Available online at www.sciencedirect.com
ScienceDirect
Procedia Engineering 150 (2016) 2163 – 2167
Procedia Engineering
www.elsevier.com/locate/procedia

International Conference on Industrial Engineering, ICIE 2016

Structural Features of the Cement-sand Mortar Reinforced with a Modified Basalt Microfiber.

V.A. Gurieva*, T.C. Belova

Orenburg State University, av. Pobeda 13, Orenburg 460018, Russia

Abstract

Use of modified reinforcing fibers that are dispersed in the mortar mixture increases the strength properties of a stone mortar. This happens due to the formation of structures and determines the need to study this phenomenon. Study of the mortar stone structure was carried out by comparing the samples of the reinforced solution and the solution without reinforcement. Investigation of the slurry microstructure revealed that administration of a modified microfiber basaltic composition in the solution reduces the number and size of pores, cracks, defects. This is due to the fact that upon the presence of a carbon nanomodifier the acerous calcium silicate neoplasms are formed, which fill the voids in the stone structure, thus sealing its. The interface reinforcing microfibers and a cement-sand matrix is characterized by a tight grip thereby increasing the efficiency of the particulate reinforcement in the cement. The results of the X-ray diffraction data confirm the electron microscopy data. They also point to the growth rate of tumors gel (calcium hydrosilicate type C-S-H (I and II). The established features of the structure of the cement-sand mortar, which is a modified basalt microfiber reinforcement allow us to explain increase in physical and mechanical properties of the dispersion-reinforced mortar.

Peer-review under responsibility of the organizing committee of ICIE 2016

Keywords: modified basalt microfiber; reinforced dispersion-solution composition; structure;

1. Introduction

Currently, solutions based on Portland cement is widely used in the device monolithic floors in buildings of industrial and civil objects. This is due to the simplicity of preparation technology mortars on the basis of the type of

* Corresponding author. Tel +7-905-819-9423.
E-mail address: victoria-gurieva@.rambler.ru

Peer-review under responsibility of the organizing committee of ICIE 2016
doi:10.1016/j.proeng.2016.07.258

binder and to a broad array of its physical and mechanical characteristics. However, the material in the floor structure is characterized by high flexural strength in comparison with a compressive strength, lack of durability, in some cases, high fracturing, peeling of the surface layer of the floor, an indicator of dust emission, etc. [1]. These drawbacks hindering the use of cement concrete and solutions in the construction of facilities, which are increased requirements for their performance characteristics [2].

One way to meet the challenges of improving the performance of the artificial stone is its reinforcement of different origin (mineral or organic) and the nature of materials types of fibers (metal and nonmetal) [3, 4]. This contributes to a significant densification, resulting in increased strength characteristics, increased frost resistance and water resistance of said material [5-7]. In addition, active development in the last two decades in building materials in nanotechnology combined with disperse reinforcement of cement-sand matrix material allows to obtain a composite material with unique properties [8-10]. Among these "nano" tools are nanomodified dispersed reinforcing microfibers, modified fulleroids, nanotubes, etc. [11]. It is known that the use of these modified microfibers which composed of concrete and mortar leads to a dynamic self-reinforcing cement stone [12-14]. In this regard, it is interesting application of basalt microfiber modified by carbon nanostructures fulleroid type. However, despite some cases of using this type of microfiber in concrete[15], there is no scientifically designed technology of preparation and laying mortar based on it and investigate the influence of the modified micro-basalt (hereinafter PBI) on the structure and properties of the solution.

By the solution used for the device monolithic floors, presented a set of requirements: fast paced curing, high final strength, low abrasion, crack, dust-free, dimensional stability, resistance to shock impacts [16], which are provided mainly structure of cement-sand composite. The properties of the starting components of the mix, their relationship with each other, the quantitative content of the reinforcing fibers in the mixture have an impact on the formation of the structure of dispersion-reinforced cement compositions [10,17, 18].

The authors of papers [19, 20] in a study the possibility of using modified basalt microfiber in the preparation of dispersion-reinforced mortar studied the mechanical properties of the synthesized building. To explain the experimental results to determine the physico-mechanical properties of cement mortars, reinforced with dispersed MBM, the microstructure of this solution was investigated. For comparison, a microstructure analysis of samples was conducted unreinforced. These images were obtained with a scanning electron microscope, the Japanese firm JEOLJSM-6460LV.

