International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 01,January-2015

Experimental Study on Strength Properties of Concrete using Steel Fibre and GGBS as Partial Replacement of Cement

Siddharth
Dept. of Civil Engineering,
PDA College of Engineering, Gulbarga.

Prof. Seetharam.Munnur
Dept. of Civil Engineering,
PDA College of Engineering, Gulbarga.

Abstract- **The present study focuses on the partial replacement of cement by waste material or by-product from manufacturing processes. The ground granulated blast furnace slag (GGBS) is a waste product from iron manufacturing industry, which is being used as partial replacement of cement in concrete because it has more cementitious properties. The fibres are generally used as resistance to cracking and strengthening of concrete, fibres are able to hold the concrete together even after wider cracking. The real contribution of the fibres is to increase the toughness of the concrete. In this experimental work the compressive strength, split tensile strength, flexural strength tests were conducted by adding ground granulated blast furnace slag (GGBS) in various percentage of 0%, 10%, 20%, 30% and 40% to the weight of cement and 1% steel fibres of round crimped type having aspect ratio 54 were used. From the test results it can be conclude that strength of the concrete increases with the increase of GGBS upto 40% and also increase in load carrying capacity of 40% GGBS beams compare to conventional beams.From the overall study it can be conclude that there was improvement in the strength of concrete by addition of GGBS up to 40% with 1% of steel fibre(SF).**

Keywords – Ground granulated blast furnace slag (GGBS), Steel fibre, Compressive strength, Split tensile strength, Flexural strength.

I. INTRODUCTION

The cement production process is a more energy consuming process, which results in emission of carbon dioxide and other green house gases, these gases adversely effect on the environment. The production cost of cement is increases and natural resources giving the raw material for its manufacturing are decreasing. The Fly ash (FA), GGBS, Rice Husk Ash (RHA), Silica Fume (SF) are some of the pozzolanic materials which can be used in concrete as partial replacement of cement.The ground granulated blast furnace slag (GGBS) is a waste product from the iron manufacturing industry, which may be used as partial replacement of cement in concrete because its has more cementitious properties.Concrete is the most widely used structural material around the world, because of its higher compressive strength, low cost and can be easily manufactured with the locally available materials, but concrete weak in tensile strength.So, to increase tensile strength and resistance to cracks fibres are added, such type of concrete is known as fibre reinforced concrete. Fibre reinforced concrete increases the toughness and durability of concrete. Fibre reinforced concrete (FRC) is concrete containing fibrous material which increases its structural bonding. It contains short discrete fibres that are uniformly distributed and randomly oriented.

GGBS is a waste product in the manufacture of iron by blast furnace method. The molten slag is lighter and floats on the top of the molten iron. The process of granulating the slag involves cooling the molten slag through high-pressure water jets. This rapid cooling of slag results in formation of granular particles generally not larger than 5 mm in diameter. The granulated slag is further processed by drying and then ground to a very fine powder, which is GGBS (ground granulated blast furnace slag). Grinding of the granulated slag is carried out in a rotating ball mill.

Applications of Steel Fibres

- Airfields, Runways, Pavements and Storage Yards, and Bridges.
- Dams, Spillways, and Hydraulic Structure.
- Blast Resistant Structures, fire- protective shells
- Tunnel Lining and Slope Stabilization.
- Thin Shell, Wall, Pipes, and Manholes.

Advantages of Steel Fibre Reinforced Concrete (SFRC)

- Improvement in tensile & flexural strength.
- Improvement in ductility and toughness.
- Improvement in Blast resistance and Impact resistance.

II. EXPERIMENTAL PROGRAMME

MATERIALS USED:

Cement

Ordinary Portland Cement (43 grade) manufactured by Vasavadatta company from a single batch was used in the present experimental work. Properties of cement as shown in table 1.

Coarse aggregate

In the present investigationwork locally available crushed ballast stoneaggregates of maximum size is 12.5mm & 20mm were used.From local region crushed ballast stone of suitable size will be used.

Fine aggregate

Locally available sand was used in the present work. The sand belongs to zone-II as per IS 383-1970.

Ground granulated blast furnace slag

Ground Granulated Blast Furnace slag (GGBS) is using in this project as replacement of cement and it is procured from the steel plant BELLARY.physical properties and Chemical composition of GGBS (as per the company) as shown in table 2 and 3.

Water

Potable tap water available in the college was used in the present investigation for both casting and curing.

Steel Fibres

Shaktimaan steel fibres of round crimped type manufactured by M/s. Stewols India (P) Limited, Nagpur were used in the present experimental work. Steel fibres used in this project work were shown in table 4.

