# REVIEW OF DRILLING AND BLASTING PARAMETERS AND SOME EFFECTS DURING BLASTING OPERATIONS

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***ABSTRACT***
*For the purpose of some investors for construction of small hydro power plants, are prepare analysis on the subject of the drilling and blasting parameters and the proper documentation for the construction of a canal for intended laying down pipeline from the catchment facility – to the dam leading to the power house of the hydro power plant.*
*During the construction of the canal the necessity for analysis and review of the applied drilling and blasting parameters has arisen, from the aspect of the resulting effects and blasting costs.*
*This paper and analysis has been prepared for that purpose, in order to help the investors to decrease the costs and promptly perform the activities, and to be useful to the Contractor in terms of efficacy and cost reduction during the performance of the blasting activities.*

## 1.0 INTRODUCTION

For construction of small hydro power plants, an analysis has been prepared on the subject of the drilling and blasting parameters and the proper documentation for the construction of a canal for intended laying down pipeline from the catchment facility – to the dam leading to the power house of the hydro power plant.

During the construction of the canal the necessity for analysis and review of the applied drilling and blasting parameters has arisen, from the aspect of the resulting effects and blasting costs.

This report has been prepared for that purpose, in order to help the investor decrease the costs and promptly perform the activities, and to be useful to the Contractor in terms of efficacy and cost reduction during the performance of the blasting activities.

The contractor must have in place prepared technical documentation – an Survey for execution of these blasting activities; also, there is elaborate-logbook of blasting activities and blasting plan prepared in advance in terms of technical and safety aspects during all of the blasting activities. The contractor should have these documents on the location of the terrain where the blasting activities are taking place.

In accordance with the blasting regulations, these documents are necessary in order to gain better control over the overall process and take all necessary working safety measures on time.

The work environment for the construction of the canal is relatively soft with disintegrated rocks – soft schists with crevices in several directions. In one portion there are disrupted rift zones where there is presence of water, which can cause a faulty operation of the explosives.

## 2.0. Calculation and analysis of the drilling and blasting parameters

For this purpose a few important parameters was been analysed. Herein are the following:

- length of blasting holes, L
- spacing between the blasting holes, a
- path of least resistance, (BURDEN) W (PLR)
- quantity of blasted material, V
- quantity of explosive material, $Q_e$
- type of explosive
- manner (way) of initiation and blast design
- length of blasting holes

- **length of blasting holes**
- $L_d = H + l_{pod} = 2.35 + 0.25$ **= 2.6m** – for vertical blasting holes
- $L_d = H/_{sina} + l_{pod} = -2.35/0.996 + 0.25 =$ **2.7m** for diagonal blasting holes at an angle of $\alpha = 75^0$

- **spacing between the blasting holes, a**

In order to inspect this parameter we have used the following formulae:

- $a = m \cdot W$, m
- $W=(25 \div 35)\ .\ d = 30\ .\ 0.64 = 2$ m – burden (path of least resistance)
- $a = 0.80\ .\ W = 1.6$m – during construction of canals
- **a = 1.6 m**

- **path of least resistance, BURDEN, W (PLR)**

  The path of least resistance during construction of canals is actually the distance from the explosive charge to the free area, which in this case is blasting with one free area that is in fact a horizontal plateau where the blasting holes have been created.

