An Experimental Investigation on the Effect of Ggbs & Steel Fibre in High Performance Concrete

M. Adams Joe[1], A. Maria Rajesh[2]

[1]Associate Professor, Dept. of Civil Engineering, TREC, Nagercoil, Tamilnadu, India
[2]Assistant Professor, Dept. of Civil Engineering, ACEW, Nagercoil, Tamilnadu, India

ABSTRACT

The present paper focuses on investigating characteristics of M40 concrete with Various propotional of replacement of cement with Ground Granulated Blast furnace Slag (GGBS) and adding 1% of steelfibre. High Performance Concrete (HPC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituent sand normal mixing. This leads toexamine the admixtures to improve the performance of the concrete. Considering costof construction also drawn the attention of investigators to explore new replacements of ingredients of concrete. Ten mixes were studied with GGBS & Steel Fibre using a water binder ratio of 0.35 and super plasticizer CONPLAST SP-430. The cubes, cylinders and prisms were tested for both Compressive, Split tensile, Flexural and Pull out strengths GGBS can enhance the durability aspects of HPC compared to control mix. Among the mixes the mix with replacement level as 0%,10%,20%,30%,40% & 50% of GGBS and 1% steel fibre is better with respect to strength and durability. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. It is found that by the 40% replacement of cement with GGBS and steel fibre helped in improving the strength of the concrete substantially compared to Control concrete.

Keywords: *High Performance Concrete (HPC), Ground Granulated Blast furnace Slag (GGBS), Steel Fibre.*

I. INTRODUCTION

Concrete has been the major instrument for providing stable and reliable infrastructure since the days of the Greek and roman civilization. Concrete is a mixture of cement, water, and aggregates, with or without admixtures. Only for special applications the concrete grade can be increased to 40 Mpa and above. These special applications of high performance concrete (HPC) cannot be achieved by Ordinary Portland Cement (OPC). It is achieved not only by reducing water cement ratio but also by replacement of cement with some mineral admixture like Silica fume, Ground Granulated Blast Furnace Slag (GGBS), Metakaolin and Fly ash etc with chemical admixtures.

II. EXPERIMENTAL INVESTIGATION

2.1 Materials used

Ordinary Portland cement, 43 Grade conforming to IS:8112-1989[4].The specific gravity of cement was **3.15.**

2.1.1 Fine aggregate

Locally available river sand conforming to Grading zone II of IS: 383 1970[5].Its specific gravity was 2.56.

2.1.2 Coarse aggregate

Locally available crushed blue granite stones conforming to graded aggregate of nominal size 20 mm as per IS: 383 – 1970

2.1.3 Ground Granulated Blast Slag (GGBS)

Ground granulated blast furnace slag obtained from Nandi Steel, Bangulore . Ground granulatedblast-furnace slag is the granular material formed when molten iron blast furnace slag is rapidlychilled (quenched) by immersion in water. It is a granular product with very limited crystalformation, is highly cementitious in nature and, ground to cement fineness, and hydrates like portland cement.

2.1.4 Super Plasticizer

A commercially available sulphonated naphthalene formaldehyde based super plasticizer (CONPLAST SP 430) was used as chemical admixture to enhance the workability of the concrete.

2.1.5 Steel fiber (SF)

Corrugated steel fibres of aspect ratio 100:1 is used.

2.2Mix Proportion and Mix details

In this investigations IS Mix Design is adopted for Proportioning of Concrete Mix M40.This code presents a generally applicable method for selecting mixture proportion for high strength concrete and optimizing this mixture proportion on basis of trial

