Experimental Study On Geopolymer Concrete Under Daylight Curing

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Abstract— *Geopolymer concrete is the developing alternative construction material by replacement of cement concrete, due to the environmental pollution cement is replaced by fly ash. Fly ash is the byproduct of thermal power plant industry. The study has been made of cement concrete and geopolymer concrete in different curing condition. In practical, heat curing is not suitable during construction and is uneconomical. To overcome these difficulties, the implementation of daylight curing is necessary. Mix proportion of cement concrete is under the guidelines of IS 10262-1982 using M25 grade concrete mix ratio cement: fine aggregate: coarse aggregate (1:1:2.70) and water cement ratio of 0.40. Geopolymer concrete mix proportion is under the "Modified guidelines for geopolymer concrete from the Bureau of Indian Standards" using 12M mix ratio fly ash: fine aggregate: coarse aggregate (1:1.54:3.43) and alkaline solution fly ash ratio of 0.55. Concrete cubes of size 150X150X150mm were prepared and cured under daylight curing. The compressive strength was founded out at 3,7,14,21,28 days. From the results, the geopolymer concrete attains the compressive strength without hydro-curing and also to achieve its target strength within 14 days of daylight curing.*

Keywords—SCC, Alccofine, steel fiber, Rheological properties, Strength characteristics.

I.INTRODUCTION

Ordinary Portland Cement (OPC) becomes an important material in the invention of concrete which act as its binder to unite all the aggregate together. However, the utilization of cement causes pollution to the environment and decline of raw material (limestone). The manufacturing of OPC requires the flaming of large quantities of fuel and decomposition of limestone, resulting in considerable emissions of carbon dioxide As such, geopolymer concrete had been introduced to reduce the above problem. In1978, J.Davidovits initiated inorganic polymeric material that can be used to react with another source material to form a binder. The application of this binder is recently being focused to replace Ordinary Portland Cement (OPC) portion in concrete. The environmental issues resulted from OPC production has taken the progress of polymer researches further nowadays. The encouragement to produce the eco-friendly concrete can be achieved by limiting the utilization of raw materials and decreasing the rate of pollutant from respective OPC production, and diminishing the cement portion in concrete. Employment of waste material like fly ash, rice husk ash, and other cement alternate material (CRM) can only substitute cement portion until certain percentage. Geopolymer, named after the reaction between polymer and geological origin resource material, is proposed to replace all cement portions in concrete as the main binder. The main constituents of geopolymer are alkaline liquid and source material. Alkaline liquid is usually a combination of sodium hydroxide or potassium hydroxide with sodium silicate or potassium silicate. The use of only alkaline hydroxide activator will outcome in low rate reaction compared to those containing soluble silicate. The addition of sodium silicate solution to sodium hydroxide solution will enhance the reaction rate between alkaline liquid and source material. Source materials used in this research are combination of fly ash. This materials have specification for calcium content, which is low in calcium. High calcium content in source material is not recommended since it can obstruct the polymerization process. B.Vijaya Rangan [1] Studied the low-calcium fly ash-based geopolymer concrete and he concluded Low-calcium fly ash (ASTM Class F) is used as the source material, instead of the Portland cement, to make concrete. Low-calcium fly ash-based geopolymer concrete has admirable compressive strength and is suitable for structural applications. P.Nath and P.K.Sarker [2] have Conducted study on ''Geopolymer Concrete for ambient Curing Condition" and they concluded Inclusion of slag in the fly ash based gpc mixture decreased the setting time and increased the compressive strength. adding slag up to 30% of total binder achieved compressive strength upto 55MPa at 28 days. With increase of alkaline activator solution in the mix from 35% to 45% of total binder, the setting time increased and compressive strength decrease. Slump of fresh concrete also increased with the increase of alkaline solution in the mixture. Djwantoro Hardjito *et.al* [3], Concluded the higher concentration (in terms of molar) sodium hydroxide solution results in the higher compressive strength of geopolymer concrete Higher the ratio of sodium- silicate- to –sodium hydroxide liquid ratio by mass, higher is the compressive strength of geopolymer concrete. N A Lioyd and B V Rangan [4], Conducted study on Geopolymer Concrete with Fly ash Geopolymer concrete results from the reaction of a source material that is rich in silica and alumina with alkaline liquid. A summary of the wide-ranging studies conducted on fly ash based geopolymer concrete is presented. The paper also includes brief details of some recent applications of geopolymer concrete. Based on the study they proposed mix proportion and method of curing of geopolymer concrete. It is concluded from the above study to study the effect on the rest period before daylight curing, Setting up of curing specimens applied to the geopolymer concrete. To observe the and hardened properties of fly ash-based geopolymer concrete, mainly its compressive strength. Longer curing time give higher compressive strength with 70°C.The compressive strength of the geopolymer concrete is increased with the increasing of concentration of NaOH.

