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STRENGTH AND DURABILITY PROPERTIES OG GEO POLYMER BRICKS

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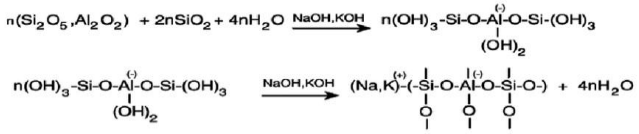
Abstract : This project deals with the experimental study to determine the strength and durability properties of geopolymer brick. This is totally clay free brick which contains granulated ground blast furnace slag (GGBS). Active alkaline liquids like sodium hydroxide (Noah), sodium silicate (Na_2SiO_3) Solutions, clay as M-Sand. Also this experiment deals with the study of fully replacement of clay by M-Sand. Also testing its compressive strength and its durability of the brick by testing with fluoride compound (fluoride attack test). Geo polymerization is a non fired process of chemical reaction between silica, alumina, calcium, magnesium, iron bearing constituents of the materials under alkaline conditions. GGBS, M sand and sodium hydroxide were mixed together then portable water was added to form an alkaline condition. The standard brick size is 190x190x90mm, the brick tests were normally conducted on 3 days, 7 days, and 21days. Durability test (fluoride test) was conducted after 90days. Different alkali molar proportions for geopolymer bricks are 2,3,4,5. In this work geo polymerization techniques were used for utilization of industrial waste like, GGBS etc. , in manufacture of high strength bricks.

Keywords— Geo-polymer, M-Sand, GGBS, Durability, NaOH, Na_2Sio_3, AAS.

INTRODUCTION

The term geo-polymer was first coined by Davidovits in 1978 to represent a broad range of materials characterized by chains or networks of inorganic molecules. Geo-polymers are chains or networks of mineral molecules linked with co-valent bonds. Geopolymer is produced by a polymeric reaction of alkaline liquid with source material of geological origin or by product material such as fly ash, rice husk ash, GGBS etc. Because the chemical reaction that takes place in this case is a polymerization process, Davidovits coined the term 'Geopolymer' to represent these binders. Geo-polymers have the chemical composition similar to Zeolites but they can be formed an amorphous structure. He also suggested the use of the term 'Poly (sialate)' for the chemical designation of geopolymers based onsilico-aluminate. Sialate is an abbreviation for silicon Oxo aluminate. Geopolymerization involves the chemical reaction of alumina-silicate oxides (Si2O5, Al2O2) with alkali polysilicatespolysilicates yielding polymeric Si–O–Al bonds. The most common alkaline polysilicates used in the geo-polymerization is the Combination of Sodium hydroxide/ Potassium hydroxide and Sodium silicate/ Potassium silicate. This combination increases the rate of reaction.

Equation 1



Equation 1 shows an example of poly condensation by alkali into poly (sialatesiloxo). The last term of Equation 1.1 indicates that water is released during the chemical reaction that occurs in the formation of geo-polymers. This water, expelled from the geopolymer matrix during the curing and further drying periods, leaves behind discontinuous Nano pores in the matrix, which provide benefits to the performance of geopolymers. The water in a geopolymer mixture, therefore, plays no role in the chemical reaction that takes place; it merely provides the workability to the mixture during handling. This is in contrast to the chemical reaction of water in a Portland cement mixture during the hydration process. Unlike ordinary Portland/pozzolanic cements, geo-polymers do not form calcium silicate- hydrates (C-S-H) for matrix formation and strength, but utilize the polycondensation of silica and alumina precursors and a high alkali content to attain structural strength. Therefore, geo-polymers are sometimes referred to as alkali activated alumino silicate binders. Ease of Use.

OBJECTIVES

- Alternative of soil bricks.
- Conserve land used for disposal of coal and combustion products.
- Resistance against chemical attack.

To produce a carbon dioxide emission free cementious material

- An environmentally pollution free construction material.
- To reduce carbon-di-oxide emition by replacing OPC from GPC.

SCOPE OF THE PAPER

- Development of high strength Geopolymer bricks manufactured with silicates and hydroxides of potassium.
- Investigations on the effect of varying percentage of reinforcement on flexural and shear capacity of Geopolymer brick.
- Shear strengthening of Geopolymer bricks with fibre wrapping.
- Study on the addition of various fibres in Geopolymer bricks and their effect on enhancement of strengths.
- The flexural behaviour of Geopolymer bricks including Flexural strength, crack pattern, deflection, and ductility.
- The behaviour and strength of reinforced Geopolymer bricks subjected to axial load and bending moment.

