Experimental Study on Geopolymer Pervious Concrete

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Abstract— This paper investigate the proportion of ground granulated blast furnace slag(GGBS) to be used to attain a good pervious geopolymer concrete . It was prepared from fly ash class-C, sodium silicate , sodium hydroxide solution and coarse aggregate various ratio of fly ash and GGBS was used. The physical and mechanical properties of pervious geopolymer concrete (PGC) will be beneficial for the forthcoming use of fly ash and GGBS geopolymer in the construction field of pervious concrete which will lead to reduce the cement consumption and environmental issue.

***Key words*:** Geopolymer previous concrete, sodium silicate , alkali molar , fly ash , paving block, Ground granulated blast furnace slag(GGBS),pervious geopolymer concrete(PGC)

I. Introduction

Geopolymer concrete have been studied by several innovator and were found to have a significantly advantage in high early strength, high later age strength, and excellent resistance to acid attack.Geopolymer has attracted attention as a practical alternative to Portland cement. There are nine different classes of geopolymer. In comparison to Portland cement, most geopolymer concrete rely on marginally processed natural materials or industrial waste material products to provide the binding agents. Eco-friendly geopolymer cements can be used as that of cement concrete application. Nasvi (2012) reported that changes in the permeability of geopolymer concrete changes with temperature. And it has found that the between 60^0C and 90^0C optimum curing temperature of geopolymer greater strength and lower porosity. Tawatchai (2011) studied that the behaviour of pervious concrete using Class-C fly ash geopolymer binder. Hence it has been concluded that class-c fly ash geopolymer binder could be used for high strength porous concrete.

Therefore, this study concentrates on the porous concrete by using a geopolymer binder which includes class-c fly ash, sodium hydroxide solution, sodium silicate and coarse aggregate, ground granulated blast furnace slag . The mechanical and physical properties of the PGC were tested. The sustainable development in construction field includes the saving of an energy consumption and to make the ecofriendly environment using waste material keeping the theme of recycling and reusing. GGBS and fly ash which are waste found to be promising materials in the construction field.

II. Experimental details

A. Materials:

Laboratory sodium hydroxide in pallet form and sodium silicate solution supplied found from Jain Industrial chemicals and ground granulated blast furnace slag source from JSW industries. Class C fly ash was used from Neyveli thermal power plant. Sodium silicate (Na_2SiO_3) solution was used without doing any modification ,different concentrations of sodium hydroxide solution (NaOH) viz; 12M was prepared by dissolving NaOH pellets in water totaling 1 litre. Fly ash and GGBS was used with different ratios with coarse aggregate. The ground granulated blast furnace slag sample used in the experiment is shown Figure1.

Fig. 1: Ground granulated blast furnace slag

Chemical Composition		Physical Properties	
MgO	28-45%	Specific Gravity	2.9
AL_2O_3	5-18%	Hardness	7 Mo
CaO	30-48%	Conductivity mS/M	4.8
SiO_2	1-18%	Chloride content	<0.001

Table 1: Properties of ground granulated blast furnace slag

III. Mix proportions, mixing, placing

The Fly ash and GGBS to coarse aggregate has been adopted. Concentration of NaOH 12 Molar (M) was used. Fly ash and GGBS at different proportions (80/20,60/40,50/50) was mixed with alkaline solution for five minutes, Coarse aggregate was then added and mixed for few minutes to have a homogeneous mixture. After mixing Coarse aggregate addition of sodium silicate with a final mixed of 1 minutes. After mix was over, the PGC was placed in 100 mm in diameter and 100 mm in height cylindrical molds and 75 mm in height, 200 mm length and 110 mm with cubical molds used . It was compacted to take out the entrapped air by tempering rod. After demoulding, the paving blocks or cuboid moulds are stored at dry place in ambient temperature until testing .The specimens are shown below in figure 2 & figure 3 respectively.

Fig. 2: PGC blocks at the time of casting

Fig. 3: Geopolymer concrete blocks containing GGBS

IV. TESTING DETAIL

The mix proportion of pervious concrete block is given in table no.2 and mix proportion with cylindrical molds is given in table no.3.The blocks are casted in 200x110x75mm size. And cylindrical molds are casted in 100x100mm size. Three identical specimen were casted for its testing.

