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Impact of Variable Base Flyash Activated With 8% K_2O Content Of Fly Ash

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ABSTRACT: *This investigation explores the comparative studies of harden properties of typical fly ashes i.e. black, grey and white. This research shows that the parametric study of geo-polymer paste resulting from controlled percentage of alkali activator. The activator is prepared by mixing of* Na_2SiO_3 *and KOH solution. For every case activator subjected to a constant temperature 27°C stands for 24 hours. The geopolymer sample were mixed in a predetermine mix proportion. Then the sample were casted in a mould and it was cured for 24hours 85°C. To know the parameters like characteristic strength, water absorption, sorptivity the experiment was conducted.*

KEYWORDS: *Geo-polymer, Fly-ash, Alkali activator, characteristic strength, water absorption, sorptivity.*

I. INTRODUCTION

A geopolymer is an alkali alumino-silicate cementatious material which have better functional properties like mechanical, chemical and thermal as compared to Portland-based cements, significantly producing less CO_2[1]. Silica and alumina are pozzolanic composition which produced geo-polymer by dissolving in alkaline solution it is itself part of geopolymerization[2]. Instead of Portland cement the geo-polymer technology shows considerable promise for application in concrete industries as alternative binder [3]. Research was done on slag,a supplementary material in fly ash basedgeo-polymer to obtain a favorable effect of geo-polymer properties[4]. The setting time is less for using calcium compound to the fly-ash and it is also improve the strength [5].

The heat curing is needed to gain strength of geo-polymer[6]. The reaction of fly ash with an aqua solutioncontainpotassiumhydroxide and sodium silicate, result in a material with 3-d polymeric chain and ring structure consisting of Si-O-Al-O bond[7]. There are two main constituents of geo-polymer namely, source material and alkaline liquid. The source material for geo-poly based on alumina silicate should be rich in silicon and aluminum. The most common alkaline liquid used in geo-polymer is a combination of NaOH/KOHand sodium silicate/potassium silicate[8].

The environmental pollution is the major problem .The ordinary Portland cement (OPC) formation is emission the pollutants which causes the pollution in environment. The industry of Portland cement are produced huge amount of carbon dioxide like one ton CO_2 produced by made of one ton ordinary Portland cement [9].

II. EXPERIMENTAL

2.1. Materials:

Low calcium (Black and Grey) and high calcium (White) fly ash used in the present research work was collected from Kolaghat Thermal Power Plant near Kolkata, India. It had chemical composition as given in Tabl-1. About 75% of particles were finer than 45 micron and specific gravity of fly ash is 2.04.Sodium silicate solution (Na2O = 8%, SiO2 = 26.5% and 65.5% water) with silicate modulus ~ 3.3 and a bulk density of 1410 kg/m^3 was supplied by LobaChemie Ltd., India. Toprepare the alkaline activating solutions by dissolving required quantity of potassium hydroxide pellets directly into water.

The activator solution (potassium hydroxide and water) was left at room temperature for 24 h. After that, predetermined quantity of sodium silicate solution was added 3 hours before being used to manufacture geo-polymer specimens. Sodium silicate solution was added in a manner to maintain SiO_2/Na_2O ratio as 3.31 and SiO_2/K_2O ratio is 1.It had Na_2O content or K_2O content equal to 8.0% of fly ash. Water to Fly ash ratio was of 0.32.

Table-1: Chemical Composition of Flyash

CHEMICAL COMPOSITION	Black Fly Ash	Grey Fly Ash	White Fly Ash
SiO2	51.3	46.5	35.4
Al_2O_3	30.5	24.1	16.4
Fe_2O_3	6.7	5.4	5.3
SO_3	3.1	0.9	3.3
MgO	1	1.2	4.6
CaO	3.5	7.9	28.4
Na_2O_3	1.2	2.5	1.6
K_2O	0.86	0.9	0.9
Loss of Ignition	0.6	0.4	0.8

