EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT BY GGBS

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Abstract - One of the main ingredients used for the production of concrete is the Ordinary Portland Cement (OPC). Carbon-dioxide (CO_2) gas which is a major contributor in greenhouse effect and the global warming, is produced in the production of cement, hence it is needed either to search for another material or partially replace cement by some other material. In recent years Ground Granulated Blast Furnace Slag (GGBS) when replaced with cement has emerged as a major alternative to conventional concrete and has rapidly drawn the concrete industry attention due to its cement savings, energy savings, and cost savings, environmental and socio-economic benefits. GGBS is the waste product of iron industry. Portland cement was partially replaced by 5%, 10%, 15%, 20% and 25% of GGBS. The specimens are curing at the ages of 28 days and tested for compressive strength.

Index Terms - Portland Cement, Ground Granulated Blast Furnace Slag (GGBS)

1 INTRODUCTION

1.1 General

Concrete is probably the most extensively used construction material. The present paper focuses on investigating characteristics of M25 grade concrete with partial replacement of cement with GGBS by replacing cement via 5%, 10%, 15%, 20% and 25%.

1.2 GGBS (Ground Granulated Blast furnace Slag)

GGBS is a vitrified substance which is a by product of iron production in a blast furnace.

It consists primarily of oxides of calcium, silicon, aluminum and magnesium. Although normally designated as "GGBS.

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1.3 STRUCTURE OF GGBS

Ground Granulated Blast furnace Slag (GGBS) [1] is a byproduct from the blast furnaces used to make iron. These operate at a temperature of about 1500 degrees centigrade and are fed with a carefully controlled mixture of iron ore, coke and limestone. The quenching optimizes the cementitious properties and produces granules similar to coarse sand. This "granulated" slag is then dried and ground to a fine powder.

2 OBJECTIVES

GGBS can be used in concrete to improve its strength.

To minimize the overall environmental effects of concrete production using GGBS as partial replacement.

2.1 SCOPE

Use of GGBS as Cement replacement simultaneously reduces cost of concrete and help to reduce rate of cement consumption.

2.2 LITERATURE REVIEW

Abeer M. Humad, Ankit Kothari, John L. Provis and AndrzejCwirzen (2019) The aim of this study was to determine the effects of partial fly ash

substitution in to a series of alkali-activated concrete based on a high-MgO blast furnace slag BFS. The results showed that, an increase in the fly ash content extended the initial setting time but had very little effect on the final setting time.

AissaBouaissi, Long-yuan Li, Mohd Mustafa Al Bakri Abdullah, Quoc-Bao Bui (2019) This paper presents an experimental investigation on the mechanical properties and microstructure of geopolymer concrete mixed using class F fly ash (FA), ground granulated blast-furnace slag (GGBS) and high-magnesium nickel slag (HMNS). It was found that the replacement of FA with 20% of GGBS and 10% of HMNS in GP concrete increases the 28-day compressive strength by 100% and the 28-day splitting tensile strength by 58%.

Ananthi.A, KishoreKumar.A, ManojKumar.K, Vetriselvan.K (2018) Workability test was carried out on fresh properties of concrete. It is found that the partial replacement of helped in improving the strength of the concrete substantially compared to normal mix concrete. Compressive strength test was carried out for 7, 14 and 28 days.

3 METHODOLOGY AND MATERIAL TESTING

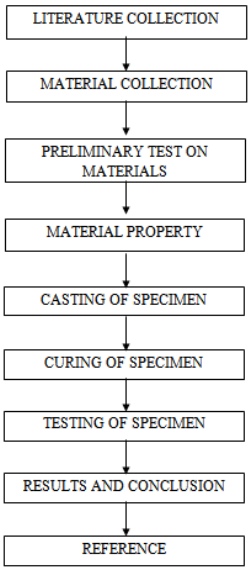

Fig 1: Flow chart

4 MATERIAL USED

4.1 CEMENT

Cement in concrete acts as a binding material that harden after the addition of water. It plays an important role in construction sector. Various tests were performed on cement they are: Specific Gravity test, Initial and final setting time.

4.2 AGGREGATE

The crushed granite stone with a maximum size of 12 mm, and specific gravity 2.65 was used as coarse aggregate. Both fine aggregate and coarse aggregate used conform to IS: 383-1970.

4.2.1 FINE AGGREGATE

The material which passes through BIS test sieve number 4 is termed as fine aggregate usually natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregates.

4.2.2 COARSE AGGREGATE

The material which is retained on BIS test sieve number 4 (4.75mm) is termed as coarse aggregate. The broken stone is generally used as a stone aggregate. Coarse aggregate used is locally available crushed angular aggregate of size 20mm and 10mm are used for this experimental work.

