Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 5, May-2017

EXPERIMENTAL STUDY ON GROUND GRANULATED BLAST FURNACE SLAG AND GLASS FIBER REINFORCED CONCRETE

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Abstract — ***The composite matrix that is obtained by combining cement, Ground Granulated Blast Furnace Slag, aggregates and fibers is known as "Ground Granulated Blast Furnace Slag Fiber reinforced concrete". The fibre in the cement Ground Granulated Blast Furnace Slag based matrix acts as crack- arresters, which restrict the growth of micro cracks and prevent these from enlarging under load. The experimental work has carried out to study the effects of replacement of cement (by weight) with (15%, 30%, and 45%) Ground Granulated Blast Furnace Slag and the effects of addition of (0.5%, .1.0%, 1.5%) Glass Fiber composite. A M25 Grade of concrete control mixture of proportions 1:1.45:2.52 with w/c of 0.45 designed.***

Keywords- Cement, coarse aggregate, Glass fibre reinforced concrete, split tensile strength, Ground Granulated Blast Furnace Slag.

1 INTRODUCTION

Fresh concrete or plastic concrete is freshly mixed material which can be moulded in any shape hardens into a rock like mass known as concrete. The utility and elegance as well as durability of concrete structures built during first half of the last century was with OPC and reinforcement. The availability of constant material of concrete and knowledge that virtually any combination of constituent leads to mass of concrete has great contempt. The hardening is caused by chemical reaction between water and cement, which continues for a long time, consequently concrete, grows stronger with age. The harden concrete may be consider as synthetic stone in which voids of larger particle (coarse aggregate) filled by smaller particle (fine aggregate) and voids of fine aggregate are filled by cement.

In a concrete mix cementing material and water from a paste called cement water paste which in addition to filling the voids of fine aggregate, coats the surface of fine and coarse aggregates and binds them together it cures, thereby cementing the particles of aggregates together in a compact mass. The key to generate a strong durable and uniform concrete i.e high performance concrete lies in the careful control of its basic process composition.

2 EXPERIMENTAL INVESTIGATION

Experimental work is done in to achieve two major objectives to investigate the improvement in compressive strength of glass fiber reinforced GGBS concrete and to investigate the cracking strength and reserve strength of concrete.

2.1 Materials used:

2.1.1 *Ordinary Portland cement*: Cement used is ordinary Portland cement (OPC 53 grade) as a binding material As per IS 12269-1970. The preliminary tests like normal consistency (amount of water to be added), specific gravity, initial and final setting times and compressive are conducted. Sieve analysis for the grading curve and fineness test conducted as well as the determination of its moisture and with specific gravity (2.86).

TABLE: 1 Test Results on Cement

SR.NO	PROPERTY	Value
1	Specific gravity	3.14
2	Fineness test	7.4%
3	Soundness test	4.5 mm

4	Grade of cement	OPC 53

2.1.2 Coarse aggregate: The crushed granite, passing through 20 mm and retained on 4.75mm sieve, some preliminary test are conducted as per IS 383-1978.

TABLE: 2 Test Results on Course Aggregate

SR.NO	PROPERTY	Value
1	Specific gravity	2.60
2	Fineness modulus	4.99% (20 mm size aggregate)
3	Fineness modulus	3.98% (10 mm size aggregate)
4	Grade of cement	OPC 53

2.1.3 Fine aggregate: The river sand with zone III, passing through 4.75mm sieve as per IS 383-197.

TABLE: 3 Test Results on Fine Aggregate

SR.NO	PROPERTY	Value
1	Specific gravity	2.66
2	Sieve analysis	ZONE III

***2.1.4 Water*:** Portable water as per IS 456-2000.

***2.1.5 Glass fiber*:** In the present work, we used glass fiber of density 2680kg/m_3. We added glass fiber 0.50% & 1.00% and 1.5% of volume of concrete.

2.2 *MIX CALCULATIONS:*

a) Volume of concrete = 1m^3
b) Mass of cement= 438.13 m^3
c) Mass of water = 197.1 lit
d) Mass of coarse aggregate= 1104.89 kg/m^3
e) Mass of fine aggregate= 635.84 kg/m^3
f) WATER-CEMENT RATIO = 0.45
g) MIX PROPORTION =1:1.45:2.52

3 TEST ON FRESH CONCRETE

3.1 Workability of Concrete

It can be defined as the ease with which concrete can be mixed placed, compacted, transported and cured. It can be measured by two popular methods.

(1) Slump test (2) Compaction factor test.

3.1.1 Slump Test

Slump test is the most commonly used method of measuring consistency of concrete, which can be employed either in laboratory or at site of work. It is not suitable method for very wet or very dry concrete. It does not measure all factors Contributing to workability nor it is always representative of playability of concrete. However, it used conveniently as a control test and gives an indication of uniformity of concrete from batch to batch. Repeated batches of same mix brought to the same slump, will have the same water content and water cement ratio provided the weights of aggregates, cement and admixtures are uniform and aggregate grading is within acceptable limits. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps.

