AN EXPERIMENTAL STUDY ON EFFECT OF CURING TEMPERATURE ON GEOPOLYMER CONCRETE USING FOUNDARY SAND

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Abstract:- *Concrete is absolutely indispensable in modern society's fascination with new roads, buildings and other constructions. It is estimated that the present consumption of concrete in the world is of the order of 10 billion tonnes (12 billion tons) every year. The structural concrete elements can be formed into a variety of shapes and sizes. This is because freshly made concrete is of a plastic consistency, which permits the material to flow into prefabricated formwork. After a number of hours, the formwork can be removed for reuse when the concrete has solidified and hardened to a strong mass. The present research explores the possibilities of geopolymer concrete for economy and environmental sustainability. The results of present study revealed that Heat-cured fly ash-based geopolymer concrete using foundry sand offers several economic benefits over Portland cement concrete. The price of one ton of fly ash is only a small fraction of the price of one ton production of Portland cement.*

Keywords: Geopolymer Concrete, Fly Ash.

1. Introduction

The fly ash is used instead of cement along with alkaline liquid to produce geopolymer concrete (figure 1). Fly ash and alkaline solution is used to make binder which binds the coarse & fine aggregate. It's a new technology that reduces carbon dioxide emission to the atmosphere [25]. Inspired by this new technology an attempt has been made to develop an alternative concrete binder or a substitute for cement by using the geopolymer technology and utilizing the fly ash as main ingredient to produce geopolymer concrete. Geopolymer concrete is designed same as cement, concrete design methods.

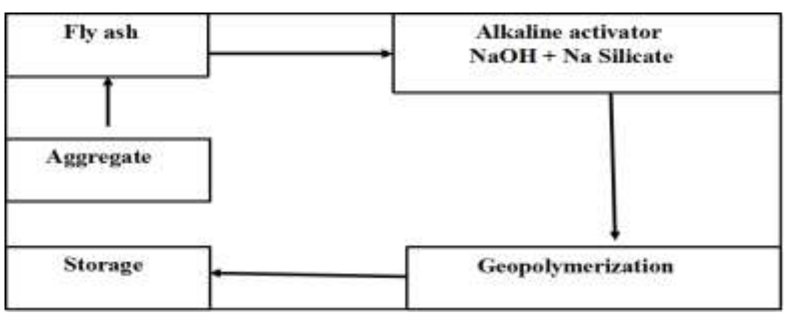

Figure 1 process of making geopolymer concrete.

Fly ash was used in small proportions in mass concreting for dams and other hydraulic. Fly ash closely resembles volcanic ashes. It was used in production of the earliest known hydraulic cement about 2,300 years ago. Instead of volcanoes, today's fly ash comes primarily from coal-fired electricity generating power plants. These power plants grind coal to powder fineness before it is burned. Fly ash – the mineral residue produced by burning coal - is captured from the power plant's exhaust gases and collected for use.

2. Objectives of the Study

The objectives of this study are:

1. To utilize the waste material such as foundry sand, fly ash in geopolymer concrete.

2. To study the variation in the properties of geopolymer concrete on addition of foundry sand with respect to variation in curing temperature and curing time period.
3. To study the variation in the properties of geopolymer concrete using foundry sand due to sodium hydroxide and sodium silicate.
4. To compare the strength at different curing temperature.
5. To compare the strength with variation in foundry sand.

3. Mix Proportion

Assume density of aggregate as unit weight of concrete = 2400 kg/m3.

Mass of Combined aggregate = 75-80 %

Let we take 77% aggregate

2400 x 0.77% = 1848 kg/m3

Mass of combined aggregate = 1848 kg/m3

Mass of coarse aggregate = 1201.2kg/m3 and mass of fine aggregate = 646.8kg/m3

(As ratio of fine aggregate to total aggregate = .35)

Mass of Fly ash and alkaline Liquid = 2400 - 1848 = 552 kg/m3

Let us take alkaline liquid to fly ash ratio as 0.4.

