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Simulation of Performance Formation Process of Loader with Wedge-like Working Elements as Part of Blast and Bulk Tunneling Complex

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Abstract

The article deals with the problems of theory and calculating the productivity of the cutting blasting-bulking complex provided with the bottom wedge driving transporting organ (WDTO) and receiving bunker based on generalizing the experimental data. Mathematical models of the volumes on the cells exit at WDTO working considering the regularities of transmitting the load pressure for the bottom of WDTO are based. The algorithm and the program of the imitating of modeling the process of cyclical load volume changing at the cells exit considering load profile forming in the bunker and random particle size changing in the cells are worked out. The proposed methods permit to evaluate the complex productivity and parametrical synthesis of new technical decisions.

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Keywords: blasting bulking cutting complex; wedge draughting transporting organ; cutting complex profuctivity; mathematical models of load volume at the wedge cell exit; casual process of middle particle size changing in a cell; algorithm and the program of imitating modelling of the complex productivity.

1. Introduction

One of the most perspective ways of increasing driving underground working efficiency is creating unitizing cutting systems – complexes. The cutting blasting-bulking complex (CBBC) [1-5] not having any analogues in world practice has been worked out with the help of the complex of methods of structural synthesis of mining cutting equipment [6-9] at the Shakhty institute (branch) of Platov South-Russian state polytechnic university (NPI).

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The base part of CBBC is loading-transporting module (fig. 1) representing bunker for blasting-bulking with turned (rotating) sides overlapping the heading for all its width. A conveyer with a wedge driving transporting organ consisting of movable and fixed wedges is situated in the bunler bottom. Besides, a running cart with two sets of drilling equipment and a preserving timber moving according to the guide paths along the bunker are the ingredients of the complex. The characteristic feature of CBBC is that loading of the blasted mining mass to the reloader is realized not by a special loading organ but by the blast energy.

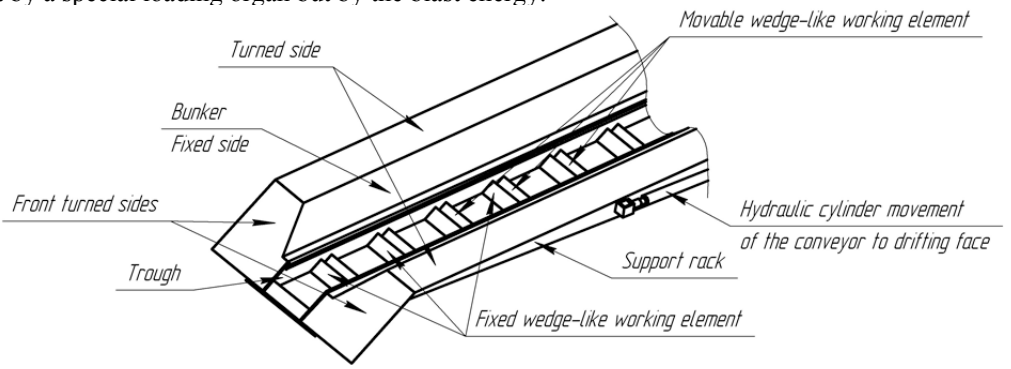

Fig. 1. General sight of the loading organ of CBBC.

The investigation carried out [10,11] showed workability of such solution. The efficiency evaluation [12,13] was fulfilled, and the productivity [14,15] of CBBC was defined. Forecast rates of working out drifting by such a complex with drill and blast method in strong rocks is till 300 m/month.

2. The review of investigating the process of the material transporting by WDTO

Mathematical model of WDTO productivity at work in transporting regime, i.e. at the layer height H_{lr} of the transported material not exceeding five heights of the movable wedge h_{mov}. In the work [16] this model is corrected for the layer height $H_{lr} = (5 \div 10) h_{mov}$. In both cases the process of transporting is considered in the width limit B_c of WDTO limited with the vertical sides having the height which is more than the layer height H_{lr}. In these works it is stated that at increasing the layer height WDTO productivity increases. It is clear, that such increase cannot be endless. Such behavior of the performing organs at its interaction with friable medium is watched, for example, at coming the head dredger into the ground [17]. Besides it, from the existing mathematical models [17, 18] it follows that at the increase of an average size of a particle d_{mean} productivity descends, which does not correspond to the experimental data given in [19].

However, in the complex CBBC WDTO works inside the bunker restricted with the bottom, fixed sides and turned sides (look at fig. 1). The width B_c of WDTO is less than the width of WDTO which is equal to the width of the mining heading. The material is transported from the central part of the bunker but stays immobile on the turned sides. Turned sides accumulate a part of the load and, rising, transfer it to the area of WDTO work. In this case the height of the layer does not have constant meaning along the whole width of CBBC, and, hence, cannot be the main factor defining the productivity of WDTO. Besides it, fixed sides have the angle of inclination about 50 o. It brings to the fact that part of pressure of transmitted to the bunker walls and, correspondingly, the process of forming the volume V_{out} of pushing is changed.

For working out mathematical models of forming the material flow of WDTO in the regime of work “under the dirt pile” inside the bunker it is necessary:

- to define the factors influencing the forming of a material flow of WDTO;
- to ground the dependence of the material volume on the exit of WDTO on the influencing factors;