BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Tomul LIV (LVIII), Fasc. 3, 2011
Secţia
CONSTRUCŢII. ARHITECTURĂ

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

BY

BOGDAN RUJANU*

“Gheorghe Asachi” Technical University of Iaşi,
Faculty of Civil Engineering and Building Services

Received: August 2, 2011
Accepted for publication: September 22, 2011

Abstract. The studies that were made until now emphasized the fact that the thermoelectric power station ash which is introduced in concrete composition contributes to the impermeability increase. It is also known that the ash addition leads to reduction in cement dosage and thus the concrete will be cheaper and under these circumstances is important to analyse the influence of the ash addition and the level of impermeability in concrete made with belitic type cement.

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

1. Introduction

Concrete works suppose the realization of advanced characteristics from all points of view. In this respect a concrete with high permeability exigency can be made using active addition provided that there is not neglected the resistance characteristic. The permeability characteristic is made by means of structural-compactness, porosity characteristics. If on compactness there can be intervened in the way of increasing it, by using active additions, at an experimental level there was observed that the totality of the technical characteristics obtained on this kind of concrete were close to the concrete without adding. So there is important for each concrete mixture made with

* *e-mail*: rujanu_bogdan@yahoo.com

belitic cement to analyse the permeability characteristic in comparison with other important technical characteristics for a favourable concrete behavior and to be chosen the best overall behavior.

2. General Aspects Regarding the Influence of Ashes Addition on Some Concrete Characteristics

Cement concretes use the cement as a binder and this one influences the forming of the concrete structure by its nature and by the dosage used in order to realize the mixture. In the case of the hydrotechnical cements which are used at making concrete and in whose category falls in and makes the subject of the present study, has in its composition 6…20% furnace basic slag which improves its structural characteristics.

From the point of view of the addition action mechanism this type of addition produces changes in the structure of the cement stone and implicitly on the characteristics of the formed structure and thus on the whole behavior of the binder used in concrete mixtures. Thus, the slag is hydrated in the presence of the calcium hydroxide solution which results following the reaction between water and cement clinker. While the hardening takes place, the cement paste becomes rigid, the viscosity around the slag particles increases which leads to the slowing of the diffusion processes. During this period there takes place the formation of saturated gyps solution, calcium hydroxide and small quantities of SiO_2 and Al_2O_3. The speed with which it is dissolved and hydrates Al_2O_3 is smaller than the speed with which it later separates from the hydroaluminate. SiO_2, which is present in the solution, also involves the hydration of the tricalcium silicate. Later there will take place reactions between water, calcium hydroxide and calcium sulphate with the active compounds of the slag. In the first place the slag suffers a superficial colloidation and later there will take place the formation of the hydro silicates, hydro aluminates and complex hydro compounds. The formed hydro silicates will favour the volume increase of new gel like formations which following the hardening process lead to an intense process of microfissure. In this situation there is recommended the keeping until the concrete hardens in a moist environment or under water in order to prevent the contractions and at the same time contributing to the increase of its compactness. The previous studies emphasized the fact that although the mechanic resistances increase slowly, at the end they have close values to the cements without additions and at increased hardening periods of time which can surpass the resistances of the cement without addition.

The research made until now which used as addition the thermo-electric power station ashes and belitic cements with furnace basic slag addition (that means the same type of addition) did not cross over the total proportion of 30%…40% addition. In this situation there is the possibility to have some consequences as follows:

a) a bigger content of mixture water imposed by the addition which is fine part with the big specific surface determines the moving tendency of the pores' dimension with 0.5…1 mm towards bigger dimensions;

b) the number increase of the capillary pores by increasing the addition volume from the concrete mixture.

These modifications are theoretically unfavourable to the concrete structure forming and can have negative influences on concrete structural characteristics, a fact which imposes a very strict correlation of the fine part from the mixture. This means that the ash dosage has to consider the cement dosage so as the fine part not to surpass certain limits and at the same time there has to be taken into consideration the fact that the mixture water dosage and the balance that is made between the water and the fine part to be kept in reduced limits or to be reduced by using tensioactive additives.

3. Experiment Organization

When organizing the experiment there were taken into consideration the NE 012-1/2007 norms corroborated with NE 012/2010 ones which refer to making concrete in different working conditions and which mentions certain limits for composition factors (cement dosage, maximum A/C dosage) and at the same time recommends, according to the concrete exposure class, even the cement type which is recommended to be used.

Making use of the experience in this field and the norms restrictions we made three concrete recipes using river aggregate with a maximum dimension of 16 mm, cement composite type H II/A-S 32.5 and, as an addition, thermoelectric power station ashes harvested in dry way, all these for different values of the component dosages and we obtained the compound characteristics presented in Table 1.