Adopting mix proportional are 1 : 1.09 : 1.89 : 0.35

2.3Test Specimens and Test procedure

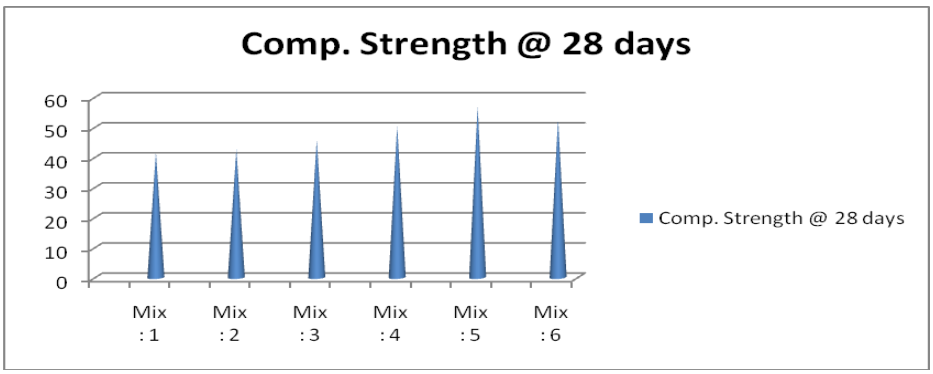
The concrete cubes of 150mm size, cylinders of size 150mm diameter and 300mm length and prism 500 X 100 X 100 mm size were used as test specimens to determine the compressive strength of concrete and split tensile strength and Flexural strength of concrete for the both cases i.e. normal concrete and modified concrete. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes and cylinders were properly compacted. All the mixes were prepared by mixing the concrete in laboratory mixer along with water and super plasticizer

III. RESULTS AND DISCUSSIONS

The compressive strength of concrete was determined at the age of 28 days. The specimens were cast and tested as per IS: 516-1959.

Table: 1 Comp. Strength @ 28 days

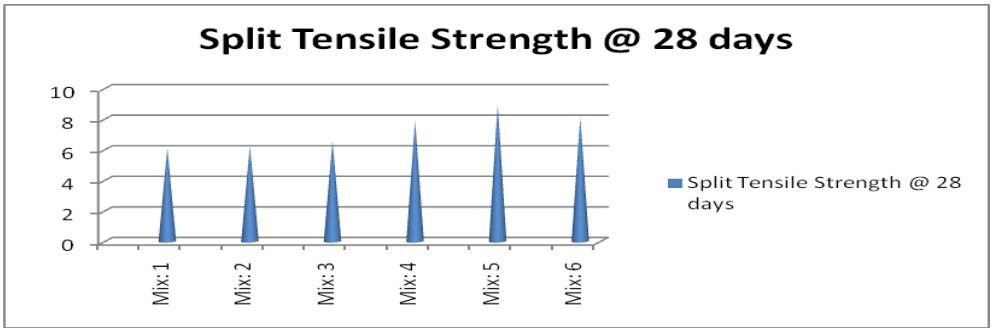
Mix	% of GGBS	% of Cement	Steel Fibre	% of Super plasticizer	Comp. Strength @ 28 days
M1	0	100	1	2	41.55
M2	10	90	1	2	42.60
M3	20	80	1	2	45.85
M4	30	70	1	2	50.45
M5	40	60	1	2	56.85
M6	50	50	1	2	52.7



The splitting tensile strength of concrete cylinder was determined based on IS: 516-1959. Load is applied until the specimen fails, along the vertical diameter.

Table: 2 Split Tensile Strength @ 28 days

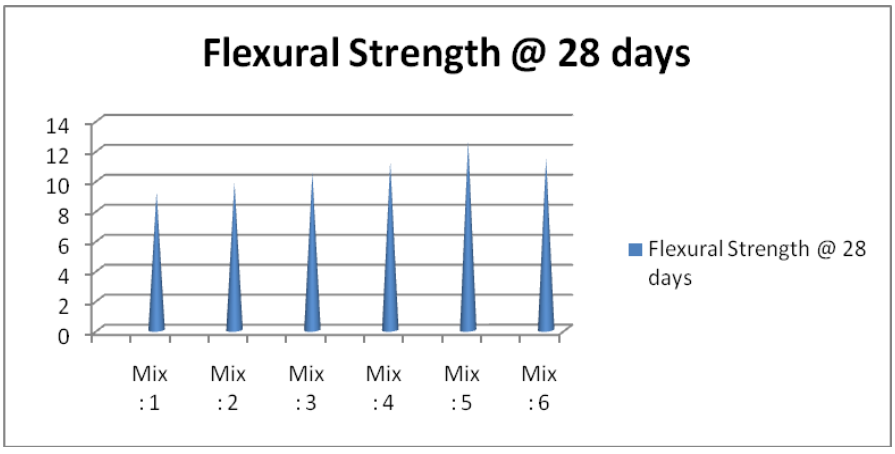
Mix	% of GGBS	% of Cement	Steel Fibre	% of Super plasticizer	Split Tensile Strength @ 28 days
M1	0	100	1	2	6.10
M2	10	90	1	2	6.25
M3	20	80	1	2	6.55
M4	30	70	1	2	7.90
M5	40	60	1	2	8.95
M6	50	50	1	2	8.10



The Flexural strength of concrete was determined at the age of 28 days. The specimens were cast and tested as per IS: 516-1959.

