METHODOLOGY FOR ASSESSING THE SAFETY OF A GEARBOX UNDER DYNAMIC LOAD

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Abstract: *The gearboxes (reducing gears) built in the rotating excavators used at surface coal mines, are exposed to dynamic loads which are frequently unpredictable (stochastic) given the exploitation conditions. These gearboxes are very frequently oversized by the manufacturer. Nevertheless, the possibility of impact loads due to unpredictable working resistances the excavators run up against, can reduce the safety of the gearbox, even to the extent of breakdown of some of the constituent elements in given period till the planned overhaul. This paper presents the methodology for assessing the safety (reliability) of most unreliable gear in specific gearbox, being ascertained by the maintenance experience of the gearbox. Concerning this gearbox, the load function has been established based on experimental investigations, being presented in this paper. Regarding the most unreliable gear, the carrying capacity function has been established by means of theoretical research being displayed in the comparative diagram together with the load function. This comparative diagram helps to infer the safety of the most unreliable gear in the gearbox, i.e. the safety of the gearbox as a whole. The loading on the gearbox is a variable course of the rotating moment with the driven shaft depending on the time span during the total exploitation life of the gearbox. The carrying capacity of the gearbox is equal to the permissible temporally constant rotating moment acting on the driven shaft within a time span encompassing a number of changes in the loading on the driving shaft. The presented methodology can be applied to investigate the safety of other similar gearboxes.*

Keywords: DYNAMIC LOAD, GEARBOX, SAFETY

1. Introduction

The loading regime of the gearbox (reducing gears) at the working organ (working wheel) on an excavator under normal and specific conditions of exploitation, is defined by the distribution function of the rotating moment at the output shaft depending on the load variations within the expected exploitation lifetime of the gearbox.

The loading regime of the gearbox with the working wheel on the excavator SRs-630 used at the coal mine Suvodol-Bitola is determined based on performed experimental measurements and extensive theoretical analysis.

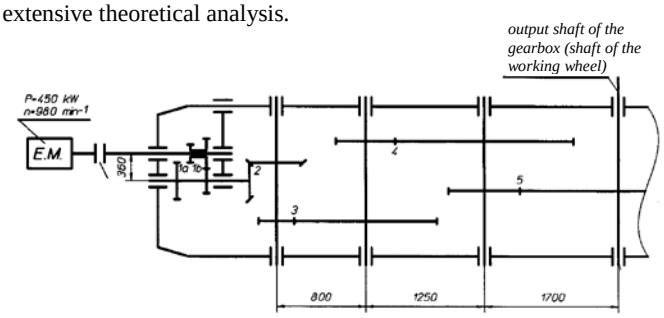

Fig. 1 *Sheme of the gearbox (reducing gears) with the working wheel on the excavator SRs-630*

The carrying capacity of the gearbox (reducing gears) at the work wheel on an excavator is determined by its mostly loaded gear, that is, by the gear whereon some weaknesses during exploitation have been noticed.

The functions of the carrying capacity for all gears within the gearbox at the work wheel on the excavator SRs-630, are derived theoretically by means of methodology set up for this purpose. The analysis showed that the most loaded is the last gear pair of the gearbox (marked with 5 on figure 1), to wit, the driven gear of the gear pair, which is mounted on the output shaft of the gearbox. The same conclusion was confirmed by the maintenance practice of the gearbox showing most interventions on this gear.

2. Load function of the gearbox

The loading of the gearbox (reducing gears) is a variation course of the rotating moment at the driven shaft depending on the time point over the entire exploitation life of the gearbox.

The loading of the gearbox of the working wheel on the excavator SRs-630 represents a variation course of the rotating moment T_2 at the driven shaft depending on the time point during the total exploitation life of the gearbox.

The load function of this gearbox (shown on figure 2) is obtained by processing the deformation records on the output shaft of the gearbox under characteristic working regimes by means of experimental measurements.

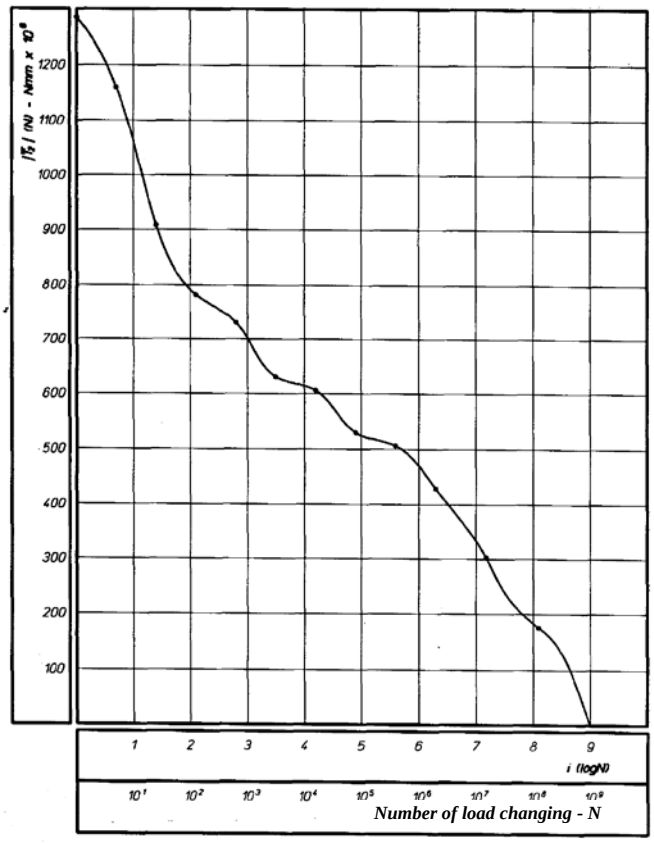

Fig. 2 *Load function of the gearbox at the working wheel on the rotating excavator SRs-630 under working conditions at the coal mine Suvodol-Bitola*

3. Carrying capacity function of the gearbox

The carrying capacity stands for the ability of the material having certain shape to withstand certain types of maximum loads entailing number of changes, under certain working conditions. The carrying capacity can be brought into proportion with the Veler's curves of fatigue, obtained by checking the gear (separately the flexion at the tooth root, and likewise of the side surface pressure). This is achieved by theoretical figuring out of the carrying capacity function curve, whilst for practical purposes it suffices to establish only two points on the curve, and define their the driving factor value.

