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Heat Curing Effect on Strength of Geo-Polymer Concrete

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ABSTRACT

This study represents the effect of Geopolymer concrete prepared with the locally available materials. The Geopolymer utilizes industrial by-products such as fly ash, which disposed in landfill. Therefore the use of geopolymer not only reduces the emission of the carbon dioxide (CO_2) in atmosphere but also utilizes industrial by-products. The fly ash is procured from the nearest thermal power plant. The geopolymer consist of fly ash, coarse aggregates and fine aggregates and alkaline liquid. Alkaline liquid formed by mixing of sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3). The study describes the result of the test preformed. All the cubes are cured and tested for comparing the compressive strength of cubes. Alkaline liquid is prepared before 24 hours of the mixing of materials. The dry mix of material is done for about 2-3 minutes and in that alkaline liquid is mixed for 3-4 minutes. Prepared the concrete blocks and provide them a rest period for about 24 hours. Then curing is done at different temperature in oven. The compressive strength of geopolymer concrete depends on curing temperature and duration of heating hours. The percentage of CaO is highly influences the strength of geopolymer concrete.

Keywords: Geopolymer concrete, fly ash, strength, precast pipes, application.

1. INTRODUCTION

Concrete usage around the world is second only to water. Ordinary Portland cement is conventionally used as the primary binder to produce concrete. The environmental issues associated with the production of OPC are well known. The amount of carbon dioxide released during the manufacturing of ordinary Portland cement due to calcination of lime stone and combustion of fossil fuels is in the order of 1 ton for every turn off ordinary Portland cement produced.

On the other hand the abundant availability of fly ash worldwide creates a opportunity to utilize this by product of burning coal, and the substitute for ordinary Portland cement to manufacture concrete. Disposal of fly ash has the object of saving vast amount of land meant for Ash ponds to store flash. With the present practice of fly ash disposal in ash pond general in form of slurry, the total land required for cash disposal about would be 82200 hectares by the year 2030 at an estimate 0.6 hectare per MW. When used as a partial replacement of ordinary Portland cement come in the presence of water and in ambient temperature, fly ash reacts with calcium hydroxide during the hydration process of ordinary Portland cement to form the calcium silicate hydrate gel. The development and application of high volume fly ash concrete which enabled the replacement of ordinary Portland cement up to 60% by mass is a significant development.

In this work low calcium fly ash based geopolymer is used as a binder instead of Portland or other hydraulic cement paste to produce concrete the flash based geopolymer paste binds the loose coarse aggregate, fine aggregates and other unreacted materials together to form the geopolymer concrete, with or without the presence of admixtures. The manufacture of geopolymer concrete is carried out using the usual concrete technology method as in the use of ordinary Portland cement concrete the aggregates occupy about 75 to 80% by mass in polymer concrete. The silicon and the aluminium in the low calcium fly ash class f react with the alkaline liquid that is in a combination of sodium silicate and sodium hydroxide solution to form the geopolymer face that binds the aggregate and other unreached material.

It is estimated that with demographic growth and industrialization, the pollution generated by Portland cement production in a few years will represent 17% of the worldwide carbon dioxide emission. In addition, as compared to the ordinary Portland cement, they are characterized by higher environmental sustainability manufacturing geopolymeric cement generate five times less carbon dioxide then does the manufacturing of Portland cement it was estimated that the manufacturing of a ton of clinker produces about 0.9 tons of carbon dioxide deriving from raw material decomposition and from fuel combustion. Any country that converted to the manufacturing of geopolymeric cement or concrete will eliminate it percent of the mission generated from the cement and aggregate industries. Geopolymer features and 90% or greater reduction in carbon dioxide emission

This research utilizes low calcium class f fly ash as the best material for making geo polymer concrete. The flash was obtained from only one source thermal power station at Paras Akola. The main focus of this study is curing temperature and duration of curing specimens together with the alkaline solution to flash ratio, are some of the variables. To study the varying ratios of alkaline liquid to fly ash there by preparing alkaline solution with wearing ratios to fly ash. also prepare the solution with same alkaline to flash ratio but different varieties. The work conducted by preparing geopolymer concrete mix to evaluate the effect of various parameters affecting the compressive strength in order to enhance its overall performance. Also study the short-term behavior that is workability and setting time and the engineering properties like compressive strength of fly ash best geopolymer concrete.

