TECHNICAL NOTE

DETERMINATION OF BLASTHOLE PARAMETERS BASED ON FIELD RESULTS

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Abstract Correct selection of coefficients for blasthole parameters in Ghalat limestone mine in Shahr-e-kord of Iran has resulted is designing and performing 20 blasting operations. After each blast, fragmented rocks larger than one square meter, called oversize, are estimated and prepared for secondary blasting. Next blast hole pattern were designed based on previous blasting results. The results of these field operations studies have shown that the best ratio between spacing (S) and burden (B) in Ghalat limestone mine is 1.25. The ratio of cut height (H), subdrilling(J) and length of stemming (T) to burden are: 4, 0.5 and 1 (H/B=4, J/B=0.5, T/B=1). Field results of these relations have shown that more than 90 percentage of fragmented rocks have sizes less than one square meter and the cost of production is reduced by 18.9 percentage.

Key Words Blasting, Secondary Blasting, Fragmentation, Oversize, Flyrok, Over Break, Under Break

چکیده انتخاب ضرایب مناسب برای پارامترهای چالهای انفجاری مانند فاصله بین دو چال در یک ردیف "S" ، فاصله ردیف چالها یا مرکز چال تا نزدیک ترین سطح آزاد "B" ، ارتفاع جبهه کار "H" ، اضافه حفاری "J" و طول پودر سنگ "T" در هر معدن می تواند موجب کاهش انفجار ثانویه و هزینه تولید شود. براین اساس و برای انتخاب بهترین ضرایب پارامترهای چالهای انفجاری در معدن سنگ آهک غلات شهر کرد ۲۰ انفجار طراحی و منفجر گردید. در هر انفجار سنگهای خرد شده که ابعاد بزرگتر از یک متر مربع داشتند سنگ بزرگ نامیده شدند و به منظور انفجار ثانویه جمع آوری می شدند. انفجارهای بعدی براساس نتایج انفجارهای قبلی طراحی شدند. نتایج مطالعات عملیات صحرائی نشان داده است که مناسبترین نسبت بین "S" و "B" در معدن سنگ آهک غلات ۱/۲۵ و بین H ، J ، T به B به ترتیب ۴، ۰/۵ و یک است (H/B=۴ ، J/B = ۰/۵ ، T/B=۱) انفجارهای انجام شده با این روابط نشان می دهد که ۹۰ درصد سنگهای خرد شده کوچکتر از یک متر مربع اند و این امر باعث شده است تا هزینه عملیات معدن ۱۸/۹ در صد تقلیل یابد.

INTRODUCTION

Proper selection of coefficient for blasthole parameters such as spacing, burden, cutheight, subdrilling and length of stemming for each particular mine can reduce secondary blasting operations as well as the cost of production [1, 2]. Today there are several equations that show the relation between spacing, cutheight, subdrilling, lenght of stemming and burden [3-5]. But non of these equations can be used as a general equation for all type of rocks, because the rock is a highly complex material. It varies in its characteristics across very short distance [6]; therefore, it is necessary to find specific equations that show the best relation between blasthole parameters of each particular mine. This paper discusses the correct selection of coefficients for blasthole parameters in Ghalat limestione mine in Shahr-e-kord of Iran. Ghalat limestone mine is located at 8 km west of Shahr-e- kord in south west of Iran, between 32°, 26', 24" longitudinal and 50°, 42', 36" latitudinal (Figure 1).

Yearly production of this mine is 120000 tonne and is mostly used by the concrete manufacturer located 2 km from Ghalat limestone mine. Since the manufacturer can not use mine raw materials straight away, it is required to reduce mine limestone to sand and gravel. For this purpose, crusher with entrance of one square meter area is used. Therefore, all mine fragmented rocks must have less than one square meter dimensions.

Otherwise, it would require secondary blasting operations. In the past, Ghalat mine limestone was mined by drilling and blasting without using particular relation for designing blast hole parameters. Problems like fly rock and ground vibrations were observed. A serious problem was that, more than 25% of blasted rocks had greater than one square meter dimensions.

