Effect of Concentration of Alkaline Solution on Types of Fly Ash on Geopolymer Concrete

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Abstract- *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 6M and 22M NaOH gave relatively high strength. As expected, 5M NaOH gave low strength due to low leaching of Si and Al ions in NaOH solution.*

Keywords- Alkali activated, GPC, types of curing,

I. INTRODUCTION

With the increased use of cement in concrete, there have been environmental concerns both in terms of damage caused by the extraction of raw materials and emission of carbon dioxide during cement manufacture. This has brought Pressures to reduce the cement consumption in the construction industry. An attempt in this regard is the development of geo-polymer concrete. In a research study conducted by on geo-polymer concrete manufactured from low-calcium fly ash activated with sodium silicate and sodium hydroxide solution, the authors have reported higher compressive strength and better durability of geo-polymer concrete compared to Portland cement concrete. We have demonstrated that a combination of sodium hydroxide and sodium silicate solutions can be a good application for activator in fly ash-based geo-polymer concrete. Concentration of sodium hydroxide is the most important factor for geo-polymer synthesis. The solubility of alumino silicate increases with increase in hydroxide concentration. The use of higher concentration of sodium hydroxide yield higher compressive strength of geo-polymer concrete.

fly ash-based geo-polymer and fly-ash is used as the binder, instead of Portland or other hydraulic cement paste, to produce concrete. The fly ash-based geo-polymer paste binds the loose coarse aggregates, fine aggregate sand other un-reacted materials together to form the geo-polymer concrete, without the presence of admixtures. The manufacture of geo-polymer concrete is carried out using the usual concrete technology methods. As in the case of OPC concrete, the aggregates occupy about 75-80 % by mass, in geo-polymer concrete. The silicon and the aluminum in the fly ash react with an alkaline liquid that is a combination of sodium silicate and sodium hydroxide solutions to form the geo-polymer paste that binds the aggregates and other un-reacted materials.

II. LITERATURE REVIEW

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.

Nisha Jain et.al [2016] investigated that, the compressive strength goes on increasing with the increase in the rest period of geopolymer concrete with addition of 10% of Lime and it's cured at normal room temperature. The maximum compressive strength was achieved at the completion of 28 days of rest period thereby giving it a wide scope. The compressive strength achieved by grade M30 of geopolymer concrete cured at normal room temperature at a rest period of 7 days is higher than the compressive strength achieved by ordinary concrete for similar rest period.

Yewale V V et.al [2016] studied that Compressive strength can be achieved for both the grade of GPC by replacing Fly ash with Cement for various percentages i.e. 5% & 10% by opting wet curing. The compressive strength goes

on increasing with the increase in replacement percentage with cement in M30 grade of GPC by opting wet curing where maximum can be achieved by replacing 10% with cement.

Tanpure S M et.al [2017] investigated that the geopolymer concrete also shows excellent resistance to sulfate attack, good acid resistance, undergoes low creep, and suffers very little drying shrinkage. If steam curing of geopolymer concrete is done then its increases the strength of concrete. It is impermeable and shows higher resistance to heat. The increase in the content of bases increases both compressive as well as tensile strength. The setting time is very short so it is necessary to add super plasticizer to delay the setting time.
S. L. Hake et.al [2017] says desired compressive strength was achieved by fixing the solution to fly ash ratio of 0.35 for the mixed design of fly ash based geopolymer concrete on the basis of various parameter such as quantity and fineness of fly ash, quantity of water and grading of fine aggregate. Sandeep Hake, et al [2016], The oven heat curing for geopolymer concrete is mostly used. The researchers studied only for different curing temperature in oven curing, but only few of them work on steam, membrane curing and no one work on accelerated curing, as well as comparison on steam, accelerated, membrane, natural and oven curing. So there is scope on method of curing of geo-polymer concrete. Also researchers studied for different curing time like 6,12,18,24 and the optimum strength obtained at 18 Hrs of Curing. The different curing temperatures like 60^0 C, 90^0 C, 120^0C and 150^0C. The different type of curing like Oven, Accelerated, Membrane and Steam curing are needed to be Study. The effect on compressive strength of Geopolymer concrete by using these parameter need to be study.

