ID1217

RESEARCH OF PROPERTIES OF STEEL FIBER CONCRETE DEPENDING ON KIND OF STEEL FIBER

Klara V.Talantova[1], Nikolai M.Micheev[2], Sergei V.Tolstenev[3], Aleksander N.Tushev[1],

[1] Altai State Technical University, 46 Lenina St., Barnaul, 656099, RUSSIA
Fax:385 226 0516, E-mail: tkv@agtu.secna.ru
2Barnaul Building College, 68, Lenina St., Barnaul, 656099, RUSSIA
[3]AltaiAvtoDor, 105 Papanintsev St., Barnaul, 656099, RUSSIA
FAX: 385 224 9967, E-mail: root@autodor.alt.ru

KEYWORDS: Steel turning fiber, steel wire fiber, steel sheet fiber, steel milling fiber, steel fiber concrete, properties, comparative estimation, mathematical evaluation.

SUMMARY: The properties of steel fiber concrete and constructions with its application depend on quantity and quality of a steel fiber. The given operation is devoted to research of properties and definition of rational area of application of a building composite - steel fiber concrete, prepared with application of four types fiber: wire smooth (base variant), turning, sheet with anchors on the ends and steel milling fiber.

INTRODUCTION

The world and domestic research practice, experimental and practical use of construction composite steel fiber concrete showed high efficiency, reliability and durability of construction made of it. Composite nature of the material allows adjusting its properties within enough wide range. But even more effect can be reached by SFC properties control.

Besides other factors SFC and constructions with SFC characteristics depend on quantity and quality of steel fiber. Fiber – steel fiber – is determined by geometry (d_f, l_f), section shape, configuration, temporary resistance to tension ($R_{s,f}$), modulus of elasticity ($E_{s,f}$), ability to provide cohesion with concrete matrix (the condition of the surface, presence of anchors), production technology and price.

MODELING

In order to study the properties of SFC made out of four different kinds of fiber and to determine the rational field of its application, experimental and theoretical research is conducted, which includes:

- Production of experimental samples in small quantities (cubes 10*10*10 cm, beams 10*10*40 cm and small beams 4*4*16 cm);
- Sample testing in order to determine temporary resistance to pressure (R_{fb}), bend tension (R_{ftb}) and cleaving tension (R_{fbt}), as well as modulus of elasticity (E_f) and modulus of complete deformation ($E_{f,tot}$), Poisson coefficient (μ_f), maximum tensility ($\varepsilon_{ft,u}$) and compressibility ($\varepsilon_{fc,u}$) of material depending on kind of fibers;
- Mathematical evaluation of testing results for making the models of dependence of durability and deformation properties of SFC on kinds of fibers taking into account samples geometry and its correlation with parameters of fiber reinforcement, and control of adequacy and statistical evaluation of mistake;

- Formulating of suggestions on rational application each kind of fiber for specific kind of SFC design.

Smooth wire fibers, sheet fiber with anchors in the ends, milling and turning fiber were used in the research (Table 1). Percentage by volume of fiber reinforcement equal to 1.0 and 2.0 were assumed in research.

Out of listed types of fiber primary attention is given to study of characteristics of SFC reinforced with turning fiber.

Table 1: Characteristics of Steel Fiber

Kind of Fiber	Diameter of fibers d_f, mm	Length of fibers l_f, mm	Length/Diameter l_f/d_f	Calculated resistance $R_{s,f}$, MPa	Modulus of elasticity, $E_{s,f}$, MPa
Turning	0,24	20	83	400	$2,0*10^5$
Wire	0,39	32	82	500	$2,0*10^5$
Sheet	0,60	35	58	400	$2,1*10^5$
Milling	0,60	34	57	300	$1,8*10^5$

Turning fiber is worked out by the specialists of Saint-Petersburg Technical University and is of special interest, since it can be produced in the process of turning machining of parts, which provides not so high cost while having very good physical and mechanical characteristics of SFC. In publications and research authors have data on the use of different types of fiber, primarily wire fiber. Data on SFC with turning fiber is very scarce.

As raw material for preparation of a SFC mix were used cement Ì500 of a Iskitim cement factory, sand with gradation factor 2 of Shulginsk opencast with the characteristics: bulk density 1,57 t/m^3, true density 2.74 t/m^3, hollowness - 43 %.

