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EFFECT OF TYPE OF CURING ON HARDENED PROPERTIES OF GEOPOLYMER CONCRETE

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ABSTRACT

Concrete is the most useful material in construction work. But due to the ill effect cement concrete creates problems for the environment. Recent research suggested that by using fly ash as source material in alkaline activated concrete we can replace the cement by 100 percent. but fly ash concrete required temperature curing for gaining the strength which is not possible in actual practice. Considering this point in view to achieve the maximum strength without temperature curing this experimental work has been carried out. For that course, various mix proportion is used. It has been suggested from a result that this fly ash-based geopolymer concrete will be an alternative construction material to cement concrete. In this project, fly ash based Geopolymer concrete was studied by adding some percentage of cement to study the strength variation between temperature curing and ambient curing. In this job Na_2SiO_3 and NaOH were used as an alkaline activator solution.

Keywords: GPC, Alkaline Activators, Mixes And Tests Of Concrete.

I. INTRODUCTION

Geopolymer is a new Material in the world of concrete in which cement is replaced by pozzolanic material (Flyash) that is rich in silica and alumina and activated by alkaline liquids to act as a binder in the concrete. The geopolymer concrete (GPC) required a chemical activator to activate the fly ash as binder and temperature curing where normal concrete required water curing. For large-scale construction, temperature curing is not possible at every stage in the case of GPC. To overcome such curing difficulties the efforts have been made to produce GPC by producing internal heat of hydration reaction by adding some percentages of cement in GPC. Geopolymer is an inorganic alumino-silicate polymer synthesized from predominantly silicon (Si) and aluminum (Al) materials of the geological origin or by-product materials such as fly ash. The term geopolymer was introduced by Davidovits to represent the mineral polymers resulting from geochemistry. The process involves a chemical reaction under highly alkaline conditions on Si-Al minerals, yielding polymeric Si-O-Al-O bonds in amorphous form.

Mayank Kumar [1] published paper on “Geopolymer concrete” in this paper he described test results obtained on large number of Geopolymer concrete units by various researchers around the world and illustrates methods adopted for preparation, mixing, curing of eco-concrete, mechanical properties of GPC, and other useful properties like shrinkage, creep, fire and chemical resistance. Basic Properties of Geopolymer Concrete and OPC concrete based on test results are being compared

Sandeep Hake et al. [2] investigated on effect of temperature and curing on properties of fly ash base geopolymer and also on compressive strength of concrete. Generally oven heat curing for geopolymer concrete is mostly used. Higher temperature require less duration of heating for achieving desire strength. In this investigation they change the temperature from 60 degree celsius to 150 degree celsius in the interval of 30 degree celsius and they also changes the type of curing oven, steam, accelerated, membrane and natural curing. The specimen testing were completed at 7 day and from the result they conclude in oven curing the rate of gain of strength is slow at 60 degree celsius and increases at 90 degree celsius and sudden down at 150 degree celsius. In case of steam curing the compressive strength achieved at 100 degree celsius. In membrane curing the compressive strength is obtain at 90 degree celsius and in the accelerated curing the effect of temperature on geopolymer concrete will show the optimum result at 80 degree celsius.

Properties of Alkaline Activator

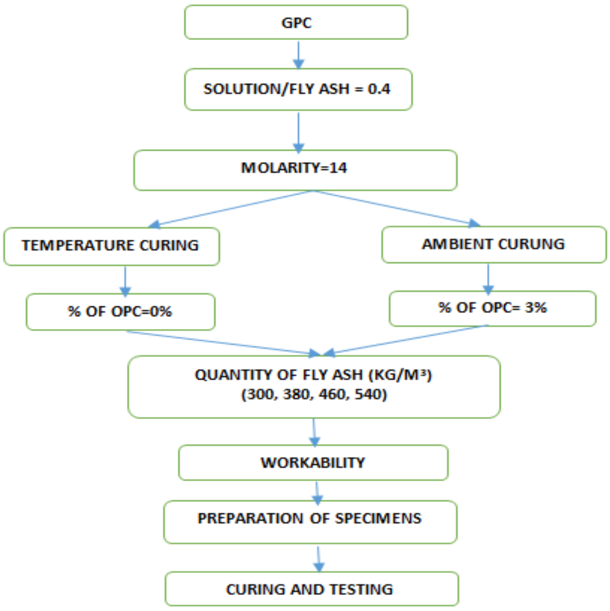
Sodium Hydroxide (NaOH) flake from 98% purity (Sandesh Industries, Amravati) and Sodium Silicate (Na2SiO3) in liquid form (supplied by Chemical Industries Nagpur) is used as an alkaline activator. They are called alkaline activator because they are alkaline in nature and they activate the binding property of fly ash.

