iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** VI **Month of publication:** June 2018

DOI: http://doi.org/10.22214/ijraset.2018.6271

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VI, June 2018- Available at www.ijraset.com

Study on Properties of Cement Concrete by Partially Replacing Cement with GGBS

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***Abstract**: India has an enormous growth in the industry of steel and copper. These industries produce hazardous by products like ground granulated blast furnace slag (GGBS). If they were not disposed off properly, they may cause hazards to the atmosphere. Considering the long term performance and stability of structures, this study suggests replacing some percentage of cement with GGBS to develop high performance concrete. This paper presents an experimental investigation to know the use of GGBS in concrete as a replacing agent of cement.. To accomplish this 53 grade Ordinary Portland cement were used in preparing concrete mix with a w/c ratio of 0.40 with suitable superplasticizers. In order to confirm the use of GGBS as a replacing agent tests were conducted. Cement was replaced with 0% to 40% with GGBS respectively. Concrete control specimens without replacement were also cast for comparison. After casting the cube moulds specimens were tested for various tests like compressive strength test, tensile strength test, flexural strength test.*

***Keywords**: Cement, GGBS, Super plasticizer, Compressive strength test, Tensile strength test, Flexural strength test.*

I. INTRODUCTION

Ground granulated blast furnace slag (GGBS) is the by product of manufacturing of pig iron. Iron ore, coke and lime stone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500^{o}C to 1600^{o}C. The molten slag has composition close to chemical composition of Portland cement. After the molten iron is tapped off, the remaining molten slag, which consist of mainly siliceous and aluminous residue is then water-quenched rapidly, resulting in formulation of glassy granulate. This glassy granulate is dried and ground to required size, which is known as Ground granulated blast furnace slag (GGBS). The main component of blast furnace slag are CaO (30-50%), SiO2 (30-40%), Al2O3 (8 -24%) and MgO (1-18%) which is close to the chemical composition of portland cement. It is commonly used in combination with portland cement in concrete for many applications. Concrete made with GGBS has many advantages, including improved strength, durability, workability, economic and environmental benefits. The only drawback in the use of GGBS concrete is that its strength development is considerably slower under the standard curing conditions than that of portland cement concrete, although the ultimate strength is higher for the same water– binder ratio.

II. LITERATURE SURVEY

A. *Magandeep, Ravi Kant Pareek and Varinder Singh, in paper "Utilization of Ground Granulated Blast Furnace Slag to Improve Properties of Concrete"*, "International Journal on Emerging Technologies, Vol. 6, Issue 2, , pp. 72-79, e-ISSN: 2249-3255",[Aug. 2015] in there paper observed that the Slump values of various mix proportions of GGBFS concretes increased when replacement of GGBFS increases from 10 to 40 %. Compressive strength and flexural strength decreases as the percentage of GGBFS increases at the age of 7 and 28 days but it increases with the increase in percentage of GGBFS at the age of 56 days. He also observed that the split tensile strength of the mix with 20% and 30% cement replacement better performed than control mix at 56 days where as the mix with 40% cement replacement showed a decrease in strength at 56 days. The sulfate resistance and chloride resistance increased in the specimens with 30% GGBFS content than the specimens without GGBFS.Page Layout

B. *S. Arivalagan, in the paper "Sustainable Studies on Concrete with GGBS as a Replacement Material in Cement"*, "Jordan Journal of Civil Engineering, Vol. 8, Issue 3, pp. 263-270",[Feb 2014], investigated the strength and strength efficiency factors of hardened concrete, by partially replacing cement with 20% , 30% and 40% GGBS at different ages. The specimens when tested at 7 and 28 days, showed increase in compressive strength for 20% replacement of cement. Split tensile strength and flexural strength of concrete also increased at 20% cement replacement. The increasing strength is due to filler effect of GGBS. It was also found that the degree of workability of concrete was normal and it increased with the addition of GGBS.

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III. OBJECTIVES OF THE STUDY

A. The Objectives of the Experimental Study are As Follows,

1) To evaluate the effect of replacing the cement GGBS used in concrete and to study the compressive strength, split tensile strength and flexure strength of concrete under varying percentage of GGBS.
2) To understand the actual behavior of concrete when GGBS has been replaced by cement and to ascertain strength of concrete which is one of the important criteria of the concrete.
3) To determine the optimum level of GGBS can be replaced by cement in concrete elements with highest compressive strength.
4) To reduce the cost of concrete by using the GGBS in concrete as it is more economical compare to cement.
5) To produce an environment friendly concrete by utilizing the waste material (GGBS) in concrete.