All samples for testing were made of the same materials. Their preparation, hardening and testing was held under the same conditions. The class of a concrete matrix was accepted Â30. A ratio of components of a concrete matrix of fine-grained concrete and control concrete was accepted constant: Cement: Sand =1:2, W/C = 0,44. On everyone SFC batch control concrete samples of the same structure are made. Laboratory samples hardened in normal conditions, at t = 18 ±3°Ñ and humidity 100 % current 28 day. After a set of durability samples were kept in air dry conditions.

RESULTS

SFC tests on compression were held. During the tests observations of nature of failure of the samples with SFC were held: samples with wire and turning fiber failed smoothly and viscously without sample loosing its shape; samples with milling fiber failed with fragility with typical crack and significant failure; the nature the samples with sheet fiber reacted occupied the middle position between the samples with wire and milling fiber.

The results of tests have shown an insignificant incremental of density SFC in comparison with control concrete, which has made from 2% up to 5%. Some growth of density with increase of the fiber contents was observed for all fiber types, of exception milling fiber. However strength characteristic of SFC with milling fiber had thus the tendency of growth.

Table 2. Average values of density SFC depending on a fiber type and percent of an armoring

Fiber type	Average density SFC $\rho_f \pm m$ (kg / m^3) at volumetric percent of an armoring		
	μ=1.0 %	μ=1.5 %	μ=2.0 %
Sheet	2266,64 ± 162	2275,63 ± 162	2304,64 ± 170
Turning	2275,55 ± 170	2266,74 ± 169	2307,26 ±171
Milling	2261,19 ± 162	2258,48 ± 158	2063,97 ± 148
Wire	2279,57 ± 171	2281,71 ± 162	2304,89 ± 178

Table 3: Tension durability of SFC depending on kind of fiber and portion of reinforcement

Percentage by volume of reinforcement, μ	Durability of SFC at compression $R_f \pm m$ (MPa) for fiber			
	Turning	Wire	Sheet	Milling
1,0	49,06 ±1,02	52,26 ± 1,09	54,08 ± 1,12	46,06 ± 0,99
2,0	57,65 ± 1,20	60,05 ± 1,24	49,80 ± 1,03	55,52 ± 1,15

Mathematical evaluation of testing results was done using the special software, which allowed besides basic statistical procedures to analyze the properties of SFC depending on discrete and continuous parameters.

CONCLUSION

The comparative analysis of results of tests SFC on durability with different fiber's types has shown, that the incremental of durability SFC on compression (R_f) in the ratio with durability of control concrete (R) has made 10-50%, that corresponds to the literary data. Comparison SFC durability characteristics with wire fiber (the base variant) with the similar SFC characteristics with other types of fiber has shown some excess of the SFC characteristics at 1% of an armoring of a material with sheet fiber, small difference - with turning fiber and lowest parameters of a material with milling fiber.

Preliminary results of SFC compression testing (Table 2,3) showed that nature of SFC reinforced with turning fiber and its durability characteristics allow supposing the wide use in the future of such kind of fiber for important construction elements, particularly bridges. The same is true for SFC with milling fiber that can be used in constructions that undertake static load. SFC with sheet fiber needs further research.

REFERENCES

1. «Projects owoond the World. World Construction», Vol. 35. N 6. C.44, 49-53.
2. Colin D. Johnston. «Concreto reforzado con fibras», - *Revista JMCYC*. Vol. 19, num. 127 /noviembre/ 1981, pag. 35-40, 43-48, 50-56,58-63.
3. J. Walraven, «The evolution of concrete», *Journal of the fib Structural Concrete*,1999, P1, No.1 March, p. 3 –11.
4. Lobanov I. A. “The Basics of the Disperse Enforced Concrete (Fiber Concrete)”. *Dissertation Abstract*. Leningrad, 1982.

5. Kurbatov L.G., Ermilov U.I. “Steel Fiber Concrete Constructions in Building”. *Overview Information*, #8. Moscow, 1983, p.58
6. Talantova K.V., Tolstenev S.V., Mikheev N.M. “Experience in Use of Steel Fiber Concrete for Highway Engineering”. In: *Use of Fiber Concrete in Construction*. Leningrad, 1985, p.p. 47–50.
7. Talantova K.V., Mikheev N.M. “Summary on the Performance of Steel Fiber Constructions for Highway Engineering”. In: *Technology of Manufacture and Qualities of New Composite Building Materials*. Leningrad, 1986, p.p. 35–40.