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Effect of Different Curing Conditions on Geopolymer Concrete by Partially Replacing sand with Foundry sand

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Abstract: In the present paper, fly ash (no other solid material was used) with highly alkaline solutions is described. These solutions, made with NaOH, Na2Sio3.This paper, report on the study of the processing of geopolymer using fly ash and alkaline activator with geopolymerization process. The factors that influence flexural strength such as different curing condition. The fly ash, fine aggregate with replacement of foundry sand, coarse aggregats and alkaline solution were is used to make geopolymer concrete. The foundry sand is replaced by normal sand in different amount. The main purpose of replacement of foundry sand in to utilize waste by product and save environment also to see the effect on proprety of geopolymer concrete. The flexural strength is carriedout by UT machine at 7 and 28 days.

Keyword: curing condition, foundry sand, flexural strength, environment.

1. INTRODUCTION

Concrete is a major construction material, has been used all around the world. Concrete is currently made up using OPC. OPC production is an extremely energy-intensive, and reduce carbon dioxide to the atmosphere, so the environmental issue associated with OPC concrete. The geopolymer technology was first introduced in 1978 by Davidovit. This technology could reduce the CO2 emission caused due to the production of cement. In this technology, cement is totally replaced with materials those contain silicon and aluminum. Geopolymers are members of the family of inorganic polymers. The chemical composition of the geopolymer material is similar to natural zeolitic materials, but the microstructure is amorphous. Any material that contains silicon (Si) and aluminium (Al) used to develop geopolymer concrete. The most commonly fly

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ash is used along with alkaline liquid (combination of sodium hydroxide or potassium hydroxide and sodium silicate or potassium silicate) to form binder. The fly ash used as a main material in concrete. The geopolymer concrete designed same as cement concrete. Difference between OPC and fly ash based geopolymer concrete [Akhilesh, Vikas Reddy Morepally, Peketi Padmakanth]- Geopolymer concrete (GPC) using "fly ash" has greater corrosion resistance, and substantially higher fire resistance (up to 2400° F). The compressive and tensile strengths of geopolymer concrete are high and rapid strength gain and lower shrinkage.

Durability aspects of geopolymer products include good sustainability to weathering effects. Several experimental studies showed that geopolymer concrete specimens immersed in sulphuric acid and caloric acid were found to be resistant to acid attack. While the Portland based cement showed deleterious reaction and resulted in surface deterioration followed by weight loss [Davidovits, 1994]. Extensive studies have also demonstrated that heat-cured fly ash based geopolymer concrete has an excellent resistance to sulphate attack due to the formation of stronger polymer chain due to poly condensation reaction.

2. EXPERIMENTAL WORK

2.1 Materials

The following materials have been used in the experimental study :

a. **Fly ash:** In this experimental work, Class F Low calcium fly ash (ASTM Class F) conforming to IS: 3812-1987 specifications, collected from Ramagundam Super Thermal Power Station, India is utilized in this study.
b. **Fine aggregate:** Zone -III locally available sand is used to confirm to IS:383-1970 having specific gravity 2.63 and fineness modulus of 3.32.
c. **Foundry sand:** foundry sand was used as a partial replacement of natural sand, 10%, 20%, and 30% having specific gravity 2.65 and fineness modulus 2.45. The foundry sand was obtained from DCM (Delhi Cloth Mills) Engineering Limited Ropar.
d. **Coarse aggregate:** locally available angular 20mm graded aggregates are used to confirm to IS:383-1970 having specific gravity 2.72.
e. **Water:** distilled water is used .
f. **Alkaline solution:** In this research Analytical Grade Sodium Hydroxide pellets and sodium silicate solution were used with 98% purity. The alkaline liquid is prepared by mixing both the solutions together. 1st of all sodium hydroxide pellets dissolved in distilled water. Sodium hydroxide and sodium silicate mixed together. The mass of NaOH solids in a solution varied depending on the concentration.

g. **Concentration of Sodium Hydroxide:** The mass of NaOH solids in a solution varied depending on the concentration of the solution expressed in terms of molar, M. NaOH solution with a concentration of 8M consisted of 8x40 = 320 grams of NaOH solid pellet per liter of the solution, where 40 is the molecular weight of NaOH, similar as for other morality. Increasing molar concentration increase in the strength.

h. **Curing:** On the previous studies geopolymer concrete did not attain strength at room temperature or by water curing. The geopolymer concrete is harden at steam curing or hot curing and the minimum curing period should be 24hours. After casting the specimens, they were kept in rest period in room temperature for 2 days. The term 'Rest Period' was coined to indicate the time taken from the completion of casting of test specimen to the start of curing at an elevated temperature. The geopolymer concrete was demoulded and then placed in an oven for heat curing for 24 hours at a temperature of 60°C. The cubes were then allowed to cool in room temperature.

