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Calculation of the Optimal Distance Between Parallel-Converged Charges When Exploding High Ledges

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Abstract: *The article shows that application of the parallel-close charges cause distance substantial growth between separate bunches of holes, in concrete mountain-geological conditions. The method of detonation of the parallel-close charges is effective only at certain diameters of holes. Crushing of rocks is carried out mainly by three phases of development of explosion: camouflage, wave and quasistatic. Quasistatic action of explosion is meant as processes which develop in a massif at a stage secondary, after wave expansion of a gas cavity. In article the description of the offered model of a shape of a cavity and a zone of quasistatic action of explosion in the top part of a blasthole charge is given. The received mathematical dependences for determination of volumes and parameters are given in an area of coverage of spherical part of a quasistatic phase of explosion. By the developed technique, with use of the developed computer program, parameters of process and fineness of crushing of rock by a quasistatic phase of explosion, in the top part of a ledge are calculated. Results of demonstration calculation of distribution of energy of destruction and fineness of crushing of rock on conditionally allocated settlement volumes are given.Dependences of optimum distance between holes from their effective diameter, density and speed of a detonation of industrial explosives, durabilities of rocks to crush, relations of acoustics rigidity industrial explosives and blown up rocks are received.*

Keywords: high benches, hole, blasting, parallel-close charges, distance between holes, rock strength, rock.

I. INTRODUCTION

One of the most common methods for solving the problem of blasting high ledges in deep pits is the method of blasting using parallel-converged borehole explosive charges [1].

The parameters of the stress field, which are determined by the shape of the explosive pulse and the distribution of the stress components at different distances from the explosion, have a great influence on the nature of the destruction of the medium when pulse loads are applied to it. A significant change in the total stresses under constant conditions of explosion is observed when groups of parallel-converged charges located in a single line explode[2].

Large-diameter single holes are replaced by a pair of divergent holes of a smaller diameter, in which one hole is always vertical, and the other one is inclined towards the bench; the single holes of the larger diameter are replaced with a pair of divergent bundles of parallel converged holes, in which one bundle is vertical, and the other is inclined towards the bench; the single holes of the larger diameter are replaced with a pair of divergent holes of a smaller diameter, in which one hole is vertical, and the other is inclined towards the bench and positioned in the vertical plane parallel with the first one and distant from it by 1-2 hole diameters [3]. The disadvantage of this method when increasing due to technological reasons, the working height of the scarp is the inevitable necessity of advance increment the value of the resistance line explosion on the sole thump of hands ledge (LSP) and, as a consequence, the diameter of borehole charges to overcome it; thus the value of the diameter of the wells quickly goes beyond the technical capabilities of the existing drilling equipment. The objective of the invention is to intensify and increase the efficiency of drilling and blasting and mining operations by increasing the height abusively and blasted rock ledges, improve the performance of drilling and reducing the specific consumption of explosives, while maintaining the required degree of fragmentation [5].

II. MATERIAL AND METHODS

An effective way to control the parameters of the voltage field is to change the shape of the charge. The use of flat charges makes it possible to intensify the crushing of rocks by increasing the stresses at remote points in the array. The formation of a flat front of the stress wave is associated with the existence of shock waves in the zone near the charge. A perturbation of a large amplitude has a high propagation speed and contributes to the creep of the front in the zone of plastic deformations. A consequence of extensive mining activities is the disturbance of the surface and surface structures. The extent of damage depends on the size and shape of mining excavation, the nature of the rock formations affected by mining operations and the type of support employed. Another important factor is the depth of mining [6]. At relatively shallow depth, the stresses are low. This has two consequences, namely rock fracturing around excavations tends to be restricted to low-strength rock formations. The second effect concerns rock wedges in the roof of excavations which can move relatively freely because of lack of confinement due to the low horizontal stresses. As a result, subsidence is a common problem in many shallow mining situations in low-strength and intensely jointed rock masses. This type of subsidence is known as discontinuous subsidence. As the depth of mining increases the horizontal stresses in the rock mass increase and gravity-driven rock movement is restricted by frictional forces. As a result rock movement above mined out areas becomes more continuous and the pattern of surface subsidence more predictable. Apart from the vertical downward movement of the surface, horizontal strains are observed on the surface. These tend to be compressive in the middle of the mined out area and tensile close to the edges of the mined out area and beyond it [7].

