AN EXPERIMENTAL STUDY ON THE BEHAVIOUR OF FIBER REINFORCED CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH FLYASH & GGBS

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***Abstract*— In last few decades, the construction activities have increased many folds in almost all the developing countries of the world. Cement is becoming a scarce commodity globally because of its growing demand day by day. Also, the production of cement from industries emits CO2. The production of 1ton of cement emits approximately one ton of CO2 and it is responsible for 65% of global warming.This research was experimentally carried out to investigate the properties of Fly Ash (FA) and Ground Granulated Blast Furnace Slag (GGBS) when used as a partial replacement for cement (OPC) in concrete at varying percentage of admixtures by weight of cement for M40 Concrete mix Comparison done on experimental study on workability and compressive strength on concrete after 7, 14 and 28 days of curing.**

Keywords— ***Ground Granulated Blast Furnace Slag (GGBS), flyash, Compressive Strength, Split Tensile Strength, Flexural Strength, Workability.***

I. INTRODUCTION

Concrete plays an important role in the construction industry. Concrete is the most Widely used and versatile building materials which is generally used to resist compressive force by addition of some pozzolanic materials, the various properties of concrete viz, workability, durability, strength resistance to cracks and Permeability can be improved. The term concrete refers to a mixture of aggregates, usually sand, and either gravel or crushed stone, held together by a binder of cement paste. The paste is typically made up of Portland cement and water and may also contain supplementary cementing materials, such as fly ash or slag cement, and chemical admixtures. Many modern concrete mixes are modified with addition of admixture, which improve the microstructure as well as decrease the calcium hydroxide concentration by consuming it through a pozzolanic reaction. Replacement of cement leads to cost savings; energy required to process these materials is also much lower than cement. Environmental damage and pollution is minimized by the use of these by-products.

This publication covers the materials used in concrete and the essentials required to design and control concrete mixtures for a wide variety of structures.The concrete industry has recognized the need to monitor concrete workability to ensure that concrete can be properly placed and can achieve adequate hardened strength. A myriad of test procedures for determining workability have been developed for research, mix proportioning, and field use.With the exception of the widely used slump test, the few methods that have been studied extensively have generally failed to gain widespread acceptance. Even with the increase in knowledge of concrete.Slump test remains the predominately used test method for measuring concrete workability.

II. OBJECTIVE

- To study the behaviour of Fiber Reinforced concrete with partial percentage replacement of GGBS and Fly ash as cementitious materials
- Look into the feasibility of application of replaced concrete in structural elements
- To evaluate the optimum mix proportion of fiber concrete with fly ash replaced in various percentage by GGBS.
- To reduce the environmental pollution caused by cement and to produce a “Green Concrete”.

III. MATERIALS USED AND THEIR PROPERTIES

1. Cement-OPC 53 grade
2. Fly ash
3. Ground granulated blast furnace slag (GGBS)
4. Aggregates
   i. Fine aggregate
   ii. Coarse aggregate
5. Jute Fiber
6. Water

A. Fly Ash

Fly ash or flue ash, also known as pulverized fuel ash is a coal combustion product that is composed of the particulates 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 (SiO2) (both amorphous and crystalline), aluminum oxide

(Al2O3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.

TABLE I. PROPERTIES OF FLY ASH

SNo.	Property	Value
1	Specific Gravity	2.44
2	Fineness	227.8 g/m2
3	Fineness Modulus	5
4	Density	1029.7 Kg/m3

Properties of Fly Ash:

- Improving workability without increasing water requirements.
- Increase the pump-ability of concrete and life cycle expectancy.
- Resistance to corrosion of concrete reinforcement, sulphate, acid, salt and alkali-silica reaction attack.
- Increased durability.
- Reduced efflorescence.
- Higher strength.
- Decreased permeability

B. GGBS

Ground-granulated blast-furnace slag (GGBS or GGBFS) 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.The main components of blast furnace slag are CaO (30-50%), SiO2 (28-38%), Al2O3 (8-24%), and MgO (1-18%).

