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ENGINEERING GEOLOGY ROCK PARAMETERS FOR CONTROLLED ROCK BLASTING ON THE HIGHWAY SPLIT-PLOČE

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ABSTRACT
Defining geology engineering and hydrology parameters of the route is very important from the aspect of rock mass data collection and resulting blast design. Over the last decade there have been considerable advances in our ability to measure and analyze blasting performance. These can now be combined with the continuing growth in computing power to develop a more effective description of rock fragmentation for use by future blasting practitioners. Results of engineering-geological research are significant for the optimization of blasting parameters. These data are showing a real picture of rock mass, and they are as follows: statistics of density of discontinuities, determination of "GSI", Hoek-Brown criteria for strength of rock mass and "in situ" determination of mechanical parameters, including geophysical survey data. Three factors control the fragment size distribution: the rock structure, the quantity of explosive and its distribution within the rock mass. Rock excavation by blasting for the highway is held in complex environment. Such conditions force restrictive criteria which than protect environment from seismic influence and mechanical damage.
Keywords: Rock Parameters, Explosives, Blasting, Fragmentation model, Highway

1. INTRODUCTION
Effective blast monitoring and blast design tools, geophysical exploration of rock masses, rock mass mapping and advanced modeling system have been rapid developed in the last then years and now can be applied to the problem of more effective blasting [1]. Pre-blast assessment of rock mass, appropriate geometry and diameter of boreholes, explosive characteristics and blasting control are the most important parameters for blasting results. Fragment size, volume and mass of blasted rock are fundamental variables for evaluating the quality of a blast. Size and shape of blasting fragment give a very important information for development of effective and optimal blasting. Geological strength index (GSI) is a very useful criterion for description of rock mass behaviour in blasting process [2].

2. ENGINEERING GEOLOGICAL INVESTIGATION
Results of engineering-geological research are significant for the optimization of blasting parameters. These data are showing a real picture of rock mass, and they are as follows: statistics of density of discontinuities, determination of "GSI", Hoek-Brown criteria for strength of rock mass and "in situ" determination of mechanical parameters, including geophysical survey data. Rock formations as they occur are not homogenous and isotropic and even on small scale the homogeneity varies [3]. Interaction between the rock mass and stresses generated due to explosion, may produce favorable or

harmful blasting results. From the aspect of rock mass data collection and resulting blast design, definition of engineering-geology data is very important. Field and laboratory tests rock mass properties giving collection of necessary data for geomechanical and GSI classification. In case of ground water, its effect and exact water table must be determined. Ground water influence on blasting parameters and chosen methods and explosive type [4]. Also is important to determine thickness of humus layer and clay components, because that can make difficulties at drilling and load blastholes. Graphic presentation of Rock mass characteristics research, including structural feature recognition and pre-blasting fragmentation size distribution is presented on Figure 1.

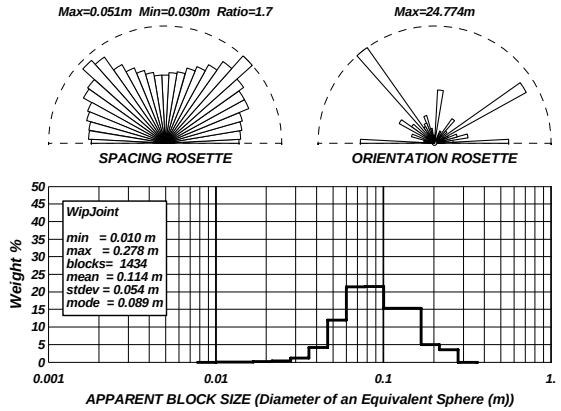

Figure 1. Rock mass characteristics including structural feature recognition and fragmentation size distribution with the use of WipFrag software –WipJoint module.

Anisotropy or quaziisotropy of rock masses is defined with the existing discontinuities and their densities. Structural and geological observations enable, the tectonic phases, which has caused rock deformation, to be defined. Based on structural geological definitions, following sets of discontinuities in rock masses could be obtained:

- Bedding and interbedding cleavage,
- Axial plane cleavage,
- Fractures normal to local or regional structural axis b,
- Reverse faults with subvertical a-lineation.

Figure 2. depicts fragmentation of the blasted material and terrain on the area of the highway route.

Figure 2. Terrain on the area of the highway route and fragmentation of the blasted material.

