Investigate Partial Replacement of Alkaline Activators on Geopolymer Concrete

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Abstract- *Geopolymer concrete shall be produced without using any amount of Ordinary Portland Cement. This project reviews the constituents of geopolymer concrete, its strength and potential applications. The experimental work conducted on processes fly ash is activated by different types of alkaline solutions such as Sodium hydroxide, sodium silicate, potassium hydroxide, potassium silicate, calcium hydroxide and respective silicates. These alkaline solutions partially replaced with each other with their respective silicate. The solution to the fly ash ratio were kept as 0.35 for all types of activators only extra water content may vary. The casted cubes were kept for oven curing under 60^0C For 24 Hours duration. Then it was tested for 7, 14, 28 days for compressive strength is conducted on each of 3 mixes. It was observed that the sodium hydroxide solution is more effective as compare to others. The detailed investigation conclusion drawn from experimental work have been highlighted in this dissertation.*

Keywords- Fly ash, GPC, Alkaline Activators.,

I. INTRODUCTION

Recently, reduction in cement utilizing became an important issue in construction industry. It is because on its production process, cement was released CO2 gases which contribute in the formed of glass house effect. In order to succeed the sustainable development mission, geopolymer materials were introduced as an alternative eco-green material. Geopolymer material is an inorganic material which contain Silica, alumina and alkaline as an activator. So far, raw material used to make geopolymer concrete was fly ash. Fly ash can be used as raw material in geopolymer concrete because its rich in silica and alumina. In this research, new alternative raw materials named trams were introduced. Trass a volcanic material which rich in silica and alumina can be used as alternative raw material beside fly ash. However, the different content of silica and alumina could deliver different mechanical properties of geopolymer concrete. Trass which has similar content to fly ash expected to increased mechanical behavior of geopolymer concrete. Reactant from alkaline was needed to release unnecessary ion in polymerization reaction. Sodium Hydroxide or NaOH which have strong alkali characteristic were used as alkaline reactant, while sodium silicate or Na_2SiO_3 used as catalyst. Previous research by Hardjito stated that ratio between Na_2SiO_3 to NaOH were influence the mechanical properties of geopolymer concrete. In order to investigate the influence of alkaline activator ratio in geopolymer concrete, the mass ratio in range of 0.5 to 2.5 were applied.

The geopolymer technology was first introduced by Davidovits in 1978. His work considerably shows that the adoption of the geopolymer technology could reduce the CO_2 emission caused due to cement industries. Davidovits proposed that an alkaline liquid could be used to react with alumina silicate in a source material of geological origin or in by-product materials such as fly ash to make a binder. Geopolymer is synthesized by the polycondensation of silico-aluminate structures. Highly alkaline solutes such as NaOH and KOH are incorporated with source materials rich in SiO2 and Al2O3 .The geopolymer binders show good bonding properties and utilize a material such as fly ash or met kaolin as the source of silicon and aluminum for reaction by an alkali. Geopolymer binders are used together with aggregates to produce geopolymer concrete. Primary binder to produce concrete. The production of cement is increasing about 7% annually. The environmental issues associated with the production of OPC are well known. The large extent of energy is required to produce OPC. The production of one ton of cement liberates about one ton of CO2 as the result of de-carbonation of limestone during manufacturing of cement and the combustion of fossil fuels supported the idea that the alkali activation of met kaolin using solutions containing sodium silicate and NaOH results in the production of materials exhibiting higher mechanical strength compared to activation with only NaOH. The studied the influence of NaOH solution on the synthesis of fly ash geopolymer, the results revealed that solubility of fly ash depends on concentration of NaOH and duration of mixing with NaOH where the use of 10M and 15M NaOH gave relatively high strength. As expected, 5M NaOH gave low strength due to low

II. LITERATURE REVIEW

Sharayu Satpute et al, (2016) studied on geopolymer concrete technology has the the mixture of coarse aggregate,

sand, fly ash and alkaline solution of Sodium hydroxide (NaOH) or Potassium hydroxide (K2SiO3) or Calcium hydroxide and sodium silicate (Na2SiO3) or Potassium silicate (K2Si) 3) or calcium silicate .This study presents the experimental investigation were total nine different trial combination of alkaline activators are used having concrete grade M30 with 8M molarities at 800 oven curing. From those, three combinations is selected for further studies as KOH + Na2SiO3, NaOH+K2SiO3 and KOH + Na2SiO3for different morality for temperature 900. The compressive strength of Geo polymer concrete were carried out during this study and it was observed that, how different alkaline activators effect the strength of Geopolymer concrete. Also it is found that KOH+Na2SiO3 combination having maximum strength than other two combinations... Also it is found that KOH + Na2SiO3 and KOH + Na2SiO3is suitable for concrete work.

