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DETERMINATION OF THE STRESS-STRAIN STATE OF CONCRETE USING THE TENSOMETRY METHOD

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The article discusses the effectiveness of the use of load cells in the study of deformation characteristics of concrete. The technology of manufacturing deep sensors is described. The effectiveness of this type of sensor for the study of concrete deformation is being proved.

Ensuring the high reliability of the structures being created and optimizing the calculation parameters are largely determined by the availability of information on the physical and mechanical properties of the materials used. At present, a large amount of information on the standard mechanical characteristics of the behaviour of concrete of different strength has been accumulated [1].

The mechanism of destruction of concrete, as is known, is associated with the formation and development of micro- and macro-cracks under the action of a load. The cause of the appearance of the first microcracks is the concentration of stresses near the defects of the structure: pores, inclusions, dislocations. According to modern concepts, microcracks appear at low stress levels – $\sigma_c = 0{,}3 f_{cm}$. Destruction of concrete begins with the development of cracks in the contact zone (matrix-aggregate) with their subsequent exit into the matrix. Contact cracks develop under the action of shear, and cracks in the matrix - tensile stresses [9].

All these cases are caused by expansion (pressure) or compression of the intraporous phase, leading to the deformation of the structure, then to stresses, at a critical value of which cracks appear in the structure [2].

In order to correctly determine the remaining life of structures, the initial data must be determined by the results of field tests and measurements. Unfortunately, for most constructions, obtaining reliable source data is difficult, which naturally reduces the correctness of calculations. The stresses occurring in the structures are usually taken as the result of formalized calculations, which does not reflect the actual operation of the structure. There is a need to seek reliable operational methods for obtaining initial data for calculations directly from full-scale structures. In this situation the way out would be the use of telemetric systems for monitoring the state of objects [3].

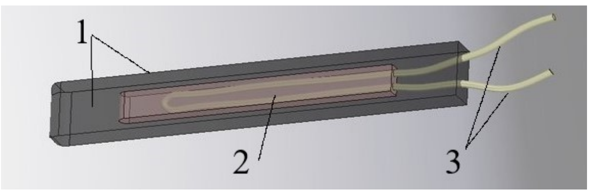
Load cells are used as primary sensors for obtaining information characterizing the loading parameters and stress state of the structure. The method of strain gauges, at the present moment, is one of the best developed in the measurement of mechanical stresses. Transformation of information from sensors into a form convenient for further coding does not cause fundamental difficulties and can be realized by any known method [5].

The algorithm of the system functioning assumes the following operations [3]:

1. Reading of the information of strain gauges fixed on a design for the operative formation of an array of initial data;
2. Coding information of each sensor and forming a group signal that allows to identify the number of each sensor and the number of the object on which the sensors are installed;
3. Transmission of information via radio channels from each object to the base station;
4. Analysis of the loading state of each of the N objects and the remaining resource on the basis of calculations.

Experimental studies of concrete deformation in conditions of a complex stress state with short-term and long-term load action are associated with great methodological difficulties. The main problem with such a study is the limited or total lack of access to the surface of a concrete sample, which makes it difficult to measure deformations with traditional measuring instruments. In addition, the measurement zone should be located as far as possible from the contact surface of the sample and the loading element [6].

For more detailed study of the development of deformations in concrete samples, it was decided to use deep sensors in [1, 8–10]. As shown by the studies [7], the application of this type of deep sensor (Figure 1) gives a good convergence of experimental and theoretical data.



1 – Mastic;
2 – Strain gauge transducer;
3 - Wires endings.

Fig. 1. Model of a deep sensor

Deep load cells are manufactured using the following technology [7]:

1) In a collapsible metal mold (the cell for making each sensor has a size of 100X10X5mm), greased with a synthetic oil, a layer of 2.5 mm thick mastic was laid. The mastic consisted of a mixture of glue BF-2 with cement in the ratio of 1: 2.

2) After the mastic dried (within 24 hours), strain gauges were pasted onto it, which, in turn, was covered with a second layer of mastic. Only the parts of the sensor head with leads remained free.

3) After the wires were soldered to the terminals, this part of the sensor was isolated.

4) After heat treatment in an oven at the temperature of 150 ° for 1 hour, the sensors were removed from the mold.

In the future, a similar experiment is planned to monitor the deformations of concrete samples using this type of deep-seated sensors.

The results of the studies described in [1, 8–10] testify to the promising application of the sensors considered for studying the stress-strain state of concrete. Their main advantages are simplicity, low cost of their manufacture and the possibility of using traditional measuring strain gauges [6].

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