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Using GGBS, An Experimental Investigation of Concrete Characteristics Was Conducted (Ground Granulated Blast Furnace Slag)

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Abstract: ***Ground Granulated Blast Furnace Slag is a waste product formed during the iron-making process. It has an off-white colour and cementitious characteristics similar to cement. As a result, supplement materials are good for the environment, as cement production emits a lot of carbon dioxide. As a result, supplement material is always sought. This page is about the compressive strength of M40 concrete (Design mix) made of Ordinary Portland cement (Dalmia) 53 garde, with GGBS partially replaced in 0 percent, 15%, 20%, and 25% proportions, and more.***
Keywords: GGBS, OPC, Mix-Design, and compressive strength are among of the terms used in this paper.

I. INTRODUCTION

Concrete, as we all know, is a common building material made up of cement, sand, coarse aggregate, and water. As a result, it plays an important role in the development of civilization, concrete has been utilised since ancient civilizations, with the only modification being the binding agent. To increase cement setting conditions, some people used lime, then added volcanic ash or old bricks and tiles. Later on, we switched to Portland cement. Cement production or manufacturing is a high-energy process that produces a large amount of greenhouse gases, which are known to be harmful to the environment. Thus, the utilisation of waste material in the most commonly used material, concrete, has substantial positive environmental effects, but the waste must be of a type that possesses cementitious qualities, such as cement. It can be partially replaced and the properties do not differ significantly. Many studies are being conducted in order to conserve the environment, since many pollutants will be minimised, and garbage will be appropriately utilised. In this picture, we have ground granulated blast furnace slag (GGBS), which is a waste byproduct from the iron-making sector and has a very similar composition to cement. GGBS is a by-product that is considered a waste, as we all know. GGBS is made in a blast furnace in the iron-making industry, when molten iron slag is quenched in water.

The method of selecting appropriate ingredients of concrete and determining their relative amount with the intention of producing a concrete of the necessary strength durability and workability as efficiently as possible is termed the concrete mix design. The level of quality control is often an inexpensive cooperation and depends on the concrete by adding the several other economical and waste material as a partial substitute of cement. In this study, attempt is made to study the properties of concrete after using GGBS partially for M40 grade of concrete cubes.

II. LITERATURE REVIEW

Experimental results demonstrated that GGBS offers better resistance to weight loss than fly ash, according to Sonali K. Gadpalliwar, R. S. Deotale, and Abhijeet R. Narde. with GGBS Replacement of 15%, 20%, and 25%, which offers good M40 grade strength results, and in varying proportions of partial replacement by GGBS for 7 days, 21 days, and 28 days. According to the findings, GGBS concrete has a higher early strength.

In comparison to conventional concrete, the results of GGBS concrete are superior than conventional concrete after 28 days.

J.Vengadesh Marshall Raman , V.Murali Krishnan(2014) combined GGBS with cement with partial substitution of OPC with GGBS of 15%, 20%, and 25% for a mix design of M40 for 7 days and 28 days.

Kishan Lal Jain(2015) incorporated the blast furnace slag which is waste product from iron industry. They used it as partial replacement of cement n concrete as it has cementititous property. They prepared several proportions ranging from 0% to 40% partial replacement by GGBS. It is observed 25% replacement of cementis optimum without compromising much the compressive strength at 28 days.

D. Suresh and K. Nagaraju (2015) The topic deals with the usage of GGBS and advantages as well as disadvantages in using it in concrete. This usage of GGBS serves as replacement to already depleting conventional building materials and the recent years and also as being a by product it serves as an Eco Friendly way of utilizing the product without dumping it on ground.

V. Vinod, B. Susheel(2015) Concrete cubes were prepared by replacing the cement with GGBS in three different proportions (15%,20%,25%). The cubes casted with the above proportions have been tested for the compressive strength and the values obtained were compared with those of control specimens at the end of 7, 14 and 28 day curing periods. They concluded increase in the compressive strength at 28 days.

III. MATERIALS

A. Cement

For all combinations, Dalmia cement of grade 53 Ordinary Portland Cement (OPC) was utilised for casting cubes. The cement has a consistent colour and is free of lumps. Table 3.1 lists the OPC attributes that were utilised.

