SYNCHRONIZATION OF OVERBURDEN DUMPING IN BUCIM OPEN PIT MINE IN FUNCTION OF MINIMAL COSTS

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ABSTRACT

Overburden exploatation in open pit "Bucim" is performed from 3 (three) ore bodies, with least 2 (two) excavating zone. Overburden dumping is in 3 dump: two external and one internal. The need for synchronization of work is imminent, given that it is the same transport machinery - 12 trucks.

In this paper it was made an attempt for mathematical modeling of synchronization of transporting and overburden dumping in three dumps.

INTRODUCTION

The development of the open pit mine "Bucim" and its deepness increases the transport distance for the dry ground and for transporting the ore to the primary grind. Dump No.1 for dumping an overburden from surface mines in "Bucim" already exceeds defined levels and amounts under the existing valid mining projects.

There is the need to find a possible alternative solutions to dumping with the formation of internal dump, which has become a reality. Namely, the digging from the sothern part of the open pit mine according to the given projects and geological research that the rest reserves of ore are dugged and the configuration itself, geometric of slopes and others geometric elements do not allow further digging of the pit mine

Exploatation in open pit "Bucim" is performed from 3 (three) ore bodies, with least 2 (two) excavating zone. Overburden dumping is in 3 dumps: two external and one internal. Basically, this is a complex system that in turn requires synchronization in order to minimize the costs of exploitation.

DISPOSAL OF OVERBURDEN

Disposal of the sterile mass is on three dumps: Dump no. 1, with the greatest capacity. It is intended to accept the sterile masses from "Chukar 1" and "CRT" and is located on its southern border. Initial mound that formed the dump is at a distance of 250-300 meters from the ore body "Chukar 1" and conjunction path is guided by isohypses 630, a basic level of dumping. Dump no. 2 is located eastern of the open pit "Vrsnik", at the distance of cca 500 m, with communication relation for truck transportation with the benches 705 and 690. Dump no. 3 was for disposal of poor copper ore (0,1 - 0,2% Cu), and with aim to use the metal in the process of leaching. Dump no. 4 is located northern of Central ore body, with relatively small capacity for disposal the sterile mass from the upper benches of the Central ore body and ore body "Vrsnik", as well as for protection of the pit from atmospheric waters from that basin.

Basic principles according which are designed the solutions for the dump sites are:

- selection of optimal transport relations for disposal, and in function of the purpose: reaching the minimum amount of ton - kilometers per year.
- from ecological aspect, covering smaller area
- provided reliability of technological process and stability of the buildings
- locating the dumps on the terrain that are unpromising regarding the mineralization, i.e. on sterile areas.

Knowing these criteria, it can be concluded that the location of the dump sites, generally, satisfies the techno - economic conditions which are part of the whole mining process.

Starting from the fact that the current exploitation changed much economic criteria as expanded areas for exploitation, and thus the priorities of exploitation, where sterile masses are generally disposed on the dump no. 1, which are violated certain basic criteria for the main project, entails making: "Additional mining project to redefine the existing contours of dump no.1" for the following reasons:

- over the past mining activity (cca 30 years) amount of the level plane where disposal is done has changed, so the level of disposal is raised from level 630 to level 675;
- absolute height of the sterile bench is increased from planned 90 m to 145 m on some locations, and now is formed another level plane on level 680 as a strip on which will be left bench threshold of 25 - 30 m to the edge of the level plane on 660 m;
- planned area for disposal of the sterile mass doesn't satisfies the needs, and space expanding of the disposal in all directions is limited: from north - open pit, from east - infrastructure and asphalt access road to the mine, from south - the new plant for leaching of the oxide ores that will continue until leaching of whole dump no. 1 and from west - planned preparation for exploitation of the ore body "Bunardzik" and left the area for free flow of the atmospheric falls in the basin of the river Bojkovica. Previous changes on the dump no. 1 appears from the increased quantities of sterile mass, and the changes are because of:

- increased depth of the open pit for excavation of the "Centralore body" and "Cukar - 2";
- extension of the pits as a consequence of the newly ore reserves in the ore body "Cukar - 2" and in the interspace between the two ore bodies;
- opening and exploitation of the northeastern part of the "Central ore body" and
- opening and exploitation of ore body "Vrsnik" and storage of the oxide ores from it for further treatment with the leaching method.

