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HYDRATION STUDIES OF BOME BLENDED PORTLAID CEMENTS

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Abstract

Hydration properties of rice-husk ash (15%) by weight), coaldust-flyash (20% by weight) and brick-kiln ath (10% by weight) blended portlandcomments have been studied employing different experimental techniques such as the determination of setting time, free lime content, non-evaporable water content, compressive strength, analysis of liquid phase etc. Various results indicate that the. presence of these waste materials initially retards the hydration of portland cement. However, from the compressive strength measurements, it is found that at later stages these blended cements give better strength. The free lime contents in the blended cements are found to be always lower than the control (even at 28 days of hydration). This decrease of free lime in blended cements is to the consumption of the liberated calcium hydroxide in reaction with amorphous silica and alumina present in the waste materials. This clearly shows that these materials have appreciable pozzolanic properties. Further, the possolanic reaction is accelerated with increase of temperature. The increase in strength may be due to a change in the microstructure of the hydration products. Besides these, if an accelerating admixture such as calcium chloride is added to these blended cements, the extent of hydration is increased.

Introduction

Blended cements are usually blends of portland clickers with other finely ground materials in well-defined percentage. These materials, known as pozzolanas, are either rich in smorphous

silica or have higher amount of calcium ions in their glassy structure. They take part in the hydration reactions and thereby make a substantial contribution to the hydration products.

Number of materials such as pulverisedfuel ash, gramiated blast Furnace slag are already being used in the preparation of blended portlant cement and these cements have proved to be economical and better than ordinary portland cement (OFC).

Various other types of waste materials which are disposal misance and pollutant are being characterized and find out regarding their possible effective utilisation as Mending components. Rice-husk ash (REA) and flyash (FA) are two of them. In the present paper hydration properties of EA, coaldust-flyash (CFA) and brick-kiln ash (BKA) blended OFC have been studied and compared to that of control.

Researches have shown the REA can be used as building material (1-7). It is pointed out that the reactivity of A depends on the burning conditions (8,9). Controlled barning at different temperatures (6000-10005 C) gives ash best suitablefor blended cement (10). In the present work suitability of HA obtained by burning only at in 500d has been find out.

A large number of research papers describing the effect of fly ashes on the hydration of cement have been published during the last few years (11-14). Flyash for the present work was obtained from a local thermal power plant and used as such though it was mixed with coal dust and tested for its utility.

Ashes obtained from brick-kilns have also pozzolanie properties and can be used in the preparation of blended cement. In this paper hydration of BKA-blended OFC has also been studied.

Experimental:

Materials:

OFC with oxide and mineralogical compositions given in Table 1, was used for the hydration studies. The Blaine surface area was found to be 2815 cm2/g. Ricehusk was allowed to burn in open air and the blackish ash obtained was again burnt at 500°C for 2 h. This RHA, CFA and

BKA all were allowed to pass through a siene of 100 mesh. The chemical composition of RHA, CFA and BKA are also given in Table 1.

Table 1 Composition of reactants

Constituents	composition (%)			
	OFC	RHA	CFA	BKA
CaO	65.2	0.2	3.7	4.9
$S10_2$	22.2	95.2	65.2	65.0
Al_20_3	6.3	-	8.0	16.2
Fe_20_3	2.8	0.2	11.5	7.3
Mg0	2.4	0.9	0.5	2.5
SO_3	1.4	-	-	-
Na_20	-	0.8	-	-
K_20	-	1.0	-	-
LOI	2.7	-	9.8	1.8
C_3S	47.74			
C_2S	25.22			
C3	11.96			
C_4AF	8.52			

Preparation of Smaples

OIC, OFC containing 15% RIA, OFC containing 20% CPA and OPC containing 10 BKA wore allowed to cure for various durations with W/a 1 at 30°C (room temperature). After hydration, reaction was stopped with isopropyl alcohol and other and dried at 100°c in an electric over. The hydrated samples were sealed in polythene bags and stored in a desiccator.

Setting time:

Initial and final setting times were determined with the help of Vicat apparatus. The water-solid ratio kept as 0.35.

