

Study of the impact of preliminary contour blasting on changing the zone of intensive rock crushing and reducing the level of watering of the massif in quarry

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Abstract. This article discusses the optimal parameters of contour blasting, which influences the creation of intensive crushing zones with increased filtration characteristics.

Key words: contour blasting, increased filtration zone, intensive crushing zone, contour massif, drilling scheme for a contour row of wells.

It is traditionally believed that contour blasting in quarries is used mainly to increase the stability of the slope of benches and sides of rock quarries when they reach the design contour. There are generalized recommendations both on the choice of design and linear density of the charge in contour wells, and on taking into account the geological and structural conditions of the deposits. The existing production experience of using contour blasting to reduce the water cut of blocks is currently not supported by scientific recommendations on the selection of contour charge parameters. Along with almost complete drying of the block after preliminary contour blasting, there are cases of a very slight decrease in the water cut coefficient.

Previously completed and published work on reducing water inflows during preliminary blasting of some wells with a bottom charge was devoted mainly to testing the idea of creating zones of increased filtration and sharing experience.

For the effective use of this method in production, a theoretically substantiated choice of preliminary contour blasting parameters is necessary based on a study of the technical and economic indicators of drilling and blasting operations and the enlarged features of its feasibility. The mechanism for reducing the water cut of a block planned for development using the proposed design of a charge in contour wells is shown in Fig. 1.

The upper part of the charge is a garland of intermediate detonators distributed with a linear density of 1-2 kg/m³ depending on the convergence of the boreholes and the strength of the blasted rocks in accordance with existing recommendations in scientific and regulatory literature, as well as the experience available in quarries. The task of this part of the charge is to create a relatively flat surface of the slope of the end part of the bench next to the mining front.

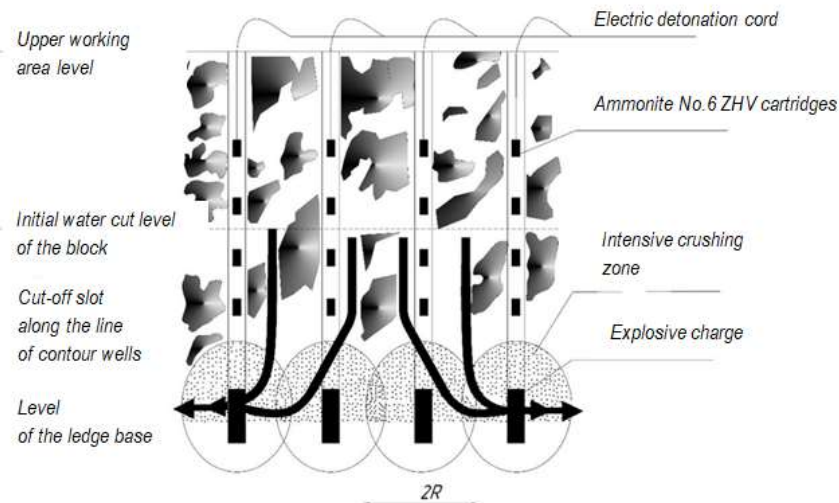


Fig. 1. Mechanism for reducing water cut after preliminary contour blasting with a bottom charge

The purpose of the lower parts of the charge is to create a system of intersecting zones of intensive crushing with increased filtration characteristics due to loosening of the crushed rock when freeing up the space previously occupied by the bottom charge of explosives.

The intersection of adjacent zones of intensive crushing can be ensured both by increasing the mass of the bottom charge in the boreholes and by bringing them closer together. Thus, the parameters of preliminary contour blasting to reduce the water cut of a block are understood to be the distance between the wells of the contour row (a_k, m), the height of the charge column (h_{zar}, m), which depend on the diameter of the wells and the strength of the blasted rock. The possibility of using one or another factor for this purpose is determined by the pattern of change in the radius of the intensive crushing zone depending on the diameter of the wells and the mass of the bottom charge in the contour well.

The solution to the problem is performed by theoretically substantiating the pattern of change in the radius of the intensive crushing zone depending on the height of the bottom charge column, the diameter of the boreholes and the strength of the rock, followed by determining some constant coefficients. The theoretical assessment of these parameters is closely related to modern concepts of the effect of an explosion on rock and its condition in the vicinity of the charge after the explosion. Based on the analysis of the studies, the following conclusions were made: the intensive crushing zone of an elongated cylindrical charge has an ellipsoid shape; the radius of the intensive crushing zone (the horizontal axis of the ellipsoid) is proportional to the radius of the charge; the volume of the intensive crushing zone is proportional to the mass of the charge; the radius of the intensive crushing zone exponentially depends on the strength of the rocks with a negative exponent.

