Materials of Conferences

THE ANALYSIS AND APPLICATION OF RESULTS OF CALCULATION OF THE STRAINS APPEARING AT DESTRUCTION OF THE GRANITE

Tsygankov D.A.

N. A. Chinakal Institute of Mining, Siberian Branch, Russian Academy of Sciences, Novosibirsk, e-mail: dmtsygankov@fastmail.fm

This report provides results of solving a problem, linked to defining special features of forming a tense condition of rock when fluid tear crack emerges in it. The process of destroying granite with implementation of plastic substance, forced out along the axis of drilled barehole into the formed crack has been studied theoretically. The process of destruction has been carried out via bar that forced out plastic substance into the formed crack as a result of its introduction into barehole. During the process, the bar is fixed to a manual crashing took via special spring lock.

Systems of differential equations of the second order that are included into specialized package of computer procession and further analysis of the received data *Comsol Multiphysics 3.5a* have been used to carry out calculations. The ultimate goal of the calculations was definition of horizontal stretching tensions that emerge near peak of a crack, formed along barehole axis, and also around its diametrical section. Further conclusions have been made in accordance with comparing differences of their values.

The following initial data has been used has been used for calculation at the example of granite: destruction pressure, needed in barehole – no less than 40 MPa; barehole radius – 25 mm; length of the formed crack – 0,2 m; utmost stretching tensions – σ_p = 40 MPa; utmost compressing tensions – σ_c = 200 MPa; coefficient of crushing tool bar friction against barehole walls – 1; coefficient of filling crack with plastic substance – 0,6; Yung's modulus – $2{,}8 \cdot 10^{10}$ Pa; Poisson's ratio – 0.33; density – 2670 kg/m^3; coefficient of temperature expansion – $1{,}2 \cdot 10^{-5}$.

The performed work concludes:

1. Actual tensions that emerge in granite during its destruction, are minimal in their module in the area of barehole sector and peak of a crack, formed from it with facilitation of fluid tear.

2. Maximum tensions that emerge in granite, destroyed with fluid tear, are located at the distance of 2–2,5 diameters of barehole that forms a crack.

The following values of the searched indexes of tension and conclusions are typical for granite, destroyed with fluid tear method under the given border conditions:

1. Facilitation of a bar, introduced into the barehole with crashing tool, is linked to an emergence of friction that causes formation of high (≈ 65 MPa) tensions in the area of its contact with barehole walls and the destructed granite. Destruction of granite does no take place or carries chaotic nature in this area.

2. Facilitation of plastic substance that is introduced into the barehole with its further forcing out into the formed crack, decreases friction and thus causes emergence of low (≈ 40 MPa) tensions in the area of its contact with barehole walls and the destructed granite. In this case it is reasonable to use tension concentrators that create conditions for destroying granite in the required direction. Destruction of rock under relatively low (in comparison to 65 MPa), but initially significant tensions will provide for the formation of straight cracks, set towards the required direction.

3. Partial filling of the formed crack with plastic substance that is forced out of it (≈ 60 %) provides for emergence of lower tensions on its area near barehole section(≈ 40 MPa) than on its peak (≈ 55 MPa).

4. The degree of actual deviation of the formed crack from the set direction is defined by the difference between tensions that emerge in crack peak and near barehole section. The greater this difference it, the greater is actual deviation of crack, formed with facilitation of plastic substance, from the set direction.

Scientific conclusion of the work is represented by the following thesises:

1. It has been proved that the amount of actual deviation of crack, formed by the method of fluid tear, from the set direction is in dependence on degree of difference between tensions that emerge in its peak and diametrical section of barehole, from which plastic substance is forced out.

2. It has been established that decrease in degree of this difference will allow one to decrease deviation of the formed crack from the set direction.

Practical significance of this work is presented by the fact that decrease in degree of difference between these values are achieved with decrease in fluidity and consumption of plastic substance, forced out of barehole into the formed crack while carrying out mining operations of breaking down monoliths of natural rock in quarries.

This measure provides for decrease in curvature of the broken monoliths and simultaneous decrease in output of solid waste of main production

during its breaking and further cutting into blocks on plants of natural rock procession.

The research result shows that maximum deviation of crack, formed in solid rock (granite, marble, and marbleized limestone) with usage of plastic substances, equals ±14 mm per each 200 mm of its length (7%). According to our calculations, in case of breaking off monolith of length of 5 m in its rear vertical side, maximum deviation of the formed crack from the set direction will equal 0,35 m. If height of such monolith equals 1,5 m, maximum output of main production solid waste will equal 1,31 m^3 during its breaking in rear side. If width of monolith equals 1 m, volume of the broken out rock, considering maximum possible waste output will equal 8,81 m^3. Thus, maximum output of solid waste during breaking out monolith of 7,5 m^3 in volume will equal 14,87%.

The results of this study can be introduced into mining industry by suggesting the «Methodics of calculating output of main production solid waste output during breaking out monoliths of natural stone with usage of plastic substances».

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