Experimental Study on Mechanical Properties of Steel Fiber Based Concrete with Partial Replacement of GGBS

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Abstract— Concrete is the most common construction material used in the world. As per 2019 the annual consumption of the cement is 25billion tonnes throughout the world. Cement manufacture causes environmental impacts at all stages of the process. The emission of co2 is very high during the manufacture of cement which causes environmental pollution and the cost of cement is increasing day by day .so in order to reduce the emission of co2 and cost of construction supplementary materials like GGBS , Flyash and silica fume are used .In this paper we are going to find out the characteristics of M30grade concrete with partial replacement of cement with ground granulated blast furnace slag (GGBS) by replacing cement via 20% by weight and by addition of steel fiber in different percentages (0%,0.1%,0.2%,0.3%,0.4%,0.5%,0.6%) .The cubes, cylinders, prims are tested for compressive strength, split tensile, strength flexural strength.

Keywords: Concrete, Ground Granulated Blast Furnace Slag, Steel Fibre, compressive strength, flexural strength and split tensile strength

I. INTRODUCTION

Concrete is the most probably used construction material in the world about 25 billion tones being produced every year. It is next to water in terms of consumption. The cement manufacture industry is one of the two largest producers of carbon dioxide (CO2), creating up to 8% of worldwide man-made emissions of this gas, of which 50% is from the chemical process and 40% from burning fuel. To reduce the co2 alternatives like ggbs and fly as is used. Cement is partially replaced with ggbs which increase the mechanical properties of concrete and the reduces the consumption of concrete .GGBS is obtained by crushing the molten iron slag from blast furnace in water or steam to produce a non-crystalline solid then this solid is ground into fine powder. Ground granulated blast furnace slag is high in CSH (calcium silicate hydrate) which increases the strength, durability and appearance of the concrete. In order to increase the brittle nature of the concrete small amount of fibres can be added .This type of concrete is called as fiber reinforced concrete .we can use different fibers like steel, glass, and nylon, synthetic to increase the strength of the fibers. In this paper we are going to add the steel fiber in concrete.

II. MATERIALS AND PROPERTIES:

A. Cement:

The cement used is OPC 53 grade available in the local market OPC 53 grade has higher strength and durability. The cement should be fresh and free from lumps .All the properties of the cement are tested by referring IS 12269-1987

SI.NO	PROPERTY	RESULT
1	Normal consistency	33m
2	Specific Gravity	3.15
3	Fineness of cement	7.4%
4	Initial setting time	40 min
5	Final setting time	270mm

Table 2.1 Properties of cement

B. Fine Aggregate:

We have used locally available sand of zone iii and sieved by using IS sieve 4.5mm

S.no	Property	Result
1	Sieve analysis	Zone l
2	Specific gravity	2.67

Table 2.2 Properties of Fine aggregate

C. COARSE AGGREGATE:

We have used locally available crushed stone by sieving the aggregate

S No	Property	Result
1	Crushing value	23.9%
2	Impact value	18.5
3	Abrasion value	34.76%
4	Specific gravity	2.68
5	Water absorption	2.1

D. WATER:

The water used is locally available water in our locality.

SI.NO	Property	Result
1	Colour	colourless
2	Turbidity	0.1-1.0 NTU
3	pH	7
4	Alkalinity	20-200 mg/liter
5	Density	997kg/m3

Table 2.4 properties of water

E. GGBS (Ground granulated blast -furnace slag):

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

Colour	off _white
Specific gravity	2650 kg /m*3
Bulk Density	1800kg/m*3
Maximum dry density (KN/ m*2)	2.56gm/cc
Optimum moisture content %	20%
CBR soaked and cured values	32%

Table 2.5: physical properties of GGBS:

Fig. 1: Chemical composition of GGBS:

F. Steel Fibre:

Steel fibre can be defined as individual, short length of steel having ratio of its length to diameter (i.e. aspect ratio) in the range of 50 with any of the several cross-section, and that are sufficiently small to be easily and randomly dispersed in fresh concrete mix using conventional mixing procedure. The fibre used her is crimpled end. Length of the fibre is 25 mm and diameter is 0.5mm.

