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THE RECULTIVATION OF THE RBB-BOR CEROVO-CEMENTACIJA 1 OPEN PIT WASTE DUMP

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Abstract: The development of the human society is unbreakably bonded with the development of industrial production. This increases the amount of mineral resources exploitation, thus increasing the area of degraded soil. The consequences of these processes are many and are destructive for the environment, so if nothing was done, the justification of exploitation would be questioned. Looking into the seriousness of the problem, special care is taken to recultivate the degraded soil and rehabilitate its reproductive capabilities.

The basic goal of this paper is the proposal of the solution for the establishing of the conditions for long-lasting, viable vegetation covers on the degraded areas of Cerovo-Cementacija 1 open pit waste dump.

Key words: Open pit mine, degraded soil, recultivation, environment.

Introduction

The quality of the environment at the area of the Cerovo-Cementacija 1 open pit mine, before copper ore extraction and overburden disposal, was preserved and with undisturbed ecosystems. Mining operations degraded the area by both ore extraction and overburden disposal. Structures degrading the soil are the cavity of the pit, waste dumps and industrial facilities such as crushing mill, hydro-transport facilities, eco dams, stock pile etc.

Overburden disposal formed the waste dump which is consisted of two separate dumps, North and South and their areas are given in table 1. [1]

Table 1 *– total area of degrade surfaces at Cerovo-Cementacija 1waste dump*

Location	Planes m^2	Slopes m^2	Total m^2
South waste dump	64 795	175 110	239 905
North waste dump	9 035	61 970	71 005
Σ	73 830	237 080	310 910

The shape of both waste dumps is mainly elliptic and the average height is about 90 m. The location of the waste dumps and the Cerovo open pit is shown in figure 1.

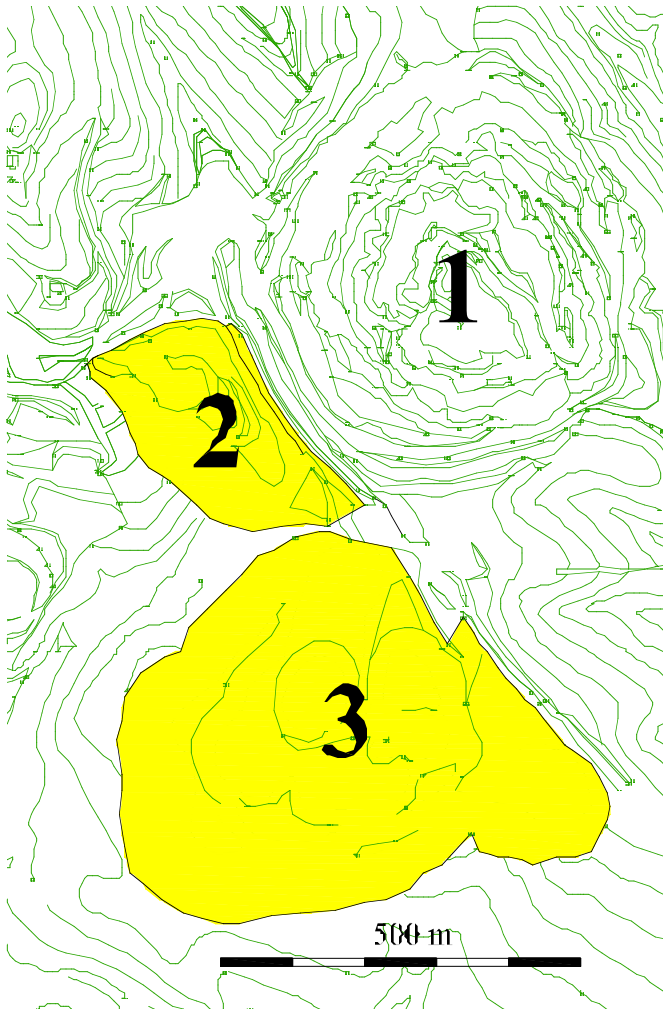

Figure 1. *The position of the Cerovo-Cementacija 1 waste dumps and the open pit 1-Open pit, 2-North waste dump, 3-south waste dump*

After the end of mining operations the soil can not be returned into its original condition. Ecosystem is irretrievably changed but with modern methods of recultivation it is possible, within relatively short time of 10 to 15 years, to some extent, to give back natural reproductive potential of the environment.