Mixture Proportion

Based on the limited past research on GPC available and experience gain during the preliminary experimental work, the following quantities of material were selected for the mixture used in mixing. Solution/fly ash=1 From the above equation, we have calculated the quantities of source material for the different ratio of chemicals (Na2SIO3 And NaOH)

II. METHODOLOGY

The following flow chart shows the various parameters considered in the experimental work to meet the objectives.



The number of specimens casted for ratio of Na2SiO3 / NaOH is 1 and 3% percent of cement added during mixing process. Dimensions of test specimens are as under:

Cube of size 100mm x 100mm x 100mm

Beam of size 500mm x 100mm x 100mm

Push off size 300mm x 100mm x 100mm

For each grade we made up three specimens and total no of specimen is 72. Before done work of research we checked the properties of fly ash, aggregate, Sodium Hydroxide (NaOH), Sodium Silicate (Na_2SiO_3) and cement. The cement used in this experimental work is "53 Grade ordinary Portland Cement".

Temperature curing: The geopolymer concrete (GPC) required a chemical activator to activate the fly ash as binder and temperature curing where normal concrete required water curing. In temperature curing mold filled up and place at oven for 24 hours at 100-degree Centigrade temperature.

Ambient curing: For large-scale construction, temperature curing is not possible at every stage in the case of GPC. Hence here we were added 3% OPC cement for generation of heat in concrete and after molding specimen placed at normal temperature for 28 days.

III. EXPERIMENTAL WORK

For checking the effects of ambient curing on GPC taken material quantities per cubic meter.

Table 1: Quantities of Materials for one cubic meter

Mix Proportion	**Temperature Curing**				**Ambient Curing**			
Material	**300**	**380**	**460**	**540**	**300**	**380**	**460**	**540**

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	(kg/m^3)	(kg/m^3)	(kg/m^3)	(kg/m^3)	(kg/m^3)	(kg/m^3)	(kg/m^3)	(kg/m^3\)
Fly Ash	2.995	3.76	4.55	4.71	2.88	3.65	4.42	4.57
OPC	0	0	0	0	0.11	0.11	0.13	0.14
Sodium Silicate	0.60	0.76	0.91	0.94	0.60	0.76	0.91	0.94
Sodium Hydroxide	0.60	0.76	0.91	0.94	0.60	0.76	0.91	0.94
Sand	6.99	6.22	6.24	5.26	6.99	6.22	6.24	5.26
20mm Agg.	9.21	8.66	8.23	6.90	9.21	8.66	8.23	6.90
10mm Agg.	3.94	3.69	3.54	2.93	3.94	3.69	3.54	2.93
Water	0.71	4.31	0.53	3.25	0.71	4.31	0.53	3.25
Admixture	0.060	0.07	0.09	0.091	0.060	0.07	0.09	0.091

Table 2: Schedule of Casting

No. of Specimens						
Sr. No.	Fly Ash (kg/m^3)	Beam	Cube	Push Off	Type of Curing	No. of Specimen
1	300	3	3	3	Temperature curing	9
2	380	3	3	3		9
3	460	3	3	3		9
4	540	3	3	3		9
5	300	3	3	3	Ambient curing	9
6	380	3	3	3		9
7	460	3	3	3		9
8	540	3	3	3		9
Total Specimen						72

