operation life of the two design variants, with doted line the 109 bearing.

This analysis was made because it assists in the execution of the 41MoCr11/STAS 791-80 alloyed steel rolling paths execution improvement and not steel for RUL2 bearings.

The thermal treatment applied is superficial tempering of the rolling path, since on the opposite M30 end threaded holes required to mount the bearing on the metal structure of the excavator are executed.

As a result of superficial tampering, along the rolling path the hardness is uneven, leading to its uneven wear.

Both for the axial bearing and for the toothed wheel cyclical change of the excavator position to the face is required, for an even wear of the rolling path segments, and of the toothed wheel segments, respectively.

Fig. 6 shows an improvement solution for the longitudinal ball bearing.

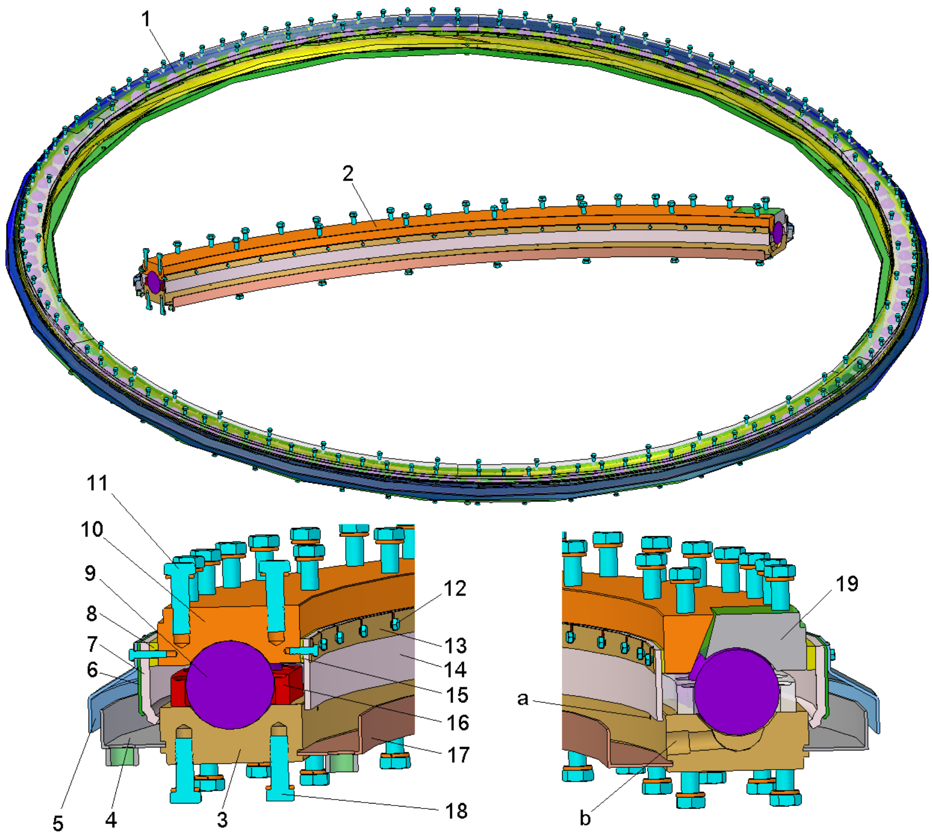

FIGURE 2. Longitudinal ball bearing with 8650 rolling diameter

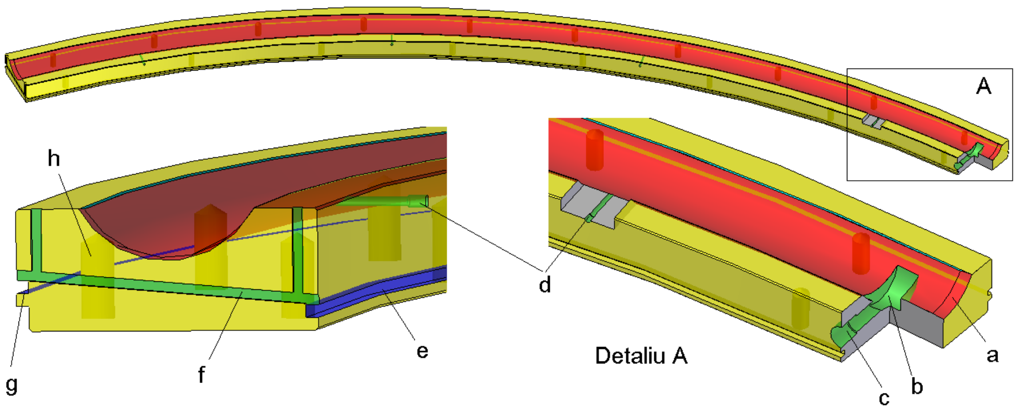

FIGURE 3. Lower rolling path segment
a – 1,5x20 mm cut at the end of the segment; b – collecting duct; c – G $1^1/_4''$ hole for oil removal; d – 4 M12x1,5 holes for oil supply under pressure; e – duct for positioning the lower chute; f – 12x8 mm ducts for oil removal from cage greasing; g – duct for positioning outside duct; h – 16 M30x50/60 holes.

