BULETINUL INSTITUTULUI POLITEHNIC DIN IAȘI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iași
Tomul LVIII (LXII), Fasc. 4, 2012
Secția
CONSTRUCȚII. ARHITECTURĂ

FLY ASH ADMIXTURE AND ITS INFLUENCE ON ALITIC TYPE CEMENT CONCRETE PERMEABILITY

BY

MIRCEA RUJANU[*] and BOGDAN RUJANU

"Gheorghe Asachi" Technical University of Iași
Faculty of Civil Engineering and Building Services

Received: September 5, 2012
Accepted for publication: September 27, 2012

Abstract. Experimental and theoretical studies pointed that adding fly ash in concrete composition, could favour its impermeability characteristic improvement. It is known, also, that fly ash admixture achieves cement dosage reduction, so that concrete will be cheaper, and in this conditions it is important to analyse fly ash admixture influence on impermeability degree, too.

Key words: fly ash; concrete; cement dosage; impermeability degree.

1. Introduction

Achievement of concrete strength structures represents, virtually, a convenient alternative regarding price/performance ratio, but all of them are investments with important price cost and from this point of view it is imposed the achievement of performance characteristics from all relations. A concrete with high permeability exigency can be achieved using reactive admixtures, but without neglecting strength characteristic. It is well known that in order to have

[*]Corresponding author: *e-mail*: mrujanu@yahoo.com

a competitive permeability feature it is necessary to realize certain interdependence through structural characteristics: compactness, porosity. Compactness can be modified by increasing it, using active admixtures in different dosages and finally choosing the alternatives with best behavior view.

2. General Aspects Regarding Fly Ash Admixture Influence on Concrete Permeability

Cement, as a binding material, influences concrete structure formation through its nature and dosage, used to achieve the mix. A large variety of cements are used for different concrete mixtures, having in their composition 15%…30% active admixtures which ensure structural characteristics. The admixtures used in concrete compositions are: blast-furnace slag, fly ash and different pozzoulanic materials. All those admixtures are causing changes in cement stone structure formation and implicit on characteristics of the formed structure, and, consequently, on behavior of the binder used in concrete mixtures.

Fly ash is a material of silica-aluminous nature, in a refined divided state and will react in the presence of humidity with calcium hydroxide, forming compounds with binding properties. Formed hydro silicates will favour the increase of new gel formations volume, which, by hardening process will bring to an intense action of micro cracking than in case of using cements or concretes without admixtures. In this situation it is recommended preservation of concrete in moist environment or under water, till hardening, in order to prevent contraction and same contributing to its compactness growth. Previous studies have shown that mechanical strengths are slowly growing, and finally present close values to those of cements without admixtures. Researches, that were made, has focused onto cements with admixtures of maximum 30%…40%. In these experimental conditions, could be made the following observations:

a) Existance of the tendency, determined by the high content of mixing water imposed by fly ash large specific surface, of translocation for the pores with dimensions between 0.5…1 mm, towards larger dimensions.

b) Growth of capillary pores volume by increasing fly ash volume, used in concrete mixes.

Those changes are unfavourable as regards the concrete structure formation and they have negative influences on its structural characteristics, which impose a very strict correlation of the fine aggregate content and admixture from the composition. In these conditions fly ash dosage has to take into account cement dosage (which can contain this admixture), so as the fine part not to exceed certain limits. So it has to consider that mixing water dosage and water – fine part ratio to be in small amounts or to be reduced by using surface-active admixtures.

3. Experimental Procedure

Experimental procedure has taken into account present standards which refers to concrete achievement in different working conditions and dictates certain limits for composition factors (minimum cement dosage, maximum W/C ratio) and in the meantime recommends, according to exposure class of concrete, the type of cement to be used (NE 012/1-2007, NE 012/2-2010).

Taking into account experience in this field and restrictions imposed by actual standards, were achieved four concrete recipes using river aggregates with 16 mm maximum dimension, composite cement type CEM II/A-S 32,5 and fly ash as an admixture, yielded by dry way, all of this for different values of components dosages, being realized the compositional characteristics indicated in Table 1.

Table 1
Compositional Characteristics

Recipe index	Components dosage			Technical chracteristic
	Cement – C kg/m^3	Fly ash – Fa kg/m^3	Water – W L/m^3	Consistency class
B1	200	150	235	C3
B2	200	200	220	C3
B3	250	125	226	C3

For this purpose was made up cubical samples with 14.1 cm side, three from each recipe being kept in standard conditions to be tested regarding permeability, and other three samples were kept in standard conditions to be tested regarding compression at the age of 28 days.