Table-2: Details of Mix Design of Geo-Polymer

Fly ash type	Fly ash amount (gm)	KOH (gm)	84% purity (gm)	Na_2SiO_3 (gm)	Free water (gm)	SiO_2/K_2O in activator	SiO_2/X_2O in activator	Water/ fly ash	$\%K_2O$
Black (GPBF)	1000	95.32	110.57	302	106.87	1	0.77	0.32	8
Grey (GPGF)	1000	95.32	110.57	302	106.87	1	0.77	0.32	8
White (GPWF)	1000	95.32	110.57	302	106.87	1	0.77	0.32	8

X_2O is the combination of Na_2O & K_2O, where in this study source of Na_2O in activator is Sodium Silicate and source of K_2O is Potassium Hydroxide.

2.2. Preparation of Solution & Sample

Required KOH solution was prepared by using potassiumhydroxide &measured water & place it room temp(27°c.) for 24 hrs. After that the calculated amount of Na_2SiO_3 sol, was added before 3 hours of mixing geo-polymer sample. Assuming (SiO_2/K_2O=1). Therefore K_2O content and SiO_2 content as 8%. Water to flyash ratio was 0.32.

In the mixing process the flyash wasmixed with the prepared solution for five minutes. After that the mix was placed into ($50\times50\times50$ mm^3) cube (wooden) mould for casting. To drive out air the casting mould was tampered. After that the sample were cured in the oven for 48 hours atconstant temp at 85°C[10]. After that the sample was placed in the oven for cooling (without heating). The mix proportion is shown above in the Table-2.

2.3. Testing and Analysis

Compressive Strength Test: Compressive strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression. Aimil Compression Testing Machines conform to IS: 14858 (2000) and calibrated with accuracy of + 1% as per the requirement of 1828 (Class 1)was used in our set up. The machine in which the sample specimen was tested was 500 KN capacity. The test result are shown in Table-3.

Figure-1: Specimen under compressive testing set up and Fracture surface of typical geopolymer material.

Water absorption test: To determine the water absorption of mortar specimens, three cubes from each series were oven dried at a temperature of 85°C for 24 hours and its weight was determined as initial weight. The samples were then immersed in water for 24 hours and its saturated surface dry weight was recorded as the final weight. Water absorption of specimens is reported as the percentage increase in weight. The test result was shown in Table-4.

Figure- 2: Specimen submersion in fresh water

Sorptivity test: Sorptivity test of specimen was conducted on specimens previously painted with waterproof enamel paint on all four sides such that only unidirectional uptake from the bottom is possible. A curve of cumulative mass gained per exposed surface area was drawn against square root of time and the slope of the linear portion was considered for determination of sorptivity. The test result shown in Table-5.

Figure-3: Specimen subjected to unidirectional sorption

III. RESULT AND DISCUSSION:

From the Compressive strength test the sample GPBF (BLACK) shows the high characteristic strength, as shown in the bar-chart, among GPGF (GREY) and GPWF (WHITE). The strength of GPBF is given as 36 MPa, whereas Grey sample provides 20 MPa, and white sample provides 10 MPa. So from the compressive strength characteristic it is understandable as Black fly-ash provides more strength compared to the Grey and White sample specimen at higher alkalinity. It is because of excessive presence of reactive silica in black fly ash.

