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CALCULATION OF DRILLING AND BLASTING PARAMETERS FOR QUARRY "DOBRNJA" NEAR BANJA LUKA

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ABSTRACT

Using of explosives in modern mining is very important for the good, efficient and rational organization for obtaining of solid minerals, especially in the exploitation of mineral resources on mines with large capacities. Technological phases of drilling and blasting in the exploitation process are very important in this case, and the analysis in this paper, because specific working environment and technical construction-limestone, where performance and capacities for further technological stages largely depends on the granularity of blasted materials (capacities of bulldozers, capacities of loaders-excavators, capacities of trucks and equipment for stone crushing and grinding). Objective of this paper is to get the best drilling and blasting parameters with different combinations of explosives, to get an optimum combination that will be continusly used.

Key words: *exploitation, blasting, explosives*

INTRODUCTION

In the modern mining industry, for the proper efficient and rational organization of obtaining solid minerals, using of explosives is essential, especially in the exploitation of mineral resources in large-scale mining with large capacities. Drilling-blasting operations are one of the most influential factors on the cost of mineral resources exploitation because using of explosives in the process of obtaining minerals create the conditions for the application of other modern mining techniques.

Technological phases of drilling and blasting in this process of exploitation are very important in this case and the analysis in this paper, because specific working environment and technical construction limestone, where performance and capacity for further technological stages largely depend on the particle size of blasted materials (capacities of bulldozers, loading units, trucks and equipment for crushing and grinding) [1].

Analysis of physical, mechanical and technical characteristics of the rock that makes the working environment at quarry "Dobrnja" in Banja Luka, defined the way selection and definition drilling and blasting parameters and the choice sets for drilling and explosives.

According to well-established and accepted methods of choice and calculation drilling-blasting parameters, the paper elaborated different types (combinations) of explosives and their impact on other parameters (geometry of drilling, distance between blastholes, construction of blastholes, etc.). The results of such development and variant of resolving issues of choice explosives, agreed with the concrete conditions of the working environment should show a great impact specific working conditions and the use of certain types of explosives, not only on the effectiveness of the execution of drilling and blasting works in technical terms, but also in economic terms, where can significantly affect the organization and costs of conducting these technological exploitation phase in mines and quarries.

DEPOSIT DESCRIPTION

Bearing technical construction stone-limestone "Dobrnja" in Banja Luka is located on the northern slopes of the mountain Manjača. Surface prospecting affected exploration activities is approximately 30 ha. Height difference on the tray of 490 m.a.s.l. to 650 m.a.s.l. In geological terms this part of the field is built entirely of Cretaceous limestone. Distribution of the limestone massif is much broader than the study sites, so this slot is part of Lower Cretaceous limestone formations that are present on the surface of a few square kilometers [2].

ENGINEERING- GORLOGICAL CHARACTERISTICS OF DEPOSIT

Mineral resources presented limestone which occurs in the form of layers and banks. In pripovršinski parts is cracked and cracks have different orientations and sizes, from microcracks to centimeter. They were filled with clay with small limestone debris, rarely calcite, and surface zone beneath the topsoil and red soil. With the depth of the cracked reduced and the rock becomes more compact. Are mapped and caverns that are empty somewhere, and somewhere partially filled with clay mixed with limestone inwards. Also, have been karstifikaciona recesses filled with this material. All these characteristics of the working environment are reflected in the operating conditions and the stability and digs [2].

By engineering-geological classification, deposit is represented with two types of rocks and rock masses:

1. solid rock and rock mass (limestone)
2. unbound rocks (eluvium, diluvium, prolluvium and mound).

The study of physical and mechanical properties of limestone from research hole and exploratory sink, the following parameters were obtained by the working environment:

- ompressive strength in the dry state ....127,5 MPa
- compressive strength in water condition .... 96,9 MPa
- compressive strength after freezing ....103,6 MPa
- porosity..1–3,4 %
- water absorption...0,27 %
- density..2,67 gr/cm^3

SPECIAL PART

On the production and technical results of mining influence: the structure and Rock fractures, blasting-technical features rock characteristics of used explosives, way of activating the mine field, etc.

Specification mining depend on the selected loading and transport equipment, and equipment at the plant for crushing and grading of technical-building stone and concrete conditions "Dobrnja" they are:

Granulation: up to 600 mm with a maximum of 10% oversize granules 800 mm,

Safety: harmonize mining in terms of safety on wasteful pieces [1].

DEFINING THE WORKING ENVIRONMENT ON QUARRY "DOBRNJA"

The physical characteristicsof rocks are:

a) structure (physical and morphological appearance of the way of the rock mass, ie shape, size and arrangement of the individual particles of which made the rock itself) and limestone Dobrnja belong to medium jointed rock masses.

Limestone on "Dobrnja" falls into the third category by number of fissures. Figure 1. shown is an open profile with rocks "Dobrnja".

