MECHANICAL PROPERTES OF CONCRETE WITH PARTIAL REPLACEMENT OF GGBS AND ADDITION OF STEEL FIBER

Jyoti B Hosur[1], Mallaraddi A Meti[2], Varsha G B[3], Umesh Hooli[4], Chaitra M N[5]

[1234]*UG Student, Dept. of civil engineering, S.T.J.I.T College, Ranebennur, Karnataka, India.*
[5]*Asst Professor, Dept. of civil engineering, S.T.J.I.T College, Ranebennur, Karnataka, India.*

Abstract - *To study the behavior of steel fiber and ground granulated blast furnace slag (GGBS) on concrete strength characteristics of a high-strength test program has been accomplished. Different concrete mixtures were cast and tested with 40% replacement of cement by GGBS and steel fibers are added with increment of 0.5% i.e (0 %, 0.5 %, 1 %, 1.5 %, and 2% by volume of concrete). High strength concrete (HSC) is a concrete meeting special combinations of performance and uniformity requirements. This leads to examine the admixtures to improve the strength of the concrete. The usage of mineral admixtures in the concrete enhances the strength properties of concrete. The main objective of this study is to determine the optimal replacement percentages that can be appropriately used in Indian conditions. To find the optimal replacement of GGBS with the addition of steel fiber in M30 grade concrete with maintaining water cement ratio of 0.45. It was observed that, 40% GGBS and 1% of Steel fiber is optimum percentage replacement of cement in concrete. Present study aim to partially replace cement with natural pozzolanic material i.e. GGBS. The 28days compressive strength test, flexural strength test and split tensile strength test performed on the specimens have shown encouraging results.*

Key Words: GGBS, Steel fiber, compressive strength, split tensile strength, flexural strength and High strength concrete.

1. INTRODUCTION

Concrete is the versatile construction material that is widely used in structural works. In the last few decades, many researchers have been carried on the properties of concrete by using waste cementitious materials and by products. It is well known heterogeneous mix of cement, water, coarse aggregate and water. However, precast concrete members have been increasingly utilized in civil engineering construction due to their advantages: reliable quality assurance, simple production process, faster construction speed and environmentally friendly building operations. Environmental damage caused by the extraction of raw materials and CO_2 emission during cement manufacture. There is a need to economize the use of cement. One of practical solution is to optimize the use of cement is by replacing cement with pozzolanic waste material like wood ash, fly ash, GGBS. 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 it has more cementitious properties. Concrete is weak in tensile strength. So to increase tensile strength and resistance to cracks steel fibers are added. These materials are the miracle of present and tool for the future when the natural resources are on the verge of extinction.

2. OBJECTIVES

2.1 The objective of this work is to develop concrete with good strength. For this purpose, it requires the use of different hydraulic and pozzolanic materials like ground granulated blast furnace slag, and steel fiber. So the experiment carried out;

1. To study the mechanical properties of conventional concrete of grade M30.
2. To study the compressive strength of concrete by adding GGBS and steel fiber.
3. To study flexural strength of concrete by adding the GGBS and steel fiber.
4. To study the tensile strength of the concrete by adding GGBS and steel fiber.
5. Comparison between conventional concrete and concrete with steel fiber and GGBS.

3. MATERIALS USED

3.1. Cement:

In the present research work, ordinary Portland cement of 43 grade is used. The tests on cement were conducted in accordance with Indian standard confirming to IS 12269-1987.

Table.1. Properties of Cement

Properties	Results
Grade	OPC 43
Initial setting time	30min
Final setting time	320min
Normal consistency	34%
Specific gravity	3.15

3.2. Fine Aggregates:

Fine Aggregate Locally available river sand was used as fine aggregate.

Table.2. Properties Of Fine aggregate (River Sand)

Properties	Results
Specific gravity	2.47
Water absorption	1.0%
Fineness modulus	2.96

3.3. Coarse Aggregate:

Locally available crushed granite coarse aggregate having the maximum size of 20mm are used in this study. The aggregates are tested as per IS: 2386-1963

Table.3. Properties of Coarse Aggregate

Properties	Results
Specific gravity	2.10
Water absorption	0.1%

3.4. Water:

In this experiment work, Portable water is used.

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

Ground Granulated Blast-furnace Slag (GGBS): Ground granulated blast-furnace slag is the granular material formed when molten iron blast furnace slag is rapidly chilled (quenched) by immersion in water. It is a granular product with very limited crystal formation and is highly cementitious in nature. It is ground to cement fineness and hydrates like Portland cement, It is obtained by quenching molten iron blast furnace slag immediately in water or stream, to produce a glassy granular product that is then dried and ground into a fine powder. It is an excellent binder to produce high performance cement and concrete.

3.6 Steel fiber:

It is a small piece of reinforcing material and they are crimped.

