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Suitability Study of GGBs Incorporated M20 Grade Cement Concrete for Partial Replacement of Cement

KEYWORDS: GGBS slag, Cement, Material Test

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ABSTRACT *Concrete plays an important role in the construction industry and cement is the main ingredient of concrete which makes the binding in between fine aggregate and coarse aggregate. The production of cement results in emission of many greenhouse gases in atmosphere, which are responsi¬ble for global warming. Hence, the researchers are currently focused on use of waste material having cementitious properties, like GGBS (ground granulated blast furnace slag) Rice husk ash, which are easily available in market which can be added in cement concrete as partial replacement of cement, without compromising on its strength, stability and durability, which will result in decrease of cement production and reduces global warming, thus reduction in emission in greenhouse gases, in addition to sustain¬able management of the waste. The GGBS is a waste product from the iron manufacturing industry, which may be used as partial replacement of cement in concrete due to its inherent cementing properties. This paper presents an experimental study of compressive strength of M20 grade of concrete. Jawergi sand from Bheema river is taken as fine aggregate which is black in color and was allowed to pass from 4.75mm of IS sieve. Cubes were cast with Ordinary Portland Cement, partially replaced by ground granulated blast furnace slag in different proportions varying 0% 15% and 30%. Curing period was taken as 3, 7 and 28 days. It is observed from the investigation that the strength of GGBS incorporated concrete is inversely proportional to the % of replacement of cement with ground granulated blast furnace slag.*

I. INTRODUCTION

Mixture of cement, coarse aggregate, fine aggregate and water in an appropriate proportion is a concrete. As the fine aggregate is easily available in local area of Gulbarga from bheema river of jawargi which is allowed to pass from 4.75mm sieve size and 20mm size of coarse aggregate, opc of 53 grade ultratech (syed barey agency of ultratech cement)which is allowed to pass from 90 micron sieve and which is used in concrete of this experiment. As the cement production results in emission of many greenhouse gases in atmosphere, which are responsible for global warminghence the waste materials coming from industries like GGBS can be partially replaced with cement to make the binding property with concrete. In this experiment, M20 grade of concrete with proportions of 1:2.03:3.3 with water cement ratio of 0.55 is taken. the replacement of cement with GGBS is made varying 0%, 15%, and 30%. This can increase workability in less curing period and increases strength in longer period of curing. in this experiment 3, 7, and 28 days of curing has been studied.

It is concluded that 20% replacement is possible without compromising the compressive strength of concrete with 90 days of curing [1] On replacement of OPC with 15% GGBS the depreciation in 28 day compressive strength is being near about 5%[2] The partial replacement of OPC with GGBS improves the workability but causes a decrease in the plastic density of the concrete [7]

II. AIMS AND OBJECTIVE:

The aim of this experimental study is to reduce the production of cement by using industrial waste materials like GGBS by replacing partially as admixture in concrete. By providing longer period of curing the compressive strength of concrete will increase compere to normal concrete. I this experiment GGBS has been partially replaced by cement varying 0%, 15%,and 30% with 3,7 and 28 days of curing has been taken and compressive has been tested.

III. METHEDOLOGY

The GGBS is a by-product in the manufacture of iron and the amounts of iron and slag obtained are of the same order. Iron ore, coke and limestone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500°C to 1600°C. After the molten iron is tapped off, the remaining molten slag, which consists of mainly siliceous and aluminous residue is then water-quenched rapidly, resulting in the formation of a glassy granulate. This glassy granulate is dried and ground to the required size, which is known as GGBS. The GGBS required in this study obtained from steel plant of Bangalore. The GGBS which is used passes, 90% through 90 micron sieve. The aim of this work is to ascertain the performance of concrete mix containing GGBS as replacement of OPC and to compare it with the plain concrete mix of M20 grade of concretes. The chemical composition of GGBS is obtained from X-ray analysis at laboratory and

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is shown in Table – 1.

