DESIGN OF AN INTERNAL WASTE DUMP WITHIN THE BOUNDARIES OF THE OPEN PIT

Zoran Panov, DSc.,[1], MSc., Kircho Minov, MSc.[2], Radmila Karanakova Stefanovska[3], M.Sc.[1],
Slobodan Stojanov, B.Sc.[2], Blagica Doneva, M.Sc.[5]
[1,3,5] "Goce Delcev" University, Faculty of Natural and Technical Science, K. Misirkov bb, Stip, Macedonia,
email: zoran.panov@ugd.edu.mk
[2.4] "Bucim" DOOEL Radovis, Macedonia, email: kircominov@bucim.com.mk

ABSTRACT

With the deepening of the open pit, the transport distances for the sterile mass and the ore increased. This paper deals with the formation of an internal waste dump within the boundaries of the open pit. The development of such waste dump should be in function of the space for disposing the waste according to existing situation on the field and the space for dumping. The internal waste dump will be used for permanent dumping and waste storage. Modern methods will be used to assess the slopes stability of the dump – ordinary method, the method of Bishop, the method of Spencer and Janbu.

Key words: internal waste dump, slope stability, open pit

1. Introduction

The development of the open pit "Bucim" and on the one hand his deepening, daily increases distances of transport for damping the waste, and from the other side transportation of ore to the primary entrance point of crushing. The necessity of finding alternative solutions for damping with formation of internal dump, becomes not only an opportunity but mostly unavoidability. Namely, the impoverishment of the southern part of the open pit under the current mining projects, and verification of geological research that all ore reserves has been used, and the configuration of the pit, the geometry of slopes and other geometric elements, not allow further deeping of the pit. These factors impose need of extensive engineering and scientific research for the formation of internal dump of the waste in the southern part of the open pit "Bucim".

This paper aims to define the formation of the internal dump, and to define the technical factors associated with exploitation, transportation and damping of the waste from the open pit "Bucim" and amounts of open pit "Vrshnik. Special emphasis is given to the stability of slopes of the new internal dump and general procedures of its formation.

2. Review of the Existing Situation of Space Planned for Damping in Internal Waste Dump

Under the given situation, compliance with mining reserves, their degree of exploitation, new research, access to the ground, geomechanical characteristics, technical – technological, economical, point to the fact that it is technical - technological and economically feasible damping of waste in internal waste dump located in southern part of the open pit "Bucim".

2.1. Geomechanical characteristics of the surface and surrounding rocks

From the engineering - geological perspective and based on existing knowledge, the area of the site is characterized in stable areas with specific features of their stability.

For defining the slopes from the aspects of stability in the area of the ore deposit are made some researches and obtained the appropriate physical and mechanical characteristics, which are used in the design of slopes of the open pit.

Narrow cracks are registered without filling, and those wide cracks are filled with the clayey and decomposed material. Crackness in the field is expressed through the coefficient of the crackness and module of crackness.

Under coefficient of crackness means surface of cracks reduced the unit section of a typical part of the structure - texture zone. For quantitative evaluation of the frequency of occurrence of cracks and system of the crevices is used module of crackness that represents the number of cracks of a meter shall cross section of rock.

From the examination in the open pit "Bucim" are received the following sizes of the aforementioned variables:

Table 1

Cracked of the working environmental

Type of rock and ore	Coefficient of crackness [%]	Module of crackness	Degree of crackness
Andensite	4.1	7.0	Medium crackness
Gneiss	3.8	5.5	Medium crackness
Ore	3.9	5.8	Medium crackness

Based on this classification, the measured cracks in the ore body in Central part belong to the class of small and middle cracks. Also based on certain measurements of crackness which ranges from 2.8 to 4.8, as well as module of crackness which moves in the range of 2 - 9. Based on these measurements, the complex is categorized in the group of rocks with an middle of crackness.

