THE ESTIMATION OF THE ENERGY OF MOVEMENT IN STICK-SLIP EXPERIMENTS

Kaznacheev P.A., Maibuk Z.Y., Ponomarev A.V., Sobolev G.A., Kokh V.V., Krayushkin D.V.

Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, Moscow, Russia

e-mail: p_a_k@mail.ru

The work is devoted to the study of energy release during process of intermittent sliding of rock blocks along fault model (stick-slip experiment).

The experimental setup was a lever press. Forces were applied separately through two punches to two blocks of rock (light marble) pressed against each other in direction perpendicular to the contact. The blocks are inclined parallelepipeds with inclination of about 70 degrees. Pressing of blocks is carried out due to external compression by tightening device.

Sliding modes with two different loading rigidities differing by about 10 times have been studied. In one mode (with less rigidity - "soft"loading), a spring dynamometer was installed between one punch and one block, in another mode (with more rigidity – "hard"loading), the dynamometer was not installed.

Following parameters were recorded: displacement of blocks relative to each other with high time and amplitude resolution (using a laser rangefinder), displacement with lower time but higher amplitude resolution (using a LVDT displacement sensor), acoustic emission (using the ALine-32D registration system) and force (using an ATM strain gauge station).

Several loads were carried out on full possible course of displacement of blocks relative to each other. During each loading, several (up to twenty) episodes of strong rapid movements were recorded. After experiments, the measured data were processed and analyzed in more detail.

Average value of observed movements was about 250 um. The use of the high–speed laser rangefinder makes it possible to estimate not only absolute magnitude of movement, but also dynamic parameters in process of movement, in particular, speed and acceleration. Average value of velocity amplitude was about 0.15 m/s. According to these data, it is possible to estimate mechanical energy of movement, assuming that it passes into kinetic energy of motion during acceleration of block and into the work of friction force on its braking. In this case, the estimation of kinetic energy and the work of friction forces can be done independently of each other. The average value of both the kinetic energy of the block and the work of the friction force was about 0.7 J.

Separately, a dependence of maximum speed amplitude of the block measured during movement and the square root of the energy estimated through the work of friction forces was constructed. The dependence shows a character close to linear, with energy varying in the range from 0.6 to 1 J and velocity in the range from 0.1 to 0.2 m/s.

Main parameter of dynamic estimation is a mass of the block, which can be estimated in two independent ways. The first is through energy under assumption that all kinetic energy goes into the work of friction forces. The second is through known volume of the block and rock density. Estimates gives similar values, differing by no more than 20%.

The work was carried out under the state task for the Schmidt Institute of Physics of the Earth of the RAS.