II. MATERIALS AND MIX PROPORTIONS

a) Fly Ash

Fly ash consists of finely divided ashes produced by pulverized coal in thermal power stations. The chemical composition depends on the mineral composition of the coal gangue (the inorganic part of the coal). **The fly ash was obtained from Thermal Power Station Tamilnadu, India.** The properties of fly ash are given in table 1.

TABLE 1: Properties of flyash

S.No	*Properties*	*Results*
1.	Specific Gravity	2.82
2.	Fineness modulus	1.375
3.	Specific surface area	310 m^2/kg
4.	Density	1.4 kg/m^3

b) Aggregates

Local aggregates, comprising 20 mm, 14 mm and 7 mm coarse aggregates and fine aggregates, in saturated surface dry condition, were used. The coarse aggregates were crushed granite-type aggregates and the fine aggregate was fine sand. The properties of coarse aggregate are given in table 2.

TABLE 2: The properties of aggregates

Aggregates	**Specific gravity**	**Fineness modulus**
Coarse aggregate	2.96	6.00
Fine aggregate	2.36	2.80

c) Cement

Cement is a binder or a substance that sets and hardens and can bind other materials together. The specific gravity of cement is 3.14.

d) Alkaline liquid

The alkaline liquid used was a combination of sodium silicate solution and sodium hydroxide solution. The sodium silicate solution (Na2O= 13.7%, SiO2=29.4%, and water=55.9% by mass) was purchased from a local supplier in bulk. The sodium hydroxide (NaOH) in flakes or pellets from with 97%-98% purity was also purchased from a local supplier in bulk. The NaOH solids were dissolved in water to make the solution.

e) Super Plasticizer

A commercially available sulphonated naphthalene formaldehyde based super plasticizer (CONPLAST SP 430) was used as chemical admixture to enhance the workability of the concrete. Color: Brown; Type: liquid; Specific gravity: 1.22-1.225 @ 300˚C.

f) Mix Design For Geopolymer Concrete

According to modified guidelines of geopolymer mix proportion was arrived [5]. The geopolymer mix proportion becomes **1:1.54:3.43.**

TABLE 3: Mix proportion for gpc 12m

S.No	*Materials*	*Mass(kg/m^3)*
1.	Coarse aggregate	1276.8
2.	Fine aggrgate	547.20
3.	Flyash	371.6
4.	Sodium silicate solution	122.628
5.	Sodium Hydroxide solution	81.75
6.	Superplasticizer	1.5 % from flyash

g. Mix Design For Cement Concrete

According to IS 10262-1985 [6] the mix proportion for M25 grade of concrete was arrived.

Water	**Cement**	**Fine aggregate**	**Coarse aggregate**
191.6 lit	476 kg/m^3	473.11 kg/m^3	1290.74 kg/m^3
0.41	**1**	**1**	**2.70**

TABLE 4: Mix proportion for cc

h. Casting and Curing

Usually cube size of 150 × 150 x 150 mm are used for the casting the specimens. The Moulds are tightened. Then oil is applied on the interior of the Mould. Next step the concrete is filled in three layers in the Mould. Each layer is compacted 25 strokes with the tamping rod. Then the surface is finished. The Mould is left to dry in air for 24 hours. **For geopolymer concrete,** After 48 hours of drying, the moulds are removed. Then the concrete is placed directly in the sunlight for the required number of days. **For conventional concrete**, After 24 hours of drying, the moulds are removed. Then the concrete is placed in the curing tank for the required number of days.

