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EXPERIMENTAL STUDY OF THE DISCHARGE EXPLOSION PROCESS USING FLAT CHARGES DURING DEVELOPMENT UPLAND QUARRIES

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Annotation
The paper considers the issues of finding such a design of a flat charge, in which the maximum propellant effect of an explosion is achieved with a constant consumption of explosives. Two variants of the charge design were tested and compared - solid (according to traditional technology) and stepped.

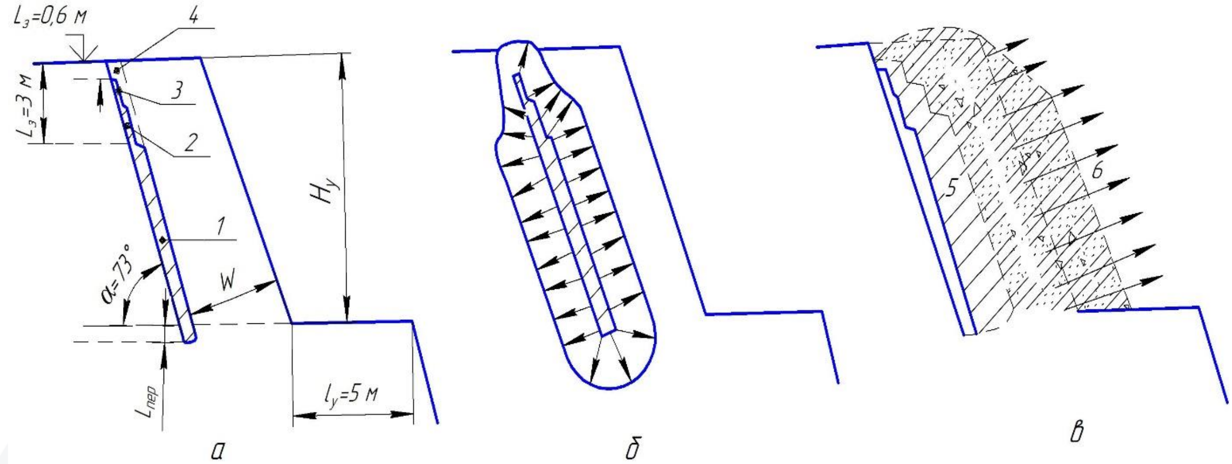
Keywords: wells, directional explosion, explosive quality, charge design, measurements, propellant effect of explosion, single-row blasting, parameters of bulk, remaining rock.

The aim of the experiment is to find such a design of a flat charge, in which the maximum propellant effect of the explosion is achieved ($V_{ocm} \to \min$) at a constant flow rate of explosives.

Wells with a diameter of 105 mm were drilled by machines GL-150. First of all, the technical requirements for a directional explosion were met: D = 16 m and S =3 m. As an explosive substance (BB), 6ZHV ammonite was adopted. The specific consumption of explosives was 0.5 kg / m^3. At the same time, its value exceeded the specific explosive consumption during blasting operations using conventional technology (on average, 0.34 kg / m^3). The angle of inclination of the wells was assumed to be 73°, which corresponds to the angle of stability of the slope of the ledge. The height of the ledge was 10 m, the width of the berm on the ledge was 5 m, W = 4 m.

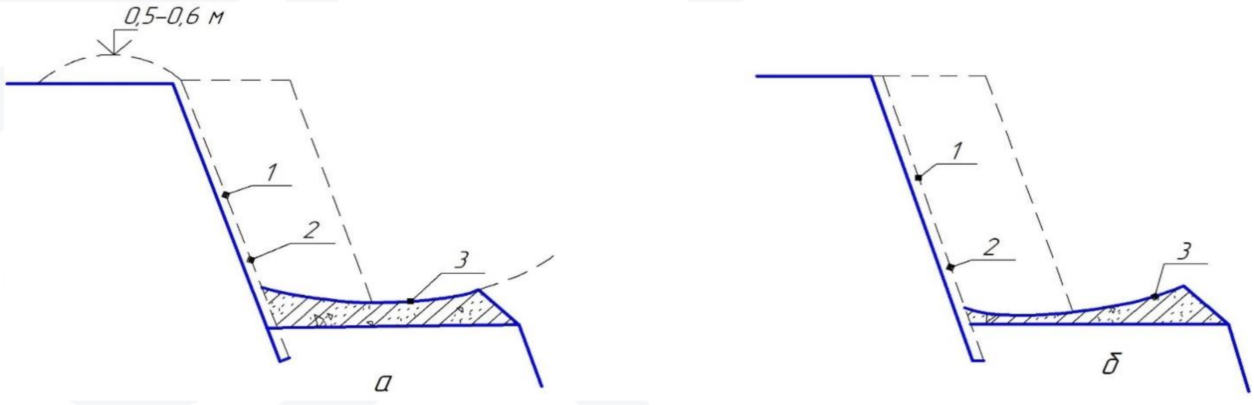
Two variants of the charge design were tested and compared - solid (according to traditional technology) and stepped. In the first case, concentrated charges with a length of 8 m were used with a face length of $L_з$ = 3 m provided $L_з$ = (0,7-1,0) W. In the second version, the charge consisted of three stages: the lower concentrated charge with a length of 8 m, the middle one with a garland of connected cartridges with a total diameter of 52 mm and a length of 1.5 m, and the upper one with single cartridges with a diameter of 30 mm and a length of 0.9 m (Fig. 1); the face here was 0.6 m, based on the condition $L_з$ = (20-24) $d_з$, where $d_з$ – diameter of the charge.

