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OPTIMIZATION OF BASALT FIBER CONCRETE COMPOSITION

Rakhimov Rasuljon Ravshanbek o‘g‘li
Ferghana Polytechnic Institute
r.r.rakhimov@ferpi.uz (ORCID 0000-0003-2864-5735)

Abstract
This article studies the composition of basalt fiber concrete. It is aimed at determining the optimal composition for fiber concrete in an experimental setting. The article provides information about the optimal composition of basalt fiber for fiber concrete.

Keywords: Basalt, fiber, fiber concrete, fiberconcrete, construction.

Introduction

Basalt is a common volcanic rock on Earth. Basalts are formed as a result of the rapid cooling of lava on the surface of the Earth and at the bottom of the oceans. Basalt is igneous, so its structure is more like a complex mixture of amorphous volcanic glass, micron-sized feldspar crystals, quartz, carbonates, sulfide ores. Basalt rock is melted and passed through spinnerets of special shapes that determine the thickness of the fibers. Basalt fiber is obtained in sizes from 0.5 to 20 microns (Figure 1.1). Basalt fiber has a number of useful properties, which are as follows:

- high temperature resistance;
- noise and heat insulation;
- frost resistance (withstands temperatures down to -200°C);
- strength and elasticity;
- low cost.

Nonwovens and textiles are made from basalt fiber, the material is added to tile adhesives, concrete and cement mixtures [3,4].

Figure 1. Basalt fiber

Materials and Methods

Fiber concrete is a composite material, which is a mixture of fibers (fibers) from various materials evenly distributed throughout its volume. At the same time, a spatial micro-pored cement matrix is formed in concrete, which resists compressive and tensile stresses that occur in concrete during hardening and compressive deformations under the influence of external forces. The presence of fibers in concrete increases its strength, stiffness and maximum deformations, contributes to a uniform distribution of stresses, prevents the appearance and development of cracks under various types of loads, improves water resistance, frost resistance, resistance to abrasion, shrinkage, creep and other properties of concrete. [1, 2].

An important factor affecting the rheological properties and homogeneity of the fiber-reinforced concrete mixture, as well as the physical and mechanical properties of fiber-reinforced concrete, is the correct determination of the composition of the mixture, taking into account the combination of components, the size of inert fillers, the composition and parameters of the fibers, etc. [2,3].

When choosing the type of fiber, it is necessary to carry out appropriate scientific justification, depending on the purpose and operating conditions of structures and products made of fiber-reinforced concrete. Steel fiber is prone to corrosion, its use leads to a significant increase in the cost of concrete and an increase in its weight. Glass fibers have low resistance to the alkaline environment of hydrated cements.

For the preparation of fiber concrete samples, self-compacting concrete with fine aggregate was used as a matrix, which allowed to ensure a high degree of saturation with fibers and high dispersion of reinforcement [4,5,6].

The material consumption for each batch of fiber concrete mixture was determined in the volume required to prepare a certain number of samples - cubes and specimens - prisms.

Results: For the experiment, 9 pieces of concrete were tested in concrete cubes with added basalt fibers

№	Dimensions of concrete cubes, mm			The value of breaking force, kN, obtained as a result of compressive testing of standard concrete cubes under the press								
	A	B	H	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9
1	150	149	151	375	365	380	380,1	340,1	340	365	355	350

In this case, cube samples of (150x149x151) mm were tested. All 9 samples are treated as identical [2,5].

Data on sample concrete cubes are entered into the table:

Table 1

Sample icon	Sample age and hardening condition	Dimensions of concrete cubes, mm			Cross-sectional area ***A***, mm^2	Sample size
		a	***b***	***h***		
1.	28 s, normal	149	151	150	22499	3374850
2.	28 s, normal	149	151	150	22499	3374850
3.	28 s, normal	149	151	150	22499	3374850
4.	28 s, normal	149	151	150	22499	3374850
5.	28 s, normal	149	151	150	22499	3374850
6.	28 s, normal	149	151	150	22499	3374850
7.	28 s, normal	149	151	150	22499	3374850
8.	28 s, normal	149	151	150	22499	3374850
9.	28 s, normal	149	151	150	22499	3374850

