Natal'ya Lukutzova, Olga Postnikova
Anastasiya Motzaenko, Irina Pinchukova

NANOMODIFIED DECORATIVE CONCRETE

Introduction

Nanodispersed additions in multicomponent alloys help to realize effects of structure formation. These effects lead to nano-sized particles reveal themselves as nucleus of structure-forming, substrate for crystallization, centres of new formation zoning in matrix substance, nano-reinforcing matrix element.

Usage of nanomodifiers leads to microstructure transformation that decreases capillary porosity, quantity of microcracks in system aquation. It provides building conglomerates with durability and reliability [1].

According to the science researches [2-4] nanodispersed additions give opportunity to get effective fine-grained concrete with better characteristics. It can be possible if thousandth up to 20% of nano-modifiers of binding mass are put in solution.

The aim of the work is ascertainment of possibility to change the structure of decorative fine-grained concrete that is modified by nanodispersed addition on basis of titanium dioxide.

1. Experimental part

Nanodispersed addition on basis of titanium dioxide was taken by dispersion of pigmentary dust by ultrasonic method with wave frequency of 34 kHz. The size of particles of pigmentary dust is 30÷45 mictomicron.

Steadiness of titanium diooxide particles in engineered suspension was provided with organical solvent (ethanol). The analysis of disperce modification of engineered addition shows the modification of coagulation steadiness as time goes by. Nevertheless, the second suspension treatment by ultrasound leads to redispersion.

To provide the most effective qualities of decorative fine-grained concrete nanodispersed addition on basis of titanium dioxide was applied at the age of 3 days.

To evaluate strengthening indexes of decorative fine-grained concrete test beams in size of 40*40*160 mm were built. CEM I 42.5 N and alluvial quartz sand with gradation factor M_k = 1.5÷1.8 were used in investigation.

2. Results and discussion

Differential thermal analysis (DTA) shows calcium hydrosilicates step-by-step dehydration of decorative fine-grained concrete. Thermograms (Fig. 1) show three endothermic effects in temperature area of 125÷150, 500÷525, 550÷575°C.

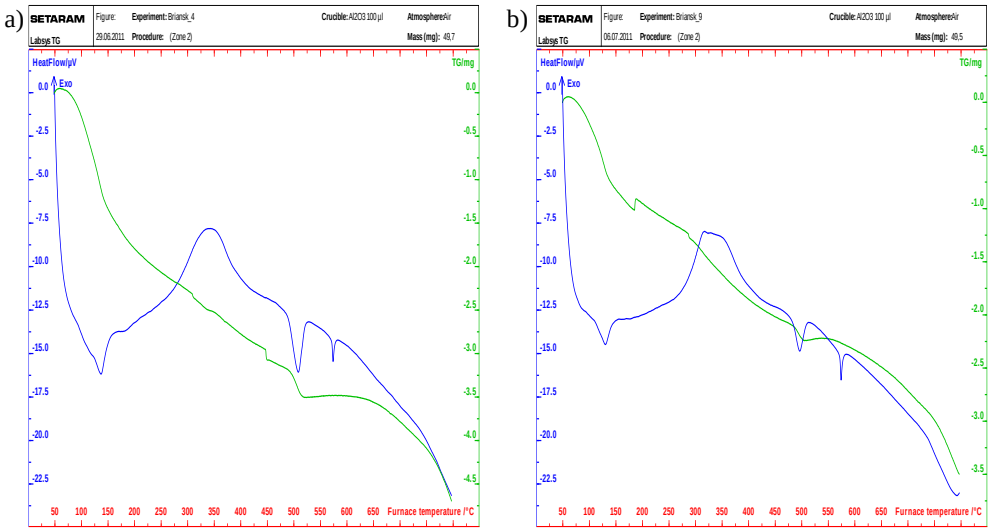

Fig. 1. Spectra DTA of concrete stencil, curves of TGA and DSC: a) reference template, b) modified template

Endothermic effect in reference template reveals at temperature of 575°C. The same effect happens in modified template at temperature of 562°C. Probably it is connected with increasing of calcium hydrosilicates basicity. Calcium hydrosilicates' endothermic effects with increasing of ratio CaO:SiO (over 1.5) temperature of dehydration shift to the left on the axis. Ratio decreasing lower 1.5 dehydration takes place at higher temperatures [4]. According to findings, in concrete stone, modified by nanodispersed addition on basis of titanium dioxide, more high-basis calcium hydrosilicates are formed.