Trial mix	Flyash (in gm)	GGBS (in gm)	NaOH (in gm)	Na_2SiO_3 (in gm)	Coarse aggregate (in gm)
PGC 1	20%= 626	80%= 2502	527	1319	9800
PGC 2	40%= 1252	60%= 1878	527	1319	9800
PGC 3	50%= 1565	50%= 1565	527	1319	9800

Table 2: Mix proportion of $1m^3$ of 12M for paving blocks

Trial mix	Flyash (in gm)	GGBS (in gm)	NaOH (in gm)	Na_2SiO_3 (in gm)	Coarse aggregate
PGC 1	20%= 297	80%= 1191	251	627	2334
PGC 2	40%= 595	60%= 893	251	627	2334
PGC 3	50%= 744	50%= 744	251	627	2334

Table 3: Mix proportion of $1m^3$ of 12M cylinders

V. TESTING

A. *Water Permeability Test:*

Permeability test was obtained by constant head method used. A calculation of permeability following Darcy's low was used.

K= QL/HAt

Where:- K=permeability coefficient,

Q = quantity of water at time

L = length of specimen

H= water head

A=cross-section aria

t = time

B. *Compressive Strengths Testing:*

Compressive strength testing of hardened geopolymer previous concrete was conducted using Universal Testing Machine. At the age of 7 days and 28 days a result are given in table

VI. RESULTS AND DISCUSSION

A. *Compressive Strength Test:*

Compressive test for same molar(12M) of geopolymer previous concrete graph was given for increased GGBS concentration result in compressive strength higher. The compression testing was done by 50% replacement of GGBS by cement and 50% replacement of fly ash by cement similarly for 60% GGBS, 40% fly ash and 80% GGBS, 20% fly ash. This results proves that percentages of GGBS affects the strength of concrete , hence the higher content of GGBS enhance higher strength.

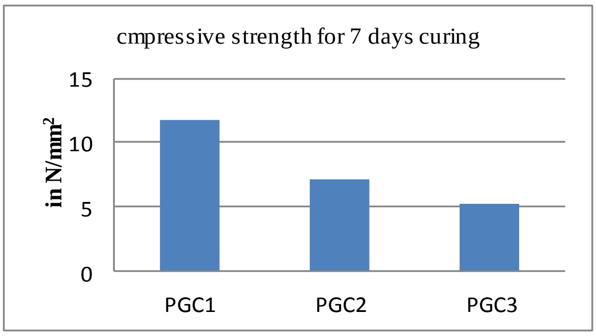

Fig. 4: Compressive strength

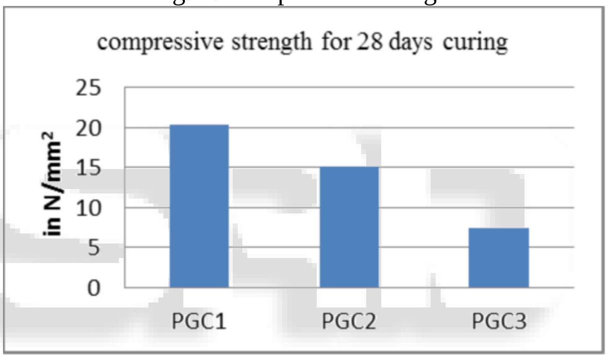

Fig. 5: Compressive strength

B. *Permeability Test:*

Fig. 6: Pervious Geopolymer cylinders

Fig. 7: Permeability test with constant head method

The average values of all three trial mixes are shown below in figure 8

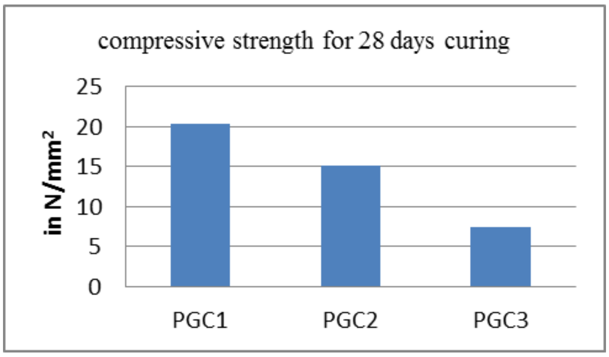

Fig. 8: Average values of permeability test

VII. DISCUSSION

This investigation shows that higher concentration of ground granulated blast furnace slag comparatively gives higher strength. In this research three trial mix were prepared of 80% GGBS, 20% fly ash similarly for 60/40% and 50/50% in which PGC1 was having good strength as compared to other mix as in this mix GGBS was used about 80% of total mix and 20% fly ash of total mix , as molarity also plays an important role but it was kept same throughout the test i.e 12M gives good strength. The permeability is also good as compared to normal concrete.

VIII. CONCLUSION

Geopolymer pervious concrete with ground granulated blast furnace slag and fly ash imparts adequate strength. In geopolymer pervious concrete setting time taken is less as compared to normal concrete. As GGBS is more costly then fly ash we can also use PGC2 as there is an slight difference between PGC1 and PGC2 regarding compressive strength we have both option it depends on our requirement As void are more therefore permeaability of concrete is also more. Hence it took less time to permeate the concrete.

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