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### **FLY ROCKS IN SURFACE MINE DURING THE BLASTING**

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**Abstract:** In this paper are present fly rocks in surface mine during exploitation by blasting. Fly rocks can occur for two reason which are: for reason of stemming and for reason of burden. For reason of stemming fly rocks can occur if leaved small stemming when charging the drilling with explosive or if make the stemming with material by big pieces, for to avoidance fly rocks for this reason, must to leave the stemming according to the calculations and to make stemming with material by piece from 4 to 8 [mm]. For reason of burden, fly rocks can occur for cause of drilling deviation and for cause of cave. For to avoidance fly rocks for this reason, must to make the drilling by the right angle and not to charging drillings by the short burden distance, also not to charge the cave more than is calculated before.

**Key words:** Fly rocks, blasting, drilling, stemming, burden

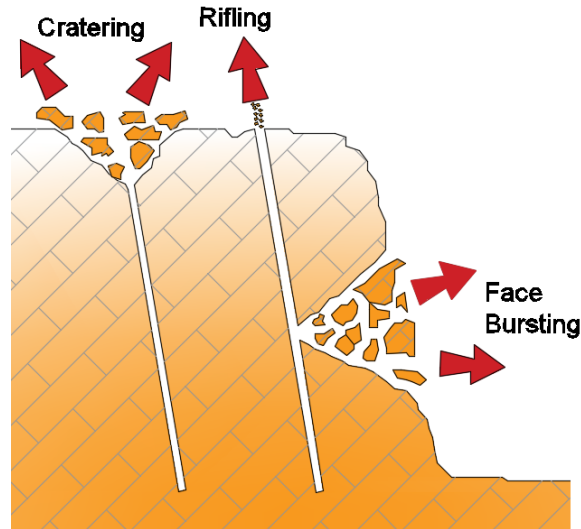
#### **1. INTRODUCTION**

During the execution of the burst we are required to have maximum security, so as not to endanger the objects, machinery and people around the blasting field. Where it is known that the blasts are carried out with the help of the explosive and sometimes if we do not pay attention to some drilling and filling parameters, it can result in stones being thrown away and this may result in damage to the objects and the machinery around mining, this could also result in fatality if it comes to stroke people out of mining pieces. Fly rocks during the blast occurs due to the position of drilling in relation to the free face at the front of the bench and from the excessive loading of drilling with explosive, where these will be elaborated in the continuation of this paper.

#### **2. FLY ROCKS**

The discovery of the cause of the throwing of stones during the execution of the blasting sends to the solution of the problem of fly rocks and the avoidance of the fly rocks, taking appropriate precautionary measures. Based on literature and experience, fly rocks can be for two reasons at the blasts, such as:

- 1) For reason of stemming and
- 2) For reason of burden Figure 1.



**Figure 1.** Fly rocks for reason of stemming and burden

### 2.1. Fly rocks for reason of stemming

Fly rocks for reason of stemming occurs in case of excessive filling of drilling with explosive, to leave very short the length of stemming and in case to make the stemming with the bad material (with large size pieces).

To avoid these fly rocks, we must be careful that:

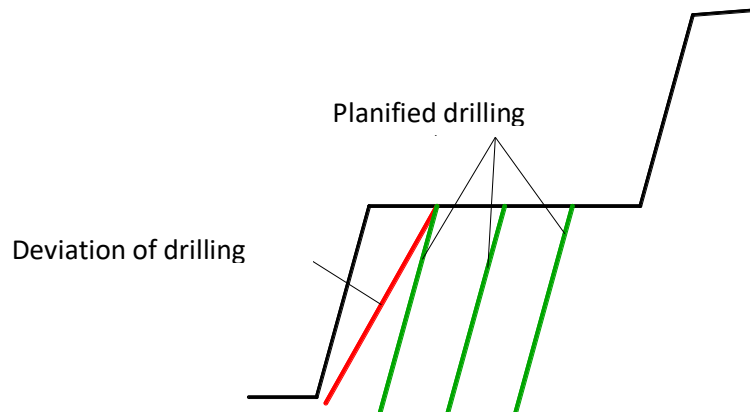
- Always the stemming to make with inert material,
- Always to use the material emerging from the drilling itself or material from crusher with grain size 4 – 8 [mm],
- Always to filling drillings with explosive just to calculated level of stemming,
- It is always necessary to test with a wooden rod during the stemming that the material is blocked during the downfall, so that it does not come to blocking the drilling and remains without enough stemming,
- Never to made the stemming with explosive properties material,
- Never put the material into stemming with large size pieces,
- Never to filling drillings with explosive more than it is stipulated before with calculations,
- Never to forgotten any drilling without stemming,

