The trigger effect of a periodic force impact on rocks

Voznesenskii A.S., Krasilov M.N., Kutkin Y.O., Tavostin M.N., Tyutcheva A.O., Nasibullin R.R., Luchnikova A.O.

National University of Science and Technology "MISIS", Mining Institute, Moscow, Russia

e-mail: al48@mail.ru

Trigger effects in rocks, consisting in their destruction or breakdown of contacts between individual blocks, are considered, as a rule, because of weak effects in relation to the increase in load with constant strength. Fracture is also possible due to the gradual decrease in strength at constant load. This report discusses the results of experiments on the cyclic mechanical effects of various types on rock samples, leading to a fatigue decrease in their strength. The subject of study was the dependence of strength on the number of loading cycles, as well as their relationship with the acoustic properties of rocks of various types. Among them the velocities of longitudinal and transverse elastic waves, as well as acoustic quality factor were considered. It should be noted that in these experiments, cyclic loads were used as a means of increasing the disturbance of geomaterial and reducing strength, which allows reducing the time of destruction processes, which in real conditions occur over years and decades of years.

Periodic quasistatic (slow) effects on compression – stretching machines, as well as dynamic effects on an installation with split Hopkinson rods were investigated. Loading/unloading in experiments with a slow impact was carried out within the limits, the lower of which was set at a level of 3-5% of the strength. The upper limit was set at various levels ranging from 40 to 90% of the strength. The duration of the phases of loading and unloading ranged from a few to several tens of seconds. The load change rates were kept constant.

In case of slow loads, the experiments were carried out under compression, stretching according to the Brazilian scheme, as well as during bending of the beam samples. In the first two cases, the dependences of changes in both the strength of the samples and acoustic properties on the number of fatigue loading cycles were obtained for various types of rocks. It is shown that for such types of stress state of rocks a manifestation of low-cycle fatigue is characteristic. Their destruction occurred in the range from several units to the first hundreds of cyclic loads in wide limits of the maximum load.

Bending specimens of beams showed significant distinguishing features. In a wide range of maximum load, multi-cycle fatigue manifested itself, at which the destruction did not occur even with several thousand loading cycles. Instantaneous brittle failure occurred at maximum loads close to strength. The range of maximum loads at which low-cycle fatigue was observed was very narrow, and for different samples, the boundaries of this range did not overlap with each other. The transition from the high-cycle fatigue mode to the brittle fracture mode was very narrow and unpredictable. Registration of the acoustic emission signal was used to set the low-cycle fatigue mode.

Changes in acoustic properties were also analyzed depending on the number of fatigue loading cycles in addition to strength. The results can be used for non-destructive testing and prediction of the destruction of the rock mass around the mine workings.

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