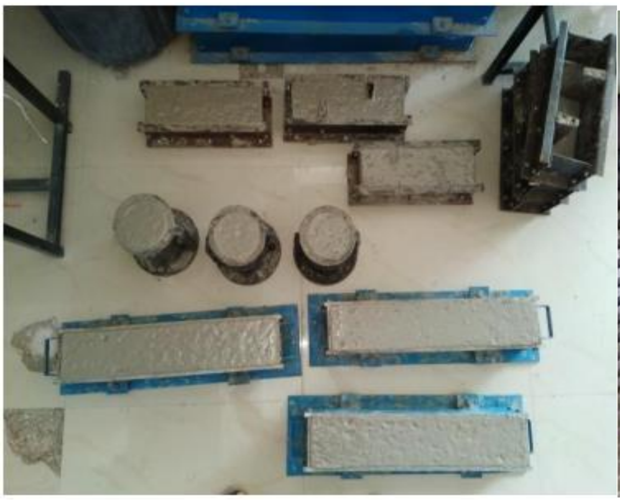

Figure 1:- Casting of Specimen

Figure 2:- Testing of Specimen

IV. RESULT ANALYSIS

The result of the compressive test on GPC are present in table 3 column 3 represent temperature curing and column 5 represent ambient curing.

Table no 3: compressive strength of GPC by temperature and ambient curing.

Sr.No.	Flyash quantity (KG/M³)	Temperature Curing (N/mm²)			Average	Ambient Curing (N/mm²)			Average
1	300	24.1	25.1	26.3	25.18	21.07	19.6	22.7	21.15
2	380	28	26.5	24	26.05	22.1	25.1	23.84	22.47
3	460	28	27.4	26.52	27.30	22.14	23.11	24.5	23.25
4	540	28.7	29.1	28.3	28.7	22.18	26.17	25.36	24.57

The result of the flexural strength test on GPC is obtained on the beam specimen. The result of flexural strength is present in the following table no. 4.

Table no 4: Flexural Strength of GPC by temperature and ambient curing.

Sr.No.	Flyash quantity (KG/M³)	Temperature Curing (N/mm²)			Average	Ambient Curing (N/mm²)			Average
1	300	1.756	1.692	2.453	1.967	1.92	1.716	1.64	1.756
2	380	2.84	3.00	2.244	2.69	2.208	2.04	2.02	2.122
3	460	2.984	3.036	2.556	2.92	2.616	2.12	3.484	2.640
4	540	4.188	3.168	3.208	3.530	3.384	3.696	3.168	3.416

The result of the flexural strength test on GPC is obtained on the push of the specimen. The result of shear strength is present in following table no. 5.

Table no 5: Result of shear Strength Test by temperature and ambient curing.

Sr.No.	Flyash quantity (KG/M³)	Temperature Curing (N/mm²)			Average	Ambient Curing (N/mm²)			Average
1	300	2.415	2.1	2.73	2.415	1.365	1.4	1.65	1.47
2	380	2.37	3.27	2.25	2.72	2.05	1.99	1.93	1.99
3	460	2.72	3.51	3.11	3.11	2.5	2.10	1.98	2.19
4	540	3.27	4.2	3.735	3.735	2.71	2.59	2.51	2.60

V. RESULTS AND DISCUSSION

The conclusion drawn from the results discussed in the previous chapter is summarized as follows:

1. The workability of Geopolymer concrete increases with increasing the quantity of fly ash in the mix.
2. At 3% cement content the workability is found good for handling the concrete.
3. The flexural strength of GPC at 300 kg/m³ fly ash content in temperature and ambient curing found 1.967 N/mm²and 1.756 N/mm²which is11.23% greater strength than ambient curing.
4. The compressive strength of GPC at 300 kg/m³ fly ash content in temperature and ambient curing was found 25.18 N/mm²and 21.15 N/mm²which is 16% greater strength than ambient curing.
5. The shear strength of GPC at 300 kg/m³ fly ash content in temperature and ambient curing was found 2.415 N/mm²and 1.47 N/mm²which is 39.1% greater strength than ambient curing.

VI. CONCLUSION

From overall project work, it is found that the strength gain in GPC at temperature curing is rapid and greater than ambient curing. Also, this work can be used for studying the following aspects of the fly ash-based geopolymer concrete.

1. High strength GPC with ambient curing.

2. Fiber-reinforced GPC with ambient curing.
3. Hardened stage property of ambient cured GPC.
4. The durability of ambient cured GPC.
5. Use of other source materials like silica fume, rice husk ash, ground granulated blast furnace slag.

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