Table 1. Properties of Cement

Sl no	Properties	Results	Requirements as per IS:122689 - 1987
1	Specific gravity	3.15	-
2	Initial setting time(min)	45	Not less then 30
3	Final setting time(min)	230	Not more then 600
4	Normal consistency	32%	-
5	Fineness	3%	10%

Table 2.Physical Properties of GGBS

Sl no	Properties	Results
1	Colour	Off-white
2	Specific gravity	2.43

Table 3. Chemical Composition of GGBS

Constituents	In %
SiO_2	33.52
FeO	1.28
Al_2O_3	19.81
CaO	34.77
MgO	7.38
MnO	0.45
TiO_2	0.88
S	0.89
K_2O	0.39
Na_2O	0.23

Table 4. Properties of Steel Fibre

Length	30mm
Diameter	0.55 mm
Appearance	Clear & bright
Aspect ratio	54

MIX PROPORTION:For M_{20} Grade of concrete

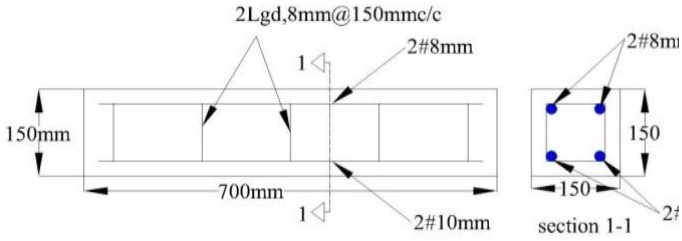
As per IS-10262 2009

W/C : C : FA : CA
0.55 : 1 : 1.939 : 3.368

DETAILS OF SPECIMENS CASTED :

Type of specimen	Mould size	Total no. of specimens
Cubes	150mmX150mmX150mm	40
Cylinders	150mm dia and 300mm ht	40
Prisms	75mmX100mmX500mm	40
Beams	150mmX150mmX700mm	6

Plate 1.concrete mix



Reinforcement details of beam specimens

III. RESULTS AND DISCUSSION

In this experimental investigation studied the strength properties of concrete with partial replacement of cement by GGBS powder and keeping constant 1% steel fibre. Results are shown in fig 1, 2 and 3.

NOTATIONS

Sl..No	Designation	% GGBS Replacement of cement
1	G 0	0
2	G 10	10
3	G 20	20
4	G 30	30
5	G 40	40
For beams		
1	CB	Conventional beam 0%
2	GB	GGBS beam 40%

