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EXPERIMENTAL INVESTIGATION ON FLY ASH BASED GEOPOLYMER CONCRETE

THIYAGARAJ S[1], GOKULRAM H[2], Karthick B[3]

[1]PG Student, Dept. of Structural Engg, CSI College of Engineering, Tamil Nadu, India,
[2]Associate Professor, Dept of Structural Engg, CSI college of Engineering, Tamil Nadu, India,
[3]Head of the Department, Dept. of Structural Engg, CSI college of Engineering, Tamil Nadu, India,

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Abstract: *The most important construction material is cement, which acts as the binding agent in cement and water. High amount of CO_2 and other greenhouse gases are released due to the manufacture of cement many efforts are taken*

To overcome this problem, by using industrial wastes or by-products such as silica fume, fly ash, GGBS, etc… of geopolymer concrete has to replacement of cement in the construction industry. The geopolymer concrete is a type of binder manufactured using materials like fly ash, which is rich in silica, aluminum, and activated by alkaline liquids. It can also be carried as a concrete. The current paper deals with the usage of geopolymer binder replacing cement, which saving energy, protecting the environment etc…

KEYWORDS: Geopolymer, Fly ash, Ground Granulated Blast-furnace Slag (GGBS), Polypropylene fiber, compressive strength, split tensile strength, flexural strength.

1. INTRODUCTION

Due to its versatile applications. Large number of cement is manufactured in India and china. In 1978, davidovits proposed that a binder could be produced by a polymerization process. Silicon aluminum in amorphous form which come from natural minerals. geo polymers do not form calcium silicate hydrates. The sodium hydroxide in the form of tiny granules with 98% purity and water glass (na2o=14.7% sio2=29.4% and H2O=55.9%). The production of 1 tons of cement directly generator 0.55tonnes of chemical co2 Concrete is one of the essential materials for the infrastructure development and requires the consumption of carbon fuel to yield an addition 0.40tonnes of co2

A. Fly Ash

Fly ash is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Depending upon the source and composition of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2), aluminum oxide (Al_2O_2) and calcium oxide (CaO), the main mineral compounds in coal bearing rock strata.

Two classes of fly ash are defined by ASTM C618: Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silica, alumina, and iron content in the fly ash.

B. GGBS

Ground Granulated Blast-furnace Slag is obtained by quenching molten iron slag (a by-product of iron and steel- making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. GGBS is highly cementations and high in calcium silicate hydrates which is a strength enhancing compound which increases the strength, durability and appearance of the concrete.

C. Polypropylene fiber

Polypropylene is a thermoplastic polymer used in a wide variety of application. Polypropylene fiber is a light weight synthetic fiber is formed from a polypropylene melt. Is generally superior to polyamide fibers in elasticity and resiliency, but it has lower wear resistance. It prevents crack formation and provides reinforcement to the concrete structure. It displays good heat- insulating properties and is highly resistance to acids, alkalis, and organic solvents.

D. Alkaline solution

The alkaline liquid was a combination of sodium silicate solution and sodium hydroxide solution. The sodium silicate solution is in liquid form it available from suppliers. The sodium hydroxide (NaOH) in flakes or pellets from with 97%-98% purity .The sodium hydroxide (NaOH) solution was prepared by dissolving either the flakes or the pellets in water. The mass of NaOH solids in a

solution varied depending on the concentration of the solution expressed in terms of molar, M. The molecular weight of NaOH is 40. For this, volumetric flask of 1 litre capacity is taken, NaOH flakes are added slowly to distilled water to prepare 1litre solution. For example to prepare 8M of NaOH solution 320g of NaOH flakes are weighed and they can be dissolved in distilled water to form 1 litre solution. In order to improve the workability of fresh concrete, high-range water-reducing naphthalene based super plasticizer was used.

2. MATERIALS AND MIX PROPORTIONS

The materials used for the preparation of concrete mix are cement paste, coarse and fine aggregates, water, super plasticizers and water. The ratio of alkaline solution to binder in M1, M2, and M3 is 0.45. And the ratio of sodium hydroxide to sodium silicate is 1:2.5.

The mix proportions of geopolymer concrete composites are given in table 1

TABLE -1: Mix proportion for M_{40} Grade of FBGP concrete (kg/m^3)

MIX	BINDR	BINDER		F.A	C.A	WATER	SODIUM HYDROXIDE (16M)	SODIUM SILICATE
		F.A	GGBS					
M1	100%F.A,0 % GGBS	394.3	0	646.8	1201	96.58	45.06	112.64
M2	50%F.A, 50%GGBS	197.1	197.5	646.8	1201	96.58	45.06	112.64
M3	0%F.A,100 %GGBS	0	394.3	646.8	1201	96.58	45.06	112.64

3. EXPERIMENTAL SETUP

Cube of mould size 150mm x 150mm x 150mm, cylinders of mould size 100mm x 300mm and beam mould of size 100mm x 150mm were cast and cured.

4. TESTS ON CONCRETE

A. Basic Tests On Materials

Specific gravity test was done on fine and coarse aggregates using pycnometer. The fineness modulus was calculated using sieve analysis test.

The impact test was done to determine the toughness using impact testing machine, abrasion test was done using Los Angeles abrasion machine. The consistency of cement was found using Vicat's Apparatus. The results of these tests are tabulated in Table-III.

B. Tests On Fresh Concrete

The workability of fresh concrete is measured using the Vee Bee Consist meter apparatus. This test is used to measure the change in the concrete shape from slump cone to cylinder by mode of vibration.