Fig 1 Slump Cone

3.1.2 Compaction Factor Test

It is designed primarily for use in laboratory but it can also be used in field. It is more precise and sensitive than the slump test and is primarily useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration. Such dry concrete are insensitive to concrete. This test works on the principle of determining degree of compaction achieved by a standard amount of work done by allowing the concrete to fall through a standard height. Degree of compaction, called the compacting factor is measured by density ratio i,e the ratio of density actually achieved in the test to the density of same concrete fully compacted.

Fig 2 Compaction factor apparatus

3.2 Test on hardened concrete

3.2.1 Compression Testing of cubes

In the present investigation, the cubes were casted with fiber reinforcement, and tested. The dimensions of the cube are 150x150x150mm in accordance to IS 456-2009.The casted cubes for curing and tested after 3days,7days ,28 days and the capacity of concrete cube noted in KN that is force (P) by placing on any one side of the cube .The cross sectional area(A) of cube is 225cm^2.Finally the division compressive force by cross sectional area of cube gives the compressive strength of that particular cube .This work is carried out for all grade M25 after 3days, 7days 28 days and 56 days. The mathematical representation of compressive strength. $\sigma = P/A$

Fig 3 Compression test

3.2.2 Split Tensile strength

Generally, split tensile strength will be predicted by using cylinders of diameter 150 mm and depth or height 300 mm placing longitudinally and applying force by machine. The mathematical representation of split tensile strength. $\boldsymbol{\sigma_T = 2P/\pi h}$

In the present investigation, the cylinders were casted with glass fibre reinforcement and tested. The dimension of the cylinder was 150 mm diameter and 300mm height. The casted cylinders kept for curing and tested after 7days, 28 days and 56 days capacity of concrete cylinders were noted in KN i.e placing axially under testing machine.

4. RESULTS AND DISCUSSION

Table 4. Slump test results

SR.NO	Designation	Slump(mm)	SR.NO	Designation	Slump(mm)
1	$GGBS_0\ GF_0$	36	6	$GGBS_{30}GF_{1.0}$	75
2	$GGBS_{15}\ GF_{0.5}$	40	7	$GGBS_{30}GF_{1.5}$	63
3	$GGBS_{15}\ GF_{1.0}$	52	8	$GGBS_{45}\ GF_{0.5}$	65
4	$GGBS_{15}\ GF_{1.5}$	70	9	$GGBS_{45}GF_{1.0}$	80
5	$GGBS_{30}\ GF_{0.5}$	45	10	$GGBS_{45}\ GF_{1.5}$	55

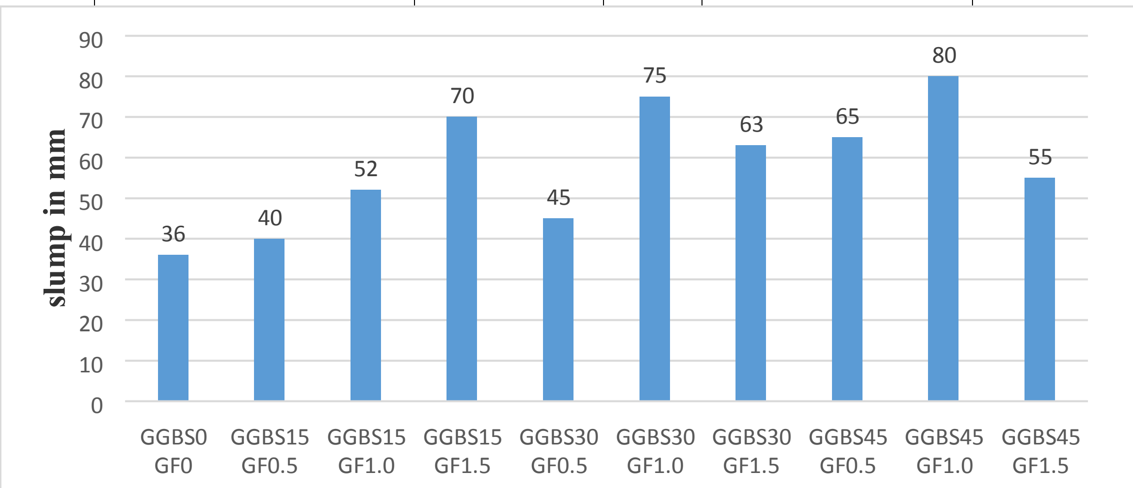


FIG. 4 Slump Test Result

- **Compressive Strength Result**

Table: 5 Compressive Strength of Glass Fibre Reinforced GGBS Concrete For 0.50% of Glass Fibre.

