EXPERIMENTAL STUDY ON THE FLEXURAL BEHAVIOR OF GGBS & SF BLENDED CEMENT CONCRETE BEAM WITH BASLT ROCK FIBER

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ABSTRACT

This paper presents the results of research of use of industrial by-products and waste material as in concrete. The objective is effectively use industrial by-products and waste materials in concrete without affecting the quality of concrete. Experimental investigations were carried out to study the effect of use of GGBS, SILICA FUME as partial replacement of cement with addition of basalt rock fiber (BRF) in concrete. The mix ratio of 1:1.35:3.00:0.45 is used to cast cubes (150mm size), prisms (100mmx 100mm x 500mm) GGBS, silica fume replacement of cement with addition of basalt rock fiber (BRF) in concrete. Test specimens were cast. The strength development for various replacement of cement is compared to the strength of normal concrete at various ages and it was found that all the concrete mixes produce lower compressive strength than the controlled mix. Among five type of replacement specimen with the GGBS, SILICAFUME replaced by cement with addition of basalt rock fiber (BRF) has the load carrying capacity more or less equal to that of control beam. The flexural strength of concrete compared with the control concrete.

Keywords: Basalt Rock Fiber, GGBS,SILICA FUME, flexural strength of concrete.

I. INTRODUCTION

Environmental pollution is one of the major problems associated with rapid industrialization, urbanization and rise in living standards of people. For developing countries, industrialization is must and still this activity, very much demands to build self-reliant and in uplifting nation's economy. However, industrialization on the other hand also causes serious problems relating to environmental pollution. Therefore, wastes seem to be a by-product of growth. Countries like India can ill-afford to lose them as sheer waste. On the other hand, with increasing demand for raw materials for industrial production, the non-renewable resources are dwindling day-by-day. Therefore, efforts are to be made for controlling pollution arising out of the disposal of wastes by conversion of these unwanted wastes into utilizable raw materials for various beneficial uses. The problems related to disposal of industrial solid wastes are associated with lack of infrastructural facilities and negligence of industries to take proper safeguards.

1.1 GGBS

GGBS is made from a by-product of the production of iron in a blast furnace where iron ore, limestone and coke are heated to about 1500°C. When these materials melt in the blast furnace, two products are produced—

molten iron, and molten slag. The molten slag is lighter and floats on the top of the molten iron. The molten slag comprises mostly silicates and alumina from the original iron ore, combined with some oxides from the limestone.

The process of granulating the slag involves cooling the molten slag through high-pressure water jets. This rapidly quenches the slag and forms granular particles generally not larger than 5 mm in diameter. The rapid cooling prevents the formation of larger crystals, and the resulting granular material comprises about 95% non-crystalline calcium-aluminosilicates.

1.2 Silica Fume

Silica fume also referred to as micro silica or condensed silica fume another material that is also used as an artificial pozzolonic admixtures. **Micro silica/Silica fume** is a by-product of producing silicon metal or ferrosilicon alloys in smelters using electric arc furnaces. These metals are used in many industrial applications to include aluminum and steel production, computer chip fabrication and production of silicones, which are widely used in lubricants and sealants. While these are very valuable materials, the by-product micro silica/silica fume is of more importance to the concrete industry.

II. EXPERIMENTAL INVESTIGATION

2.1 Study on Materials

The properties of materials used namely cement, fine aggregate, coarse aggregate and mineral admixtures (GGBS,Silica fume) have been described. Also, it gives an overview of casting procedures and test results. The influence of clinker in the properties of concrete in normal conditions are absorbed through this test and compared with control plain concrete in terms of compressive strength, flexural strength, ductility, toughness and stress-strain relationships. For this investigation, M30 grade of concrete is used.

The materials used in this experimental investigation are

1.	Cement	:	PENNA 53 grade ordinary Portland cement (OPC) (IS 1489 PART I 1991).
2.	Fine aggregate	:	Locally available clean river sand ZONE II of IS 383 – 1970
3.	Coarse aggregate	:	Locally available well graded crushed granite Coarse aggregate of normal size greater than 4.7mm and less than 20mm is used.
4.	Water	:	Locally available portable water obtained From source of college campus bore well is used for mixing and curing of concrete for normal conditions conforming to the requirements of water for concreting and curing as per IS: 456 – 2000.
5.	Mineral admixtures	:	GGBS is received from NANDI CEMENTS Pvt. Ltd at Bangalore. Silica fume is received from ASTRA CHEMICALS at Chennai.