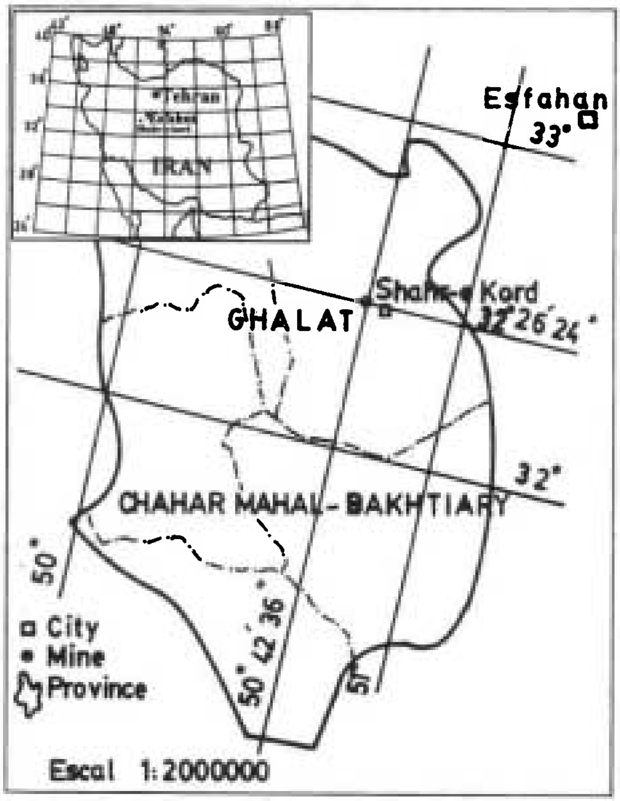

Figure 1. The location of Ghalat limestone mine in southwest of Iran.

This problem caused secondary blasting operations, high production cost and sometimes stopped crushing processes. In these experimental studies, it is tried to design and perform several blasting operations, based on blasting results and estimated amount of fragmented rocks that have less than one square meter dimensions and find the best parametric ratios for S, H, T, J and B.

FIELD OPERATIONS

In Ghalat limestone mine, the average specific gravity of limestone is 2.6 and its hardness is estimated to be 3. The formation does not have major joints, therefore, the effect of joints on the blasting of rocks were minor. A wagon drill with 3" diameter is used for drilling operations. To explode the rock, ANFO with specific gravity of 0.8 was used as a main charge, dynamite was used as a primer and booster. In each explosion, the condition of explosion such as number of holes, hole depth, total drilling meterage, tonnage of blasting rocks, spacing, burden, subdrilling, length of stemming, amount of charge per hole and weather conditions were recorded. After each explosion, the percentage of oversize was estimated. If the amount of oversize was more than 10 percent of total blasted rocks, the explosion was called" bad explosion" (Table 1). In this case, the total amount of oversize was collected and prepared for secondary blasting operations (Figures 2-4).

The next blast was designed on the basis of the previous blasting results. The parameters were rearranged in order to have a good explosion. This trend were continued until more than 90% of the blasted rocks had less than one square meter dimension and they could pass through the crusher. This blast was called "good explosion" as shown in Figure 5.

By choosing correct delay, the fly rocks and ground vibration became under control. After 14 explosions the oversize and fly rocks were minor and

Figure 2. One typical of bad explosion " Too much oversize".

Figure 3. The total amount of oversize collected for secondary blasting operations.

TABLE 1. Shows The Overal Conditions of Typical Bad Blasting Operation.

No. of Row	1	2	3
No. of Holes	29	38	30
Hole depth H (m)	4	4.5	5.5
Dynamite (gr/hole)	62.5	125	187.5
ANFO (kg/hole)	3	6.5	8.5
S(m)	2.2	2.2	2.2
B (m)	2	2	2
T (m)	1	1.1	1.2
J (m)	0.6	0.7	0.7

Figure 4. The total amount of oversize blasted rocks prepared for secondary blasting operation.

Figure 5. A typical good explosion where more than 90% of blasted rocks had less than one square meter dimensions.

the selected explosion conditions were recommended for the next blasting operations. Table 2 shows the conditions of a good explosion in Ghalat limestone mine.

