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Using pre-splitting controlled blasting method and comparing it with non-control method in Chehel Kooreh copper mine

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ABSTRACT: In blasting operations in tunnels, the occurrence of back breaks caused by the high energy content of explosives leads to many problems. This project, it is tried to solve the problems caused by non-controlling blasting by controlled blasting in a pre-splitting method in one of the march tunnels of the Chehel Kooreh mine in Zahedan. To design the blasting pattern in the tunnel section, the "theory of energy transfer" and "nitronobel (Swedish) methods" were investigated with parallel and angular holes, which ultimately led to a blast pattern based on the "energy transfer theory" with parallel holes as the final design of the selection And the control hole pattern was also designed in a "pre-splitting" manner. Finally, the proposed design was implemented in the march tunnel of the Chehel Kooreh mine. Finding the results of the blasting based on the proposed design showed that the face and the roof and walls were much smoother than the blasting based operation according to the current design, which would result in more and better matching of the units with the walls and roof And preventing increased stress concentration on them. To evaluate the pre-splitting controlled blasting performance, the QCB factor is used quantitatively, after which the factor was used, the controlled blasting performance of the Chehel Kooreh mine march tunnel was excellent based on the proposed design.

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1. INTRODUCTION

Controlled blasting prevents damage to remaining rock walls in tunnels and underground mines by capturing the energy released from blasting; it also controls back-breaking, leading the created surface to be stable, uniform, and well-formed. While there are several methods for implementing controlled blasting, but all control blast holes have the same characteristics as follows:

All are drilled while surrounding the intended area;

The distance between the two control holes is less than the distance the exists between two production holes;

Control blast holes should be drilled in parallel, otherwise, any deviation leads to back-breaking, bench toeing, and wall corrugating;

The charge's diameter is less than the blast holes diameter;

Blasting often occurs suddenly, but sometimes with a little delay;

Controlled blast holes are drilled all together at the same time – before or after drilling production holes;

The charge is commonly distributed along the length of the blast hole.

In controlled pre-splitting blasting, a planar crack is propagated in the rock wall before drilling production holes, mainly by a row of low-diameter holes with unpaired charges.

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The aim is to create an artificial planar fracture to prevent the blasting wave from affecting the remaining rock structure.

In this study, the factor "QCB" was used for analyzing data on controlled blasting. The factor is calculated using the equation [1] as follows:

$$QCB = A(MHCF) + \frac{1}{B(BB)} + C(ACH) + D(SCH)$$

Where MHCF is modified factor "HCF", BB is mean back-breaking value, ACH is a mean percentage of half the perimeter of the control hole, SCH is a mean percentage of the distance between control holes, and "A", "B", "C", and "D" are coefficients that are determined based on parameters affecting above-mentioned factors.

The present study aims at providing an appropriate design for blasting the working face (with a cross-sectional area of 5.6 m2) in CHEL KOOREH cooper mine (Zahedan, Iran). It also aims at implementing a controlled pre-splitting blasting to leave a wall and roof with completely smooth and even surfaces, as well as to control back-breaking.

Controlled blasting is not used extensively in advancing tunnels in Iran; and, under other conditions, smooth blasting is mainly preferred when boring tunnels (except for mining). This is an innovative study aiming to assess the efficiency of controlled pre-splitting blasting when boring tunnels.

Table 1. Section specification

Cross sectional area	5.6 (m^2)
Tunnel's height	2.5 (m)
Tunnel's width	2.5 (m)
Walls' height	1.25 (m)
Arch radius	1.25 (m)

Table 2. Amount of charging holes and delays number in the present plan

Delay No.	Delay rate	Number of holes	Number of cartridge per hole	Total number of cartridges	Charge weight for each number (kg)
1	3200 ms	4	3	12	2.4
2	3400 ms	5	3	15	3
3	3600 ms	7	2	14	2.8
4	3800 ms	5	3	15	3
Total		21		56	11.2

Table 3. Amount of charging holes and delays number in the design according to the theory of energy transfer with parallel holes (proposed pattern)