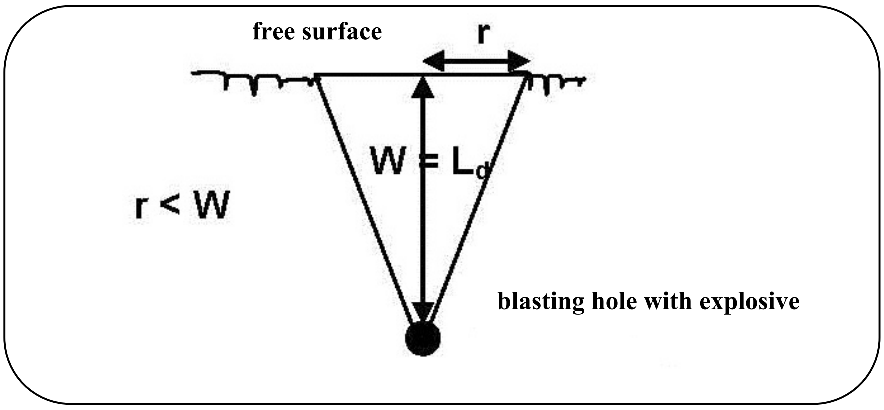
  The resulting value for PLR is: $W =(25 - 35).\ d = 25\ .\ 0,064 \div 35\ .\ 0.064 = 1.6 \div 2.24$ it is rounded to W = 2.0 m.

- **quantity of blasted material, V**

  The quantity of blasted material is calculated per one blasting hole, which in this case is the volume of the cone of one blasting hole.

  The volume of the crater is defined by two parameters:
  - depth of the crater or blasting hole and
  - radius of the crater (cone) at regular crushing.

  The ration of these two parameters **defines the index of explosive effect, n** (Picture 1)




*Picture 1. Diagram of "weakened" crater - cone*

The case presented on Fig. 1 depicts the actions of blasting for construction of canals. Moreover, the radius "r" is shorter that the path of least resistance, i.e. half of the distance between the blasting holes (a/2).

in this case "n" < 1 i.e. $r / W = 0.8 / 2 = 0.4 < 1$

The blasting device has a loosening effect and the blasted material remain within the area in crushed and loose form.

This effect is utilized during blasting of soft rocks which are structurally deformed and loosened from the presence of the chaotic cracks.

*Picture 2. Cross-section of the incline of the terrain with structural deformities and existing cracks*

- The quantity of blasted material per one drilled hole may be calculated in several ways:

  - according to the performed drilling parameters within the area:

$V = S_k . (a/2+a/2) . L_k = 3.0 . (0.6+0.6) . 2.4 = 5.64m^3$

where are:

$V = S_k$ – width of canal after the blasting, 3.0 m
a – distance between blasting holes, a = 1.2 m
$L_k$– reached depth of canal, 2.4 m

According to the project dimensions for construction of the canal:
$V = Sk . (a/2+a/2) L_k = 1.9 . (0.6+0.6) . 2.35 = 5.4m^3$

Having taken into consideration the above mentioned theoretical depictions of the formation of a crater after the blasting activities performed for construction of canals, the loosened upper surface of one blasting hole should have a radius smaller than the depth of the blasting hole.

In order to form a cone with weakened effect and a canal with regular length, the radius of the cone that is formed by the blasting should be smaller than the depth of the blasting hole.

In practice, that means (and also results from actual blasting activities) that the radius of the cone is r=1.2 to 1.5 m, i.e. the actual resulting length of the canal is 2.4 to 3 m.

If this is calculated for the volume of material per blasting hole, the result (with rounded mean values) is:

$$V = (r + r) . (a/2+a/2) . Lk = (1.35 + 1.35) . (0.6 + 0.6) . 2.4 = 7.8m^3$$

- **quantity of explosive, $Q_e$ and type of explosive**

The necessary quantity of explosive material per blasting hole is calculated according to the following pattern:

$Q = p . (L_d - l_{cep}) . kg)$

where are:
p – quantity of explosive material per meter, kg/m'
$L_d$ - $l_{cep}$ = lp - charge length, m'
$l_{cep}$ - length of stemming, 1.5m
$p = pd^2/4 . \Delta = 3.14 . 0.06^2/4 . 1.05 = 3kg/m'$
Q = 3 . (2.7 - 1.5) = 3 . 1.2 = **3.6kg/hole**

The type of explosive material has values that should ensure the best possible energy transmission in the rocky massif.

According to the type of rocks, the suitable tipe of explosive would be AN-cartridges explosives with 1.05 $kg/dm^3$ density.

