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FLEXURAL STRENTH ANALYSIS OF FLY ASH BASED ON GEOPOLYMER CONCRETE

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***Abstract*—The geopolymer technology was first introduced by Davidovits in 1978. His work considerably shows that the adoption of the geopolymer technology could reduce the CO2 emission caused due to cement industries. Davidovits proposed that an alkaline liquid could be used to react with alumina silicate in a source material of geological origin or in by-product materials such as fly ash to make a binder. Recently, cement utilizing became an important issue in construction industry. It is because on its production process, cement was released CO2 gases which contribute in the formed of glass house effect. In order to succeed the sustainable development mission, geopolymer materials were introduced as an alternative eco-green material. Geopolymer material is an inorganic material which contain Silica, alumina and alkaline as an activator.**

Keywords—GPC; Ecofriendly Material; Alkaline Activator; Heat curing; Flexural Behaviour.

I. INTRODUCTION

This The concern related environment-

- Large quantity of CO2 released during production of cement
- Availability of large quantity of fly ash(by product)

In this respect, the geopolymer technology proposed by Davidovits (1988) shows considerable promise for application in concrete industry as an alternative binder to the Portland cement (Duxson et al, 2007). In terms of global warming, the geopolymer technology could significantly reduce the CO2 emission to the atmosphere caused by the cement industries as shown by the detailed analyses of Gartner (2004). The objectives of the study to examine the short term engineering properties of fresh and harden fly ash based GPC, to examine the behaviour of fly ash based GPC.

I.1 PROPEERTIES OF GEOPOLYMER CONCRETE-

High-early strength gain is a characteristic of geopolymer concrete when dry-heat or steam cured, although ambient temperature curing is possible for geopolymer concrete. It has been used to produce precast railway sleepers and other pre-stressed concrete building components. The early-age strength gain is a characteristic that can best be exploited in the precast industry where steam curing or heated bed curing is common practice and is used to maximize the rate of production of elements. Recently geopolymer concrete has been tried in the production of precast box culverts with successful production in a commercial precast yard with steam curing.

I.2 OBJECTIVES-

This study is conducted to accomplish some predefined objectives.

1. To study the effect of fineness of flyash on properties of fresh geopolymer concrete.
2. To study the effect of fineness of flyash on flexural strength of fly ash based geopolymer concrete.
3. To compare compressive and flexural strength of geopolyer concrete for varying fineness of flyash.

I.3 ADVANTAGES OF GEOPOLYMER CONCRETE-

- By use of geopolymer concrete the CO2 emission get reduced.
- Geopolymer concrete is durable.
- Geopolymer concrete is cheap to produce.
- Geopolymer concrete is fire proof so that it helps in fire reduction.
- Permeability of geopolymer concrete is low.
- Geopolymer concrete is good chemical resistance material.

I.4 DISADVANTAGES-

- For geopolymer concrete curing required power.

- The workability of this concrete is less than conventional concrete.
- Geopolymer concrete is difficult to create.
- Geopolymerisation process is sensitive: This field of study has been proven inclusive and extremely volatile.

I.5 APPLICATIONS OF GEOPOLYMER CONCRETE-

- It is used for Precast concrete products like railway sleepers, electric power poles, parking tiles.
- Geopolymer concrete is used in marine structures.
- This type of concrete used where fire resistance material is required .
- In road construction, this concrete is used most of the times.
- In future construction works this going to be perform a good role.

Fig. 1- GPC Deck type bridge

II. MATERIALS

A. FLY ASH

Fly ash used in study is low calcium class F fly ash from Dirk India Private Limited under the name of product POZZOCRETE 60 , POZZOCRETE 63 , POZZOCRETE 80, POZZOCRETE 100 . The specific gravity of fly ash used is2.26. The residue of fly ash retained on 45 micrometer IS Sieve was reported as 16.84%.. In the US, fly ash is generally stored at coal power plants or placed in landfills. About 43% is recycled,[3] often used as a pozzolans to produce hydraulic cement or hydraulic plaster and a replacement or partial replacement for Portland cement in concrete production.

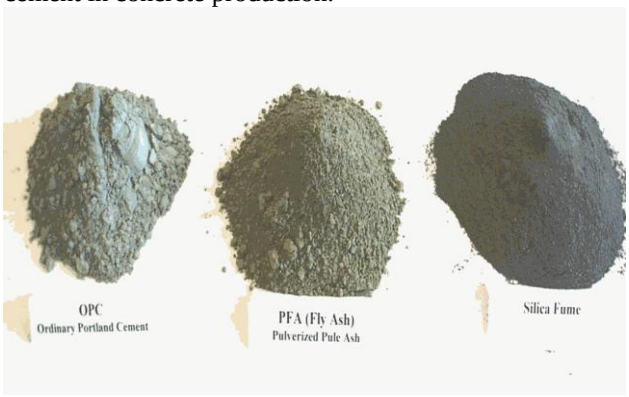

Fig-3 Fly Ash

Fly ash, also known as "pulverized fuel ash" in the United Kingdom, is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash.