S. L. Hake, et.al, (2015) studied on the Concrete is the world's most important Construction material so the demand of cement is increases. The production of cement is highly energy intensive & the production on one ton of cement liberates about one ton of CO2 to atmosphere. The contribution of cement industry to the greenhouse gas emission is estimated to be about 70% of the total green gas emission. Also it consumes large amount of natural resources. Hence it is essential to find alternative to cement. Geopolymer concrete is an innovative material in which the binder is produced but the reaction of an alkaline liquid with a source material that is rich in silica alumina. The present work deals with the result of the experimental investigation carried out on geopolymer concrete using steel fiber. The study analyses the effect of steel on compressive strength. Geopolymer concrete mixes were prepared using low calcium fly ash & activated by alkaline solution. (NaOH & Na2SiO3) with alkaline liquid to fly ash ratio of 0.35 Alkaline solution. Used for present study combination of sodium hydroxide & sodium silicate with ratio 2.5. The mix was designed for molarity of 16M & grade chosen for investigation was M30. Hooked end steel fiber. All tests were conducted according to IS-code procedure. The result for each variation are tabulated & discussed in details & some important conclusions are made.

S. L. Hake et.al [2018] studied that Pore sizes get reduced after addition of Lime stone dust into geopolymer paste sample. This phenomena influences water absorption and compressive strength. Incorporation of Lime stone dust up to 12% increases the compressive strength of paste specimens about 40%.This could be due to the notable variations of porosity between the specimens prepared with or without Lime stone dust. Water absorption values were found directly related to total porosity of specimens. For paste specimens, water absorption showed a decreasing trend in water absorption with increasing Lime stone dust content.

S. L.Hake et al (2019) studied that the concentrates on low calcium fly ash based geopolymer concrete. In the geopolymer concrete, the diverse centralization of sodium hydroxide was utilized. The sodium silicate to sodium hydroxide proportion kept up as 2.5. the fly powder based geopolymer concrete as contrast with hydrochloric corrosive.The cube sample cured for oven and steam curing. The optimized degree of heating used for different curing methods. After the curing, thecube sample were kept in sulfuric and hydrochloric acidic environment for up to the six months. The acidic effect evaluated at a time interval of 0, 45, 90, 135, 180 days. It is observed that the sulfuric acid is harmful to the fly ash based geopolymerconcrete as compare to hydrochloric acid.

S. L. Hake et al (2019) the type of curing like oven, accelerated, membrane, steam, wet and natural sun light (room temperature). Once the temperature for type of curing is lock then proceed to curing time i.e. 6, 12, 18 and 24 hours. At the end temperature, type of curing and curing time finalize then optimize the rest period or testing age of concrete. The rest period differ like 1, 3, 7, 14, 21, 28, 56 days. In this study these variable are to be analyze with the help of compressive strength of geopolymer concrete.

S. L. Hake et al (2019) investigated that the geopolymer concrete, cement is completely replaced by fly ash (P60). Sodium Hydroxide (NaOH) and Sodium Silicate (Na2SiO3) of 13 moles was initially used as an alkaline solution with Na2SiO3: NaOH ratio 2.5. Three type of lime samples is used i.e. Quick, Hydrated and Slaked with variation in lime percentiles as 5%, 10%, 15% and 20%. The sodium hydroxide of 10, 13, 16 and 19 molarity are used along with optimum lime percentage for comparative and tensile behavior study. The temperature curing for the polymerization is not required in case of the lime added fly ash based geopolymer concrete.

III. METHODOLOGY

Geopolymer material is an inorganic material which contain Silica, alumina and alkaline as an activator. So far, raw material used to make geopolymer concrete was fly ash. Fly ash can be used as raw material in geopolymer concrete because its rich in silica and alumina.

A. Material used

Fly ash used in study is low calcium class F fly ash from Dirk India Private Limited

B. Alkaline Activators

Different types of Hydrates used in geopolymer concrete such as NaOH, CaOH, KOH etc. Different types of Silicates used in geopolymer concrete such as Na2Sio3, Ca_2SiO_3, K_2SiO_3 etc.

C. Aggregate

On the basis of experimental trials on locally available coarse aggregates (CA) derived from basalt that produced a cohesive mix, a combination of 14 mm (20%), 10 mm (40%) and 7 mm (40%) is used in the present work.

D. Aggregate

Coarse aggregate are crushed stone is used for making concrete. The size of coarse aggregate 20 mm is used. Locally available sand is used as fine aggregate. The sand confirming to IS: 2386 (part I) 1963 is used as fine aggregate.

IV. RESULT AND DISCUSSIONS

The experimental work that mainly carried on effect of oven curing, for different fly ash / activators ratio on compressive strength. Workability & alkalinity test was carried on geopolymer concrete.

