Effect of Morphology of Raw Resources of the North Caucasus, Used in the Production of Astringent Low Water Requirements, on the Strength Characteristics of Fiber-Reinforced Concrete

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Abstract. Every year, technical progress is gaining momentum, providing the society with innovations in the field of building materials science. But many problems still remain unresolved. With the growth of urban areas, there is a need for building materials that provide the required strength characteristics and have a minimal negative impact on the environment. The use of local raw materials for the production of astringent low water requirements with subsequent use in fiber-reinforced concrete in the North Caucasus allows solving these problems. Not only natural resources of the North Caucasus in the form of sand were used as the main components of the astringent low water demand, but also wastes from the construction industry. Secondary use of construction waste in addition to technological features improves the ecological territory of the region, reducing the landfill area. In addition to environmental safety, the use of this building material reduces the water-cement ratio and the consumption of Portland cement. The use of basalt fiber as a micro-reinforcing material increases the chemical resistance of fiber-reinforced concrete in general and allows using it in underground structures where aggressive groundwater is present. Also, this type of dispersible reinforced concrete, taking into account its thinness, is rationally used for reconstruction and repair in connection with the low weight of elements, in order to reduce the cost of reinforcing foundations, bases and bearing structures in conditions of increased seismicity. It has been proven by experience that the use of fiber-reinforced concrete with the use of binder from local raw materials is expedient for the erection, repair and reconstruction of buildings and structures in the North Caucasus.

1. Introduction

The North Caucasus is part of Russia, located in the mountains and foothills of the Caucasus. Geographically, it is located in Asia, south of the European part of Russia. In this region are the most fertile lands, the most important resorts and the highest peaks of the country [1]. This region is special

not only because there are a large number of mountain peaks on its territory, but also the presence of mineral water sources attracting an impressive number of tourists in health resorts of the North Caucasus.

All this is a favorable factor for recreation; however, it negatively affects the buildings and facilities of this region. Surface waters close to the surface have a negative impact on the bearing capacity of the base and the materials of the underground structures [2, 11, 12, 13], and mountain formation (or orogenesis) occurs under the influence of intense ascending tectonic movements [3, 15], which are accompanied by seismic activity that adversely affects buildings and structures in whole.

On the basis of the above-stated, when erecting and renovating buildings and structures in the North Caucasus, it is necessary to use materials that retain their strength characteristics under the influence of vibration loads and chemical effects. Another important aspect is the use of local raw materials for the production of building materials and structures in order to reduce the cost of transporting the raw material.

2. The description of a problem and its solutions.

When analyzing materials used for construction and repair in the region under consideration, fibro-concrete is of particular interest. Dispersed reinforcement is carried out by fiber-fibers, which are uniformly dispersed in the volume of the concrete matrix. For this, various types of metallic and nonmetallic fibers of mineral or organic origin are used [4, 14, 16, 18]. Hence the name fibro-concrete.

When designing the composition of fiber-reinforced concrete, it was decided to use basalt fiber as a dispersive-reinforcing element, as an astringent - an astringent for low water demand based on local raw materials, as well as small and large aggregates of local natural deposits.

The use of basaltic fiber, which is represented in Figure 1, is advisable because basalt is chemically inert material that does not enter into chemical reactions with salts or dyes, imparts resistance to fibrous concrete to aggressive media [5, 17, 18].

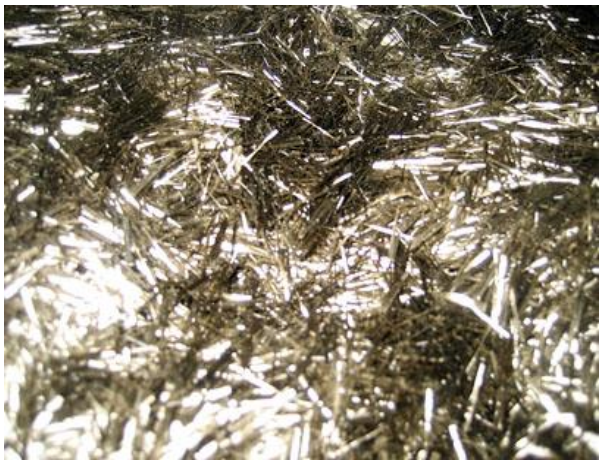

Figure 1. Basalt fiber.