4.3 WATER

Portable water is generally considered fit for making concrete. Water reacts chemically with the cement to form a cement paste in which inert aggregate are held in suspension until cement paste are hardened.

4.4 GGBS

Being a byproduct and waste using it effectively up to some extent serves as a step for a greener environment and at the same time keeping in mind that the strength of the concrete does not degrades by the usage GGBS. (Furnaces from Steel plants) Effectively concentrating on both the factors have been successful up to a good extent and thats what

we CIVIL ENGINEERS are very keen about in the present era of construction.

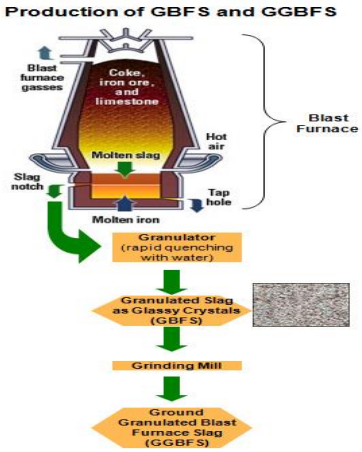

Fig 2 GGBS

5 EXPERIMENTAL WORK

5.1 MIXING:

In general, the aggregate component of a concrete or mortar mix is usually several times that of the cement. A strong concrete mix would be something like 1:3:5 (Cement, Sand, Coarse Gravel).

5.2 CASTING:

i. Clean the moulds and apply oil.
ii. Fill the concrete in moulds in layers approximately 5cm thick.
iii. Compact each layer with not less than 35 strokes per layer using a tamping rod.
iv. Level the top surface and smoothen it with a trowel.

5.3 CURING:

- The first batch of 9 test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the moulds and kept submerged in clean fresh water until taken out prior to test.
- The next batch of 9 test specimens is casted and stored in moulds for 24 hours after demoulding the first batch. After this the specimens are removed from the moulds and kept submerged in clean water until taken out prior to test.

Fig 3 Curing

6 RESULT AND DISCUSSION

6.1 COMPRESSIVE STRENGTH TEST ON CUBES

Procedure of Compressive Test:

1. The specimens from water before 30 minutes of testing.

2. Remove any loose sand or other material from the surface of the specimens and let them dry.

3. Clean the bearing surface of the compression testing machine.

4. Now place the cube in the testing machine in such a manner that the load is applied o the opposite sides of the cubes.

5. Align the axis of the specimen with the centre of thrust of spherically seated platen.

a. Apply the load increasingly at a rate of 140 kg/cm² per minute until the cube collapse.

b. Note down the maximum load applied to the specimen and any other unusual activities at the time of failure.

6.2 Calculation:

$$\text{Compressive strength of concrete} = \frac{\text{Maximumloadappliedtothecubes}}{\text{c/s area of cube}}$$

Compressive strength at different curing days of cube: Dimension of Specimen in mm – 150 x 150 x 150mm

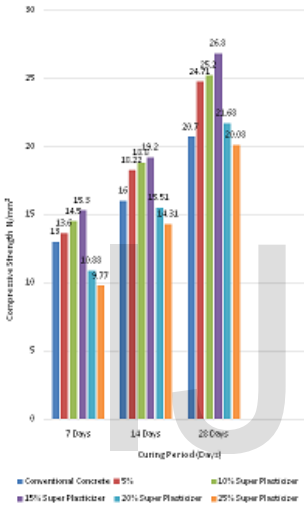

Fig 4: Compression Tension Strength

6.3 BEAM

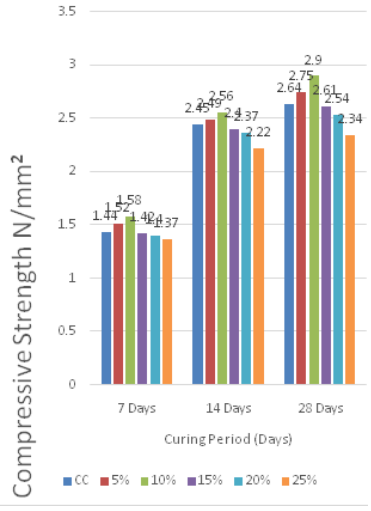

Fig 5: Split Tensile Strength Test

7 CONCLUSION

- The sample concrete cube increases its compressive strength upto adding 15% of GGBS and on further it decreases.
- The sample concrete beam increases its Split tensile strength upto adding 10% GGBS and on further it decreases.
- It helps in reducing the pollution in environment.

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