In the study for evaluation of stability are presented in tables parameters of sturdiness for represented members, and is characterized values for:

Table 2

Geomechanical parameters

N⁰	Type of environmental	Cohesion (planned condition) C [кPa]	Cohesion (condition in the moment) C [кPa]	Angle of internal friction φ[°]	Volume weight γ [kN/m³]
1	Alternate gneiss (parallel foliation) RMR = 37	150.00	≤30.00	33.54	26.20
2	Alternate gneiss (normal foliation) RMR = 40	310.00	≤30.00	36.17	26.20
3	Andesite RMR = 54	2770.00	≤30.00	43.79	26.70
4	Fault zones RMR = 23	40.00	0.00	31.89	22.00
5	Cracks	0.00	0.00	31.89	22.00

Indisputable is the conclusion that the choice of values of sturdiness parameters of materials is one of the most complex and most sensitive tasks in geomechanical analysis of stability in the design of open pit mine, so when defining the same is going to use all available media from examination and research to receive more possible reliable and relevant data.

2.2. Geomechanical characteristics of the waste

If we take into account that in the internal waste dump will dumping the material – andesite and gneisses presented, we can conclude that it will have all the features of the aforementioned with the exception of the following specifics:

1. Waste as loosening material is with coefficient of loosening from 1.3 - 1.4, and it will consolidate with the wedges and the development of dump from elevation 450 to elevation 630, as the middle coefficient of overburden 1:35,
2. The material is loosening and it doesn't have a cohesion, ie it has zero value,
3. Volume weight of the material is adopted and 19.00 kN/m^3
4. Angle of internal friction is adopted for 33^0.

3. Construction of internal dump

The construction of internal dump was made on the basis of situation map of the current state of the southern part of open pit mine "Bucim" inclusive with the condition from 30 June 2010, then based on the respective cross sections from dump and multiple insights on the ground.

Based on the required space for the dumping the waste from exploitation of open pit mine "Bucim" the available equipment for work, and adopted angles of the slope of the final slopes and in accordance with the requirements of open pit mine "Bucim" needed to perform the construction of the internal dump for deposit the 50 million tons of solid matter in the next five years with an annual capacity of 10 million tons of waste.

Generally, with the damping will be create 2 (two) down-face bench:

- bench 555 (Phase 1, Fig. 1) и
- bench 630 (Phase 3, Fig. 3).

The formation of these 2 (two) bench will create another 2 (two) temporary benches as follows:

- bench 480 и
- bench 600 (Phase 2, Fig. 2).

The base of dump is horizontal with an altitude of 450 m and consists of solid rock - andesite and gneisses.

3.1. Calculating for the space for dumping

The internal dump fully meets the required of the total mass of waste for dumping, and planned dynamics.

3.2. Define of basic geometric elements of the internal dump

It is necessary to define the basic geometric elements of the internal dump as:

- height of dump,
- number of bench,
- minimum width of the bench in more benches dumps,
- working angle of bench,
- completed angle of bench,
- completed angle in one benches dump and
- points of dumping.

The selection and definition of basic geometric elements of the internal dump in the southern part of the open pit mine "Bucim" is a function of:

- configuration of the ground,
- geotechnical characteristics of the base,
- planned total mass of waste for dumping,
- planned annual capacity of waste for dumping,
- stability of slopes of the dumping and carrying of the base,
- technical capabilities of available equipment, the methodology and mode of dumping (mining trucks and bulldozers).

