An Experimental Study on Strength of concrete using GGBS and Alcofine

Surendra . B.V[1], Rajendra T N[2]

[1,2]*Associate Professor, Department of civil Engineering*
New Horizon college of Engineering, Bengaluru, Karnataka, India 560103

Abstract – 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. An experimental study has been performed to evaluate compressive strength , split tensile strength and flexural strength of hardened concrete by partially replacing the cement by 30% of GGBS and various percentages of alccofine (10%, 20% & 30%) for M20 concrete. Compressive strength, tensile strength and flexural strength are compared with those of concrete prepared with OPC. The test results indicate that it is possible to produce concrete replacing cement partially with GGBS and ALCCOFINE

Key Words: Cement, concrete, GGBS,ALCCOFINE, Compressive Strength, Split tensile strength. Flexural strength.

1. INTRODUCTION

High Performance concrete is a concrete specially designed to meet the combinations of strength and durability requirements that cannot be achieved routinely by using conventional constituents and normal mixing, this leads to examine the admixtures to improve the performance of the concrete.

A lot of research and modifications are being carried out to produce concrete with desired characteristics, since the usage of concrete is next only to water. With the advancement of technology and increased field of application of concrete and mortars, the strength, workability, durability and other characteristics of the ordinary concrete needed modification to make it more suitable for various situations. The cost of concrete is attributed to the cost of its ingredients. The ingredients which are becoming scarce and expensive, has lead to the usage of economically alternative materials. Ground granulated blast slag (GGBS) has been used as a replacement for OPC since this material has both the strength and durability enhancing characteristics of concrete. Apart from that it also has a lower heat of hydration generation, hence generating less heat during concrete production and curing. Alcofine is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. Due to its unique chemistry and ultrafine particle size, it leads to reduced water demand for a given workability.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1 Cement: Ordinary Portland cement of 43 grade confirming to Indian Standards was used in the present investigation and the specific gravity of the sample was evaluated. The results have been tabulated in table2.1.

2.1.2 Fine aggregates: River Sand of fineness modulus 3.65, conforming to zone III was used in the present investigation and the specific gravity of the sample was evaluated. The results have been tabulated in table2.1.

2.1.3 Coarse aggregates: Crushed granite with fineness modulus 6.9 having size between 20 mm and 4.75 mm was used in the present investigation and the specific gravity of the sample was evaluated. The results have been tabulated in table 2.1.

2.1.4 Water: Drinking water was used for the experimental study.

2.1.5 GGBS: It is a by-product of the iron manufacturing industry. Its production requires less energy as compared with the energy needed for the production of the Portland cement. The replacement of the Portland cement will lead to significant reduction in carbon dioxide gas emission.

2.1.6 Alcofine It is also used as a supplementary cementations material having bulk density in the range of 700-900kg/m^3 and fineness > 12000 cm^2/g.

Table 2.1: Significant properties of materials used

Materials	Specific gravity
Cement	3.14
Fine aggregates	2.61
Coarse aggregates	2.67
GGBS	3.44
Alcofine	2.9

Table 2.2: Chemical Composition of GGBS & Alcofine

Major Minerals	Percentage in	
	GGBS	Alcofine
Lime (Cao)	32.4	63
Silica (SiO_2)	34.06	22
Alumina (Al_2O_3)	18.08	5.3
Iron oxide (Fe_2O_3)	0.70	4.0
Magnesium oxide (MgO)	10.75	1.2
Sodium oxide (Na_2O)	0.31	-
Potassium oxide(K_2O)	0.980	-
Sulphur tri-oxide (SO_3)	0.850	2.2

2.2 Mix Proportion

M20 grade of concrete was considered for the present study. The proportion of ingredients was determined in compliance with IS 10262-2009. The various mix proportions for conventional concrete (Control specimen) as well as GGBS and Alcofine based concrete presented in Table2.3.

Table 2.3: M40 Mix proportion

Mix Proportion	Cement content (Kg/m³)	GGBS (Kg/m³)	Alcofine(Kg/m³)	F.A (Kg/m³)	C.A (Kg/m³)	W/C
Control specimen	438	…….	…….	694	1028	0.45
GGBS 30% Alcofine 0%	307	131	-----	694	1028	0.45
GGBS 30% Alcofine 10%	276	131	31	694	1028	0.45
GGBS 30% Alcofine 20%	245	131	62	694	1028	0.45
GGBS 30% Alcofine 30%	214	131	93	694	1028	0.45

3. Experimental Program

The experimental program consisted of casting and testing of M20 grade concrete specimens of cube (150 mm) and cylinder (150 X 300 mm).