6. Fibers used : Basalt fiber is received from Muktagiri industrial Corporation –Mumbai.

III. PREPARATION OF TEST SPECIMEN

In this experiment work, concrete specimens were cast with and without clinker. The specimens considered in this study consisted of 45 numbers. The nominal mix proportion used for casting the specimens was 1: 1.35:3:0.45 (Cement: fine aggregate: coarse aggregate: water cement ratio). Fresh concrete was cast in steel moulds and hand compaction.

The following specimens were prepared:

- 150mm cubes (for compressive strength as per IS 516-1999)
- 100* 100* 500 mm prism specimens.

Three specimens each were tested in the case of compressive strength and flexural strength experiments. In the case of flexural test single beam is used, and the value of this test is reported. Specially fabricated steel moulds were used for casting the specimens. Before casting, machine oil was applied on all the surfaces of the moulds to facilitate easy demoulding of the specimens.

All ingredients are weighed separately as per the mix details. The uniformity of concrete mainly depends on the mixing procedure. Cement and aggregates are mixed thoroughly by using rotary mixer. While the mixing operation is in progress, 80% of water is added first and mixed for about 5 minutes then the remaining water is added and mixed thoroughly. For each mix a total of 3 cube of 150* 150* 150mm, 100* 100* 500 prisms. After placing the cage in position inside the mould the ingredients were mixed in a drum type mixer machine. The concrete was poured through the mould and got compacted using tamping rods in three layers to avoid honey combing. The top surface was hand troweled for smooth finishing. The specimens were demoulded after 24 hours of casting and placed inside a water tank until the age of testing.

3.1 Description of Specimens

The following table represents the number of specimens cast in detail.

Table 3.1 Description of Specimens

Sl.No	Type of Specimen	% of BRF	OPC	GGBS	SF
1	M1	0.5	95	0	5
		1			
		1.5			
		2.0			
		2.5			
2	M2	0.5	90	0	10
		1			
		1.5			
		2.0			
		2.5			

3	M3	0.5	70	30	0
		1			
		1.5			
		2.0			
		2.5			
4	M4	0.5	80	20	0
		1			
		1.5			
		2.0			
		2.5			
5	M5	0.5	90	10	0
		1			
		1.5			
		2.0			
		2.5			

IV.RESULTS AND DISCUSSION

4.1 Compressive Strength

Compressive strength of control concrete and other described cubes are reported in table 4.1

Table 4.1Compressive Strength of Concrete and Other Descriptive Cubes

Sl.No	Type of sample	Compressive strength(N/mm^2) (N/mm^2)	
		7 days	28 days
1	M1 0.5	19.95	24.76
2	M1 1	21.78	28.90
3	M1 1.5	16.59	22.15
4	M1 2	14.02	20.38
5	M2 0.5	12.75	29.57
6	M2 1	17.78	29.59
7	M2 1.5	16.00	28.78
8	M2 2	14.32	27.82
9	M3 0.5	28.82	32.40
10	M3 1	30.22	33.79

11	M3 1.5	32.66	36.04
12	M3 2	25.63	31.02
13	M4 0.5	35.26	36.92
14	M4 1	34.30	35.33
15	M4 1.5	27.55	30.38
16	M4 2	24.00	35.59
17	M5 0.5	36.30	37.47
18	M5 1	37.76	39.09
19	M5 1.5	27.78	29.41
20	M5 2	25.70	28.62