From the pictures it is clear that in a sample of basalt microfiber modified microstructure is more dense, homogeneous, with fewer defects (fig. 1b). Sample control composition characterized by significant cracking and the presence of pores. In the modified pattern no delamination between the matrix and filler solution.

a) b)

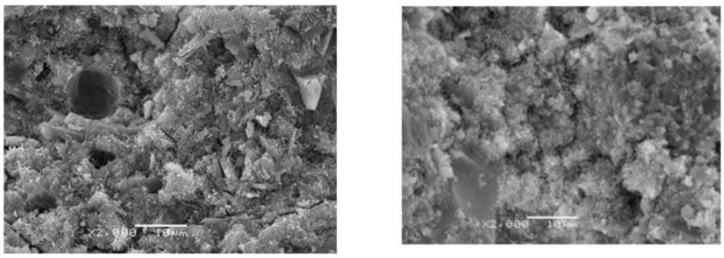

Fig. 1. The microstructure of cement mortar: a) controlling the composition; b) a composition containing MBM

The study of the morphology of neoplasms in the material revealed that the structure of the sample of the cement stone, dispersion-reinforced basalt fiber, represented mainly by fused agglomerates consisting of spherical (size 5 ÷ 25 mm), and granular structures, the cement matrix, which are located between the fibers. On the surface of the fibers present thin hexagonal plates and needle-like crystals that grow together with cement grains, and is a product of interaction of the surface layer of the fiber and hydration products of the cement system. Furthermore, in the sample containing MBM in places marked accumulation of needle crystals of calcium hydrosilicate, which is clearly visible at 5,500 x magnification of said region (fig. 2).

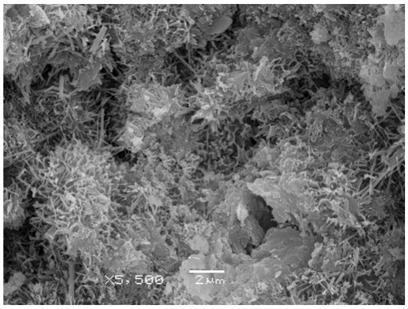

Figure 2. Area of cement-sand mortar with tumors of needle-like crystals of calcium Hydrosilicates

We can assume that in the presence of carbon in the slurry nanomodifier needle formed tumors - basic low calcium hydrosilicates. Formation of such a structure determines the increase in the strength of dispersion-reinforced cement mortar. Thus, according to [21], depending on the content of PBI fibers dispersion method compressive strength increases from 15.7% to 23.3%, flexural strength increases from 28.5% to 31.1%. In the shown [22] that the composition and the modifying microfiber super plasticizer in an amount of 1% by weight of cement results in reduced abrasion of the solution in the floor construction from 0.852 to 0.05 g / cm2, and reduced dust separation means.

Figure 3 shows microscopy structure of cement stone on the border with basalt microfiber section cement-sandy matrix, made with a scanning transmission electron microscope, a JEOL 6000 NeoScope.

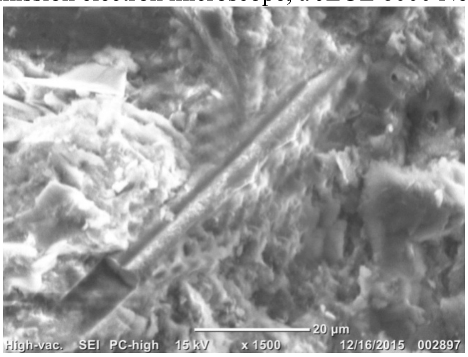

Figure 3. Detail of cement stone microstructure reinforced modified basalt microfiber, with increasing h1500

As can be seen from the picture, the interface between the modified basalt fibers and cement-sand matrix solution is characterized by strong adhesion, as evidenced by the absence of cracks and gaps. It permeates fused fiber agglomerates, consisting of rounded zèren C-S-H. Neoplasms are mostly located on the border of the cement stone and basalt fiber, which indicate chemisorption interaction with the emergence of additional neoplasms, perhaps related to the low basic calcium silicate. High adhesion reinforcing microfibers to a cement-sandy matrix enhances the strength properties of the composite. However, it should be noted that these processes are typical for regions along the border section "fiber-cement stone" and not for the entire volume of the cement stone.

X-ray phase analysis (XRD) to study the composition of hydration products controlling composition of the solutions was conducted with the content of the modified basalt microfiber. The diffraction patterns of the samples are shown in fig. 4.

The study showed that in the samples of stone mortar at the age of 28 days of hardening are present diffraction reflections residual quartz (3,34; 2,45, 2,28; 2,23, 1,817 Å), not hydrated minerals: alite C3S (interplanar distance of 3 87, 2,78 Å), belite C2S (interplanar distance of 2,78, 2,74 Å), hydrate formations - portlandite (interplanarspacings of 4.91, 3.11, 2, 63, 1,927 Å). At the same stone in a solution containing MBM significantly increased the number and intensity of portlandite peaks.