RESULTS

After 20 blasting operation in Ghalat limestone mine and analysing the results of operations, it was found that the best conditions to obtain the optimum results are as following.

TABLE 2. Conditions of the Good Blasting Operation.

No. of Row	1	2	3	4
No. of Holes	6	8	12	15
Hole depth H (m)	7.5	7	6	5
Dynamite (gr/hole)	625	625	625	625
ANFO (kg/hole)	33	31	28	25
S(m)	2	2	2	2
B (m)	1.6	1.6	1.6	1.6
T (m)	1	1	1	1
J (m)	0.5	0.5	0.5	0.5

1. The ratio between spacing and burden is:

$$S/B=K_S \quad (1)$$

where K_S is spacing coefficient and the best value of K_S is 1.25, Therefore.

$$S=1.25B \quad (2)$$

The best value of S ranges between 1.7 to 2 and the best value of B ranges between 1.4 to 1.6 (Figure 6).

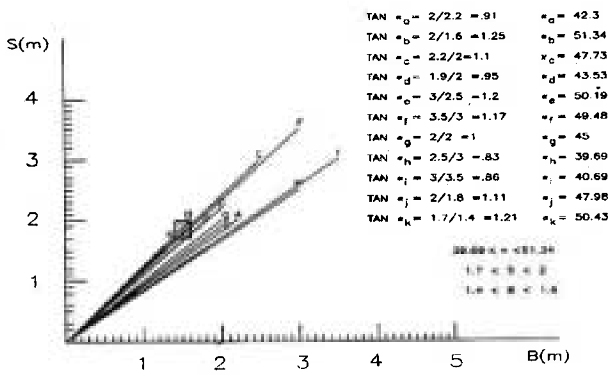

Figure 6. The relation between Spacing "S" and Burden "B". The optimum results were obtained at "S" ranging between 1.7 to 2 and "B" ranging between 1.4 to 1.6.

2. The ratio between cutheight and burden is:

$$H/B=K_h \quad (3)$$

Where K_h is the cutheight coefficient and the best value of K_h is 4. Therefore:

$$H = 4B \quad (4)$$

3.The ratio between subdrilling and burden is:

$$J/B=K_j \quad (5)$$

where K_j is the coefficient of subdrilling and the best value of K_j is 0.5. Therefore:

$$J = 0.5B \quad (6)$$

4. The ratio between length of stemming and burden is:

$$T/B=K_t \quad (7)$$

where K_t is the coefficient of stemming and the best value of K_t is 1. Therefore:

$$T=B \quad (8)$$

5. The ratio between burden and blasthole diameter is:

$$B = K_B.D_h$$

where K_B is the cofficient of burden and the best value of K_B in Ghalat limestone mine is 21. Therefore:

$$B = 21D_h$$

In Ghalat limestone mine the best results are

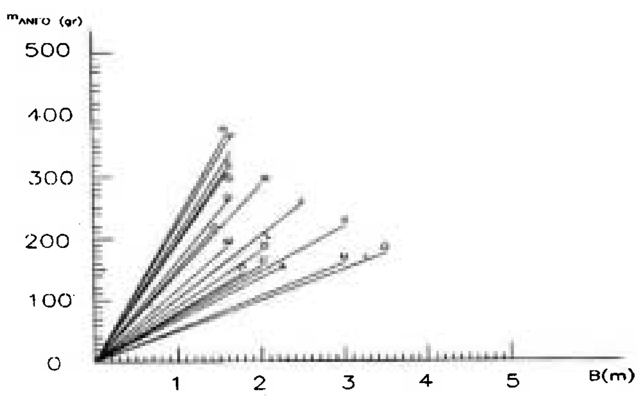

Figure 7. The relation between "B" and the amount of ANFO required per ton of limestone. The best result is obtained at B=1.6 meter and 260 grams of ANFO per ton of limestone.