2. EXPERIMENTAL WORK

1. Preparing alkaline solution

a combination of sodium silicate solution and sodium hydroxide solution can be used as alkaline liquid. Liquid is ready by mixing both the solutions together at least 24 hours prior to use, for heat of hydration properly dissolved. Distil water was used to prepare the alkaline solution and also if it exceeds 36 hours it terminates two semi solid liquid still so the prepared solution was used within this point. The sodium silicate solution is commercially available in numerous place. The sodium silicate solution having SiO2 = 25.0 to 28.0 %, Na2O =7.5 to 8.5 % and the water glass is generally used.

The sodium hydroxide with 97 to 98% purity in flake or pellet form is commercially available. The solids must be dissolved in distilled water to make the solution with the required concentration. Sodium hydroxide pellets and taken and dissolved in water at rate of 8 molar concentration.

The concentration of sodium hydroxide solution of 8 molar adequate for most applications. The mass of sodium hydroxide solid in the solution varies depending on the concentration of the solution. For instance sodium hydroxide solution with concentration of 1 molar consists of 8 X 40 = 320 grams sodium hydroxide solids per liter of the solution where 40 is the molecular weight of sodium hydroxide.

2. Mixture proportions of geopolymer concrete:

Based on the past research on geopolymer concrete which is obtainable the subsequent ranges were selected for the constituent of the mixture used in for the studies.

a. Ratio of sodium silicate solution to sodium hydroxide solution by mass is 0.4 to 3.0.

b. Molarity of sodium hydroxide solution is 8 M.

c. The ratio of activator solution to flash by mass in the range of 0.3 and 0.40.

d. Coarse aggregate and fine aggregates of roughly 75% to 80% of the entire mixture by mass. This value is similar to that used in ordinary Portland cement concrete.

This ratio of sodium hydroxide to sodium silicate solution was fixed at 2.5 for many of the mixture because the sodium silicate solution is considerably cheaper than the sodium hydroxide solution. The primary difference between geopolymer concrete and Portland cement concrete is the Banda. The silicon and aluminum oxide in the low calcium fly ash reacts with the alkaline liquid to form geopolymer paste that binds the illusion coarse aggregates and fine aggregates and the other un-reacted materials together to form the geopolymer concrete.

As in the case of Portland cement concrete, the coarse and fine aggregates occupy about 75 to 80% of the mass of geopolymer concrete. This component of geopolymer concrete mixtures can be design using the tool currently available for Portland cement concrete the compressive strength and the workability of geopolymer concrete are influenced by the proportions and the properties of constituent material that make the geopolymer paste.

Following points are taken into consideration while preparing geopolymer concrete:

1. High concentration in terms of mole of sodium hydroxide solution leads to higher compressive strength of geopolymer concrete.
2. Higher the ratio of sodium silicate solution to sodium hydroxide solution ratio by mass coma higher is the compressive strength of geopolymer concrete.
3. The slump value of fresh geopolymer concrete increases when the water content of the mixture increases.
4. As the H_2O to Na_2O molar ratio increases the compressive strength of geopolymer concrete decreases.

3. Materials

a. Fly ash:
The fly ash employed in the study was low calcium class f dry fly ash. The chemical composition of the fly ash was determined by x-ray fluorescence analysis using IS 1727-1967. The silicon and Aluminium constitute about 80% of the entire mass and the ratio of silicon to Aluminium oxide are about to also the percentage of calcium oxide is less than 5

2. Aggregates :
Local aggregates, all 20mm coarse aggregates and fine aggregates in saturated surface dry condition where used the coarse aggregate work best granite type aggregates in the fine aggregate was fine sand. The preparation of aggregate to surface saturated dry condition is achieved by soaking the aggregate in water for 24 hours, draining and the air drying entrees to get rid of surface moisture. The fineness modulus of coarse aggregate was 4.26 and for sand was 4.07 both coarse and fine aggregates were in saturated surface dry condition in accordance with the relevant Indian standards, I.S.383-1970. Coarse aggregates were obtained in crushed form majority of the particles were of granite type. The fine aggregate was obtained from the river sand is in uncrushed form. Natural river sand confirming to zone 4 as per Indian standard 383-1970.

