Investigations of the acoustic properties of rock mass and concrete lining in natural conditions

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A study was focused onto the experimental research of the propagation of acoustic signal (AS) in rock masses and concrete stratum with specified structural and mechanical characteristics. The measured parameters were the AC velocity detected by the first contact with a piezo-transducer and the spectrum in a broad frequency range. The measured value of the acoustic wave velocity for the rock mass and concrete well coincided with those calculated by elastic theory formula (with taking into account the stratum geometry in the latter case).

In addition, the photoelastic method was applied for measuring the acoustic wave stress, which allowed us to evaluate the mechanical energy of the wave. The energy balance in the process "AS source" – "transmitting media" – "AS receiver" was analyzed using a spectral analysis device. In laboratory investigations, the elastic collision of a steel ball (as AS source) with the sample surface served as wave radiation source. To exclude non-elastic processes at the instant of collision, a metal laying was applied. The spectral composition of the wave energy was also determined.

The obtained results could be used in the development of methods of the determination of AS source parameters (including its energy and location) as well as the structure of the transmitting media. Thereby, the information capacity of the acoustic emission method would be significantly increased.

Towards a correct interpretation of the results of the detecting of elastic waves signals from the rock massive in the system A-Line DDM, the study of the acoustic properties of the rock mass and concrete lining was needed. For this purpose, a film-type piezo-transducer with a linear amplitude-frequency response in the range of 20 kHz was designed, fabricated, and calibrated for measuring the elastic wave stress. The measurements of elastic waves were carried out by detecting a response of concrete lining and rock mass on the impact action. Impact was performed by a steel ball of 4.68 kg in mass through a steel plate attached to a concrete wall as well as over a laying imbedded in the concrete wall. The performed measurements of the elastic wave velocity in concrete stratum, triggered by the ball impact, were found to be of 3920 m/s. The wave velocity value in concrete estimated from the calculation of the elastic modulus for a plane wave appeared to be of 4343 m/s. The controlled rock massif was aggregated by biotite gneisses. The measurements of elastic waves velocity in the rock massive showed the value of 5318 m/s. The spectral composition of the rock mass response on the ball impact was measured, and the elastic wave energy was estimated (0.3 J). The spectral density of the impact-induced massif excitation was concentrated in the range of 0.7 – 3.2 kHz.