3.2 Compressive strength

Six numbers of cubes were cast for each mix and tested using 200T capacity Compression Testing Machine (CTM).

3.3 Split Tensile strength

Six numbers of cylinders were cast for each mix and tested using 200T capacity Compression Testing Machine (CTM).

3.4 Flexural Strength

Six numbers of beamswere cast for each mix and tested using 200T capacity Compression Testing Machine with suitable set up.(CTM).

4. Results and discussions

4.1 Compressive strength: The compressive strength was determined after normal curing for 7 days and 28 days. The results are presented in Table 4.1 and are also depicted graphically in figure 4.1.

Table 4.1 Compressive Strength Test results

Specifications	Compressive strength (N/mm²)	
	7 days	28 days
Control specimen	19.18	28.26
GGBS 30% Alcofine 0%	23.77	34.09
GGBS 30% Alcofine 10%	25.10	34.58
GGBS 30% Alcofine 20%	24.48	35.05
GGBS 30% Alcofine 30%	25.45	35.79

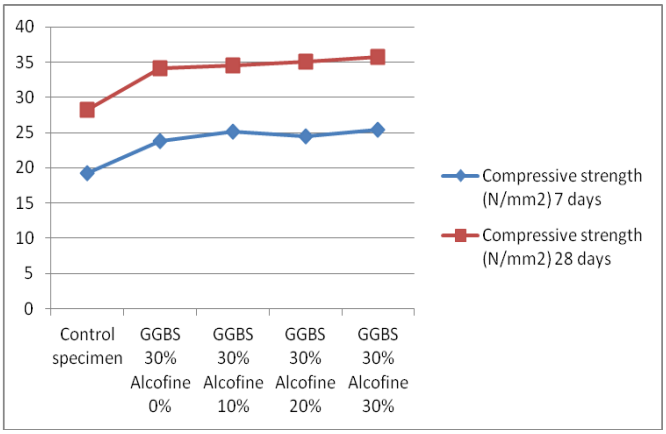

Fig. 4.1 Compressive strength test results

Table 4.2 Flexural Strength Test results

Specifications	Flexural strength (N/mm²)	
	7 days	28 days
Control specimen	1.56	3.17
GGBS 30% Alcofine 0%	2.82	3.43
GGBS 30% Alcofine 10%	2.84	3.46
GGBS 30% Alcofine 20%	2.89	3.50
GGBS 30% Alcofine 30%	2.94	3.53

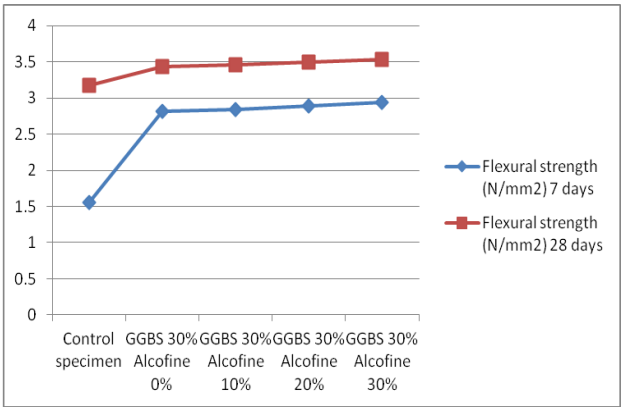

Fig. 4.2 Flexural Strength Test results

4.2 Flexural strength

The flexural strength was determined after normal curing for 7 and 28 days. The results are presented in Table 4.2. and are also depicted graphically in figure 4.2.

4.3 Split Tensile strength

The split tensile strength was determined after normal curing for 28 days. The results are presented in Table 4.3. and are also depicted graphically in figure 4.1.

