5th JUBILEE BALKAN MINING CONGRESS

PROCEEDINGS

18th-21st September 2013 Ohrid, Macedonia

ELEM
MACEDONIAN POWER PLANTS

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BALKANMINE 2013

Ohrid, Republic of Macedonia

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Track-type loader excavator at work
- Dmitry Kalinovsky
Miner in a pit
- NTRES Reuters Srdjan Zivulovic

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USING SEISMIC METHODS FOR DEFINING OPTIMAL PARAMETERS FOR BLASTING

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ABSTRACT

Mining is basic in the process of exploitation of mineral raw materials, whether it is a surface or underground mines. Separate section is the special blasting which must ensure strict, advance superiors conditions. Success in performed blasting depends on the applied method, the rocky massif and quantity of explosives.

To determine the method for blasting and the quantity of explosive in the blast holes, it is necessary to know the mechanical properties of the ground: direction of foliation, degree of cracking, Jung modulus of elasticity and other parameters which are used for mathematical modeling to define the position of the blast holes and the optimal quantity of explosive in them.

As a proper geophysical method for defining the mechanical properties of the rock complex is seismic method which gave all relevant parameters for successful blasting. Seismic method could be useful applied in defining the explosion zones: zone of thermal influence, internal plastic zone and external plastic zone.

In the paper, briefly, will be presented seismic method and the mechanical parameters derived from investigation.

Keywords

Blasting, Mechanical Properties, Parameters, Seismic Method

1. INTRODUCTION

Mass application of the blasting technique, especially in mining, results from the fact that one blasting replaces several months of work of many people and machines. Besides time efficiency, economic benefit should be taken into account. Highly developed blasting techniques, today, allow good control of the seismic action on the rock masses.

During the explosion of the mine charge, in the first phase, explosive changes into highly compressed gases, than comes to expansion of the explosive gases in the area and potential energy changes into mechanical work. The energy near the place of the explosion break and crush the rock mass and in the surrounding creates cracks and permanent deformations, than changes into elastic deformation. This elastic deformation, depending of the area, can cover larger area and could cause side effects on the engineering objects and surrounding settlements in the wider blasting zone.

Today are used different blasting methods with aim to increase efficiency of the blasting, or much of the energy to be spent in the zone of breaking and crushing, and a smaller part to be changed in energy of the elastic deformation of the area.

Modern blasting methods give possibility of relative control of the dimensions of pieces of crushed rock mass with aim to reduce the secondary blasting of the blocks.

2. PHYSICAL BASIS FOR APPLICATION OF SEISMIC METHOD IN THE BLASTING TECHNIQUES

Spreading of the seismic waves in the rocks is related to deformations caused by natural and artificial forces, or rock masses act as an elastic medium. From that point of view, it is necessary to define the relation between the deformations D, strain N and parameters of elasticity Pi - $D = F(N, Pi)$

In the theory are known several parameters of elasticity Pi:

- Young's modulus of elasticity E

$$E = \frac{l}{\Delta l} \cdot N$$

where: l- length of the deformation rod

$\triangle l$- length deformation

$N = \frac{F}{S}$ F- action force

S- cross section of rod

- Poison's coefficient ν

$$\nu = \frac{\Delta d}{d} \cdot \frac{l}{\Delta l}$$

where: d- diameter of rod

$\triangle d$- deformation of rod's diameter

- Shearing modulus G

From the elasticity theory is known that elastic parameters G and E are mutualy dependant, and the depandance is present with the relation:

$$G = \frac{E}{2(1+\nu)}$$

- Volume modulus K

If on solid body with voulume V act homogenous compresive force (hydraulic pressure), the body decreasis its volume. Volume module is given with the relation:

$$K = N \cdot \frac{V}{\Delta V}$$

Relation between seismic velocities of longitudinal Vp and transversal Vs waves

Modern seismic methods can very precisely measure the seismic velocities Vp and Vs. With the following relations are given connections between the spreading velocity of the seismic waves and the elastic parameters of the medium:

$$Vp = \sqrt{\frac{1}{\rho} \frac{E(1-\nu)}{(1+\nu)(1+2\nu)}} \qquad Vs = \sqrt{\frac{G}{\rho}}$$

ρ - density of medium

3. SEISMICAL EFFECTS OF BLASTING

For successful blasting it is necessary to know physical properties of the rock masses, and in this case, the best is geophysical seismic method.