Based on the aforementioned analysis and consultation with the professional team in the open pit mine "Bucim" has decided to plan the formation of a dump with the following characteristics:

Table 3

N⁰	Characteristic	Value
1	Number of benches	2
2	Height of dump	180 m
3	Index of first bench	E 555
4	Index of second bench	E 630
5	Height of bench E 555	105 m
6	Height of bench E 630	75 m
7	Index of half benches	1
8	Index of half-bench	E 600
9	Height of half-bench	45 m
10	minimum width of the bench	15+20+15 = 50 m
11	working angle of bench	32-35^o
12	completed angle of bench	32-35^o
13	Working angle of dump	30-31^o
14	Completed angle of dump	30-31^o
15	Number of points for dumping	5
16	Volume of area for dumping	132753 m^2
17	Perimeter of dumping	1411 m

3.3. Geotechnical stability of internal dumping

Static geotechnical analysis showed the stability of the slopes of dump. High values of the factors of security, relatively high geomechanical characteristics of the material is being damping and base of dump and "impacted" of dump on three sides in the existing contours of the open pit, indicate on the factor that it is a dump with planned stable slopes .

No matter how stable is dump, during the damping should be conducted all the safety measures and technical protection. From special interest is to continuous with monitoring of the slopes of the internal dump.

Namely, continuous of geodetic measurements and interpretations of possible deformations and shifts are necessary in building such a facility geotechnical object.

3.4. Construction of dump

The development of internal dump in the open pit mine "Bucim" is in function with the space for damping the waste according to already existing situation on the ground and the space for the damping. Based on the position of transport communications or their level will start the formation and development of dump in the north - south with the formation of one depth bench whose newly height does not exceed more than 30 meters.

Namely, first is formed plateau, of the bench 450 to elevation 480. This space will be fill with the rest of the minimal volume of waste from the central ore body and the further deepening of the open pit. Dumping would be start from the point T_1 (Phase 1, Fig. 1).

Furthermore, dump will developed to elevation 555, with full formation and leveling of elevation 555. Dumping will be from the point T_2 and T_4. Than is planed charting of the communication road east - west, which will serve to transport waste and ore from the expansion in the Northeast part of the bench with a level 520-555 (Phase 1, Fig. 1).

Next phase is addition to the level of 600 (Phase 2, Fig 3). The formation of dump on level 600 will be performed by three points for dumping: T_4, T_5 and some T_3. This way of dumping will continue in the future by taking all measures for security of equipment for dumping. Finally, this would establish the highest bench 630 (Phase 3, Fig. 3). Dumping will be derived from the point T_5.

4. Discussion

The research which is made is based on conditions in the requirements for disposal of waste with minimal costs in the open pit mine “Bucim ". All conditions are fully met. The amount of accommodating a total mass of 50 million tons of waste in solid condition can be located in the remaining part of the open pit "Bucim" with the addition and expansion of this internal dump, defined in this research.

This will be served after the complete exploitation of the deepening of the central ore body and the enlargement of the northeast. Then, with new research to further extension of this dump, will fulfill this requirement.