IV. METHODOLOGY

A. Basic Test Conducted On Cement

1) Specific Gravity of Cement
2) Normal Consistency
3) Setting Time Test

B. BASIC TEST CONDUCTED ON FINE AGGREGATE

1) Specific Gravity
2) Sieve Analysis

C. BASIC TEST CONDUCTED ON COARSE AGGREGATE

1) Specific Gravity

D. BASIC TEST CONDUCTED ON FRESH CONCRETE

1) Slump Cone Test

E. BASIC TEST CONDUCTED ON HARDENED CONCRETE

1) Compressive Strength Test
2) Split Tensile Test
3) Flexure Strength

F. MIX DESIGN

Mix Proportion of Normal Concrete (M40 Grade)
As per IS 10262:2009

Table I MIX PROPORTION OF CONCRETE WITH GGBS REPLACEMENT

Replacement of GGBS	% of Cement	% of GGBS	Water lit/m^3	Cement kg/m^3	GGBS kg/m^3	FA kg/m^3	CA kg/m^3
R0	100	0	138	345	0	891	1176
R20	80	20	138	276	69	891	1176
R30	70	30	138	242	103	891	1176
R40	60	40	138	207	138	891	1176

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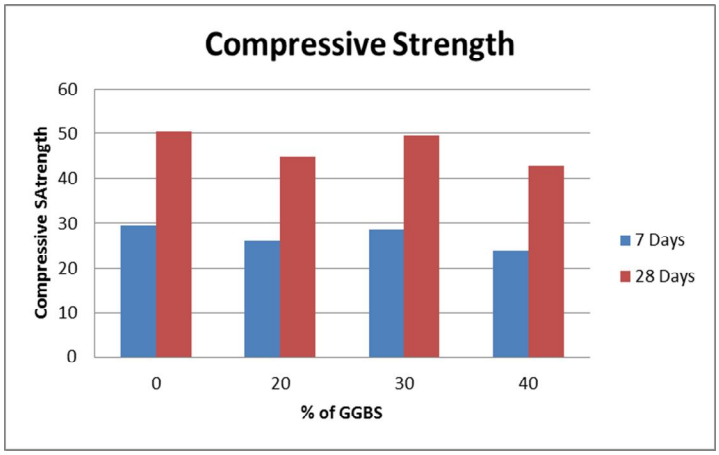
V. RESULT

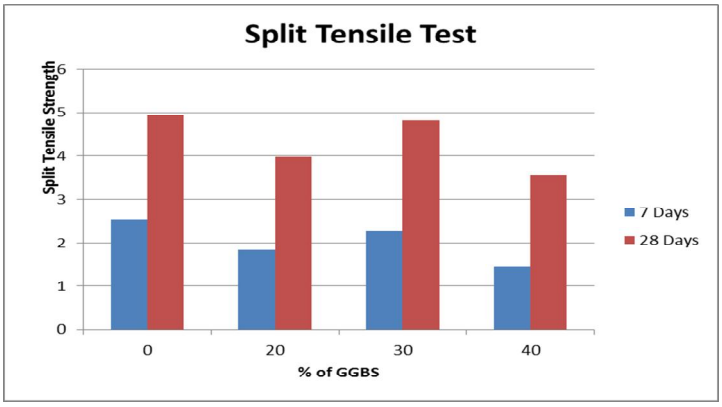
A. Compressive Strength

% OF GGBS	7 DAYS (N/mm^2)	28 DAYS(N/mm^2)
0	29.53	50.33
20	26.055	44.88
30	28.648	49.53
40	23.95	42.58



B. *Split Tensile Strength*

% OF GGBS	7 DAYS (N/mm2)	28 DAYS(N/mm2)
0	2.54	4.95
20	1.84	3.98
30	2.28	4.82
40	1.45	3.65



C. *Flexural Strength*

% GGBS	28 DAYS
0	6.48
20	5.56
30	6.16
40	5.06

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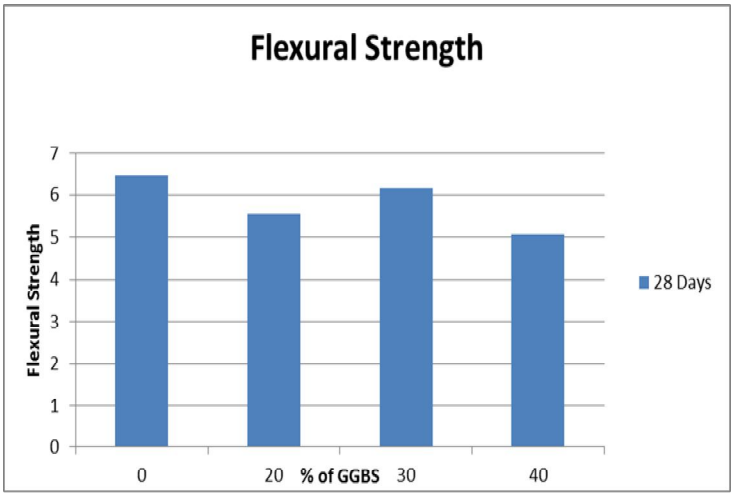

III. CONCLUSION

A. 20% replacement of GGBS with cement decreases compressive strength of M40 concrete by 10.8% & 40% replacement decreases compressive strength by 15.4%.