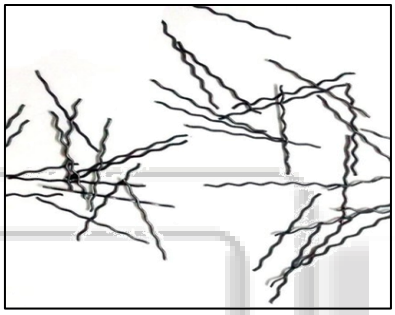


Fig. 2: Steel Fiber

III. EXPERIMENTAL PROCEDURE:

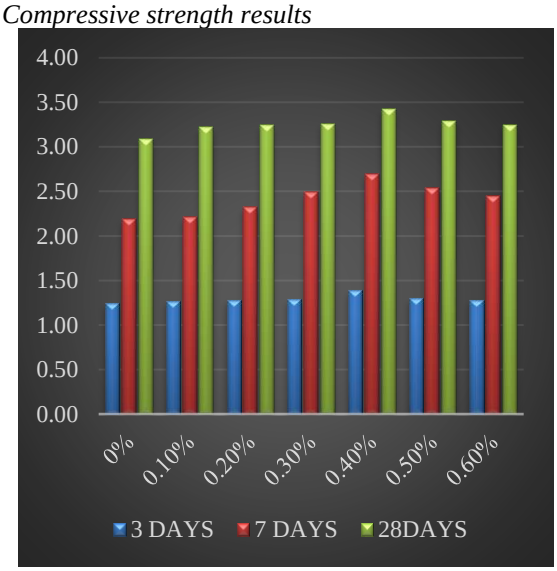
M30 grade of concrete is designed by following the code book IS: 10262 – 2009 with replacement of cement with ground granulated blast furnace slag and steel fibre. The mix proportion of M30 grade is 1:1.6:2.8:0.45 (Cement : fine aggregate : coarse aggregate : water) with water cement ratio of 0.45 and GGBS of 20% (by weight of cement).Steel fibre is added at varying percentages of 0%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5% and 0.6% by weight of cement. The specimen are casted for compressive strength, split tensile strength and flexural strength test. The specimens are cured in water for 28 days. The tests are done after 14 and 28 days of curing. Before testing the cubes they are removed from the curing and placed in the sunlight. T hen the tests are done accordingly:

IV. EXPERIMENTAL RESULTS:

A. Compressive Strength of Concrete

Compressive strength (N/MM^2)			
	3days	7-days	28-days
TBHFC0	12.45	21.91	30.97
TBHFC0.1	12.70	22.09	32.24
TBHFC0.2	12.79	23.24	32.49
TBHFC0.3	12.85	24.99	32.60
TBHFC0.4	13.24	26.98	33.24
TBHFC0.5	12.98	25.49	32.98
TBHFC0.6	12.80	24.58	32.44