III.RESULTS

When exploding parallel-converged charges, the flat front of the stress wave will be formed only in the case of a strictly defined distance between them. This makes it possible to determine the principles for calculating the effective parameters of parallel-converged wells [2].

Due to the symmetry of the picture in the future, we will consider the area S only in the first quarter of the coordinates (for y>0 and x>0). The area under consideration can be represented as a difference

$$S=S_1 - S_2,$$

where S_1 is the area of the rectangle abcd; S_2 is the area of the shape anmd.

Let's Express S_1 and S_2 in the form

$$S_1 = R^2 ctg\beta;$$

$$S_2 = \int_0^{x_m} \sqrt{R^2\left(x-\frac{a}{2}\right)^2}dx = \frac{1}{2}\left[\left(x_m-\frac{a}{2}\right)\sqrt{R^2-\left(x_m-\frac{a}{2}\right)^2}+R^2\arcsin\frac{x_m-\frac{a}{2}}{R}+R^2\arcsin\frac{a}{2R}+\frac{a}{2}\sqrt{R^2-\frac{a^2}{2}}\right],$$

where x_m is the abscissa of the point m.

Find the minimum of this function relative to the parameter a

$$\frac{\partial S}{\partial a} = \frac{1}{2}\sqrt{R^2-\left(Rctg\beta-\frac{a}{2}\right)^2}-\frac{1}{2}\sqrt{R^2-\frac{a^2}{4}}=0,$$

Solving the resulting equation, we determine that the extremum is reached at the point a=Rctgβ. We prove that at this point the value of S is minimal

$$\frac{d^2S}{da^2} = \frac{1}{4}\frac{Rctg\beta\frac{a}{2}}{\sqrt{R^2-\left(Rctg\beta-\frac{a}{2}\right)^2}}+\frac{a}{8\sqrt{R^2-\frac{a^2}{4}}};$$

With the existing blasting technology, always ctgß<2. It follows that in the applicability of the calculation scheme, the second derivative function that determines the dependence of the area on the parameter a is positive, which proves the existence of a minimum at the found point.

Thus, the criterion for optimal convergence of paired wells is the fulfillment of the condition

$$a = Rctg\beta.$$

in meaning, it should be equal to the size of the plastically deformed zone along the line connecting the centers of charges. According to experimental data

$$R \approx 3R_{пл}.$$

The change in stress depending on the distance in the plastic zone will correspond to the Cole formula [3]:

$$\sigma = \frac{1800}{r^{1,13}},$$

where r is the relative distance from the BB charge, m.

The pressure at the boundary of the charging cavity is determined from the ratio

$$P = \frac{\rho_{BB} D^2}{2(1+J)},$$

BB and breed.

From the resulting

$$P_{пл} = \left[\frac{\rho_{BB} D^2}{2(1+J)\sigma_*} . \right]^{0,88},$$

$$a' = 1{,}5 d_{эф} \left[\frac{\rho_{BB} D^2}{2(1+J)\sigma_*} . \right]^{0,88} ctg\beta,$$

where Def is the effective diameter of wells, mm:

$$d_{эф} = \sqrt{2} \cdot d_3.$$

where d_z is the charge diameter, mm.

Traditional schemes blasting blasting high ledges in open pits based on the proportionality between the energy of borehole charges volume of exploding rocks, in particular high value resistance line explosion on the bench bottom (LSPP) and include mainly the increase in the diameter of the wells [8]. However, the possibility of increasing the diameter of the borehole drilling equipment commercially available at the present time, industry is almost exhausted. The experimental results for the preparation of new types of industrial explosives based on ammonium nitrate by using semi-finished product of trinitrotoluene synthesis and wax-like substances as fuel materials were shown. The basic advantages and disadvantages of the developed mixtures of ammonium nitrate/fuel were found out. The calculation of explosive characteristics of mixtures on the basis of ammonium nitrate was conducted, and some design characteristics of the studied compounds were presented. The experiments on determination of physical and chemical characteristics of the given mixtures were carried out. The method of recycling technical dinitrotoluene by using it for the manufacture of granular mixed explosives based on ammonium nitrate was suggested. An express method for determination of caking in industrial explosives was developed. The results of laboratory tests of these components were provided. The results obtained show that the developed compositions are suitable for practical application in mining industry and do not concede the existing analogues.

