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Fine Concrete Polypropylene Fibers

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Abstract: The this study we discusses use of polypropylene fibers to disperse reinforcement of fine-grained concrete. We made experimental studies on composite samples of fiber concretes binder. We find the optimum percentage of particulate reinforcement fine concrete polypropylene fibers equal to 4 kg/m^3. This is due to the fact that further increase in the percentage of particulate reinforcement gives a slight increase in performance and in some cases and their reduction by reducing the thickness of the concrete layer so that the material exhibited a tendency to delamination.

Key words: Fine concrete, technogenic sand, fibrous concrete, polypropylene, exhibited

INTRODUCTION

At present time, the scope of using of reinforced concrete constructions in Russia is significantly expanded. The use of composite materials are able to solve these problems (Adamyan, 2000).

The use of dispersion-reinforced cement compositions allows to produce lightweight constructions with high flexural strength and toughness. The choice of fiber caused by the fact which properties should have the composition to meet the specified requirements.

There are numerous variations of fiber-reinforced products which find a variety of uses. The use of polypropylene fibers provides a cost savings by reducing the size of the sections. Exploring the possibility of replacing the polypropylene fiber of other fibers in concrete has shown that the resulting durable and lightweight composite with high fracture toughness is very promising.

In the science of steel fibro concrete great contribution made by scientists from Austria, Australia, Belgium, Germany, Holland, Spain, Canada, China, Poland, the USA, France, Czech Republic, Switzerland, South Africa, Japan, and other countries, we should noted J.P. Romualdi, B. Gordon, G.B. Batson, M. Jeffrey, I.A. Mandel, I.L. Carson, W.F. Chen, D.I. Hannant, B. Kelly, P.S. Mangat, A.E. Naaman, R.N. Swamy, D. Colin Johnston, D.R. Lankard, V. Ramakrishnan, G. Ruffert, K. Kordina, W.A. Marsden, J. Vodichka, etc.

MAIN PART

In recent years in practice, very often there are cases when the construction area no quality coarse aggregates. Transportation of rubble from other regions often over considerable distances, it becomes economically justified. In this case, the question arises about the feasibility of using local materials including sand and waste mining industry as a concrete aggregate (Adamyan, 2000; Seryh, 2005; Minasyan *et al*., 2005).

Currently, non-metallic, mining and other industries are dumped annually in the dumps hundreds of millions of cubic meters of loose waste of different composition and structure which have a grain size of 10 mm. One of the reasons for the underutilization of these waste as fine aggregate concrete is the lack of their classification, insufficient knowledge of their characteristics and properties of concrete and concrete mixtures thereof.

Properties of technogenic sand, concrete, mortar and concrete based on them are dependent on many factors due to the properties of the original rocks, grinding their ways and methods of enrichment of the resulting product, etc. Most significantly influenced by the strength of the structure and composition of the source rocks.

When comparing the properties of natural and synthetic sands pay attention on a note of the main, fundamental differences of these materials. If the former are mainly quartz with a rounded shape of grains and

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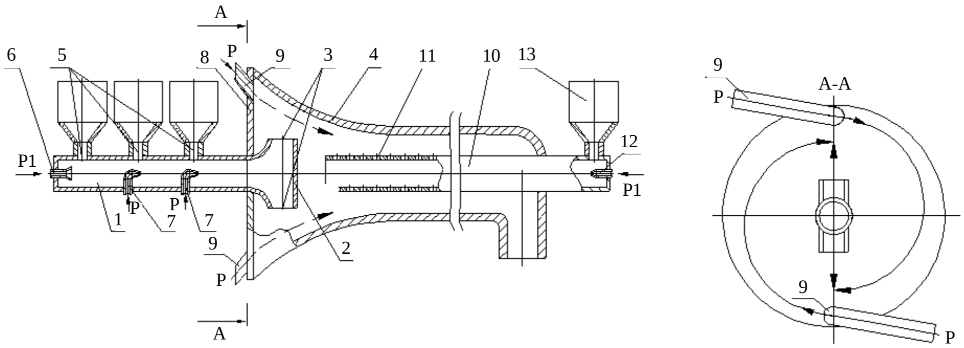

Fig. 1: Countercurrent air mixer: 1: feeding tube; 2: a closed end; 3: outputs; 4: body; 5: input connections; 6, 7, 12: air nozzles; 8: big butt; 9: angled air nozzles; 10: pipe; 11: radial holes

Table 1: Chemical composition of concrete

	Chemical composition (% by weight)								
Cement type	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	R_2O	CaO_{CB}	Other
Cem I 42.5N	22.49±0.5	4.77±0.3	4.40±0.1	67.22±1.0	0.43±0.03	2.04±0.01	0.20±0.05	0.20±0.05	1.5±0.5

Table 2: Physical and mechanical properties of aggregate

Indicators	Screenings of KVP	Tavoljanskyi sand
Fineness modulus	3.50	1.38
Loose weight density (kg/m^3)	1415	1448.00
True density (kg/m^3)	2710	2630.00
Void content (%)	47.8	44.90
Water demand (%)	5.5	7.00

smooth surface, the latter are significant differences in the composition and properties of the original rocks, the form of grains and their surface roughness. Artificial sands have exposed surface. As a result, properties of the latter are different. The interaction of the surface of man-made sand with cement paste and the cement is much more complicated than that of natural sand. Without this interaction is not possible to examine the influence of particle size distribution, grain shape, surface roughness and other characteristics of the sand on the properties of mortar and concrete (Klyuyev *et al*., 2012, 2013; Klyuyev, 2011; Klyuyev and Lesovik, 2011; Lesovik and Klyuyev, 2011).