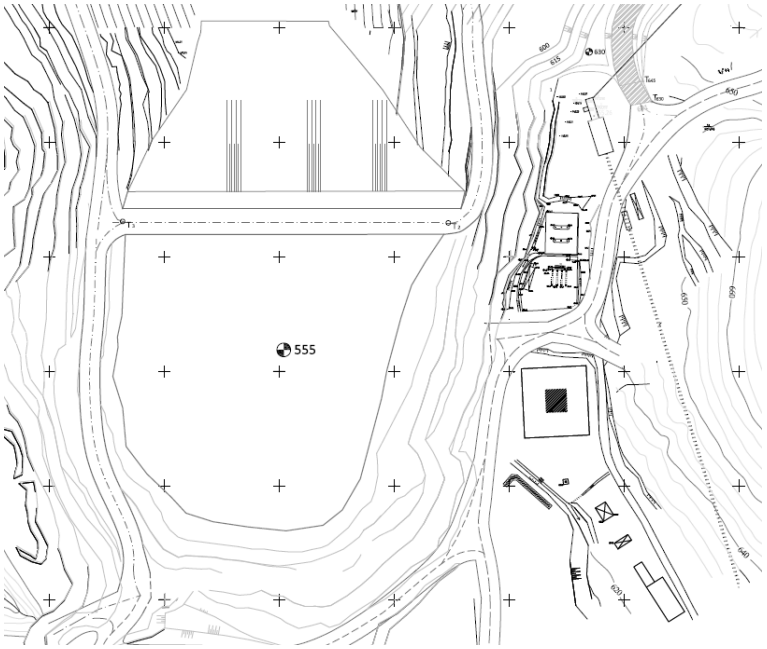


Fig. 1 Formation of internal dump -Phase 1

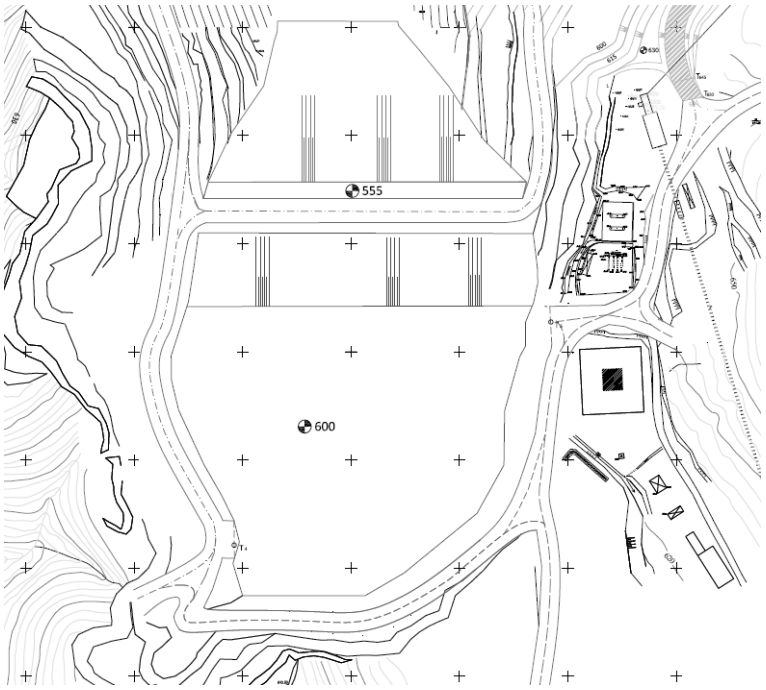


Fig 2. Formation of internal dump -Phase 2

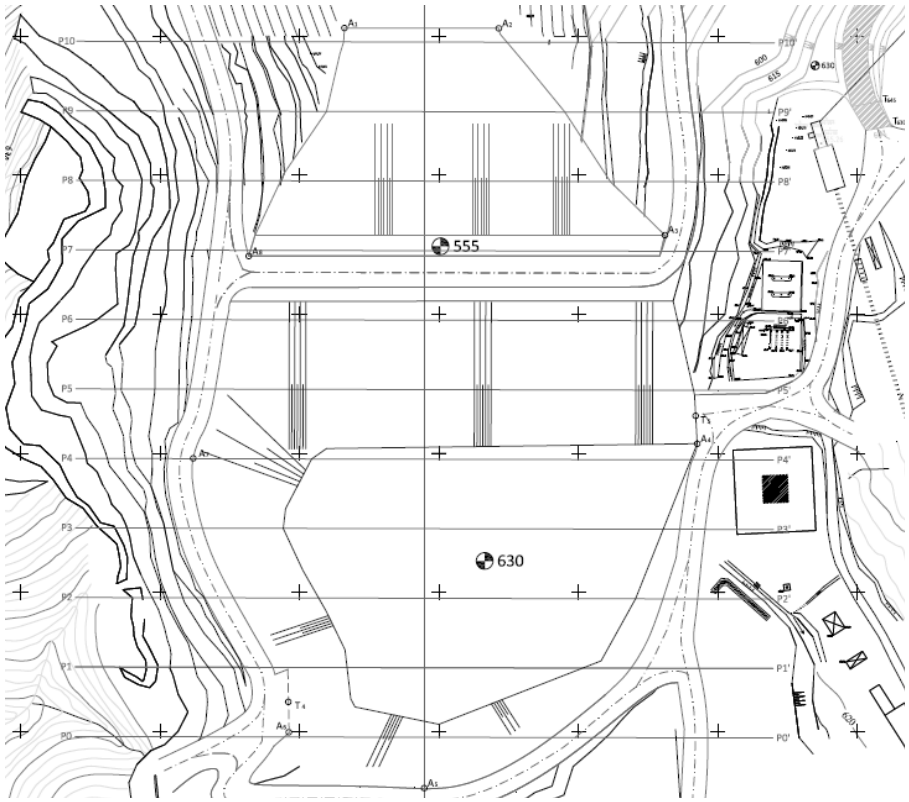
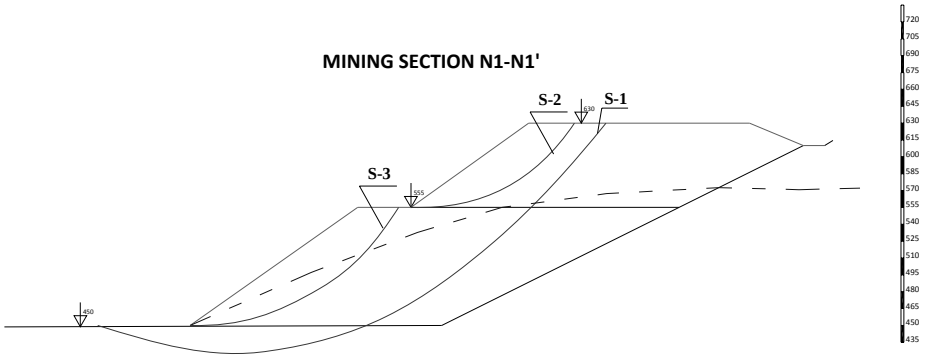


Fig 3. Formation of internal dump -Phase 3



Minimal Value of Factor of Stability						
Proposed slice surfaces and level of underground water (Ru=0.2)	S-1		S-2		S-3	
	M	F	M	F	M	F
Ordinary	1.561		1.394		1.303	
Bishop	1.733		1.506		1.412	
Janbu		1.557		1.393		1.306
Spencer	1.742	1.747	1.505	1.508	1.416	1.417

Minimal Value of Factor of Stability						
Proposed slice surfaces (Ru = 0)	S-1		S-2		S-3	
	M	F	M	F	M	F
Ordinary	1.717		1.494		1.473	
Bishop	1.891		1.596		1.655	
Janbu		1.694		1.493		1.484
Spencer	1.895	1.900	1.505	1.508	1.649	1.645

Fig 4. Longitudinal mining section N1-N1'

5. Conclusion

In this paper is fully developed the design of all phases of internal dump in the southern part of the open pit mine ”Bucim”. Is made analysis of the current situation, plan for further development of the waste excavation in the open pit mine "Bucim", especially the ability to fit into future technological solutions for waste dumping.

The basic mining - technological conditions given in the requests by management in the mine "Bucim" are fully met. It was designed two benches internal dump. The development of dump is given in five stages, while it provides detailed explanations for depth dumping from 5 points on dumping.

The planned total volume of dumping about 9.4 million m^3 meets the requirements for dumping 18.38 million tons of waste in solid state. Requesting that the annual dumping of 10 million tons of solid is completely satisfied and is incorporated in the dynamics of exploitation of the slag.

The stability of slopes of dump is satisfactory and the planned final slopes are stable with minimum factor of safety bigger than 1.3. In the dump is planned existing equipment without need for specifying a new one.

The development of dump, his design provides an opportunity for further development planned north, with the possibility of synchronized dumping of waste from new open pits Vrshnik and Bunardzik normally after creating the proper conditions.

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