4. Experimental Results

According to compositional characteristics of the three recipes and by testing the samples, there were recorded the results synthetically presented in Table 2.

Table 2
Experimental Results

Recipe index	Cementing material C + Fa	Compression strength at 28 days N/mm^2	Specific increment at 28 days N/mm^2/kg ×10,000	Impermeability degree
B 1	200+150	12.8	36.6	P4
B 2	200+200	17.0	42.5	P8
B 3	250+125	24.8	66.1	P12

A graphic materialization will permit a clearly appraisal of concrete permeability characteristic corresponding to the three recipes, as it follows (Figs. 1,…,3).

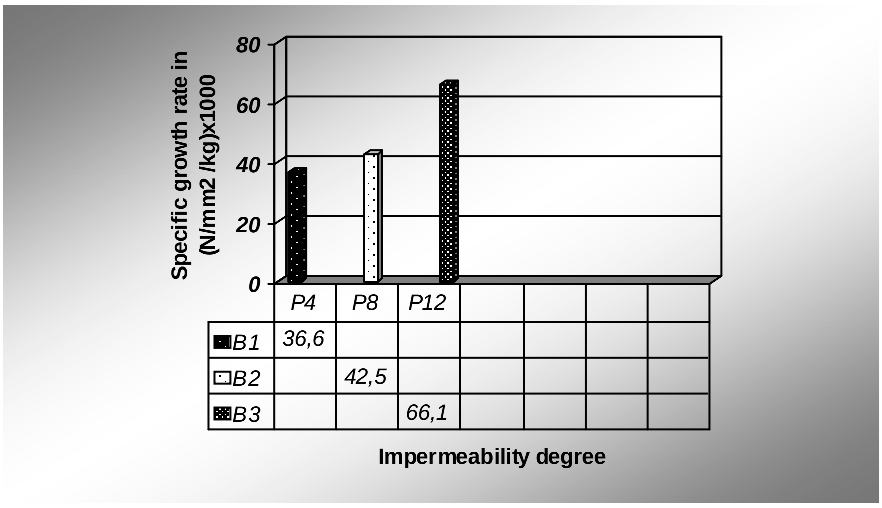

Fig. 1 – Impermeability degree variation according to specific growth rate.

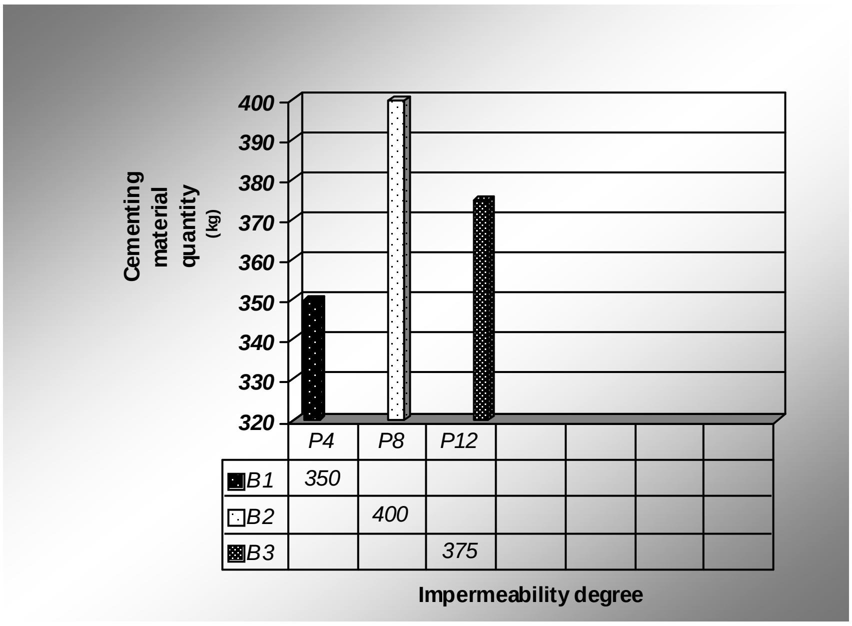

Fig. 2 – Impermeability degree variation according to cementing material quantity.