3. Curing :
Immediately after casting, the samples were covered by a film to avoid the loss of water due to a operation during curing at elevated temperatures the coarse and fine aggregates in geo polymer concrete mixture neither Be too dry to absorb water from the mixture nor to wet to add water to the mixture. Two types of curing where applied heat curing and ambient curing. For heat curing the specimens were cured in an oven and for ambient curing the specimens were left 2 year for desired properties. The geopolymer concrete specimens should be wrapped during curing at elevated temperatures in a dry environment to forestall excessive evaporation.

3. TRIAL MIX:

According to the research paper "Development of Geopolymer Concrete for Precast Structure" Dissertation Report, MSc, The University of Texas At Arlington. By Preeti Shrestha, the trial mix proportions are

No.	Fly ash (lb/ft^3)	Aggregates (lb/ft^3)	Sand (lb/ft^3)	Sodium Hydroxide (lb/ft^3)	Sodium Silicate (lb/ft^3)	Molarity (M)
1	25.5	80	35	2.6	6.5	8

Converting it to Kg/m^3 by using formula

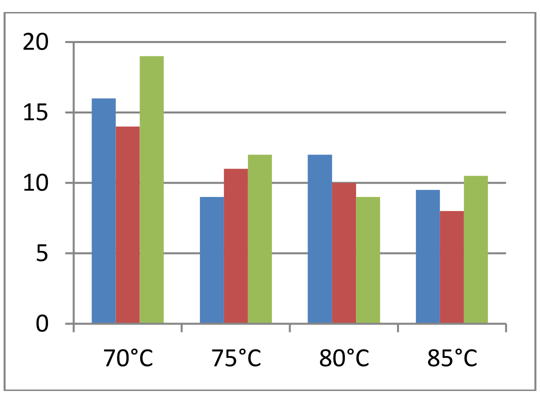
$$\ldots\ldots\ lb/ft^3 * 0.158 * 101.97 = \ldots\ldots\ kg/m^3$$

No.	Fly ash (kg/m^3)	Aggregates (kg/m^3)	Sand (kg/m^3)	Sodium Hydroxide (kg/m^3)	Sodium Silicate (kg/m^3)	Molarity (M)
1	410	1288.90	563.83	41.88	104.72	8

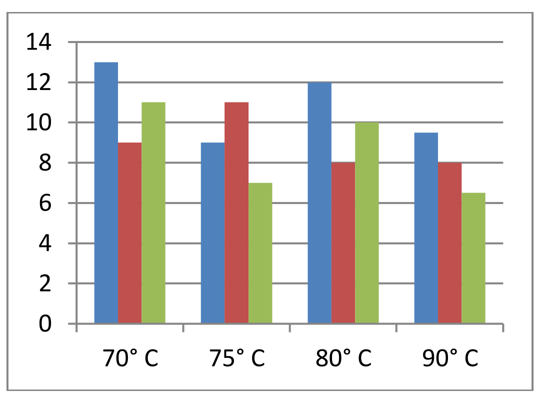
For 1 cube of 150 X 150X 150 mm, requirements are as follows:

No.	Fly ash (kg)	Aggregates (kg)	Sand (kg)	Sodium Hydroxide (kg)	Sodium Silicate (kg)	Molarity (M)
1	1.38	4.35	1.90	0.15	0.350	8

