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Failure analysis and reconstruction design of the slewing platform mantle of the bucket wheel excavator O&K SchRs 630

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ABSTRACT

The slewing platform is the fundamental part of the bucket wheel excavator (BWE) structure. The occurrence and propagation of cracks in the zones of the slewing platform mantle holes, may probably lead to BWE collapse. The goals of the study presented in the paper were to: (1) Diagnose the cause of cracks occurrence; (2) Define the reconstruction design of the mantle; (3) Verify the reconstructed structure by numerical–experimental analysis. The identification of the stress–strain state of the mantle is done by applying the finite element method. Experimental stress analysis of the reconstructed mantle's structure is executed two times in the BWE real working conditions, using methods of strain gauges. The maximum measured value of stress is about 10% lower in relation to the calculated value of stress for the studied load case. Speaking from the engineering standpoint, the mentioned deviation is quite acceptable, particularly having in mind the stochastic character of the excavation process. Besides experimental investigations, the validity of the presented reconstruction also unquestionably confirms the mentioned failure-free exploitation, while the BWE excavated more than 2.6×10^6 t of coal after the reconstruction.

1. Introduction

The ongoing bucket wheel excavators (BWE) exploitation in extremely heavy duty conditions causes failures of their structural parts – plastic deformations, cracks and fractures [1–6]. Failures always cause direct as well as indirect costs due to the downtime that substantially diminishes the effects of BWE exploitation. Furthermore, the replacement of damaged parts is executed on site, often in hard working conditions that essentially prolong the downtime of the complete surface mining system. Losses caused by machine downtime i.e. the system as a whole, may exceed direct material damage several times [7]. For instance, the cost of 1 h of downtime for the system in which operates BWE shown in Fig. 1 is 11,000 €. The size of the negative economic effects caused by failures is remarkably reflected in the fact that the total cost of failures in USA and Europe is of an order of 4% of GNP [8].

Cracks on the BWE O&K SchRs 630 slewing platform mantle, Fig. 1, have been detected in the zones of holes (160 mm in diameter) through all of which pass electric power cables, Figs. 2–4.

The mentioned cracks lead to deplanation of the cylindrical mantle surface, Fig. 5. The occurrence and propagation of cracks in the zones of slewing platform mantle holes may probably lead to BWE collapse, such as described in [1–3]. The goals of the study presented in the paper were to: (1) Diagnose the cause of failure; (2) Define the mantle redesign solution; (3) Verify the redesigned structure by numerical–experimental analysis.

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