The relationship of the characteristics of the spectra of ultrasonic sensing signals with the loading conditions of a rock sample

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According to the data of three-axial tests of rock samples carried out on the controlled INOVA press of the GO Borok IFZ RAS, the analysis of waveforms of ultrasonic sounding (ultrasonic) signals was carried out. Samples of highly porous sandstone were loaded with a constant deformation rate under conditions of all-round pressure. At the level of 85-90 % of the ultimate strength of the material, water was injected into the upper end of the sample. Further tests were carried out under the conditions of the modulating effect of pore pressure.

During the test, waveforms of acoustic emission signals were recorded. Ultrasonic probing of the sample was carried out at specified time intervals in 16 straight and inclined directions.

The waveforms of ultrasonic signals were subjected to spectral analysis. When calculating the Fourier spectrum of the signal, the amplitude-frequency response of the receiving and transmitting path, including the characteristics of the sensors themselves, was taken into account. To estimate the magnitude of the frequency-dependent attenuation of the elastic wave spectrum, a power function approximation was used. As an indicator of attenuation, the degree of slope of the spectrum of the ultrasonic signal was used, taking into account the frequency response of the receiving path.

A significant influence of the supplied fluid on the characteristics of the ultrasonic signal spectrum is noted. It is shown that the frequency-dependent attenuation of the ultrasonic wave is associated with both the level of destruction of the sample and the pressure of the pore fluid. When comparing the dynamics of elastic wave propagation velocities in a dry sample with variations in the frequency-dependent attenuation index, the similarity of their changes in the presence of several characteristic points (moments of change in the direction of growth of these indicators) was noted. In the saturated sample stage, the changes in the propagation velocities of elastic waves over time basically repeat the dynamics of the axial load and weakly depend on the pore pressure. At the same time , the attenuation degree indicator significantly correlates with the pore pressure value and can serve as its indicator.

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