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*Dragan Ignjatović[*1], Lidija Đurđevac-Ignjatović[*2], Dušan Tašić[*3], Vanja Đurđevac[*4]*

COMPARATIVE ANALYSIS OF A COMPRESSIVE STRENGTH OF CONCRETE WITH AND WITHOUT MICRO-REINFORCEMENT[**]

Orcid: 1) https://orcid.org/0000-0003-2333-6853; 2) https://orcid.org/0000-0002-1113-5360; 3) https://orcid.org/0000-0001-8005-9640; 4) https://orcid.org/0000-0002-7973-0916

Abstract

The applicability and purpose of the micro-reinforced concrete is such that they are made according to the special systems and recipes with the addition of additives, fibers or additives and fibers, which should provide the concrete with the most optimal properties for each of the specific cases of use. The micro-reinforced concrete with polypropylene fibers is used for shotcrete, in the remedial mortars, for making floors, in plaster mortars, to improve the fire resistance and so on. A compressive strength is one of the physical and mechanical characteristics, that is partially mentioned in this paper.

Keywords*: micro reinforced concrete, fibers, compressive strength*

1 INTRODUCTION

Concrete, a man-made material, is the most widely used material around the world. Following its production, a figure of about six billion cubic meters per year was reached.

The economic turnover of the concrete industry is about 35 billion dollars and employs about two million workers in the USA alone. China consumes about 40% of the world's consumption of cement, i.e., concrete [1].

In the shortest and most simplified way, it can be said that concrete is created by solidification a mixture of mineral binder, stone aggregates and water. At the same time, the mineral binders and water are active ingredients of concrete, and stone aggregates are ingredients that serve to fill the concrete mass without chemical participation. Various types of binding materials are used to make concrete, such as: cement, gypsum, lime, asphalt, epoxy resins. Depending on the type of binding material, the following are obtained: cement concrete, gypsum concrete, lime concrete, asphalt concrete, epoxy concrete, etc. Aggregates for making concrete can be natural or artificial. The most commonly used aggregates are the natural gravel and sand, crushed stone, various types of slag, etc. Stone aggregates are the concrete gravel and concrete sand, and less often artificially crushed stone. In practice, the cement concrete is mostly used. The Portland cement is used as a binder. Different additives and fibers can be present in the concrete mixture with the

[*] *Mining and Metallurgy Institute Bor, Alberta Ajnštajna 1, 19210 Bor, Serbia, E-mail: lidija.ignjatovic@irmbor.co.rs*

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aim of improving the corresponding characteristics of the concrete [2].

Today, the "special concretes" have their share in the concrete industry that are made according to the special installation systems and recipes with the addition of additives, fibers or additives and fibers, which should provide the concrete with the most optimal properties for each of the specific cases of use.

2 CHARACTERISTICS OF THE MICRO-REINFORCED STRUCTURES

The term micro-reinforced concrete usually refers to the composites, the basis of which is 0/4 mm coarse sand, coarse aggregate (up to 16 mm), binders and micro-reinforcements. How much micro reinforcement (microfibers) will be used depends on many factors, but the most important is the property of concrete [3]. Most often, this amount is in the range of 0.1-5% in relation to the total volume.

The role of fibers in concrete is multiple, but their greatest contribution is to increase the strength while simultaneously reducing the volume deformations during shrinkage [4].

Also, the addition of fibers can significantly contribute to increase the resistance of composite to wear, better adhesion at the contact of old and new concrete, increased resistance to the dynamic influences, resistance to the effects of fire and similar [5].

3 APPLICABILITY OF MICRO-REINFORCED CONCRETE

Micro-reinforced concrete is used in the structural elements where the classic reinforcement is not crucial for the safety and integrity of the structure. It is important to point out that in the load-bearing structural elements, the fibers cannot completely replace the classic reinforcement.

The basic division of fibers used for the micro-reinforcement of concrete is steel, polymer, glass and natural fibers. The most commonly used fibers are steel and polypropylene, Figure 1. The important properties of fibers are, in addition to the geometrical characteristics, tensile strength, modulus of elasticity and elongation at break. The usual technological procedures of production, transportation, installation and maintenance of concrete are possible with the micro-reinforced concrete [6].

a) b)

Figure 1 *View of fibers: a) steel b) polypropylene*

Micro-reinforced concrete with steel fibers is used in the industrial floors, prefabricated elements, for the slope stabilization, in tunnel construction, in the road slabs, airport runways, then in the parts of hydrotechnical facilities, thin shells and domes, for rehabilitation and strengthening the structures and in the structures exposed to

high temperatures, shock load, seismic action or explosions.

Micro-reinforced concrete with polypropylene fibers is used for shotcrete, in remedial mortars, for making floors, in plaster mortars, to improve the fire resistance and similar.

The minimum amount of steel fibers in concrete should be 20 kg/m^3, and polypropylene 0.9 kg/m^3.

4 TESTING THE COMPRESSIVE STRENGTH OF MICRO-REINFORCED AND PLAIN CONCRETE TEST TUBES

As already mentioned in the text, the micro-reinforced concrete has the improved physical and mechanical properties, compared to the same concrete made without the micro-reinforcement. The aim of this research was to demonstrate the increase in compressive strength of micro-reinforced concrete.

The compressive strength measurement of the test tubes of both types of concrete was performed on a hydraulic press with a capacity of 3000 kN, Figure 2.

Figure 2 *Device for compressive strength measurement*

Based on the known recipe, the six test tubes with the same concrete content were made, except that in three test tubes, according to the already mentioned minimum amount of fibers, the polypropylene fibers were added, Figure 3. In addition to all the already mentioned physical properties of concrete, emphasis is placed on the compressive strength of the test tubes, i.e., ratio of compressive strength of the test tubes with and without fibers.

a) b)

Figure 3 *Concrete tubes: a) without reinforcement and b) with reinforcement*

The parameters, used in measurement the compressive strength of the concrete test tubes, are:

- Force application speed of 13.5 kN/s,
- Dimensions of the test tubes are: 150 x 150 x 150 mm.

After 28 days of care the test tubes, the following results were obtained, shown in Table 1 and Table 2:

Table 1 *Test tubes without micro-reinforcement*

Order number	Maximum breaking force [kN]	Compressive strength [MPa]
1.	875.543	38.913
2.	878.310	39.036
3.	917.888	40.795
Mean value	890.573	39.581

Table 2 *Test tubes with polypropylene micro-reinforcement*

Order number	Maximum breaking force [kN]	Compressive strength [MPa]
1.	1240.695	55.142
2.	1273.500	56.600
3.	1304.258	57.967
Mean value	1272.803	56.569

According to the obtained results of the compressive strength measurement, by addition the polypropylene fibers to the basic recipe for concrete, and according to the mentioned regulation of 0.9 kg/m^3, it can be seen that an increased compressive strength of approximately 43% was achieved.

5 CONCLUSION

After testing the compressive strength of concrete test tubes with and without micro-reinforcement, it can be seen that the fibers contribute to a significant increase of this mechanical characteristic.

In order to get a complete view of improvement the quality of micro-reinforced concrete, it is necessary to conduct a number of other physical and mechanical tests, in order to confirm their quality and use.

Therefore, such composites could be used in construction in various areas, such as: making the cement screeds, industrial floors, open concrete surfaces and similar.

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