S. L. Hake et.al [2017] says, made an attempts to find out an optimum mix for the geopolymer concrete and they have casted cubes of size 150 x 150 x 150 mm and cured under Steam curing for 24 hours.The compressive strength was found out at 7 days and 28 days.The result are compared. The optimum mix is Fly ash: fineaggregate: coarse aggregate with a solution NaOH & Na_2SiO_3 combined together to fly ash ratio of 0.35. high and early strength was obtained in the Geo-polymer concrete mix.

Satpute S S et al [2016] says fly ash based geopolymer is better than normal concrete in many aspects such as compressive strength, exposure to aggressive environment, workability and exposure to high temperature. When the curing time and temperature increases, the compressive strength also increases. Sodium silicate is also the most suitable as alkaline activator because it contain dissolved and partially polymerized silicon which reacts easily, incorporate in to the reaction product and significantly contributes to improving in mortar characteristics.

III. METHODOLOGY

The details of development of the process of making fly ash based geo-polymer concrete. In 2001, very little knowledge and know-how of making of fly ash-based geo-polymer concrete were available in the published literature. Due to this lack of information, the study began based on limited available literature on geo-polymer pastes and mortars. The published papers on geo-polymers available at that time mostly reported the use Of metakaolin or calcined kaolin as source material of geo-polymer paste.

A. Material used

Fly ash used in study is low calcium class F fly ash from Dirk India Private Limited under the name of product POZZOCRETE 60

B. Alkaline Activators

The sodium hydroxide used was either a technical grade sodium hydroxide in flakes form (3mm), with a specific gravity of 2.130, 98% purity The sodium hydroxide (NaOH) solution was prepared by dissolving either the flakes or the pellets in water. The mass of NaOH solids in a solution varied depending on the concentration of the solution expressed in terms of molar, M. For instance, NaOH solution with a concentration of 8M consisted 8x40 = 320 grams of NaOH solids (inflake or pellet form) per liter of the solution, where 40 is the molecular weight of NaOH.

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. Coarse aggregate

Coarse aggregate are crushed stone is used for making concrete. The commercial stone is quarried, crushed, and graded. The size of coarse aggregate 20 mm is used.

E. Fine Aggregates

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.

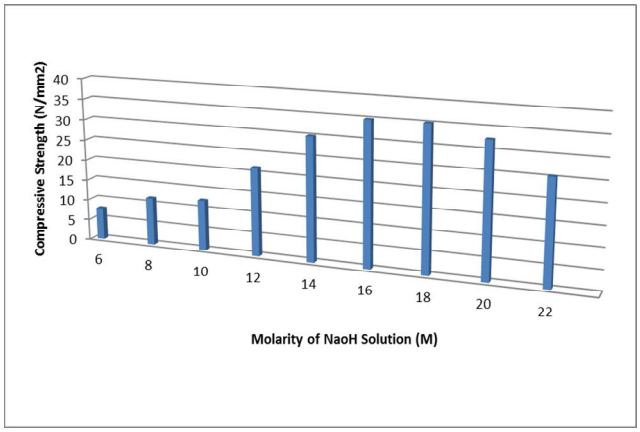

Fig.1 Effect of Concentration of Sodium Hydroxide

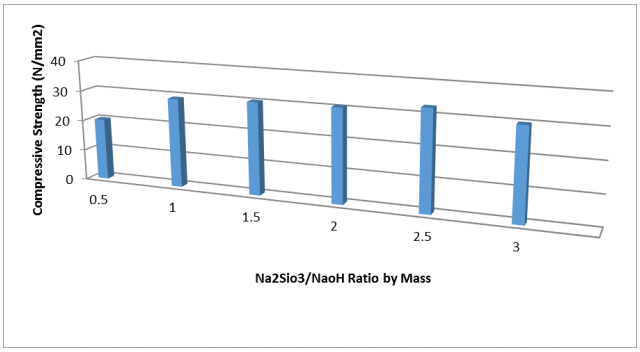

Fig. 2 Effect of Sodium Silicate to Sodium Hydroxide Ratio by Mass.

