EVALUATION ON TYPES OF FLY ASH AND ALKALINE ACTIVATORS OF GPC

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ABSTRACT:

The Cement production generated carbon dioxide, which pollutes the atmosphere. The Thermal Industry produces a waste called fly ash which is simply dumped on the earth, occupies larges areas. The waste water from the Chemical Industries is discharged into the ground which contaminates ground water. By producing Geo-polymer Concrete all the above mentioned issues shall be solved by rearranging them. Waste Fly Ash from Thermal Industry + Waste water from Chemical Refineries = Geo polymer concrete. Further, 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 fly ash form the different cities like Bhusawal, Nashik & Beed etc. in this paper the effect of alkaline solution on different fly ash will be investigated.

KEYWORD: Types of fly ash, forms of sodium hydroxide, geopolymer concrete.

INTRODUCTION:

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).

RESEARCH REVIEW:

S.V Patankar (Dec 2007) said that, 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. Geopolymer concrete with the processed fly ash, showed a higher strength than geopolymer concrete with unprocessed fly ash. The rate of strength gain in geopolymer concrete with processed fly ash was higher during 4 to 8 hours the rate reduced thereafter. And the rate of strength gain in unprocessed fly ash was uniform from 4 to 24 hours during temperature curing. The alkalinity of geopolymer concrete was slightly affected by the fly ash fineness but it was similar to that of cement concrete. Curing temperature and its duration are also important in the activation of geopolymer concrete. Curing time, in the range of 6 to 24 hours, produces higher compressive strength. However, the increase in strength beyond 20 hours is not significant. The rate of gain of strength is slow at 60°C compared to strength at 120°C. However, the compressive strength beyond 120°C is not significant. The difference between compressive strength of geopolymer concrete 16 to 20 hours is not much significant. So, it should be minimizes to 16 hours for saving of consumption of energy. More than 60 MPa strength can be achieved by fly ash based geopolymer concrete in just 24 hours of curing

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 solutions. 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. He 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/m^3, thereafter the rate decreases when fly ash content is increased to 650 kg/m^3. 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/m^3, as the rate of gain of strength decreases when FA content is increased to 650 kg/m^3. 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.

A.M. Mustafa Al Bakri (Aug 2011) Studied the current knowledge about the properties and characteristics of fly ash-based geopolymer by reviewing previous research work. Fly ash-based geopolymer also provides superior performance givens its better resistance to aggressive environments compared to normal concrete. Investigations about fly ash-based geopolymer have found a potential material for replacing the use of OPC in infrastructure development. However, it must be noted that different samples of fly ash may give different reactivity due to their varying chemical compositions. The current knowledge shows that the influence of NaOH molarity, fly ash/alkaline activator ratio, Na2SiO3/NaOH ratio, and curing temperature are essential for achieving the optimum strength of geopolymer. Moreover, the durability of the fly ash-based geopolymer is better than OPC when exposed to an aggressive environment.

Rajan Bhattacharya (June 2012) Concluded that Plasticizer and super plasticizer 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. 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 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.

EXPERIMENTAL WORK:

The geopolymer concrete was design for characteristics strength of M30 grade. The mix proportion for M30 grade [13]. The cement is totally replaced by different fly ash. For the mixing of solution to fly ash ratio maintained as 0.35 for all types of curing. The alkali activators ratio i.e sodium silicate to sodium hydroxide solution ratio is 2.5. The rest period for GPC is of 7 days and curing time for concrete 18 hrs for all types of curing. The effects of processed and unprocessed fly ash on alkaline activators were studied in this paper.

THE PRELIMINARY LABORATORY WORK:

We all know that for making 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-to sodium hydroxide solution ratio by mass, higher is the compressive strength of geopolymer concrete.

