ADVANCED COMPOSITE CONSTRUCTION MATERIALS, FILLED WITH BASALT

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Predstavleny the results of research of building materials filled with basalt. On the basis of experiment it was shown that the basaltic component allows you to increase the carrying capacity of the product at work in compression and bending. The experiment showed that the Flexural strength in the initial period of hardening of samples containing 2,5% of basalt fibers with a length of 0,5 cm greater than the strength of control sample, upon further curing, the strength values differ slightly. Test results show that the introduction of basalt filler increases the strength of the samples. The possibility of using basalt aggregates in combination with traditional astringent cement. The resulting research shows that the introduction of finely ground basalt dust as a mineral filler it is possible to obtain building materials of high strength.

Keywords: cement, basalt, experiment, Flexural strength, concrete, construction

Advantages of basalt filler

One of the most promising trends in the construction industry is the creation of new materials, including concrete with the addition of basalt, with high strength under compression, bending and tension. On the basis of basalt fibers can be obtained heat-insulating, sound-absorbing, moisture-proof and high-strength composites have the low cost [1–4].

The structure of the concrete using basalt fibers is close to the structure of ferrocement with reinforcement of steel mesh. However, basaltine has higher strength and deformability, as basalt reinforcing it provides a higher dispersion degree of stone reinforcing, and the basalt has higher strength (1800–2500 MPa) than steel mesh.

In addition, basaltine can carry large elastic deformations because basalt fiber tensile plastic deformation has not, and elasticity greater than that of steel. During hardening of cement stone formed aggressive environment, which destroys the surface of the fibers, forming a shell. The fiber strength is reduced by 10%, but the resulting shells of the bonding strength of the stone and fiber increases, so the strength of the structure itself increases.

When using thick fibers (more than 100 microns), their strength is not changed. Made from rocks, basalt fiber does not react with salts or dyes, therefore, concrete mixtures with the addition of fibers can be used in construction of marine structures, and in architectural and decorative concrete. In pavement, the fiber protects the concrete and rebar from the penetration of de-icing salts and aggressive substances, and increases the residual strength and resistance to freezing-thawing increases the surface roughness.

The use of quality concrete with special additives, including monofilament reinforcement provides resistance to temperature extremes, protecting against faults, cracks and exfoliation of the surface, eliminates plastic shrinkage cracks, increases the durability of the surface, edge and seam, as well as resistance to abrasion and impact, provides an early compressive strength, that is strength, which becomes normal concrete only after 28 days.

The main features of basaltina is the ability to endure large strains in the elastic state, as well as its high durability in all types of tense States. Armed with these properties, the relative deformation of the cement stone without cracking reaches 0,7–0,9%. This deformation in the 35–45 times greater than the ultimate state of non-reinforced cement, by eliminating the basalt fiber of the influence of stress concentration where there are places weakened structural defects of cement, there is a significant increase of deformability and strength.

Research of possibility of application of basalt in building construction

Tests have shown that the use of coarse basalt fibers most effectively in the construction in which the clamps are set according to design requirements. When these indicators achieved 100% reduction in the consumption of steel for transverse reinforcement. The experiment confirmed the possibility of using continuous basalt fibers and coarse fibers as reinforcement in concrete mixtures for construction. The smaller the diameter of basalt fiber, the greater the reduction in strength in a cement environment.

Strength in compression samples with different content of basalt filler

Composition	Compressive strength, *R*, MPa			
	3 day	14 day	28 day	after 20 frost cycles
Cement	30,1	32,0	40,2	40,8
Cement + sand + 2,5 % finely ground basaltic component	39,0	40,0	45,0	45,5
Cement + sand + 5 % finely ground basaltic component	28,0	29,0	39,0	38,9

We have conducted an experimental study of the impact of fine basalt filler on the strength of the samples [5]. Comparative results of determination of compressive strength (R_{com}) experimental samples of the cement composites of different composition are given in Table. Samples of the compositions were tested for resistance to frost. One cycle was 3–4h of freezing and thawing. The compressive strength was determined after 20 frost cycles.

The data show (Table):

– in comparison with standard (control) sample, the highest compressive strength of samples of composite materials containing 2,5 % finely ground basalt (R = 45M MPa);

– after 20 cycles of freezing and thawing durability of the experimental samples almost fell.

The resulting research shows that the introduction of finely ground basalt wool (basalt dust) as mineral filler, it is possible to obtain building materials of high strength.

