Investigation of concrete properties using basalt fiber

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ABSTRACT

Modern construction is inextricably linked with the tasks of increasing the efficiency of construction production, reducing the cost and complexity of technological processes, economical use of material and energy resources, the use of new progressive materials.

Keywords: fiber concrete, basalt, homogenization, fillers, superplasticizers

Global trends in the construction of high-rise buildings and other high-load structures, such as long-span bridges, offshore oil platforms, etc., are associated with the use of concretes with a previously unattainable set of properties, including: high strength (class B80 and higher), crack resistance and durability, with high mobility of the initial concrete mixture.

Thus, according to a number of research scientists, the production of high-strength concrete is possible provided that a large aggregate with a maximum compressive strength of 120-130 MPa and having a highly defective structure is rejected.

Ultra-high-strength concretes can be divided into two types according to the fractional composition of aggregates: fine-grained concretes with a maximum grain size of 5-1.5 mm and fine-grained concretes with a grain size of less than 1.5 mm. However, there is little information about the fractional composition of the recommended fillers. Basically, we are talking about the use of various types of superplasticizers and their effect on the technological properties of mixtures. To increase the tensile strength, crack resistance, impact strength, fiber is recommended: steel, glass and polymer.

The world practice of construction has revealed fibroconcrete as one of the promising building materials of the XXI century. The experience of such developed countries as the USA, Great Britain, Japan, Germany, Italy, France and Australia has convincingly shown the technical and economic efficiency of the use of fiber concrete in building structures and structures.

All existing fiber-reinforced concrete can be classified according to the types of fibers that are used in their reinforcement:

- Steel fiber reinforced concrete - reinforcement is made of steel fiber from wire, ropes, slabs, sheet;
- Fiberglass - reinforcement is made with fiber from quartz and other glasses;

• Basalt fiber reinforced concrete is reinforced with segments of basalt fiber and continuous threads of basalt;

• Fiber-reinforced concrete with the use of synthetic fibers - reinforcement is made with nylon, polyethylene, polypropylene, etc. fibers;

• Asbestos cement - reinforcement is made with short (0.5-4 mm) chrysotile asbestos fibers.

Comparative characteristics of all existing types of dispersed fittings are presented in table 1.

Table 1. shows the average values of various types of fibers. From the above list of fibers, glass, basalt, steel and carbon fibers can be considered the most effective for dispersed reinforcement of concrete in order to significantly increase its strength

Table 1.
Technical characteristics of fiber

Fiber	*Density, g/cm3*	*Tensile strength, GPa*	*Modulus of elasticity, GPa*	*Elongation at break,%*	*Geometric characteristics, L x H, mm*
Polyethylene	*0,95*	*0,7*	*1,4-4,2*	*10*	*5-30 x 0,005-0,015*
Acrylic	*1,1*	*0,21-0,42*	*2-4*	*25-45*	*5-30 x до0,02*
Asbestos	*2,6*	*0,91-3,1*	*68*	*0,6*	*0,1-10 x 0,001-0,05*
Glass	*2,6*	*1,05-3,25*	*70-80*	*1,5-3,5*	*5-50 x 0,005-0,05*
Basalt	*2,65*	*1,9-3,9*	*90-130*	*1,2-3,2*	*5-50 x 0,005-0,05*
Steel	*7,8*	*0,8-3,1*	*200*	*3,5-4,0*	*5-50 x 0,1-2*
Carbon	*2,0*	*2*	*245*		

When solving the issues of dispersed reinforcement of concrete materials, it is necessary to take into account that not all artificial fibers are able to withstand the effects of the environment of hydrating cements. Glass fibers of the usual composition are subjected to intense corrosion in hardening concrete on Portland cement. When cement stone hardens, an aggressive environment is formed, which destroys the surface of the fiber, forming shells at the same time. However, this may not only negatively affect the strength of the material as a whole. By introducing an additional fiber concrete additive, it is possible to regulate the degree of interaction of the fiber with the lime released during hydration of portlandcement.

From a number of mineral fibers, when assessing their resistance in an alkaline environment, basalt fiber is distinguished. According to some data, its strength when used in cement concretes does not change during the entire service life.

Basalt fiber concrete in comparison with steel fiber concrete, subject to the development of optimal methods of fiber distribution in the matrix and the development of the matrix itself, will be able to have higher strength and deformability, because the basalt fiber reinforcing it provides a higher degree of dispersion of cement stone reinforcement and the basalt fiber itself has a higher strength than steel fiber, which is 1.9 - 3.9 GPa. In addition, basalt fiber concrete will be able to tolerate large elastic deformations because basalt fiber has practically no plastic deformations during stretching, and exceeds concrete by more than 3 times in modulus of elasticity. The density of basalt fibers, with other comparable characteristics with steel fiber, is 3 times less. This facilitates the construction of basalt-fiber concrete, reduces the total weight of buildings and the cost of their construction as a whole. Due to the thickness of the fibers 10-12 mm, which is less than the minimum possible diameter of the steel fiber by an order of magnitude, the adhesion surface with the cement matrix can reach up to 100,000 m / kg, depending on the dosage of the fiber in the cement system. At the same time, none of the modifications of the known fibers has such a powerful raw material base.

The influence of basalt fibers on the properties of concrete depends on their length and the ratio of length to diameter. Theoretically, longer fibers and with a larger length-to-diameter ratio are better than shorter ones. The longer the length of the fibers, the more the fiber affects the strength characteristics of concrete as a whole. However, long fibers are more difficult to distribute and lay, they are less distributed in concrete. The most effective length of mineral fiber for dispersed concrete reinforcement is 8-15 mm, while the condition must be met that the length of the fiber must exceed the double diameter of the largest aggregate.

