Effect of Fineness of Fly Ash on Alkali Activated GPC

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Abstract- *The use of fly ash as a value added material as in the case of geopolymer concrete, reduces the consumption of cement. Reduction of cement usage will reduce the production of cement which in turn cut the CO_2 emissions. Many researchers have worked on the development of geopolymer cement and concrete for the past ten years .The present work deals with the result of the experimental investigation carried out on geopolymer concrete using processed and unprocessed fly ash with Sodium Silicate and Sodium Hydroxide. The study analyses the effect of processed and unprocessed fly ash on compressive strength & split tensile strength for different temperature. To study the effect of different types of processed & unprocessed fly ash like processed fly ash we use P60, P80& P100 etc. from, dirk pvt. ltd and unprocessed flyash form the different cities like Ahmednagar, Nashik & Beed etc.*

I. INTRODUCTION

Now a days, Concrete is one of the most widely used construction materials. It is usually associated with Portland cement as the component for making concrete. Ordinary Portland Cement (OPC) is conventionally used as the primary binder to produce concrete. Production of Portland cement is currently exceeding 2.6 billion tons per year worldwide & growing at 5% annually. 5-8% of all humans generated atm. Carbon-di-oxide worldwide comes from the concrete industry. Among the greenhouse, carbon-di-oxide contributes about 65% of global warming.

Although the use Portland cement is still in avoidable until the foreseeable future, many efforts are being made in order to reduce the use of P.C.C.. On the other hand, a huge volume of fly ash is generated around the world. Most of the fly ash is not effectively used, & a large part of it disposed in landfills which affects aquifers & surface bodies of fresh water.

The production of cement is increasing about 3% annually (McCaffrey 2002). The production of one ton of cement liberates about one ton of CO2 to the atmosphere, as the result of de-carbonation of limestone in the kiln during manufacturing of cement and the combustion of fossil fuels (Roy 1999).

The contribution of Portland cement production worldwide to the greenhouse gas emission is estimated to be about 1.35 billion tons annually or about 7% of the total greenhouse gas emissions to the earth's atmosphere (Malhotra 2002). Cement is also among the most energy-intensive construction materials, after aluminium and steel. Furthermore, it has been reported that the durability of ordinary Portland cement(OPC) concrete is under examination, as many concrete structures, especially those built in corrosive environments, start to deteriorate after 20 to 30 years, even though they have been designed for more than 50 years of service life (Mehta and Burrows2001).

II. LITERATURE REVIEW

S.S. Jamkar et al. (April 2013) investigate the effect of fly ash fineness on the compressive strength of geopolymer concrete. Geopolymer concrete was produced by activating fly ash with a highly alkaline solution of sodium silicate containing 16.45% Na2O, 34.35% SiO2 and 49.20% H2O and 13 molar sodium hydroxide solution. The literature on the subject indicates that fly ash activation can be achieved as follows. Activation of silicon and calcium in class C fly ash by low to mild concentration of alkaline solution resulting in calcium silicate hydrate (C-S-H) and Activation of silicon and alumina rich class F fly ash by highly alkaline solutions to form inorganic alumino-silicate called geopolymer.

It is also concluded that the increase in quantity of FA increases workability of GPC mixes in terms of slump and flow values for a constant solution to fly ash ratio. The rate of increase of slump and flow values with increase of fly ash content is higher when fly ash content increases from 550 to 600 kg/m³, thereafter the rate decreases when fly ash content is increased to 650 kg/m³. It may be due to increase in the surface area because of more fines in the mix. The compressive strength of geopolymer concrete increases as the content of fly ash, having similar fineness, increases due to the availability of more SiO2 for polymerization process. The rate of gain of strength with increase of fly ash content is higher when FA content increases from 550 to 600 kg/m³, the reafter the rate of gain of strength decreases when FA content is increased to 650 kg/m³. It may be due to more SiO2 available in FA for polymerization up to certain limit, further increase in the quantity of FA might be slowing down the polymerization process.

Hake S.L. (2015) Concluded that In this research review paper methods of curing of geopolymer concrete is discussed in brief. Oven heat curing of geopolymer concrete has been attempted by various researchers. but for curing of geopolymer concrete is quit difficult on site by using oven, so there is scope to work on types of curing which makes geopolymer concrete cure easily. Most of researcher used only oven heat curing for geopolymer concrete. They studied only for different curing temperature in oven curing, but only few researcher 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 geopolymer concrete. Most of researchers work on compressive strength only, so there is scope to study the mechanical properties like short term as well as long term property of geopolymer concrete. Also researchers studied for different curing time like 6,12,18,24 hours and also for different curing temperature but few researchers worked on different rest period, so there is scope for work.

