Behaviourof Ground Granulated Blast Furnace Slag Infilled Concrete Column with Different End Conditions

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Abstract— **The production of cement results in emission of many greenhouse gases in atmosphere, which are responsible for global warming. Hence, the researchers are currently focussed on use of waste material having cementing properties, which can be added in cement concrete as partial replacement of cement, without compromising on its strength and durability, which will result in decrease of cement production thus reduction in emission in greenhouse gases, in addition to sustainable management of the waste.**

Ordinary Portland cement concrete is used for making the various civil structures. In India, about 7.8 million tons of GGBS is produced per year. Portland cement can be replaced by Ground Granulated Blast Furnace Slag (GGBS).The utilization of supplementary cementitious materials is well accepted because of the several improvements possible in the concrete composites, and due to the overall economy. This report introduces studies and the properties of ground granulated blast furnace slag (GGBS). As concrete being important constituent in construction industry, improvements need to be done in concrete. Use of GGBS improves the quality of concrete. In recent years 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

Index Terms—**strength, durability.**

I. INTRODUCTION

Concrete is primarily comprised of Portland cement, aggregates, and water. Although Portland cement typically comprises only 12% of the concrete mass, it accounts for approximately 93% of the total embodied energy of concrete and 6% to 7% of the worldwide CO_2emissions.If concrete is mixed with ground granulated blast furnace slag as a partial replacement for Portland cement, it would provide environmental and economic benefits and the required workability, durability, and strength necessary for the design of the structures. Ground granulated blast furnace slag from modern thermal power plants generally does not require processing prior to being incorporated into concrete and is therefore considered to be an environmentally free input material.

In the country like India, where the development of the infrastructures projects such as large irrigation, road and building projects are either being constructed or in completion of their planning and design stage, such uses of waste material in cement concrete will not only reduce the emission of greenhouse gases but also will be the sustainable way of management of waste. Columns are the basic parts of a many engineering structures.

The columns majorly take the axial loads and try to resist the bending caused due to the applied axial loads In this paper the maximum deflections and maximum stresses are compared with the three columns with varying percentage of GGBS also with different end conditions.

II. MATERIALS AND METHODS

1. GGBS

Ground Granulated Blast Furnace Slag (GGBFS) is a byproduct of the steel industry. GGBFS is produced when molten slag isquenched rapidly using water jets, which produces a granular glassy aggregate. Thus Ground Granulated Blast Furnace Slag is advantageous over various other cementing materials. The composition of blast-furnace slag is changed depend on the ores, fluxing stone and impurities in the coke feed into the blast furnace. Normally, silica, calcium, aluminum, magnesium, and oxygenare more than 95% in the composition of the blast-furnace slag. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging.

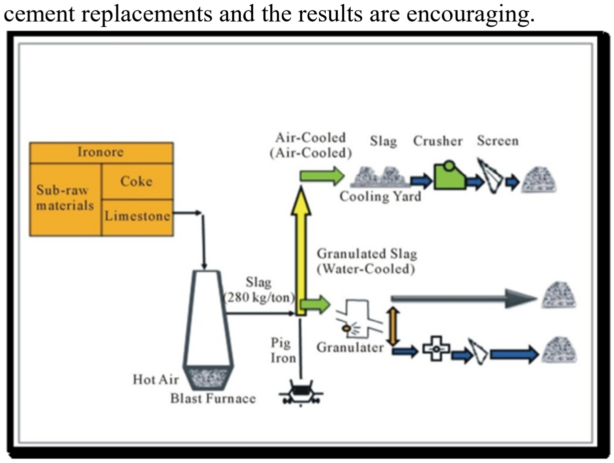

Fig.1 Manufacturing Process of GGBS

1.1 Typical physical properties:-

Table 1.Typical physical propertiesof GGBS.

Colour	off white
Specific gravity	2.9
Bulk density	1200 Kg/m^3

Fineness	350 m^2/kg

1.2 Chemical Composition Of GGBS

The chemical composition of a slag varies considerably depending on the composition of the raw materials in the iron production process.

Table 2.Typical chemical composition of GGBS.

Constituents	%
SiO2	34.4
Al2O3	21.5
Fe2O3	0.2
CaO	33.2
MgO	9.5
K2O	0.39
Na2O	0.34
SO3	0.66

2. Cement

The cement used in this experimental work is "Ulttratech 53 grade Ordinary Portland Cement". All properties of cement are tested by referring IS 12269 - 1987 Specification for 53 Grade Ordinary Portland Cement.

3. Fine Aggregate

River sand confirming to IS 383-1970 is used. Various tests such as specific gravity, water absorption, sieve analysis etc. have been conducted on C.A. to know their quality & grading.