Free time:

The percent free 1ime in each hydrated sample was deter mined by modified Franke method (15).

Non-evaporable Water Content (W_2) :

The Wn was determined from the difference in weight of a sample after it was heated at 105°C for one hour and then at 1000°C.

Liquid phase analysis:

Analyses of the liquid phase for Ca and OH ions were made by titrating against standard solution of EDTA and hydro -chloric acid respectively.

Compressive strengths

Cubes of 8x8x8 cm^3 of OFC and blended cements were prepared with a water-solid ratio 0.35. The cubes were vibrated for 5 minutes on a vibrating machine (AIMIL 416) for uniform packing. They were demoulded after 24 h. and submerged in water. The compressive strength were measured after 3,7,15 and 28 days with the help of an AIMIL 304 machine.

Results and Discussions

The variation of setting times in the presence of different amounts of blending materials is given in Fig. 1. Initial setting time increases upto 15% RHA and 10% BKA whereas it decreases with the increase in the amount of CFA. It appears that initial stiffening is enhanced as the amount of CFA is increased. Final setting time increases upto 15% RHA, 10% BKA and 20% CFA. ne results therefore indicate that in the presence of these blending materials retards the hydration. The initial set retardation may be due to dilution effect.

The variation of free time contents is given in Fig.2. In the case of control the free time values increase as the hydration time and temperature is increased. However in the presence of blending materials, the values are always lower. This is mainly attributed to the consumption of the liberated Ca(OH)2 by the blends. As the temperature increases, possolanic reaction is accelerated and less free Ca(OH) remains.

The non-evaporable water content increases with hydration time (Fig. 3) and the values are always higher in presence of blends. It appears that the $Ca(OH)_2$ formed in the hydration process is consumed in the pozzolanic reaction to give more of C-S-H. Massazza and Costa (16) have found that C-3-H obtained in blended cement has lower Ca0/3102 ratio than obtained from the hydration of OPC alone. This is probably one of the reasons for the better chemical resistance of portland-pozzolana blended cements. Addition of $CaCP_2$ accelerates the hydration.

The variation of Cat++ ion concentration in the solution is shown in Fig. 4 which clearly shows that as soon as OFC comes in contact with water, Ca2+ ions of the cement go into solution and the solution immediately becomes saturated with respect to Ca++ ions. After reaching to a maximum value its concentration decreases due to the precipitation of $Ca(OH)_2$ But once the hydration accelerates more and more Ca++ ions will go into the solution and as a result the concentration of Ca ion will increase. In the presence of blending materials the variation of Ca++ien follows a similar trend but with lower values. It appears that these materials combine with $Ca(OH)_2$ forming some insoluble products, as a result of which the Ca++ ion concentration is decreased. In a similar fashion the variation of OH-ion concentration in solution (Fig. 5) can be explained.

The results of compressive strength are plotted in Fig.6. The values are an average of three tests. The compressive strength increases with in presence of curring time. increase of A, the values are always lover except at 28 days. In presence of KA the values are lower only below 15 days whereas in presence of CFA the values are always higher. The lower values at sar27 stages may be due to

a) the presence of crystalline 8102 which has little pozzolanic activity
b) the dilution effect cominates resulting into higherporosity.

c)incomplete hydration.

The higher values at later stages suggests that a sufficient amount of Ca(OH)2 is formed and the pozzolanic activity is sufficient to form massive hydration products with smaller pore size. However, the high values throughout in presence of CPA indicate that probably the coal dust acts as filler reducing the pore size and pore size distribution and the hydration products. are formed across the filler material. It may also enhance the pozzolanic reaction resulting in the formation of larger amounts of hydration products.

Conclusions:

RHA obtained by burning at a temperature as low as 500° C, fly ash which had been swept along with coal dust, and ash from brick-kiln have also aufficient pozzolanic property and can be used potentially to prepare blended cementa. Purther, the properties may be modified in the presence of suitable admin tures and temperature. In order to have the complete understanding of the mechanism of action of pozzolanie materials during the hydration detailed investigation in needed.

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