SYNCHRONIZATION OF DISPOSAL ON THREE DUMPS

Synchronization of disposal on the three dumps should be done according the following requirements:

- disposal of the total planned quantity of overburden,
- reaching the necessary dynamics and capacities for disposal,
- disposal regime with minimization of waiting,
- disposal is made in conditions of planned geotechnical stability,
- drainage should be according the planned process,
- to minimize the impacts on the environment.

Reaching of these requirements is a basic element for technically safe and efficient way of disposal.
To all of these requirements should be added another which is minimizing the cost of transport and slag. That is to develop a model that despite these, as the main criterion will take the cost of transportation and disposal. It means to develop synchronized mode in which the will be taken in consideration following criteria:

- any truck can't wait to unload,
- transport distances to be minimized,
- to allow process of rapid formation of the dumping areas with aim to reduce the time for disposal,
- dumpers to be redirected and redistributed through the dispatch center to those areas where there are free excavators or there is need to intensify the capacity of the overburden excavation.

PROCESS OF SYNCHRONIZATION

Main process in synchronization is harmonization of times: time of moving to the place of loading of overburden (t_{im}), waiting time for loading (t_{wt}), time during loading (t_l), time of the movement of full truck (t_{tt}), waiting time for unloading (t_{wd}), time during unloading (td) and time of motion of empty truck (t_{rm}).
At the same time, in the dispatch center is analyzed:

- Minimization of the total time for transport and disposal of overburden:

$$T = T_{im} + T_{wt} + T_l + T_{tt} + T_{wd} + T_d + T_{rt}\ [min] \rightarrow minimum$$

- Time from the difference between the moving times of full and empty trucks for different traces should not be larger than the waiting time, or:

$$(t_{pmi} - t_{pmj}) < (t_{wt} + t_{wd})$$

- Synchronization of the moving velocities. In order to achieve the required time, you need sync speed of movement of trucks within their permitted speeds.
- Provide and define the dumps. Formation and reclamation of the disposed material.
- Continuous monitoring and maintenance of the roads depending of the intensity of usage.
- Regular maintenance of trucks, excavators and other auxiliary machinery.

Knowing all previous criteria was defined model for synchronization of the disposal of overburden on the three dumps. Using Monte Carlo method, several approaches for solving this problem were made. .

In addition, simulations were made of random variables - time of loading, time of transport, time of unloading and waiting time for a total of 18 varieties, two for each excavation from three open pits on three dumps. For each of the variants are simulated 100 random numbers in their respective intervals.

- When it made simulations of unexpected variables - time of loading, time of transport, time of unloading and waiting time for a total of 18 varieties, 2 for each excavation blocks of 3 open pit mines of 3 damps. For each of the variants are simulated 100 unexpected numbers in their respective intervals. It is made a Monte Carlo analysis and calculated the probability of the minimum possible time for transport for various variants. It is defines the possible approaches to synchronization of the process for dumping and transport of overburden.
- Possible approaches are given for further processing in the call center in order to synchronize the disposal of overburden.
- For this purpose is provided a new system for monitoring and control to existing dispatch system .

CONCLUSION

The basic objectives in this paper is the process of synchronizing of the transport and damping of overburden in 3 disposal in open pit mine “Bucim” in order to minimize the costs. Because of this, was developed a model for synchronization of transport and overburden dumping. Simulations in the model are made using the Monte Carlo method. There were defined probabilities for loading times, transportation, damping and waiting trucks from 6 excavated fields, 3 dumps, exactly 18 variants. The results of these simulations as possible approaches serve as input for issuing commands from the dispatcher upgraded system with a system for monitoring and control.

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