### 2.2. Fly rocks for cause of burden

Fly rocks for cause of burden can be:

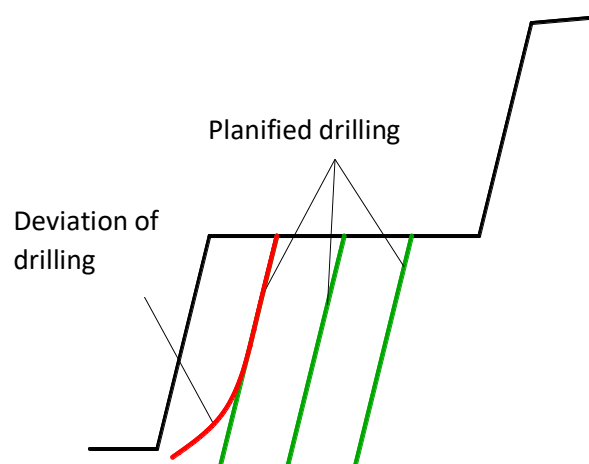
- I. Because of the deviation of drilling angle
  - II. Because of the deviation of drilling during the drilling process
  - III. Because of not keeping the foreseen distance of the burden and
  - IV. Because of the caves
- I. Fly rocks because of the deviation of drilling angle occurs, when placing the boom in the drilling position, the placement of the boom does not occur at the foreseen drilling angle but deviates in the direction of the scale Figure 2. With this deviation of the drilling angle, the down burden at the end of the drilling

decreases and thus enables the explosive material to drop that part of the rock in the pieces form on large distances at the moment of initiation. For this reason, the boom of drilling machine should be positioned correctly before starting the drilling, and do not come to the reduction of the down burden at the end of the drilling.



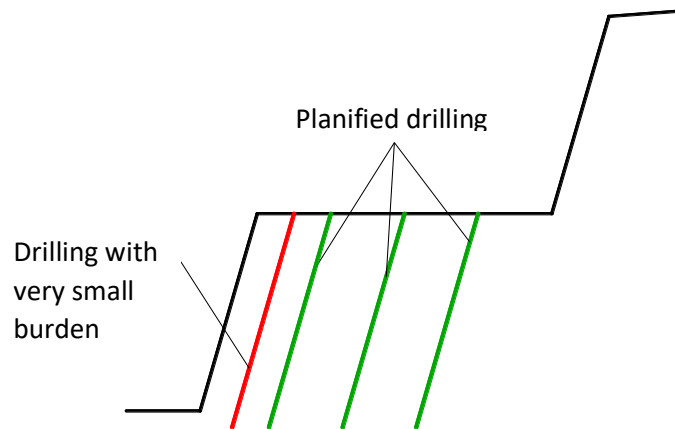
**Figure 2.** Deviation of the drilling angle

- II. Fly rocks because of the deviation of drilling angle during the drilling process. This can be the case if during the drilling process when the crown passes through the rocks with different hardness, tectonics, in case of cracks, in case of change of the material type and in the presence of caves. If the crown deviates toward the free face of scale, it results in the reduction of the down burden and allows for the throw of the stones Figure 3. To avoid this deviation, the drilling machine manipulator, as soon as it detects that it has changed drilling material, from mild material to strong material, slows the drilling speed so that drilling crowns do not deviate but keep drilling in the foreseeable direction. For this reason, prior to filling first row drills near the scale, be checked and if we encounter any deviations that have deviated, we ought to remove it or fill the deviated drilling part with inert material and then the remaining part of drilling must filling with explosive. All this should be done to avoid the risk of throwing pieces after initiating the field.



