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USE THE SOFTWARE FOR PREDICTION OF ROCK FRAGMENTATION

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Abstract

The dependence of parameters of rock massif and drilling-blasting parameters, on the one hand, and individual fractions as well as the size of the middle portion, is the basis for the development of mathematical model and software's programs are crucial for the management (prediction) and to analysing the granulation of the blasted material.

In blasting of any kind of rock mass in order to achieve physical crushing to certain granulation, the need for simple and fast estimation of the granulation of the material blasted are inevitable.

Key words: *Prediction, blasting, rock, granulation, fragmentation, blasted material.*

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1. Introduction

In order to obtain good granulation of blasted rock mass it is necessary to study and define all physical - mechanical and structural characteristics of the rock mass and based on that to apply the most appropriate blasting method, the type of explosive, structure of the explosive charge, etc.

Numerous theoretical analyses on individual mine series were carried out by simulation analysis by the application of Breaker package in which drilling - blasting parameters were analysed (specific consumption of explosive) as well as the change of costs depending on the kind of working environment. Terrain experimental investigations were also carried out in several blasting series in different working environments.

The analyses required a better determination of granulation of the material mined out in primary crushing. It was also necessary to precisely define (by screen analysis) the passing granulation of the primary crushed material.

The blast operators must know what the aim of blasting is and what granulation size should be obtained.

Depending on granulation needed, a blast series is designed (with regard to the pattern of drill holes) the construction of blasting material, the mode of connection, opening etc.

2. Principles of "Breaker" program package

Investigations in granulation prediction in blasting are directed towards optimal definition of parameters of drilling and blasting such as:

- Optimum granulation of ore mass blasted,
- Minimum expenditure of explosive (accounting for 80 per cent of the total blasting costs).

Establishing correlation between the parameters mentioned is a challenge for scientists in the field. In that regard numerous experiments have been performed consisting of changing the parameters such as the smallest resistance, the distance between drill-holes, height of benches, specific explosive expenditure etc.

Over the past twenty-five years various and intense investigations were carried out using different mathematical bases, in different working environments and variable drilling-blasting parameters. During the investigations each prediction model was better than the earlier. So, present day models are regarded as highest-level investigations.

Some experts, as simple mathematical expressions such as the dependence presented through parabolic dependence, express the index of equation of granulation or the so-called "index of size":

$Y = X^n$ for $0 < X < 1$ . . . . (1)

where: Y is function depends of index of size.

X is size of pieces (mm)

The value of the coefficient according to Cunningham is in 0.8 and 1.5 span or $0.8 < n \geq 2$. If **n** is higher than the functional dependence of parameters and the obtained curves of granulometric composition, the granulometric curve is more pronounced (steeper) or the relationship between the size of pieces is smaller and granulation is, as a whole, equal which means the high values of **n** are very favorable compared with the granulation of the blasted mass.

3. Screening of Results

For presents the some results of this software, we will use the results obtained for predicted granulation of the blasted material - limestone (Volume mass: 2,73 t/m^3 , Porosity: 0,01 %, strength of pressure: σ_c = 14,48 N/cm^2) with the application of "Breaker" software and the granulation obtained after blasting.

The change of certain drilling – blasting parameters, their influence on the granulometric composition, the size of meddle portion, the state of bench slope behind the blast series are analyzed.

The mains drilling - blasting parameters for the **Firs blasting serie are:**

- number of blast hole: 44 (two row)
- diameter of drilling, d = 105mm
- length of hole, L = 22m
- burden, W = 3,0m
- distance between hole, a = 3m
- distance between row, b = 3,5m
- tip of explosive: An - cartridge (lazarit)
- initiation: detonating fuse with delay detonators

- explosive total: 5 368kg
- specific charge: q = 0,42 kg/m^3
- Average size of pieces, Dav = 36cm

For the Second blasting serie the main drilling-blasting parameters are:

- number of blast hole: 39 (two row)
- diameter of drilling, d = 105mm
- length of hole, L = 22m
- burden, W = 3,5m
- distance between hole, a = 3,5m
- distance between row, b = 3,5m
- tip of explosive: An - cartridge (ϕ90mm, lazarit, ϕ90 elotol)
- initiation: Nonel - explosive total: 5 532 kg
- specific charge: q = 0,45 kg/m^3
- Average size of pieces, Dav = 33,5cm

Two blasting series characteristic of the open pit are analyzed. The series are of the same drilling – blasting parameters but only the specific expenditure (powder factor) of blasting material is changed (fig.1):

