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Nanosilica modifiers for cement mortars

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Abstract

Man-made products containing 95...96% of amorphous nanostructured silica were studied for the purpose of their usage as modifiers for cement mortars. These products are “belaya sazha (carbon white)” BS120 (BS) obtained by means of hydrochemical synthesis and amorphous silicon dioxide (ADK) produced from rice husk being thermally treated at 800 °C. Morphological properties and pozzolanic activity of the modifiers were analyzed. Nanostructured material BS is formed from corpuscular nanoscaled particles that are merged into aggregates. Lamellar and flaky ADK particles consist of coalesced nanoscaled granules.

The authors explain improving the performance properties of nanomodified cement mortars: increase of durability, water resistance and adhesion indices, reduction of water adsorption and decrease of shrinkage deformation while hardening. Development of mortar formula for waterproofing work is the practical application of the research findings.

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Keywords: modifiers for cement mortars; ultradispersed silica; nanostructured silica; cement mortars; paste matrix.

1. Introduction

Ultra-dispersed silica is an essential component of high quality concretes and cement mortars – a new generation of materials which possess unique performance properties in terms of strength, durability, permeability, and corrosion resistance [1]. Silica fume with the particle size of about 100 nm is a well-known and thoroughly studied representative of ultra-dispersed silicon dioxides which is used in cement technologies whereas ultra-dispersed nanostructured silicas obtaining greater dispersion are not widely applied due to lack of relevant research findings.

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The aim of this work was to investigate morphological characteristics of modifiers consisting of nanostructured silica and performance properties of modified cement mortars. The first modifier obtained by means of hydrochemical synthesis is produced in Russia under the trade name “Belaya Sazha (carbon white)”, BS120 (BS). The second modifier is produced from rice husk being thermally treated at 800°C and is known in Russia as ADK or “amorphous silicon dioxide” (ADK).

The following modifiers were studied: belaya sazha BS 120, Sterlitomak city (GOST 18307-78); amorphous silicon dioxide ADK, Shchyolkovo city (Technical Specification TU 2169-276-00209792-2005).

2. Morphological characteristics of modifiers

Silicon dioxide content in modifiers BS and ADK being determined by X-ray fluorescence analysis with an ARLOPTIM'X-035 Spectrometer was 95 and 96 %, respectively.

A Tesla BS-350 electron microscope was used for the analysis of the surface morphology, with image registration being conducted in a mode of secondary emission. The images showed that BS particles were aggregates consisting of interconnected corpuscular nanoscaled particles and had a spherical shape, Fig. 1a. Lamellar and flaky ADK particles were aggregates of coalesced nanoscaled granules separated by pore channels, Fig. 1b. The size of primary corpuscular BS particles was 20 nm, and the size of ADK granules was in the range of 60 – 120 nm.

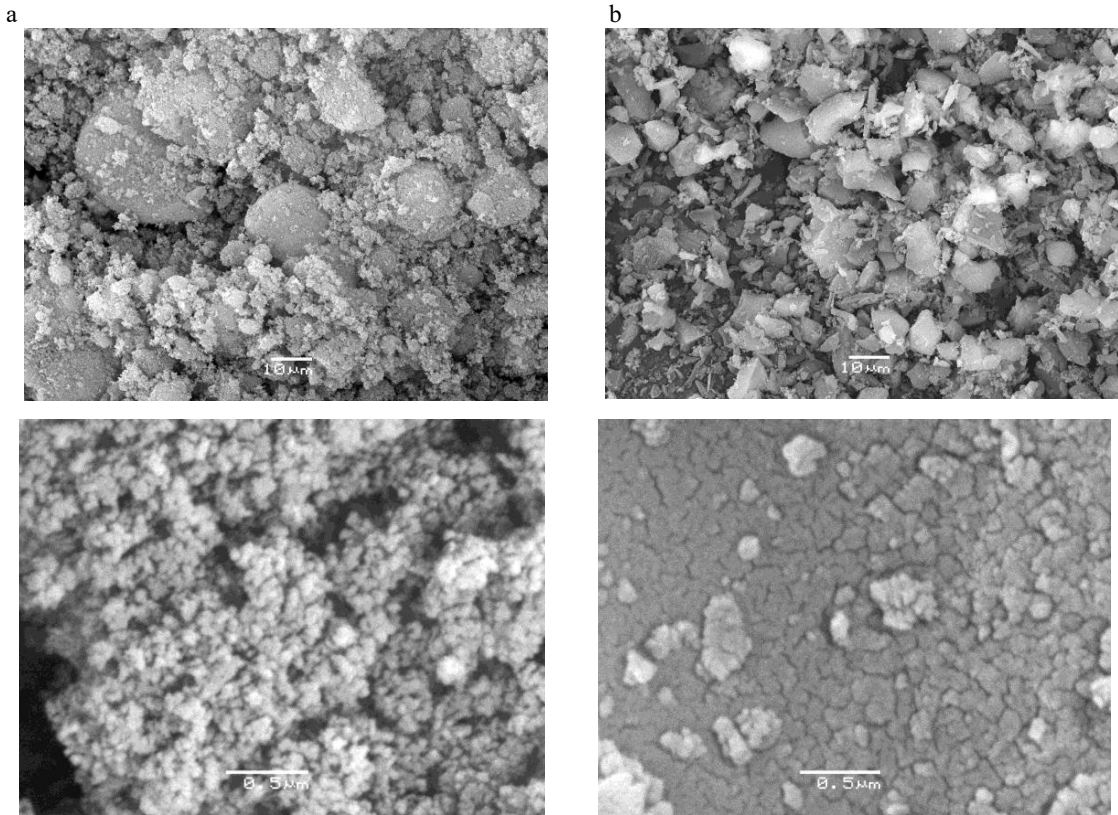


Fig. 1. Electron microscope images: (a) BS; (b) ADK.

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