In other words, if the distance between the contour boreholes is more than $(10 \div 12)d_{\text{boreholes}}$, then a significant reduction in the water cut of the block cannot be achieved with any mass of the bottom charge. Preliminary contour blasting of watered blocks with placement of a bottom charge in contour wells allows to reduce the level of water cut of the massif, which entails an increase in the productivity of drilling rigs along the length of drilled wells, an increase in the durability of drill bits and a decrease in the consumption of relatively expensive water-resistant types of explosives.

When contouring a double bench and its suppression on the side of the quarry, it is necessary to meet a number of technical requirements:

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- achieve the design position of the contours of the location of the lines of the upper and lower edges of the double bench, and the amplitude of the over- or under-collection of rock from the design lines of these contours should not exceed 1.0 m;
- minimize the depth of disturbance in the contour massif;
- perform a thorough cleaning of the surface of the bench slope with an excavator bucket from chips and the surface layer, prone to the accumulation of rockfall on the safety berm in the future when pieces of rock fall from the surface of the bench slope. The collapse of the disturbed layer provokes the shaking effect of seismic waves on the near-surface thickness of the massif during mass explosions in the quarry, as well as the action of natural forces.

To optimize the parameters of contour blasting to increase the efficiency of the preliminary slit formation technology on the marginal contour, the following is proposed. In the pre-created block along the design contour of the bench to be extinguished, a cut-off slit is made to the depth of the double bench, followed by the development of the near-contour blocks, first on the upper bench, and then on the lower one. To do this, along the line of the future double bench to be extinguished, a contour row of inclined technological wells (60° to the horizontal) is drilled every 2.5-3.0 m, 32-34 m long. The stemming is shortened to 2-3 m long. The total weight of explosives in the borehole charge is brought to 100 kg. In the marginal block of the upper bench, consisting, for example, of 3-4 longitudinal rows of breakout holes and a number of contour close-in holes drilled on two benches, when a short-delay explosion of borehole explosive charges develops, they are detonated in the contour close-in holes in sections instantly, 3-4 holes in each section and with a time lead of 50 ms in relation to the explosion of the sections of explosive charges in the breakout holes of the marginal block of the bench

After the marginal block on the upper bench has been developed and the surface of its slope has been thoroughly cleaned, the marginal block of the lower bench is drilled only with rows of breakout holes, taking into account the fact that the contour cut-off gap on the lower bench will already have been created by the previously conducted explosion of the block on the upper bench. The final design of the slope of the double bench is carried out after the block on the lower bench has been developed. In order to maintain the achieved quality of contouring the slope of a double bench, but with a reduced volume of drilling operations, as well as to simplify the design of the explosive charge in the contour well to reduce the labor intensity of its loading, the following two options are proposed.

In a row of contour wells, not all closely spaced wells are drilled to a depth of up to 34 m, but only with alternation: one deep 34 m and two shortened wells with a length equal to $1/3$ of the technological bench height (the first option).

The second option differs from the first in that in the same row one of the shortened wells is drilled with an underdrilling of 1.5-2.0 m to the bottom of the upper extinguished bench. At the same time, in both options, in the bottom of the contour wells, not garland charges of explosives are used, but column charges formed mechanized for the entire cross-section of the well with the corresponding mass flows.

A more advanced scheme of drilling a contour row of wells with a new alternation of wells of variable length, multiples of the lengths of the extension rods in the drilling string during well drilling, i.e. with successively alternating lengths of shortened wells multiples of 7, 14 and 21, is also proposed. In addition, when drilling a marginal block on the lower bench with wells in a contour row of vertical breakout wells, it is proposed to additionally drill one inclined breakout well between them with a reverse angle of inclination at an angle to the horizontal of 75° and with an underdrill of 1.0 m to the

lower edge of the future double bench. The mass of explosive charges in these additional breakout wells is taken to be 25-30% less than the mass of explosive charges in the vertical breakout wells of the marginal block of the lower bench.

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