CASTING AND CURING:

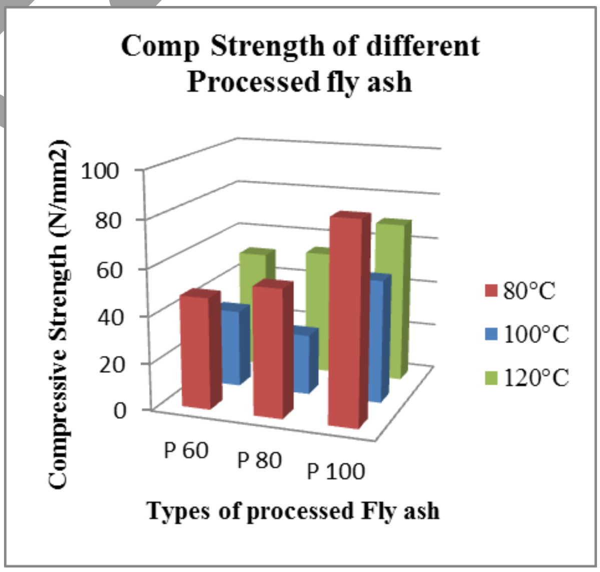
After the mixture is properly mix the material is collected in the 150×150×150 mm size cubes by using table vibrator. Immediately after casting, the samples are rest for 24 hours specimens were cured in an oven at a specified temperature of 80°C, 100°C, and 120°C for a period of 18 hrs. The specimens 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 tested on compression testing machine. 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-polymerisation. Both curing temperature and curing time directly influence final compressive strength values of geo-polymer specimens. While it has been noted that an increase of reaction time and temperature positively affect geo-polymerization, similar research shows that these factors are only an enhancement to mechanics at an early age. As reaction time increases at later ages, the curing temperature increment has a negative effect, provoking a decrease in final strength value.

RESULT AND DISCUSSION:

In this Paper, the geopolymer concrete was analyzing the processed and unprocessed fly ash with sodium hydroxide of flakes and pallets forms. The fineness of fly ash play vital role in Geopolymerization. In case of sodium hydroxide forms flakes and pallets gives a significance importance in process of polymerization.

TEST RESULT FOR DIFFERENT TYPE OF PROCESSED FLY ASH (PALLETS FORM):

The compressive strength of processed fly ash P 60, P 80 and P 100 were analyzed with different temperature 80⁰C, 100⁰C and 120⁰C. In case of P 100 the compressive strength shows the less strength as compare other fly ash.

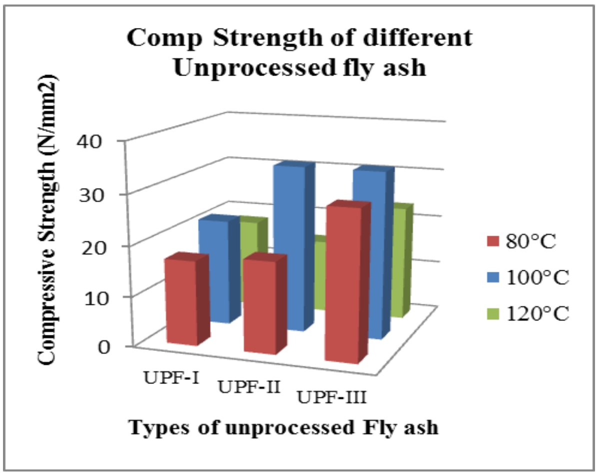


Graph no. 1: Compressive Strength of different processed fly ash

TEST RESULT FOR DIFFERENT TYPE OF UNPROCESSED FLY ASH (PALLETS FORM):

The Compressive Strength of different types of unprocessed fly ash. The unprocessed fly ash procured from bhusawal, Nashik & Beed thermal power plant. The unprocessed fly ash analyze at different temperature 80⁰C, 100⁰C and