To assess the feasibility of technogenic sand as raw material for the production of fiber-reinforced formulations were developed using fine concrete as aggregate crushing crushing quartzite dropout. For more dense packing of the filler used sand deposits Tavolzhanskiy.

Experimental studies related to the study of the behavior of concrete elements, dispersion-reinforced polypropylene fiber, compressive and flexural strength.

For the preparation of high-strength fine-grained concrete use different ways to increase activity and quality of cement concrete mix (final grinding and vibro activation of cement, cement vibro mixing, using of superplasticizers).

Great prospects in obtaining high-strength concrete associated with the use of the composite binder which is prepared by co-milling of high-quality cement and superplasticizer C-3.

To produce it they used marketable cement of JSC "Belgorod cement" CEM I 42,5N (Table 1) and superplasticizer C-3.

To assess the quality of used aggregates were studied their basic physical and mechanical characteristics (Table 2).

Industrial practice has shown that the reinforcement of the cement matrix polypropylene fiber which has a high chemical resistance to alkaline environment. Polypropylene fibers are incorporated into concrete designs to increase the compressive strength of from 10-60% and bend from 10-200%.

Preparation of particulate-reinforced mixture in the dry state is one of the crucial stages of production. To ensure the quality of the department specialists mixture of mechanical equipment of BSTU named after V.G. Shukhov air mixer for the production of particulate-reinforced mixes for mixing the dry mixture in Fig. 1. Experimental studies have demonstrated its high performance and guarantee open of lumps of fibers.

The dried sand, screenings of crushing quartzite sandstone, composite binders and polypropylene fiber were mixed to obtain a homogeneous composition. Then, water was added to obtain a homogeneous mass. After forming and compacting the samples were within 24 h at a temperature of not lower than 15°C were then removed

Table 3: Physical and mechanical characteristics of fine-concrete depending on the length of the polypropylene fibers

Consistency of concrete	Without fiber	Polypropylene fiber with the length of 3 mm	Polypropylene fiber with the length of 6 mm	Polypropylene fiber with the length of 12 mm
CEM I 42.5 N (kg)	400.0	400.0	400.0	400.0
Sand (kg)	520.0	520.0	520.0	520.0
Quartzitic sandstone screenings (kg)	1240.0	1229.0	1229.0	1229.0
Water (L)	220.0	223.0	225.0	226.0
Polypropylene fiber (kg)	-	4.0	4.0	4.0
Compression strength (kg)	36.2	43.5	45.4	40.3
Bending strength	4.3	6.2	6.5	5.8

Table 4: Cosistency of concrete

Cosistency of concrete	1	2	3	4
VNV-100 (kg)	400	400	400	400
Sand (kg)	520	520	520	520
Quartzitic sandstone screenings (kg)	1240	1229	1224	1221
Water (L)	220	225	227	229
Polypropylene fiber, length of 6 mm (kg)	-	3	4	5

and the concrete forms of the samples transferred to a dry place (curing chamber with a temperature of 20°C and humidity of 90% which corresponds to the requirements of GOST).

Test samples for determination of compressive strength (blocks 100×100×100 mm) and flexural strength (prisms 100×100×400 mm) were conducted on a universal testing machine according to standard procedure. The results are presented in Table 2.

To increase the performance of the proposed use of fine-grained concrete composite binder and particulate reinforcement polypropylene fiber because it is not affected by acids.

At the present time most widely used polypropylene fibers circular diameter of 20-30 microns and a length of 3, 6, 12 and 18 mm in Fig. 2.

The diameter of a polypropylene fiber depend performance and its longevity. Use of a polypropylene fiber with a smaller diameter provides high tensile strength and flexural toughness. Research have shown that the larger diameter fibers, the longer it retains its reinforcing ability.

In order to identify rational dimensions of polypropylene fibers for fine-grained concrete was studied its effect on the strength characteristics. Percentage of reinforcement selected 4 kg/m^3. The results of these studies are presented in Table 3.

Analysis of the studies shows that the greatest increase in strength characteristics observed at reinforcing polypropylene fiber length of 6 mm. For further research we will use this one.

To optimize the structure of fine fiber-reinforced concrete as a binder will apply VNV-100 and establish optimal percentage disperse reinforcing polypropylene fiber. Composition of particulate-reinforced fine-grained concrete is shown in Table 4.

