THE METHOD OF DETERMINING THE RELATIVE DEFORMATION OF CONCRETE WITH THE ADDITION OF POLYACRYLATES

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Annotation. The article presents the data substantiation of rational methods for determining the relative deformation of concrete with additives.

Keywords*:* cement concrete, increasing the deformability of polyacrylates, test method, short-term load, the coefficient of transverse deformation, changes in the relative deformation of concrete.

1. Introduction: In modern practice, the use of polyacrylate additives is relevant for modifying the structure of cement stone. They can be introduced into dry mixtures in the form of an aqueous dispersion. After laying the concrete mixture, due to partial evaporation of water and active hydration processes, the concentration of polymer dispersion increases, and polymer films are formed on its basis, including on the concrete surface. As a result, water evaporation is blocked and thereby conditions are created for the most complete hydration of cement, reducing shrinkage.

The spatial system of polymer films (membranes), which is formed inside the cement stone, increases its tensile strength and serves as a micro-damping element that increases wear resistance and facilitates relaxation processes in the hardening system.

The effect of polyacrylate additives (K-9) on the relative deformations of concrete depending on the cement consumption, type and dosage of the additive has been studied. The deformability of concrete was studied by axial compression of samples-prisms 10x10x40 cm, hardened at a temperature of 20 + 20 C and a relative humidity of 75-80%, with the determination of deformations at each stage of loading by an electronic meter.

The effect on concrete deformations of step loading with short-term stops (15-20 cm); with an exposure time at each stage of the stress state from 2 to 12 minutes; with multiple loads at each stage was also studied. It is established that the type of loading does not significantly affect the magnitude of deformations.

2. Technology: Load cells with a base of 50 mm were glued to the prepared surface of concrete prisms with 192-T glue, which were connected to an electronic meter. Compression deformations were determined by longitudinal and transverse sensors glued in the middle part of each side face, and tensile deformations during bending were determined by two sensors located on the side of the stretched and compressed zones.

During compression tests, the prism samples were centered using longitudinal load cells under a load of 2 tons. After centering, the prisms were loaded sequentially in stages until destruction. The actual value of the loading stages created a stress in the concrete equal to 0.1 Rp. At each stage, excerpts were given that were necessary to take readings from the instruments. During the tensile test at the moment of bending, the loading of the beams was carried out by two concentrated forces located in the thirds of the span.

At the same time, to study the process of micro-destruction in concrete, recording heads of the UKB-1 ultrasonic device were installed on the side faces of the prism.

The adopted short-term load test method allowed us to determine the longitudinal and transverse relative deformations, to identify the change in the differential coefficient of transverse deformation Δγ, to establish the boundaries of the beginning of micro-destruction R_T ^° and microcracking R_T ^γ by the moment of the fall in the velocity of propagation of ultrasonic pulses.

The process of studying the internal stress state of samples under load was carried out according to the O.Ya.Berg method described in [2-13]. In accordance with the methodology for assessing the physical nature of the phenomena causing stress, it is necessary to calculate the coefficient of transverse deformation not by the values of the deformations themselves, but by increments of Δε. The curve Δγ will characterize the actual change in transverse deformation and the corresponding change in volume. The value Δγ is called the differential coefficient of transverse deformation and is characterized by the dependence:

$$\Delta\gamma = \frac{\Delta\varepsilon_1}{\Delta\varepsilon_2}, \qquad (1)$$

where Δε_1 and Δε_2, respectively, are increments of relative longitudinal and transverse deformations at each stage of load increment ΔP. The increment of the sample volume ΔQ corresponding to this physical process follows from the condition:

ΔQ= Δε_1-2Δε_2 (2)

The process of formation and development of microcracks according to O.Ya.Berg's research indicates that the material goes through three stages: compaction, decompression and destruction [4-8]. At the same time, the compaction stage is characterized by almost complete constancy of the elastic modulus of concrete E and Δγ. An increase in the load causes an increase in transverse deformations and Δγ deviates from the initial value. This moment is considered as the beginning of micro-destruction. After reaching the lower limit of the micro-destruction R_(T)^°, the differential coefficient Δγ begins to increase more intensively. [10-13]. At Δγ=0.5, the largest reduction in the sample volume occurs, which characterizes the upper conditional boundary of microcrack formation. The transition from decompression (loosening) of the structure to micro-fractures and microcracks occurs in the interval R_(T)^° and R_T^γ .

Discussion of the results: Figures 1 and 2 show changes in the relative deformations of different concrete compositions under the action of short-term loads. As can be seen from the above data, the maximum relative deformations of concrete with the addition of polyacrylate in the stretched zone are greater by 13-18 and 22-28%, and the tensile strength during bending is 11-22 and 20-31% than that of concrete without additives. Deformations in the compressed zone of concrete with additives are 3-10 and 15-22% higher, respectively, compared to conventional concrete.