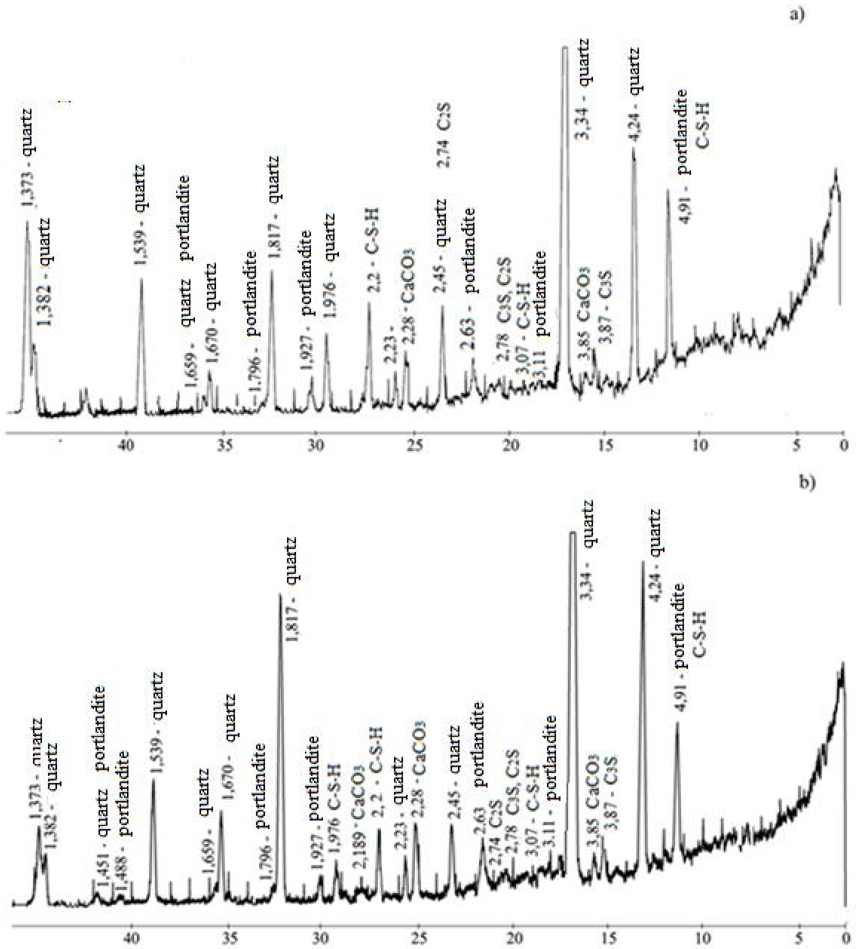

Figure 4. The diffraction patterns of Samples stone mortar and - a control composition; b - composition containing MBM

In the artificial stone both joints marked education as a result of carbonization of calcite (interplanar distance of 3,85, 2,28, 2,189 Å) of gelled neoplasms (Hydrosilicates type calcium CSH (I and II) - interplanar distance of 4.91, 3.07 and 2, 20, 1,976 Å). However, the reflection at small angles for these phases (12,5 and 9,80 Å) is not detectability by X-ray, although the formation of the gel in a solution hydrosilicate structure indicates the characteristic halo in the diffraction patterns. This suggests that the increase in strength of the artificial stone in the long process of hardening is due to the crystallization gel neoplasms (basic low calcium hydrosilicate) and formation of calcite. Increasing the number of data peaks tumors, their growth rate more actively occurs in the structure of the stone mortar containing MBM, as evidenced by Figure 4, diffraction pattern used.

Investigation of the structure of tumors found that they form a gel-like knitted space frame further enhanced reinforcing effect of the fibers, which, according to AV Volzhensky provides high strength materials performance. This gel structure is characterized by high stress relaxation and, consequently, a great opportunity to plastic - deformation and thus an increased fracture toughness, which is particularly important in the manufacture of foam concrete non-autoclave curing. Such a structure in which microcracks develop slowly as a result of blocking the process of plastic deformation of foam concrete provides high performance, good frost resistance and durability, which was confirmed by the test results.

2. Conclusions

- First point: Investigation of the microstructure slurries revealed that administration of modified microfiber basaltic composition in solution reduces the number and size of pores, cracks, defects. In addition, in the presence of carbon nanomodifier formed needle neoplasms calcium silicate, which fill the emptiness in the stone structure, thereby compacting it.
- Second point: The interface reinforcing microfibers and cement-sand matrix is characterized by a tight grip, thereby increasing the efficiency of the particulate reinforcement in the cement.
- Third point: X-ray diffraction results confirm the data of electron microscopy and also indicate the rate of growth of neoplasms gel (calcium hydrosilicate type C-S-H (I and II), which explains the increase in physical and mechanical properties of dispersion-reinforced mortar.