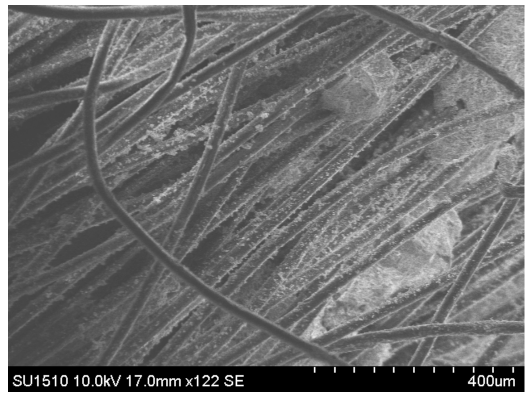

Fig. 2: The microstructure of the beam of polypropylene fibers

The results of experimental studies on the effect of reinforcing material on the strength characteristics of fine-grained concrete are shown in Fig. 3.

Research have shown the effect of particulate reinforcement fine concrete on technogenic raw materials and composite binders as compressive strength increased to 32% and flexural strength up to 64%. Thus, set the optimal content of polypropylene fibers in fine concrete coating roads equal to 4 kg/m^3.

From these experimental studies demonstrated the possibility of using a countercurrent air mixer for producing dispersion-reinforced blends, as thanks to its use is a “fluff” of polypropylene fibers and avoids the formation “hedgehog” and “lumps” which leads to an increase in the content of the reinforcing material into a fine-grained concrete to 5 times, this leads to an increase in its strength characteristics.

In fine-grained concrete (composition 4) is its “re-reinforcement” that leads to a decrease in strength characteristics and a further increase in the content of polypropylene fibers is not feasible, it is because the thickness of the cement matrix between the fibers becomes too small and the sample is prone to delamination. Studying the microstructure of the contact zone of polypropylene fiber and cement paste are shown in Fig. 4.

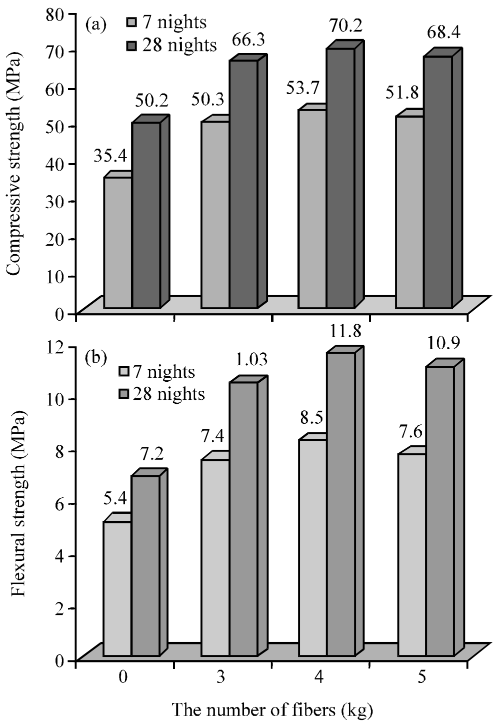

Fig. 3: The results of experimental studies of fine fiber-reinforced concrete: a) compressive strength and b) flexural strength

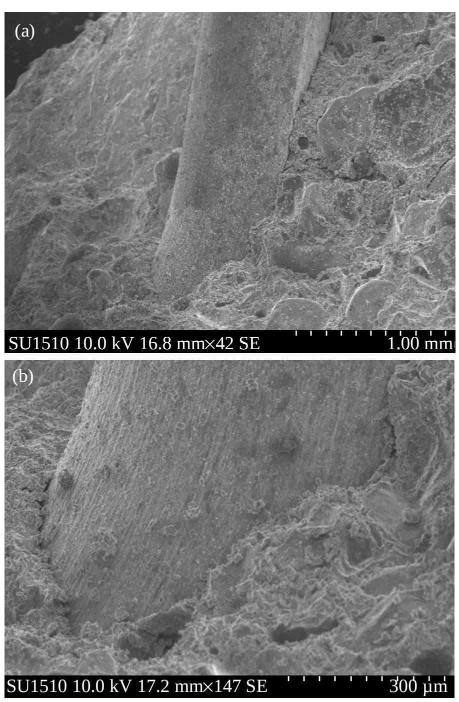

Fig. 4: The microstructure of the contact zone "cement stone polypropylene fiber": a) by VNV-100 and b) be CEM I 42.5H

CONCLUSION

The optimum percentage of particulate reinforcement fine concrete polypropylene fibers equal to 4 kg/m ^{3}. This is due to the fact that further increase in the percentage of particulate reinforcement gives a slight increase in performance and in some cases and their reduction by reducing the thickness of the concrete layer so that the material exhibited a tendency to delamination.

The features of the microstructure of the contact zone polypropylene fiber-cement matrix depending on the type of binder, filler and superplasticizer. The character of the dependence of the bond strength of polypropylene fibers on the type and quantity of the above parameters.

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