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INVESTIGATION OF THE EFFECTIVENESS OF AN EXPLOSION WITH MULTI-POINT INITIATION OR DISTRIBUTED CHARGES

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, yё; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

FOLLOWING ARE THE CORRESPONDING RUSSIAN AND ENGLISH DESIGNATIONS OF THE TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}
rot	curl
lg	log

INVESTIGATION OF THE EFFECTIVENESS OF AN EXPLOSION WITH MULTI-POINT INITIATION OF DISTRIBUTED CHARGES

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(Institute of Mining im. A. A. Skochinskiy)

As investigations have shown [1], to improve the dynamics of the demolition process and to increase the effectiveness of an explosion it is necessary to assure repeated action of the source on the medium due to a change in the internal gas dynamics in the charge hole. This can also be attained by using multi-point initiation of a distributed charge.

Let us examine a charge placed in a hole and bounded on one side by a solid plug. Let us assume that with one-point initiation a detonation wave arises at the coordinate origin at moment t=0 at the wall, and is propagated in a positive direction. Then the pressure at the front of the detonation wave P_H, the velocity of the detonation products behind the wave front U_H, the density at the wave front ρ_H and the speed of sound C_H will be defined by the expressions [2]:

$$P_н = \frac{\rho_0 D^2}{\gamma + 1};$$

$$U_н = \frac{D}{\gamma + 1};$$

$$\rho_н = \frac{\gamma + 1}{\gamma} \rho_0;$$

$$C_н = \frac{\gamma D}{\gamma + 1},$$

where D - detonation rate; γ - specific heat ratio.

The movement of the wave is described by the equations

$$U + C = \frac{x}{t};$$

$$U = \frac{2C - D}{\gamma - 1}.$$

From the condition U=0, let us determine the equation of line $x = (D/2)t$ on which $C = D/2$.

Consequently, graphs of the distribution of velocity U and the speed of sound C behind the front of the detonation wave can be expressed as a function of x/t by straight lines in the interval $Dt/(2) \leq x \leq Dt$, while in the interval $0 \leq x < (Dt)/2$ the velocity of the explosion products (EP) is equal to zero while the speed of sound remains constant.

The distribution of pressure will be defined by a power function. At a certain distance behind the wave front the average pressure will be established:

$$P_{ср} \approx \frac{P_{дет}}{2} = \frac{\rho_0 D^2}{8}.$$

The movement of the front of the detonation wave is described by the equation x=Dt. In this case the functions of the gas velocity and the speed of sound will have the form

$$U = \frac{D}{4}\left[\frac{2x}{Dt} - 1\right];$$

$$C = \frac{D}{4}\left[\frac{2x}{Dt} + 1\right].$$

Since U=0, C=D/2 at the wall, consequently, behind the detonation wave a rarefaction wave will follow at the speed of sound C.

At the instant of complete detonation of the charge $t_1 = \frac{H_з}{D}$ the detonation wave will reach the end of the charge and it will be reflected from the bottom of the hole.

The parameters of the reflected wave are defined by the relationships [2]:

$$\frac{P_{отр}}{P_н} = \frac{5\gamma + 1 + \sqrt{17\gamma^2 + 2\gamma + 1}}{4\gamma};$$

$$\frac{\rho_{отр}}{\rho_н} = \frac{4\gamma^2 + \gamma + 1 + \sqrt{17\gamma^2 + 2\gamma + 1}}{2(2\gamma^2 - \gamma - 1)};$$

$$-\frac{D_{отр}}{D_н} = \frac{\gamma - 3 + \sqrt{17\gamma^2 + 2\gamma + 1}}{4(\gamma + 1)},$$

which, for γ=3, gives

$$P_{отр} = 2{,}4P_н;$$

$$\rho_{отр} = 1{,}25\rho_н;$$

$$D_{отр} = -0{,}77D.$$

Considering that after reflection the wave will move through the gas having a positive velocity, we obtain the rate of movement of the reflected wave relative to the axis of the hole

$$D'_{отр} = D - U.$$

After the interaction of the reflected wave and the rarefaction wave a new wave appears which will propagate to the bottom of the hole according to the law [3]

$$U - C = -\frac{D}{2}$$

and to the mouth of the hole x=0 according to the law

$$U + C = \frac{x + 2H_з}{t}.$$

The parameters of this wave will be defined by the expressions

$$U=-\frac{D}{2}\left[\frac{x+2H_3}{Dt}-\frac{1}{2}\right];$$

$$C=\frac{D}{2}\left[\frac{x+2H_3}{Dt}+\frac{1}{2}\right];$$

$$P=0{,}3P_н\left[\frac{x+2H_3}{Dt}+\frac{1}{2}\right]^3.$$

Consequently, the pressure in the shock wave which is propagated along the EP will be the less, the greater the distance it travels. In addition, the formation of the secondary compression wave will be determined by the time of detonation of the entire charge and by the time of travel of the shock wave along the hole. This time can be greater than the time of the initial compression wave, as a result of which the formation of the secondary wave does not yield the desired results.

