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RESEARCH ARTICLE

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Study on the Behavior of Fly Ash Based Geo Polymer Concrete with 20 molar NaOH Activator

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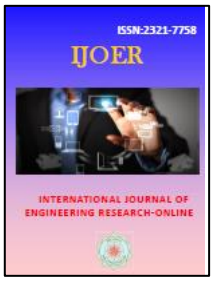

ABSTRACT
Greenhouse gas emissions are the main problem in the present scenario. The amount of Greenhouse gas emissions are increasing and CO_2 one of the greenhouse gas which effects the environment and leads to global warming. This paper deals with the alternate materials for the cement which is a green concrete (GEOPOLYMER CONCRETE) and it reduces the emission of CO_2. Fly ash is a byproduct of thermal industry which is converted into useful material. This Geo polymer concrete is a mixture of fly ash, metakaolin, sodium hydroxide (NaOH) and sodiumsilicate (Na_2Sio_3). The strength of geo polymer concrete is increased with molarity of NaOH. The 20 molarity is used in this paper. Fly ash has rich content of silica and alumina, it reacts with alkaline solution to produce aluminosilicate gel that binds aggregate to produce good content of Geopolymer Concrete. In this paper different tests are conducted to find properties such as compressive strength, flexural strength and split tensile strength for 3, 7 and 28 days for 20M.

Key words: Fly ash, Geo polymer concrete, Molarity, alkaline solution, ambient curing

1 INTRODUCTION

Now a day's content of CO_2 is increasing drastically in earth'satmosphere. There are many products which directly or indirectly emit more amount of CO_2 than permissible limit or amount which the atmosphere couldn't digest, in which our ordinary Portland cement (OPC)fall at higher rank in construction industry. In order to protect the environment, which to be done at great magnitude, necessity for alternative materials to be introduced, which is environment friendly and economical aroused in front of researchers, one of the alternative materialsis geo-polymer concrete, which can replace general or ordinary concrete and is environmentally friendly product. Not only to reduce the CO_2, but also increase the compressive strength than OPC and uses the byproduct, which in turns helps in effective disposal. The term geo-polymer was introduced by Davidovits in1978.Geopolymer is an industrial by product like flyash,bagasse ash,Lowcalcium flyash(CLASS F) was used.The curing process of Geo-polymer concrete plays a vital role in physical properties of hardened concrete. It can be done by ambient and oven curing process. In oven curing process external heat is supplied, but in practical conditions providing the entire structure external heating source is a difficult task and which is not possible. Hence in this paper we studied and found a method, where ambient curing is also as such effective as oven curing. This paper summarizes the behaviour of fly ash based

Geo-polymer concrete with the specified molarity of NaOH activator.

In this paper to study the behavior of flyash based geopolymer concrete. To understand the effect of the sequence of adding the alkaline activator to the solids constituents manually.To identify and evaluate the effect of strength properties at different ratios of alkaline activators.

2. MATERIALS USED

Following materials were used for laboratory.

- Fly ash
- Fine aggregate
- Coarse aggregate
- Alkaline liquid: Sodium hydroxide (NaOH) and Sodium Silicate (Na_2SiO_3)
- Metakaolin

2.1 Fly ash

Fly ash has been obtained from local electrostatic precipitator (ESP) hoppers of Vijayawada Thermal Power Station (VTPS), Ibrahimpatnam about 18km away from the Vijayawada City, India. The chemical composition of fly ash as supplied by VTPS authorities are given in Table 1. Based on the chemical composition, the fly ash used in this investigation comes under category of Class F (ASTM C618).

Table 1: Chemical Composition of the Fly Ash

S. No.	Name of the Chemical	% by weight
1	Silica (SiO_2)	64.08%
2	Alumina (Al_2O_3)	20.21%
3	Ferric Oxide (Fe_2O_3 + Fe_3O_4)	4.17%
4	Titanium Dioxide (TiO_2)	0.42%
5	Calcium Oxide (CaO)	6.20%
6	Magnesium Oxide (MgO)	0.91%
7	Sulfate (SO_4)	1.24%
8	Loss on Ignition (LOI)	1.07%

2.2 Coarse aggregate: The material that is retained on as IS sieve of size 4.75 is called coarse aggregate.10mm coarse aggregates are used.

2.3 **Fine aggregate:** Fine aggregate is the natural river sand. It should not contain any clay balls or harmful impurities. Silt content should not exceed 4%.

2.4 **Alkaline Liquid:** The most common alkaline liquid used in geo-polymerization is a combination of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate or potassium silicate. In this paper sodium hydroxide (NaOH) and sodium silicate activators are used. Generally NaOH has available 2 forms i.e., flakes and pellets. Flakes are used in this study.

2.5 **Metakaolin:** If the metakaolin used only purpose is easily removed specimen for even shape. So 20%metakaolin was used.

3. **METHODOLOGY**

3.1 **Preparation of Alkaline Solutions:** The molecular weight of sodium hydroxide is 40. To prepare 20M sodium hydroxide solution, 800g of sodium hydroxide flakes were weighed and dissolved in distilled water. The flakes dissolved without any residue, now remaining water is added to make 1liter solution. This NaOH should prepare before 24hours of casting. Na_2SiO_3were added to NaOH before 20min of casting and mixed thoroughly.