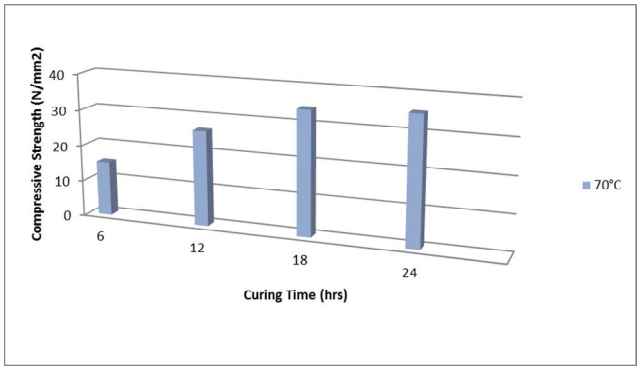

Fig 3 Effect of Curing duration of GPC

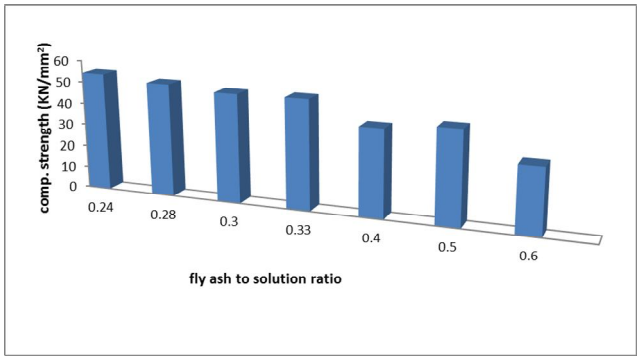

Fig.4 fly ash to solution ratio and comp. strength

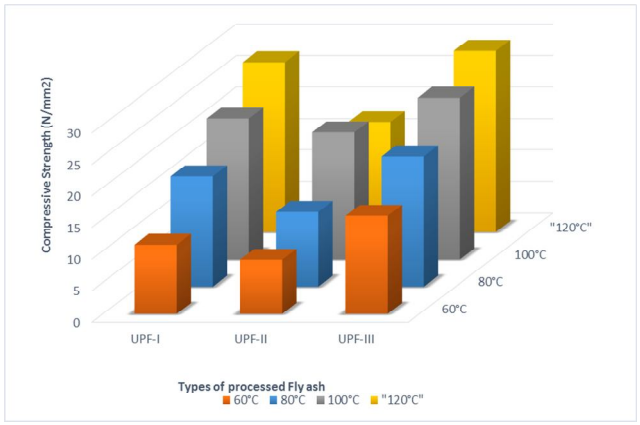

Fig. 5 Temperature effect on Unprocessed Fly ash.

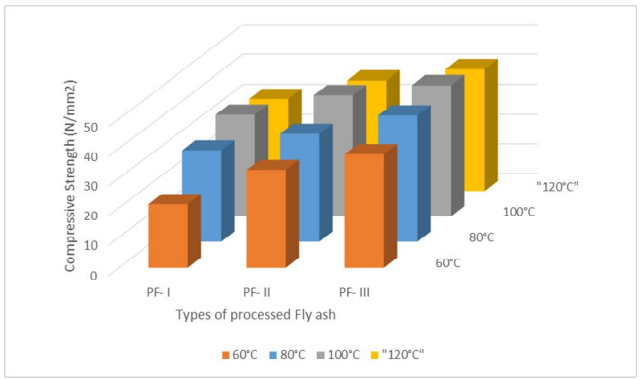

Fig 6 Temperature effect on Processed Fly ash.

V. CONCLUSION

1. It is observed that the as the fineness of fly ash increases the strength of oven cured geopolymer concrete increases with consideration of temperature variation for polymerization.
2. Fly ash-based geopolymer with 16M NaOH concentration shows excellent result with high compressive strength for 7th days of testing.

3. The forms of sodium hydroxide shows significance on compressive strength. The flex form of sodium hydroxide is economical as compare to the pallets form.

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