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THE INFLUENCE OF THE THERMAL POWER PLANT ASH ADMIXTURE ON THE PERMEABILITY OF THE CONCRETES WITH HYDROTECHNIC CEMENT

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Abstract: *The studies conducted for now highlighted that the thermal power plant ash that is introduced in some concretes composition, is contributing to the decrease of their permeability. Is known, as well, that the ash admixture is leading to the reducing of the cement dosage, therefore the concretes will be cheaper and in this conditions is important to analyse the influence of the ash admixture on the impermeabillity degree for concretes realized with hydrotechnic cements.*

Key words: *concrete, thermal power plant ash, permeability, hydrotechnic cement.*

1. Introduction

The concrete works supposed to obtain some performant characteristics from all the points of view. In this sense, a concrete with great permeability exigencies can be realize using active admixtures, in the conditions when the strength characteristic is not neglected. The permeability characteristic [1, 2] is realized through the structural characteristics – compactness, porosity. If on the compactness can interfere in the sense of its increasing, by using of active admixtures, it was experimentally concluded that the assembly of the obtained technical characteristics of these concretes were closed the concretes realized without admixtures. So, it is imposed that for each concrete mixture realized with belitic cement the permeability characteristic to be analysed in comparison with other important technical characteristics for the favourable behaviour of the concretes and to choose the versions with the best assembly behaviour.

2. General Aspects Regarding the Influence of the Ash Admixture on some Concretes Characteristics

The cement concretes are using the cement as binder, and this is influencing the concrete structure's forming by its nature and the dosage used for mixture's realizing. In the case of hydrotechnic cements that are used for concretes preparation, in which

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category is entering and that represents the subject of this study [3, 4], has in its composition 6 – 20% alkali furnace slag that is improving its structural characteristics.

From the admixture's action mechanism point of view, this type of admixture is producing modifications in forming of the cement stone and implicitly on the formed structure's characteristics, so on the assembly behaviour of the binder that is used in concretes mixtures. So, the slag is hydrating in the presence of the calcium hydroxide solution that is resulting from the reaction with water of the cement clinker. During the hardening, the paste is stiffening, the viscosity around the slag particles is increasing and that leads to the diffusion processes slowing. In this time, the forming of the gypsum, calcium hydroxide and low amounts of silicon dioxide and aluminium trioxide saturated solutions forming is occurring. The dissolving and hydration velocity of the aluminium hydroxide is lower than the velocity with the hydro aluminate is later separating. The silicon hydroxide from the solution supposed the tricalcic silicate's hydration, as well. Later the reactions between the water, calcium hydroxide and calcium sulphate with the active compounds from the slag will occur. In a first phase, the slag suffers a superficial colloidal transformation, and further will occur the formation of the hydrosilicates, hydroaluminates and the complex hydrocompounds. The formed hydrosilcates will favourize the increase of the new gelic formations volume, that after the hardening process are leading to an intense microcracking process [5, 6]. In this situation is recommended to maintain up to the hardening the concrete in wet environment or under water, to prevent the shrinkage and, in the same time, contributing to its compactness increase [5]. The previous studies highlighted that the mechanical strength are slowly increasing, finally presenting values closed to the cements without admixtures and for a long time hardening the strengths of the cement without admixtures can be exceeded.

The previous researches that used as admixture the thermal power plant ash and belitic cements based on alkali furnace slag admixtures (the same type of admixture) did not exceed the total admixture proportion of 30 – 40% [7]. The utilization of great admixture proportions are leading to the following consequences:

- The greater amount of mixing water, that represents fine part having a great specific surface, is determining the displacement tendency of the 0.5 – 1 mm pores dimensions towards greater dimensions;
- The increase of the capillarity pores volume by the increase of the admixture volume from the concretes mixture.

This modifications are theoretical unfavourable for the forming of the concrete's structure, that impose a strictly correlation of cementing materials from the mixture [8]. This supposes that the ash dosage have to take into account the cement dosage, so that the fine part to not exceed certain limits and, in the same time, it has to be considered that the mixing water dosage and the ratio between the water and the fine part (cementing material) to remain in reduced limits or to be reduced by using tensioactive additives.

3. Experimental Program

The experimental program was conducted according to the Standards NE 012-1/2007 and NE 012/2010 [9, 10] regarding the realization of the concretes in different working conditions and certain limits for the composition factors (minim cement dosage, maxim W/C ratio etc.) and, in the same time is recommending function the concrete's exposure class, even the cement type that is recommended to be used.

Taking into account the expertise in this field and the requirements imposed by the Standards, three concrete receipts were designed having the maxim dimension of 16 mm, composite cement of type H II/A-S 32.5 and as admixture thermal power plant ash collected by dry process, all these for different values of the components dosages realizing the following compositional characteristics, presented in Table 1.