2. Alkaline activator

1) Sodium Silicate

Different types of Silicates used in geopolymer concrete such as Na2Sio3, Ca_2SiO_3, K_2SiO_3 etc.

The following are different IS Code compositions used in geoplymer concrete

- $NaOH + Na_2SiO_3$,
- $NaOH + Ca_2SiO_3$,
- $NaOH + K_2SiO_3$,
- $CaOH + Na_2SiO_3$,
- $CaOH + Ca_2SiO_3$,
- $CaOH + K_2SiO_3$,
- $KOH + Na_2SiO_3$,
- $KOH + Ca_2SiO_3$,
- $KOH + K_2SiO_3$

For the present work, available sodium silicate solids either a technical grade in flakes form with a specific gravity of 2.130, is used .Available sodium silicate liquid contains Na_2O = 14.61 %, SiO_2 = 25.18% and water = 59.99 %.

B. Sodium Hydroxide

Different types of Hydrates used in geopolymer concrete such as NaOH, CaOH,KOH etc.

The sodium hydroxide (NaOH) solution was prepared by dissolving either the flakes or the pellets in water for this experiment .

II 3. Coarse aggregete

locally available coarse aggregates (CA) derived from basalt that produced a cohesive mix, a combination of 20 mm to 4.76 mm is used in the present work.

fig.4- Coarse aggregate

Physical properties of the coarse aggregate is given in the below table.

Physical properties of coarse aggregate

Specific gravity	2.64
Shape of grains	Angular
Fineness modulus	7.73

II.4 Fine Aggregates

Locally available sand is used as fine aggregate. The sand confirming to IS: 2386 (part I) 1963 is used as fine aggregate.

fig-5 FINE AGGREGATE

Physical properties of the sand is given in the below table.

Table No.3.3 Physical properties of sand

Specific gravity	2.56
Color	Gray
Shape of grains	Sub angular
Fineness modulus	3.57

III. METHODOLOGY

Mixing, Casting, and Compaction of Geopolymer Concrete.

Geopolymer concrete can be manufactured by adopting the conventional techniques used in the manufacture of Portland cement concrete.

- In the laboratory, the fly ash and the aggregates were first mixed together dry manually for about three minutes.
- The alkaline liquid was mixed and the extra water will be added, if required
- The alkaline liquid of the mixture was then added to the dry materials and the mixing continued usually for another four minutes.
- The fresh concrete could be handled up to 120 minutes without any sign of setting and without any degradation in the compressive strength.
- Then beam were casted in three layer. Each layer was compacted concrete tamping rod of diameter 10mm.
- After compacting concrete, the top surface was leveled off by using trowel and also struk the sides of mould by using hammer so as to expel air if any present inside the concrete and smoothen the sides
- The fresh concrete was cast and compacted by the usual methods used in the case of Portland cement concrete.(Djwantoro Hardjito and Vijaya Rangan, 2005, wallah and rangan , 2006 sumajouw and rangan 2006). Fresh fly ash-based geopolymer concrete was usually cohesive.

- The workability of the fresh concrete was measured by means of the conventional slump test.

Curing of Geopolymer Concrete

After one day casting beam were demoulded and placed in oven at 60^0C for 24 hours curing. After specified period of natural curing, , beams, were tested for flexural test strength . Water to geopolymer binder ratio heat curing was done for 24 hours at 60^0C in oven. After completion of respective heating duration, the oven was switched off to avoid the sudden variation in temperature; concrete beams were allowed to cool down up to room temperature in the oven for 24 hrs. After that specimen were removed from oven and then tested for flexural strength.

IV. CONCLUSION

- Strength of concrete , volume stability , durability of concrete can be increased by using geopolymer .
- Geopolymer liquid can achieve higher bonding strength than cement .
- Cost of geopolymer Concrete may be less than OPC .
- Using geopolymer concrete we can produce more durable infrastructure capable of design life measure in hundred of years .
- It can be totally eliminate the cement from concrete

V..Acknowledgment

It is the matter of great pleasure for me to present my project report on **"Flexural Strength analysis of Fly Ash based Geopolymer Concrete"** I take this opportunity to express out deepest gratitude and heartly thanks to Prof. P.B. AUTADE for his valuable suggestions and guidance during the course of my Project preparation .I am also thankful to honorable Prof. U.R. KAWADE Head of Civil Department for his several valuable comments on earlier versions of this project report. I express my heartfelt thanks and gratitude to all staff members for their moral support. Finally I wish to render thanks to all my friends of Civil Departments for their help and encouragement during the preparation of this project.

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