Near the mining borehole, during the blasting comes to breaking and crushing of rocks and that is the useful part of the spent energy of blasting. On the distance from the borehole axes, depending of the quantity of explosive and of the physical - mechanical properties of the rock mass, elastic - plastic deformations are generated (fig. 1).

The distance on which elastic deformations appear is

$$d = 0.12\sqrt[3]{Q} \qquad Q - quantity\ of\ \exp losive\ in\ kg$$

Depending which parameter of the oscilation is registered (displacement, velocity or acceleration), the recording is called seismogram, velosigram or accelerogram.

Basic factor of the seismic action in blasting is the pressure of the explosive wave , given with the relation:

$$\Pi = \frac{1}{4}\rho E_v^2 \cdot 10^{-5} \left[N/cm^2\right]$$

where: ρ - density of medium

E_v - explosive velocity

Velocity of oscilation V_v that occured during explosion is $V_v = \frac{1}{4}E_v$.

Problem for defining the action from the blasting is relativeli complex and depend from many parameters, but the most often is used the speed of vibration of particles, given by

$$U_v = k\left(\frac{L}{Q^{0.5}}\right)^{-u}$$

where: k - parameter of medium

u - parameter of seismic action of the medium

Q - unit explosiv filling

L - radial distance from the unit filling

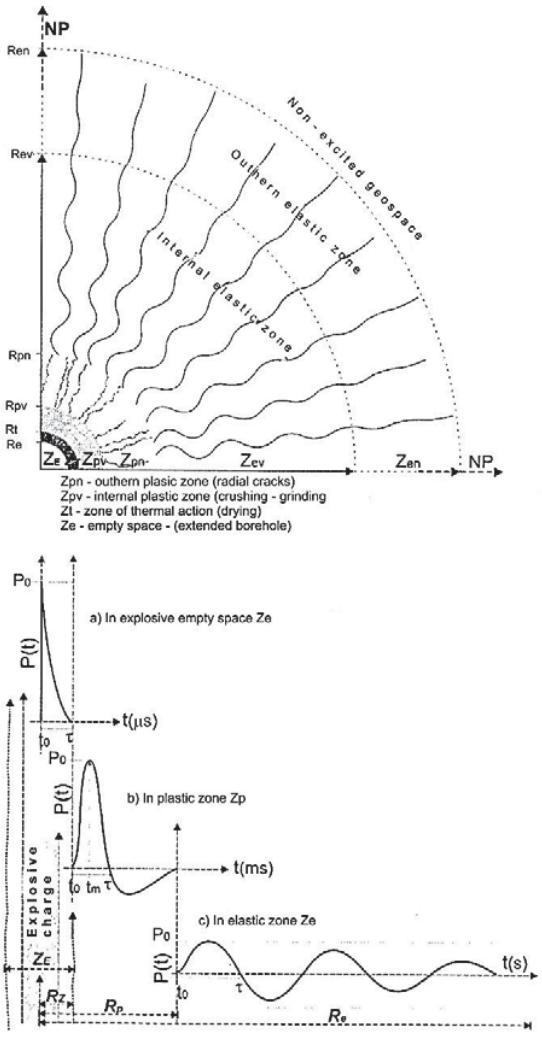

Figure 1. Time diagrams of pressure P(t) of shock wave of tension by zone of explosion (Mirakovski, 2007)

Analysing the above stayed for the selection of blasting method, explosive and assesment of the destroing action, as well as the seismic affection on the wider vicinity, the first of all is necesary good knowing of the physical properties of the rock masses in situ. For definiton of these parameters of the medium, it is useful to use seismic method on the area for blasting with aim to define the parameters of the rocks necesary to define optimal method for blasting.

4. CONCLUSION

Blasting is a complex mining - geological process that depends of many engineering parameters, type of the explosive, schedule of the mine boreholes, dimension of unit filling, scheme of ignition and other important activities which should be implemented in blasting. It should be known that blasting is one of the most important processes in mining.

In this paper, attention is paied on the real problem to define the physical - mechanical characteristics of the rock mass for blasting, with aim to determine optimal model of blasting appropriate for that geological medium.

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