Material and Methods

Mining operations at Cerovo-Cementacija 1 lasted from 1991 to 2002 wit the annual ore output of 2.5 Mt. The overburden was disposed irregularly, with the surface material disposed on the bottom and the material from the deepest benches disposed as the top layer of the waste dump. The waste texture is consisted of sand alumina with alumina content of 35.5 % and sand content of 64.3 % and with pH factor of 3-4.6. This means that the soils cannot cover themselves with protective vegetation without the human intervention. In order to sustain vegetation growth at this area, recultivation must be undertaken trough three main phases [2], preparatory operations, technical and biological phase.

Preparatory operations for recultivation are construction of the access roads, leveling of plain surfaces, humus acquiring, loading and transport to the waste dump. Technical phase of recultivation is consisted of terrace cut-in on the slopes and humus leveling on the finishing planes of the waste dump.

Biological phase gives solutions that associate seeds, plants, soil conditioners, binders, fertilizers in order to integrate the site in its original landscape.

Results and Discussion

Preparatory operations are expensive and complex, but they are necessary. Bulldozer CATERPILLAR D8L with hydraulic tilthdoser, angledoser and ripper will be used for access road construction, leveling of finishing and bench planes and ripping in the depth of 65 cm, the total area to be leveled and ripped is 76 380 m^2.

Since slope angles of the finishing slopes are steep, about 35, it is necessary to cut small 4 m wide terraces, to make the traffic of light mechanization possible. The terraces will be cut using the articulated multi-functional combined machine FOREDIL model FM500T. This machine meets the demands of efficient cutting and later servicing of the terraces since the height of the terrace slope is 4.5 m and the maximum cutting height of the machine is 5 m. Figure 2 gives the basic dimensions of the terraces.

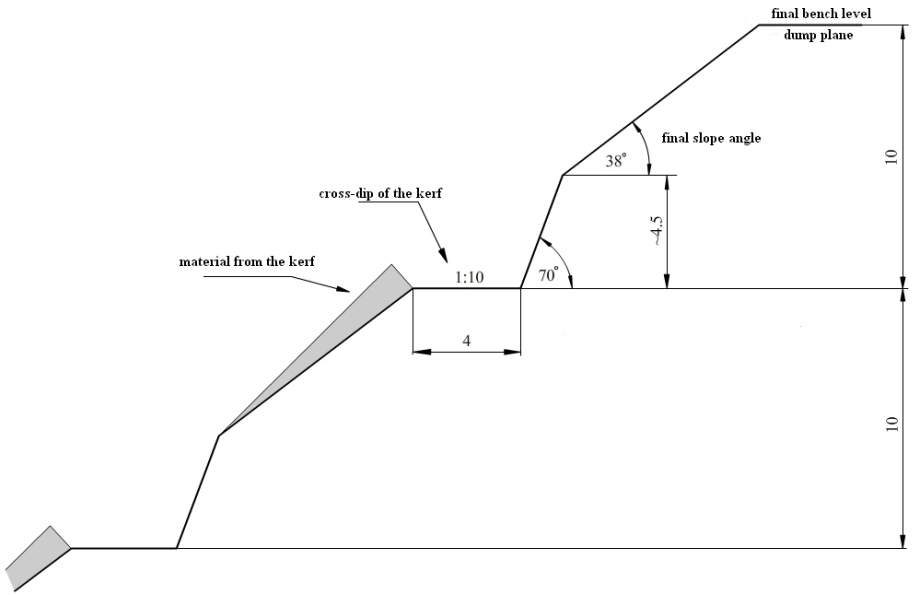

Figure 2. *– Basic terrace dimensions*

Articulated construction of the machines ensures its maneuverability in small areas and the backhoe attachment will be used for trench and dibble hole digging. The production efficiency of the machine is 20 m of terrace per shift or 15 dibble holes per hour.