S.L. Hake (2016) Concluded that Plasticizer and superplasticizer dosage improves workability (measured by slump test) of fly ash based geopolymer concrete for molar strength of NaOH solution less than 4 M. As the dose of water reducer increases, there is a decrease in the value of rheological parameters. In general, 1st generation lignin based water reducer At higher molar concentration of NaOH (above 4 M), plasticizer/superplasticizer dosage has the adverse effect on slump and rheological parameters of fly ash geopolymer concrete. Lignin based plasticizer still shows better performance, measured by slump test, than PC based superplasticizer at higher molar concentrations. has been found to be more effective than 3rd generation PC based superplasticizer. However, segregation of concrete takes place with the addition of lignin based water reducer at 1.5% and above. The trading of carbon dioxide (CO2) emissions is a critical factor for the industries, including the cement industries, as the greenhouse effect created by the emissions is considered to produce an increase in the global temperature that may result in climate changes. The 'tradable emissions' refers to the economic mechanisms that are expected to help the countries worldwide to meet the emission reduction targets established by the 1997 Kyoto Protocol. Speculation has arisen that one ton of emissions can have a trading value about US$10. The fineness of fly ash plays a role in the strength development of geopolymer concrete. A higher fineness resulted in a higher workability as measured by the flow test. The rate of strength gain in unprocessed fly ash, UPF-II, was uniform from 4 to 24 hours during temperature curing. While the mix with UPF-I showed a uniform strength gain between 8 to 24 hours. Geopolymer concrete with the processed fly ash, PF-I, PF-II and PF-III, showed a higher strength than geopolymer concrete with unprocessed UPF-I and UPF-II. The rate of strength gain in geopolymer concrete with PF-I, PF-II and PF-III was higher during 4 to 8 hours. The rate reduced thereafter.

III. EXPERIMENTAL WORK

The conventional concrete the cement is most important ingredient for binding the fine aggregate, coarse aggregate &sand etc. Like that for making the geopolymer concrete fly ash is most important ingredient to for binding the all material used in gpc. The fly ash may be of processed and unprocessed type. The processed fly ash contain the silicon and aluminum oxides in the low-calcium fly ash reacts with the alkaline liquid to form the geopolymer paste that binds the loose coarse aggregates, fine aggregates, and 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 designed using the tools currently available for Portland cement concrete. The compressive strength and the workability of geopolymer concrete are influenced by the proportions and properties of the constituent materials that make the geopolymer paste. Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of geopolymer concrete. Higher the ratio of sodium silicate solution-tosodiumhydroxide solution ratio by mass, higher is the compressive strength of geopolymer concrete. The slump value of the fresh geopolymer concrete increases when the water content of the mixture increases.

MATERIAL USED:

Fly Ash.

According to the American Concrete Institute (ACI) Committee 116R, fly ash is defined as „the finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gasses from the combustion zone to the particle removal system (ACI Committee 232 2004). Fly ash is removed from the combustion gases by the dust collection system, either mechanically or by using electrostatic precipitators, before they are discharged to the atmosphere.

Aggregate.

Aggregate are used for making geo-polymer concrete are fine aggregate and coarse aggregate having detail s specification.

Alkaline Activators.

The most common alkaline solution used ingeopolymerisation is a combination of sodium hydroxide (NaOH) and sodium silicate (Na2SiO3) In this study, a combination of sodium silicate and sodium hydroxide was chosen as the alkaline liquid. Sodium-based solutions were chosen because they are cheaper than Potassium-based solutions.

When lime is mixed with water, lime slowly turns into the mineral portlandite(dense) in the reaction CaO + H_2O = Ca $(OH)_2$. Lime is mixed with an excess of water so it stays fluid, this is called slaking and the lime resulting is called slaked lime. Slaked lime continues to harden over a period of weeks. Lime has to be mixed with sand and other ingredients to take form of slaked lime cement, that can be used as mortar between stones or bricks in a wall or spread over the surface of a wall There, over the next several weeks or longer, it reacts with CO_2 in the air to form calcite again (artificial limestone) Concrete made with lime cement is well known from more than 5000 years old. It was widely used in all over the world. Sign of its usage can be found easily after surveying different archaeological sites. In dry conditions, it works extremely well

Mixing and Casting.

It was found that the fresh fly ash-based geo-polymer concrete was dark in colour (due to the dark color of the fly ash), and was cohesive. The amount of water in the mixture played an important role on the behavior of fresh concrete. When the mixing time was long, mixtures with high water content bled and segregation of aggregates and the paste occurred. This phenomenon was usually followed by low compressive strength result of hardened concrete.

