Studying of influence of fiber reinforcing at fine-grained concrete applying in transport construction

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Abstract. We observed causes of using fiber in nowadays construction industry and its influence on a final product properties, where the fine-grained concrete basing of repairing dry construction mix was used as a base. However, in Russia we do not have such experience. If we’re talking about changes occurring in the fine-grained concrete all of its are known about it, either in concrete, but in dry-construction mixes changes may have another purpose. Advantages and disadvantages of using fiber were oblieved also in that article. The main subject of this research is the influence of fiber on a mechanical properties of fine-grained concrete. The most attention is paid to estimate the influence of a concrete’s properties by metal fibers: casting time (initial and final), workability and strength (tensile strength and compressive strength) in this article. The most popular different type of metal fiber compares for its length and width and the optimum quantity of metal component chooses, which will indicate the maximum possible affirmative result of its using. Dependences comparing properties of fine-grained properties with fiber’s type, measurements and quantity which show the evident result of researching are discussed.

1. Introduction
As it is already known, using different fiber in production technology of construction materials, units and designs, especially in fine concretes and dry construction mixtures is not an innovation [1, 2].

Today many manufacturers of construction materials apply fiber reinforcement technology and receive a product with a new structure and increased strength. They do it when it is necessary to raise the tensile strength not in 3 - 4 times, but in 1.2 - 2 times with the minimum expenses. Unfortunately, sometimes it is not possible to find a reason why does it occurs, what properties will change, what are advantages and disadvantages of reinforcement technology and does it have some economy. So I think that this subject deserves an attention [3-5].

There are some sources [6-9], which describe why fiber is a unique component which is capable to convert initial material to final product that have an ability to resist high mechanical properties. The main advantage of reinforced technology is a fact that material receive high adaptation to abrasive force and dynamic shock force [10, 11]. Moreover it increases durability because of high frost resistance and reducing shrinkage deformations appearing during usage period. These advantages play an important role at the market of construction materials allowing to narrow down the competition among the similar products [12-14].
Figure 1. Use of steel fiber in fine-concrete.

As it is already known, the increasing of strength of the material with fiber reinforced technology is caused by metal particles which are good in tension and by hardening process of concrete in which metal fiber it is squeezed by concrete’s matrix and because of that it is firmly embed in the structure [15,16].

As for exact values of a final product with increased characteristics, we can say that these values are not rather high in comparison with the material without fiber but give us an opportunity to think about using this material instead of the same products without fiber:
- increased tensile strength from 2 to 3 times;
- increased compressive strength up to 10%-50%;
- increased axial tensile strength up to 10%-40%;
- increased impact strength from 8 to 12 times;
- increased crack resistance from 2 to 3 times;
- increased frost resistance and water resistance not less than one grade.

In addition these values are possible to receive with minimal expenses than to increase the grade of concrete or cement.

But nothing is perfect in and metal fiber has disadvantages, such as:
1. difficulty in handling
2. uneven distribution in the volume
3. rapid deterioration of the equipment.

It was determined that the polymer fiber does not give these high indicators of compressive and tensile strength instead of metal fiber.

It could be noted that world using of metal fiber in concrete is rather wide instead of dry construction mixes where it's using is not quite wide in Russia. So this subject is not widely discussed and we have not more information about changes which take place in these mixes and concretes.

2. Materials and methods
The dry construction mix for repairing and reinforcing concretes was chosen as a base. It has the following structure:
- portland cement (CEM I 42.5N) — 40%
- fractioned sand— 50%
- complex of mineral additives— 10%

All tests were carried out according to the existing Russian Standard: GOST 11356, GOST 11357, GOST 11358, GOST 10180, GOST 10181.
**Figure 2.** Using steel fiber: a) fiber №1—length 30 mm, diameter 0.3 mm, covered by brass and corrugated; b) fiber №2—length 35 mm, diameter 0.7 mm, steel and wavy; c) fiber №3—length 50 mm, diameter 1.0 mm, steel and anchor.

### 3. Results

It was tested three types of fiber (Figure 2) in quantity from 2% to 5% by weight of control mix. The results are shown at Figure 3—Figure 6.

**Figure 3.** Diagram of initial casting time – later 5 minutes after the water was added.

**Figure 4.** Diagram of final casting time – later 35 minutes after the water was added.
4. Discussion
In comparison with control mix samples of the concrete without fiber and depending on fiber type and quantity of the fiber in a mix there are following conclusions:
— the tensile strength after 24 hours varies from 0.8 to 1.8 times;
— the compressive strength after 24 hours varies from 0.6 to 1.4 times;
— the initial casting time varies within 16%, final - 14%;
— the workability of mix fall from 4% to 16 %.

From three types of testing fibers the best result was obtained in the fiber №1 by testing mechanical properties (tensile strength increased in 1.8 times) in quantity from 3.5% to 4% by mass of mixture components.

The obtained data show:
• the bigger diameter of the fiber – the worse tensile strength the material has and the opposite is also true;
• there is a maximum dosage when the performances tensile strength are growing, but if this maximum will be exceeded these performances will decrease;
• the bigger dosage of the fiber - the bigger volume the mix has, so the worse initial and final workability will be.

5. Conclusion
On the whole the tendency of changes mechanical properties of reinforced fine-grained concrete (by metal fiber) is almost the same that in standard fine-grained concrete but a positive effect by reinforcing metal fiber is higher.

The future experiments will be connected with studying influence of reinforcement of the fine-grained concrete by other different metal fiber with the subsequent transition to a low-modular fiber (polypropylene, polyamide, nylon) and with analysis of its’s influence to mechanical properties depending on own fiber’s characteristics such as geometrical factor.

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