Table – 1: Chemical Composition of GGBS

Constituents	%
SiO_2	34.4
Al_2O_3	21.5
Fe_2O_3	0.2
CaO	33.2
MgO	9.5
K_2O	0.39
Na_2O	0.34
SO_3	0.66

The cement is a material that has cohesive and adhesive properties in the presence of water, consist primarily of silicates and aluminates of lime. The OPC (53 Grade) of ultratech (taken from syed barey cement agency) is used for this study. The fine aggregate are material passing through an IS sieve that is less than 4.75 mm gauge beyond which they are known as coarse aggregate. The main function of the fine aggregate is to provide workability and uniformity in the mixture. The fine aggregate uses in this study is locally available river sand of Jawergi Gulbarga district which conforms to zone II. The coarse aggregate form the main matrix of the concrete, whereas fine aggregate form the filler matrix between the coarse aggregate. The maximum size of aggregate used in this study is 20 mm. The coarse aggregate is confirmed by IS 383:1977 and is 20 mm maximum size. The cement, fine and coarse aggregates required for experimentation are tested in the laboratory and the results are shown in

Table – 2 : Properties of OPC, Fine and Coarse Aggregate

Properties	Value
(a) Cement	
Specific gravity	3.10
Initial setting time	75 min
Final setting time	360 min
(b) Fine Aggregate	
Specific gravity	2.61
Water absorption	1%
Fineness modulus	4.84
(c) Coarse Aggregate	
Specific gravity	2.72
Water absorption	0.5%
Fineness modulus	2.83

IV. EXPERIMENTAL PROGRAMS

The cement concrete mix is prepared as per the procedure given in the IS 10262:2009. For optimal dosage selection of GGBS in concrete mix, modified cubes (percentage 0% 15% and 30%) are prepared and compared with plain cement concrete cubes with mix proportion of 1:2.03:3.3 are prepared of M20 grade of concrete. The replacements of OPC with GGBS are made on an equal weight basis. The w/c ratio is taken 0.55%,for all the mixes. The result of mix design of the concrete is shown in Table – 3.

Particulars	Plain concrete mix	15%	30%
Cement in kg/m3	348.32	296.072	243.824
Sand in kg/m3	709.47	709.47	709.47
Coarse aggregate in kg/m3	1156.4	1156.4	1156.4
GGBS in kg/m3	0	52.248	104.496
Water in kg/m3	191.58	191.58	191.58

Table – 3: Mix Specification for 1 m3

Concrete

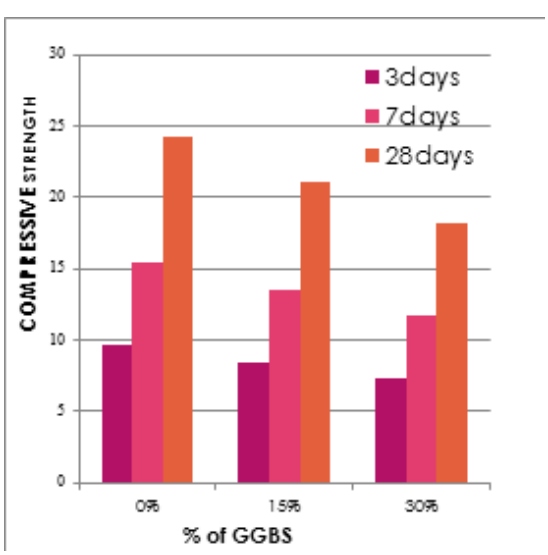
in this investigation 27 cubes specimen are tested. The Cubes with the dimension of 150 x 150 x 150 mm are prepared for each batch of mixes to measure compressive strength and of concrete respectively at the age of 3 days, 7 days and 28 days of curing.

All the specimens are kept in water tank for curing and thereafter tested as per BIS norms and standard. All the cube specimens are tested for compressive strength in compression testing machine (CTM).

V. RESULT AND DISCUSSION

Concrete Types	Compressive Strength		
	3 Days	7 Days	28 Days
100%OPC	9.69	15.45	24.18
15%GGBS 85%OPC	8.45	13.52	21.04
30%GGBS 70%OPC	7.36	11.74	18.21

Fig-1Graphical representation of compressive strength



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The compressive strength of cement concrete containing various % of GGBS at the age of 3,7, 28 days are given in Table4

VI. CONCLUSIONS

The main aim of the study is to obtain the suitability of GGBS as replacement of OPC in concrete. The results of compression test are shown in graphical form in Figure – 1. It may be observed from the plots that the properties of concrete can be maintained with GGBS as partial replacement of cement but strength will not increase more than normal concrete.

* The increase in % of GGBS results in decrease in strength of concrete.
- The reduction in the cost of concrete will be there
- The partial replacement of OPC in concrete by GGBS, not only provides the economy in the construction but it also facilitates environmental friendly disposal of the waste slag which is generated in huge quantities from the steel industries.

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