Thus, the carrying capacity of the gearbox-reducing gears is equal to the allowable temporally constant rotating moment acting upon the driven shaft within a period of changes of the load at the driving shaft.

The carrying capacity of the gearbox at the working wheel on the excavator SRs-630 (shown on figure 3) is equal to the allowable temporally constant rotating moment T_2 acting on the driven shaft during N changes of the load upon the driving shaft, that is, the ability of the shaped material in gear to withstand certain maximum loads entailing number of changes under certain working conditions.

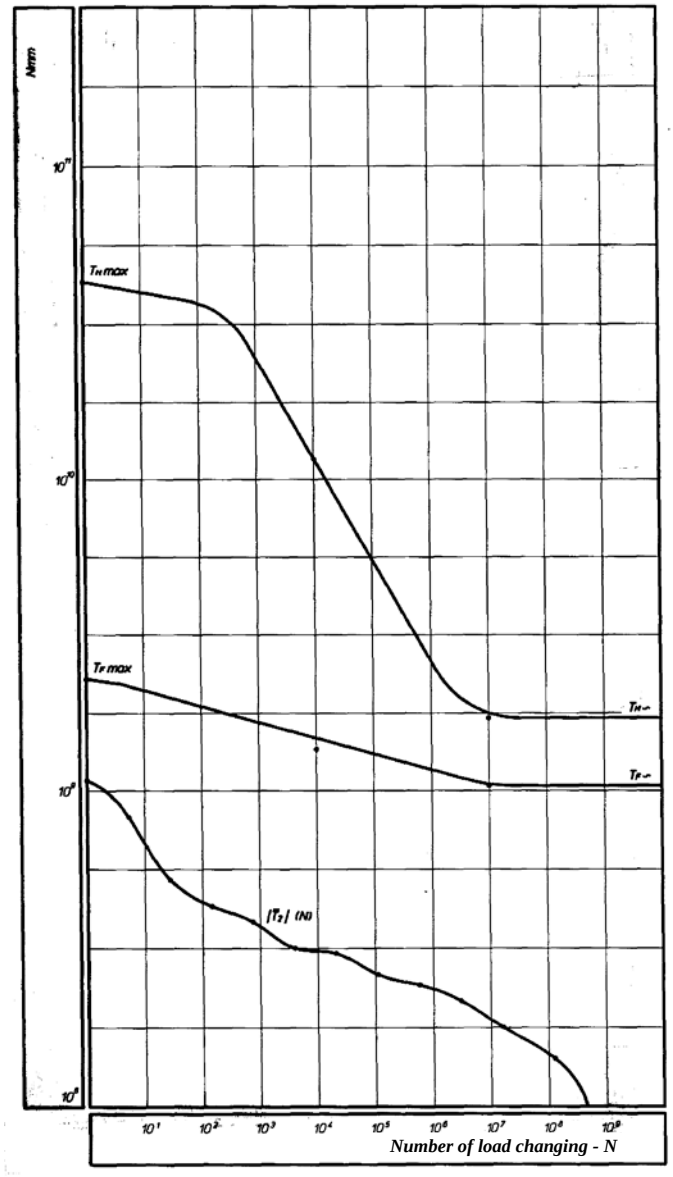

Fig. 3 *Comparative diagram of load function and carrying capacity functions of the gearbox at the working wheel of the rotating excavator SRs-630 under working conditions at the coal mine Suvodol-Bitola*

4. Comparing of the load and carrying capacity functions of the gearbox

Comparing the load function of the gearbox at the working wheel on the rotating excavator SRs-630 with carrying capacity functions for surface pressure and bending (shown on figure 3) yielded the following: the load function with a value $T_2 = 1{,}2\text{x}10^9$ Nmm for $N = 10^0$ changes of the load and decreasing values for T_2 with increase for the number of changes of the load N, is significantly lower in relation to the carrying capacity functions, for surface pressure and bending. Since these curves do not intersect and are not touching, theoretically deduced, the conclusion has been reached that the gearbox is oversized and possesses greater safety under nominal working regime of the excavator.

5. Conclusion

Loading regime condition of the gearbox at the working wheel under normal and specific conditions of exploitation on the excavator determined by experimental measuring, is defined by the function of rotating moment T_2 distribution upon the driving shaft depending on the number of load changes within the gearbox over the expected exploitation lifetime of the gearbox.

The analysis of the results from theoretical and experimental research, as well as comparative analysis of the load function of the gearbox and carrying capacity functions, it can be concluded that the load functions with increasing number of load changes is significantly lower positioned in relation to the carrying capacity functions for the surface pressure and bending.

The general conclusion would be: the gearbox at the rotating wheel on the excavator SRs-630 (shown on figure 4) altogether possesses high safety and reliability to work under normal exploitation conditions, in terms of design and construction parameters and characteristics.

Fig. 4 *View of the rotating excavator SRs-630*

6. References

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Numerous documentation for modifications and repairs of gearboxes from the coal mine Suvodol-Bitola.