In moist or humid areas waterproof explosives are recommended, and some of those present on the market are Detonex, Emulit, Zelex etc.

For dry and cracked rocks it is proposed to use cartridges AN-FO explosive with f60mm and has less powerful blasting features, but more powerful gas energy that is convenient for this type of rocks. On the other hand, this explosive is far less expensive than the above mentioned cartridges explosives.
This explosive may be used along with the existing AN- explosive (2AN: 1ANFO)

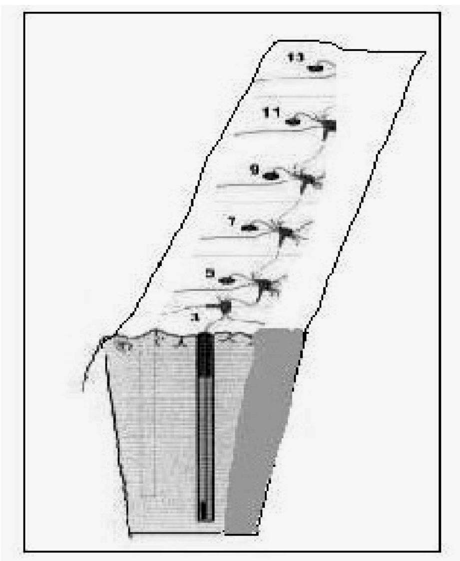
AN ANFO AN

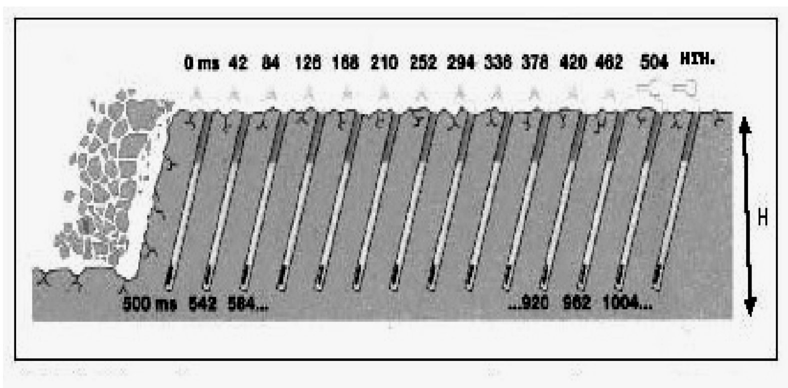
- **<u>way (manner) of initiation</u>**

For these methods of construction of canal it is proposed to use interval initiation with interconnected one or two holes in one interval.

That would enable the formation of additional free area in the front of the canal and would cause the explosive energy to be distributed evenly in that direction and would be less directed to the upper area of the canal. This causes greater loosening of the upper layers of the canal.

