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Research and Testing of Basalt Fiber Reinforced Concrete Beams on Slope Section

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Abstract: In this article, the strength of reinforced concrete beams reinforced with basalt fibers in the slope section was studied experimentally and theoretically. The role of fibers in the concrete structure, their effect on crack elimination and their contribution to shear strength were analyzed. According to the results of laboratory tests, it was found that basalt fibers increase the shear strength and energy absorption capacity of concrete in the slope section. The results of the studies were compared with ordinary reinforced concrete, and suggestions were made on the optimal fiber content.

Keywords: basalt fiber, reinforced concrete beam, oblique section, shear strength, dispersion reinforcement, cracking deformation, experimental test.

Introduction. Reliability of constructions, long service life and seismic stability are the main requirements in the field of construction. Cracks along the inclined section of reinforced concrete beams are a weak point that causes the failure of the structure. Application of basalt fibers in addition to normal reinforcement:

- increases the tensile strength of concrete;
- slows down the development of cracks;
- improves the ability to absorb cutting forces;
- increases resistance to corrosion and high temperature.

Therefore, cross-sectional testing of basalt fiber reinforced concrete beams and assessment of their performance are very relevant in modern construction.

In reinforced concrete structures, stresses are mainly in the bending and tensile states. However, under the influence of shear forces, large cracks appear along the cross-section, threatening the overall reliability of the beam. Fiber-reinforced concrete (FRC) is one of the most effective technologies to overcome this problem point.

Main part. Basalt fibers are naturally occurring, stable at high temperatures, non-corrosive, and bond well with concrete. In this study, the amount of basalt fiber and its effect on the strength of the slope were evaluated through practical tests. Analysis of research conducted on the topic: Research conducted by scientists has yielded the following main conclusions:

1. Zhang Y., Wu H. (2020) noted that basalt fibers increase the shear strength of concrete by 15–30%.
2. Aliyev R. (2019) found that the energy absorption capacity of basalt fiber concrete was significantly improved.
3. Neville A. (2015) noted that the addition of dispersed reinforcement to concrete limits crack propagation.
4. In local researches (Karimov, Farmonkulov) positive results regarding strength, deformation and seismic stability of fiber concrete were noted.

At the same time, a comprehensive study of basalt fiber beams in a precise cross-section testing scheme has not yet been sufficiently covered.

Research methodology and test scheme. The study used 1500 mm long reinforced concrete beams with a cross section of 100×200 mm. A shear-forced scheme was established using three-point loading. Types:

1. 0% fiber (control sample)
2. 0.5% basalt fiber concrete
3. 1% basalt fiber concrete

The length of the fibers is 12 mm, the diameter is 18–20 μm.

The tests were conducted on a universal hydraulic press, using strain gauges and the following equipment:

1. Hydraulic press (100–500 kN)
2. Sensors (LVDT) – for strain measurement
3. Strain gauge – to measure reinforcement elongation
4. Crack monitoring (Crack meter)

The test steps are as follows:

1. The beam is mounted on supports.
2. The load is applied gradually (0.1–0.2 kN/s).
3. The moment of appearance of cracks is recorded.
4. The propagation of cracks in the oblique section is observed.
5. The beam is loaded until it reaches its full limit state and fails.
6. All force-deformation graphs are prepared.

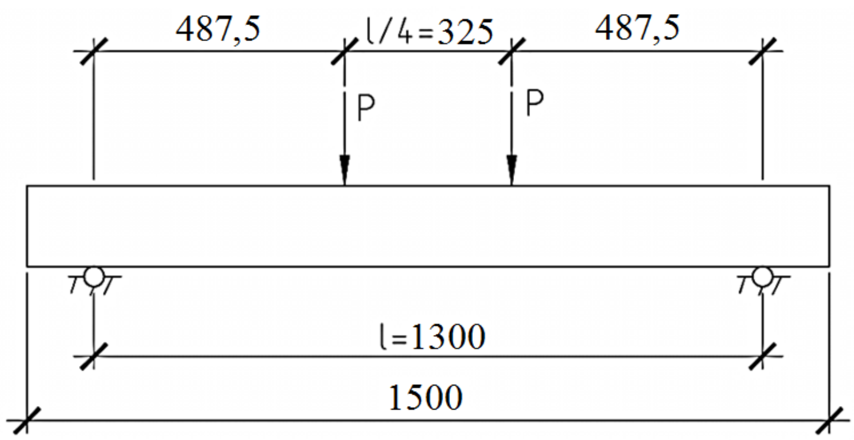

Figure 1. Scheme and dimensions of placing loads on beams

Figure 2. The process of testing barriers

Results:

1. Results on shear strength:

№	Sample type	Maximum cutting force Vmax (kN)	The difference in durability
1	0% fiber (control)	51 kN	–
2	0.5% basalt fiber	62 kN	+22%
3	1% basalt fiber	70 kN	+37%

2. Characteristics of cracks;

1. Control sample: one large crack in 45° inclined directions, rapid failure.
2. 0.5% fiber concrete: a few small scattered cracks, expansion is reduced.
3. 1% fiber concrete: cracks are small and numerous, developing slowly with increasing deformation.

3. Ability to absorb energy

Basalt fibers increased the plasticity of concrete and improved the energy absorption capacity of the structure during testing.

Conclusion.

As a result of the research, the following main conclusions were reached:

1. Basalt fibers significantly increase the shear strength of reinforced concrete beams.
2. Fibers slow down the development of cracks and improve energy absorption.
3. The maximum shear strength of 1% fiber concrete was 37% higher than that of the control sample.
4. Basalt fibers increase the plasticity of concrete and improve the seismic stability of the structure.
5. Basalt fiber concrete structures make it possible to partially replace ordinary shear reinforcement in construction.

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