TABLE II. PROPERTIES OF GGBS

S No.	Property	Value
1	Specific Gravity	2.58
2	Fineness	202.7 g/m2
3	Fineness Modulus	7
4	Density	2067.06 Kg/m3

C. FIBER

Jute Fiber is 100% bio-degradable and recyclable and environmentally friendly. Non-Metallic fiber controls the micro shrinkage cracks developed during hydration, making the structure plaster component inherently stronger. Further, when the loads imposed on concrete approach that of failure cracks will propagate, sometimes rapidly. Addition of metallic fiber to concrete will improve the strength of concrete.

TABLE III. PROPERTIES OF JUTE FIBER (FROM MANUFACTURE)

Diameter	0.6 mm
Fiber length	20mm
Density	1460kg/m3
Tensile Strength	400-800 Mps
Stiffness	1020 Kn/mm2

Coarse Aggregate in concrete

Aggregate are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. The aggregate occupy 70-80 percent of concrete. The aggregates which are used for the project is crushed angular type. The size of the aggregates used is 20 mm. The aggregates were cleaned well in water and dried well in air before used for concrete mix.

Role of Sand

The properties of a specific concrete mix will be determined by the proportion and type of and used to formulate the concrete. Sand is usually a larger component of the mix than cement.

Water in Concrete

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully.

Preliminary Test

From the preliminary test, properties of various ingredients used in Basalt Fiber reinforced concrete are used studied.

Test of Fine Aggregate

- Fineness Modulus
- Specific Gravity
- Bulk Density

Test of Coarse Aggregate

- Fineness Modulus
- Specific Gravity
- Bulk Density
- Water absorption

Test on Cement

- Fineness Modulus
- Specific Gravity
- Consistency
- Setting time
- Soundness

Test on Fine Aggregate

a. Fineness Modulus

From sieve test analysis,
Fineness modulus=2.75
Zone of fine aggregate: Zone II As per IS Code 383-1970

b. Specific Gravity of Fine Aggregate

From the pycnometer test,

Specific gravity of sand = (W2 – W1) / [(W2 – W1) – (W3 – W4)
Specific Gravity of fine aggregate = 2.65

c. Bulk Density of Fine Aggregate
Bulk density = mass/volume
Compacted Bulk Density = 1711 kg/m3

Test for Coarse Aggregate
a. Sieve Analysis
Fineness modulus=7.38

b. Specific Gravity of Coarse Aggregate
S.G of 20mm Aggregate = 2.77

c. Bulk Density of Coarse Aggregate
Bulk density = Mass / Volume
Volume of cylinder = 3.18X10-3 m3
Loose Bulk density = 1491 kg/m3
Compacted Bulk density = 1642 kg/m3

Test on Cement
a. Fineness Test of Cement
Weight of Cement
% of fineness =(Weight of residue / Weight of Cement) x 100
% of fineness = 1.0

b. Determination of Specific Gravity of Cement
By Chatelier flask test, Specific Gravity = (W2-W1) / [(W2-W1) - (W3-W4)] x 0.79
Where, W1 = Weight of Empty Flask
W2 = Weight of Flask + Cement
W3 = Weight of Flask + Cement + Kerosene
W4 = Specific Gravity of Kerosene

TABLE IV. SPECIFIC GRAVITY OF CEMENT

S.No.	Observation	Weight (kg)
1	Weight of Cement (gm.)	64
2	Weight of Kerosene displace (ml)	20.3
3	Specific Gravity of Cement	3.15

c. Standard Consistency of Cement
Percentage of Water, P = wx100/c.

TABLE V. STANDARD CONSISTENCY OF CEMENT

S.No	Weight of Cement (g)	Quantity of Water Added (ml)	Percentage of water to weight of cement	Penetration of Plunger from bottom (mm)
1	400	112	28	30
2	400	116	29	24
3	400	124	31	14
4	400	128	32	7

Consistency of Cement = 32%

d. Setting Time of Cement :
By Vicat Apparatus test

Initial Setting Time = 35 min.