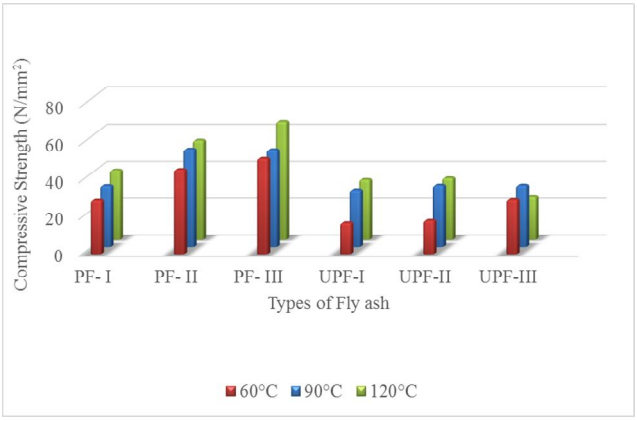

Fig. 1 Temperature effect on PF and UPF.

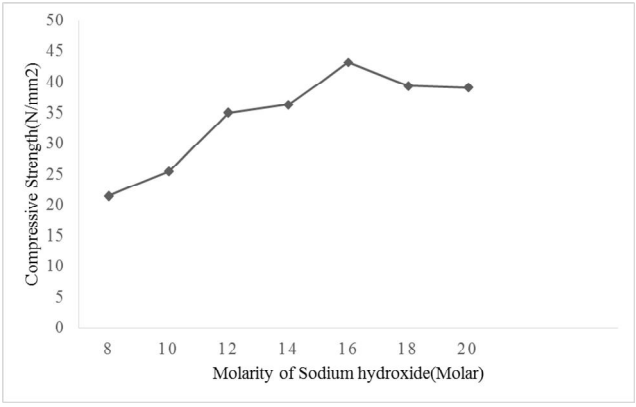

Fig.2 Effect of Concentration of Sodium Hydroxide

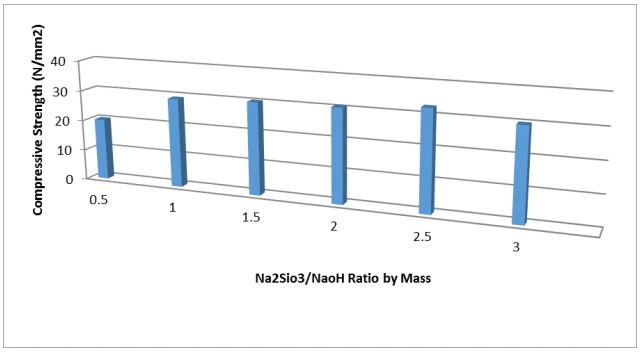

Fig. 3 Effect of Sodium Silicate to Sodium Hydroxide Ratio by Mass.

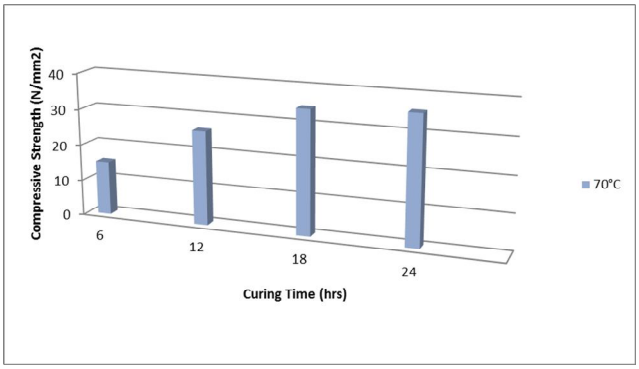

Fig 4 Effect of Curing duration of GPC

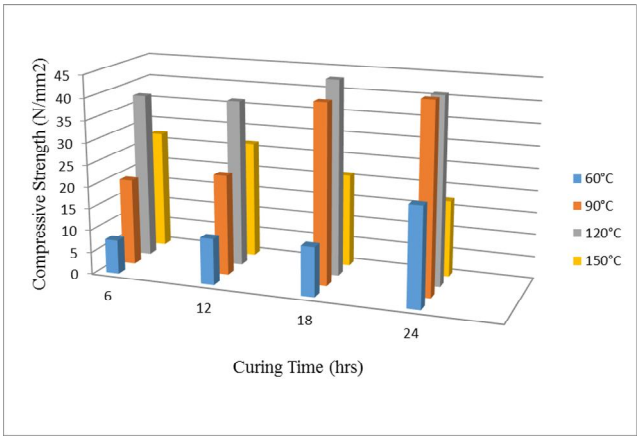

Fig. 5 Effect of Curing Duration and Degree of Heating on Geopolymer Concrete.

V. CONCLUSION

1. The utilization of sodium hydroxide and sodium silicate is more for manufacturing of GPC, The combination effect of alkaline activators shows their importance in it.
2. The alkaline activators combinely used shows or gives the optimal use of alkaline activators.
3. The potassium (hydroxide and silicate) and calcium (hydroxide and silicate) plays important role for activators of Geopolymer Concrete (GPC).
4. The combined effect shows the importance of alkaline activators with different combination ratio based on different activators of Geopolymer Concrete (GPC).

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