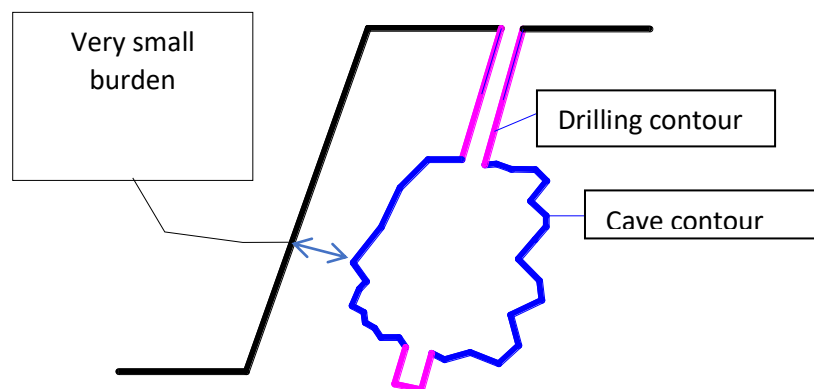
**Figure 3.** The deviation of drilling

- III. Fly rocks because of not keeping the foreseen distance of the burden may occur if drilling approaches the edge of the scale more than previously provided or planned. In this case the throws can be along the whole length of drilling Figure 4. All of this may come as a result of the carelessness of the drill machine manipulator, which does not properly measure the distance between the drill and the upper lip of the scale. If we encounter such cases, then this drilling or these drillings should not be filled with explosive (to be canceled). Or if we have to blasting anyhow these drillings, then it is necessary to place inert material before the scale, in order to increase the burden distance.



**Figure 4.** Do not keeping the foreseeable distance of the burden

- IV. Fly rocks because of caves may occur at those cases when the drilling passes through the cave and this can be large in size and, if it is in the first row, then it affects in the burden decrease and allows it to have throwing Figure 5. In order to avoid the throw in this case, the amount of the explosive placed in this drill should not be greater than the calculated quantity for filling this drill, on the contrary if we try to fill this drilling with explosive to the level of the stemming, then the throws will be inevitable, because the amount of explosive material in this drill will be much greater than the calculated value and the burden of this drilling is much smaller than the foreseen.



**Figure 5.** Cave

### 3. CALCULATIONS FOR FLY ROCKS

In order to be sure that there can't to have no fly rocks during the blasting, we need to make the preliminary calculations based on the drilling and explosives parameters in order to determine the distance of the throw. This calculation is done using the following equations:

- The equation for the calculation of the fly rocks due to the burden (W):

$$L_{max} = \frac{k^2}{g} \cdot \left( \frac{\sqrt{m}}{W} \right)^{2.6} [m]$$

- The equation for the calculation of the crater throws due to the length of stemming ( $l_s$ ):

$$L_{max} = \frac{k^2}{g} \cdot \left( \frac{\sqrt{m}}{l_s} \right)^{2.6} [m]$$

- The equation for calculation of ruff throws, for reason of material which is used for stemming:

$$L_{max} = \frac{k^2}{g} \cdot \left( \frac{\sqrt{m}}{l_s} \right)^{2.6} \cdot \sin \beta [m]$$

Where are:

$L_{max}$  – maximal length of fly rocks [m]

$\beta$  – angle of drilling [ $^\circ$ ]

$m$  – quantity of explosive for one meter of drilling length [kg/m]

$W$  – burden [m]

$l_s$  – stemming length [m]

$g$  – gravity constant [ $m/s^2$ ]

$k$  – constant with value: for soft rocks 13.5, up to 27 for hard rocks

Example:

The calculation is made for diameter of drilling  $\Phi 89$  [mm] and for ANFO explosive (5.29 [kg/m])

**Table 1.** Fly rocks for reason of burden

The burden $W$ , [m]	0.5	1	1.5	2	2.5	3
The maximal length of fly rocks $L_{max}$ , [m]	2850.74	470.20	163.85	77.55	43.41	27.02