Grade	Curing Day/ GGBS	Compressive strength(N/mm^2) for 0.50 % GF			
	GGBS %	0	15%	30%	45%
M 25	3 day	14.2	17.8	18.5	17.1
	7 day	17.40	21.6	22.1	20.6
	28 day	30.6	33.8	34.2	32.6
	56 day	31.9	35.4	36.6	35.0

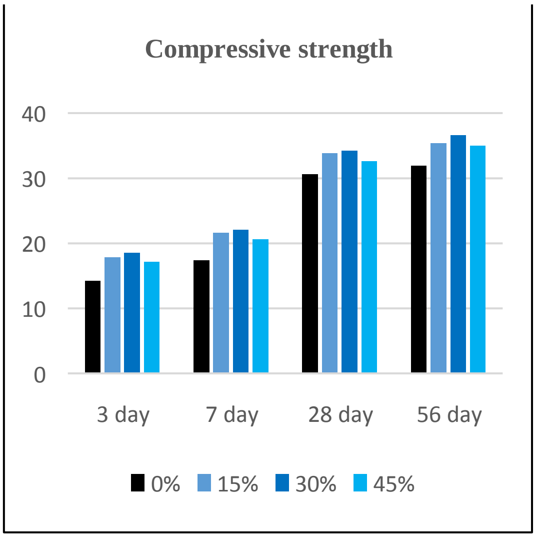


Table: 6 Compressive Strength of Glass Fibre Reinforced GGBS Concrete For 1.0% of Glass Fibre.

Grade	Curing Day/ GGBS	Compressive strength(N/mm^2) for 1.0 % GF			
	GGBS %	0	15%	30%	45%
M 25	3 day	14.2	18.5	21.4	17.8
	7 day	17.40	24.4	24.4	22.0
	28 day	30.6	37.5	37.5	33.8
	56 day	31.9	36.6	40.20	35.8

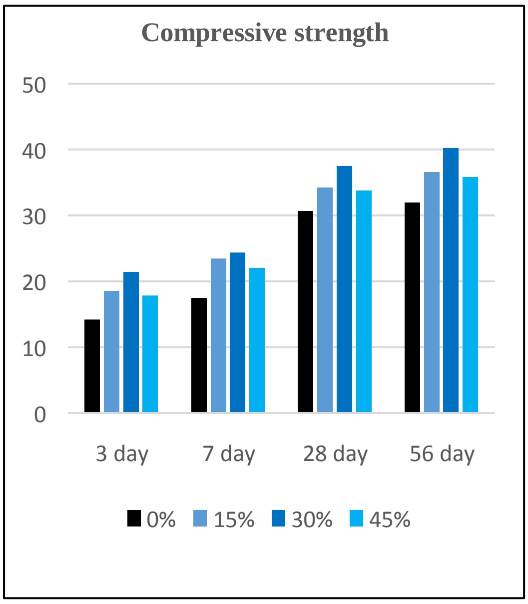
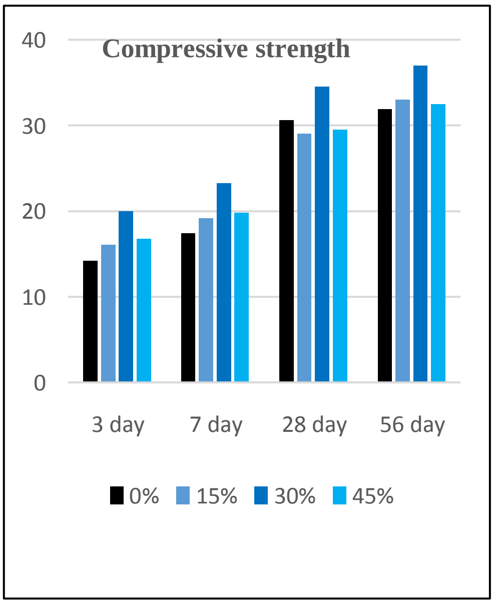


Table: 7 Compressive Strength of Glass Fibre Reinforced GGBS Concrete For 1.5% of Glass Fibre.

Grade	Curing Day/ GGBS	Compressive strength(N/mm^2) for 1.5 % GF			
	GGBS %	0	15%	30%	45%
M 25	3 day	14.2	16.1	20.0	16.8
	7 day	17.40	19.2	23.2	19.8
	28 day	30.6	29	34.5	29.5
	56 day	31.9	33	37.0	32.5



❖ **Split Tensile strength**

Table: 8 Split Tensile strength of Glass Fibre Reinforced GGBS Concrete For 0.5% of Glass Fibre.

