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Issue Article

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STRESS-STRAIN STATE OF FIBER REINFORCED CONCRETE BEAMS

Abstract: *The article presents the results of laboratory research on the stress-strain state of fiber reinforced concrete beams dispersed with reinforced concrete and basalt fibers.*
Key words: *reinforced concrete, beam, stress, strain, basalt fiber, flexure, strength, dispersed reinforcement.*
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Introduction

Basalt fiber is a complex of continuous basalt fibers of a certain length. Basalt fiber is derived from a variety of rocks, such as basalt, basanites, amphibolites, gabrodiabases, or mixtures thereof, which are chemically similar. The production of basalt fibers is based on the production of basalt solution (mixture) in smelting furnaces and its free flow through special devices. Melting point is 1450ºC. The advantages of basalt fiber for disperse reinforcement are that it has high strength as well as does not stretch under the influence of stresses, is resistant to chemical, corrosion and thermal effects of the external environment, changes in temperature and voltage direction, as well as cost not too expensive[1-6].

Many scientists have studied the mechanical properties of fibrous reinforced concrete based on basalt fibers. However, the results are scattered and can be explained by differences in the amount, quantity, and technology of fibers used. Kudyakov K.L. [3] states that the addition of basalt fibers to concrete increases the maximum values of deformation during compression and elongation, and at the same time increases the plasticity of the material collapse[7-17].

Research and analysis of scientific studies show that flexible fiber-reinforced concrete structures based on basalt fibers have not been sufficiently studied. Therefore, it is advisable to conduct experimental studies on the stress-strain state of flexible fiber reinforced concrete beams with basalt fibers.

RESEARCH METHODOLOGY

Reinforced concrete beams for dispersed reinforcement have a density of 2650 kg / cm^3, fiber diameter 17 µm, fiber length 10; 30 mm basalt fibers were used. An overview of the fibers used in the study is shown in Figure 1.

Figure 1. Basalt fibers

Six series of beams were prepared and laboratory tests were performed to study the stress-strain state of fiber reinforced concrete beams. The first series of reinforced concrete beams are made of concrete without basalt fibers. The rest of the series of fibro-reinforced concrete beams are made of basalt fibers of different sizes and lengths.

The cross-section dimensions of reinforced concrete and fiber-reinforced concrete beams, as well as the diameters and lengths of the reinforcement used, are shown in Figure 2.

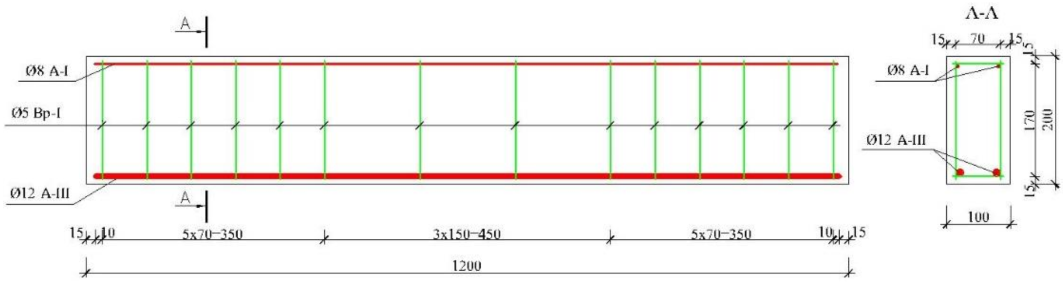

Figure 2. An overview of sample beam reinforcement.

Dispersed reinforced concrete beams with reinforced concrete and basalt fibers were formed using a hydraulic press of OKS-1671M brand, modernized by the authors, with a load capacity of 400 kN. The layout of the samples on the test device is shown in Figure 3.

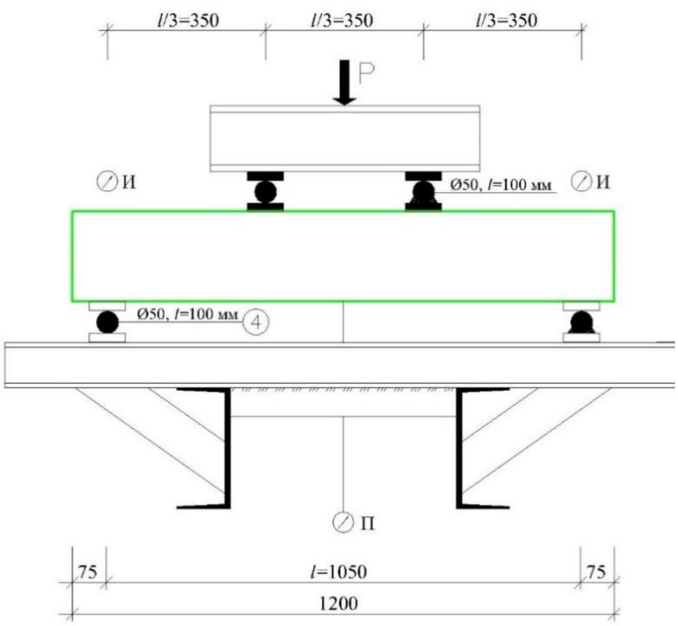

Figure 3. View of the sample on the test device.