Table-3: Compressive Strength Test

SampleName	Load(KN)	Strength(MPa)
GPBF	90	36
GPGF	30	12
GPWF	25	10

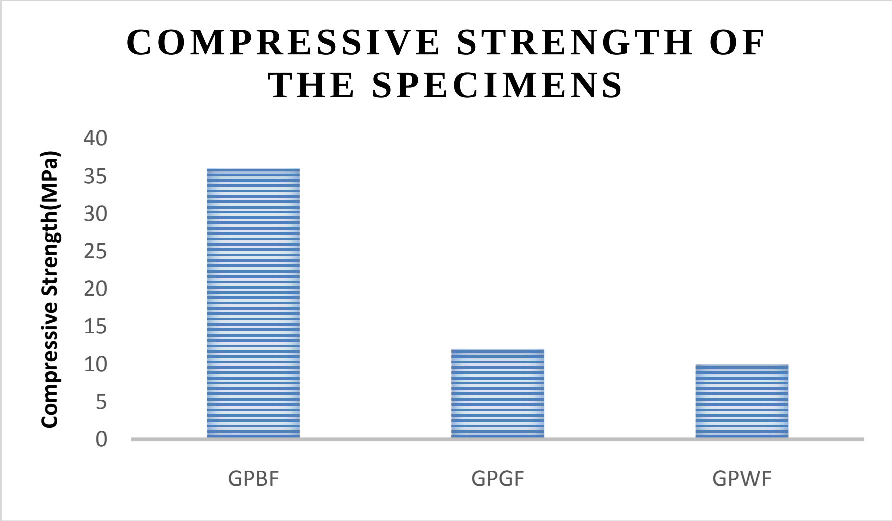

Figure-4: Graphical representation of compressive strength of different samples

Table-4: Water absorption test and Apparent Porosity

Sample	Dry Weight Of Sample (gm)	Weight At Suspended Sample (gm)	Weight Of Sample At S.S.D Condition (gm)	Water absorption(%)	Apparent Porosity (%)
GPBF	193	82	202	4.6%	7.5
GPGF	163	83	173.5	6.4%	11.60

From table 4 it is obvious that the water absorption value is almost same for both GPBF and GPGF sample.But apparent porosity level is different.As the apparent porosity indicates percentage of void volume occupied by moisture.It indicates that permeable pore is high for GPGF sample.It is because of lower formation of amorphous phase.In compare to that GPBF is much porous but void is not permeable in that manner.

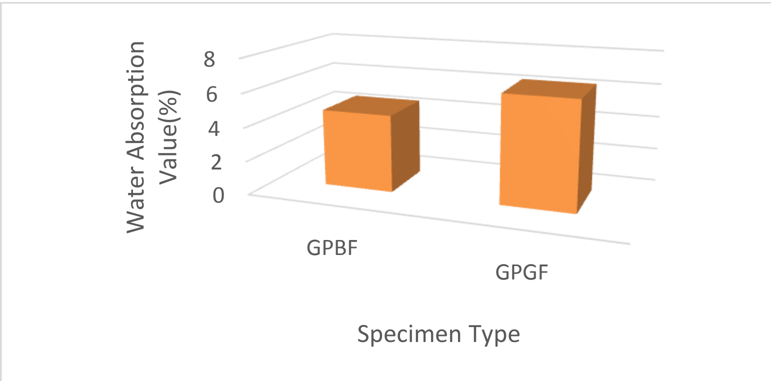

Figure-5: Graphical representation of water absorption of different samples

Figure-6: Graphical representation of apparent porosity of different samples

Sorptivity Test

Sorptivity is the process of measuring suction rate in unidirectional manner. So this test depicts the rate of absorption not the overall absorption.Fromsorptivity test it is observed that the value of sorptivity is lowest for GPBF (6) in compare to GPGF (9) &GPWF (8). This phenomena supports that the pore structure is less permeable in nature for GPBF sample.Again this conclusion supports better geopolymerisation for the specimen prepared for black fly ash.

Table-5: Sorptivity Data

Sample	Dry Wt. (gm)	Wt of sample subjected to sorption after						
		2nd Min	5th min	10th Min	15th Min	30th Min	1 Hour	2 Hour
GPBF	209	210	210	210	210.5	210.5	210.5	211
GPGF	185.5	187	187	188	188	188	188.5	189
GPWF	199	200	200	200	200.5	201	201	201.5