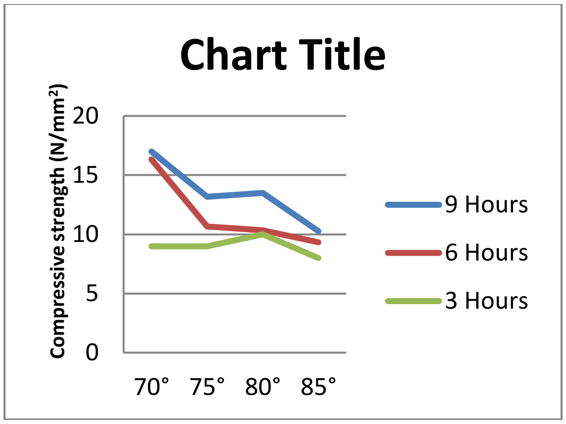
4. RESULTS



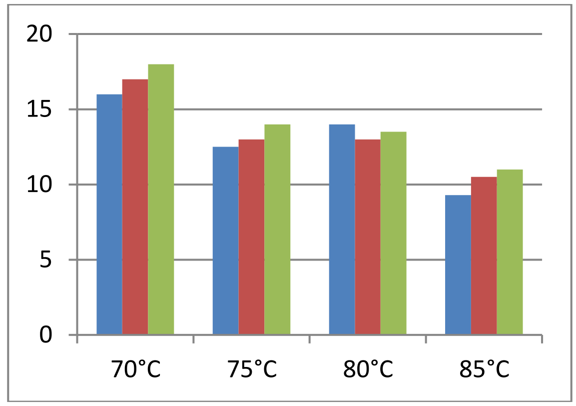
Results of compressive strength after curing for 3 Hours



Results of compressive strength after curing for 6 Hours



Results of compressive strength after curing for 9 Hours.



Cumulative Result based on Effect of Temperature.

5. CONCLUSION:

- The compressive strength of geopolymer concrete depends upon curing temperature in duration of heating hours.
- The compressive strength of geopolymer concrete is increase with increase in temperature up to 80 degree Celsius after that it decreases.
- The increase in curing time the compressive strength of cube is increased up to certain extent.
- Oven heat curing is necessary geopolymerization process when alkaline liquid i.e. NaOH and Na_2SiO_3 is used.
- The compressive strength of geopolymer concrete is highly influenced by the percentage of CaO present in fly ash.
- The fly ash with CaO 1.68% seems to not feasible for geopolymer concrete.
- The curing should be provided in continuous manner, during in interval results in reduction in the strength of the mix.

6. REFERENCES:

[1] Priti Sreshtha, “Development Of Geopolymer Concrete For Precast Structures” Dissertation Report Msc The University Of Texas At Arlington Des 2013
[2] Subhash V Patan Kar, Sanjay S Jamkar, Yuvraj M Guhgal Effect Of Water To Jio Polymer Binder Ratio On The Production Of Fly Ash Based Geopolymer Concrete International Journal Of Advanced Technology In Civil Engineering ISSN: 2231-5721 VOLUME 2 ISSUE 1, 2013
[3] Rakesh Kumar, Sanjay Kumar, S.P. Mehrotra, “Towards A Sustainable Solution For Flash Through Mechanical Activation” Resource Conversion And Recycling 52, 2007, 157-179
[4] RAIJIWAL D.B. Patil H.S. “Geopolymer Concrete: Concrete Of Next Decade “ Journal Of Engineering Research And Studies Volume 2 2011 19 - 25.
[5] Prakash R Vora, Urmi V Dave “Parametric Studies Of Compressive Strength Of Geopolymer Concrete” Procedia Engineering51,2013,210-219.
[6] ACI Committee 232 (2004). “Use Of Fly Ash In Concrete” Farmington Hills, Michigan USA From America Concrete Institute: 41.
[7] IS 1727-1967 Indian Standard “Method Of Test Off Pozzolanic Materials.”
[8] IS 383 - 1970 Specification Of For Coarse And Fine Aggregate From Natural Resources For Concrete, Bureau Of Indian Standards, New Delhi.
[9] IS 2386 Part 1 1963 Indian Standard Method Of Testing For Aggregate For Concrete Part 1 Particle Size And Shape.
[10] IS 516 1959 Method Of Testing For Strength Of Concrete, Bureau Of Indian Standards, New Delhi.