The authors conducted a study of compositions with crushed basalt wool of different length to study its effect on the strength characteristics of the compositions. We investigated the properties of composite materials filled with inorganic matrix in the form of crushed basalt wool and basalt fiber. We used the following materials: Portland cement grade 300 and above; siliceous component: Wolski standard sand with a fineness modulus of 2,1; basalt component: crushed basalt wool and basalt fiber with a fiber length of 0,5 and 2 cm. Basalt filler was injected in an amount of 2,5 % and 5 % by weight of cement.

The amount of water was determined from the ratio of To/TS = 0,4 mm. Materials compositions are dosed out by weight. For the purpose of uniform fine distribution of the filler was carried out mechanical activation of cement with sand and basalt filler in a ball mill for 2 h Composition prepared by mixing materials in a laboratory mixer. The tests were carried out on samples of cement stone 4×4×16 cm. All samples were mixed according GOST [5]. After the first day, the samples were resalable and steamed for 12 hours. Testing of samples was performed after storage under normal conditions (temperature 20 ± 2 °C, humidity 100 %) for 7–28 days.

As a counterpart served as a control sample, composed of cement, sand and water. Comparative results of changes of bending strength of composite materials of different composition is shown in Fig. 1, 2.

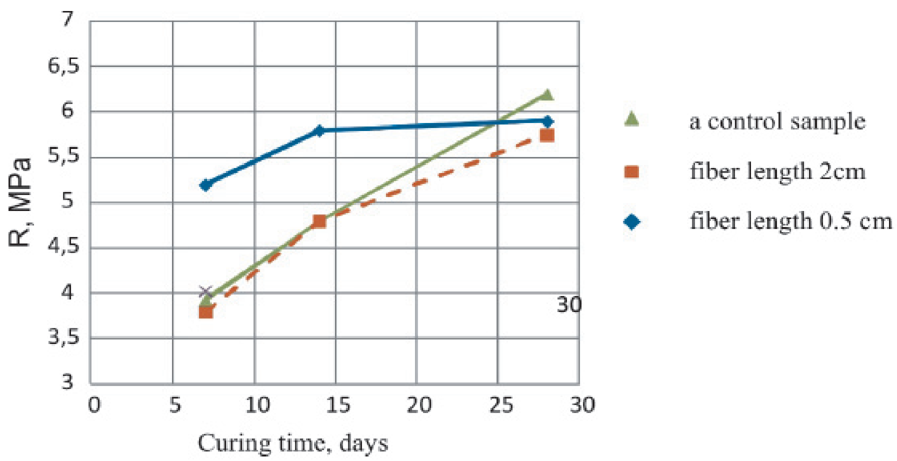

Fig. 1. The change in the strength of samples in bending containing 2,5 % basalt

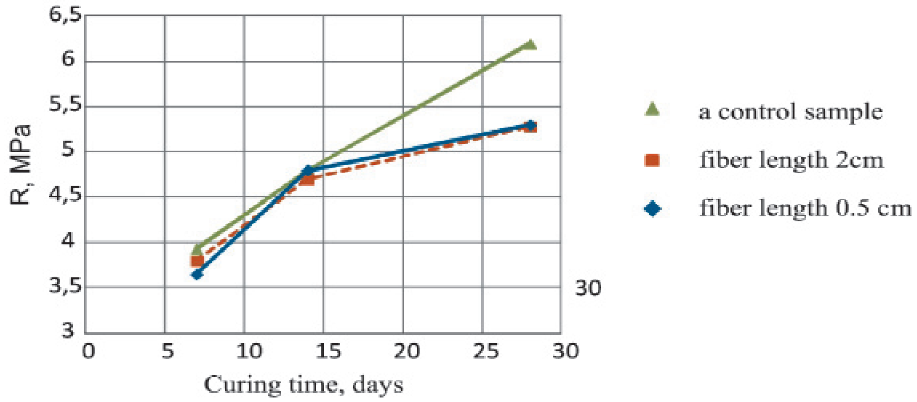

Fig. 2. The change in the strength of samples in bending containing 5 % basalt

Analysis of experimental data showed that the Flexural strength in the initial period of hardening (7 days) in samples containing a 2,5 % basalt wool length 0,5 cm greater than the strength of control sample, with a further hardening (28 days) strength values vary slightly. The introduction of the filler length of 5 cm leads to a decrease in bending strength in comparison with the control sample (Fig. 2).