Now the mass of fly ash = (552)/ (1.4) = 394.28 kg/m3

Mass of alkaline liquid = 552-394.28 = 157.21 kg/m3

Let us consider the ratio of NaOH to Na2SiO3 as 2.5.

Now mass of NaOH solution = (157.21)/ (3.5) = 45.06 kg/m3

Mass of Na2SiO3 solution = 157.21-45.06 = 112.64 kg/m3

Table-11- Mixture proportion

Fly ash based geopolymer concrete for M 40					
Sr. No.	Material	0% Replacement of foundry Sand	10% replacement of foundry Sand	20% replacement of foundry Sand	30% replacement of foundry sand
1	Fly ash	394.3	394.3	394.3	394.3
2	Normal Sand	646.8	582.12	517.44	452.76
3	Foundry sand	000	64.68	129.36	194.04
5	Coarse aggt	1201.2	1201.2	1201.2	1201.2
6	NaOH	45.06	45.06	45.06	45.06
7	Na2SiO3	112.64	112.64	112.64	112.64
8	Molarity	16	16	16	16
	Ratio of mix. Prop.	1:1.64:3.04	1:1.64:3.04	1:1.64:3.04	1:1.64:3.04
	Liquid/binder Ratio	.40	.40	.40	.40

4. Results and Discussion

COMPRESSIVE STRENGTH RESULTS:

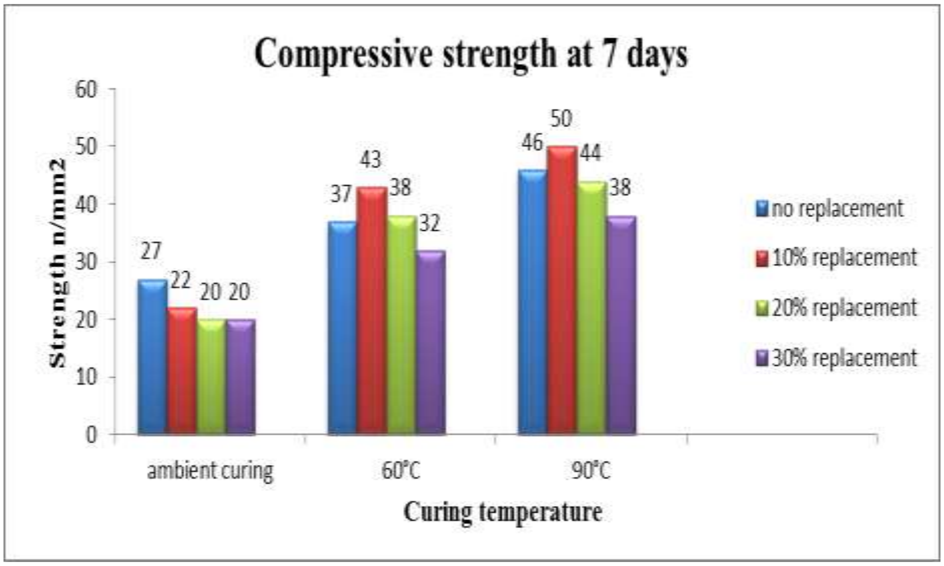

Figure 2 Compressive strength of GPC w.r.t. different curing condition and replacement of foundry sand at 7 days.

It has been clearly shown by the above mentioned results that after 7 days of casting geopolymer concrete achieved 95 % and 28 days of casting achieved 100% compressive strength under heat curing and 60% to 70% compressive Strength under ambient temperature at 7 days and. Also it has been observed that during same time period compressive strength is increased 10 to 25% by 10 percent replacement of foundry sand and. But further increase in foundry sand upto 30/% is inversely affecting the compressive Strength by same proportion. It is clearly indicated by the test results that the behavior of geopolymer concrete is similar for both 7 and 28 days with respect to replacement of foundry sand. It also observed that at ambient curing concrete achieved least compressive strength with increase in temperature upto 60°C the compressive strength increased up to 80% and temperature varied from 60° to 90°C the strength increase 20%.