Table 4.3 Split tensile test results

Specifications	28 days Split Tensile Strength (N/mm²)
Control specimen	2.89
GGBS 30% Alcofine 0%	3.25
GGBS 30% Alcofine 10%	3.76
GGBS 30% Alcofine 20%	3.87
GGBS 30% Alcofine 30%	3.95

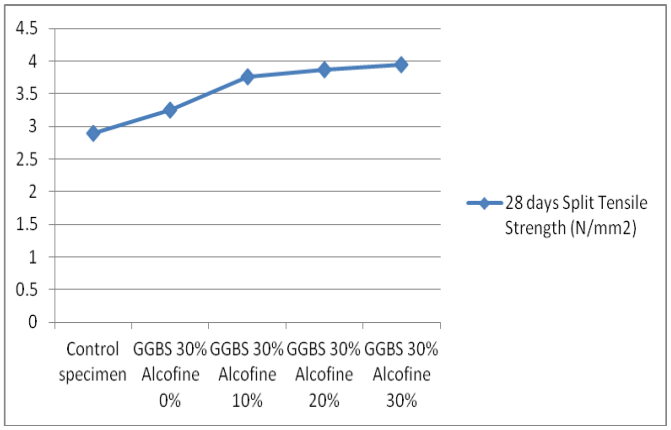

Fig. 4.3 Split tensile Strength test results

It is observed from the From the graph and table, that all the three the strength parameters considered increase with replacement of cement by alcofine and GGBS. With the constant proportion (30%) of GGBS and with varying % of alcofine from 0-30%, the following observations are noted.

- Compressive strength increased from 20% to 26%
- Flexural strength increased from 8% to 11%
- Split tensile strength increased from 12% to 36%

5. Conclusions

It can be concluded that,

The compressive strength, Flexural strength and split tensile strength increases with the replacement of cement by GGBS and alcofine.

This can be attributed because of th hydraulic as well as pozzolonic properties of alcofine & GGBS and due to better compaction because of the use of alcofine.

REFERENCES

1. Pazhani.K., Jeyaraj.R, "Study On Durability Of High Performance Concrete With Industrial Wastes" Applied Technologies & Innovations ,Volume 2, Issue 2, August 2010 ,19-28
2. J.J. Brooks, M.A. Megat Johari, M. Mazloom, "Effect Of Admixtures On The Setting Times Of High-Strength Concrete" Cement & Concrete Composites 22 (2000), 293-301
3. G.J. Osborne, "Durability Of Portland Blast-Furnace Slag Cement Concrete" Cement And Concrete Composites 21 (1999), 11-21
4. S. Pavía And E. Condren , " Study Of The Durability Of OPC Versus Ggbs Concrete On Exposure To Silage Effluent" Journal Of Materials In Civil Engineering Asce, April 2008, 313-319.
5. Darren T.Y. Lim; Da Xu; B. Sabet Divsholi ; B. Kondraivendhan and Susanto Teng, "Effect Of Ultra Fine Slag Replacement On Durability And Mechanical Properties Of High Strength Concrete" 36th Conference On Our World In Concrete & Structures, August 2011.
6. N. Arreshvhina, Z. Fadhadli, H. Mohd Warid, A.H. Zuhairy, Roswadi, "Microstructural Behavior Of Aerated Concrete Containing High Volume Of GGBFS" Asia-Pacific Structural Engineering And Construction Conference (APSEC 2006), September 2006.
7. Nagabhushana1 And H. Sharada Bai, "Use Of Crushed Rock Powder As Replacement Of Fine Aggregate In Mortar And Concrete" Indian Journal Of Science And Technology Vol. 4 No. 8 (Aug 2011), 917-922.
8. Appukutty P. , Murugesan R, "Substitution Of Quarry Dust To Sand For Mortar In Brick Masonry Works" International Journal On Design And Manufacturing Technologies, Vol.3, No.1, January 2009, 59-62.
9. Venu Malagavelli And P. N. Rao, "High Performance Concrete With GGGBS And Robo Sand" International Journal Of Engineering Science And Technology Vol. 2(10), 2010, 5107-5113.
10. Indian Standards 10262 – 2009: Recommended Guidelines for Concrete Mix Design.
11. Indian Standards 456 – 2000: Plain and Reinforced Concrete Code of Practice.
12. Specifications 23 – Specification for the concrete Mix designs.
13. Indian Standards 2386 – 1963: Methods of Test for Aggregates for Concrete.
14. Indian Standards 383 – 1970: Specification for Coarse and fine Aggregates from Natural Sources for Concrete (Second revision).
15. Indian Standards 455 – 1989: Portland Slag Cement-Specification.
16. Indian Standards 1199 – 1959: Indian Standard Methods of Sampling And Analysis of Concrete.
17. Indian Standards 12089-1987: Specification for Granulated Slag For The Manufacture Of Portland Slag Cement.
18. Indian Standards 12269-1987: Specification for 53 Grade Ordinary Portland Cement.

BIOGRAPHY

Surendra B V (M.E, (PhD)).
Associate Professor

Rajendra T N (M. Tec h)
Assistant Professor.