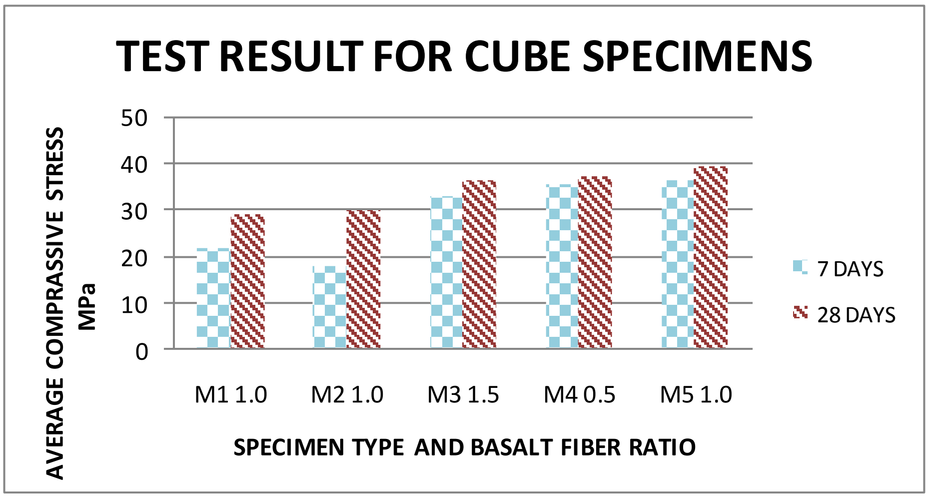

Fig 4.1 Compressive Strength at 7, 28 Days.

4.2 Split Tensile Test

Split tensile test of control concrete and other described cubes are reported in table 4.2

Table 4.2Split tensile testof Concrete and Other Descriptive Cubes

Sl.No	Type of sample	Compressive strength	
		7 days	28 days
1	M1 0.5	2.11	4.45
2	M1 1.0	2.59	4.60
3	M1 1.5	2.45	3.70
4	M1 2.0	2.09	3.62
5	M2 0.5	2.38	3.71
6	M2 1.0	2.57	4.57

7	M2 1.5	2.61	4.46
8	M2 2.0	1.89	3.11
9	M3 0.5	13.24	4.98
10	M3 1.0	4.74	6.18
11	M3 1.5	5.19	7.09
12	M3 2.0	3.23	5.70
13	M4 0.5	6.30	8.51
14	M4 1.0	5.00	5.71
15	M4 1.5	3.78	4.47
16	M4 2.0	3.06	3.75
17	M5 0.5	7.00	9.49
18	M5 1.0	7.68	10.28
19	M5 1.5	3.70	5.33
20	M5 2.0	2.68	4.53

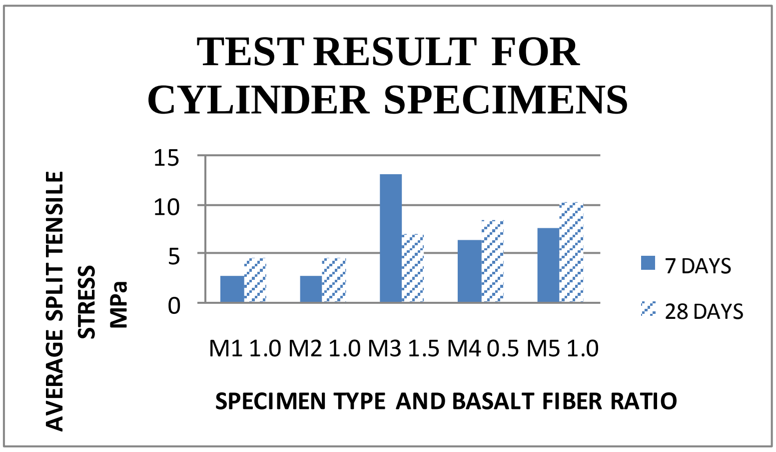

Fig 4.2 Split tensile Strength at 7, 28 Days

TABLE 4.3 New Specifications

Type of specimen	Name
M2 1.0	S1
M4 0.5	S2
M3 0.5	S3
M5 0.5	S4
M1 1.0	S5

4.3 Flexural Strength of Beams

The Flexural Test Results for the Beams Specimens are presented in the Table 4.4

Table 4.4 Flexural Test Results

S.No	Specimen Type	Initial Crack	Ultimate Load(KN)
1	S1	12	48.545
2	S2	14	54.971
3	S3	10	46.243
4	S4	8	42.618
5	S5	10	44.712