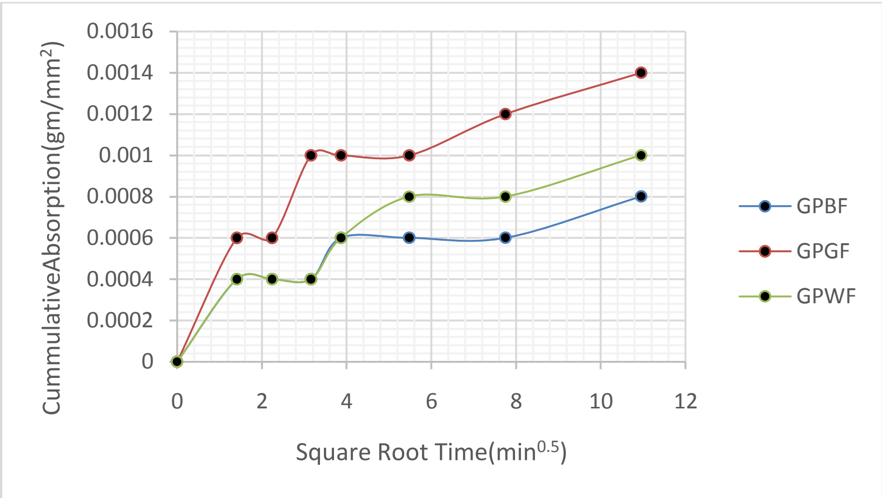

Figure-6: Graphical representation of cumalitive sorption with time function of different samples

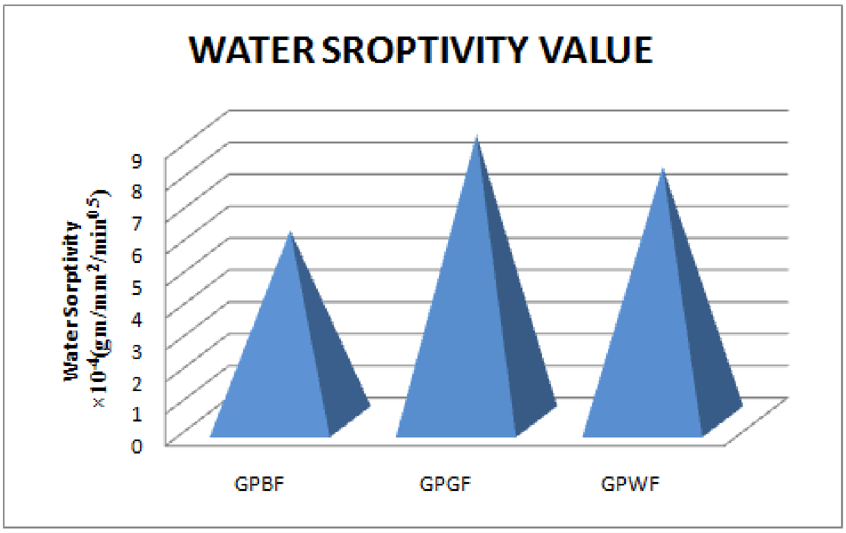

Figure-6: Graphical representation of mode value of sorptivity

IV. CONCLUSION

1. Compressive strength of GPBF fly ash sample is higher than GPGF and GPWF fly ash sample. The strength of GPBF fly ash is 36Mpa. The strength of GPGF and GPWF fly ash sample 12Mpa and 10Mpa respectively.

   Gained strength is propotional to polymerization while the rate of polymerization directly depends on the presence of reactive silica.

2. Water absorption valueof GPBF and GPGF are 4.6% and 6.4% respectively.Geopolymer of Black fly ash is consuming less amount of water than geo-polymer of grey fly ash.It indicates less permeable pores for sample GPBF.
3. The apparent porosity is less for GPBF which again supports the lower intrusion of moisture through pores.
4. The geo-polymer specimen of black fly ash exihibits lowersorptivity index 0.144 than that made of grey and white.Sorptivity value is higher forgeopoymer made from gray and white fly ash.In fact higher calcium content in geopolymer induce secondary CSH product which makes reduction in meann median pore size, which in fact affect surface tension as well as sorptivity.

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