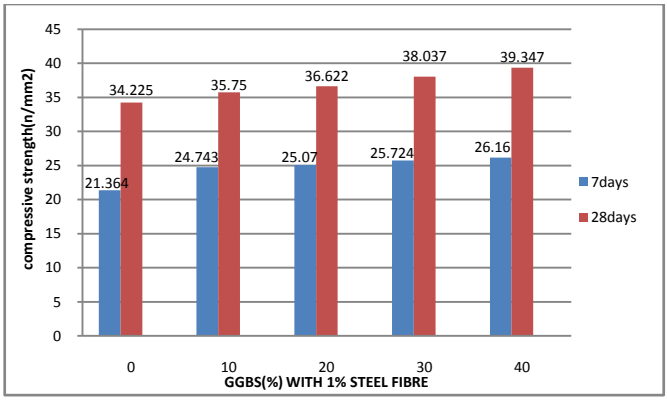


Fig1. compressive strength v/s different % of GGBS

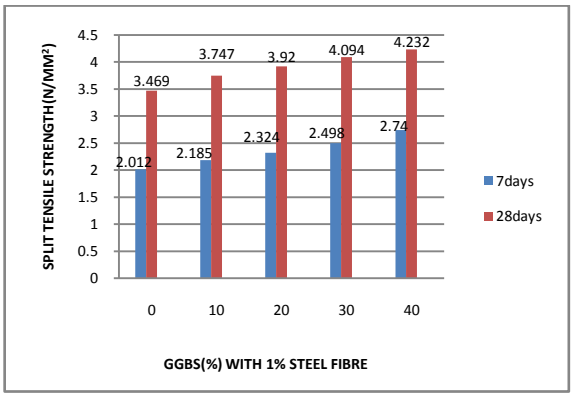


Fig2. split tensile strength v/s different % of GGBS

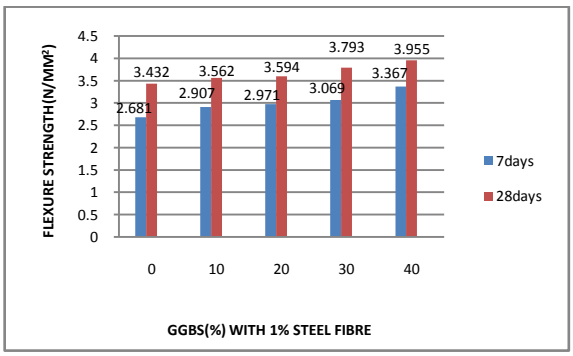


Fig 3. flexure strength v/s different % of GGBS

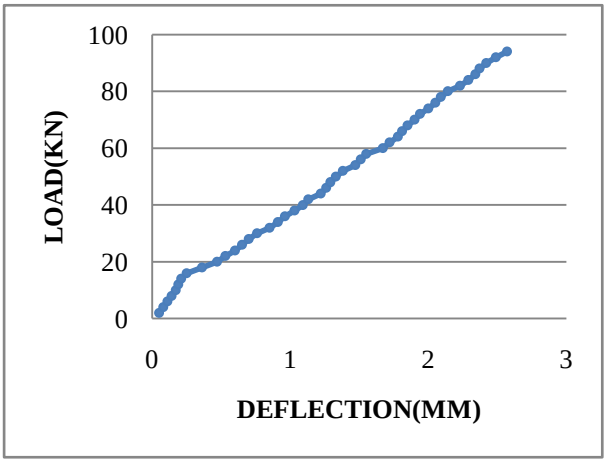


Fig4. Load v/s Deflection curve for CB

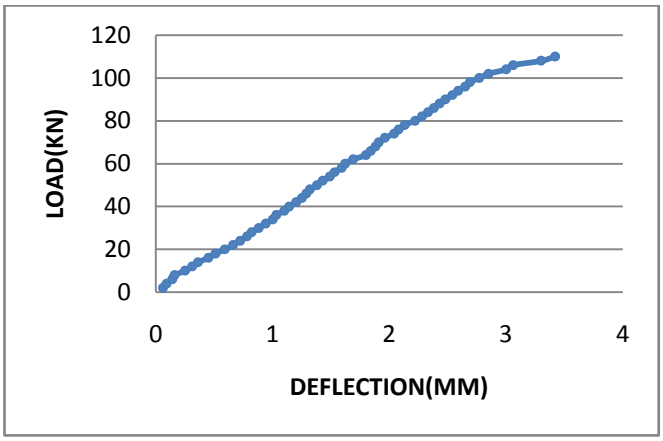


Fig 5. Load v/s Deflection curve for GB

FLEXURE STRENGTH TEST FOR BEAMS: The vertical flexure cracks were observed in the mid span of the beam and Crack formations were observed on the beam at every load interval, the first crack always appears close to the mid span of the beam. Final development of cracks and cracks at failure pattern of the test specimens for conventional beam (CB) and 40% GGBS with 1% SF beam (GB) as shown in plate 2 and 3 respectively. Load v/s deflection curve shown in fig 4 and 5. Results are shown in table 6.

Table 6. Load and Deflection results for CB and GB

Sl No	Designation	% GGBS Replacement of cement	Average Load (KN)	Average Deflection (mm)	Remarks	Average Flexural strength (N/mm^2) of Beams at 28 days
1	CB	0	26	0.77	First crack load and deflection	16.35
			93	2.76	Ultimate load and deflection	
2	GB	40	29	1.11	First crack load and deflection	19.31
			112	3.93	Ultimate load and deflection	

Plate 2.failure pattern of conventional concrete beam

Plate 3.failure pattern of 40% GGBS with 1% SF beam

IV. CONCLUSIONS

The following conclusions are made for GGBS at 40% and 1% SF with respect to conventional concrete.

1. Compressive strength and Split tensile strength of concrete increased about 13% and 18.20% respectively.
2. Flexure strength of prisms and beams increased about 15.16% and 15.32% respectively.
3. The partial replacement of cement by GGBS, not only provides the economy in the construction but it also facilitates successful utilisation of the GGBS which is generated in huge quantities from the steel industries.

REFERENCES

1. Mehta. P.K (2001), "Reducing the Environmental Impact of Concrete", pp. 61-66.
2. Oner and Akyuz, S (2006), "An Experimental Study on Optimum Usage of GGBS For the Compressive Strength of Concrete", Vol. 29, pp.507-508.
3. A.M. Shende1, A.M. Pande, M. GulfamPathan, "Experimental Study on Steel Fiber Reinforced Concrete for M-40 Grade"Volume 1, Issue 1 (September 2012), PP. 043-048.
4. Romualdi. J.P,& Batson. G.B, "Mechanics of crack arrest in concrete" Proceedings of ASCE, Vol-89, EM 3, June 1963, pp. 147-168.
5. S.P.Sangeetha, P.S Joanna, "Flexural Behaviour of Reinforced Concrete Beams with Partial Replacement of GGBS"American Journal of Engineering Research (AJER),Volume-03, Issue-01, pp-119-127.
6. AmitRana, "Some Studies on Steel Fiber Reinforced Concrete"International Journal of Emerging Technology and Advanced Engineering Volume 3, Issue 1, January 2013).
7. D.Neeraja, "Experimental Investigations on Strength Characteristics of Steel Fibre Reinforced Concrete" volume 4, issue 2, February-2013.
8. Indian standard Code of Practice for Plain and Reinforced Concrete, IS- 456: 2000, 4th Revision, Bureau of Indian Standards, New Delhi.
9. Indian standard recommended guidelines for Concrete Mix Design, IS 10262: 2009. 1st Revision, Bureau of Indian Standards, New Delhi.
10. Indian standard Specifications for coarse and fine aggregates from natural sources for concrete, IS 383-1970, Bureau of Indian Standards, New Delhi.