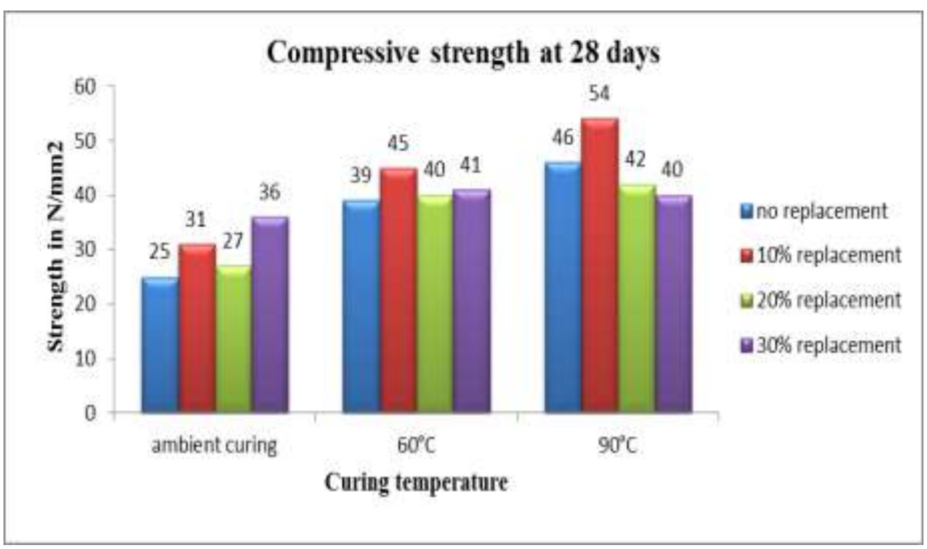

Figure 3 Compressive Strength of GPC w.r.t. Different Curing Condition and Replacement of Foundry Sand at 28 Days.

SPLIT TENSILE STRENGTH RESULTS:

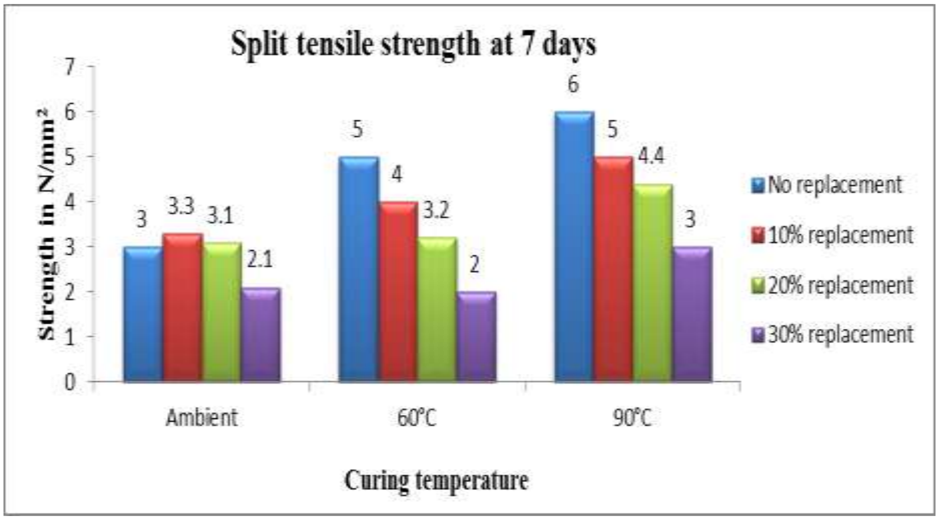

Figure 4 Split tensile strength of GPC w.r.t. different curing condition and replacement of foundry sand at 7 days.

