Natalya LUKUTTSOVA, Aleksej PYKIN, Dmitrij KIREYENKOV
Federal State Budget Educational Institutional of Higher Professional Education
«Bryansk State Technological Academy of Engineering», Russia

NANOMODIFIED CEMENT- AND SAND CONCRETE

Physical and mechanical properties of cement- and sand concrete modified by nanodispersed admixture such as water suspension of schungite (Karelia, Russia) are investigated. Admixture was obtained by ultrasonic dispersion reduced to powder schungite in water in the presence of the stabilizer.

Keywords: schungite, ultrasonic dispersion (USD), cement- and sand concrete (CSC)

INTRODUCTION

Nowadays in Russia and abroad the urgent task of nanotechnology in construction industry is to discover cheap and efficient methods of obtaining nanomodifying admixtures which make it possible, at nano- and microlevels, to control the processes of structure formation of composite materials and concrete among them. Promising scientific and technical area is the accumulation of knowledge and experience in cavitation technology. Examples of practical application of these technologies is obtaining nanoparticles in exploding cavitation bubbles, hyperfine dispersion of organic and inorganic materials in liquid media, ultra-fine aerosols for the needs of nanoelectronics and chemical industry, coating, obtaining nanosuspensions and nanoemulsions, compacting nanopowders, cleaning and so on. The aim of this work is to investigate the dependence of the particle diameter of schungite water suspensions on the time of ultrasound and the presence of the stabilizer and as well as to study the effect of the suspension on physical and mechanical properties of cement- and sand concrete (CSC).

1. EXPERIMENTAL PART

A characteristic feature of schungite is the structure of its carbon, which is the globule size from 6 to 10 nm. Scientists have determined the morphological similarity of schungite carbon globules and fullerenes: presence of an inner cavity and a two-dimensional hexagonal cell of carbon atoms. The carbon part of schungite is described by formula: $C_{690\text{-}2300}H_{100}N_{5\text{-}14}O_{5\text{-}16}S_{1\text{-}12}$. The specificity of schungite structure is also in the fact that silicon dioxide and carbon form strong interpenetrating nets. Therefore, each particle of schungite powder contains a nonpolar carbon and polar mineral components. Schungite makes it possible to produce electroconducting construction materials on its basis (mechanical strength, abrasion resistance, freeze-thaw resistance, electrical conduction, corrosion stability). Besides, the unique features of schungite are used to create on its basis structural radio waves shielding materials [1].

In order to obtain schungite powder with a specific surface of particles 360÷380 m^2/kg grinding of schungite gravel fraction 5÷10 mm was being conducted for 1 h in a vibratory mill. The particle size of schungite powder was determined by method of laser granulometry with «MicroSizer201».

Then, the schungite powder was added to water in the amount of 3% and treated by ultrasonic at frequency of 35 kHz from 15 till 30 minutes. The same was done with schungite powder the particles surface of which was treated with molecules of stabilizer of naphthalene-formaldehyde type (NF) at combined dry grinding of schungite and NF composition (1:0.2).

The size of the particles obtained after USD suspension was determined with the help of a multilevel system 90Plus/Bi-MAS. This system was designed to determine the particle size of concentrated suspensions of macromolecules.

To study the effect of nanodispersed schungite on mass specific gravity, water absorption, ultimate compressive strength and initial modulus of deformations of cement- and sand concrete test beams of 4×4×16 cm size were produced. They were made of Portland cement CEM I 42.5 N and quartz sand with fineness modulus 1.5 composition of (1:3). Supplements were admixtures in the amount of 0.3% (based on dry matter) from cement mass with water. These test beams were hardened under normal conditions.

To determine the initial modulus of deformation of test cement- and sand concrete were modified by microdispersed schungite at 5% from cement mass and subjected to static and dynamic loads.

2. RESULTS AND DISCUSSION

Figure 1 shows that the optimum time of ultrasonic dispersion of schungite powder in water without stabilizers is 15 minutes. It helps to obtain a suspension with particles from 124 to 1346 nm. An increase in the USD up to 30 minutes leads to particle aggregation and formation of more coarse suspensions with particle size ranges from 201 to 5112 nm (Fig. 2).

Aqueous suspensions of schungite are kinetic polydisperse and unstable regardless of the time of ultrasonic treatment. Sedimentation of aggregated particles is observed after 1÷2 hours [2].

The smallest diameter of schungite particles in water suspension, the absence of their aggregation and sedimentation are observed in the dry depositing of molecules of the stabilizer of naphthalene-formaldehyde type on the surface of schungite particles under the combined grinding components according to USD.

Ultrasonic dispersion of such particles during 15 minutes helps to obtain a suspension with a particle diameter from 51 to 304 nm (Fig. 3).

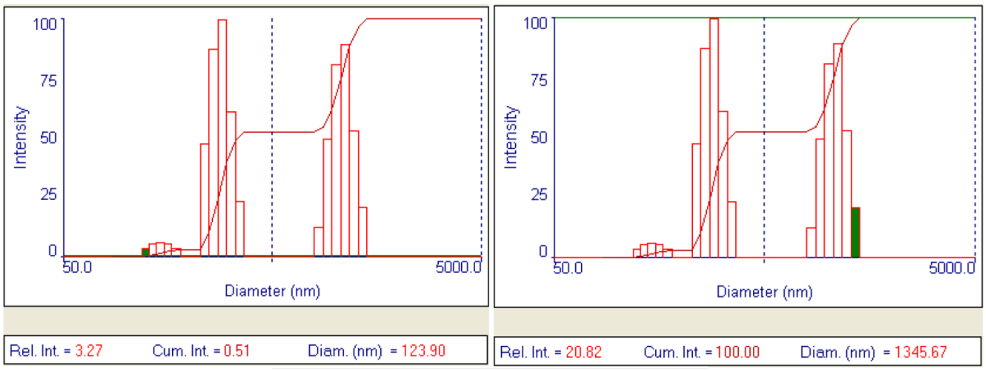

Fig. 1. Histogram of schungite particles distribution according to their sizes after the USD in water during 15 minutes

