INFLUENCE OF SILICA FUME ON SCC CONCRETE PROPERTIES

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Abstract

The use of recycled materials or waste increases sustainability in the construction sector. Likewise, the self-compacting concrete (SCC) has shown improvement in mechanical properties, when made with some waste pozzolanic materials. The differences in the compressive strength of the SCC concrete sample in the case of 5% by mass share of silica fume compared to samples with 7% were explored. The results shown that optimal replacement of Ordinary Portland Cement by silica fume is 5%, under applied experimental conditions.

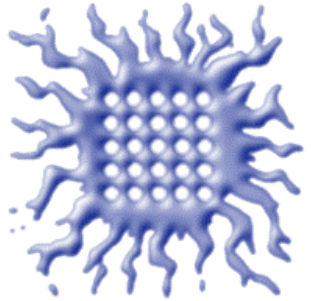
Keywords: sustainability, recycling, compressive strength

INTRODUCTION

Silica fume represents a by-product from the exhaust gases of ferrosilicon, silicon, and metal alloys smelting furnaces [1].

Silica fume addition in concrete leads to **improvement in permeability and durability** of concrete, as well as **the increase in strengths**.

The **better performance** of concrete could be attributed to the fact that it exhibits lesser micro cracking and dense microstructure due to silica fume and calcined clays as pozzolans for concrete.



The **self-compacting concrete** (a special type of concrete which is placed into the formwork without any means of compactions, only by the gravity and its own weight, no meter how complex is the geometry of formwork and how dense is the reinforcement packup) has also revealed **improvement** in mechanical properties made by using silica fume.

By some authors, the optimized dosage of silica fume lies in **7 – 10 or 8 – 10% share of cement (by weight)**. However, several studies showed that the optimal rate of silica fume in concrete is 5%.

The aim of this study was to investigate the effect of reducing the recommended silica fume dose in **SCC with recycled aggregate**. The **differences in the compressive strength** of SCC concrete in the case of a 5% share of silica fume compared to samples with 7% were explored.

EXPERIMENTAL

Materials of samples were:

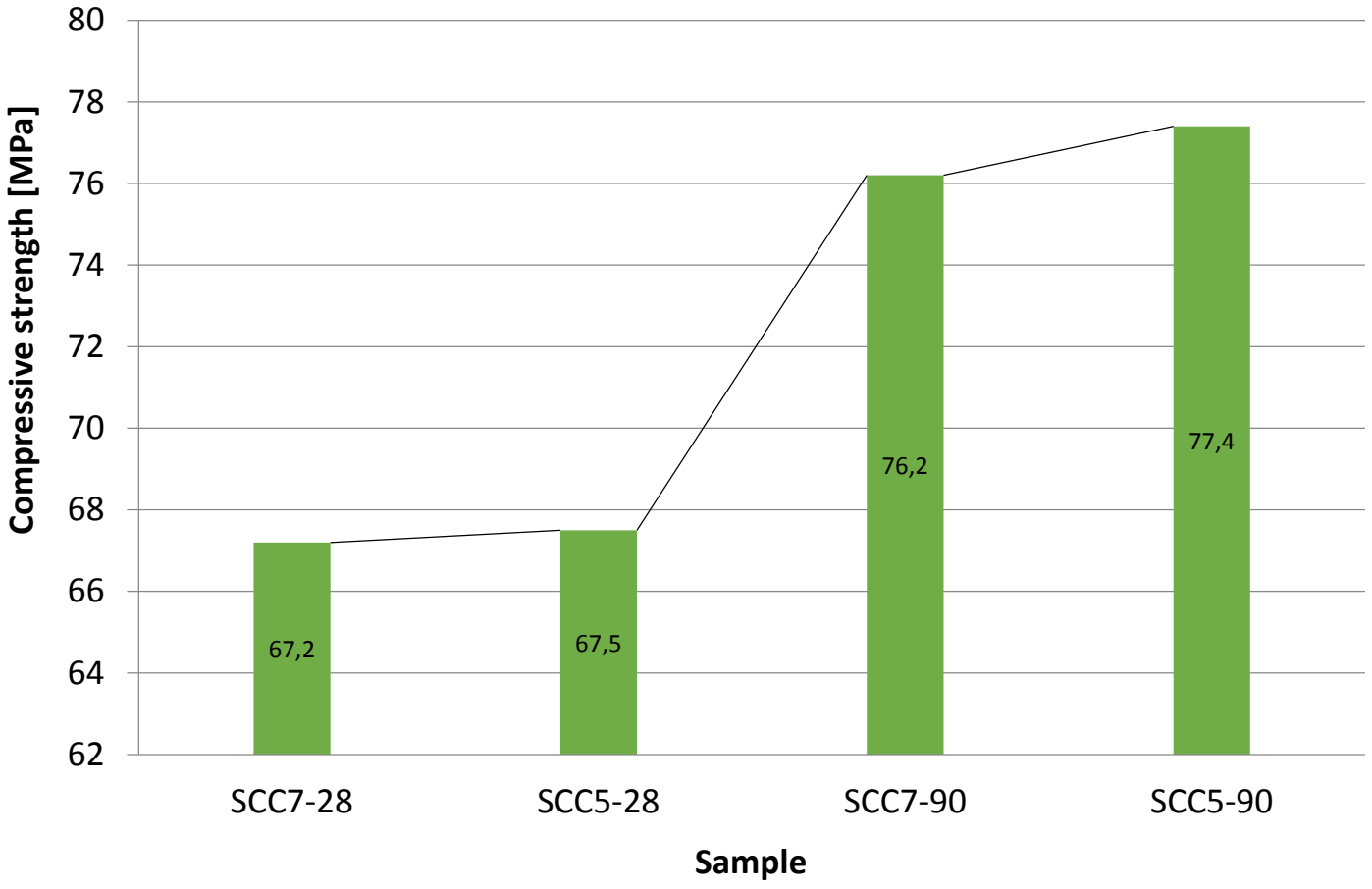
- Silica fume (0.1μm average particle size);
- OPC, PC 35 M (V-L) 42.5 R, Beočin, Serbia;
- Limestone filler, Granit peščar, Ljig, Serbia;
- Superplasticizer, TKK, Slovenia;
- Aggregate, Gradient, Serbia;
- Recycled aggregate, smashed experimental samples;
- Water.