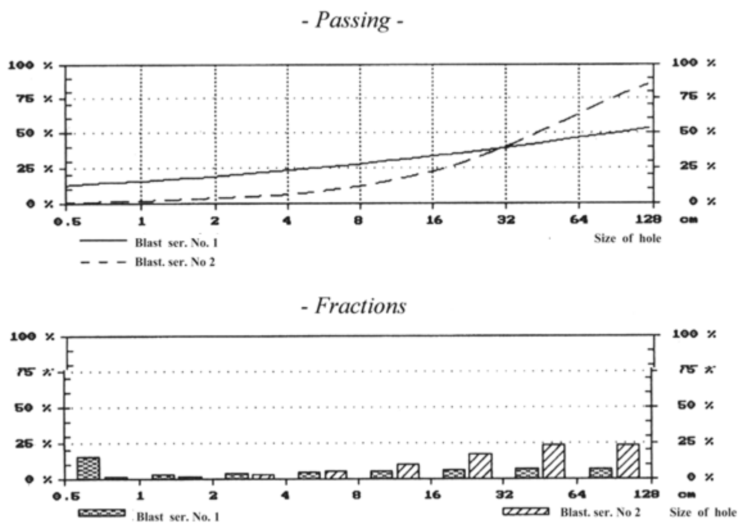

Fig. 1. Presentation of predicted granulation for the two blasting series in open pit for limestone, Banjani, Skopje

The influence of physical – mechanical characteristics can be seen in the strength characteristics of the environment and impedance of the environment.

It can also be concluded that for the working environment in the Banjani open pit marbleized limestone it is possible to use explosives with lower acoustic impedance or lower density and detonating speed. On the other hand this means that it is possible to purchase of less expensive explosives and reduction of total blasting costs.

In the fig. 2 are present distribution of granulation for different types of rocks in diferent mines (Bucim mine and Banjani mine) which are predicted [3].

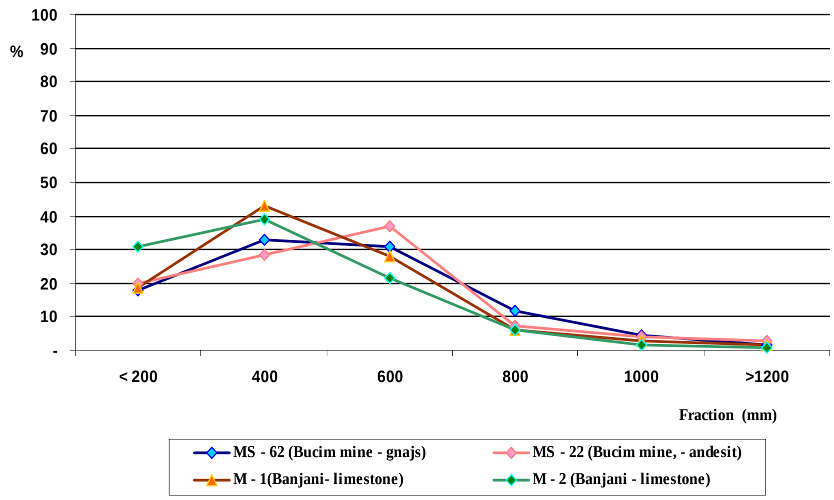

Fig. 2. Presentation of predicted granulation for different types of rock

4. Simulation at individual blasting series

The following table and graphs show a summary of the simulation carried out for a number of blasting series and variable expenditure of blasting material. For all blasting series the specific condition of use is metamorphic **andesite** rock The results obtained indicate that:

Table 1. Percentage distribution of screen size in blasting series

No. Of Blasting Series, **(q)**	Screen size, **(cm)**								
	1	**2**	**4**	**8**	**16**	**32**	**64**	**128**	$\mathbf{D_{av}}$	$\mathbf{F_i}$
1 (0,2)	28,5	19,0	23,0	27,7	33,1	39,24	46,0	53,48	92.88	0,31
2 (0,3)	11,2	9,55	13,7	19,54	27,38	37,55	50,0	63,9	64	0,557
3 (0,35)	8,0	7,38	11,1	16,56	24,28	34,77	48,13	63,52	69.86	0,619
4 (0,4)	5,6	5,86	9,6	15,56	24,66	37,75	54,77	73,5	53.35	0,743
5 (0,45	4,0	4,28	7,67	13,54	23,3	38,38	58,65	80,0	48.39	0,867
6 (0,5)	2,4	3,15	6,17	11,89	22,25	39,36	63,0	86,0	44.46	0,991
7 (0,6)	1,3	2,0	4,5	9,94	21,0	41,0	70,0	93,0	39.88	1,177

$\mathbf{D_{av}}$ - the value of average size of pieces (cm),$\mathbf{F_i}$ - index of fragmentation

q - specific charge (expenditure) ,(kg/m^3)

In blasting, the series in the same working environment with the change of the specific expenditure (powder factor) of explosive from q = 0.2 kg/m^3 to q = 0.6 kg/m^3 and the use of the same kind of AN-FO explosive and total volume of blasted mass, different values were obtained for explosive expenditure relative for the loose mass (m^3/kg, kg/t, t/kg).

