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STRENGTH OF BASALT FIBER CONCRETES

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Abstract
This article describes the results of experimental research on basalt fiber-reinforced concrete and the experimental studies conducted. It also presents conclusions on the strength and fracture toughness of basalt fiber-reinforced concrete.

Keywords: Basalt, fiber, strength, fracture toughness, concrete, cube, fiber concrete, press.

Introduction

Currently, the demand for energy-efficient and economically affordable materials and products is increasing in the construction industry worldwide. In this regard, building materials made from local raw materials and industrial waste, firstly, save energy during the production process, and secondly, since local waste is used, its cost is also partially reduced. At the same time, the use of secondary resources in order to rationally use depleting resources is currently a topical issue [7]. Construction materials account for 55-60% of the cost of construction work, so modern architecture requires new, high-quality, affordable, lightweight and earthquake-resistant, innovative construction materials. High-quality, affordable, modern construction materials are needed for social facilities, non-residential and residential buildings [7].

In our country, there were 7995 enterprises producing building materials until 2017, and now there are 10552, which are focused on the production of 180 types of building materials. Fiber concrete, which is made on the basis of basalt and other fibers, is one of the most modern and durable building materials. There are many reserves of basalt and rocks on the territory of Uzbekistan, on the basis of which the production of mineral fibers based on basalt has been established, which is being carried out in the Jizzakh, Navoi and Fergana regions [7]. The production of composite materials based on basalt fibers helps to solve the following urgent problems:

- saves the main raw material base for the production of building materials, that is, resources, and eliminates the shortage of natural raw materials;
- local secondary resources are used instead of imported raw materials;
- solves environmental issues, ecological systems, and reduces land occupation;

- saves energy resources and dramatically reduces costs. Composite materials obtained on the basis of basalt fiber, fiber concrete, allow to reduce the consumption of the main reinforcement elements in reinforced concrete construction [7].

Due to the strong bonding of basalt fibers with concrete, the tensile strength of concrete increases by 20...40%, crack resistance and durability, durability, as well as other properties are significantly improved [3]. The presence of a large amount of portlandite Ca(ON)2 in the concrete during the hardening process can have a negative effect on basalt fiber. Therefore, various active additives can be used to bind it: microsilica, metakaolin (thermally treated kaolin). As a result of adding basalt fiber and active additives to concrete, its water absorption also increases, so it is advisable to use special superplasticizers.

For experimental studies, 5 different types of cubic samples with dimensions of 10x10, 18 pieces each, were prepared. Ordinary heavy concrete was used for the samples. Portland cement of the M400 brand from the cement plant in the Beshariq district of the Fergana region with an activity of 42.5 MPa was used as a binder for concrete. Granite pebbles (sheben) with a fraction of 5-15 mm and quartz river sand from the Akbarabad quarry in the Kuva district of the Fergana region with a size modulus of M2.25 were used as fillers. The composition of the concrete was selected so that its cubic strength would have a compressive strength corresponding to the B20 class. Type 1 samples were prepared from ordinary heavy concrete. Basalt fiber fibers with a size of 10 mm were added to type 2 samples. Basalt fiber fibers with a size of 12 mm were added to type 3 samples. Type 4 samples were supplemented with 15 mm basalt fiber fibers. Type 5 samples were supplemented with 18 mm basalt fiber fibers. The composition of the samples is given in Table 1. The granite pebbles were sieved, washed in a special device, and then dried [8].

Table 1. Composition of sample concrete cubes.

Samples	Amount of cement, kg	Water volume, liters	Crushed stone, kg	Quartz sand, kg	Basalt fiber 10 mm, %	Basalt fiber 12 mm, %	Basalt fiber 15 mm, %	Basalt fiber 18 mm, %	Water cement ratioW/S
1-type	300	150	1220	720	-	-	-	-	0,5
2-type	300	150	1220	720	3	-	-	-	0,5
3-type	300	150	1220	720	-	3	-	-	0,5
4-type	300	150	1220	720	-	-	3	-	0,5
5-type	300	150	1220	720	-	-	-	3	0,5

The materials were dosed by weight with an accuracy of ±0.1 kg. A high-precision electronic scale was used for this purpose. The results of the cube tests are presented in Table 2.