Table 1
Concrete Composition Characteristics in Fresh State

Recipe indicative	Component dosage			A/C+Fa	Consistency class (cm)
	Cement–C kg/m^3	Fly ash–Fa kg/m^3	Water–W l/m^3		
*B*1	100	200	223	0,74	C3(8,5)
*B*2	200	200	215	0,55	C3(8,5)
*B*3	300	150	216	0,49	C3(8,5)

There were made cubic test pieces with an angle side of 14.1 cm, three from each recipe were kept in standard conditions in order to be tried for permeability and other three test pieces were as well kept in standard conditions and tried for compression at the age of 28 days.

4. Experimental Results

According to the composition characteristics of the four recipes, after the sample trials, there were registered the results presented synthetically in Table 2.

Table 2
Experimental Results

Symbol samples	Cementing material content C + Ce	Resistance at 28 days N/mm^2	Specific increase at 28 days $N/mm^2/kg \times 1,000$	Impermeability level
*B*1	100 + 200	6.0	20	*P*4
*B*2	200 + 200	18.0	45	*P*8
*B*3	300 + 150	25.2	50	*P*12

A graphic interpretation of the experimental results would allow a more clear interpretation of the permeability characteristic (Fig. 1).

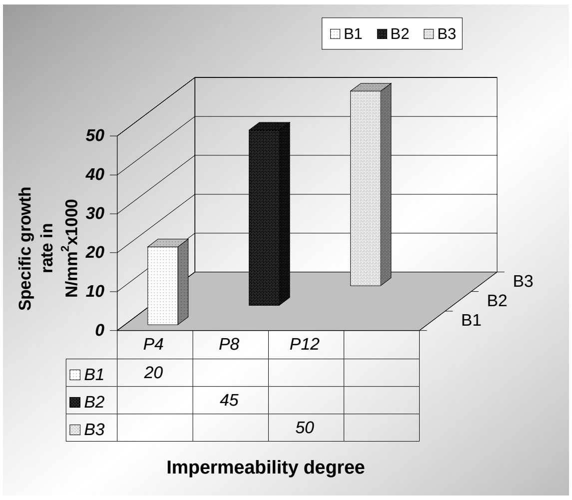

Fig. 1 – Permeability variation according to specific growth rate.

5. Conclusions

The analysis of the experimental values completed with the graphic interpretation leads to the following conclusions:

1. Recipes *B*1, *B*2 and *B*3 have cement dosages of 100, 200 and, respectively, 300 kg/m^3, in the conditions in which the ashes dosage is of 200, 200, respectively, 150 kg/m^3, presents an increasing permeability degree in

accordance with the specific increase, where there were practically kept the same consistency characteristics.

2. Recipe *B*1 presents a reduced permeability characteristic when the cement dosage is only 100 kg/m^3 and the ash dosage represents 200% comparing to the cement dosage. Under these circumstances the concrete resistance is very much reduced in comparison to the cement dosage which was used, with the reserve that for a hardening period of over 90 days its value will be in accordance with cement dosage used. It is worth mentioning the fact that in this case the impermeability degree in this case is also reduced, only *P*4, but there is the reserve that after 90 days it will present improvements specific to this type of cement;

3. It is necessary to consider that recipe *B*3 presents very good characterristics in hardened shape at 28 days from casting, a fact which recommends it from the point of view of resistance as well as permeability degree.

4. From the point of view of the economical efficiency, taking into consideration the impermeability characteristic it may be noticed recipe *B*2. Although in its case, for a cement dosage of 200 kg/m^3 and ashes 200 kg/m^3 there is obtained a specific increase with 10% smaller than in the case of recipe *B*3, in the conditions of a higher cement dosage with 33% and the ashes dosage smaller with 25% and consequently recipe *B*2 best reflects the behaviour improvement from the impermeability point of view in the situation where there were introduced higher thermoelectric power station ashes dosages if there is to compare it to recipe *B*1.

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ADAOSUL DE CENUŞE DE TERMOCENTRALĂ ŞI INFLUENŢA SA ASUPRA PERMEABILITĂŢII LA BETOANE CU CIMENT DE TIP BELITIC

(Rezumat)

Studiile teoretice şi experimentale pun în evidenţă faptul că cenuşa de termocentrală introdusă în compoziţia betoanelor poate favoriza îmbunătăţirea caracteristicii de impermeabilitate a acestuia. Se cunoaşte de asemenea faptul că adaosul

de cenuşe favorizează reducerea dozajului de ciment, astfel că betoanele vor fi realizate cu costuri minime şi în aceste condiţii fiind importantă analiza influenţei adaosului de cenuşe şi asupra gradului de impermeabilitate.