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Role of mechanoelectrical transformations in NDT of concrete

Concrete is the main construction material, which is used in all construction areas. The quality of concrete structures depends on its structural composition and is determined by the porosity of the cement stone, the quality of the contact between the cement matrix and the coarse aggregate, the size and composition of the coarse aggregate. Various technological factors in concrete manufacture may lead to deviations of the structural composition of a concrete mix from the design values. Therefore, it is necessary to monitor the structural characteristics of concrete. This may solve the problem of safe operation of concrete structures.

The methods of nondestructive testing of concrete currently used do not account for the effect of structural characteristics when measuring its strength. Moreover, currently, there is no method for nondestructive testing of concrete to determine the structural characteristics of the finished product. Most of the studies abroad are devoted to the development of ultrasonic methods for nondestructive testing of the concrete porosity [1–4]. However, all these methods are still under development and have low accuracy.

To solve the problem of nondestructive testing of the structural characteristics of concrete, we propose to use the phenomenon of mechanoelectrical transformations under elastic impact excitation of heterogeneous non-metallic materials [5, 6]. The principle of the phenomenon of mechanoelectrical transformations implies that under elastic impact excitation, acoustic waves are formed in the sample. The acoustic waves affect the sources of mechanoelectrical transformations and, as a result, alternating electric field arises. The electric field arises due to the charges arising at the boundaries of piezoelectric quartz (contained in river sand and gravel) under its deformation and due to the shift of these charges and the charges of the electrical double layers (at the boundaries of the components in a heterogeneous material). The electric receiver is located near the sample surface and records the change in the total electric field in the region of its location. Therefore, the parameters of the electric response should reliably trace the processes of transformation of the characteristics of the acoustic waves when they interact with structural inhomogeneities of a heterogeneous material.

The effect of the composition of the coarse aggregate, the size of the coarse aggregate and the quality of the contact between the cement matrix and the coarse aggregate in concrete on the parameters of the electric response under elastic impact excitation were investigated. As a result, the investigations identified the basic patterns of the effect of the concrete structural characteristics on the parameters of the electric response under impact excitation. More detailed results of the investigations are described in [7, 8].

The conducted investigations shows, that the phenomenon of mechanoelectrical transformations can be used to develop the method to perfome input testing of the concrete structural characteristics. This method will enable to grade the products by their quality and increase the reliability of constructed structures. This will give an opportunity to increase the service life of concrete structures and avoid negative consequences (including human victims) as a result of their unforeseen destruction.

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