In order to measure the deformation of the beams, specially prepared metal pins were attached to the compressible and elongated parts of the beams. Holes were made in the metal studs. One of the bars has a clock-type indicator and the other has a messura.

To determine the stress-strain state of the concrete, the cross-sections of the side beams were measured using a portable messura (Figure 4) using clockwise indicators with an accuracy of 0.01 mm at a base of 300 mm.

Figure 4. view of the messura.

ANALYSIS AND RESULTS

Longitudinal elongation and compressive deformations of concrete do not have large values at the initial loads, and their variation increases almost in a straight line. Elongation deformations of concrete reached ε_{fb}= (32-45) $\cdot10^{-5}$ compressive deformations of concrete ε_{fbt}= (17-23) $\cdot10^{-5}$ when the force reached 30 kN on reinforced concrete beams of series I. Elongation deformations of concrete ε_{fb}= (12-20) $\cdot10^{-5}$ compression deformations of concrete reached ε_{fbt}= (8-12) $\cdot10^{-5}$ values when the force reaches 30 kN in sample II reinforced concrete beams.

Elongation deformations of concrete reached ε_{fb}=(150-160)$\cdot10^{-5}$ compressive deformations of concrete ε_{fbt}=(47-50)$\cdot10^{-5}$ when the amount of load reached F_{ult}(0,8-0,9). Elongation deformations of concrete in series II reinforced concrete beams ε_{fb}=(130-145)$\cdot10^{-5}$ compressive deformations of concrete up to ε_{fbt}=(28-45)$\cdot10^{-5}$.

Sample III series Elongation deformations of concrete when the amount of destructive force in fiber-reinforced concrete beams reaches F_{ult}(0,2-0,3) ε_{fb}=(13-28)$\cdot10^{-5}$ compressive deformations of concrete ε_{fbt}=(8-14)$\cdot10^{-5}$ achieved values. Elongation deformations of concrete in series IV reinforced concrete beams ε_{fb}=(14-20)$\cdot10^{-5}$ Compressive deformations of concrete ε_{fbt}=(10-17)$\cdot10^{-5}$ (Figures 5-8).

Elongation deformations of concrete in series III samples reached ε_{fb}=(130-140)$\cdot10^{-5}$ compressive deformations of concrete ε_{fbt}=(28-32)$\cdot10^{-5}$ as the loading stages approached the destructive force. Elongation deformations of concrete ε_{fb}=(115-132)$\cdot10^{-5}$ compression deformations of concrete up to ε_{fbt}=(31-35)$\cdot10^{-5}$ were found in the IV series sample fibro-reinforced concrete beams.

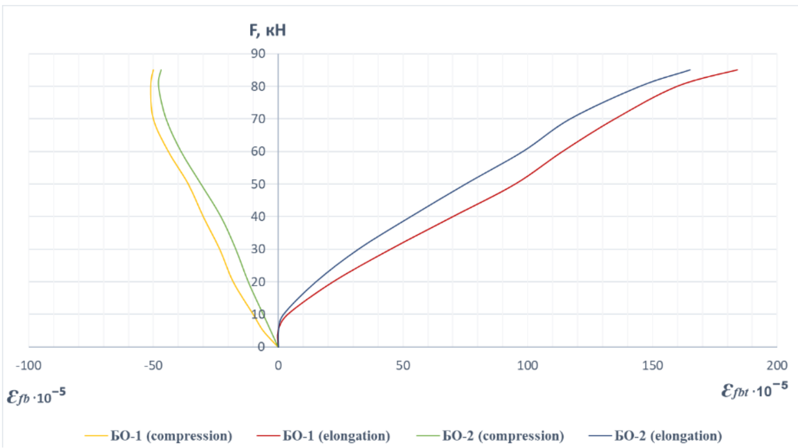

Figure 5. Average relative compressive and elongation deformations of concrete in series I ordinary reinforced concrete beams

