NANOMODIFIED CONCRETE: TECHNOLOGIES OF THE XXI CENTURY

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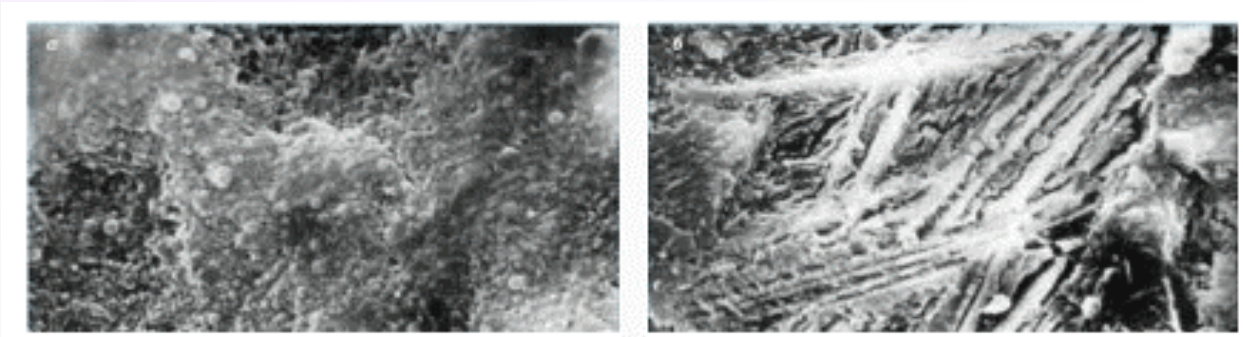
Annotation: Reinforcement of concrete with fiberglass allows you to increase strength, resistance to aggressive environments and temperature extremes, and improve other characteristics. The optimal fiber for these purposes is basalt. It is lighter than steel, does not cause corrosion, and the price is significantly lower. It also outperforms polypropylene and glass microfibers in many ways.

Keywords: Nanomodified concrete, uniform distribution, nano concrete, strength, water resistance, frost resistance.

Introduction



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Nanotechnology gives building materials amazing strength characteristics. Nano concrete - is a material that has been transformed in one way or another using nanotechnology.

The most common options are:

• Adding special components to the concrete composition.

1. Modified basalt microfiber (MBM);
2. Dry mix of ready-to-use additives (SDGD).

• Treatment of existing structures with special coatings.

• Use of modified armature in reinforced concrete.

The term "nano", despite the fact that it has taken root in the people, is still something very small, or rather, one billionth of a meter in size. And concrete, in its construction volumes, does not fit this definition in any way.

The most correct name would be “Nanomodified concrete”.

Principle work nanoparticles in concrete

Experiments with nano-additives for building materials began at the end of the 20th century. It was noticed that when intervening in the composition of carbon nanotubes in an amount from 0.001 to 0.0001% of the proportion of the consumption of the binder, the strength and other characteristics of the material increase up to 40%.

This happens due to the fact that nanoadditives provoke the growth of crystals in a mineral substance, and their rays, expanding and intertwining with each other, give the material a higher strength. This process was called dispersed self-reinforcement. At the same time, the strength of the cement stone increased by up to 40%, and of concrete - by only 10%.

In the picture: a-structure of an ordinary cement stone; b - stone, after adding nanotubes.

The second problem was that the direct introduction of an aqueous suspension with nanotubes is unacceptable for open production. Since this manufacturing method requires laboratory conditions under which a uniform distribution of micro-portions of the nanomaterial in a given environment is ensured. Otherwise, all this can fall into a useless sediment.

Strength and resistance to corrosion, the modified stone is given precisely by the strongest interconnection of nanoparticles with each other. Destruction requires only intense and prolonged external exposure to ultrasound. In addition, the bonds formed are chemically stable and do not react with alkalis or acids.

After abandoning the aqueous suspension, it was decided to apply self-reinforcement nanoinitiators directly to the solid filler:

- First we experimented on the sand. The result turned out to be better: the concrete structure began to change partly at the macro level, but the material was still not strong enough for its cost price.
- Next, instead of sand, we tested basalt microfiber. The technical characteristics of the stone obtained exceeded all expectations. It also turned out that cheaper nanoparticles (astralenes) can be used for this method.
- As a result, high quality, durable concrete was developed at a reasonable cost for use in the construction industry.