MATERIALS USED

1. Ground Granulated Blast Furnace Slag (GGBS).

It is an industrial waste material which is obtained from quenching molten iron from a blast furnace in water or steam. It is highly cementitious and high in calcium silicate hydrates which improves the strength and durability of the concrete. The main components of blast furnace slag are CaO (30-50%), SiO_2 (28-38%), Al_2O_3 (8-24%), and Mg (1-18%). In general increasing the CaO content of the slag results in raised slag basicity and an increase in compressive strength.

2. M-Sand.

This is also known as manufactured sand which is a replacement for normal river sand. Manufactured sand is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm.

3. Alkali Activated Solutions.

a)Sodium Hydroxide (NaOH).

b) Sodium Silicate (Na_2SiO_3).

4. Water.

METHODOLOGY

The methodology adopted to achieve above objectives comprise of following steps.

1) Raw materials

- GGBS
- M-SAND
- WATER
- ALKALI ACTIVATIES

2) Mixing of materials

3) Preparation of solution

4) Place the mixture in mould

5) Compact it by tamping

6) Demoulding

7) Place it for drying

- In the present study we are using concrete mould of size (190X190X90) mm.
- In this manufacturing process includes different proportion of fly ash, GGBS, M-Sand and alkali activators like (NaOH and N_2sio_3**)** that are sodium silicate and sodium hydroxide. Will be fed into mixer where water will be added in the required proportion for homogeneous mixing.
- The proportion of raw materials may vary depending upon quality of raw materials.
- The process of mixing of $NaOH+Na_2SIO_3$ to the GGBS and M-Sand in production of eco-bricks is termed as "**Alkali activation technology**".
- Alkali activated solutions are prepared based on the molarities, in this we adopted 2M,3M,4M and 5M concentrations.
- After mixing, the materials will be poured into the mould and compact the materials by tamping rod and then moulds are kept to dry by sunlight for 2 to 3 days.
- There after they are transported to open area where they are cured for 10 to 14 days.
- Also the bricks with some proportions are oven dried and different lab tests are carried out to compare the strength parameters and quality with the conventional bricks.

RESULTS AND DISCUSSION

COMPRESSION TEST

Compression test is that the main and vital for bricks

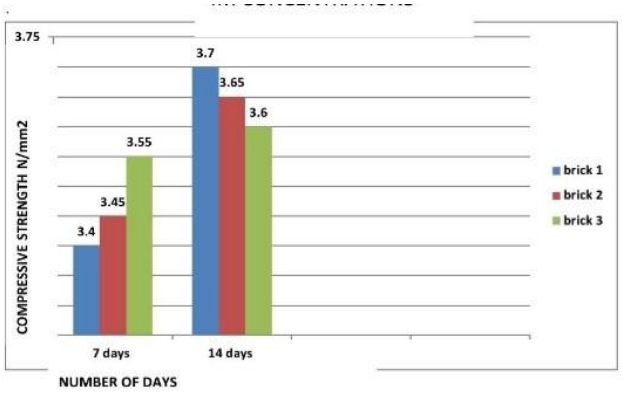
- This test was dispensed by a compression testing machine (CTM).
- This test was carried out on the 7, 14th, and days from the date of casting.
- It had been discovered while testing the specimens that the bricks didn't crush or fully collapse, it simply compressed like compressing a rubber, the

structure didn't collapse. Only the outer faces cracked and raw out.

FOR 2 MOLAR CONCENTRATIONS

No of days	Brick number	Weight in (kg)	Compressive strength (N/mm²)	Average compressive strength
7 days	1 2 3	3.39	2.5 2.6 2.5	2.53
14 days	1 2 3	3.28	2.7 2.65 2.7	2.68

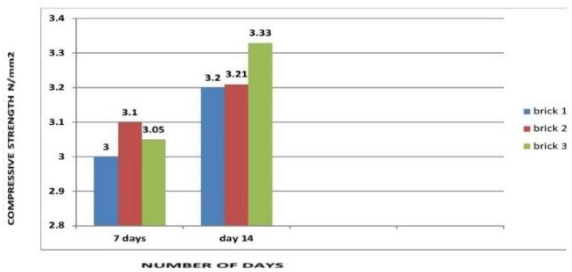
TESTS RESULTS FOR COMPRESSIVE STRENGTH ON 2 MOLAR CONCENTRATIONS



FOR 3 MOLAR CONCENTRATIONS

No of days	Brick in no	weight (KG)	Compressive strength (N/mm²)	Average compressive strength
7 days	1 2 3	3.39	3.0 3.1 3.0	3.03
14 days	1 2 3	3.23	3.2 3.2 3.3	3.23