It has been clearly shown by the above mentioned results that the strength increases with increase in temperature up to 90°C. The tensile strength goes higher with replacement of 10%, 20% foundry sand at 28 days in heat curing. The split tensile strength increased up to 30%. But in 7 days curing with replacement of sand the strength decreasing continuously by same proportion and in same curing condition. It is clearly shown by the test results that the behavior of geopolymer concrete is not similar for both 7 and 28 days with respect to replacement of foundry sand. It also observed that at ambient curing concrete achieved least strength, with increase the temperature the strength also increased.

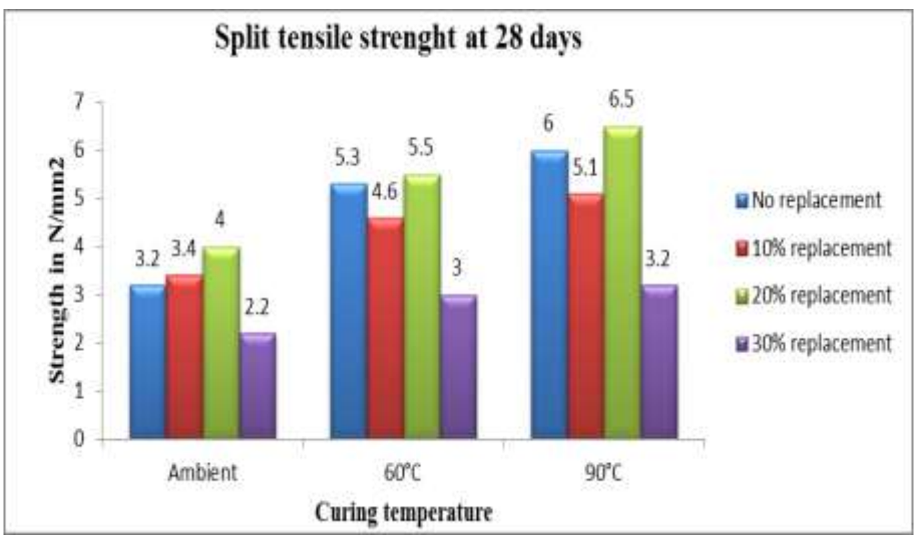

Figure 5 Split tensile strength of GPC w.r.t. different curing condition and replacement of foundry sand at 28 days.

FLEXURAL STRENGTH RESULTS:

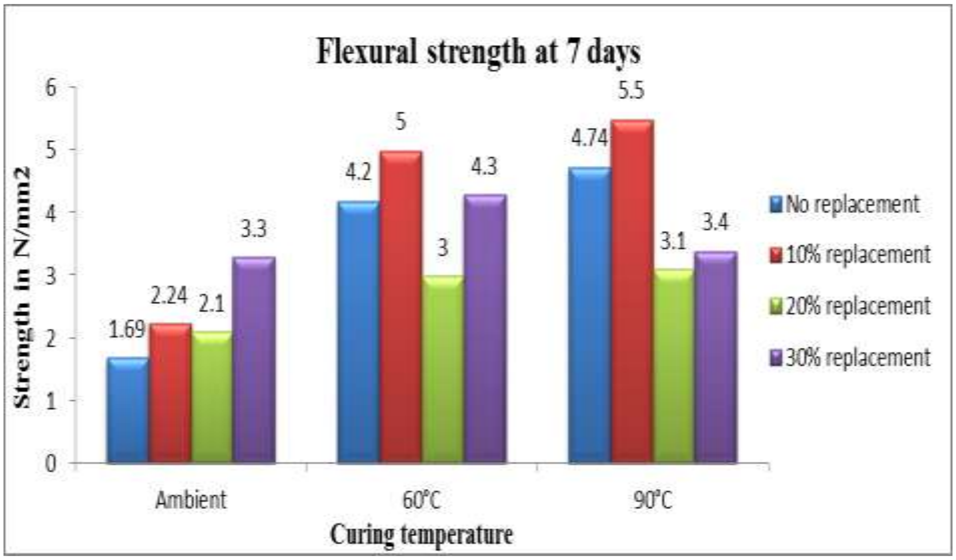

Figure: 6 Flexural strength of GPC w.r.t. different curing temperature and replacement of foundry sand at 7 days.