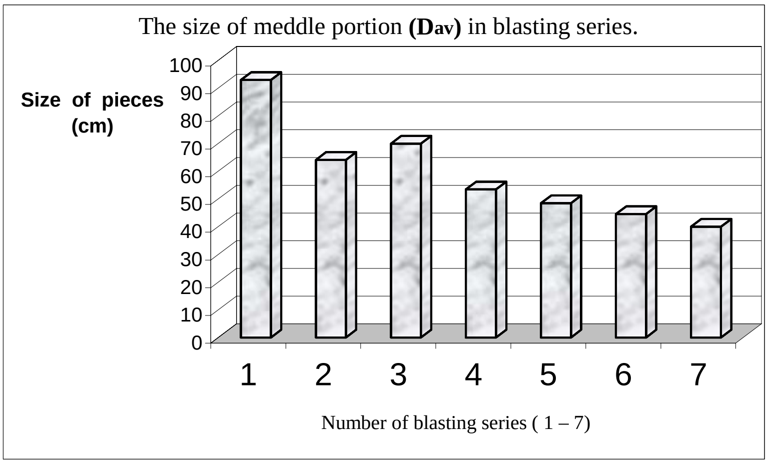

Fig. 3. Graphic presentation of sizes of medium piece obtained from blasting series

The size of meddle portion is also different and ranges from D_{av} = 92.88 cm to D_{av} = 39.88cm (Fig.3). Fragmentation index which expresses drilling – blasting parameters of the series whose optimum value should be about 1 (unit), ranges from 0.3 to 1.17.

Taking in consideration the drilling – blasting parameters set out where only the specific expenditure of explosive is changed, it can be inferred that with these blasting conditions the most favorable value for specific expenditure of explosive is the value for **q = 0.5 kg/m^3.**

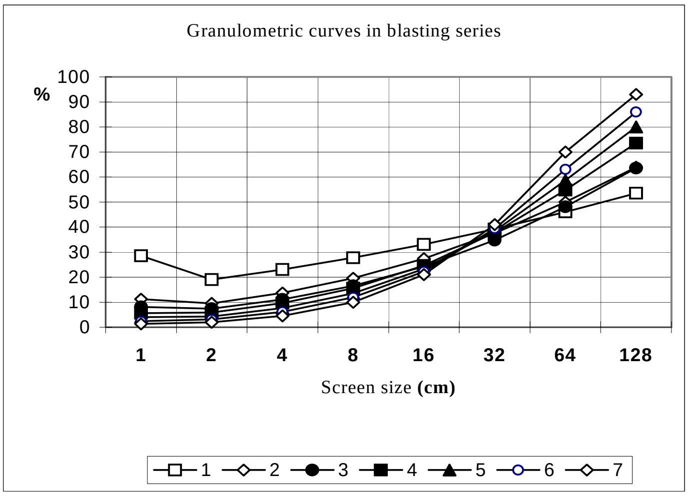

Fig. 4. Graphic presentation of granulation according to screen size in blasting series

Based on the comparison diagrams obtained it can be noticed that the most equal distribution of granulation are for the values from q = 0.5 to 0.6 kg/m^3 (blasting series number 6 and 7), (fig.4). The values for the low percent of non-overall block higher than 128 cm amounting from 6% to 14% are also noticeable. With regard to the available loading equipment the percentage of non overall is rather lower and amounts from 3 to 6%.

5. Conclusion

It was concluded that the increased amount of blasting explosive is used at the Banjani open pit owing to the type of explosive used and its distribution according to hole depth (kg/m') and distribution pattern (kg/m^3).

Increase of the drill hole pattern and the use of inter plugs are recommended. It would decrease the specific expenditure of explosive (20 to 30%) and would produce larger meddle portions in the blasted material (10 to 15%). This would also result in increased expenditures in primary crushing by 5 to 10%.

With PC - program in this case **"Breaker",** [3] for prediction of rock fragmentation, we can see the results before blasting and make some corrections if we decide, and if it necessary depends of many another factors and total cost.

6. References

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