1) Compressive strength results

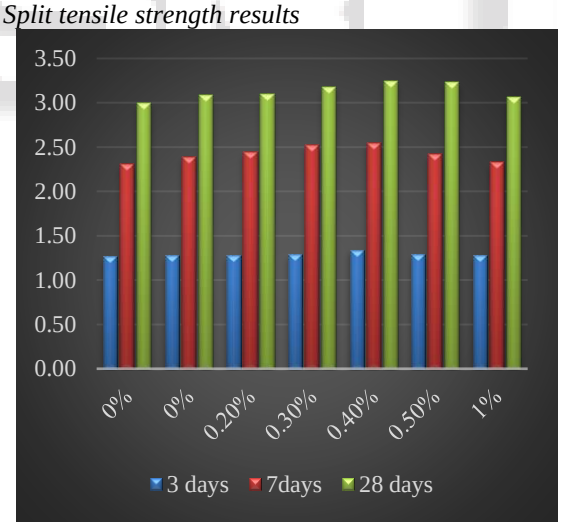


Graph 1: Compressive strength results graph

B. Split Tensile Strength of Concrete

	Split tensile strength(N/MM^2)		
	3-days	7-days	28-days
TBHFC0	1.27	2.31	3.00
TBHFC0.1	1.28	2.39	3.09
TBHFC0.2	1.28	2.44	3.10
TBHFC0.3	1.29	2.52	3.18
TBHFC0.4	1.34	2.55	3.24
TBHFC0.5	1.29	2.42	3.23
TBHFC0.6	1.28	2.33	3.06

1) Split tensile strength results

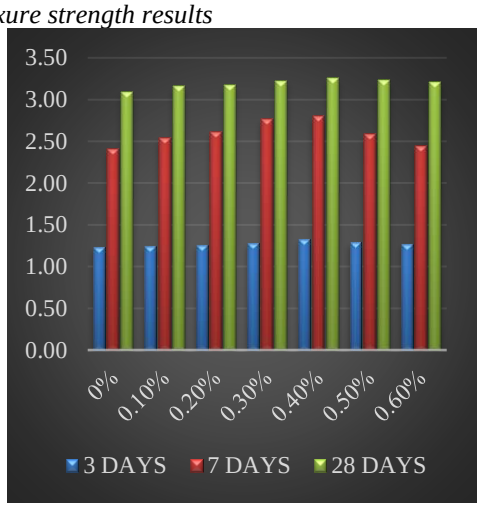


Graph 2: Split tensile strength results graph

C. Flexural Strength of Concrete

	Flexural strength(N/MM^2)		
	3-days	7-days	28-days
TBHFC0	1.23	2.41	3.09
TBHFC0.1	1.25	2.54	3.16
TBHFC0.2	1.26	2.61	3.17
TBHFC0.3	1.28	2.76	3.22
TBHFC0.4	1.32	2.80	3.25
TBHFC0.5	1.29	2.58	3.23
TBHFC0.6	1.27	2.44	3.21

1) Flexure strength results



Graph 3: Flexure strength results graph

V. CONCLUSION:

Based on the results provided above, the following conclusions can be drawn:

1) Compressive strength increases rapidly by the addition of steel fiber from 0.1 % - 0.6% (i.e., 0.1%, 0.2 %, 0.3%, 0.4%, 0.5% and 0.6%) with a constant addition of GGBS of 20% and there is a gradually decrease at after addition of steel fibers of 0.7 % and 1.0 %.
2) Split tensile strength increases rapidly by the addition of steel fiber from 0.1 % - 0.6% (i.e., 0.1%, 0.2 %, 0.3%, 0.4%, 0.5% and 0.6%) with a constant addition of GGBS of 0.2% and there is a gradually decrease at after addition of steel fibers at 0.7 % and 1.0 %.
3) Flexure strength increases rapidly by the addition of steel fiber from 0.1 % - 0.6% (i.e., 0.1%, 0.2 %, 0.3%, 0.4%, 0.5% and 0.6%) with a constant addition of GGBS of 20% and there is a gradually decrease at after addition of steel fibers at 0.7 % and 1.0 %.

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[2] Aboutcivil.org. (2019). *Ordinary Portland Cement - Tests, Properties, Manufacture & Uses*. [online] Available at: https://www.aboutcivil.org/ordinary-portland-cement.html [Accessed 16 Apr. 2019].

A. IS CODES

[1] IS 456 -2000
[2] IS 10262-2019 (Mix design)
[3] IS 516 – 1959 (Methods of tests for hardened concrete)
[4] IS 5816 – 1999 (Split tensile test)
[5] IS 383 – 2016 (Coarse and Fine aggregate for concrete specifications)
[6] IS 2386 (Part – III) – 1963 (Methods of test for aggregates for concrete)