IV. MIX PROPORTIONS

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design.

The compressive strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing.

a. Mix Proportion Designations
The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios of cement, fine and coarse aggregates.
Trial mixes with suitable adjustments till the final mix proportions are arrived at was arrived at.

TABLE VI. MIX PROPORTION

Water	Cement	Fine Aggregate	Course Aggregate	Conplast SP430G8
142 Liters / m3	355 Kg / m3	834 Kg / m3	1184 Kg / m3	3.55 Kg / m3
0.40	1	2.35	3.20	

MIX RATIO
1: 2.35 : 3.20

V. RESULTS AND DISCUSSIONS

In this chapter, results and discussion based on the experimental investigation carried out on the compressive, flexural strength, tests on fibre reinforced concrete were presented.

a. Compressive Strength Test
From the test results, it was observed that the maximum compressive strength was obtained for mix with 30% GGBS and 30% flyash.

TABLE VII. COMPRESSIVE STRENGTH TEST RESULTS

Mix	Jute Fiber (%)	Compressive Strength N/Mm2	
		7th Day	28th Day
Nominal	-	19.50	42.55
Fly Ash(30%)	0.5	17.09	38.97

Ggbs(30%)	0.5	24.85	46.32

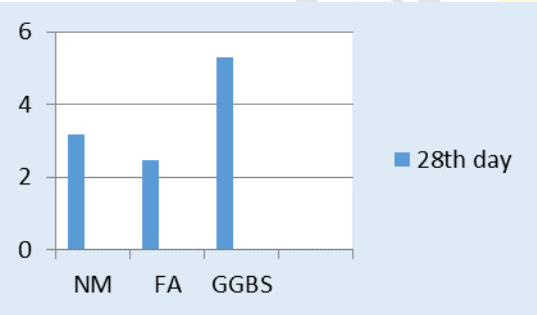
Fig 1: Bar chart of Compressive stress fibre reinforced Concrete

b. Flexural Strength Test

The results of flexural strength of concrete at the age of 28 days are presented in Table. It is observed that when the percentage of GGBS increases, the flexural strength of concrete also increases. On the contrary, the strength decreases when the percentage of flyash increases.

TABLE VIII. FLEXURAL STRENGTH VALUES OF FIBRE REINFORCED CONCRETE

Mix	Jute Fiber (%)	Flexural strength (N/mm2)
		28th Day
Nominal	-	3.16
Fly Ash(30%)	0.5	2.47
Ggbs(30%)	0.5	5.28



Fir 2: Bar chart of Flexural strength for Fibre Reinforced Concrete

VI. CONCLUSIONS AND SCOPE FOR FUTURE WORK

a. Conclusions

Based on the experimental investigation the following conclusions are listed below:

- From the test results, it was observed that the maximum strength was obtained for mix with 30% GGBS and 30% flyash.
- As the strength of concrete increases, there is decrease in the average value of Poisson's ratio.
- The Modulus of elasticity values increases with increase in compressive strength of fibre reinforced concrete.

b. Scope For Future Work

- Studies can be made on its durability properties.
- Fiber reinforced composites may be considered a solution to improve flexural strength and fracture toughness.
- Different structural elements like fibre reinforced Concrete Beam, Fibre Reinforced Concrete Columns, Reinforced Beam Column joints shall be cast for the above mentioned concentrations curing conditions and tested.

REFERENCES

[1]. Tamilarasan V.S (2012), "workability studies on concrete with ggbs as a Replacement material for cement with and Without superplasticiser", International journal of advanced research in engineering and technology, Vol. 3, Issue 2, pp. 11-21

[2]. Concrete Technology – Theory and Practice by M.S. Shetty.

[3]. IS: 10262-2009 Concrete mix proportioning-Guidelines