Figure 1 Limeston from quarry Dobrnja

b) specific and bulk density (specific gravity differ-weight per unit volume of a fully compacted material and volumetric weight-weight of the rock mass with pores per unit volume)

For limestone on quarry "Dobrnja", the specific weight of 26.9 kN/m^3 and volumetric weight of 26.2 kN/m^3.

c) porosity (ratio of volume of pores in the rock to the total volume of the rock mass, expressed as a percentage, %).

For limestone on quarry "Dobrnja" it was established porosity in the amount of 0.26% [2].

MECHANICAL PROPERTIES OF WORK ENVIRONMENT

The mechanical properties of rocks include:

a) hardness (resistance to a rock by the penetration of another, harder body in it) Depending on the method for setting distinguish several types of hardness. Hardness is determined and is expressed in Shore units Hs of 1-100.

b) Strength (feature rock that resists destruction under the influence of some external pressure force, tensile force, bending forces or twisting forces)

For limestone on "Dobrnja" were determined by the following strength:

- Compressive strength in the dry state: 127.50 (MPa)
- Resistance to pressure in a water-saturated state: 96,90 (MPa)
- Compressive strength after freezing: 103.60 (MPa) [2].

TEHNICAL CHARACTERISTISC OF WORK ENVIRONMENT

a) volume modul (expressed as the coefficient of friability, which shows the relationship of the volume of the rock mass in the massif and the blasted rock mass)

For limestone on quarry "Dobrnja" determined coefficient friability in the amount of 1.45.

b) driling resistance (resistance to penetration instrument for drilling depends on the strength, hardness and toughness)

We distinguish between passive and active bušivost. Passive bušivost expresses speed drilling unit of time. Active (abrasiveness) expresses the degree of wear of organ-blades per meter length of the borehole [3], Table 1.

Table 1 Classification of rock on the basis of abrasiveness

Class abrasiveness	Name	Abrasiveness, mgr/min	Typical rocks
I	Very little abrasive	until 5	Limestone, marble, soft sulfides without quartz, apatite, rock salt

c) crushing resistance (properties of rocks to resist crushing in frequent dynamic stresses)-limestone belong to medium hard rock with friable coefficient 0.7> k> 0.5

d) acoustic characteristics (mean velocity of propagation of longitudinal and transverse waves through the rock massif)

On the basis of the acoustic properties used for calculation of acoustic impedance of the rock mass, which is of great importance to the selection of explosives, because on the basis of acoustic impedances of explosives and rock mass selects explosives to be used in the process of mining [3].

DRILLING

According to the conditions sized pieces entering the treatment plant get drilling diameter d = 160 mm. Applying this diameter drilling may occur large amounts negabaritnih pieces, which would create additional costs to fragmentation of raw materials. To avoid the possibility of large quantities negabaritnih pieces on "Dobrnja" will be used most frequently used in quarries drilling diameters of 89 or 105 mm

During the execution of drilling-blasting works in the real conditions on the ground, it will come to the optimal parameters of drilling and blasting. In the selection of drilling equipment, make sure that the drill has the ability to drill inclined boreholes and wells of different diameters, which allow the determination of the optimal diameter drilling.

BLASTING

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Determination of blasting

Selection of explosives for blasting is one of the basic and most important tasks in the design of blasting explosives as applied as a carrier of energy is the main means of blasting and it depends on the success of mining [5].

During the design process of mining selection of the best types of explosives are made on the basis of physical and mechanical characteristics of the work environment that are expressed through the seismic characteristics and properties of explosives. Depending on the seismic characteristics (speed of propagation of longitudinal waves through the rock massif) and specific volumetric weight of the working environment we calculate the acoustic impedance of the rock mass [6]:

$$Zs = v_u \cdot \gamma,$$

v_u – speed of propagation of longitudinal waves through the rock massif (3800–4500 m/s)
γ – rocks density kg/dm^3, (for limestone 2,67 kg/dm^3).

Acoustic impedance of limestone is 10000–12000 mkg/sdm^3.

Acoustic impedance Ze explosives count as a product of density explosives δ and velocity of detonation of explosives D:

$$Ze = D \cdot \delta$$

Physico-mechanical properties of rocks are the primary influence for the selection of types of explosives and specific consumption of explosives. Energy utilization of explosives for a particular work environment depends on the relationship of acoustic impedance rock and acoustic impedance of explosives and the largest amount of energy is used for crushing if the ratio is equal to one.

However, in practice it is difficult to achieve a relationship Zs = Ze and the cause that the heterogeneity of the working environment and explosives, and moreover cracks and fissures have a very big role in the absolute value of the speed of propagation of longitudinal waves through the rock massif. Because of all this we can say that between the acoustic impedance of explosives and rocks there dependence and the calculation we have to take into account the reflection coefficient k = 0.5-0.7 [3].