It has been clearly shown by the above mentioned results that after 7 days of casting geopolymer concrete achieved 80 to 90% and 28 days of casting achieved 100% strength under heat curing. Also it has been observed that during same time period the flexural strength is increased upto 40% by 10 percent replacement of foundry sand at 7 days curing and same as in 28 days curing. Even without replacement of sand the flexural strength gave cus good results. It is clearly indicated by the test results that the behavior of geopolymer concrete is similar for both 7 and 28 days with respect to replacement of foundry sand. It also observed that at ambient curing concrete achieved least strength and the strength increased with increase in temperature upto 90°C.

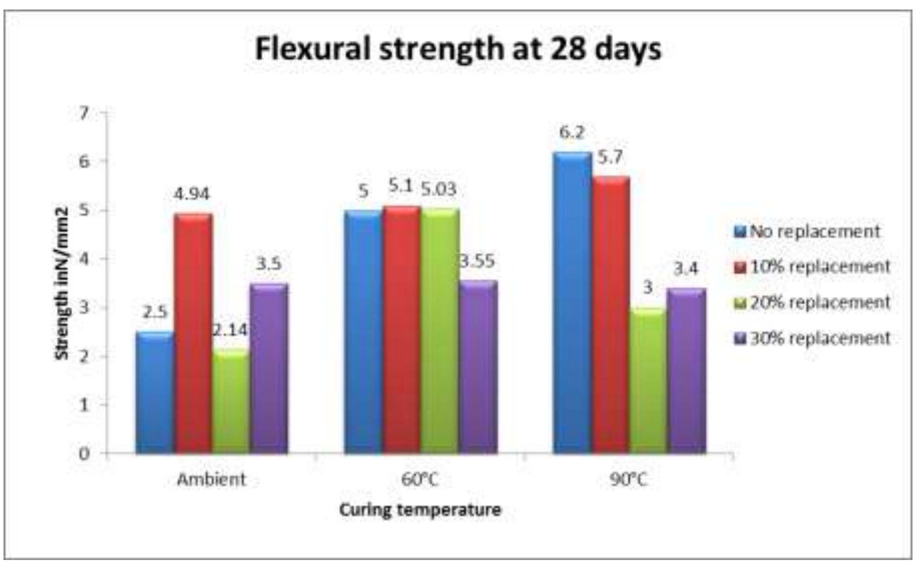

Figure: 7 flexural strength of GPC w.r.t. different curing condition and replacement of foundry sand at 28 days.

5. Conclusions

Based on the results of the experimental investigation, following conclusions are drawn: -

1. The heat cured concrete achieved higher compressive strength, split tensile strength and flexural strength in comparison with ambient curing.
2. The Compressive strength of Geopolymer concrete was found to be increasing with replacement of foundry sand. It is found that replacement of 10% of foundry sand gives highest compressive strength, the strength increased by 35%.
3. The compressive strength increased up to 70% at heat curing as compare to ambient curing.
4. Maximum strength was found at 90°C heat cured concrete with 24hrs curing oven period.
5. The split tensile strength also increasing with 10% replacement of foundry sand further increase in foundry sand results degradation in strength in order form at 7 days curing.
6. For ambient curing condition, with 10% replacement of foundry sand by normal sand the flexural strength showed good results as compare to compressive strength.
7. Heat-cured fly ash-based geopolymer concrete using foundry sand offers several economic benefits over Portland cement concrete. The price of one ton of fly ash is only a small fraction of the price of one ton production of Portland cement.

6. References

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