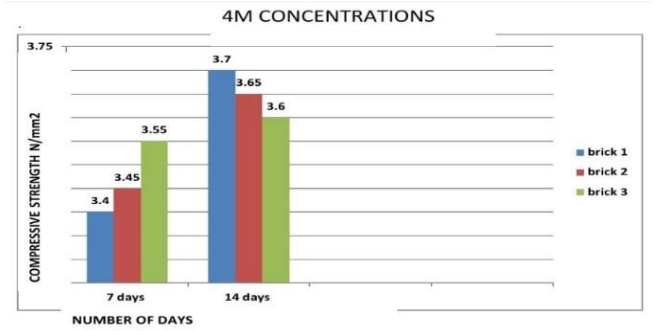
TEST RESULT FOR COMPRESSIVE STRENGTH ON 3 MOLAR CONCENTRATIONS



FOR 4 MOLAR CONCENTRATIONS

No of days	Brick number	Weight (kg)	Compressive strength (N/mm²)	Average compressive strength
7 days	1 2 3	3.25	3.4 3.45 3.4	3.41
14 days	1 2 3	3.21	3.7 3.65 3.6	3.65

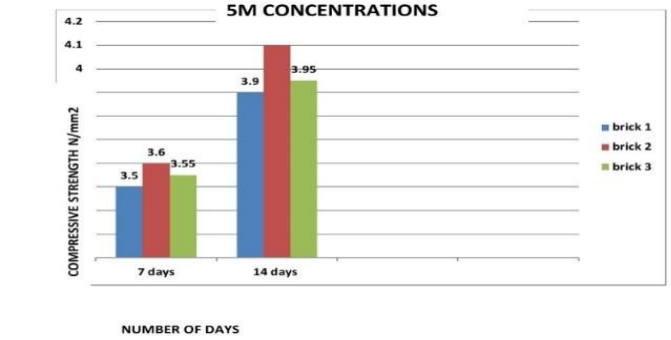
TEST RESULT FOR COMPRESSIVE STRENGTH ON 4 MOLAR CONCENTRATIONS



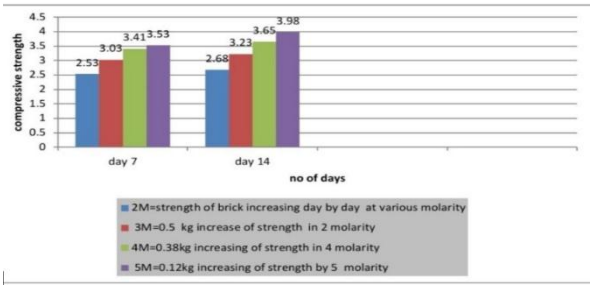
5 MOLAR CONCENTRATIONS

No of days	Bricks no.	Weight in (Kg)	Compressive strength (N/mm²)…	Average compressive strength
7 days	1 2 3	3.30	3.4 3.6 3.5	3.53
14 days	1 2 3	3.21	3.9 4.1 3.95	3.98

TEST RESULT FOR COMPRESSIVE STRENGTH ON 5 MOLAR CONCENTRATIONS



COMPARISSION BETWEEN COMPRESSION STRENGTH ON DIFFERENT MOLARITIES



FLUORIDE ATTACK

Durability test (fluoride attack); fluoride attack on concrete it eats holes in concrete, dissolve metals and causes damages in the structure.

Electro chemical DC cycle polarization and polarization resistance, surface, topographic and X-ray diffraction technology have been used to investigate the effect of fluoride ion on the corrosion behavior of the material.

Under all the conditions of the exposures it is observed that low content of fluoride less than or equal to 25ppm in the corrodent as deleterious action on the performance of the steel where as in its higher content more than or equal 100ppm the ions as rather an inhibiting effect on corrosion rate.

CONCULSION

On the basis of the results and discussions of this investigation the following conclusions can be drawn.

GGBS can be used as base materials to produce Geopolymer reactions using sodium hydroxide and sodium silicate based for +activator solution.

- These bricks can be used for load bearing and non-load bearing walls.
- The process is burning free, hence environmental is not polluted.
- These bricks are not required for curing, hence water will be saved.
- These bricks are absorbing water not more than the convention bricks.
- The compressive strength is more than 3.5N/mm^2.

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