Compositional characteristics of the fresh concrete Table 1

Receipt	**Component dosages**			**W/C+Ce**	**Consistency class - cm**
	Cement-C kg/m^3	**Ash-Ce kg/m^3**	**Water-W l/m^3**		
H1	100	200	223	0.74	C3(8.5)
H2	200	200	215	0.55	C3(8.5)
H3	300	150	216	0.49	C3(8.5)

Cubic samples having 14.1 cm sides were realized, three for each receipt, were preserved in standard conditions and then tested to permeability and other three samples were also preserved in standard conditions and subjected to compression testing at the age of 28 days.

4. Experimental Results

According to the compositional characteristics of the four receipts, after the samples subjecting to testing, the following results for compression strength and specific increase are obtained and presented in table 2, respectively table 3.

Compression strength Table 2

Samples symbol	**Cementing material containing C+Ce**	**Compression strength at 28 days N/mm^2**	**Permeability degree**
H1	100+200	6.0	P4
H2	200+200	18.0	P8
H3	300+150	25.2	P12

Specific increase Table 3

Samples symbol	**Cementing material containing C+Ce**	**Specific increase „∂” at 28 days (N/mm^2/kg) x 1000**	**Permeability degree**
H1	100+200	20	P4
H2	200+200	45	P8
H3	300+150	50	P12

Note: the specific increase is computed as a ratio between the strength and cementing material's mass, multiplied with 1000.

A graphic representation of the experimental results allows a more clear appreciation of the permeability characteristic, as follows in Figure 1 and Figure 2.