In this paper, the calculation is done on the basis of the working environment on the one hand and of the emulsion, powder and AN-FO explosives with other strane, Table 2 and table 3. To not mean that in future work the quarry can not use other types of explosives that have similar mining-technical characteristics, and it will all depend on the needs of the company that made the exploitation of that capacity, the current market price of explosives, mines, etc [1].

Table 2 Technical characteristcs of used explosives

Characteristics	Emulsion	AN–FO	AMONEX 1
Dencity, kg/dm^3	1,15	0,925	1,05
Gases volume, dm^3/kg	847	1045	975
Energy of exsplozije, kJ/kg	3851	3872	4228
Temp. of explosion, kJ/kg	-	-	2740
Speed of detonation, m/s	4500	2500	4100
Oxygen balance, %	-	0	+0,13

Table 3 Acoustic impedance of limestone, explosives and their ratio

Eksplosive	Speed of detonation m/s	Dencity, kg/dm^3	Acoustic impedance of ezplosives, mkg/sdm^3	Max. Acoustic impedace of limestone, mkg/sdm^3	Relation between impedances I_{rock}: I_{exp}
Emulsion	4500	1,15	5175	10000–12000	0,86 –1,03
AN–FO	2500	0,925	2313	10000–12000	0,41–0,50
AMONEX 1	4100	1.05	4305	10000–12000	0,68–0,82

CALCULATION OF PARAMETERS OF DRILLING AND BLASTING

According to the selection of explosives in a specific work environment can be further define the parameters of drilling and blasting. In this paper the case of variants with different drilling diameters and different combinations of explosives as a primary and ancillary charges, Table 4. Based on the results and analysis of them, we can determine the optimal combination of explosives and then the geometry of boreholes and mine fields, and the construction of an explosive charge in a borehole [7].

At the beginning of the quarry is optimally applied drilling diameter of 105 mm and a combination of powdered explosives as the main charge and AN-FO explosives as an extra charge.

If in the course of the quarry this variant does not show satisfactory results, it is suggested to use another diameter drilling and other combinations of explosives, which is discussed in this paper.

During the operation of the quarry to evaluate the suitability and other explosives and diameter drilling, in order to find potentially better and techno-economic parameters, cost-effective drilling and blasting [8].

Table 4 Racapitulation od blasting parameters

	Meas.	Mineholes with diameter 89 mm, bench height 20,0 m		Mineholes with diameter 105 mm, bench height 20,0 m	
Primary charges		AN–FO	Powder expl.	AN–FO	Powder expl.
Secondary charges		emulsion	AN – FO	emulsion	AN–FO
W	m	3,0	3,5	3,6	4,0
a	m	3,0	3,5	3,6	4,0
b	m	3,0	3,5	3,6	4,0
m		1,0	1,0	1,0	1,0
$L_{minehole}$	m	21,18	22,33	22,36	22,48
$L_{pitting}$	m	0,9	1,05	1,08	1,2
$L_{primary\ ch.}$	m	17,5	3,37	18,0	4,0
$L_{secondary\ ch.}$	m	0,68	15,46	0,76	14,48
L_{plug}	m	3,0	3,5	3,6	4,0
$Q_{pr.\ ch}$	kg	100,65	17,84	144,1	26,62
$Q_{sec.\ ch.}$	kg	4,0	89,0	4,0	115,84
Q_{total}	kg	104,65	106,84	148,1	142,46
deceleration	ms	20,0	20,0	20,0	20,0
amount	m^3	180,0	245,0	259,0	320,0
q	kg/m^3	0,581	0,436	0,572	0,446
capaties	m^3/m	8,11	10,97	11,58	14,23

CONCLUSION

From the results of the analysis done in this paper, it is possible to make the following conclusions:

Work environment, or rock material prior to the drilling and blasting is crucial in defining the parameters by which to carry out works of this technological phase which is very important in terms of technical and economic indicators.

Physical, mechanical and technical properties of rocks used as input data and are directly associated with the choice of drilling and blasting parameters.

Influence the effects of mining in the operation of equipment and machinery in other technological exploitation phase-loading, transport and preparation (crushing and grading) is great because on the basis of work and production characteristics of the equipment dimensioned drilling and blasting parameters and performance of drilling and blasting papers should be a maximum of customized operational parameters loading and transport equipment and facilities for the preparation.

Through the analysis of the specific consumption of explosives and geometry minefield is evident that the use of larger diameter drilling in blasting can lead to favorable effects of drilling-blasting works.

The paper was selected computationally most favorable combination of explosives in charge, with the definition and other drilling-blasting parameters. However, the current mining practice shows that it is possible that in the future work of a mine or quarry change occurs given solutions, all in accordance with the specific operating conditions, the results of which will achieve the drilling and blasting, or as a result of some technological changes.

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