Peaks analysis, that are characterised of Portlandite on the curves of TGA and DSC shows decreasing of heating effect on 14%, and loss of mass on 27% for the templates, modified by nanodispersed addition on the basis of titanium dioxide in comparison with control solution. This fact corresponds with increasing of peaks intensity of calcium hydrosilicates, that promote increasing of fine-grained concrete solidity.

Results of tests of structure of concrete stone with engineered addition ascertain that its pores and cracks contain additional amount of new formations. These formations are in form of solid accumulations of plates, prisms, fibers that are characteristic of calcium hydrosilicates. At the same time concrete stone of reference template has heterogeneous and imperfect structure. Pore structure of concrete stone has not many accumulations of new formations (Fig. 2).

a) b)

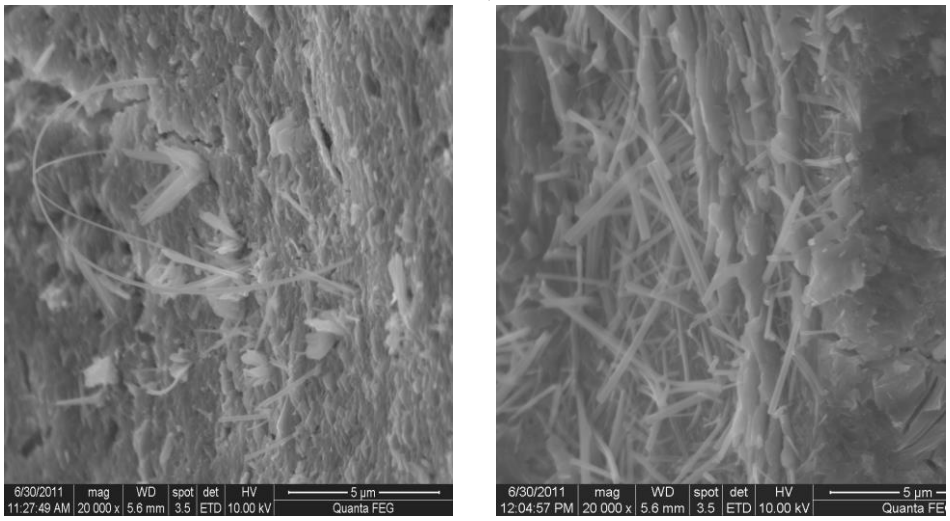

Fig. 2. Microstructure of concrete stone (X20000): a) reference template, b) modified template

In concrete systems that were modified by nanodispersed addition on the basis of titanium dioxide, favourable conditions are formed due to optimal amount of water. These conditions are favourable to form interparticle contacts of accretion in constrained conditions that promote high solidity and density on early stages of dehydration.

Disproportionate volume growth of solid phase happens during initial period of maturing at the process of physical and chemical tying of water by concrete particles. Geometrical sizes of particles increases during simultaneous decreasing of thickness of water streaks between particles. Activation of hydration processes happens in structure and ability of hydrate jointing is created.

High supersaturation in fulfilled concrete system and small gaps between particles in contact places as results of supersaturation difference in and out of contact zones leads to density gradient forming. This density gradient helps to form crystallization bridges between adjoining particles, that lead to particle accretion and durability increasing.

With the help of method of raster electronic microscopy microstructure difference of templates of decorative modified concrete and non-additional one was installed.