Flexural strength at 7 days for samples containing 5 % basalt wool length 0,5 and 2 cm below the strength of the control sample, with a further hardening (28 days) strength values significantly lower than control sample. The long fibers are difficult to distribute evenly in the composition, so further development of the technology of introduction of basalt fibers.

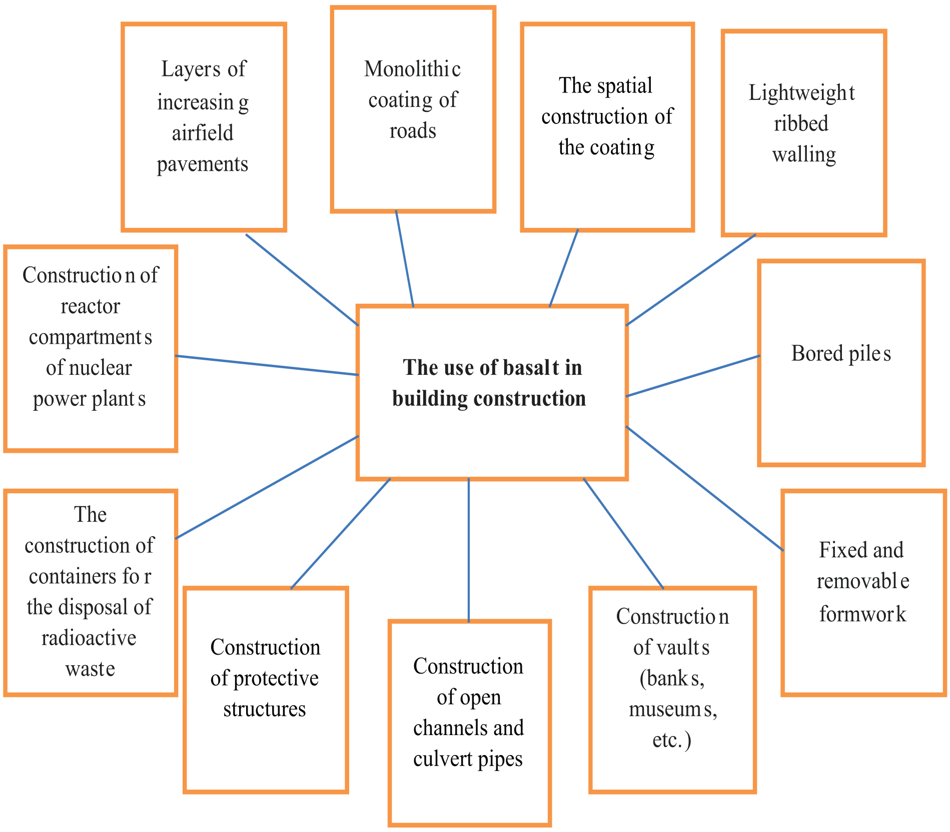

Fig. 3. Basalt in modern concrete structures

The scope of application of concrete filled with basalt

The application of new materials based on basalt fibers (Fig. 3):

– in structures, which are increased requirements for stiffness and fracture toughness;

– in buildings experiencing the impact and alternating loads;

– in thin-walled structures and structures with complex geometric shapes;

– in the reinforcement of the most intense sites of structures;

– structures transverse reinforcement which is mainly intended for the perception of mounting and transportation of loads;

– in structures, which are increased requirements for frost resistance, water resistance, durability and resistance to thermal shock.

In addition, effective use of concrete with the inclusion of basalt in the centrifuged tubes, in road construction and the supports of the contact networks in concrete water channels, fireproof structures, earthquake-resistant houses and military buildings, runways of airports, high speed roads, industrial floors in shops where heavy equipment is installed.

We recommend the use of concrete with basalt for internal reinforcement of tunnels and channels, strengthening of the slopes, repair and reconstruction of structures, coating of metal surfaces of steel structures.

Conclusion

Studies have shown the following:

– greater breadth of application of basalt in various industries and particularly in buildings made of concrete;

– the use of basalt aggregates in combination with traditional astringent cement;

– a significant effect of the type and length of basalt filler on the physico-technical properties of concrete; however, long fibers more difficult to distribute evenly in the composition;

– with the introduction of finely ground basalt wool basalt dust as a mineral filler it is possible to obtain building materials of high strength.

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