In this plan, due to repeated initiation, there can be, first, a significant pressure increase in the shock wave and, second, an optimum pulse repetition frequency of the secondary compression waves.

The movement of the plug in the hole is determined by the magnitude of the impulse transmitted to it by the EP, which is proportional to the weight of the charge. With one-point initiation the impulse transmitted to the plug is determined by the entire charge, while in multiple-point initiation it is determined by the value H_3/n, where n - number of points of initiation. Consequently, the delay of ejection of the explosion gases in the case of multiple-point initiation should be substantially greater, which means an even greater depressurization time of the charge chamber.

Thus, due to the use of multiple-point initiation, the acting time of the EP on the surrounding medium can increase and their optimum multiple action on the mass can be realized.

In 1967 at the quarry of the Uralasbest combine, one experimental-industrial massive blast was set off using multiple-point initiation of the hole charges, and in 1970 at the Kal'makyr quarry of the Almalyk mining-metallurgical combine, three experimental-industrial massive blasts were set off using multiple-point initiation of the hole charges.

Experimental explosions were set off in ledges 10-12 m high in moderately fissured rocks, consisting of secondary quartzites and altered syenite-diorites with a rock hardness ratio according to Prof. M. M. Protod'yakonov's scale of f=7-9. The rational parameters of the blasting works developed by the production workers for the given category of rocks are presented in the table.

Indices	Method of blasting	
	Conventional	Multiple-point initiation
Height of the ledge, m	10	10
Diameter of the charge hole, mm	190	190
Resistance from the floor, m	8.5	8.8
Distance between charge holes, m	6.8	7.1
Number of charge holes	1-2	1-2
Distance between strings of charges, m	6	6
Length, m		
overdrillings	3.0	3.0
tamping	6.5	6.0
Specific consumption, explosive, kg/m^3	0.36	0.35
Weight of the charge in the hole, kg	220	220
Yield of the rock mass, m^3/m	44.5	48.6

Among the number of explosives, Zernogranulit 79/21 and granulite AS were used.

For the experimental explosions, sections of a stope were selected with uniform rocks based on hardness ratio and fissured state; these sections were divided lengthwise into two parts.

The length of each section was 60-80 m. In each of the sections the setting off of the hole charges was done by the usual method, and in the other - using multiple-point initiation. Three tampings, their amounts, and all their blasting conditions were the same.

The initiation of the charges was done with the help of a detonating fuse (with a primer at the end) which is placed approximately in the center of the charge (Fig. 1b). Ammonite cartridges No. 6-ZhV each containing two electric detonators ED-8-56 were used as the primers in the multiple-point initiation.

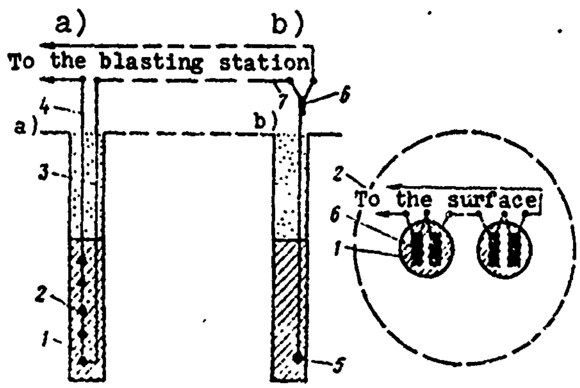

Figure 1. Diagram of the placement of the primers in a charge and their blasting using multiple-point (a) and conventional (b) methods of initiation of the charges: 1 - explosive charge; 2 - primers with electric detonators; 3 - tamping; 4 - electric wire; 5 - primer; 6 - electric detonator; 7 - main wire.

In order to reduce a possible spread in the response time of the electric detonators, they were carefully selected based on resistance, and were placed in twos in each of the primers.

The experimental hole charges were initiated at five equidistant points along the charge. The distance between the points of initiation was 1 m (Fig. 1a).

The electrical circuit for the blasting is wired in series.

The results of the experimental blasts were evaluated according to the degree of fragmentation of the hard rock.

