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HIGH PERFORMANCE AND DURABILITY OF RECYCLED SILICA FUME MORTARS

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Abstract: *The purpose of this article is to develop a special mortar, realized using cement, silica fume, sand, water and super plasticizer. The proposed silica fume mortar should have high mechanical properties such as compressive and tensile strength, but also good workability. The samples were tested at 28 days; in function of compressive and bending tensile strengths the special mortars researched can be framed into repair mortars. By recycling of silica fume we can help to protect the environment.*

Key words: *silica fume, repair mortars, high mechanical properties, environment.*

1. Introduction

Silica fume is a waste product from electric furnaces used in the manufacture of silicon metal or silicon alloys [1-3]. It can be used in the process of obtaining new mortars [4]. It is well known that, this product has several advantages such as high ultimate strength, high sulfate resistance and low heat of hydration when used in Portland cement concrete. Advantages came from the high specific surface, and also from the pozzolanic activity of silica fume particles.

From others researches it can be observed that the highest development rate of compressive strength happened at early ages (3 and 7 days) [5]. Supplementary cementations materials can be either self-cementing or pozzolanic, or both, depending on their chemical composition [6]. From the test results it is deduced that the additions of silica fume and natural pozzolan generally enhance the mechanical behavior of concrete at late curing ages by refinement of microstructure and transforming C–H into C–S–H or C–A–S–H through the pozzolanic reaction.

This study proposed to investigate the effect of silica fume on mechanical properties of mortars for different percent of solid part replaced by silica fume.

2. Materials

The aim of this experimental program is to obtain high strength mortars by recycling the silica fume.

During the experimental researches, there were made and studied 4 series of samples.

The samples were made mixing the following materials: cement, silica fume, sand, water and super plasticizer.

Cement (C) type was CEM I52.5R (produced by Carpat Cement Holding).

The superplasticiser used was the type: Dynamond SR 3 (produced by Mapei

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Silica fume (SUF) was imported from E.U. and produced in China.

Sand (S) was washed river aggregate with maximum size of 1 mm.

Water (W) was drinkable from public alimentation network.

3. Experimental Program

3.1 Series of Batches

For our experimental work there were proposed a number of four batches, each of them having three samples.

The proposed batches were compound from the presented materials, in the following percentages:

- Batch no.1:
- water: 10%
- dry materials: 90%, realized from:
  1. cement: 25%
  2. silica fume : 5%
  3. sand: 70%
- water/cement ratio=0.40
- superplasticiser: 2% from cement mass.

- Batch no.2:
- water: 10%
- dry materials: 90%, realized from:
  1. cement: 30%
  2. silica fume : 5%
  3. sand: 65%
- water/cement ratio=0.33
- superplasticiser: 2% from cement mass.

- Batch 3:
- water: 10%
- dry materials: 90%, realized from:
  1. cement: 35%
  2. silica fume : 5%
  3. sand: 60%
- water/cement ratio=0.29
- superplasticiser: 2% from cement mass.

- Batch 4:
- water: 10%
- dry materials: 90%, realized from:
  1. cement: 40%
  2. silica fume : 5%
  3. sand: 55%
- water/cement ratio=0.25
- superplasticiser: 2% from cement mass.

3.2 Mixing Program and Moulding the Samples

The mixing program was developed taking into account the optical analysis of the fresh mix. There were four steps of mixing the materials:

-step1: the cement was added in water and mixed manually for 30 seconds;
-step 2: the silica fume was added and mixed manually for 30 seconds;
-step 3: the sand was added and mixed manually for 30 seconds;
-step 4: the superplasticizer was added and the mixture were mixed into cement mixer at 120 seconds.

The fresh materials were poured into standard steel mold with the following dimensions: 40x40x160 mm.

The molds with fresh samples weren't compacted because in site this wouldn't be possible to do with a repair mortar.

3.3 Results and Discussions

The values of apparent density are presented into table 1 and figure 1, the bending tensile strengths into table 2 and figure 2 and compressive strengths into table 3 and figure 3.

The results are at 1day, 7 days, 28 days and 365 days old /1/. The cure conditions are into laboratory conditions: at 22 ^{0}C and 65% relative humidity RH.