The compressive strength of concrete cubes is found as:

$$R_i = \frac{N}{A}, \text{MPa.} \qquad (1)$$

The results of testing fiber concrete cubes are presented in Table 2 [2,4,5]:

Table 2

№	Destructive force R, N, kN	Cross-sectional area A, mm	Cubic durability $R_i = \frac{N}{A}$, MPa
1	375	22499	16,667
2	365	22499	16,223
3	380	22499	16,89
4	380,1	22499	16,894
5	340,1	22499	15,116
6	340	22499	15,112
7	365	22499	16,223
8	355	22499	15,778
9	350	22499	15,556

The average compressive strength (Rm) of fiber concrete cubes is determined as follows:

$$R_m = \frac{R_1 + R_2 + R_3 + \ldots\ldots + R_n}{n}; MPa$$

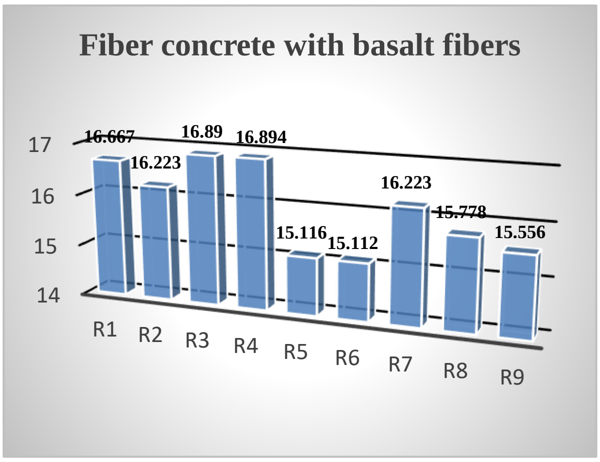
Mean square limitation of compression strength of fiber concrete cubes:

$$\sigma = \sqrt{\frac{(\Delta R_1)^2 + (\Delta R_2)^2 + (\Delta R_3)^2 + \cdots\cdots + (\Delta R_n)^2}{n-1}}; MPA$$

To simplify the calculation process, we present the calculation results in Table 3:

Table 3

R_i	Average compressive strength of concrete cubes, R_m	$\Delta R_i = R_m - R$	ΔR_i^2	The root mean square limitation of compressive strength, σ	Coefficient of variation for concrete strength, v
16,667	16,16	-0,50628571	1,7626	0,710	0,040
16,223		-0,06228571	0,4797		
16,89		-0,72928571	0,6766		
16,894		-0,73328571	0,4797		
15,116		1,044714286	0,0352		
15,112		1,048714286	7,3592		
16,223		-16,223	7,3592		
15,778		-15,778	7,3592		
15,556		-15,556	7,3592		



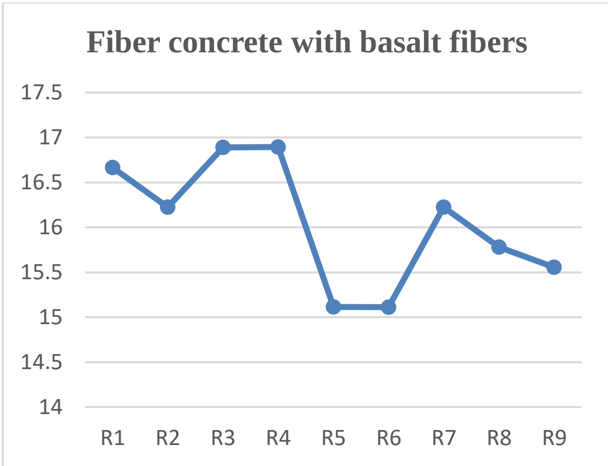


Figure 2. Experimental result of basalt fiber reinforced concrete

Conclusion

To determine the optimal composition of basalt fiber for fiber concrete, we took different sizes of basalt fiber: 6mm, 12mm, 15mm, 20mm. Experimental studies were conducted on the strength of basalt fibers of 4 lengths by adding them to the fiber concrete composition. Based on the results of this study, it was recommended to take 15mm long basalt fiber as the most optimal length for fiber concrete.

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