Measurements of the granulometric composition of the blasted rock mass (Fig. 2) attest to the high effectiveness of the blasting method using multiple-point initiation of the charge. The yield of the fraction with a size of more than 300 mm was reduced by 3-4 times, and amounted to 5-6%.

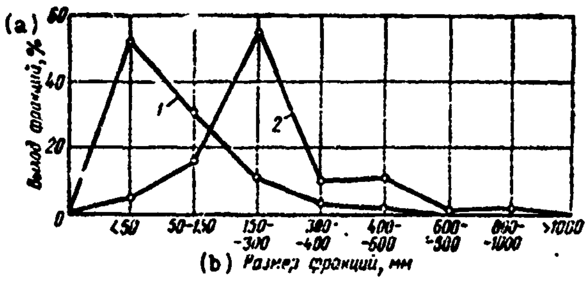

Figure 2. Granulometric composition of the blasted rock mass: 1 - using multiple-point initiation; 2 - using a conventional method of initiation of the charges.
Key: (a) yield of the fraction, %; (b) size of the fractions, mm.

During the first stage of the investigations, for the purpose of establishing a difference in the discharge velocity of the explosion products from the mouth of the bore holes using various methods of initiation, an SKS-1m high-speed camera with a speed of 1,800 frames per second was used.

Such investigations are very complex, and can be regarded as supplementary in the study of the processes of the destruction of hard rocks conducted using multiple-point initiation or the hole charges. However, a comparison of the discharge velocities of the explosion gases from the mouth of the bore hole as a function of the method of initiation is of specific interest.

In order to fix the moment of initiation of the charges using the conventional method of blasting, in the dip of the stope the detonating fuses with nodes at the ends with a length equal to the length of the fuse were placed from the electric detonator to the primer in the bore hole. The moment of initiation of the experimental charges was determined from the flash of the electric detonator.

The examination of the motion pictures indicated that the discharge of the EP from the mouth of the bore holes using multiple-point initiation occurs much later than when using the conventional method of initiation. During the conventional method of blasting, the discharge of the products of the explosion appears approximately 15-20 ms from the moment of initiation.of the charge, while during a multiple-point initiation this time increases by several times. It was found that during the explosion of charges with multiple-point initiation, the hold time of the detonation products in the charge chamber increases significantly, and the initial discharge velocity of the EP from the mouth of the bore hole is reduced (Fig. 3). Further development of the ejection of explosion gases occurs less intensively.

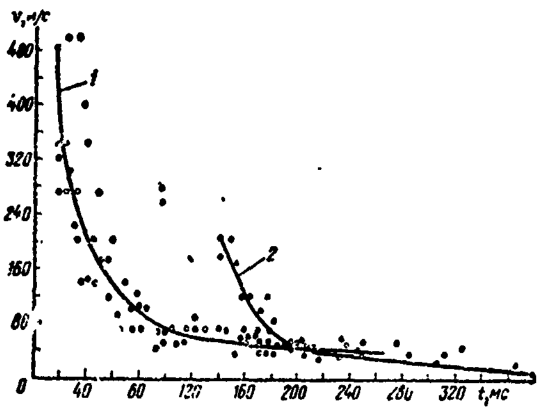

Figure 3. The change in the discharge velocity of the EP from the mouth of the bore hole ν and in time t: 1 - using the conventional method of initiation of the charges; 2 - using multiple-point initiation of the charge.

One can assume that the interaction of detonation and shock waves in the blasting chamber during the explosion of charges using multiple-point initiation is promoted by devising a gas-dynamic breech which delays the ejection of the EP from the mouth of the bore hole into the atmosphere and facilitates the transfer of a large part of the energy of the explosive into the ambient medium. Such development of the action of an explosion in a medium will assist in reducing the loss of energy and will increase its practical use.

Development of the investigations should be directed to the study of the effect of the diameter and length of the charge, properties of the rocks, types of explosives, parameters of the placement of the charge, and its design on the optimum number of points of initiation.

At the same time it is necessary to intensify the search for the development of new explosives which insure reliability and simplicity for setting off blasts using multiple-point initiation.

REFERENCES

1. Мельников Н. В. и др. Эффективные методы управления процессами взрывного дробления и выброса. «Физико-технические проблемы разработки полезных ископаемых». 1971, № 1.
2. Станюкович К. П. Неустановившиеся движения сплошной среды. М.. Гостехиздат, 1955.
3. Баум Ф. А., Санасарян Н. С. Влияние условий инициирования зарядов ВВ на величину и распределение удельных импульсов взрыва вдоль образующей скважины. В сб. «Взрывное дело», № 59/16. М., изд-во «Недра», 1966.