Table 1: Experimental Cement Properties

Particulars	Experimental Results	Limits are Results(IS : 8112-2013)
Specific Gravity	3.18	-
Initial Configuratioon Time	70min	A minimum of 30 minutes
Last But Not Least	300min	A maximum of 600 minutes

B. Fine Aggregates (F.A.)

The sand is locally procured and conforms to Zone II of grading as per IS 383-2016. The specific gravity of sand is 2.65. And the water absorption is found to be 1.27%.

Table 2: Properties of F.A.

Properties of F.A.	Results
Specific Gravity	2.65
Grading Zone	2
Water absorption	1.28%

C. Coarse Aggregate (C.A.)

The coarse aggregate utilised is locally available and has a maximum size of 20mm C.A. has a specific gravity of 2.6. And 0.6 percent of the water is absorbed.

Table 3: C.A Characteristics and Specific Result Properties

Properties of C.A.	Results
Specific Gravity	2.6
Maximum Size	20mm
Water absorption	0.6

D. Ground Granulated Blast Furnace Slag (GGBS)

GGBS is sourced from the Bokaro Steel Plant in the Jharkhand district of Bokaro. It has an off-white colour, as depicted in the illustration..

Figure 1: GGBS and Materials

E. Water

Water from the tap is used.

IV. RESEARCH AND EXPERIMENTATION PROGRAMME

The cement concrete design mix is made according to the technique outlined in IS 10262:2009. Cubes are made in the right proportions, ranging from 0% to 25% GGBS, and then compared to traditional concrete cubes. The partial replacement is carried out on the basis of weight. The mix proportions are 1:1.6136:2.8099, with a w-c ratio of 0.45 for all blends. The result of the concrete mix design (for 1 m3) is displayed in table 4. 1

Design Grade= M40

1) Type of cement= OPC53 (Birla super)
2) Maximum nominal size of aggregate= 20mm
3) Minimum cement content =360Kg/m^3 (IS456:2000)
4) A maximum water-to-cement ratio of 0.40 is required (IS456:2000)
5) Extreme exposure condition
6) non-pumping method of concrete placement
7) .Method of concrete placing=non pumping
8) Degree of supervision= Good
9) Type of aggregate = Crushed angular aggregate
10) Workability= 75 (IS456:2000)
11) Maximum cement content=450Kg/m^3(IS456:2000)
12) Chemical admixture=No
13) Specific gravity of cement=3.18
14) Specific gravity of river sand= 2.68
15) Specific gravity of course aggregate=2.6

Table 4: Mix For Compressive Strength

Particulars	Plain Cement Concrete	15%	20%	25%
Cement (kg/m^3)	413.33	380	350.67	295.34
Sand (kg/m^3)	680.96	680.96	680.96	680.96
Coarse Aggregate (kg/m^3)	1170.44	1170.44	1170.44	1170.44
GGBS (kg/m^3)	0	47.33	82.66	118.99
Water (kg/m^3)	186	186	186	186

Here, 27 cubes are put to the test. The compressive strength of the concrete mix is determined for 7 days, 21 days, and 28 days of curing using cubes with dimensions of 150mm x 150mm x 150mm. All of the cubes are put through rigorous testing in accordance with IS criteria and standards. Hand-operated Compression Testing Machine is used for testing (CTM).

Figure 2: Casting of cubes, beam and cylinder

V. RESULTS

Table 5.shows the compressive strength of concrete cubes with various proportions of GGBS partial replacement of cement at the ages of 7 days, 21 days, and 28 days with M40 grade concrete and OPC 53 grade..

Table 5: Compressive Strength Of Mix

Replacement Percentage	Compressive Strength (N/mm2)		
	7 days	21 days	28 days
0	18.31	22.71	35.62
15%	20.63	28.68	37.62
20%	25.25	32.61	39.56
25%	30.62	35.42	42.58