As an astringent, an astringent low water requirement consisting of:

- Portland cement of grade 500 without additives, Ust-Dzhegutinsky deposit, Karachaevo-Circassian Republic;
- Siliceous constituent obtained by grinding in a vibrating mill to a specific surface area of 500 m2 / kg of Malkinskoye sand;
- Ceramic component, obtained by grinding in the vibrating mill of construction waste products, representing brickbats.

In the laboratory, prototypes were made, the extraction process of which is shown in Fig. 2, for further tests of strength characteristics.

Figure 2. The process of extracting laboratory samples from molds.

Laboratory tests conducted on the basis of the North-Caucasian Branch of the Belgorod State Technological University named after. V.G. Shukhov» revealed that the low-water, astringent component parts of the binding agent up to a specific surface area of 500 m2 / kg form a solid structure of cement stone. Fibreconcrete with the use of such composite binder, coarse and fine aggregates and basalt fiber as a micro-reinforcement retains the visual integrity in the form of a T-section after removal of compressive loads, as shown in Fig. 3a.

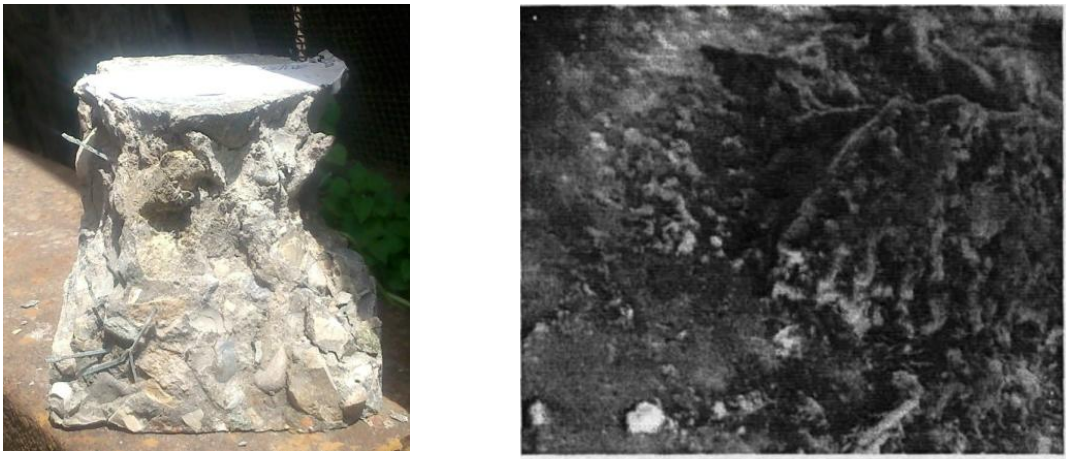

Figure 3. Fiber-reinforced concrete from the raw resources of the North Caucasus:
a) after carrying out compression tests; b) contact zone in 1000 magnification.

For definition of chemical stability fiber-concrete products tests beam in the sizes 40x40x160 mm in quantity of 7 pieces [6] have been made. Each of them has been subjected, according to the normative documentation, influence of excited environments of following types:

- Organic acids;
- Salts and bases;
- Solvents;
- Oil products [7, 19, 20].

According to the normative documentation for determining the chemical resistance of concrete, the coefficients of chemical resistance for a given type of fiber-reinforced concrete were obtained. After

the samples were found in various reagents, the average chemical resistance coefficient was found to be 0.67, which relates the considered type of fiber-reinforced concrete to chemical-resistant media [8].

Thus, it can be concluded that the use of astringent low water requirements, consisting of raw materials of the North Caucasus, is appropriate for designing a composition of fiber-reinforced concrete based on basalt fiber with subsequent use in this region. The use of this kind of building composite is possible not only in the region under consideration, but also in others where seismic activity has 8 or more points on the Richter scale [9], as well as in areas where ground waters contain mineral or organic acids or their salts [10].

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