Modified Basalt Microfiber

Reinforcement of concrete with fiberglass allows you to increase strength, resistance to aggressive environments and temperature extremes, and improve other characteristics. The optimal fiber for these purposes is basalt.

It is lighter than steel, does not cause corrosion, and the price is significantly lower. It also outperforms polypropylene and glass microfibers in many ways.

This material has a number of advantages: tensile strength; adhesion; elasticity; thermal stability; abrasion; chemical resistance.

Basalt fiber

With the advent of nanomodification, basalt fiber, already winning in almost all positions, acquired several more advantages:

- Improved the mechanics of its work in the material;
- Expanded the range of climatic conditions of use.
- The modification consists in the fact that nanoparticles (carbon astralenes) are applied to the fiber.

The chemical processes initiated by them lead to an increase in the interaction of microfiber with surrounding substances, tightly "linking" all the material to each other into a single whole.

Table 1
Experimental data

Series no.	Number of MBM,% of the binder	Mixing time, min	Spread diameter according to Suttard, mm	Cone draft, cm	Relative shrinkage deformation, %
1 (control)	0	20	210	17	0,363
2 (developed way)	7,5	20	170	13,8	0,180

The table shows a comparison of experimental data for a concrete sample with the addition of conventional basalt fiber (1) and modified (2).

• The study was conducted for the mining industry in order to understand the benefits of using the new material. The main criterion for the assessment was the shrinkage rate.

• In this test, it was found that the relative shrinkage deformation of the sample with nanomodified fiber is less than 50%. This means that the structure in which this modification is used will be less susceptible to change in shape when the concrete mixture hardens and dries.

• During the experiment, during 10-15 minutes of mixing, the modified fibers were still observed in the mixture, their clumps and clumps. That is, it is better to increase the duration of this procedure - to ensure the most uniform distribution of fibers in the volume.

• In fact, this is the only drawback: in comparison with ordinary basalt fiber, there is no time saving.

Application area

The area of application of modified basalt microfiber is largely dictated by its size - the fiber length is less than 0.5 mm. This allows it to be used not only in the manufacture of foam and aerated concrete, paving slabs, bricks, materials for gunning (decorative plaster, etc.), but also coatings applied using pneumatic spray.

Table 2

Application	**Dosage, kg / m3**
Non-autoclaved foam and aerated concrete, autoclaved, monolithic	0,6-1,0
Dry building mixtures, plaster	1,0-2,5
Repair mortars based on concrete, gypsum	2,0-3,0
Concrete floor, screed	1,5-2,5
SCC	1,5-4,0
Decorative concrete, small architectural forms	2,5-5,0
Glass fiber concrete	2,0-4,0

It turns out that the main application of nanotechnology in the construction industry is the invention of modified basalt microfiber, and nanoconcrete is one of the areas of its use.

Nanomodified concrete.

In cement mixes, to improve the quality characteristics of finished products, you can add directly modified basalt fiber along with other components. However, in 2008 (after the successful completion of the reconstruction of the bridge, see the photo below), the optimal formulation of a dry mixture of ready-made additives to the main composition of cement-sand-water was developed and patented.

Characteristics.

Concrete made with this additive is called: lightweight nanostructured concrete (BLN) - a structural building material with a low weight. No special conditions are required for the use of the DGSS.

High-tech durable nanoconcrete can be made by hand directly on the work site by adding the SSGD to the automatic mixer according to the instructions.

Table 3

Basic parameters of BLN (light nanostructured concrete)

№	Indicator name	Norm
1	Density, kg / m3	1350-1600
2	Compressive strength	35-65
3	Flexural strength	4-8
4	Flammability class	НГ
5	Flammability class, ^{0}C	750-850
6	Water resistance class, W	16-20
7	Водопоглощение, % по массе Water absorption,% by weight	0,4-1
8	Frost resistance class, F	200-500
9	Workability class	П4-Р6

Taking into account the significant cost of BLN, it is economically expedient to use it:

- During the construction of high-rise buildings;
- In bridge construction, road works and in the construction of hydraulic facilities;
- In seismically active areas, regardless of climatic zoning.

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