Materials	Amounts	
	SCC7	SCC5
OPC	353.4 kg/m^3	368.6* kg/m^3
Limestone filler	223 kg/m^3	223 kg/m^3
Superplasticizer	1.1%	1.1%
Water	178 kg/m^3	178 kg/m^3
Aggregate (I, II, and III fraction)	860; 265; 155 kg/m^3	860; 265; 155 kg/m^3
Recycled aggregate (I, II, and III fraction)	0; 265; 155 kg/m^3	0; 265; 155 kg/m^3
Silica fume	7%	5%

Before water addition, silica fume was mixed with OPC. The optimal mixing time was 90 s. Dry materials were mixed for one minute. Water was added for the next 30 s, after which the superplasticizer was dosed with the addition of water. Mixing was continued until 5 min.

RESULTS AND DISCUSSION

The samples were demolded after 1 day and cured in 20˚C water for 28 and 90 days (in total). The compressive strength tests were performed according to the standard **SRPS EN 12390-3.** on cubic samples. The results are presented in Figure 1. for SCC7 and SCC5 samples after 28 and 90 days marked as SCC7-28, SCC5-28, SCC7-90, and SCC5-90, respectively.



RESULTS AND DISCUSSION

The results showed that the compressive strength after 28 days **was not significantly affected** by the reduction in the amount of silicate fume. However, measurements after 90 days indicated that the sample **with 5% silica fume** (SCC5-90) showed **slightly higher** compressive strength.

An increase in the compressive strength in SCC5 samples could be explained by silica fume **higher amount in SCC7 than it was required for pozzolanic actions**, and hence reduction in strength [8]. Likewise, the amount of OPC in SCC5 samples was higher relative to SCC7, and compressive strength was expected to be elevated. This investigation indicated that the optimal replacement of OPC by silica fume is 5%, under applied experimental conditions.

CONCLUSION

The effect of the **recommended silica fume amount reduction** in SCC with recycled aggregate was explored. The compressive strength tests after 28 and 90 days were performed.

The results for samples SCC7-28, SCC5-28, SCC7-90, and SCC5-90, were 67.2, 67.5, 76.2, and 77.4 MPa, respectively.

An **increase in compressive strength** in samples with 5% silica fume could be explained by silica fume **higher amount in SCC7 than it was required** for pozzolanic actions and a higher amount of OPC.

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175
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