Grade	Curing Day/ GGBS	Compressive strength(N/mm^2) for 0.5 % GF			
	GGBS %	0	15%	30%	45%
M 25	7 day	2.30	2.38	2.52	2.38
	28 day	3.00	3.10	3.25	3.10
	56 day	3.20	3.8	3.90	3.20

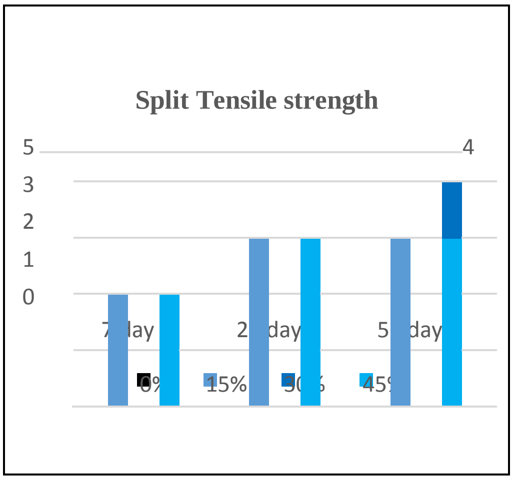


Table:9 Split Tensile strength of Glass Fibre Reinforced GGBS Concrete For 1.0% of Glass Fibre.

Grade	Curing Day/ GGBS	Compressive strength(N/mm^2) for 1.0 % GF			
	GGBS %	0	15%	30%	45%
M 25	7 day	2.30	2.52	2.82	2.52
	28day	3.00	3.40	3.48	3.40
	56 day	3.20	3.6	4.48	3.50

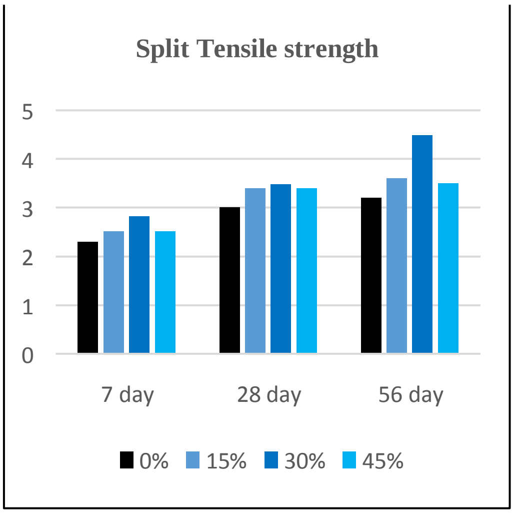
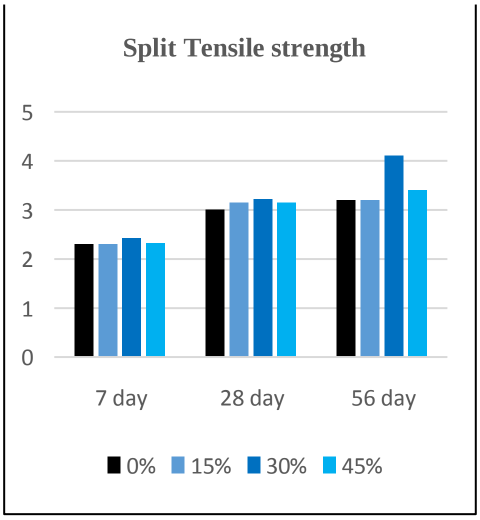


Table:10 Split Tensile strength of Glass Fibre Reinforced GGBS Concrete For 1.5% of Glass Fibre.

Grade	Curing Day/ GGBS	Compressive strength(N/mm^2) for 1.5 % GF			
	GGBS %	0	15%	30%	45%
M 25	7 day	2.30	2.30	2.42	2.32
	28 day	3.00	3.15	3.22	3.15
	56 day	3.20	3.20	4.10	3.40



5. CONCLUSION

1. From the study, it was found that, the workability of concrete increases by the addition of GGBS but the Concrete shows reduction of workability due to the addition of glass fibre.
2. The slump of this concrete increases as the addition of GGBS in 0.50% and 1.0% of glass fibre concrete up to 55%, after that the slump value gets reduced.
3. The compressive strength value of cubes casted with 1.0% of glass fibre shows effective strength as the addition of GGBS is increased from 15% to 30%, after this further addition of GGBS shows decreasing value.
4. The compressive strength value of cubes casted with 1.0% of glass fibre shows maximum effective strength as the addition of GGBS 30%, after this further addition of GGBS shows decreasing value.
5. The split tensile strength value of cylinders casted with 0.5% of glass fibre shows effective strength as the addition of GGBS is increased from 0% to 30%, after this further addition of GGBS shows decreasing value.
6. The split tensile strength value of cylinders casted with 1.00% of glass fibre shows maximum effective strength, as the addition of GGBS is increased 30%, after this further addition of GGBS shows decreasing value.

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