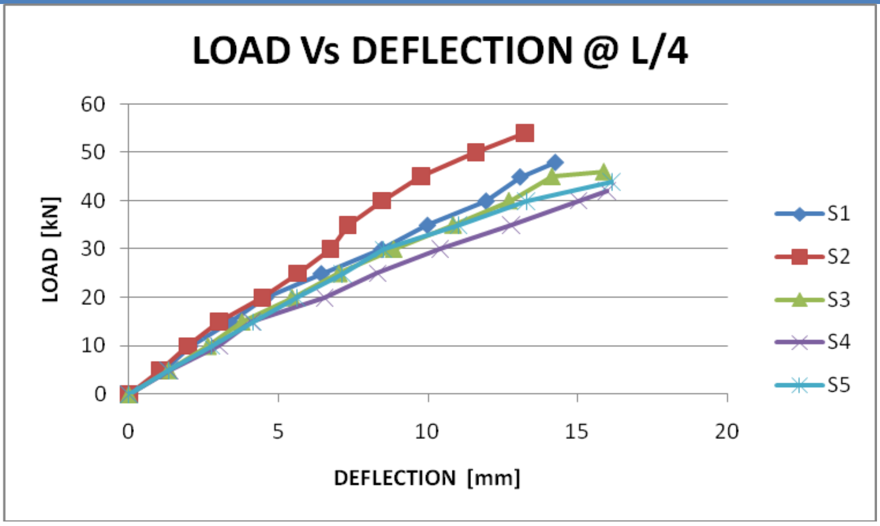

Figure 4.3 Load Vs Deflection Curve at L/4 for S1 to S5

4.4 Stress –Strain Relations for Beams

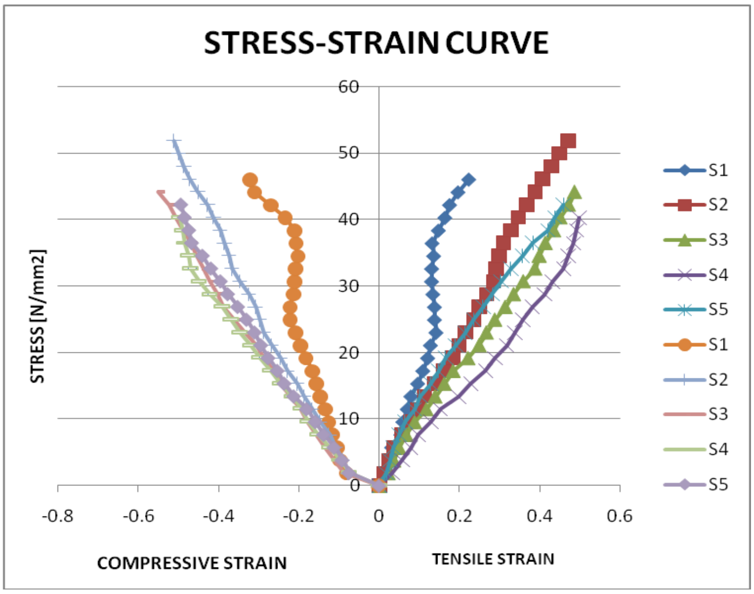

Figure 4.4 Stress – Strain Curve for S1 to S5

V. CONCLUSION

In this project basalt fiber are used to minimize the cost and ensure sustainable development and partially replacement of cement with using GGBS,SF this will suggest a sustainable replacing methodology for above waste materials additionally basalt fiber are used to develop strength and effect of partially replacement cement and blended cement on fiber reinforced concrete has been studied.

As per compressive strength

- ❖ The mechanical properties of concrete specimens are given in table 4.1. It shows an increase in the compressive strength with curing period in all concrete composition. It can be seen that M4 provide better results. M4 is the partially replacement of cement and adding 20% of GGBS and 0.5 % basalt fibers used

As per Split Tensile Strength

- ❖ The mechanical properties of concrete specimens are given in table 4.1. It shows an increase in the split tensile strength with curing period in all concrete composition. It can be seen that M5 provide better results. M5 is the partially replacement of cement and adding 10% of GGBS and 0.5 % basalt fibers used

As per flexural strength

- ❖ The flexural strength of concrete beams attains max value of 54kN ultimate load at a replacement level of 20 % of GGBS with addition 0.5 % of BR fibers.
- ❖ The load deflection behavior shows a ductile behavior at a replacement level of 20 % of GGBS with addition 0.5 % of BR fiber.

Hence it is concluded that partial replacement of cement by20 % of GGBS as mineral admixtures can be effectively used as a replacement of cement along with the addition of 0.5 % Basalt Rock Fiber.

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