Results Table 1

No.	Batch	Apparent density ρ_a, [kg/m^3]			
		1 day	7 days	28 days	365 days
1.	**C25** SUF5	2034	2030	2032	2019
2.	**C30** SUF5	2161	2158	2152	2145
3.	**C35** SUF5	2186	2180	2178	2172
4.	**C40** SUF5	2231	2225	2213	2206

Results Table 2

No.	Batch	Bending tensile strengths f_t, [N/mm^2]			
		1 day	7 days	28 days	365 days
1.	**C25** SUF5	6.8	8.87	9.26	14.77
2.	**C30** SUF5	7.71	9.48	10.13	15.03
3.	**C35** SUF5	7.39	9.69	10.78	15.47
4.	**C40** SUF5	8.86	10.88	10.97	15.52

Results Table 3

No.	Batch	Compressive strength f_c, [N/mm^2]			
		1 day	7 days	28 days	365 days
1.	**C25** SUF5	31.34	45.28	63.47	84.2
2.	**C30** SUF5	35.36	84.81	81.63	103.5
3.	**C35** SUF5	35.86	83.16	91.31	108.8
4.	**C40** SUF5	45.69	88.41	100.13	112.3

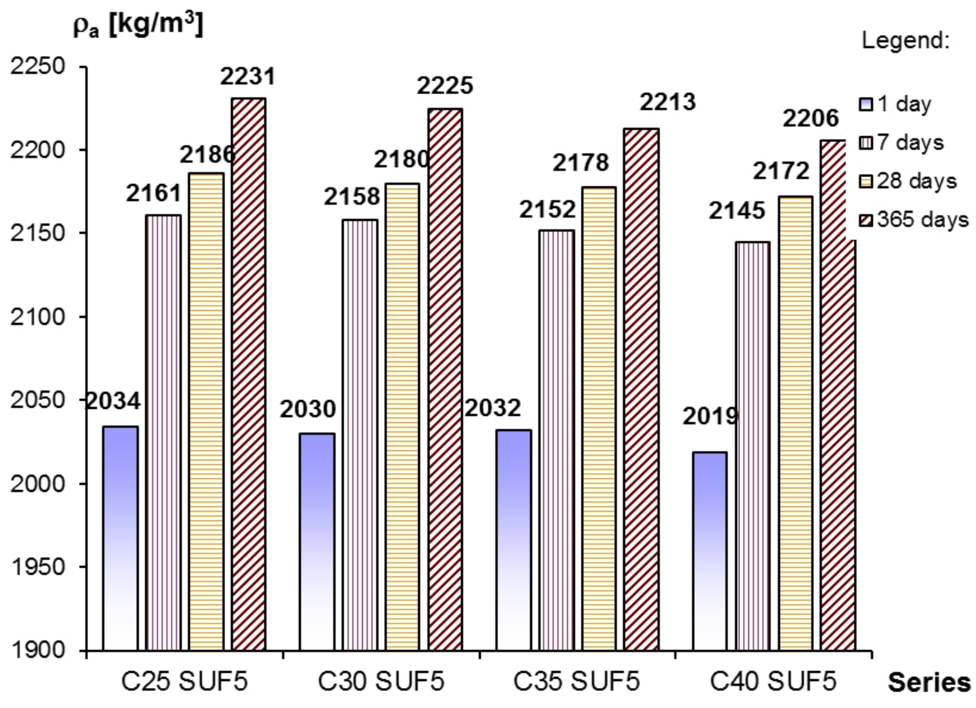

Fig. 1. *Apparent density*

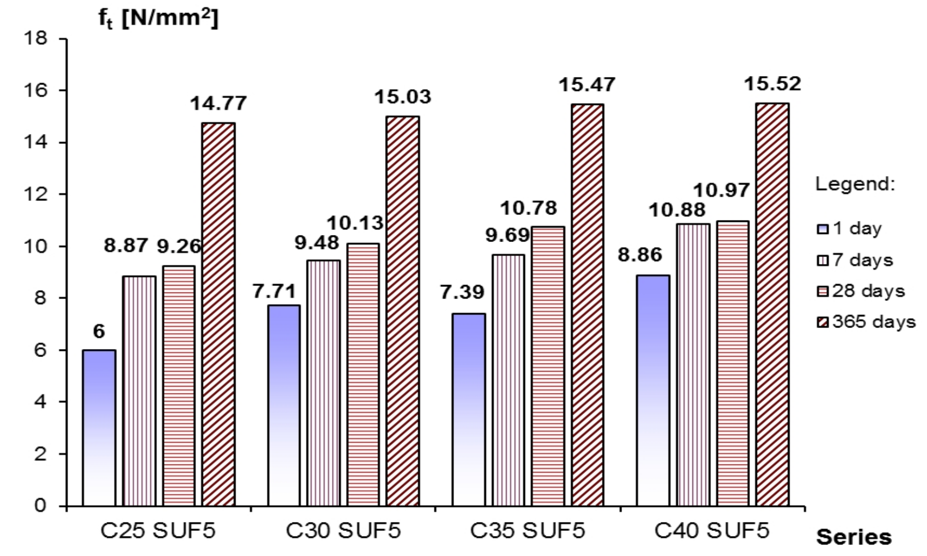

Fig.2. *Bending tensile strengths*

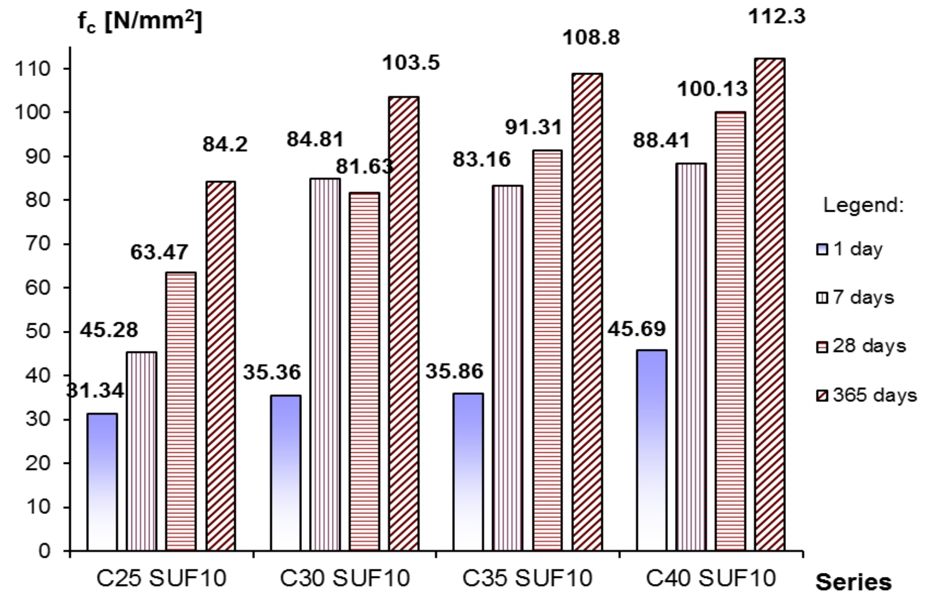

Fig. 3. *Compressive strengths*

4.Conclusions

1) The apparent density has values between 2000-2200 kg/m^3.which frames the mortars in heavy mortars class.

2) The compressive strengths have values between 30-45 N/mm^2 at 1 day and between 60-100 N/mm^2 at 28 days. The bending tensile strengths have values around 5 N/mm^2 at 1 day and around 10

N/mm^2 at 28 days; in function of compressive and bending tensile strengths he special mortars researched can be framed into high strengths mortars. This type of mortar can be used like repair mortar. The big values of strengths are obtained by using big quantity and high cement class, super plasticizer and silica fume.

3) The samples were good behavior in time. So, after 365 days the mechanical parameters were improved. The compressive strength was overcome 100 N/mm^2 and bending tensile strengths were overcome 15 N/mm^2. The reason of this increase can be the hydration of silica fume in time.

4) The high strengths can be obtained by using silica fume.

5) By recycling of big quantity of silica fume necessary to obtain repair mortars can help to protect the environment.

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