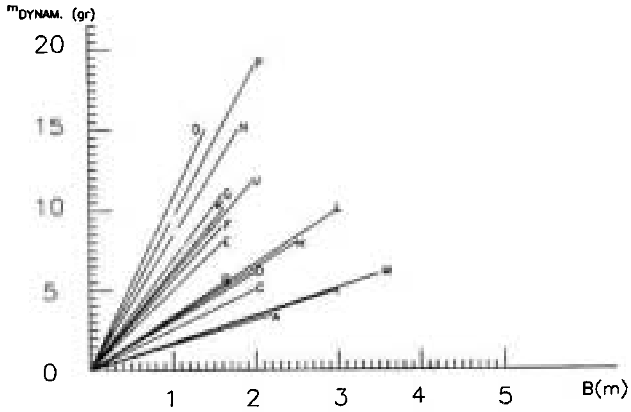

Figure 9. The relation between "B" and the amount of dynamite required per ton of limestone. The best result is obtained at B=1.6 meter and 15g of dynamite per ton of limestone.

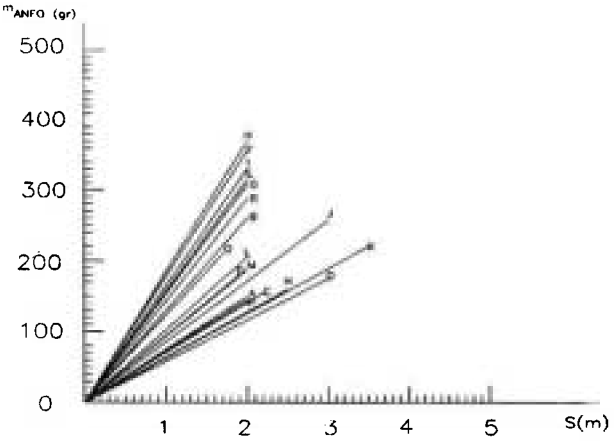

Figure 8. Shows the relation between "S" and the amount of ANFO required per tone of limestone. The best result is obtained at S=2 m and 260 grams of ANFO per ton of limestone.

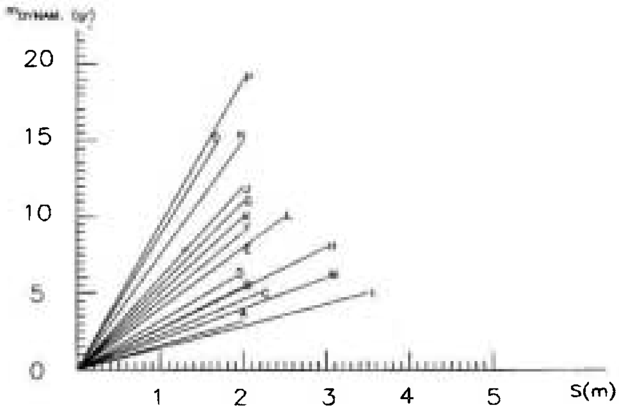

Figure 10. The relation between "S" and the amount of dynamite required per ton of limestone. The best result is obtained at S=2 m and 15g dynamite of ANFO per ton of limestone.

obtained at S=2 meter and B=1.6 meter. Based on these conditions the amount of ANFO per ton is 260 grams and the amount of dynamite per ton is 15 grams. Figures 7 to 10 show the relation between "S" and "B" with the amount of ANFO and dynamite required per ton of limestone.

CONCLUSION

Based on field operations studies in Ghalat limestone mine is Shahr-e-kord, new relationship among "B", "S", "H", "J" and "T" were found. The results of blasting operations with new equations have shown that more than 90% of blasted rocks have less than one square meter dimension to pass through the crusher. With new blasting conditions, fly rock and ground vibration were negligible. It is understood that rocks are very complex material and have different reaction in different locations. Therefore, the results obtained for Ghalt limestone mine may not exactly be the same for other limestone mines, but they are suggested as good approximations for the start up operations.

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NOMENCLATURE

D_h = diameter (m)
S = spacing (m)
B = Burden (m)
H = Cut height (m)
J = Subdrilling (m)
T = Stemming (m)
K = Coefficient

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