



Disaster of the bucket wheel excavator caused by extreme environmental impact: Consequences, rescue and reconstruction

Srđan M. Bošnjak^{a,*}, Sreten D. Savićević^b, Nebojša B. Gnjatović^a, Ivan L.J. Milenović^a, Milorad P. Pantelić^c

^a University of Belgrade, Faculty of Mechanical Engineering, Kraljice Marije 16, 11120 Belgrade 35, Serbia

^b University of Montenegro, Faculty of Mechanical Engineering, Džordža Vašingtona bb, 81000 Podgorica, Montenegro

^c University of Kragujevac, Faculty of Technical Sciences, Svetog Save 65, 32000 Čačak, Serbia

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ABSTRACT

A slope failure was the cause of a severe accident of bucket wheel excavator (BWE) Takraf SRs 1200. This paper is dedicated to the engineering challenges that accompanied the process of returning the BWE from its after accident state to the state of full exploitation readiness. After the accident, temporary stabilization of the superstructure was carried out as well as cutting off of severely damaged parts of the bucket wheel boom (BWB) with excavating device. Successful completion of the very delicate BWE rescue and balancing operation was followed by the reconstruction of the heavily damaged slewing platform. The integrity of the slewing platform structure was preserved by removing structural parts which were seriously damaged during long-term exploitation and breakdown, and installing the newly designed elements in critical zones. The redesign of the slewing platform structure produced favorable loads and stiffness distribution while eliminating geometrical stress concentrators. Comparative analyses of the stress states pointed out that the redesigned slewing platform structure meets the strength criterion, unlike the original structure. The redesign solution enabled reconstruction in field conditions. This way the time of the reconstruction realization was drastically cut and losses due to the downtime of the machine were reduced several times over. After completing the slewing platform reconstruction, the newly manufactured BWB structural elements as well as the newly manufactured bucket wheel with drive were installed i.e. a partial revitalization of the BWE was done and by that the BWE's life was essentially prolonged.

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1. Introduction

Bucket wheel excavators (BWE) are exposed to environmental impacts, predominantly those of the excavated soil [1–5]. Even in regular exploitation conditions, the outstandingly dynamic and stochastic character of the loads caused by soil impacts provides fertile ground for the occurrence of failures of structures or substructures [6–12] as well as mechanism parts [13–21]. Apart from that, BWEs can also be subjected to extraordinary environmental impacts which inevitably lead

* Corresponding author. Tel.: +381 11 3370831; fax: +381 11 3370364.

E-mail address: sbosnjak@mas.bg.ac.rs (S.M. Bošnjak).

to the occurrence of the so-called 'environment-in' defects [22]. Typical examples of extreme environmental impacts on the BWEs are slope failures, Fig. 1, which caused severe accidents of BWEs used for overburden digging and deposit in the open pit mine "Kolubara" – Serbia.

This paper is dedicated to the engineering challenges that accompanied the process of returning the BWE SRs 1200 from the state after the accident, Fig. 1a, to the state of full exploitation readiness. Its importance stems from the fact that presented technologies of rescue, repair and reconstruction in field conditions can be applied for solving the same, Fig. 1b, or similar problems which could arise during the exploitation of surface mining systems.

2. State of the BWE after the accident

Because of the total resting of the BW, Fig. 2 (view A), the catching hooks were fractured which led to the slew bearing opening for 460 mm, Fig. 2 (detail B) and vertical displacement – lowering of the counterweight boom (CWB) end for 1920 mm. Fortunately, the bucket wheel boom (BWB) head was covered with soil and thanks to that fact a total collapse of the machine was avoided. Temporary stabilization of the machine was done immediately after the accident, Fig. 3. Later, the counterweight (≈ 77.5 t) was dismantled and the superstructure returned to its regular position by successively lifting the CWB end. This was realized by hydraulic jacks mounted below the pylons of the temporary support 1 (TS1), Fig. 3 (detail A). In addition, the slewing of the platform and further opening of the slew bearing were prevented by installing specially designed elements, Fig. 4.

2.1. Description of the damage

Visual examinations and determination of the substructures' and mechanisms' damage degrees were conducted after the temporary BWE stabilization. On that occasion the following was determined:

- The head as well as the central part of the BWB have suffered severe damage followed by very pronounced plastic deformations of vital structural elements, Figs. 2 and 5a.
- The damage degree of the BW with drive and slew bearing, Fig. 5b and c was so high that their repair was not possible.
- The slewing platform also underwent serious damage, Fig. 6. It was particularly pronounced in the zones of the rear pylons leaning. In the bottom plate of the left girder, Fig. 6 (view A), a crack was observed along the contour of the ring by which the slewing platform reclines on the slew bearing. In field 5, Fig. 6 (views C and E, detail D), cracks in the vertical and bottom plate were perceived. Buckling of the vertical plate in field 5 also occurred during the accident, Fig. 6 (view C). Besides that, in the bottom plate behind the right rear pylon, another crack was noticed, Fig. 6 (view F and detail G).

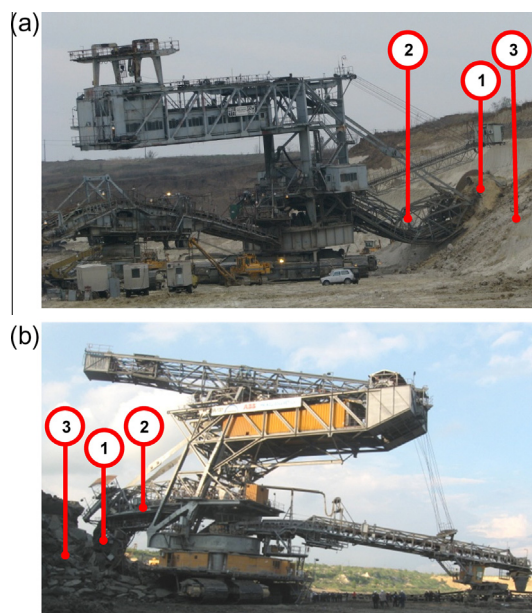


Fig. 1. Typical accidents caused by slope failure: (a) BWE SRs 1200; (b) BWE SRs 1301 (1 – bucket wheel, 2 – bucket wheel boom, 3 – failed slope).

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