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PROTECTION AGAINST FLYING PIECES DURING BLASTING AT THE OPEN PIT SEVERNI REVIR OF THE MAJDANPEK COPPER MINE

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Abstract

Majdanpek is located right next to the mine, so blasting at the open pit Severni revir can have an impact on the environment. In order to protect the environment from the harmful effects of blasting, the standards have been prescribed for the protection and intensity limits of manifestation the certain effects of blasting on a certain growth. This paper presents the determination of safe distances from flying pieces during blasting.

***Keywords**: Open pit Severni revir, flying pieces during blasting, safety distance, special protection measures, blasting mats*

1. INTRODUCTION

A discontinuous excavation technology is applied at the open pit Severni revir. Excavation of masses is carried out applying the drilling and blasting works with vertical drillholes, loading with bucket excavators and truck transport.

The town of Majdanpek is located right next to the mine and blasting at the open pit Severni revir. District pit can have an impact on the environment. If the intensity of that impact exceeds the prescribed limits, it can have the harmful and dangerous consequences for people and objects. In order to protect the environment from the harmful blasting effects, the protection standards and limits for the intensity of blasting effects at a certain distance are prescribed.

2. BLASTING TECHNOLOGY

Blasting technology at the open pit Severni revir was processed through development the following blasting procedures: preparatory works, primary blasting, and crushing of oversized, contour blasting.

Preparatory works include the preparation and leveling of terrain and marking the adopted drilling geometry on a prepared plateau. In doing so, it is important to pay attention to removal of individual larger pieces of rock from surface of future blast field, which pose a risk of being thrown away as the flying pieces of large sizes.

3. DETERMINATION OF SAFETY DISTANCES FROM FLYING PIECES DURING BLASTING

The distance of scattering the rock pieces after blasting depends on:

- Quantities of explosives used,
- Geometries of arrangement the explosive charges,
- Size of the line of least resistance,
- Rejection angle,
- Land relief.

Determining the scattering distance of the blasting mass pieces can be done in several ways, depending on what is taken as the basis for calculation. If the energy of explosion and energy of projectiles are taken into account, then the ballistic calculations of the flight speed of pieces and their range can be used to determine the distance. If the indicator of explosion effect and line size of least resistance are used, then the tables are constructed from which these distances can be read, Table 1. It can be seen from Table 1 that the safety zones depend on the line of least resistance and indicator of explosion effect (n).

Table 1. *Safety distances depending on the line of least resistance and indicators of explosion effect*

LNO W (m)	R = f (n)							
	1,0	1,5	2,0	3,0	1,0	1,5	2,0	3,0
	For people				For machines			
1,5	200	300	350	400	100	150	250	300
2	200	400	500	600	100	200	350	400
4	300	500	700	800	150	250	500	550
6	300	600	800	1.000	150	300	550	650
8	400	600	800	1.000	200	300	600	700
10	500	700	900	1.000	250	400	600	700
12	500	700	900	1.200	250	400	700	800
15	600	800	1.000	1.200	300	400	700	800
20	700	800	1.200	1.500	350	400	800	1.000
25	800	1.000	1.500	1.800	400	500	1.000	1.000
30	800	1.000	1.700	2.000	400	500	1.000	1.200

Pieces of rock ejected from the massif during detonation of explosives can have a speed of 120 to 150 m/s. The greatest range occurs with those pieces that are thrown at the maximum speed and angle of 45°.

Special attention should be paid to the high-quality production of a blast plug. The length of the blast plug must not be less than the designed length. In practice, for plugging drillholes, the drilled material is used in combination: a layer of coarse material and then a layer of finer material on several occasions.

The distance of scattering pieces during blasting can also be determined by the formula [1, 2]:

$$L = 253 \cdot n^{3/4} \cdot W^{1/3}$$

where are they:

- n - indicator of explosion effect (n = 1);
- W = 4.5 m - burden for all working environments.

L = 417 m for all working environments.