4. Coarse Aggregate

About 20 mm size of coarse aggregate is used for concrete preparation. tests such as specific gravity, water absorption, impact strength, crushing strength, etc. have been conducted on C.A. to know their quality.

5. Water

In ferrocrete, the water used for mixing cement mortar should be fresh, clean and fit for construction purposes; the water of pH equal or greater than 7 and free from organic matter such as silt, oil, sugar, chloride and acidic material

II. PREPARATION OF MIX

The grade of concrete used in the present study is M25. The mix design of the concrete is carried as per the specific code IS 10262 – 2009.

III. EXPERIMENTAL WORK

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 ranging from 25% to 75%) are prepared and compared with plain cement concrete Cubes and Columns.

In this investigation 21 cubes and 72column specimen are tested. The Cubes with the dimension of 150 x 150 x 150 mm and columns with dimension of 150 x 150 x 750 mm are prepared for each batch of mixes to measure compressive strength of concrete respectively at the age of 7 days, 28 days curing.

Table 3.Casting Details

Sr. No.	Section	Size	No. of Sections			
			Normal Concrete	GGBS Concrete		
				0-25%	25-50%	50-75%
1	Cube	150 X 150 X 150	3	3	3	3
2	Cube	150 X 150 X 150	3	3	3	3
3	Column	150 X 150 X 750	9	9	9	9
4	Column	150 X 150 X 750	9	9	9	9

V. TESTING OF SPECIMEN

The Columns were removed from curing period of 28 days. Columns were tested for Compressive strength under universal testing machine with different end conditions. The compressive strength of concrete column with diff percentage of GGBS is found out. This chapter gives a brief overview of the casting of specimens, test set-up and testing procedures

Fig.2 Testing of Column

VI. RESULTS AND DISCUSSION

The experimental study on the behaviour of column with GGBS concrete under reversed lateral loading. The specimens tested were of reinforced concrete with and without GGBS.

Table 4.Average Compressive Result

SR NO.	CEMENT %	GGBS %	Average Compressive strength (N/mm2)	
			7 days	28 days
1	100	0	22.95	34.81
2	50	50	7.18	46.04
3	40	60	21.68	39.14
4	30	70	18.88	32.23
5	20	80	17.58	28.93

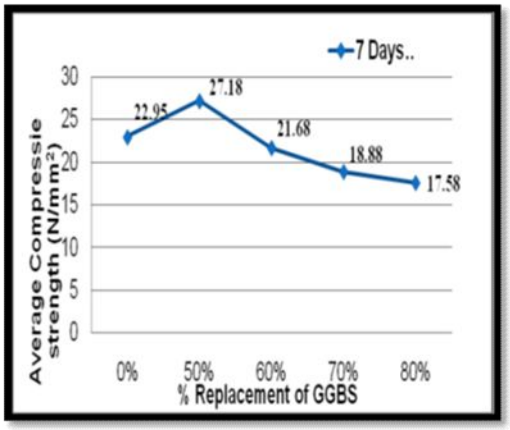

Fig.3 Test Result at 7 Days

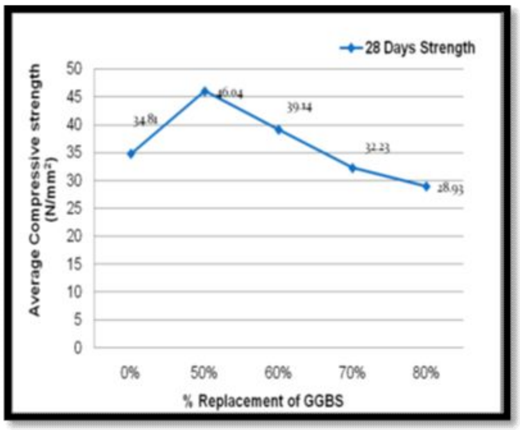

Fig.4 Test Result at 28 Days

VII. CONCLUSION

This study was primarily concerned with the evaluation the efficiency of GGBS in concretes containing normal Portland cements from the results of the investigation sported in recent years. The replacement levels in the concrete studied varied from 25% to 75% and the strength efficiencies at the 7 days and 28 days were calculated. The primary conclusions can be listed as follows Slag replacement by weight decreases the strength of concretes in short term when compared to control Portland cement concrete. However, in long term, concrete containing slag exhibits an equivalent or a greater final strength than that of control normal Portland cement concrete. The strength loss caused by increasing slag replacement level is more evident at early ages. However, the strength loss disappears in long term and, concrete containing slag develops equivalent or higher strength than that of control normal Portland cement concrete.

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