IV. DISCUSSIONS

The effect of initiation of the explosive impact in this case is the following. These observations highlight the need to exercise great care in rock mass strength assessment and to compare rock mass strength estimates of the different authors. Where possible, rock mass strength assessment should be evaluated against in situ performance of excavations situated in the particular rock mass [9]. Despite all progress made in rock mass property assessment, this remains still as one of the critical rock engineering issues in the planning stages of deep mines. Under the proposed order of initiation (blasting) a pair of diverging borehole charge transfer process in the array explosion energy is structured in time so that the explosion inclined wells in the array until the end of the process of detonation of the explosive charge in a vertical well result in a dynamic inner plane of the outcrop, which is the local screening of the compensation area, promoting the destruction of the array under the action of the less energy intensive and more effective the effective tensile stresses, and directed offset destructible array in the direction of the local compensation zone, i.e. along the line LSPP. This is also the idea of pre-primary prefracture array energy of the explosive charge inclined wells, and the final stage of destruction produced by the explosive charge from the vertical hole [10-13]. Efficient drilling and blasting in the proposed method, blasting high ledges in open pits explained not only by the geometry of the explosive charge in pairs diverging wells (bundles of closely spaced wells), which also allows to use the effect of the explosion parallel contiguous charges in areas with insufficient energy saturation of destruction, but rather a way of initiating vertical and inclined charges in pairs diverging wells (bundles of closely spaced wells)to implement targeted and less energy-intensive destruction of the array at line LSP, as well as the effect of increasing the productivity of drilling due to various changes in drilling speed and volume of drilling when replacing the ne wells of large diameter diverging a pair of wells of smaller diameter.

V. CONCLUSIONS

Application of the method of blasting beams of borehole charges based on the fact that the charges in the beams of the wells located at a distance of 4-6 diameters from each other and exploded at the same time, act as a single flat charge generating in the array plane wave voltages, which, spreading it, attenuates inversely proportional to the distance, i.e. less intensively than in the cylindrical manoseada equal potentialenergy applied centuries [14]. An issue which is still unresolved is the effect of rock dilation on fracture mechanism in strong brittle rocks. Part of the problem is that the traditional way of testing the effect of confinement on rock behaviour in conventional hydraulic cells constitutes an unrealistic loading situation as it resembles a loading system with zero lateral stiffness unlike the real situation where the rock dilation is resisted by the stiffness of the surrounding rock mass. In many deep mining situations, the rock stresses are such that rock fracturing around excavations cannot be prevented. A key rock engineering issue in deep mining is, therefore, the control of rock failure around excavations. Traditionally, this has been achieved by installing support in the form of timber props, timber packs, steel props, steel arches, bricks, concrete blocks or mass concrete[15-16]. The emphasis of these types of mine support was on controlling and supporting fractured rock and protecting mining personnel and equipment from rock falls.Due to this, the array breed more saturated with the energy of the explosion and is more intense and uniform dispersion at large distances from the charge.

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Thus, the application for blasting high ledges divergent beams of parallel closely spaced wells, the offset is the R relative to each other at the point of drilling in two vertical parallel planes, retains the main advantages of the proposed method in the conditions of high ledges, but at the same time allows to significantly increase the useful life of the explosion energy in large hard rocks, primarily due to fully maximize the effect of parallel contiguous charges in terms of creating a directional planar wavefront stresses in the direction of overcoming elevated values LSP maintain the required quality crushing [17]. The method of blasting rock at surface mines, including drilling down-hole, loading and blasting, characterized in that the breaking of rocks are pairs of diverging beams of parallel closely spaced wells drilled with the working surface of the ledge in the vertical plane, in which one beam wells are drilling perpendicular to the sole, and the second in the side of a slope at an angle to the sole, with vertical and oblique beams of each pair of beams are arranged in parallel vertical planes, remote from each other by a distance equal to 1-2 borehole diameter, equivalent to the energy used centuries pair of divergent wells.

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