The obtained value refers to the distance in direction of orientation the drillholes, that is, towards the area of the open pit, while the distances in the direction behind the drillholes (toward objects in the vicinity) are several times smaller [3,4].

4. SPECIAL PROTECTION MEASURES

Special protection measures during blasting refer to the prevention of the possible flying the pieces during blasting. In order to reduce the risk of this occurrence, it is necessary to cover drillholes, that is, their caps.

Blasting mats are placed over the blast field as the energy absorbers. They are used in blasting with smaller and medium diameter drillholes, while with large diameter mine drillholes there are difficulties in covering the entire blast field. However, when the priority is protection against flying away, it should be taken into account that in that case the large diameters should not be used, because there are usually populated areas nearby. The other environmental protection criteria, such as reducing earthquakes and air blasts from blasting, limit the quantity of explosives per deceleration interval, which also prevents the use of the large borehole diameters.

Blasting mats should be placed so that their position does not present a problem with the means of initiation during the initiation of explosive charges. They must be made of a flexible material composed of tightly woven threads that allow the gaseous products of explosion to pass through them during detonation, preventing the detonation of fragments.

There is a general rule when using blasting mats, which is that the cover material should have the same weight as the rock being blasted. The flying pieces can be prevented by placing the protective coverings over the blast field and good plugging. Special attention should be paid to the high-quality production of the blast plug. Each protective cover should meet the following requirements:

- To provide great resistance to the flying of blasted material with its own weight,
- To enable easy joining of component parts into a whole or overlapping of individual parts,
- To be easily installed and removed,
- To be able to pass the explosion gases,
- That it can be used multiple times in order to increase economy,
- To be of larger dimensions in order to cover larger areas.

There are two types of blasting mats that should be applied simultaneously: Heavy blasting mats and Partial blasting mats.

Heavy blasting mats are intended to keep the blast field intact so that no part is blown away after initiation. The name itself says that these covers have a lot of weight, and their role is to absorb energy. Gaseous products pass through the cover, but cannot

move it over greater distances. Heavy blasting mats include rubber covers for blasting; they are made of rubber parts interconnected by the steel wires.

Partial blasting mats have the function of preventing the flying pieces from one part of the blast field. Partial protective covers include: Industrial cloth and Tarpaulins.

Heavy cover should be placed as close to the rock surface as possible along with a lighter partial cover on top. Covering with heavy blankets should start from the back of the blast field towards the front, so that each subsequent blanket covers the previous one. During initiation, the overlays wave and do not follow the blasting direction. If the overlays are placed in the opposite direction, it may happen that during initiation the last rows of the blast field remain uncovered, because the overlays follow the direction of initiation.

Covering with a heavy cover is done with a crane or excavator with an inverted bucket. For smaller scale blast fields, small rubber covers should be applied, interconnected with clips, to form a protective unit of sufficient size. Partial protective blankets are then placed on top of the heavy blankets, starting from the last row of the blast field forward. Before covering the blast series, it is necessary to check whether each well is properly connected in the blast series. For more information on blasting mats, see [5,6,7].

Figures 1 - 3 show blasting using the heavy blasting mats. No piece of blasted rock flies long distances. The blasted material remains about 5 m from the blast field.

Figure 1. *Blasting using the heavy protective covers, before initiation*

Figure 2. *Blasting using the heavy protective covers, initiation of the first order*

Figure 3. *Blasting using the heavy protective covers, initiation of the second order*

5. CONCLUSION

The radius of the range zone of flying pieces is the least reliable parameter of protection during blasting because it represents a statistical quantity defined by the experimental observation.

In order to prevent pieces from flying away, the special protection measures are applied during blasting, that is, the blast drillholes are covered with blasting mats. The attention should be also paid to the quality of the blast plug. The use of blasting mats reduces the emission of gases and dust during blasting.

At the open pit Severni revir, the calculation of the amount of explosives by boreholes and series, as well as the deceleration and initiation intervals, were done so that all blasting influence zones are below the object distance limit. Blasting is carried out according to the calculated parameters with application the special protective measures and installation the blasting mats on the blast fields.

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