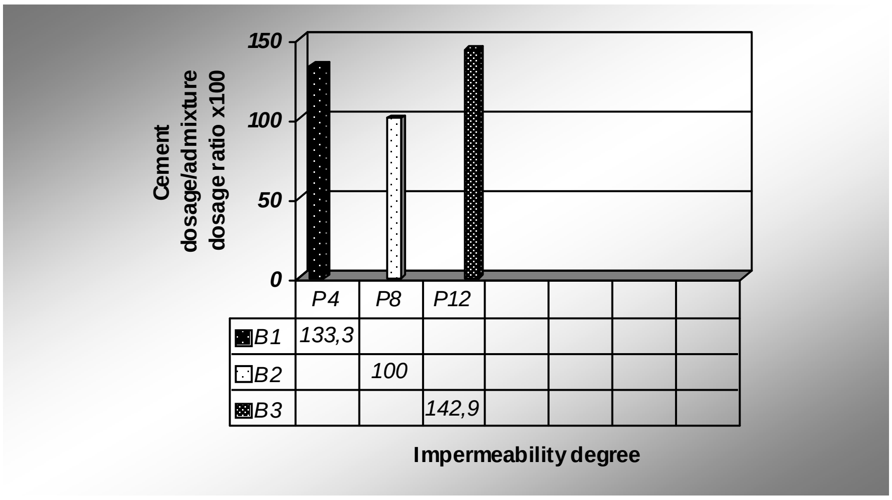

Fig. 3 – Impermeability degree variation function of cement dosage/admixture dosage ratio.

5. Conclusions

Experimental values analysis sustained by graphic interpretation allows the formulation of the following conclusions:

a) Although recipes has cement dosages of 200 kg/m^3, respectively 250 kg/m^3, whereas fly ash dosage is 150, 200, respectively 125 kg/m^3, they presents, from specific growth rate and compression strength point of view, an increase generated by admixture quantity but also by the cement.

b) B3 recipe presents best behavior for a cement dosage increased with only 50 kg/m^3 as compared to B1 recipe, and fly ash dosage represents 50% from cement dosage but with 25 kg lesser compared to B1 recipe. In these conditions concrete strength and specific growth rate are 50% elder than B1 recipe which has used a 200 kg/m^3 dosage.

c) Degree of impermeability grows from P4 to P8 for the same dosage of cement, only with an 50 kg/m^3 increase of fly ash dosage (see B1 and B2 recipes).

d) Degree of impermeability grows from P4 to P12 for a cement dosage of 200 kg/m^3, respectively 250 kg/m^3, knowing that fly ash admixture is lesser with 25 kg/m^3 (see B1 and B3 recipes).

REFERENCES

D’Arcy H.P.G., *Les fontaines publiques de la ville de Dijon*. Dalmont, Paris, 1856.

Gertis K., Kießl K., Werner H., Wolfseher U., *Hygrische Transportphänomene in Baustoffen*, Deutscher Ausschuβ für Stahlbeton, Heft *258*, Verlag Ernst u. Sohn, Berlin, 1976.

Hilsdorf H.K., *Durability of Concrete – a Measurable Quantity?*. Proc. of IABSE Symp., Lisbon, **1**, 1989, 111-123.

Koichi Maekawa *et al.*, *Modelling of Concrete Performance*. Routledge, London, 1999.

Korhonen C., *Effect of High Doses of Chemical Admixtures on the Freeze–Thaw Durability of Portland Cement Concrete*. US Army Corps of Engineers – Eng. Res. a. Develop. Center, Februarie 2002.

Marta L. *et al.*, *Proofing Additions for Mortars and Concrete*. Sci. Ses. Polyt. Inst., Iaşi, Section B, 1981, 346.

Neville A.M., *Proprietățile betonului* (transl. from English). Fourth Ed., Editura Tehnică Bucureşti, 2003.

Rujanu M., *Contribuții privind influența unor caracteristici structurale asupra comportării la coroziune a mortarelor şi betoanelor cu lianți minerali*. Ph.D. Diss., Archit. a. Constr. Faculty, Iaşi, 1993.

* * * *Permeability Testing of Site Concrete – a Review of Methods and Experience. Report of a Concrete Society Working Party, in Permeability of Concrete*. The Concrete Society, Papers of a one-day conference held at Tara Hotel, Kensington, London, December 12, 1985.

ADAOSUL DE CENUŞE DE TERMOCENTRALĂ ŞI INFLUENȚA SA ASUPRA PERMEABILITĂȚII LA BETOANE CU CIMENT DE TIP ALITIC

(Rezumat)

Studiile teoretice şi experimentale pun în evidență faptul că cenuşa de termocentrală introdusă în compoziția betoanelor poate favoriza îmbunătățirea caracteristicii de impermeabilitate a acestuia. Se cunoaşte de asemenea faptul că adaosul de cenuşe realizează reducerea dozajului de ciment, astfel că betoanele vor fi mai ieftine şi în aceste condiții este important de analizat influența adaosului de cenuşe şi asupra gradului de impermeabilitate a betoanelor.