Table: 3 Flexural Strength @ 28 days

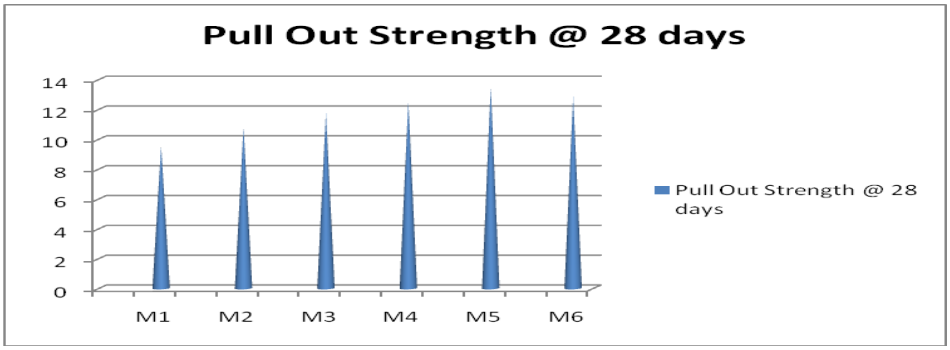
Mix	% of GGBS	% of Cement	Steel Fibre	% of Super plasticizer	Flexural Strength @ 28 days
M1	0	100	1	2	9.20
M2	10	90	1	2	9.85
M3	20	80	1	2	10.50
M4	30	70	1	2	11.20
M5	40	60	1	2	12.6
M6	50	50	1	2	11.5



The Pull out strength of concrete was determined at the age of 28 days. The specimens were cast and tested as per IS: 516-1959.

Table: 4 Pull out Strength @ 28 days

Mix	% of GGBS	% of Cement	Steel Fibre	% of Super plasticizer	Pull Out Strength @ 28 days
M1	0	100	1	2	9.50
M2	10	90	1	2	10.78
M3	20	80	1	2	11.76
M4	30	70	1	2	12.55
M5	40	60	1	2	13.5
M6	50	50	1	2	12.85



The optimum percentage levels of 40% GGBS and 1% Steel fibre replacement to the weight of the cement is taken with the HPC M40 mix ratio of 1 : 1.09 : 1.89 : 0.35 which gave the better results. In order to increase the workability, Superplasticizer is used. The Compressive strength of 56.85 N/mm2 is achieved in the HPC mix due to the presence of GGBS which exhibits more filler effect. Graph 1, 2,3 and 4 represents the compressive strength, split tensile strength, flexural strength Pull out strength of various mixes with different replacement level of GGBS and steel fibre at the age of 28 days.As there was an appreciable increase in the workability of concrete with increasing percent replacement of cement with GGBS, therefore wlc ratio can be reduced keeping the slump constant, which will result in an increase in compressive strength. The Split tensile strength of 8.95N/mm2 , Flexural strength of 12.6 N/mm2 and Pull out strength of 13.5 N/mm^2 is achieved by the usage of Superplasticizer and properties of steel fibre in the HPC mix.

IV. CONCLUSION

[1]. It is observed that the Optimum Compressive Strength of High Performance Concrete is obtained replacement of 40 % Cement by GGBS
[2]. From the above experimental results it is proved that, GGBS can be used as alternative material for the cement. Based on the results the compressive , split tensile, flexural and Pull out strengths are increased as the percentage of ggbs increased upto 40 % and above decrease.
[3]. Higher strength development is due to filler effect of GGBS and properties of steel fiibre
[4]. GGBS can be used as one of the alternative material for the cement.
[5]. From the experimental results 40% of cement can be replaced with GGBS.

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