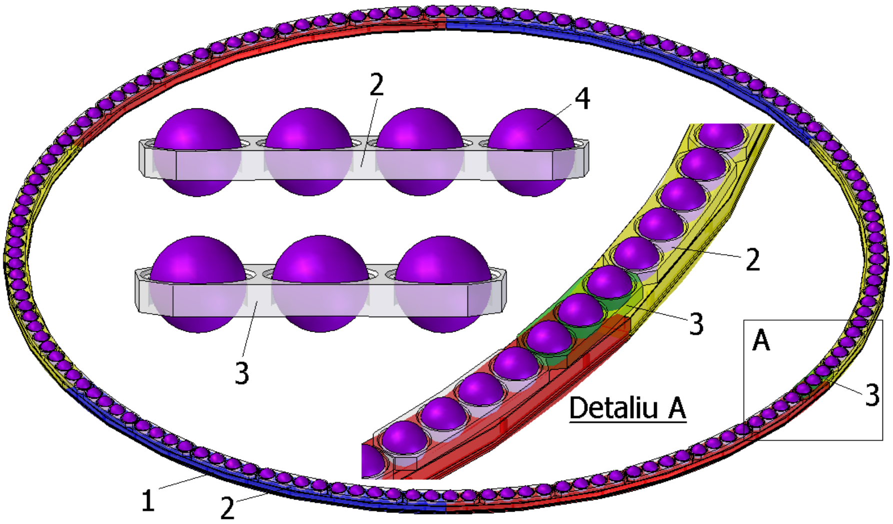

FIGURE 4. Modified bearing with 143 balls

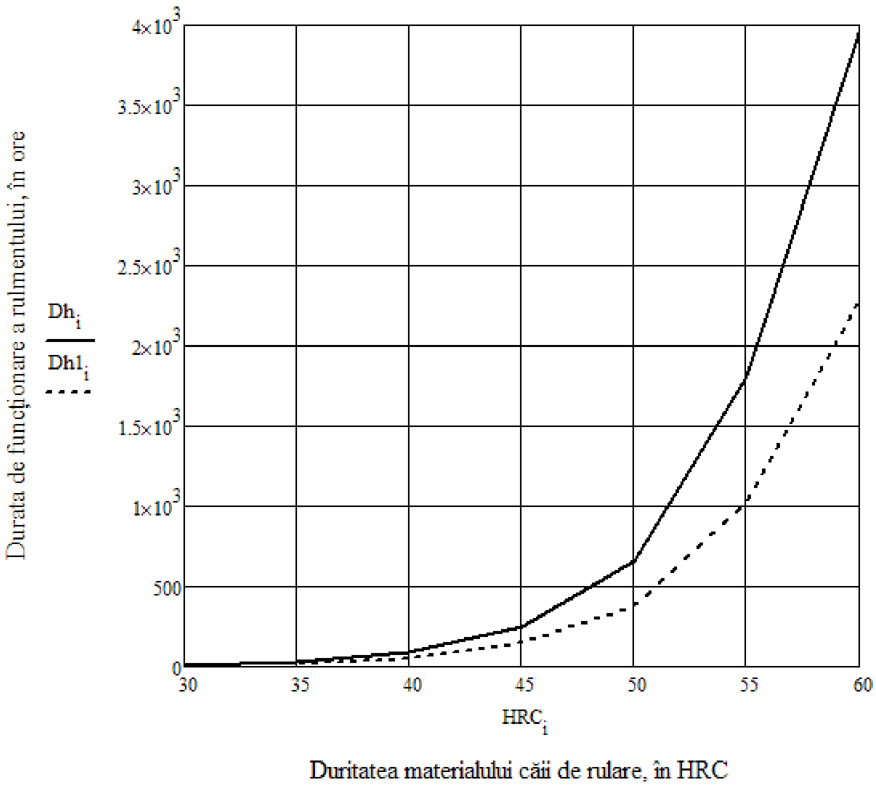

FIGURE 5. Operation life variation module for the two longitudinal ball bearing constructive variants

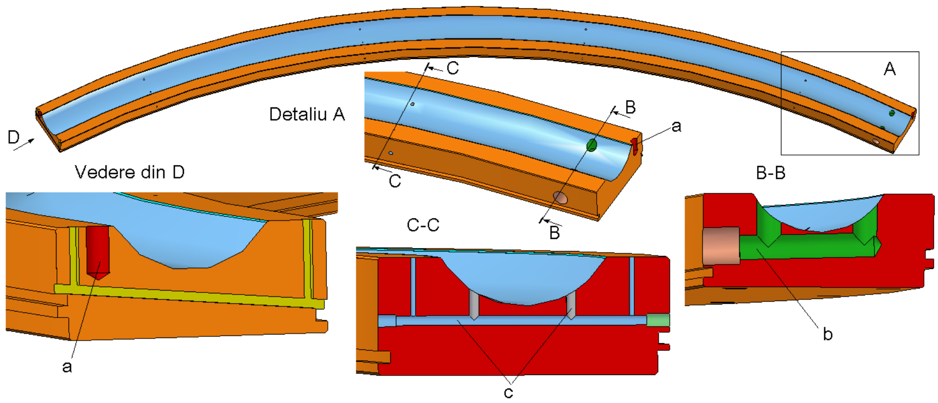

FIGURE 6. Improvement solution for the longitudinal ball bearing

4. CONCLUSIONS

Increasing the number of balls with 34, from 109 to 143, an increase of the operation life is obtained by more than 70%. In absolute value it is 300 hours at 50 HRC hardness and reaches to 1650 hours at 60 HRC harness of the rolling path. From the above, it is required a thermal treatment of superficial tampering for a harness of more than 60 HRC and in a variation range along the rolling path as small as possible, for an even wear. The rolling paths are made from improved 41MoCr11/STAS 791-80 steel alloy and not RUL2 steel for bearings.

The design of the lower rolling path of the bearing can be improved by:

– removal of (1,5x20 mm) cuts at the end of the segments to have a continuous rolling path, without thresholds;
– bores at each end for Φ20x40 mm dowel pin (a), in view of centring segments between them, a solution also found in the toothed wheel;
– modification of the oil collecting solution on the rolling path (b) in order to keep up continuity of the rolling path;
– improving solution for grease supply under pressure for the rolling path (c), with the possibility of supply on the outer or inner side and easy decongestion of grooves, with greasing of the friction surface between the cage and the lower ring.

According to literature, it is recommended to grease with consistent grease, due to the way the proofing is done, mineral oil under pressure is required, which should remove abrasive particles from the rolling path. For the future, a study can be done and tests for using a greasing system with consistent grease.

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