C. *Tests On Hardened Concrete*

Compressive strength

Compressive Strength test of concrete cubes of specimen 150mmx 150mm x 150mm are used. These specimens are tested by Universal Testing Machine (UTM) after 7 days and 28 days. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimen's fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Flexural strength

Flexural Strength test of concrete beams of specimen 150mm x 150mm x 700mm are used as per Indian standard. These specimens are tested after 14 days and 28 days. The following expression is used for estimation of modulus of rupture.

M R=3PL / 2 bd2 (N/mm2)

Where,

M R: Modulus of Rupture

P: ultimate applied load indicated by testing machine

L: Span length

b: average width of the specimen

d: average depth of the specimen

Split tensile strength

Split Tensile Strength test of concrete cylinder of specimen 150mm x 300mm are used. These specimens are tested by after 7 days and 28 days. Calculate the splitting tensile strength of the specimen as follows:

ft = 2P / ΠDL(N/mm2)

Where,

ft = splitTensile strength of concrete (N/mm2)

P = load applied (N)

D = diameter (mm)

L = effective span (mm)

5. RESULTS AND DISCUSSION

- The Vee Bee times for plain concrete, M1.M2.and M3 is 7s, 8s, 9.1s, and 12.5s.
- In this study, mechanical properties such as compressive strength, spilt tensile strength, and flexural strength were investigated.
- The results of the basic tests, compressive strength, flexural strength and split tensile strength are shown in Tables –II, III, and IV below.

A. BASIC TEST ON MTERIALS

Table-II: Basic tests on materials

S.NO	PROPERTIES	VALUE
1	Specific gravity of coarse aggregates	3.5
2	Specific gravity of fine aggregates	3.07
3	Fineness modulus	2.25
4	Impact value	14.9%
5	Abrasion value	34
6	Consistency of Fly ash	32%

B. COMPERSSIVE STRENGTH

Table-III: Compressive Strength value

COMPERSSIVE STRENGTH (N/mm²)			
Mix Ratio	7 days	14 days	28 days
M1	27.31	37.04	43.50
M2	25.23	35.23	41.50
M3	28.23	37.55	43.85

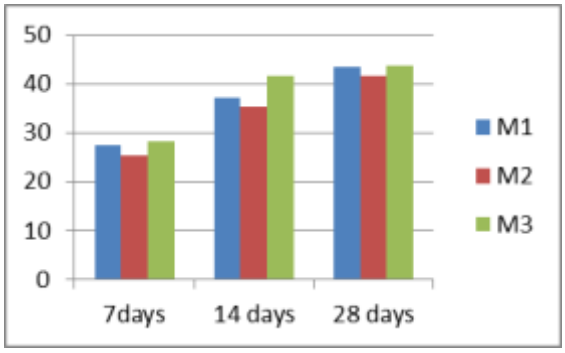

Chart- 1: Compressive Strength

C. FLEXURAL STRENGTH

Table-IV: Flexural Strength value

FLEXURAL STRENGTH (N/mm²)			
Mix Ratio	7 days	14 days	28 days
M1	5.25	5.5	5.75
M2	4.50	5.25	5.5
M3	4.95	5.45	5.85

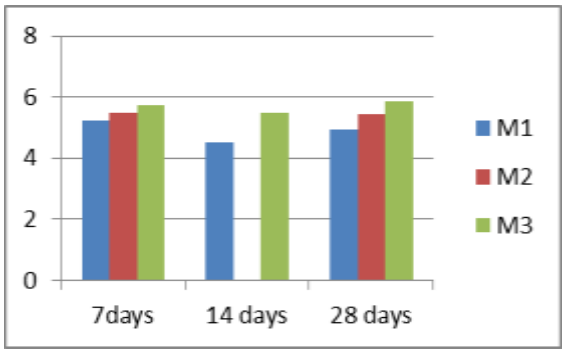

Chart- 2: Flexural Strength

D. SPLIT TENSILE STRENGTH

Table-V: Split tensile Strength value

SPLIT TENSILE STRENGTH (N/mm²)			
Mix Ratio	7 days	14 days	28 days
M1	2.3	3.15	3.5
M2	2.15	2.95	3.2
M3	2.35`	3.24	3.6

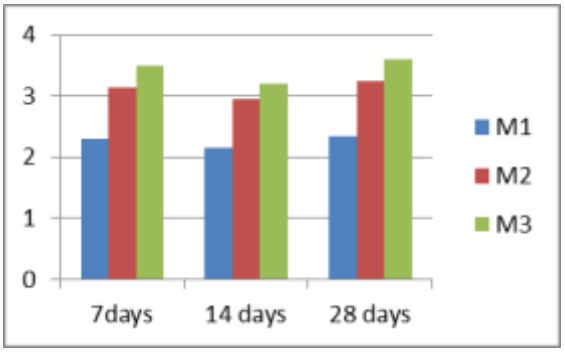

Chart- 3: Split Tensile Strength

6. CONCLUSIONS

1. The characteristics strength of concrete such as compressive strength, Flexure strength, and Split tensile strength of geopolymer concrete mixtures have been studied in present work by replacing of cement by fly ash and GGBS along with Activated Alkaline solution. On the basic of present study, following conclusions can be drawn.

2. Test is carried out on sample as above for 7, 14, and 28 days, as per prevailing standards for respective properties.

3. The test results have shown that Compressive strength increases more than conventional concrete.

4. Flexural strength of M40 grade FBGC increases over conventional concrete by 1.38 times

5. Split tensile strength of M40 grade FBGC increases over conventional concrete by 1.38 times.

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