The general process of experiments was as follows,

1. material preparation
2. sample mixing
3. casting
4. curing
5. testing

For this research following parameters were maintained constant throughout the experimental work. The parameters are:

- Ratio of Fine aggregate to total Aggregate = 0.35
- The ratio of sodium silicate to sodium hydroxide =2.5
- Curing time 24 hrs

The Final Mixture proportion is shown below:-

Fly ash = 394.3 kg/m^3
Sand without replacement = 646.8 kg/m^3
Partial replacement of foundry sand by normal sand at 10%, 20% and 30%
Coarse aggregate = 1201.2 kg/m^3
NaOH = 45.06 kg/m^3
Na_2SiO_3 = 112.64 kg/m^3
Liquid to binder ratio = .40
Ratio of mix proportion = 1:1.6:3.04
Molarity = 16M is used

3. MIXING CASTING AND TESTING

The properties of material was tested whether it is satisfying the requirements as per IS: 383-1970.

a. **Mixing:** The aggregates were used in SSD condition. Mixed the aggregates and fly ash together in dry state for 3 minutes in mixer after that alkaline solution was added in dry material and mix for another minutes. The alkaline solution prepared 24 hrs prior to use.
b. **Casting:** The standard moud of size 500mm × 100mm × 100mm were used for casting. The moulds were cleaned and oil was applied on all sides of moulds before casting. The concrete was poured in three layer in mould. The table vibrator was used for compaction.
c. **Curing:** After casting the specimens were kept in rest period in room temperature for 2 days. The concrete was demoulded and then placed in oven heat curing for 24 hours at a temperature of 60°C. after 24 hrs the specimen were allowed to cool in room temceteture. For ambient curing specimen were placed in room temperature.
d. **Testing:** The specimen were tested in UT machine at 7th day and 28th day after curing.

4. RESULTS

The test results shown below:

Table 1: Flexural strength of M40 geopolymer concrete at 7 days.

Curing Temp.	No replacement		10% replacement		20% replacement		30% replacement	
	Flexural strength	Density Kg/m³	Flexural strength	Density Kg/m³	Flexural strength	Density Kg/m³	Flexural strength	Density Kg/m³
Ambient	1.69	2300	2.24	2490	2.1	2490	3.3	2310
60°C	4.2	2350	5	2420	3	2230	4.3	2320
90°C	4.74	2320	5.5	2380	3.1	2240	3.4	2310

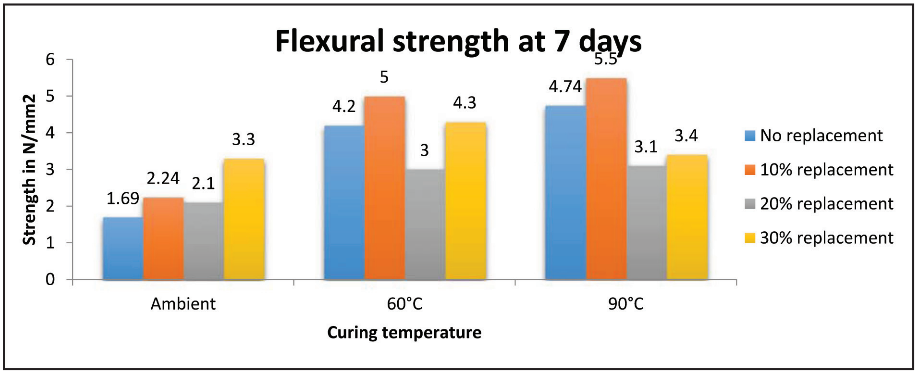

Figure 1: Flexural strength of GPC w.r.t. different curing condion and replacement of foundry sand.

Table 2: Flexural strength of M40 geopolymer concrete at 28 days.

Curing Temp.	No replacement		10% replacement		20% replacement		30% replacement	
	Flexural strength	Density Kg/m^3	Flexural strength	Density Kg/m^3	Flexural strength	Density Kg/m^3	Flexural strength	Density Kg/m^3
Ambient	2.5	2320	4.94	2270	2.14	2310	3.5	2280
60°C	5	2330	5.1	2410	3	2220	3.4	2320
90°C	6.2	2360	5.7	2370	5.03	2200	3.55	2364

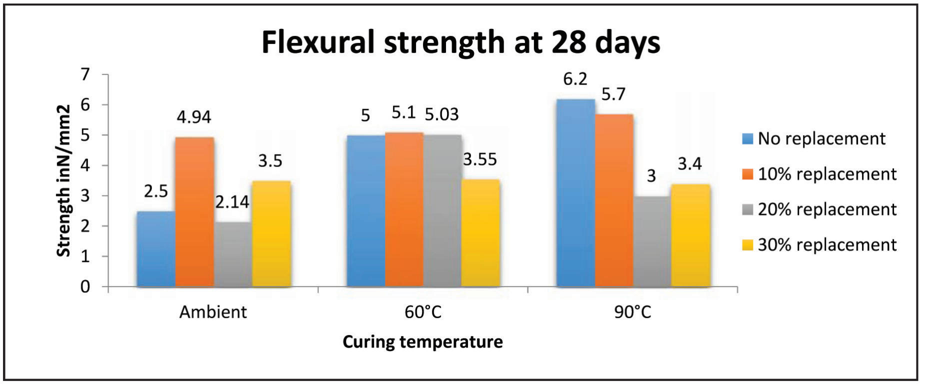

Figure 2: Flexural strength of GPC w.r.t. different curing condion and replacement of foundry sand.

It has observed that flexure strength of GPC concrete increased with increase in temperature. In abbient curing, the beam atain least flexural strength up to 20% replacement of foundry sand at 7 days curing. The strength increases with 10% replacement of foundry sand at heat 7 days curing. At 28 day curing the flexural strength of GPC gain higher strength at 90°C temperature with out replacement of sand and with replacement of 10% foundry sand the concrete gives good results.

CONCLUSION

- From the investigation it is clear that the strength increases with increase in curing temperature.
- The strength increase with 10% replacement of foundry sand and the strength increase at ambiemt curing with 30% replacement of foundry sand.
- It also observed that the strength increase with curing time.

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