4. EXPERIMENTAL PROCEDURE

M30 concrete is designed in accordance with the guidelines of code book IS 10262:2009 with replacement of cement by ground granulated blast furnace slag and steel fiber. The mix proportion arrived is 1:1.4:3 (C:FA:CA) with water cement ratio of 0.45 and GGBS dosage of 40% (by weight of cement). Steel fiber is added at varying percentages of 0%, 0.5%, 1%, 1.5% and 2.0% by weight of cement. The specimen are cast for compressive strength, split tensile strength and flexural strength test. The specimens are cured in water for 28 days. The specimens are removed from water. Then they are tested for their respective strengths.

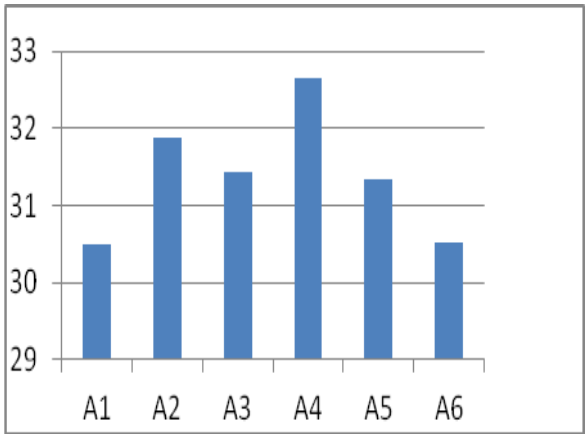
LOCATION:

1. CEMENT: Collected from Ranebennur.
2. FINE AGGREGATE: Collected from river bank (Harihar).
3. COARSE AGGREGATE: Collected from Hunasikatte quarry.
4. GGBS: Collected from Hospet.
5. STEEL FIBER: Collected from Mumbai site.

5. EXPERIMENTAL RESULTS

5.1 Compressive Strength Test Results

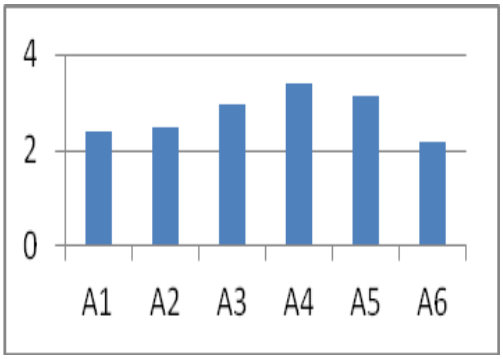
Mix Designation	Cement	GGBS	Steel fiber	Compressive strength
A1	100%	0%	0%	30.50
A2	60%	40%	0%	31.87
A3	60%	40%	0.5%	31.43
A4	60%	40%	1%	32.65
A5	60%	40%	1.5%	31.33
A6	60%	40%	2%	30.52



Graph 1. Compressive strength

5.2 Split Tensile Strength Test Results

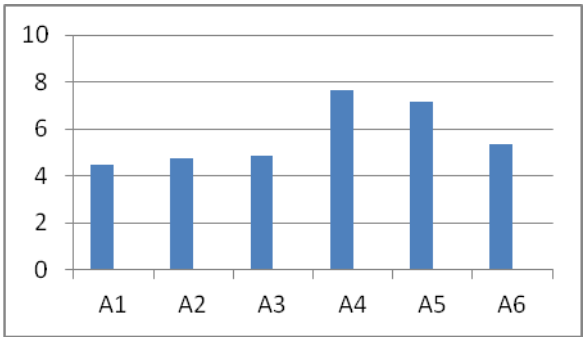
Mix Designation	Cement	GGBS	Steel fiber	Split tensile strength
A1	100%	0%	0%	2.38
A2	60%	40%	0%	2.49
A3	60%	40%	0.5%	2.98
A4	60%	40%	1%	3.39
A5	60%	40%	1.5%	3.12
A6	60%	40%	2%	2.17



Graph 2. Split tensile strength

5.3 Flexure strength test results

Mix designation	Cement	GGBS	Steel fiber	Flexural strength
A1	100%	0%	0%	4.50
A2	60%	40%	0%	4.75
A3	60%	40%	0.5%	4.85
A4	60%	40%	1%	7.65
A5	60%	40%	1.5%	7.16
A6	60%	40%	2%	5.33



Graph 3. Flexural strength

6. CONCLUSIONS

1. The use of GGBS (40% constant) as a partial replacement for cement and addition of steel fiber impart strength upto 1% of addition level and 40% of GGBS. Higher level addition of steel fiber leads to decrease the strength.
2. Replacement of 40% GGBS and addition of steel fiber increases the strength of concrete specimen to the maximum of 1% steel fiber.
3. Considering all the tests, results, it can be said that for M30 mix, 40% replacement of cement by GGBS and 1% steel fiber is considered as optimum.
4. For 20mm aggregate concrete 40% replacement of GGBS with concrete and 1% addition of steel fiber shows increase in strength by 2 to 3% .
5. The maximum compressive strength for replacement of cement with GGBS and the addition of steel fiber for 28days test is 32.65 which is obtained at 40% replacement of cement with GGBS and addition of 1% steel fiber.
6. Maximum split tensile strength for the cement replacement concrete 3.39, which is at 40% and 1% addition of steel fiber.
7. Optimum flexural strength of concrete is 7.65 for 28days at a replacement of 40% and addition of 1% steel fiber.

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