Delay No.	Delay rate	Number of holes	Number of cartridge per hole	Total number of cartridges	Charge weight for each number (kg)
0	Suddenly	13	1	13	2.6
1	500 ms	9	2	18	3.6
2	500 ms	8	2	16	3.2
3	500 ms	5	2	10	2
Total		35		57	11.4

2. CHEL KOOREH COPPER MINE

CHEL KOOREH, a traditional copper mine, is located 120 km northwest of Zahedan, Iran, on the LONKA mountain range. Its total ore deposit exceeds 8,398 million tons, of which 3,186 million tons have a density of 0.57 % - 3.4 %, and can be mined and extracted. Incline and horizontal tunnels are used as main approaches for pitting, both with different cross-sections that are designed based on their application and locating [2]. Non-controlled excavation and blasting are used for boring these tunnels, resulting in problems such as back-breaking and wall corrugating, all prevent complete matching between holding units and tunnel's wall and roof as well as the holding units to be excessively stressed. In this study, so, we decided to design and implement controlled blasting the working face with a cross-sectional area of 5.6 m2 (at the request of the mine's managers), to prevent such problems, and to enhance productivity. Information on the intended working face is provided in Table 1 [2].

3. THE PRESENT PATTERN

The blasting design is currently implemented on the advancing working face, with holes of 34 mm diameter and 1.1 m depth. Four holes (under the angle of 74 degrees) are drilled at the cutting area. There are also five holes in the advancing area. Blasting at the surrounding area isn't controlled, where a total of seven holes (34 mm in diameter, and 1.1 m in depth) are drilled toward the wall, under the angle of 7 degrees. The burden value in surrounding holes is 42.5 cm. Five holes are drilled in the floor, while two in the cutting center with 34 mm in diameter and 1.1 m in depth.

The main explosive was Emolite (0.2 kg, 27 mm in diameter, 28 cm in length) that was used under the explosion system "Nonel" (a shock tube detonator); information on the charging rate and delays number are presented in Table 2 [2].

Proposed pattern

Holes blasting arrangement and sequencing are shown in Fig. 12. The charging level and the number of delays are provided in Table 3.

Evaluating controlled blasting results in the proposed design

After blasting working face in advancing tunnel no. B9 at CHEL KOOREH mine, 10 half-casts remained from 13 drilled holes of 1.1 m length at surrounding section, with the following specifications:

· Six half-casts with 1.1 m length
· Three half-casts with 1 m length
· One half-casts with 0.95 m length

The factor QCB is, therefore, calculated as follows:

$$QBC = 1.23\left(1.01\right) + \frac{1}{0.7\left(0.1\right)} + 1.21\left(0.73\right) + 1.4\left(0.89\right) = 17.65$$

Considering the value obtained after controlled pre-splitting blasting of working face in advancing tunnel no. B9 at CHEL KOOREH mine, the overall controlled blasting efficiency is confirmed.

4. CONCLUSION

The results obtained after implementing the proposed plan using controlled pre-splitting blasting includes:

- Controlled pre-splitting blasting was implemented successfully; the pre-splitting blasting can, therefore, be used as an appropriate and applied method when boring tunnels, considering the rock's condition.
- The value of half-cast was 73.77 %, indicating that the blasting operation can considerably be acceptable; and the efficiency of the controlled pre-splitting blasting is confirmed.
- The calculated value of the QCB factor confirmed the performance of controlled pre-splitting blasting at the intended cross-section.
- The blasting operation provided a working face with an even surface, confirming the performance of the burn cut pattern and advancing holes. This facilitates better implementing the hole-crating design, and, ultimately, improves blasting results in subsequent operations.
- As a considerable achievement, the advancing rate reaches 100 % using the proposed plan.
- The dimensions of the rocks obtained after blasting (when using the proposed design) are less than that of angled holes, and they can be carried and deposit more easily and faster.

REFERENCES

[1] C. Lopez Jimeno, E. Lopez Jimeno, F. Carcedo, Drilling and blasting of rock, Rotterdam: Taylor & Francis US., 1995.

[2] Kavoshgaran Consulting Engineers, Report of Chehel Kooreh copper mine, 2007.

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