Introduction of nanodispersed addition on the basis of titanium dioxide decreases structure friability and defectiveness as it can be seen in the Figure 3. Probably, it can be explained by the fact that nano-particles of titanium dioxide are the centres of crystallization and bind together the products of hydratation with additional calcium hydrosilicates forming, that fill the structure defects.

a) b)

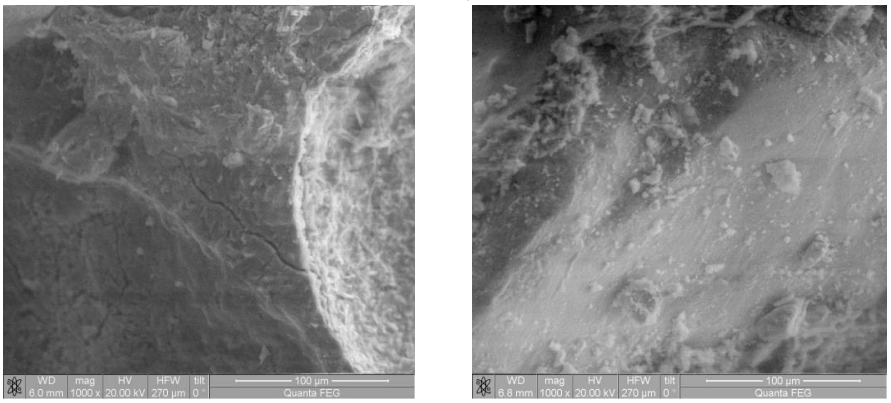

Fig. 3. Microstructure of decorative fine-grained concrete templates (X20000):
a) reference template, b) modified template

Conclusion

Analysis of finding shows that nanodispersed addition on the basis of titanium dioxide influence the mechanism of structure-formation of fine-grained concrete, that promotes formation of more solid and less imperfect structure.

References

[1] Lukutzova N., Chudakova O., Decorative mortar based on nanodispersed titanium dioxide, SITA, Migdal Haemek, 2011, 1, 13, 32-34.

[2] Patent 114904 Russian Federation, MPK B28C 9/00. Technological line of production of manufacture of decorative architectural direction / Lukutzova N.P., Ahremenko S.A., Chudakova O.A., Karpikov E.G.; declarant and patent holder is Bryansk State Technological Academy of Engineering - № 2011138245; declared 16.09.11; published 20.04.2012, Bulletin № 11. - p. 3, illustrated.

[3] Lukutzova N.P., Matveeva E.G., Pikin A.A., Chudakova O.A., Nano-modified fine-grained concrete, Stability and solidity of building materials, constructions and subfoundation: materials of the 5th International Scientific and Technical Conference, Volgograd, 23-24 April 2009. Part I. - Volgograd: Volg-GASU, 2009, 166-170.

[4] Maeva I.S., Yakovlev G.I., Pervushin G.N., Byr'yanov A.F., Pustovgar A.P., Structuring anhydrite matrix by nano-disperced modifying additions, Building materials 2009, 6, 4-5.

[5] Chernishov E.M., Artamonova O.V., Korotkikh D.N., Makeev A.I., Potamoshneva N.D, Slavcheva G.S., Nano-chemistry application in technologies of hardphase building materials: scientific engineering problem, directions and examples of usage, Building materials 2008, 2, 32-35.

Abstract

This article contains the investigation of influence of nanodispersed addition, made on the basis of titanium dioxide on structure characteristics of decorative fine-grained concrete. Nano-suspension stabilized by organic solvent was created by chemical method.

Nanomodyfikowany beton dekoracyjny

Streszczenie

Badano wpływ dodatków nanodyspersyjnych wykonanych na bazie dwutlenku tytanu na właściwości strukturalne dekoracyjnego betonu drobnoziarnistego. Nanozawiesinę stabilizowaną organicznym rozpuszczalnikiem uzyskano metodą chemiczną.