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Study on Behaviour of Self Compacting Concrete by Replacing Sand with GBFS at Sustained Elevated Temperature

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***Abstract*—Nowadays major scarcity in construction field is sand. The overuse of river sand for construction has various undesirable social and ecological consequences. Many researches are carried out to find alternative material for sand in concrete, one among such alternatives is GBFS. This study aims at investigating the possibility of replacing Granulated Blast Furnace Slag as a sand substitute in self-compacting concrete. In this investigation, natural sand is replaced by GBFS in various percentages (25%, 50%, 75% and 100%), with a constant water/cement ratio of 0.48. Mechanical properties such as compressive and split tensile strength were found by testing cubes and cylinders of 150x150mm and 150x300mm. The specimens were also tested at sustained elevated temperature (100ºc, 200ºc, 300º) for the duration of 2hrs.**

Keywords— Self Compacting, GBFS, Elevated Temperature

INTRODUCTION

In the fast growing construction industry self-compacting concrete has become the major constituent. Self-compacting concrete is a material which is used in suitable construction for placing concrete in difficult conditions and in places with congested reinforcement without any vibration. This concrete is proved to be economical.

Blast furnace slag is a non-metallic by-product produced in the process of iron making (pig iron) in a blast furnace and 300kg of Blast furnace slag is generated when 1 ton of pig iron produced. In India, annual productions of pig iron is 70-80 million tons and corresponding blast furnace slag are about 21-24 million tons.. Now in India, resources of natural sand are very lacking, it is necessary that the new fine aggregate was sought. The property of blast furnace slag is similar to natural sand, the price is cheap and the output is large too, could be regarded as the substitute of the natural sand.

In incidents like accidental fire concrete losses its properties of fire. It is of more importance to understand the change of properties of concrete due to temperature exposures. To predict the response of structure after exposure to high temperatures properties of concrete.

LITRETATURE REVIEW

Rajath u pole, M R Suresh (2014) : made an effort to study the behaviour of self-compacting by replacing the sand by foundry sand and granular blast furnace slag for M40 grade concrete. Mix proportions were found by trial and error method using European guidelines. 20%, 40%, 60%, 80% and 100% replacement were carried out, he found that at 100% replacement flow ability was pretty low. The strength was found to be same as normal SCC and decreased as the percentage of foundry sand increased.

Nileena M S, Praveen Mathew (2014): studied the effect on concrete by replacing cement and fine aggregate with GGBS and GBS. Percentage replacements were 30%, 40%, and 50%. Mix design was based on modified nansu method. Decrease in strength was observed for both compressive and split tensile tests compared to controlled specimens.

Mohammed Nadeem, Dr. A.D. Pofale (2012): made an effort to study on replacement of sand by granular slag in different percentages (25%, 50%, 75%, and 100%) in cement mortar applications. Results of study showed increase in compressive and split tensile strength of specime n upto 75% of replacement and crushing value also increased .

Ramadevi. K, Sindubala, Johnpaul.V: conducted tests on concrete by replacing sand by GBFS in in percentages (25%, 50%, 75% and 100%) and found maximum compressive and flexural strength of cubes and cylinders at 50% replacement.

OBJECTIVE OF STUDY

The main objective of the study is to check GBFS as an alternative for natural sand and to study its behaviour under sustained elevated temperature by exposing the specimen to temperature for the duration of 2 hours.

MATERIALS AND PROPERTIES

In this experimental study, Ordinary Portland cement 53 grade is used. The quantity of cement required for the experiments was collected from one single source and the bags were stored in nearly air tight container. Locally available river sand belonging to zone II of IS 383-1970 was used for the work, the particle size selected was less than 4.75mm. Granular blast furnace slag (GBS) less than 4.75mm is used. Coarse aggregate 12mm downsize confirming to IS 383-1970 is used. CONPLAST SP 430 is used as admixture with the addition of this admixture the flow able concrete with greatly reduced water content is obtained. Portable water free from impurities was used in the study.

