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INFLUENCE OF FLY ASH ADDITION ON THE COMPRESSIVE STRENGTH OF CONCRETE

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Abstract: *In the paper is analyzed the influence of fly ash dosage on the compressive strength of concrete. Five mixes were prepared, one witness without fly ash and the others with fly ash addition in dosages varying between 10% and 35% as replacement of cement. The cement type, water quantity, water/cement, water/cement+fly ash, aggregates dosages, type and dosage of superplasticizer were maintained the same for all mixes. The experimental results showed that the concrete mix with 10% fly ash had an increase in compressive strength of about 23.2%, in comparison with the witness. The mix with 35% fly ash replacement of cement had the compressive strength smaller than the witness with about 39%.*

Key words: *fly ash; cement concrete; compressive strength.*

1. Introduction

During the last decades a lot of studies had shown that different types of additions used in the concrete mix can improve some of their characteristics [1-5]. In the producing high strength concrete there is necessary to introduce an active addition such as silica fume, fly ash, etc., [6-7]. In other cases, the active addition can replace a part of cement, contributing to the environment protection and construction sustainability. In the case of geopolymer concrete, the active addition which can be a by-product material rich in silicon and aluminium, totally replaces the cement in the mix and it is chemically activated by a high-alkaline solution to form a paste that binds the coarse and fine aggregates [8-11].

It is known that in the construction industry there are used different types of concretes, with ordinary or performing characteristics. A concrete of high strength can be obtained by using near cement some active additions, in combination or not, but taking into account that the modifying of the content of fine part suppose a changed process of shrinkage, so the changing of microcracking process of cement stone [12-13]. There is a strong connection between strength and structural characteristics of concrete: compactness, porosity [14].

In the paper is analyzed the influence of fly ash dosage as replacement of cement on the compressive strength of concrete having in view to obtain cheaper concrete and to develop environmentally friendly construction materials.

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2. General aspects regarding the influence of fly ash addition on compressive strength of concrete

The cement influences the concrete structure by its nature and by its dosage in the mix. The strength characteristic of a concrete can be obtained in different ways, but in conditions in which the economical aspect is predominant, it is important to analyze the concretes with active additions. In this way the cement proposed for the study is CEM I-42,5R. As active addition in the mix was used fly ash from CET Holboca Iasi. The fly ash is a material of siliceous-aluminous nature, which has fine granules and in the humidity presence reacts with calcium hydroxide forming compounds with binder properties. Hydrosilicates will contribute to an increase of volume of new gel formations which during hardening results in an intensive microcraking process. In this direction it is recommended to keep the concrete under water until complete hardening for preventing contractions and in the same time to contribute to a better compaction [8].

Previous studies had shown that even the mechanical strengths slowly increase; finally they present values near of that of cements without addition. The researches which were made had used cements with additions under 40% from clinker content and in these conditions, the following observations were done:

- Because of the high content of mixing water which was imposed by the fly ash with a great specific surface, there is the tendency of displacement of poses size of 0.5-1 mm to higher sizes;
- The volume of capillary pores increases by increasing the fly ash dosage.

These modifications are unfavourable to the structure formation of concrete and also to the structural characteristics that imposes a correlation between the cement and addition dosages. This means that fly ash dosage is influenced by the cement dosage in such way that fine part does not exceed for both some limits and in the same time it must consider that the mix water quantity and the ratio between water and cementitious material to be kept in small limits by using tension-active additives.

3. Experiment Program

For the test experiment the actual norms [15] are considered.

For preparing the 5 mixes of concrete were used the following materials:

- River aggregates with maximum granule size of 16 mm.
- Cement type CEM I-42.5R produce in Romania.
- Fly ash from CET Holboca Iasi [16].

The dosages of components of concrete are given in Table 1.

Table 1

Mix	Components			W/C+F	Consistence
	Cement	Fly Ash	W		
	Kg/m^3	Kg/m^3	Kg	-	cm
A1	360	0	172	0.48	S2(1.5)
A2	324	36	172	0.48	S2(1.5)
A3	306	54	172	0.48	S2(1.0)
A4	288	72	172	0.48	S2(1.0)
A5	234	126	172	0.48	S2(1.0)

The test samples were cubes shape with 141 mm, 6 samples for each mix, which were kept in standard conditions 28 days before testing.

4. Experimental Results

The results of compression tests at 28 days are given in Table 2.

Table 2

Sample	W/C+F	Cement	Fly Ash	f_c	Average f_c
	-	Kg/m^3	Kg/m^3	MPa	MPa
A1	0.48	360	0	-	36.63
				32.90	
				40.36	
A2	0.48	324	36	42.85	45.14
				45.29	
				47.28	
A3	0.48	306	54	37.93	37.19
				38.08	
				35.56	
A4	0.48	288	72	37.36	35.22
				35.26	
				33.05	
A5	0.48	234	126	22.65	22.65
				22.66	
				22.65	

The graphical representation is given in Fig. 1.

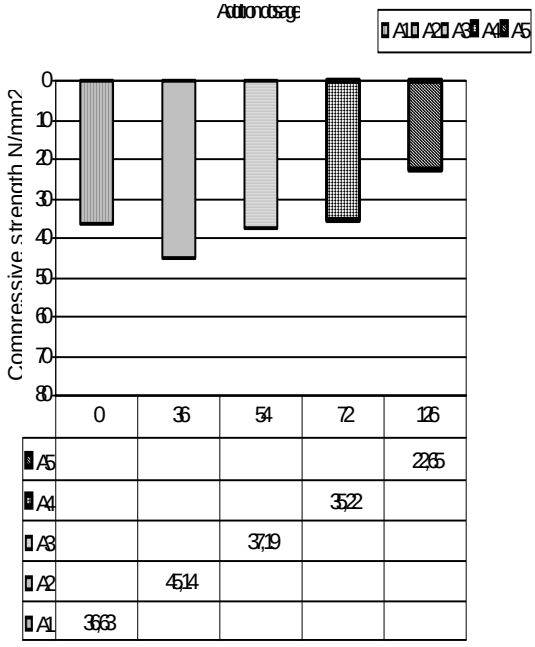

Fig. 1. *Compressive strength of concrete with fly ash dosage*

The experimental results presented in Fig.1 showed that the concrete mix with 10% fly ash (A2) had an increase in compressive strength of about 23.2%, in comparison with the witness (A1). The mix with 35% fly ash replacement of cement (A5) had the compressive strength smaller than the witness (A1) with about 39%.

4. Conclusions

The analysis of experimental results shown the following conclusions:

The mixes A5 with a higher fly ash addition (35% from cement dosage) had a value of compressive strength under the level of concrete grade strength in conditions in which were kept the same consistency characteristics, the same compounds and the test were at 28 days.

The mix A3 with a dosage of fly ash of 15% from cement dosage had the behaviour like the witness. In these conditions the compressive strength of concrete with fly ash is equal to that of mix A1.

The mixes A3 and A4, which had a similar mix, presented the characteristics of fresh and hardened concrete with close values, with a smaller value of compressive strength of mix A4 which had a reduced cement dosage.

From the economical efficiency way, by the compressive strength interpretation, the mix A2 is good. In this case, for a cement dosage of 324 kg/m3, in comparison with 360 kg/m3 and fly ash 36 kg/m3, in the conditions of a ratio W/C+F = 0.48 the increase of compressive strength at 28 days is highest.

In conclusion the concrete mix with a fly ash replacement of 10 % from cement dosage had the best behaviour from the mechanical property point of view.

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