Technical recultivation considers earth and humus digging from the borrow pit, loading and transport to the waste dump and its spreading on the flat surfaces or putting into the dibble holes. Technical recultivation is conducted during the dry period, in July, August, September and October. Earth digging from the borrow dip, loading and transport to the waste dump is necessary because the earth is spread on the flat surfaces for grass seeding and put into dibble holes.

The earth from pit location is of vital issue since it influences on the total costs of the project. The location of Cerovo-Cementacija 2 is chosen because it is at a distance of 800 m. Second reason for this choice is the plan for opening a new open pit mine at that location and because of that the pedological layer will be removed anyway. Table 2 gives the required amounts of earth and humus from the borrow pit.

Table 2 *– Required amounts of earth from the borrow pit*

Level	Area to be recultivated			Required amount of earth m^3		
	South waste dump					
	Planes m^2	Slopes m^2	Terraces m^2	Planes	Slopes	Teraces
540	19 845	0	0	323	0	0
535	32 150	0	0	524	0	0
525	12 800	0	0	209	0	0
540/530	0	28 060	4 640	0	2 293	85
530/515	0	66 870	12 000	0	5 463	219
515/500	0	42 440	19 680	0	3 467	359
500/485	0	18 520	18 240	0	1 513	333
485/470	0	15 450	19 040	0	1 262	347
470/455	0	3 770	0	0	308	0
	North waste dump					
535	4 405	0	0	868	0	0
523	2 980	0	0	596	0	0
505	1 650	0	0	329	0	0
535/530		5 630	0		460	0
530/515	0	30 650	4 320	0	2 504	79
515/500	0	15 660	5 600	0	1 279	102
500/485	0	8 040	3 200	0	657	58
485/470	0	1 990	1 280	0	163	23
Total				**2 849**	**19 369**	**1 606**
				23 824		

Loader ULT-220 will be used for the earth loading and the FAP-2635 and FAP-1314 trucks will be used for the earth transport. FAP-2635 with maximal payload of 16 t will transport the earth to the flat surfaces and the FAP-1314, with maximal payload of 8 t, will transport the earth to the terraces. Average transport distance is 1000 m. Dibble holes will be dug with drilling rig of the combined machine FOREDIL model FM500T.

Biological recultivation considers the choice of plants for forestation of the prepared areas in order to rehabilitate ecosystem. This choice is essential since the soil is poor and hostile to the vegetation due to its bad physical and chemical characteristics. The plants must be fast growing, adaptive, resistant to drought. The first choice is locust tree (Robinia pseudoacacia) and bastard acacia (Amorpha fruticosa) [3,4].

The plants will be planted in autumn, in 1.5 X 1.5 m triangular configuration for the locust tree and 1 X 1 m for the bastard acacia. The amount of necessary dibbles is 5 132 per hectare for locust tree and 11 494 dibbles per hectare of bastard acacia. The number of dibbles should be increased by 10% due to the damage during transport and handling. The dibble holes are square, 50 cm wide and deep. 2 kg of manure and 50 g of fertilizer (NPK 15:15:15) are added to each hole. The number of necessary dibbles is shown in table 3.

