ROCK MASS PROPERITES IN MINIMIZING OF GENERAL SLOPE IN SURFACE MINING OF METALS

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ABSTRACT
Exploitation of ore and overburden is done from working environments with different characteristics such as physical-mechanical and technical – technological aspect. Heterogeneity and anizotropic are one of the main features that directly effect of the determination of the geotechnical characteristics of working environment.
In this paper it was made an attempt based on the large number of theoretical and empirical studies to define the dependence between the characteristics of the work environment and maximizing general angle in surface mining of metals.

INTRODUCTION

Knowing the structural - tectonic, physical - mechanical and technical - technological characteristics of the working area is the base for optimum design, construction and safe use of the geotechnic objects. As knowledge about the geotechnical conditions are deepened and increased, so the risk of unforeseen cases of endangering the stability of the slope decreases. Basically, geotechnical design can be improved only through accurate definition of the safety factor. Optimally designed slope means minimizing of crushes and caving of the rock massive, creating a reliable system for people and machines, or creating conditions for safe use of geotechnical object.

SELECTED ROCK MASS PROPERTIES

Further are given main characteristics of the rock masses important for defining the general angle of the open pits.

For the need of designing the general angle, following parameters could be distinguished:
- level of cracking,
- coefficient of cracking,
- module of cracking,
- extreme directions of cracking,
- granular composition of massive,
- cohesion,
- angle of internal friction.

Because the sample was taken from copper mine "Bucim", further will be given comment for each of them, according the real data.

Level of cracking - For categorization of rock material in the "Bucim" deposit, the degree of cracking will use Noshpal classification. This classification is shown below:

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Type of crack		**Width of crack**
Narrow crack	....	1 mm
Small crack	....	1-5 mm
Medium crack	....	5-20 mm
Large crack	....	20-100 mm
Very large crack	....	>100 mm

According the measuring data, the most often are cracks with width 1-2 mm, rarely 3-10 cm.

The ratio between the level of cracking and coefficient of cracking, as measurable value, is presented below:

Coefficient of cracking (%)	**Level of cracking**	**Character of cracks**
1	2	3
2	Low cracking	Cracks lower then 1 mm, there are no medium and large cracks
2-5	Medium cracking	Near the cracks of 1 mm are present small (2-5 mm) and medium (5-20 mm) cracks
5-10	Large cracking	Near the small cracks, there are large cracks with width 20-100 mm
10-20	Very large cracking	Near the small cracks are present large and very large cracks with width 20-100 mm and more
> 20	Extremely very large cracking	Dominant presence of large and very large cracks

Coefficient and module of cracking - Coefficient of cracking means surface of cracks reduced to the unit section of a typical structural texture zone. For quantitative evaluation of the frequency of occurrence of the cracks and the system of cracks is used module of cracking (number of cracks on unit meter section of rock). According the results from the examination in the Deposit "Bucim", the size of mentioned parameters is given below:

Type of rock and ore	**Coefficient of cracking (%)**	**Module of cracking**	**Level of cracking**
1	2	3	4
Andesite	4,1	7,0	Medium cracking
Gneiss	3,8	5,5	Medium cracking
Ore	3,9	5,8	Medium cracking

Extreme directions of cracking - Extreme directions of cracking are mutually normal, and total changes have elliptical shape. Position of the extreme directions of cracking is determined in situ by geological service.

Granular composition of massive - Content of separetd pieces in the massive is determined according the Module of cracking. For that purpose is used extend Noshpal classification presented further.

From engineering - geological aspect, rock masses in the deposit are classified as stabile rock masses with specific characteristics. Gneisses are strong rocks with coefficient of resistance f = 10, and schistose gneisses are with coefficient f = 5. Besides gneisses, amphiboles and amphibolite schists are relatively strong and brittle, so the works in them is relatively easy. According Protogjakonov belong in group IV and I. Amphiboles are with coefficient of resistance f = 10, and amphibolite schists are with coefficient f = 5.

Category of cracking	Level of cracking of massive, blockness	Module of cracking (m^{-1})	Content of separetd blocks in % for pieces size in mm					
			+300	+500	+700	+1000	+1500	+2000
I	Slightly blocking	>10	-10	-5	→0	-	-	-
II	Medium blocking	2-10	10-70	5-40	-30	-5	→0	-
III	Large blocking	1-2	70-100	40-100	30-80	5-40	-10	→0
IV	Very large blocking	0,65-1	100	100	100	40-100	10-50	-10
V	Extraordinarily large blocking	0,65	100	100	100	100	> 50	> 10

Cohesion, angle of internal friction and volume weight – According the multiple geomechanical laboratory research, as well as the terrain mapping, the following characteristics of the working environment are adopted.

Table 1. Adopted geomechanical characteristics of working environment

No.	Type of environment	Cohesion (planned condition) C [кPa]	Angle of internal friction φ [°]	Volume weight γ [kN/m³]
1	Changed Gneiss (parallel of foliation) RMR = 37	150.00	33.54	26.20
2	Changed Gneiss (normal of foliation) RMR = 40	310.00	36.17	26.20
3	Andesite RMR = 54	2770.00	43.79	26.70
4	Fault zones RMR = 23	40.00	31.89	22.00
5	Cracks	0.00	31.89	22.00

Indisputable is the conclusion that the choice of the values of the hardness parameters of the materials is one of the most complex and most sensitive tasks in geomechanic analysis of stability when we design the open pit mine, so when defining the same we must use all available data of research and testing in order to obtain the best possible and relevant data.

BASIC GEOMETRY IN FUNCTION OF WORKING ENVIRONMENTAL CHARACTERISTICS

There were analyzed 45 varieties of general closing angles of the surface mine, 15 variants for three cases:

- model of surface mine with bench angle of profile without cutting a bench road,
- model of surface mine with bench angle of profile who cut one road,
- model of surface mine with bench angle of profile who cut two roads.

It is chosen a model with the values of the factor of stability for the three cases bigger than 1.3.

The model satisfied the stability factor and are adopted the following geometric elements of surface mine.

Table 2. Based geometrical elements

No.	Geometric element	Mark	Value	Unit	Note
1.	Height of bench	h	15	m	In all open pit
2.	Safety stage	s	7.5	m	In all open pit
3.	Bench angle	α	63	° deg	In all open pit
4.	Completed general angle	β	<43	° deg	In all open pit
5.	Completed general angle	β_1	<41	° deg	In all open pit and cut one road
6.	Completed general angle	β_2	<39	° deg	In all open pit and cut two

CONCLUSION

Based on the characteristic geomechanical parameters for analysis to define the basic geometric elements, were adopted parameters which satisfy the basic criteria for the stability of the surface mine and at the same time providing minimal amounts of overburden per ton of excavated ore. The results show of the impact of geomechanic parameters on the size of the general angle for different profiles or different conditions of surface mine.

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