Until now, the use of basalt fibers in building products has been hindered by a number of reasons. In particular, there is no regulatory framework for the design, calculation, and production technologies of building structures made of commercial concrete using basalt fiber. There is no extensive introduction of basalt fiber concretes due to the lack of regulatory documents establishing requirements for the basalt fiber itself as a dispersed reinforcement of concrete. It is for this reason that the data on the resistance of fibers to an alkaline environment differ. There are two technologies for producing basalt fiber: by blowing from the melt and by pulling fibers from the melt through dies. The first method is used to obtain thermal insulation materials. The resulting material has a large number of extraneous inclusions in the form of kings, the fibers have a large variation in geometric dimensions both for a single fiber and for the total mass of the fiber as a whole.

The second method allows you to adjust the geometric characteristics of the fibers, to obtain a fiber of the same structure and mechanical properties. This method of obtaining basalt fiber is most suitable for dispersed reinforcement of concrete.

Despite all the variety of types of fibers used in the construction industry, it is not possible to choose a single type that would meet all the requirements for modern building materials. In our case, fiber reinforced concrete reinforced with high-strength fibers with a high modulus of elasticity relative to concrete is of interest. Each of these types of fiber concrete has its own advantages and disadvantages.

The most common binder for obtaining high-strength concrete is Portland cement. The medium of hydrating Portland cement is quite aggressive towards all types of mineral fibers. However, this factor can have both a negative and a positive effect on ensuring the strength of adhesion in the contact zone between the cement matrix and reinforcing fibers.

The main component of the liquid phase of the hardening Portland cement affecting the reinforcing fibers is calcium hydroxide, which actively interacts with the components of the mineral fiber, primarily with silica. As a result of the action of the alkali-containing liquid phase of hardening cement, corrosion destruction of mineral fibers occurs due to leaching and destruction of their silicon-oxygen framework during prolonged contact with the medium. It should also be noted here that a decrease in the content of alite and an increase in the amount of the belite phase in portlandcement reduces, as a rule, the intensity of the aggressive influence of the cement hydration medium in relation to glass fibers.

However, the best results in compressive strength are shown by cements with a high content of C3S (at least 50%). Thus, cements with a high content of the alite phase are needed to obtain high strength, which can negatively affect the durability of basalt fiber over time. This problem can be solved with the help of a certain amount of active pozzolan fillers that bind calcium hydroxide released during hydration. It was noted above that one of the conditions for obtaining ultra-high-strength concrete is the rejection of a large aggregate. And the fine filler should be limited to fractions no larger than 1 mm. At the same time, granulometric selection of aggregates should be carried out, ensuring maximum packaging of all components of the granular frame of the concrete mixture. Such a filler composition is more favorable to the uniform distribution of fiber than a coarse-grained mixture. When reinforcing concrete with mineral fiber, it is recommended to use a filler with a grain size of up to 2.5 mm. One of the conditions for obtaining high-strength concrete is the minimum voidness and uniformity of its structure, achieved by the exclusion of coarse grain and the selection of appropriate fractions. Also, the quality of fiber concrete depends on the chemical and mineralogical composition of aggregates, their structure, grain shape, density, hardness, strength and other properties. Experience in the production of high-quality concrete in the USA and Europe shows that the maximum size of the aggregate should not exceed. Such concrete essentially becomes fine-grained, with a more homogenized structure. One of the most promising and effective ways to improve the structure of cement compositions and concretes based on them is the widespread use of various organic and inorganic additives. Modifying additives introduced in small quantities have an effect on the processes of hydration and crystallization, the morphology of neoplasms and, in general, on the structure of hardened cement stone, thereby changing the properties of concrete - strength, porosity, water resistance, shrinkage, crack resistance, etc. An actual direction in obtaining high-quality cement compositions that differ in a wider range of functional capabilities is the use of complex additives that combine the properties of individual additives of various functional purposes. The multicomponence of complex additives and the multicomponence of the concrete mixture makes it possible to effectively manage the processes of structure formation at all stages of the concrete preparation technology and obtain concrete with various operational properties. At the same time, the high technological properties of concrete, along with the multicomponent composition, are also provided by the high functional properties of the components themselves.

In Uzbekistan, the use of fibroconcrete in construction has not yet been given sufficient attention, due to insufficient knowledge of its properties and production technology, lack of information about the availability of a raw material base of fibrous fillers and insufficient validity of effective areas of its use. Taking into account the fact that the production of basalt fiber has been mastered in Uzbekistan (in the city of Navoi), as well as the fact that the construction industry of Uzbekistan needs new modern effective structural building materials, we consider it expedient to conduct a complex of research works to study the properties of basalt fiber concrete based on local raw materials and materials.

Conclusions: not enough attention has been paid to the use of fiber concrete in construction yet, due to insufficient knowledge of its properties and production technology, lack of information about the availability of a raw material base of fibrous fillers and insufficient validity of effective areas of its use. It is advisable to carry out a complex of scientific works on the study of the properties of fiber concrete.

Used literature:

1. V.A. Perfilov, V.A., Zubova, M.O. Influence of basalt fibers on the strength of fine-grained fiber concrete. 2015.
2. Zubova, M.About Fine-grained concrete with the use of basalt fiber and complex modifying additives: 2014.
3. Levchuk, N.V. Physico-chemical and technological aspects of the use of basalt fiber

/ N.V. Levchuk, E.I. Shlyakhova // Bulletin of Brest State Technical University. un-ta. – 2017.