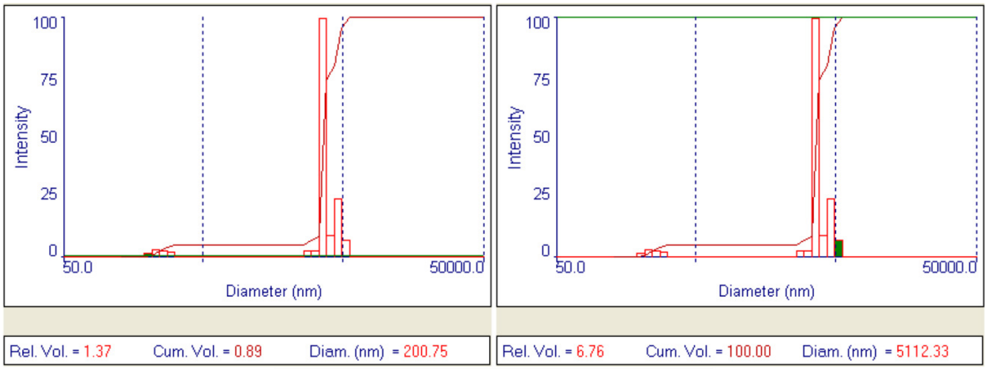

Fig. 2. Histogram of schungite particles distribution according to their sizes after the USD in water during 30 minutes

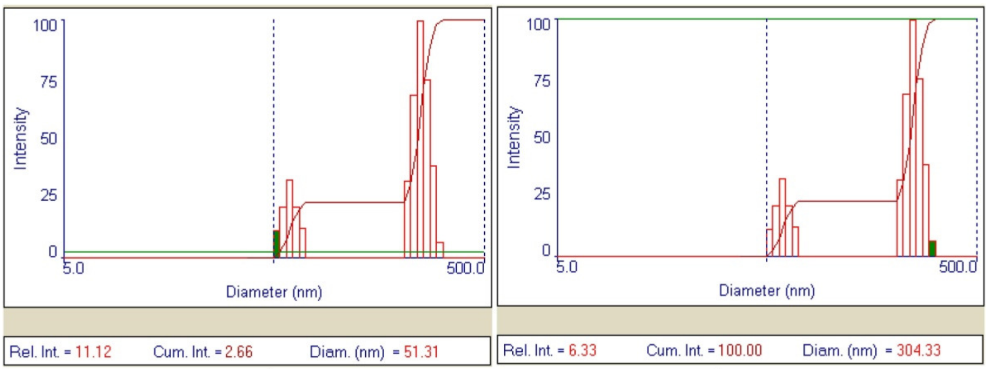

Fig. 3. Histogram of schungite particles distribution according to their sizes after the USD in water during 15 minutes in the presence of NF stabilizer

CSC maximum strength is observed with the introduction of the suspension of nanodispersed schungite suspension, which is stabilized by dry deposition NF stabilizer on the surface of schungite particles before ultrasonic dispersion (Table 1). According to the Table 1 maximum strength of modified concrete exceeds the strength of the control composition in 1.9 times after 1 days and 2.1 times after 28 days of hardening.

Table 1. **Physical and mechanical properties of cement- and sand concrete modified by suspensions nanodispersed schungite**

Composition of the CSC, the dispersion of admixture, the presence of the stabilizer	C/W	Mass specific gravity [kg/m^3]	Absorption of water [%]	Ultimate compression strength [MPa], after days of hardening		
				1	3	28
CSC control	0.43	2140	3.8	4.4	12.0	27.7
CSC with 0.3% schungite 124÷1346 nm without stabilizer	0.39	2165	2.9	5.1	19.9	34.3
CSC with 0.3% schungite 51÷304 nm with stabilizer NF	0.39	2297	1.7	8.5	33.4	57.2

The results showed an increase in mass specific gravity from 2140 to 2297 kg/m^3 and a decrease of water absorption from 3.8 to 1.7% in the strength of cement- and sand concrete with nanodispersed schungite admixture. When introducing in CSC microdispersed schungite in the amount of 5% an increase in initial dynamic modulus of the strain up to 45% takes place [3]. It is especially important in the construction of buildings and structures in the areas of high seismic activity.

CONCLUSION

A positive impact of nanodispersed schungite on the strength and deformation properties of cement- and sand concrete was determined. This method is characterized by high productivity and easy hardware. The composition of the modified cement- and sand concrete with nanodispersed schungite stabilizer in the presence of NF is recommended for covering the extra strong floors, construction elements of the urban slum (curbing, paving flag, etc.), as well as structures and constructions, resistant to bending loads.

REFERENCES

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NANOMODYFIKOWANY BETON CEMENTOWO-PIASKOWY

W artykule przedstawiono badania fizycznych i mechanicznych właściwości betonu cementowo-piaskowego modyfikowanego domieszkami nanodyspersyjnymi, jak na przykład wodna zawiesina szungitu (Karelia, Rosja). Domieszkę uzyskano poprzez ultradźwiękową dyspersję proszku szungitowego zredukowanego w wodzie w obecności stabilizatora.

Słowa kluczowe: szungit, dyspersja ultradźwiękowa (USD), beton cementowo--piaskowy (CSC)