The increased deformability of concrete with the addition of polyacrylates is explained by its damping property due to thickened adsorption layers, which are adhesive layers between the crystallohydrates of cement stone.

Transverse (left) and longitudinal relative deformations of concrete under compression

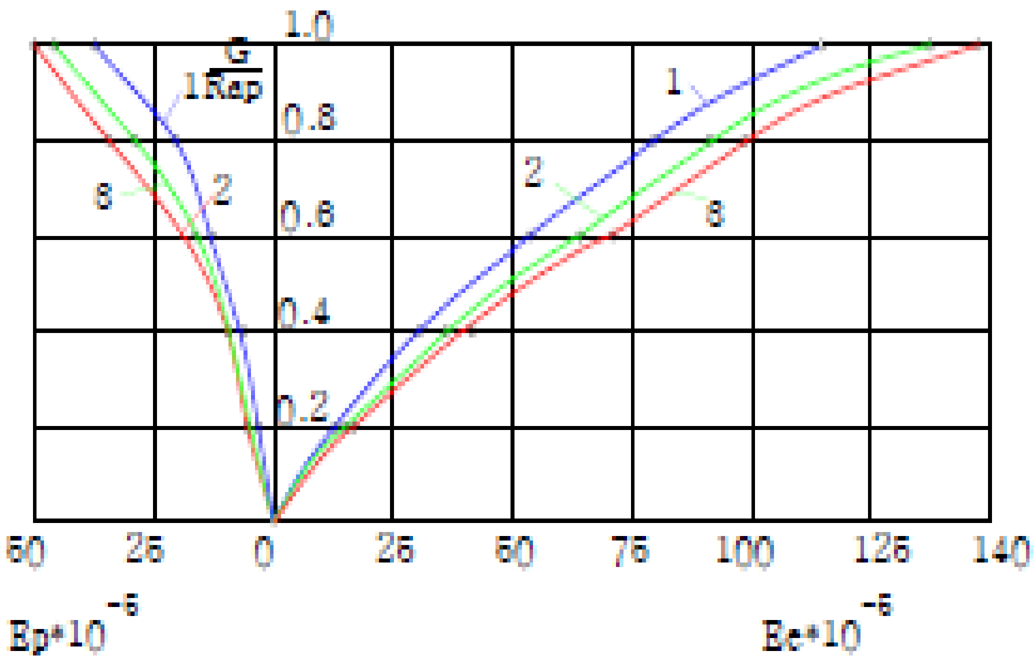

Fig.1. 1 – concrete without additives; concrete with ext. 0.005 K-9; 3 – concrete with ext.0.003 K-9.

Relative tensile deformations of concrete during bending

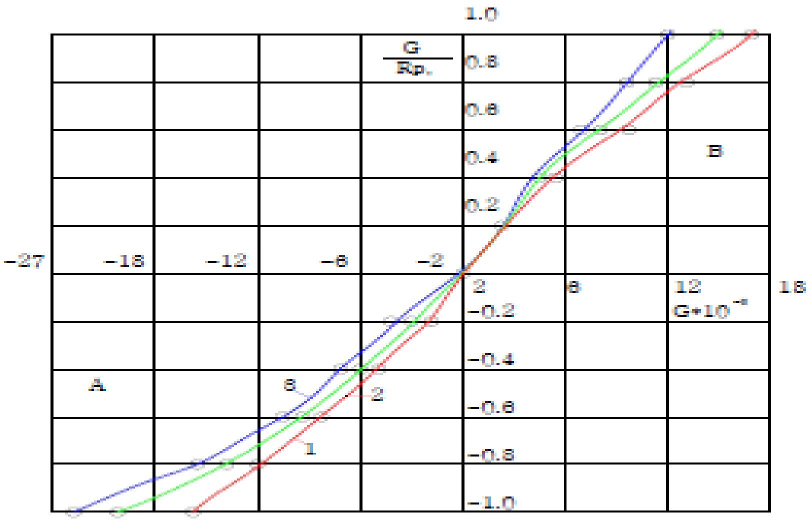

Fig.2. A - stretched zone; B – compressed zone; 1 – concrete without additives; 2 - with ext. 0.005 K-9;3 - with ext. 0.003 K-9

The increased deformability of concrete with the addition of polyacrylates is explained by its damping property due to thickened adsorption layers, which are adhesive layers between the crystallohydrates of cement stone.

3. Summary: Thus, the adopted short-term load test method made it possible to identify a change in the differential coefficient of transverse deformation Δγ and to establish the boundaries of the onset of micro-destruction R_T ^° and microcracking R_T^γ, as well as to determine the positive effect of polyacrylate additives on the deformative properties of concrete, which contributes to increasing the resistance of concrete in aggressive environments.

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