3.2 **Mix Design:** For 20Molarity geo-polymer mix 3 different proportions Na_2SiO_3were prepared i.e. 1:2, 1:2.5, and 1:3. The ratio of activator liquid to fly ash is 0.45.

3.3 Geo-polymer concrete preparation: The fly ash and aggregates were mixed, then the activator solution was added to it and mixing is continued till a uniformity is observed. It was found that the fresh fly ash based geo-polymer concrete mix was cohesive and dark in colour.

3.4 **Preparation of specimens:** The mix is placed in cubes of size 150mm×150mm×150mm, Beams of size 500mm×100mm×100mm and cylindrical moulds of size 150mm diameter and 300mm height.

3.5 **Curing:** The specimens were de-moulded after 24 hours of casting and kept for ambient curing at room temperature (24^0C) till the tests conducted for 3and 7 days.

4. RESULT AND DISCUSSIONS

4.1 **Compressive Strength:** Compressive strength is an essential property for all concrete as it also depends on curing time and curing temperature. When the curing time increase the compressive strength also increases. Compression tests were carried out at 3 , 7 and 28 days curried at ambient indoor room temperature. The compressive test was conducted as per IS: 516 – 1959.the results are shown in fig.1

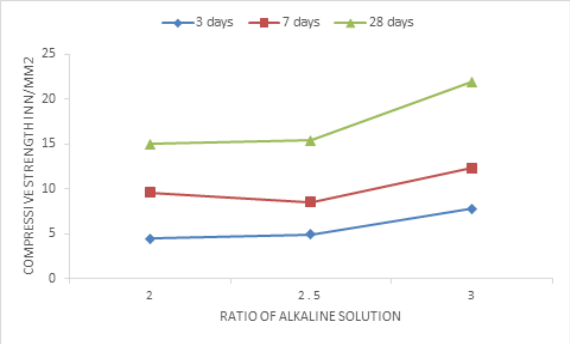

Fig.1 Compressive strength Vs. Alkaline ratio

4.2. Flexural Strength Test

Flexural test was carried out on beam specimens and load deflection curve, maximum deflection and maximum load is noted. This test was carried out on the compression testing machine as per IS: 516: 1959.the flexuralstrength results are fig.2

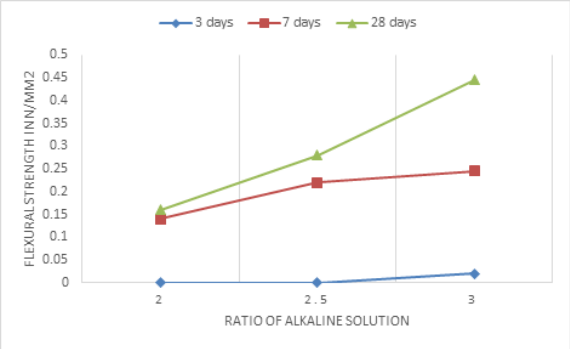

Fig.2 Flexural strength Vs. Alkaline ratio

4.3. Split Tensile Strength Test

The split tensile strength is one of the indirect tension test. This test was carried out on the compression testing machine as per IS: 5816: 1999. The split tensile strength results are given in fig. 3

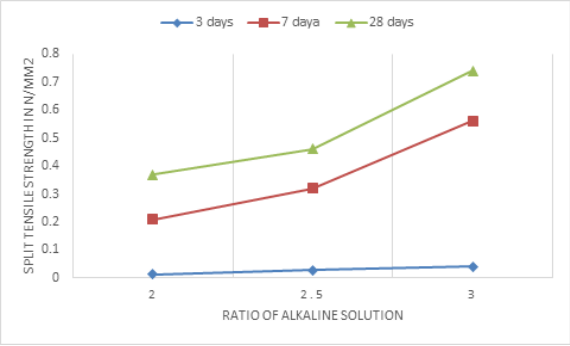

Fig.3 Split tensile strength Vs. Alkaline ratio

5. CONCLUSIONS

From the above experimental work the following conclusions are determined.

- The sodium silicate to sodium hydroxide by mass equal to 1:3 has resulted into the higher strength as compared to the ratio of 1:2 and 1:2.5 for the geopolymer concrete.
- Compressive strength of concrete increases 30% for 7days, flexural strength of concrete increases 40% for 7 days and split tensile strength 50% for 7 days when compared to 3 days strength.
- The strength of the geopolymer concrete increases with increase of concentration in terms of molarities of sodium hydroxide.
- The compressive strength of the geopolymer concrete increases with increase in the curing time.
- Geopolymer concrete does not harden immediately at room temperature as in conventional concrete. Geopolymer concrete specimens took a minimum of 3 days for complete setting without leaving a nail impression on the hardened surface. These 2 are the draw backs for geopolymer concrete to be used for practical applications.
- The fly ash can be used to produce geopolymeric binder phase which can bind the aggregate systems consisting of fine and coarse aggregate to form geopolymer concrete. Therefore these concrete can be considered as eco-friendly material

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