THE APPLICABILITY OF THE DISTRIBUTION FUNCTION OF THE STRENGTH OF CONCRETE TO EVALUATE THE TECHNICAL CONDITION OF CONSTRUCTION MATERIALS

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1. Introduction

Currently, Russia is undergoing rapid growth in housing construction with the use of new technologies. Ensuring a high quality of construction and maintenance of the technical condition of buildings and structures at the level which meets the consumer, is impossible without the use of modern methods of non-destructive testing and diagnosis [1-2].

The main characteristic used to evaluate the technical state of the objects of concrete, is the strength of the basic building material - concrete [3,4]. There are various implementations of destructive, direct non-destructive and indirect non-destructive measurement of the concrete [5]. The most convenient in practical implementation to evaluate the strength of concrete is an ultrasonic method and rebound hammer method [5]. Concrete materials are heterogeneous in structure, so the value of of strength resulting from a single measurement instrument logically be viewed as a random variable. Subsequently, the quantity is called a random variable analyzed. The most complete characterization of said random variable is its distribution function and the density of distribution. There are various assumptions about the distribution of the random variable analyzed, for example, about its normality [6]. Obviously, during the operation concrete constructions there is a change distribution pattern in the surface strength of the concrete layer. It follows that the problem of determining the nature of the distribution of the random variable analyzed in a newly erected building facilities and changing the nature of this process in continuous operation remains relevant. Note that the problem is typical for metal structures [7].

2. Theory

In the scientific literature to describe the distribution function of the analyzed random variable and other random variables specific to the construction, use a variety of laws: normal [6], lognormal [7], the Weibull [8] Gumbel [9]. The density of the normal distribution described by followed expression:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\xi)^2}{2\sigma^2}}, -\infty < x < \infty, \quad (1)$$

here ξ – average deviation, σ – standard deviation.
The distribution function of a random variable distributed according to Weibull, is as follows

$$F(x) = 1 - e^{-\left(\frac{x}{\lambda}\right)^k}, 0 < x < \infty, \quad (4)$$

where k and λ – Weibull distribution parameters.
Lognormal distribution is derived from (1) by replacing x with lnx, and Gumbel distribution is derived from (2) by the same substitutions.

3. Experiment

The aim of this paper is to determine the direction of future research related to the choice of the nature of the distribution of the strength of concrete.

In the survey process of a number of building structures measured the strength of concrete columns, stiffening diaphragms and floors. Concrete compressive strength was evaluated using an ultrasonic device "Pulsar-1.1". This instrument is designed to measure the time and velocity of ultrasonic waves in the building materials. From the measured value of the velocity of propagation of ultrasonic waves is determined by the strength of the building material.

In addition, for the evaluation of the analyzed characteristics of the concrete used device "Onyx 2.4" which complies with the measurement of of strength of construction materials for compression in accordance with GOST 22690-88, GOST 18105-86, GOST 530-95, GOST 28013-89, GOST 26633-91. The strength of of construction materials is estimated by the rebound of the striker. Calibration dependence included in memory of the device, but is allowed and a control calibration is applied to the sample standard sample of strength. The measurement range of the device "Onyx 2.4" is from 1 MPa to 100 MPa.

Figures 1 and 2 for illustration shows typical histograms of the analysis of the random values obtained using instruments "Onyx-2.4" and "Pulsar-1.1".

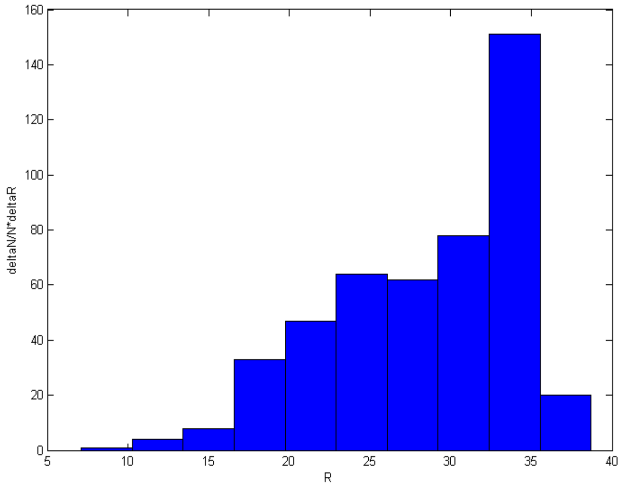

Figure 1 - distribution histogram of strength concrete (Onyx-2.4)

In appearance histograms can make a preliminary conclusion about the impossibility of attributing the analyzed random variable to a class of random variables distributed normally. A second preliminary conclusion is related to the strength of concrete similarity of histograms obtained for devices "Onyx-2.4" and "Pulsar-1.1» that most likely indicates the reproducibility of measurements. To confirm or refute the hypotheses related to the nature of the distribution of the random variable analyzed, further research is needed.

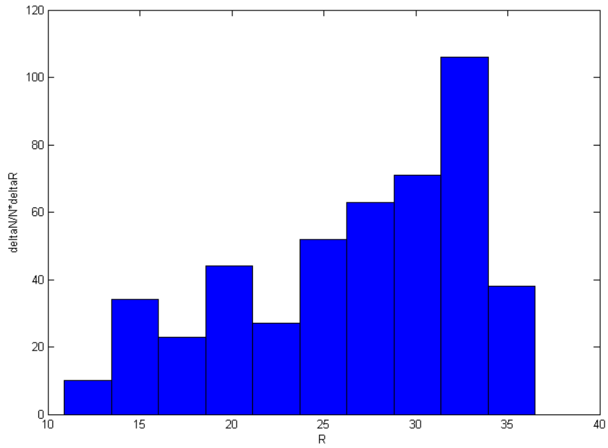

Рисунок 2 – Гистограмма распределения прочности бетона (Пульсар−1.1)

4. Conclusion

On the basis of these studies we can conclude that a probable change in the density distribution of concrete strength during the operation of building structures and structures will allow them to assess the current technical state.

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