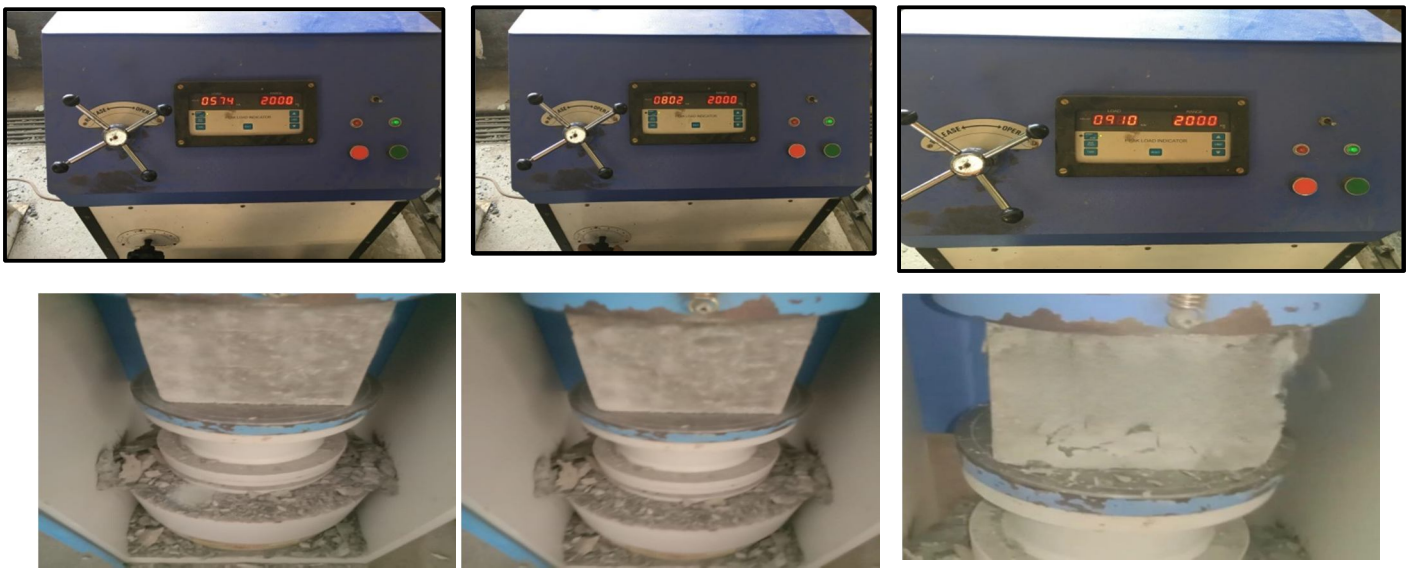

Figure 3: Testing Of Cubes On CTM

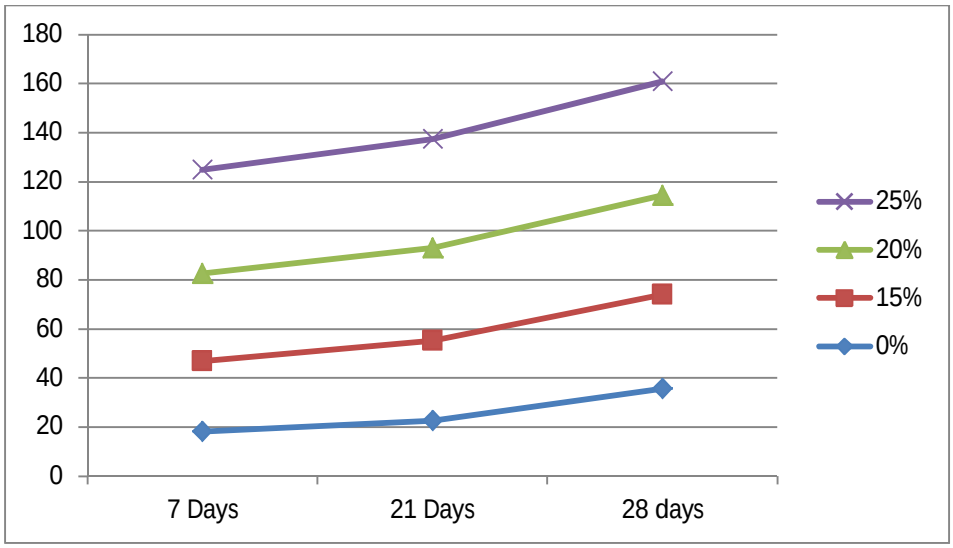

Figure 4: Graph of Compressive Strength at 7 Days,21 Days and 28Days

VI. DISCUSSION

This study aims to find the most suitable partial replacement of cement by GGBS, with several proportions ranging from 0% to 15%, 20% to 25%, and compressive strength calculated after 7 days, 21 days, and 28 days, with the results displayed in a column chart. The results show that 25% partial replacement of cement by GGBS is the most suitable for the goal, with little impact on compressive strength in comparison to t. (0 percent GGBS). As a result, according to the study, the best replacement rate in M40 grade concrete is 25% without affecting compressive strength too much**.**

VII. CONCLUSION

We learned about GGBS and their applications in concrete as a result of the project.GGBS substitution enhances compressive strength higher than normal concrete cubes, according to compression tests.According to the study and investigation, partial replacement of cement with GGBS in concrete boosts the performance of the member exponentially when compared to traditional approaches. The compressive strength of concrete diminishes as the amount of GGBS in the mix increases,however partial replacement of 25% is acceptable because the compressive strength is comparable to conventional concrete.