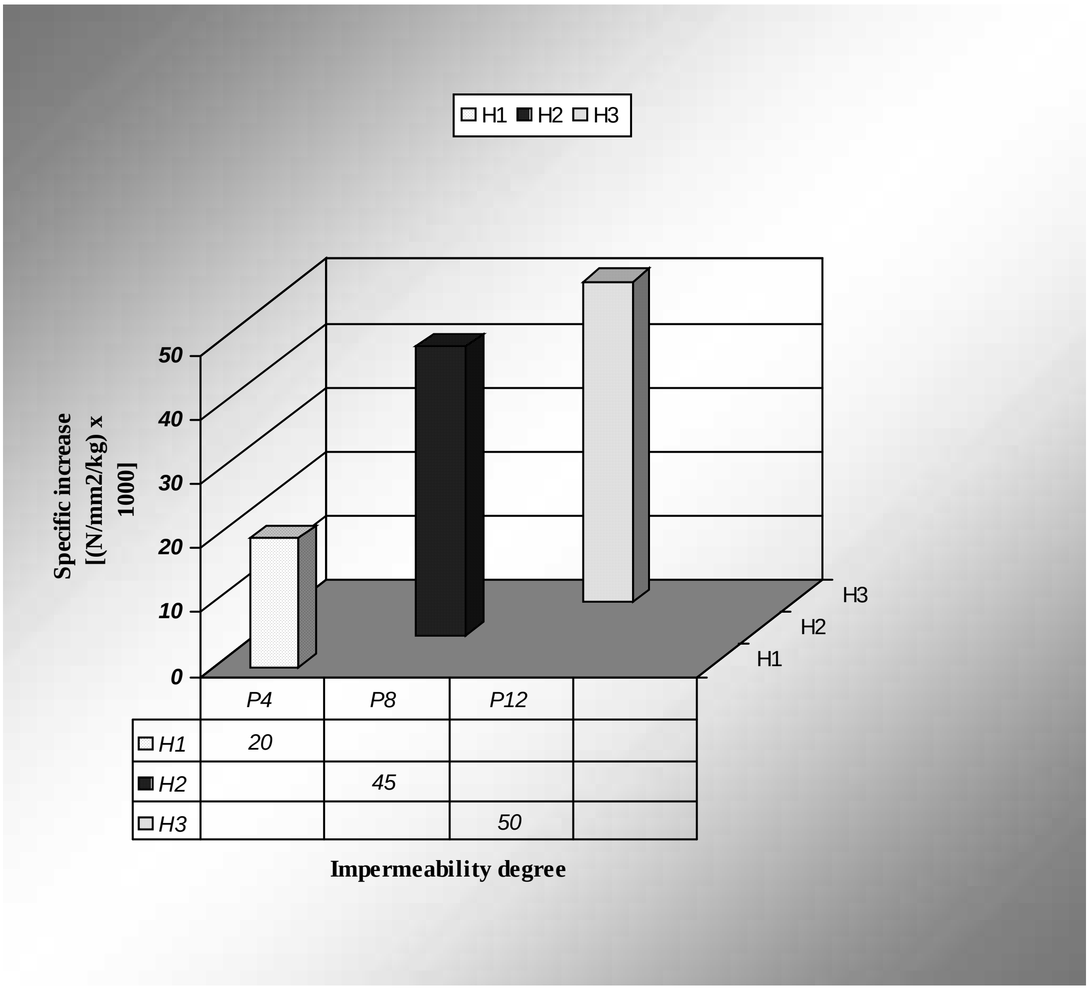

Fig. 1. *Variation of the permeability function of specific increase*

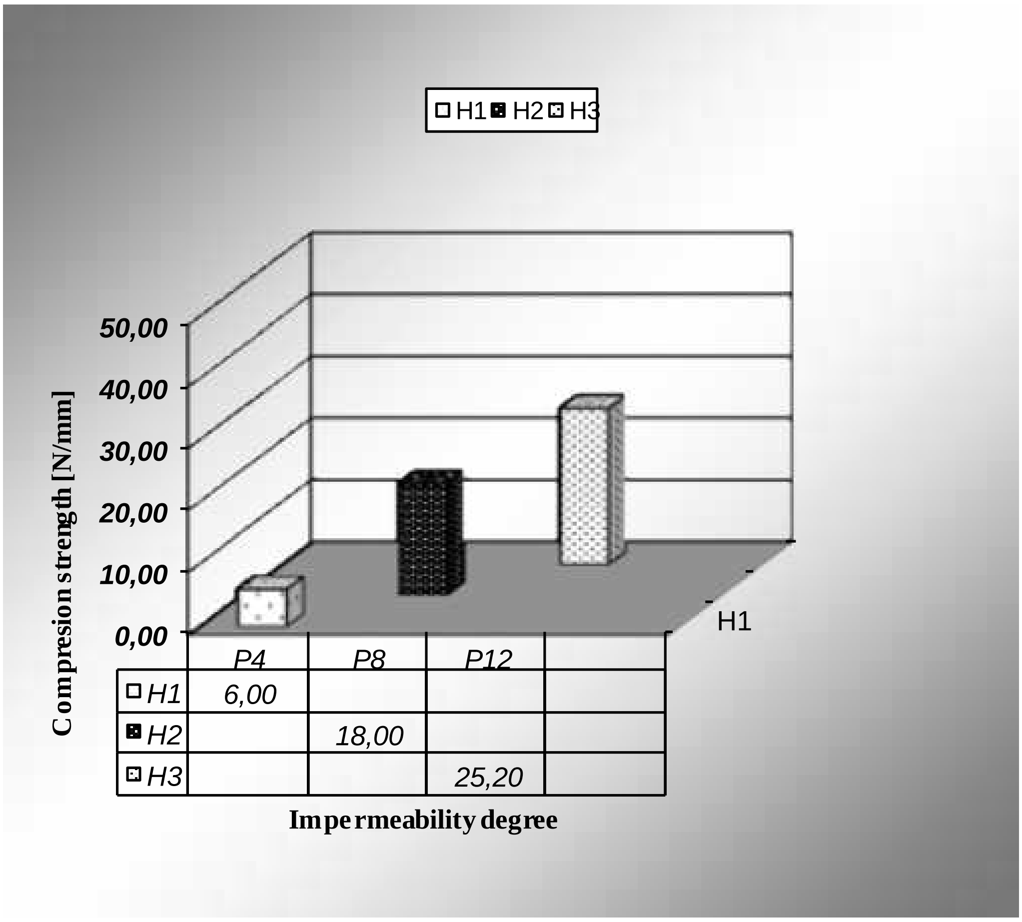

Fig.2. *Variation of the permeability function of compression strength*

4. Conclusions

Analysing the experimental values completed by the graphics interpretation can be concluded:

1. The receipts H1, H2 and H3 have cement dosages of 100, 200 and 300 kg/m^3, in the conditions when the ash dosage is 200, 200 and 150kg/m^3, present an increasing permeability degree, according to the specific increase and the compression strength, in case when the consistency characteristics were the same.
2. The receipt H1 presents a reduced permeability characteristic, in the condition when the cement dosage is only 100kg/m^3 and the ash dosage represents 200% beside the cement dosage. In this conditions the concrete's compression strength and its specific increasing is more reduced beside the used cement dosage, with a reserve that at 0 days will present improvements specific to this type of cement.

3. It can be considered that the receipt H3 presents very good characteristic in hardened state at 28 days from the casting moment that is recommending it from the strength point of view and of the permeability degree, as well.
4. From the economic efficiency point of view, function of the permeability characteristic, the receipt H2 is remarkable. Even in its case, for a cement dosage of 200kg/m^3 and ashes of 200kg/m^3, a specific increase of 10 % lower than in the case of the receipt H3 (when the compression strength is 30% lower) is obtained, in the conditions of a 33% greater cement dosage and the ash dosage lower with 25%, can be considered that this receipt shows the best the improvement of the behavior from the permeability point of view, in the conditions of introducing of some increased thermal power plant ashes, in comparison with the receipt H1.

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