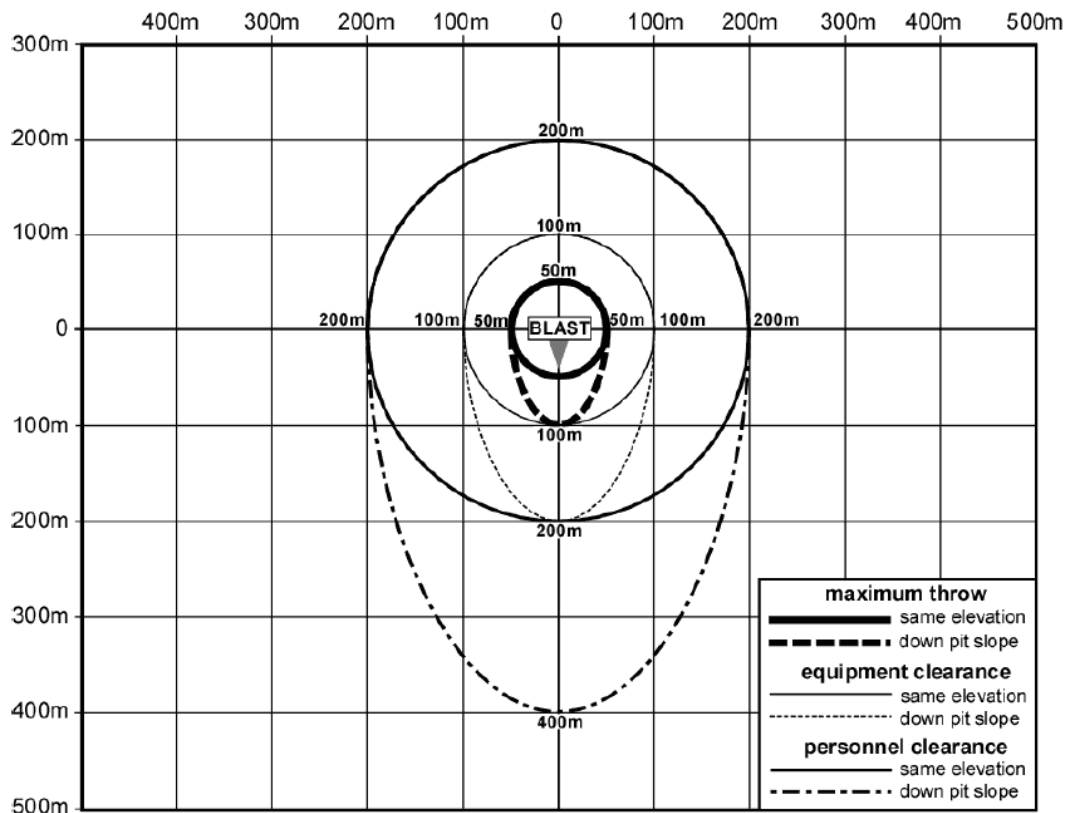
**Table 2.** Crater throws, for reason of the stemming length

The stemming length $l_s$ , [m]	0.5	1	1.5	2	2.5	3
The maximal length of fly rocks $L_{max}$ , [m]	2850.74	470.20	163.85	77.55	43.41	27.02

**Table 3.** The ruff throws for reason of the type of material, used for stemming

The stemming length $l_t$ , [m]	0.5	1	1.5	2	2.5	3
The maximal length of fly rocks $L_{max}$ , for the angle of drilling $70^\circ$ , [m]	2678.21	441.74	153.93	72.86	40.79	25.39
The maximal length of fly rocks $L_{max}$ , for the angle of drilling $75^\circ$ , [m]	2753.11	454.09	158.24	74.90	41.93	26.10

The recommended **safety zone** during the time of initiation of the blast is presented on Figure 6.



**Figure 6.** Maximum throw and recommended clearance distance from blasting

#### 4. CONCLUSION

Before starting the filling process, especially the first row drillings that are close to the edge of the bench, must be checked to see their condition with respect to the burden distance, the drilling angle, the bench angle and direction of deviation if there

is deviation. After checking of drillings, the charging process with explosive may begin.

It is imperatively necessary for to avoid the fly rocks to do check of filling with explosive of the drillings with wooden stick and don't to charge drillings more than anticipated with preliminary calculations. To do the stemming of drillings with the inert material with no large size of the grain, it is preferred that the using material for stemming to be the material that has emerged during the drilling process, but can also be used from the quarry, with a size of grain from 4 to 8 [mm].

For to avoid the deviation of the drilling, the drilling machine manipulator should reduce the operating force of the drifter at the moment of transition from a layer of soft rocks to the layer of strong rocks, in this case it prevents the deviation of drilling. Deviation of drilling usually occurs when passing the drilling crown from a mild environment to a strong environment. Drilling deviations can also occur at the moment of placement of drilling boom, if the boom isn't positioned according to drilling planning. For this, the drilling machine manipulator must looking well at what position it is putting the boom for to beginning drilling and make the boom positioning according to the drilling plan.

## REFERENCES

- [1] Dambov R.,: Dupcenje I minranje, Univerzitetski ucebnik,UGD-Stip, 2013
- [2] Moore J. Adrian.; Richards B. Alan: Golden pick cut – back, fly rock control and calibration of e predictive model, Melbourne 2005
- [3] Savić M.: Miniranje na površinskim kopovima, Kniga, Bor, R. Serbia, 2000
- [4] Brahimaj I.; Brahimaj F.: Technology of drilling and blasting II, Mitrovica 2016
- [5] Hosseini M.; Baghikhani S. M.: Analysing the ground vibration due to Blasting at AlvandQoly Limestone Mine, International Journal of Mining Engineering and Mineral Processing 2013; 2(2): 17-23
- [6] Nuredini H.: Safety technique in mining, Pristina 2006
- [7] <https://www.tmr.qld.gov.au/-/media/busind/techstdpubs/Technical-notes/Pavements-materials-geotechnical/TN03groundvibrationsairblast.pdf?la=en>