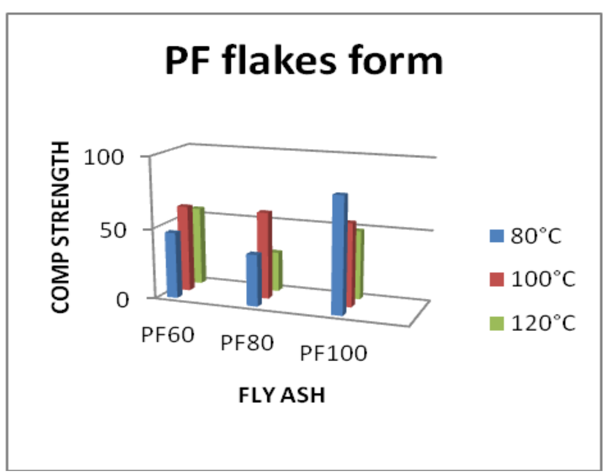
From the preliminary work, it was decided to observe the following standard process of mixing in all future studies.

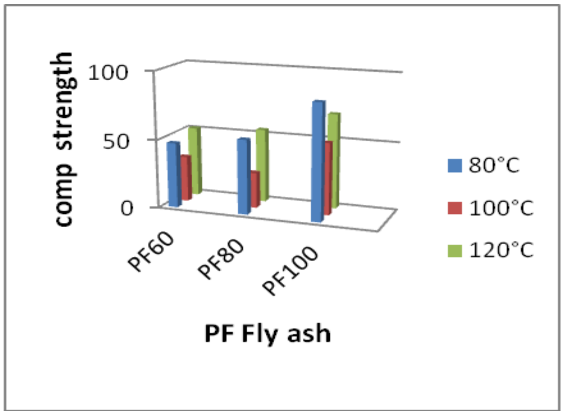
- Mix sodium hydroxide solution & sodium silicate solution together at least one day prior to adding the liquid to the dry materials.
- Mix all dry materials in the pan mixer for about 3 min. add the liquid component of the mixture at the end of dry mixing & continue the wet mixing for another 4 to 5 Min approximately.

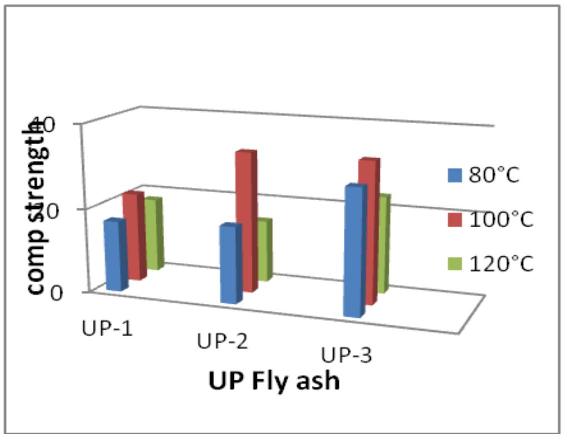
After the mixture is properly mix the material is collected in the 150×150×150 mm size cubesby using table vibrator .Immediately after casting, the samples are rest for 24 hours specimens were cured in an oven at a specified temperature of 80°C,100°C,120°C for a period of 18 hrs. At the end of curing period the150×150×150 mm cubes are removed from the moulds.The specimens are then left to air-dry at room after casting the specimens, they were kept in rest period for seven days and then they were demoulded temperature, until they are loaded in compression testing machine at the specified age.As with traditional Portland cements, geo-polymers respond better to heated curing methods. Research work has demonstrated that time and temperature greatly affect the mechanical development of geo-polymer binders; however, a temperature threshold exists, beyond which the strength gain rate is extremely slow. Temperatures in the range of 80 to 100°C are widely accepted values used for successful geo-polymer hydration. Both curing temperature and curing time directly influence final compressive strength values of geo-polymer specimens.

IV. RESULT AND DISSCUSSION

The compressive strength changes as the temperature changes. The PF60 will gives the optimum strength at 80°C. but as temperature increases upto 100°C. The strength will increases and will suddenly decrease at 120°C. The PF80 will gives the optimum strength at 80°C. but as temperature increases upto 100°C. The strength will increases and will suddenly decreases at 120°C. And for PF100 it will gives the max strength at 80°C.and continuously decrease upto120°C.







V. CONCLUSION

1. UP1 will gives the optimum strength at 80°C. but as temperature increases upto 100°CThe strength will increases and will suddenly decrease at 120°C.UP2 will gives the optimum strength at 80°C. but as temperature increases upto 100°C.The strength will increases and will suddenly decreases at 120°C.And for UP3 it will gives the max strength at 80°C.and suddenly increases at 100°C and then decrease upto120°C.
2. All processed fly ash gives the maximum compressive strength than unprocessed fly ash at same temperature. But the unprocessed fly ash(UP-3) in flakes form gives max comp strength45Mpa at 100°C which is exactly near about processed fly ash-1 at 80°C. So it is economical than processed fly ash-1.
3. PF60 gives the optimum strength at 80°C. but as temperature increases up to 100°C The strength increases and suddenly decrease at 120°C.
4. PF80 gives the optimum strength at 80°C. but as temperature increases upto 100°C The strength also increases and suddenly decreases at 120°C.
5. PF100 gives the max strength at 80°C.and continuously decrease upto 120°C.

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