Table 4 *– Number of necessary dibble and dibble holes*

Level	Area m^2			Number of holes (pcs)		
	South waste dump					
	Planes m^2	Slopes m^2	Terraces m^2	Planes	Slopes	Terraces
540	19 845	0	0	10 184	0	0
535	32 150	0	0	16 500	0	0
525	12 800	0	0	6 569	0	0
540/530	0	28 060	4 640	0	32 252	928
530/515	0	66 870	12 000	0	76 860	2 400
515/500	0	42 440	19 680	0	48 780	3 936
500/485	0	18 520	18 240	0	21 287	3 648
485/470	0	15 450	19 040	0	17 758	3 808
470/455	0	3 770	0	0	4 333	0
	North waste dump					
535	4 405	0	0	2 261	0	0
523	2 980	0	0	1 529	0	0
505	1 650	0	0	847	0	0
535/530		5 630	0	0	6 471	0
530/515	0	30 650	4 320	0	35 229	864
515/500	0	15 660	5 600	0	17 800	1 120
500/485	0	8 040	3 200	0	9 241	640
485/470	0	1 990	1 280	0	2 287	256
Total				**37 890**	**272 298**	**67 325**
				377 513		

The care about young plants is consisted of hoeing and harrowing in order to eradicate the weeds, during the first three years. Harrowing is performed in order to prevent moisture loss and improve aeration. Replanting is done only if more than 20 % of the plants withered. [3]

Biological recultivation of degraded areas prevents further erosion and triggers microorganisms to act, thus starting pedological processes of humus formation.

Conclusion

The greatest changes in Cerovo environment have happened during copper ore extraction. The changes were degradation of area and interruption of environmental balance. The presence of heavy metals in air, soil, water and vegetation before, during and after the beginning of ore extraction remained within the legal limits. To reorganize the impact on the environment it is necessary to perform full technical and biological recultivation of the degraded area trough the series of complex operation shown in this paper in the most adequate and certain order.

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REKULTIVACIJA ODLAGALIŠTA POVRŠINSKOG KOPA CEROVO-CEMENTACIJA 1 RUDNIKA BAKRA BOR

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Izvod

Razvoj ljudskog društva je u neraskidivoj vezi sa razvojem industrijske proizvodnje to povećava obim eksploatacije mineralnih sirovina, a samim tim sve je veća površina degradiranog zemljišta. Posledice ovakvih zahvata su mnogobrojne i veoma destruktivne za životnu sredinu, pa ukoliko se nita ne bi uinilo na njihovom otklanjanju, dovelo bi u pitanje opravdanost takvih eksploatacija. Sagledavajući ozbijlnost ovog problema u svetu, a i kod nas, sve veća pažnja posvećuje se rekultivaciji oštećenih zemljišta i obnavljanju njegove reproduktivne sposobnosti.

U tom smislu osnovni cilj ovog rada je predlog rešavanja problematike degradiranog područja odlagališta površinskog kopa Cerovo-Cementacija 1, koji pripada RTB-u Bor, nakon njegove trajne obustave rada, posle deset godina intenzivne eksploatacije.

Ključne reči: Površinski kop, degradirano zemljište, rekultivacija, životna sredina.

R e z i m e

U početnoj fazi formiranja površinskog kopa Cerovo-Cementacija-1 glavna preokupacija stručnjaka bila je da se dostigne što veća produktivnost, a sagledavanje negativnih posledica na okruženje bilo je u drugom planu. Sada kada je površinski kop zatvoren osnovni napori su usmereni na rekultivaciju degradiranih površina. U tom smislu u ovom radu je opisan postupak po kome bi se ta rekultivacija uspešno izvršila. Posebno se ističe značaj predložene tehnologije i opreme za narezivanje terasa na kosinama odlagališta, s obzirom da je njihov nagib oko granične vrednosti koja uopšte dozvoljava narezivanje.

Summary

In the initial phase of open pit Cerovo-Cementacija 1 work the main occupation of experts was to achieve higher productivity, so the negative consequences on the environment were neglected. Now, when the open pit is closed, main effort is to recultivate the degraded areas. This paper gives the procedure for successful recultivation. The suggested technology and equipment for terrace cutting is especially important, since the waste dump slopes angles are near the boundary values allowing terraces to be cut.

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