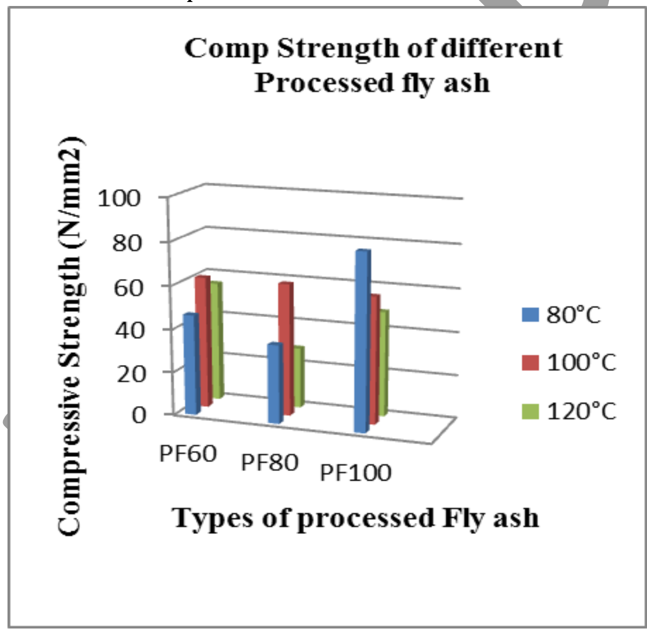
120⁰C. the compressive strength of unprocessed fly ash for pallets form of sodium hydroxide were studied. The following graph will shows the behavior of unprocessed fly ash.



Graph no 2: Compressive Strength of different unprocessed fly ash

TEST RESULT FOR DIFFERENT TYPE OF PROCESSED FLY ASH (FLEX FORM):

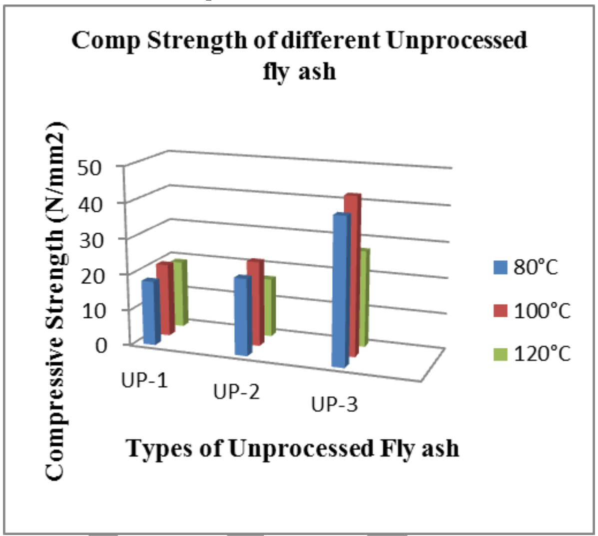
Graph 3 shows the behavior of processed fly ash on geopolymer concrete with flex form of sodium hydroxide. In oven heat curried geopolymer obtained at temperature 80 ⁰C, 100 ⁰C and 120 ⁰C.



Graph 3: Compressive Strength of different processed fly ash

TEST RESULT FOR DIFFERENT TYPE OF UNPROCESSED FLY ASH (FLEX FORM):

The graph 4 shows the compressive strength behavior of unprocessed fly ash. procured from various places. The graph shows fineness impact on compressive strength of GPC. For the polymerization the cubes were curried at 80 ⁰C, 100 ⁰C and 120 ⁰C temperature.



Graph 4: Compressive Strength of different unprocessed fly ash

CONCLUSION:

Based on investigation, the following conclusions have been drawn.

1. 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 strength 45Mpa at 100°C which is exactly near about processed fly ash-1 at 80°C. So it is economical than processed fly ash-1 with compare of cost.
2. Sodium hydroxide pallets form gives better result as compare to the flakes Form.
3. The fineness play important role in this study.
4. The compressive strength of processed fly ash is better as compare to unprocessed fly ash. because of fineness of specified fly ash.
5. For 80°C & 120°C pellets form gives the better comp strength than flaks but for 100°C flakes form gives the better comp strength than pellets form.
6. UP1 will give the optimum strength at 80°C but as temperature increases up to 100°C the strength will increases but it shows sudden down at 120°C.
7. PF 60 gives the optimum strength at 80°C as temperature increases up to 100°C the strength increases but it will suddenly decrease at 120°C because of over-heating.

The PF 60 optimum with consideration of cost and electricity consumption.

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