References

[1] G.N. Pshenichny, The problems that exist in the conduct of concrete, Technology of concrete. 12 (2014) 42–46.
[2] F.N. Rabinovich, What concrete builders need? Industrial and civil construction. 2 (2015) 41–42.
[3] S.H. Negmatullaev, S.P. Osnos, The use of materials based on basalt fiber in construction, Building materials, equipment, technologies of XXI century. 5–6 (2015) 15–20.
[4] S.V. Klyuyev, High-strength steel fiber concrete on technogenic sand KMA, Building materials, equipment, technologies of XXI century. 11 (2013) 38–39.
[5] V.G. Batrakov, Modified concrete, Stroyizdat, Moscow, 1990.
[6] A.I. Kondakov, Z.A, Mikhalev, A.G. Tkachev, A.I. Popov, S.Y. Gorski, Modifying the construction of the composite matrix functionalized carbon nanotubes, Nanotechnologies in construction: a scientific online magazine. 4 (2014) 31–44. URL: http://www.nanobuild.ru/magazine/nb/Nanobuild_4_2014.pdf.
[7] B.S. Batalin, Interaction with fiberglass cement stone, Glass and ceramics. 8 (2014) 37–40.
[8] K.A.Saraykina, V.A. Golubev, G.I. Yakovlev, S.A. Senkov, A.I. Politaeva, Nanostructuring of cement paste when dispersed basalt fiber reinforcement and building materials. 2 (2015) 34–38.
[9] J. Ambroise, S. Rols, J. Pera, Properties of self-leveling concretere in forced bysteel fibers, in: Proceedings of the 3rd International RILEM Workshop on Reinforced Cement Composites, HPFRCC3, Mainz. (1999) 9–17.
[10] V.P. Kuzmina, Formation of a three-tier structure nanomodified cement concrete - a pledge of durability of building structures, Concrete technology. 1 (2013) 16–20.
[11] Y.M. Bazhenov, V.R. Falikman, M.I. Bulgakov, Nanomaterials and nanotechnology in modern concrete technology, Herald MSUCE. 12 (2012) 125–133.
[12] A.N. Ponomarev, High-quality concrete, Analysis of opportunities and the practice of using nanotechnology methods, Civil Engineering Journal. 6 (2009) 25–33.
[13] V.R. Falikman, Nanomaterials and nanotechnology in modern concrete, Industrial and Civil Engineering. 1 (2013) 31–34.
[14] B.S. Harrison, A. Atala, Carbon nanotube application for tissue engineering, Biomaterials. 28 (2007) 344–353.
[15] S.S. Kaprielov, V.I. Travush, N.I. Karpenko, The modified new generation of concrete in the construction of MIBC Moscow City, Building Materials. 10 (2006) 13–18.
[16] Manual, Flooring.Technical requirements for sex, Design, structure and rules of acceptance of the sexes, JSC Tsniipromzdany, Moscow, 2001.
[17] V.M.C.F. Cunha, J.A.O. Barros, J.M. Sena-Cruz, An integrated approach for modeling the tensile behavior of steel fibre reinforced selfcompacting concrete, Cement and Concrete Research. 41 (2011) 64–76.
[18] F.N. Rabinovich, Composites based on fiber concrete, Questions of the theory and design, technology, design, Publishing House of the DIA, Moscow, 2004.
[19] T.K. Belova, V.A. Gurieva, V.I. Turchaninov, Study the impact of particulate reinforcement modified basalt microfiber on the strength properties of cement mortar, Don Engineering Bulletin. 2 (2015). URL: http: // www. ivdon.ru/magazine/archive/n2y2015/2883.
[20] T.K. Belova, V.A. Gurieva, Study the impact of teamwork modified basalt microfiber with a cement-sandy matrix, in: Proceeding of Innovative construction techniques, Theory and Practice, 2nd international scientific and engineering.conference dedicated to the 45th anniversary of the anniversary of the Faculty of Architecture and Construction OSU: IPK University. (2015) 146–151.
[21] V.A. Gurieva, T.K. Belova, Study of the impact of the particulate reinforcement modified basalt microfiber on the strength properties of cement mortar, Vestnik of OSU. 13 (2015) 106–109.
[22] V.A. Gurieva, T.K. Belova, Effect of particulate reinforcement modified basalt microfiber Abrasion mortars for floors, Building Materials. 1–2 (2016) 104–106.