After the samples were stored for 28 days at normal temperature t=20±20C and relative humidity φ=60-65%, the sample cubes were tested in a hydraulic press until they failed under compressive force [9].

Concrete was prepared in a concrete mixer with a volume of 0.25m3 and poured into molds and compacted using a vibrator.

The samples were released from the molds after the cubes were kept in the mold for 5-7 days and stored in laboratory conditions until testing. The cubes were tested 14 days, 21 days and 28 days after molding. The tests were carried out on a 50-ton hydraulic press. The cubes were tested until failure. The tests were carried out according to the standard method, in accordance with the requirements of GOST 10180-2012. The test results are presented in Table 2.

Figure 1. Appearance of concrete cubes and their appearance after compression testing.

Figure 2. The process of testing concrete cubes for compression.

Figure 3. Appearance of cracks in concrete cubes after compression testing.

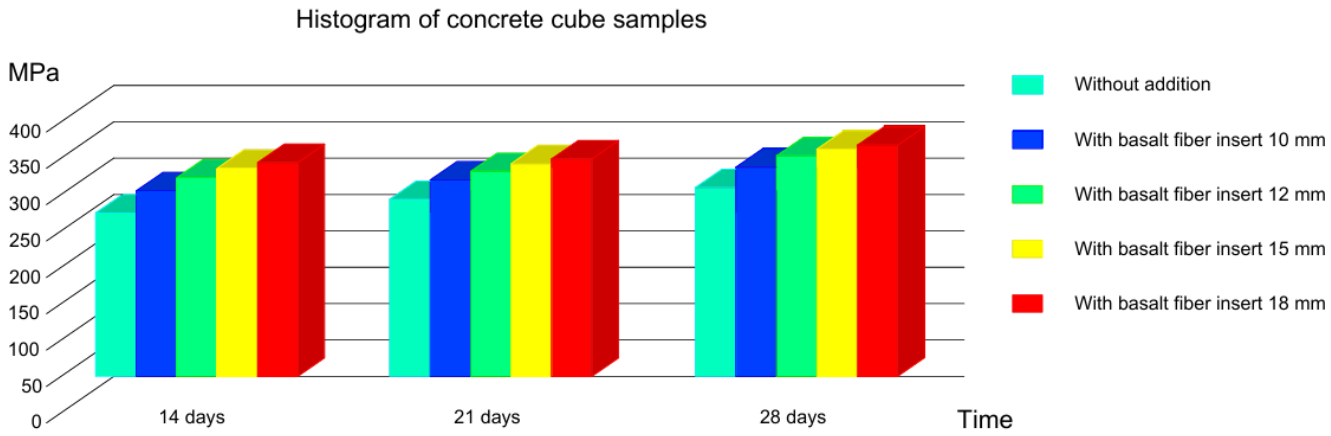

Figure 4. Histogram of concrete cube samples.

Table 2. Compressive strengths of concrete and fiber-reinforced concrete samples.

Samples	Compressive strength MPa						
	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average score
14-day samples							
T-1	245	248	250	248	245	250	248
T-2	275	280	282	272	285	282	280
T-3	290	295	292	290	293	292	292
T-4	304	305	307	305	306	305	305
T-5	312	315	313	312	318	312	314
21-day samples							
T-1	275	278	276	275	270	280	276
T-2	288	290	285	286	290	288	288
T-3	302	305	310	308	305	310	307
T-4	312	315	314	315	320	310	314
T-5	320	325	330	322	320	330	324
28-day samples							
T-1	300	295	298	300	305	290	298
T-2	305	300	302	308	310	305	305
T-3	315	320	320	315	318	312	317
T-4	325	328	330	335	320	325	327
T-5	335	340	342	338	335	345	339

Test results were obtained and analyzed. According to the results, it was found that the strength of basalt fiber concretes is higher than ordinary concretes without additives. According to the results, it can be observed that the strength of samples with 18 mm basalt fiber fiber increased by 12%.

Basalt fiber fibers added to concrete cube specimens increase the plasticity of concrete and have a positive effect on its fracture toughness. It can be seen that basalt fiber fibers slightly increase the resistance of reinforced concrete structures to dynamic impacts. This creates the opportunity to achieve good practical results in the construction of seismically resistant buildings.

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