III. RESULTS AND DISCUSSION

Compressive strength test

The results obtained from compressive strength test illustrate polymeric process in geopolymer concrete with Daylight curing treatment . The specimens of geopolymer was tested in the period of 3,7,14,21,28 days. The normal conventional concrete were casted for the grade M25 and the specimens are immersed in the water for curing, the specimens of conventional concrete also tested in the period of 3,7,14,21,28 days. The specimens were casted and tested as per IS: 516-1959.

TABLE 5: Compressive strength of geopolymer concrete

S.No	*Testing days*	*Compressive strength (N/mm^2)*
1.	3	8.77
2.	7	20.84
3.	14	27.11
4.	21	28.44
5.	28	37.33

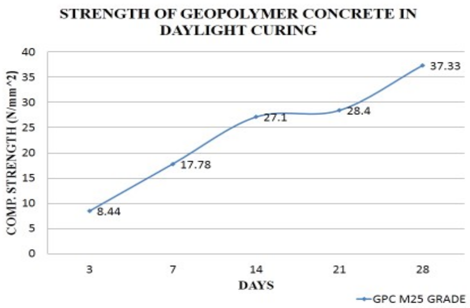

Figure 1: The compressive strength of geopolymer concrete (12m)

TABLE 6: Compressive strength of cement concrete m25 grade

S.No	*Testing days*	*Compressive strength (N/mm^2)*
1.	3	10.66
2.	7	20.88
3.	14	30.66
4.	21	32.89
5.	28	38.22

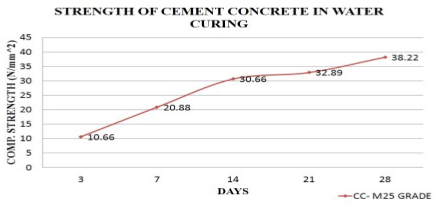

FIGURE 2: The compressive strength of cement concrete with m25 grade

COMPARISION OF GPC vs. CC

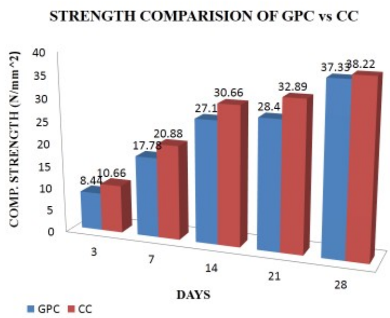

FIGURE 3: Strength comparison of geopolymer concrete with cement concrete

The results obtained from compressive strength illustrate polymeric process in geoploymer with daylight curing and cement concrete with water curing treatments. The geopolymer concrete specimens are cured under daylight temperature. Figure 3.10 & 3.11 shows the temperature status of the month February for the region around sivakasi. The maximum average temperature was 33ºC and the minimum average temperature is 20ºC Table 4.1 & figure 4.1 shows compressive strength of the geopolymer concrete specimens were tested in different days.(3,7,14,21,28).Table 4.2 & figure 4.2 shows compressive strength of the cement concrete with M25 grade specimens were tested in different days (3,7,14,21,28).Figure 4.3 Shows strength comparision of geopolymer concrete and cement concrete.

IV. CONCLUSION

1. From our test results, we observed that the geopolymer concrete attains the compressive strength without hydro-curing.
2. In practical, oven curing is not suitable during construction and is uneconomical. To overcome these difficulties, we prefer the daylight curing. While Compared to the hot air oven curing and steam curing, the GPC specimens attains the expected compressive strength under daylight curing and it is more beneficial.
3. The M25 grade geopolymer concrete attains its target strength within 14 days of daylight curing with full elimination of cement and water curing.

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