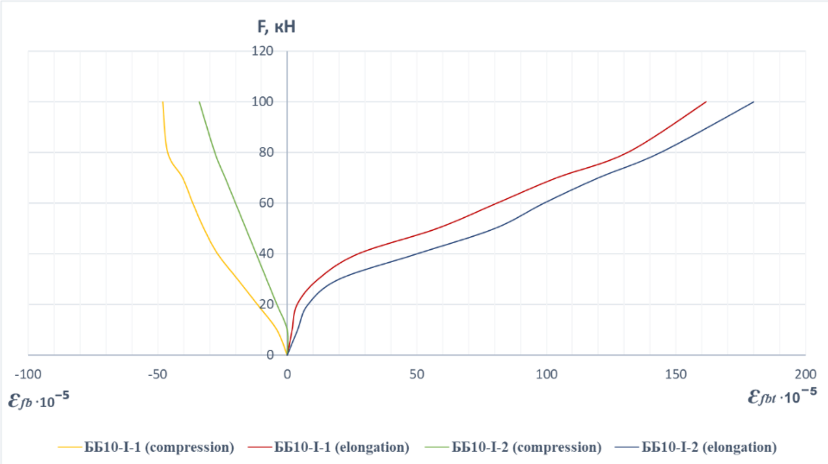

Figure 6. Average relative compressive and elongation deformations of concrete in series II fiber reinforced concrete beams

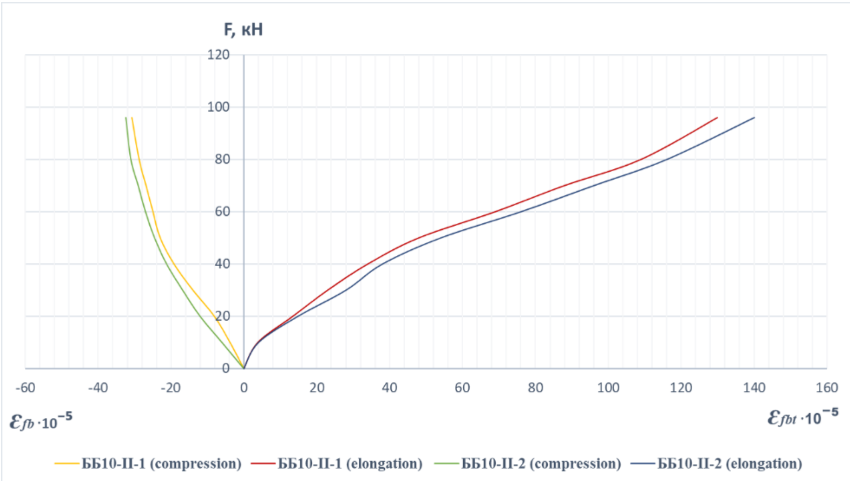

Figure 7. Average relative compressive and elongation deformations of concrete in series II fiber reinforced concrete beams

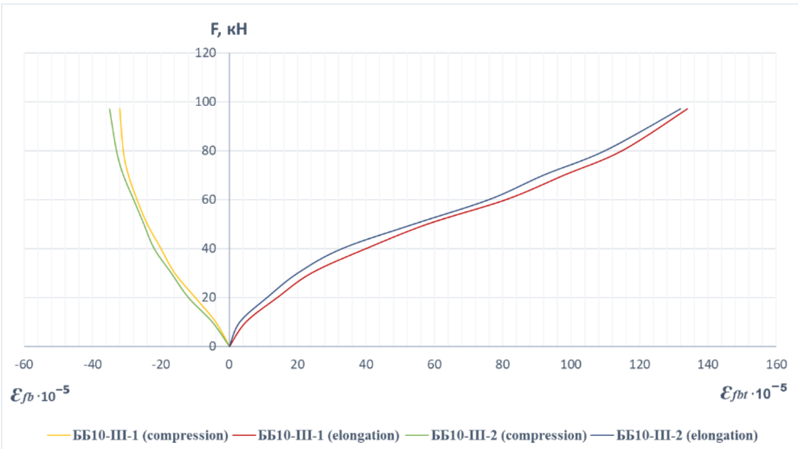

Figure 8. Average relative compressive and elongation deformations of concrete in series II fiber reinforced concrete beams

CONCLUSION

Experimental studies of sample beams have provided new data on the nature of the stress-strain state of fiber reinforced concrete beams and the strength of normal sections. Basic fiber-reinforced concrete beams have shown high strength, high load-bearing capacity, high tensile strength, and stiffness compared to ordinary reinforced concrete beams.

The addition of basalt fibers to concrete in the range of 0.1-0.3% allows more efficient use of regular reinforcement. It also has the effect of increasing the load-bearing capacity of fiber reinforced concrete beams, which are subject to bending and increasing it by an average of 10-19% compared to control samples.

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