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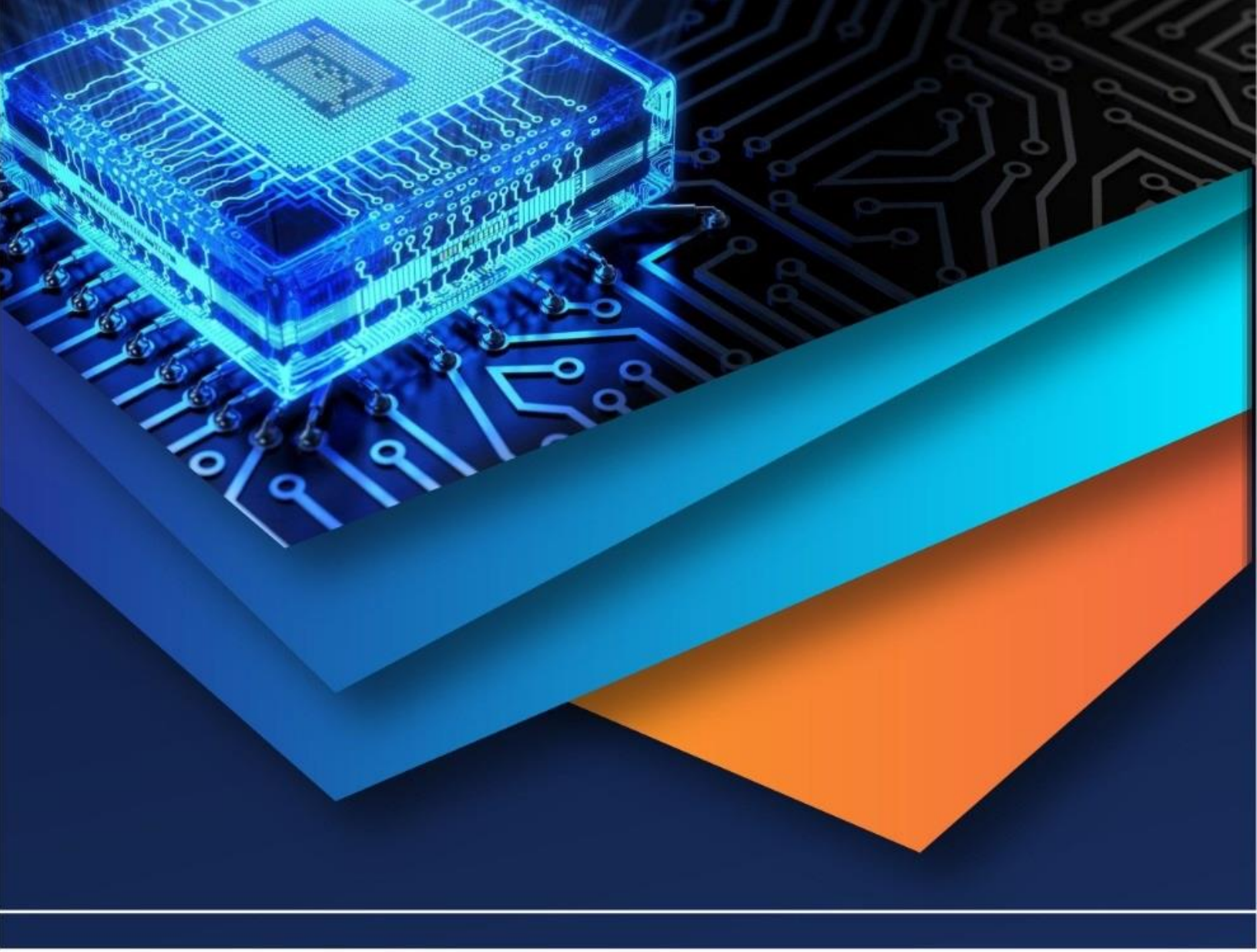

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