3. DRILLING AND BLASTING OPERATIONS

It is necessary to survey geometry of boreholes, blastholes angles and depth of drilling to correspond with project solutions. It is necessary to record drilling and blasting plans as well as drilling logs. Drilling logs should note any changes noticed while drilling, like caverns, fissures, changes in soil properties and other. All this changes should be accepted while loading blastholes. Blastholes should be cleared with compressed air and than checked for proper depth. Prepared explosive charges along with the detonators are loaded in the blastholes and pushed into place with the wooden pole. In case of separated charges, stemming in between is usually sand or clay. Loaded blastholes are filled to the top with sand or clay. It is known that inclination of the blastholes lower the influence of the seismic effects because significant part of the explosive is used on crushing and fragmentation and less on seismic disturbance. It is also not advisable to use detonating cord where highway route is in vicinity of historical or residential area. In such a places it is advisable to use Nonel system or electric initiating system with the respect of allowable amount of the explosive charge per firing stage. Mass blasting for excavation of the highway route should be performed in accordance with the Mining law. Every mass blasting should have "blasting elaborate" with content as follows: micro location of the minefield, minefield data (length, lift height, mass calculation, specific explosive consumption, sum of drill lengths, used explosive and other), borehole data (diameter, angle, borehole spacing, number of boreholes, burden,), explosive charge data (type, quantity, packaging,), initiating system data with retardation, schematics of the delay patterns and connections and schematics of the borehole cross-section with stemming design. Rock excavation by blasting for the highway is held in complex environment. Such conditions force restrictive criteria which than protect environment from seismic influence and mechanical damage.

4. RESULTS AND DISCUSSION

Empiric prediction of the desired fragmentation is usually implemented using Kuz-Ram model. This model is based on the Rosin-Rammler theory that offers very good description of the fragmentation and grade of the blasted material. SB-application, based on Kuz-Ram model (Figure 3) is developed by Ph.D. Strelec on the Faculty of Geotechnical Engineering from Varazdin [5] and used in many drilling and blasting projects in the last few years. In this application the rock mass can be defined as silty, blocky or massive.

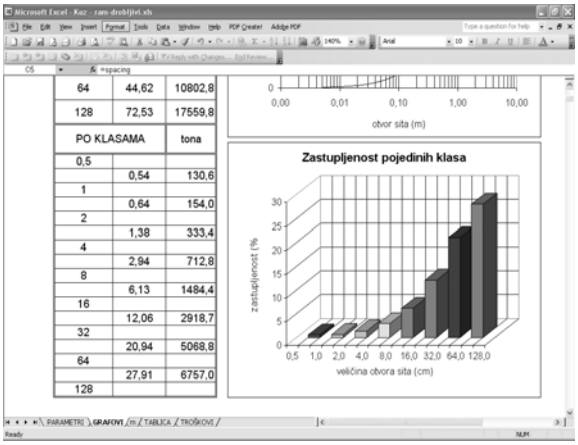

Figure 3. SB-application for Blasting optimization.

For using GSI values in this application is necessary to use empirical correlations between rock mass categorization in SB-application and GSI values, given in Table 1 [6]. GSI is giving a real picture of rock mass properties and indirect definiton of this parameter in SB-application could bring precisely prediction of fragment size of blasted rock mass.

Table 1. Empirical correlation between SB parameter and GSI value.

SB ROCK MASS PARAMETER	GSI VALUE
Silty	41 – 55
Blocky	56 – 70
Massive	71 – 85

5. CONCLUSION

Defining engineering-geology data is very important for rock mass data collection and resulting blast design. The rock fragmentation and blasting effect can be improved by determination of optimal geometry of minefield. The degree of rock fragmentation and blasting effekt can be improved by determination of optimal geometrical quantities for blasting at deep blasting holes [7]. Interaction between the rock mass and stresses generated due to explosion, may produce favorable or harmful blasting results. Quantity of explosive charges, drilling geometry, delay patterns and design of initiating are defined by drilling and blasting projects. Pre-blast assessment of rock mass, appropriate geometry and diameter of boreholes, explosive characteristics and blasting control are the most important parameters for blasting results. Empiric prediction of the desired fragmentation is usually implemented using Kuz-Ram model. Using software based on Kuz-Ram model with GSI as input parameter, which gives real picture of rock mass, could bring precisely prediction of fragment size of blasted rock mass. Blasting operations must be technically and organizationally performed to insure safe prosecution of work for people, structures and equipment from all harmful influences of the detonation, like: seismic effects, air shock, and excessive flyrock. Rock excavation by blasting for the highway is held in complex environment. Such conditions force restrictive criteria which than protect environment from seismic influence and mechanical damage. Concerning different distances from the structures along the highway route, different technology and parameters are used along the route. In such a places it is advisable to use Nonel system or electric initiating system with the respect of allowable amount of the explosive charge per firing stage.Used explosive charges: emulsive explosive is used for principal charges, and ANFO explosive for secondary charge. Only professional personnel should work on all work positions, all machines should be certificated and operate properly. Personnel should wear protective clothing and equipment.

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