B. 30% replacement of GGBS with cement decreases compressive strength of concrete by 1.6% which is optimum.

C. Split tensile strength reduces by 19.6% for 20% replacement of GGBS with cement & it reduces by 26.27% for 40% replacement of GGBS with cement.

D. Split tensile strength reduces by 2.6% for 30% replacement of GGBS with cement which is found to optimum.

E. Flexural Strength reduces by 14.19% for 20% replacement of GGBS with cement & it reduces by 21.91% for 40% replacement of GGBS with cement.

F. Flexural Strength reduces by 4.93% for 30% replacement of GGBS with cement which is found to optimum.

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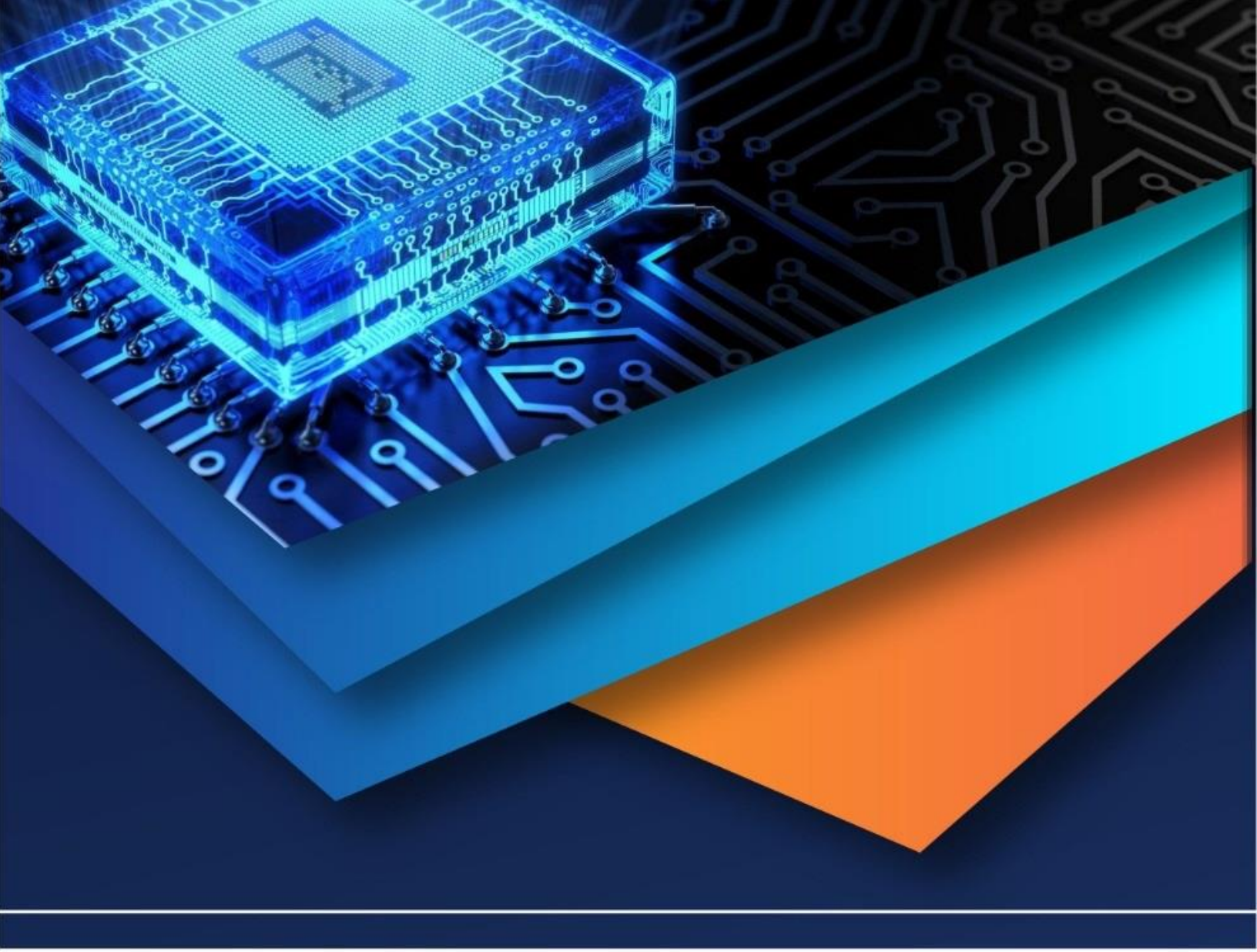

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