In total, 120 wells were blown up in the experiment, including 22 wells with a solid charge structure and 98 wells with a step structure. In all cases, the separation of the blasted rock from the massif was clear along the line of wells in a row, which made it possible to use the slope of the ledge as a measuring surface for measuring the height of the remaining bulk rock on the working site.



Rice. 1. Step charge design in the well (a), the force field of the charge (b) and the gas cavity of the explosive product (c) 1 - main charge; 2,3 - additional charges; 4 - face-off, 5 - gas cavity of explosive products; 6 - direction of departure

Measurements were made every 1 meter along the length of the front. It turned out that the height and shape of the bulk practically do not differ in cross-sections, this made it possible to operate with a single bulk profile characteristic of the studied charge design (Fig. 2).



Rice. 2. The shape of the bulk of the blasted rock mass remaining on the working platform of the ledge with a solid (but) and stepwise (b) charge

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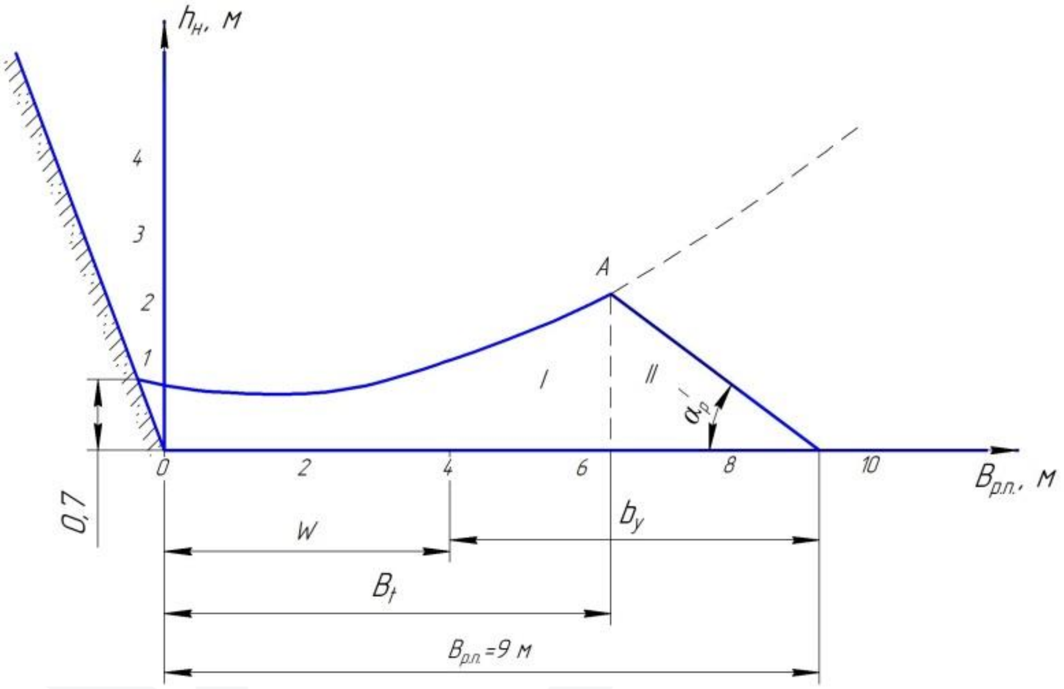
1 - breed in the rear; 2 - well; 3-rock left over from the explosion

The throwing effect of an explosion on a discard was also compared when exploding one (W = 4 m) and two (b = 4 m) rows of wells. The results of experimental explosions showed that when using charges of a stepped structure, the volume of rock mass remaining on the working site is V_{ost} it is reduced by 1.5-1.8 times in comparison with solid charges, determined by the number of rows of wells in the approach.

For single-row blasting, the volume of V_{ost} does not exceed 18 %, with two rows 36% the volume of rock in the entry (in the array).

The bulk parameters of the remaining rock can be calculated analytically. So, the height of the bulk h_n in the width function of the work platform $In_{R.\ P.}$ when using step charges, it is expressed as follows (Fig. 3):

$$h_H = 0{,}0475\ B_{p.n}^2 - 0{,}105\, B_{p.n} + 0{,}77\ m \quad (1)$$



Rice. 3. Dependence of the bulk height of the remaining rock h_n from the width of the working platform $In_{R.\ P.}$.

The maximum bulk height will be at *But*, from where the rock begins to fall under the slope of the lower ledge. Accordingly, the cross-sectional area of the bulk consists of 2 parts: I and II (fig. 3). Part II it is limited to the outer surface of the bulk at a natural slope angle a_p^1. Part I is of length

$$B_t = \sqrt{17B_{p.n} + 38{,}73} - 7{,}11\ m, \quad (2)$$

As a result, the volume of bulk remaining on the work site after the explosion of flat charges is described by the equation

$$V_{ost\ n/z} = 0{,}00131\ B_t^4 + 0{,}0096\ B_t^3 - 0{,}00056\ B_t^2 + 0{,}67\ B_t + 0{,}366\ \ m^3/m$$

(3)

As a result of reducing the height of the bulk, favorable and safe conditions are created for bulldozers to work on the basement of the blasted rock mass under the slope.

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