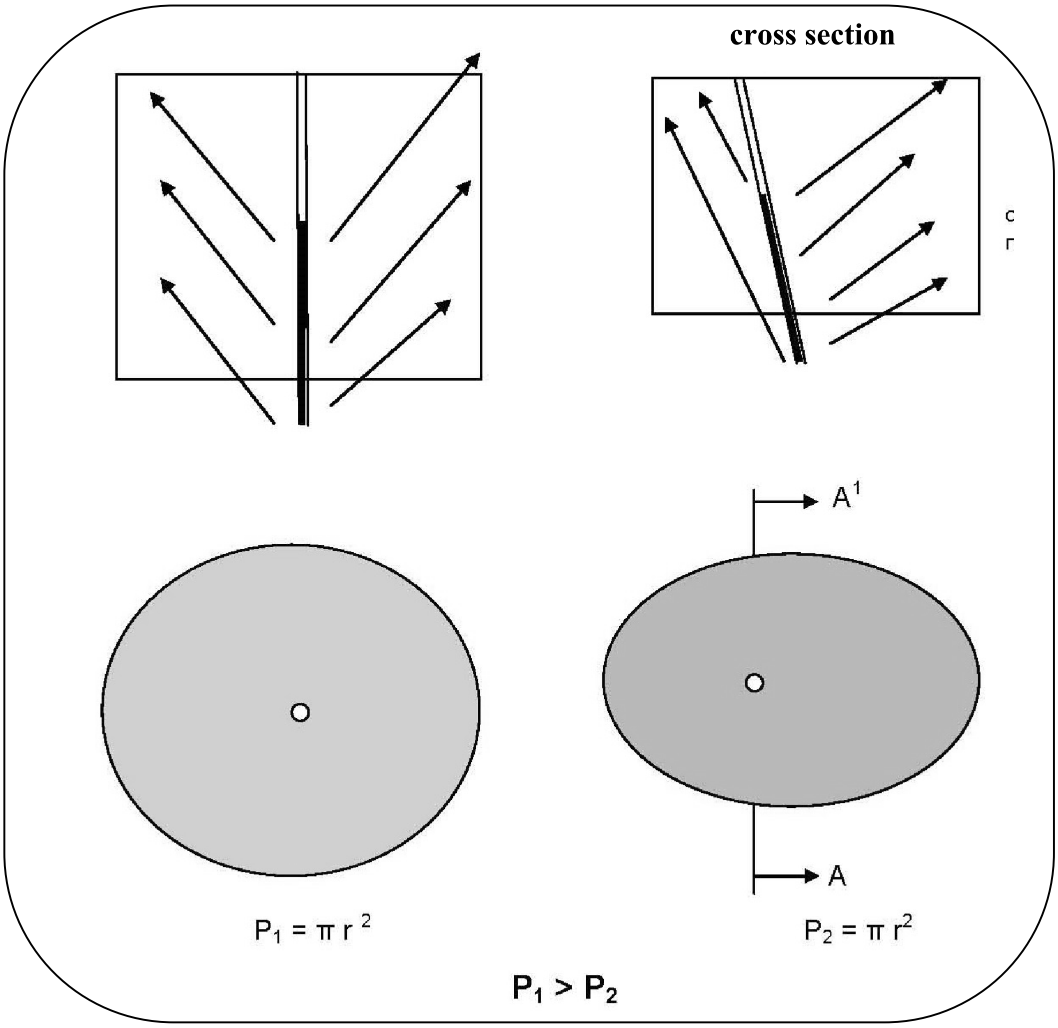
For delaying of the intervals, after taking into consideration the structural characteristics of the massif, millisecond or temporal delays can be used, which have delay rate of 42 ms or more.






(a) (b)

*Picture 3. Connection of blasting holes during blasting of canal (a), Way of initiation of diagonal blasting holes ( one by one) by Nonel system for construction of canal, H – depth of canal (b)*




*Picture 4. Area of cone within vertical and inclined blasting holes*

## 3.0 CONCLUSION AND RECOMMENDATIONS FOR FURTHER ACTIVITIES DURING CONSTRUCTION OF THE CANAL

- The distance between the blasting holes should be a = 1.3 to 1.5 m
- The drilling diameter should be properly controlled and the drilling head should be regularly changed with min. F63mm
- The filling should be performed with cartridges explosive AMONEX-4, with F60 mm or similar for dry blasting holes, while in case of moist and humid blasting holes, the waterproof explosive DETONEX, Φ60mm should be used.
- In order to cut costs and reaching similar effects during blasting, it is recommended the use of cartridges AN-FO explosive with Φ60mm in ration **2:1** with classic cartridges AMONEX -4.
- In order to create a smaller crater for disposal and better granulation of the blasting material it is recommended to introduce millisecond initiation by employing the Nonel initiation system. The initiation interval should be one blasting hole at a time or in some cases, two or three interconnected blasting holes (Picture 2 & 3).
- The drilling angle should be made to 75° in relation to the horizontal and in direction of the advancement front with opening the previously formed free area. (Picture 3 and 5)

*Picture 5. Crushed material from created cone with vertical blasting holes*

## LITERATURE

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