Particulars	Properties
CEMENT	Specific gravity- 3.15 Normal consistency- 33% Initial setting time-60mins Final setting time-350mins
GBS	Specific gravity-2.76
RIVER SAND	Specific gravity-2.58 Water absorption-0.80
12 mm down size coarse aggregate	Specific gravity-2.65 Water absorption-1.20

METHODOLOGY

The main objective of the research program was to understand the strength and durability aspects of concrete obtained using iron slag as partial replacement for sand. In order to achieve the objectives of present study, an experimental program was planned to investigate the effect of iron slag on compressive strengthened split tensile strength of concrete. The experimental program consists of casting, curing and testing of controlled and iron slag concrete specimen at different ages.
The experimental program included the following:

- Estimating of properties of materials used for making concrete.
- Design mix (M30).
- Casting and curing of specimens.
- Tests to determine the compressive strength and split tensile strength.

Tests on fresh concrete

TESTS ON HARDENED CONCRETE

Compressive Strength of Concrete:

Cube specimens of size 150 mm x 150 mm x 150 mm were taken out form the curing tank at the age of 28 days and tested immediately on removal from the water (while they were still in the wet condition). Surface water was wiped off, the specimens were tested. The position of cube when tested was at right angle to that as cast. The load as applied gradually without shock till the failure of the specimen occurs and thus the compressive strength was found.

% replacement	0%	25%	50%	75%	100%
Slump flow	590 mm	590 mm	560 mm	450 mm	300 mm
V-funnel	7sec	9sec	10sec	18sec	25sec
L-box	0.85	0.70	0.60	0.50	0.45
Sieve segregation resistance	10%	12%	16%	25%	32%

Testing of specimen

Tested specimen

Split Tensile Strength of Concrete:

The split tensile strength of concrete is determined by casting cylinders of size 150 mm X 300 mm. The cylinders were tested by placing them uniformly. Specimens were taken out from curing tank at age of 28 days of moist curing and tested after surface water dipped down from specimens. This test was performed on Universal Testing Machine (UTM). The magnitude of tensile stress (T) acting uniformly to the line of action of applied loading is given by formula

$T = 0.637P/dl$

Where,

T = Split Tensile Strength in MPa

P = Applied load,

D = Diameter of Concrete cylinder sample in mm
L =Length of Concrete cylinder sample in mm.

Testing of specimen

Tested specimen

Results

Five specimens each were casted for every percentage of sand replacement .After 28days of curing, specimens were tested and average value was taken for compressive and split tensile strengths.

Compressive Strength

Sample	Average value N	fc (N/mm^2)
0%	742	32.97
25%	784	34.84
50%	830	36.88
75%	660	29.33
100%	588	26.13

Tab: 1 Compressive strength at room temp

Sample	Average value (N)	Fc (N/mm^2)
0%	814	36.17
25%	786	34.93
50%	766	34.04
75%	658	29.24
100%	520	23.11

Tab: 2 Compressive strength at 100ºc

Sample	Average value (N)	Fc (N/mm^2)
0%	972	37.68
25%	900	36.26
50%	756	34.75
75%	676	30.40
100%	516	23.00

Tab: 3 Compressive strength at 200ºc

Sample	Average value (N)	Fc (N/mm^2)
0%	972	43.20
25%	900	40.00
50%	756	33.60
75%	676	30.04
100%	516	22.93

Tab: 4 compressive strength at 300ºc

Tensile strength

Sample	Average value (N)	Fc (N/mm^2)
0%	150	2.12
25%	130	1.84
50%	140	1.98
75%	130	1.84
100%	130	1.84

Tab: 5 split tensile strength at room temp

Sample	Average value (N)	Fc (N/mm^2)
0%	140	1.98
25%	130	1.84
50%	120	1.69
75%	100	1.41
100%	100	1.41

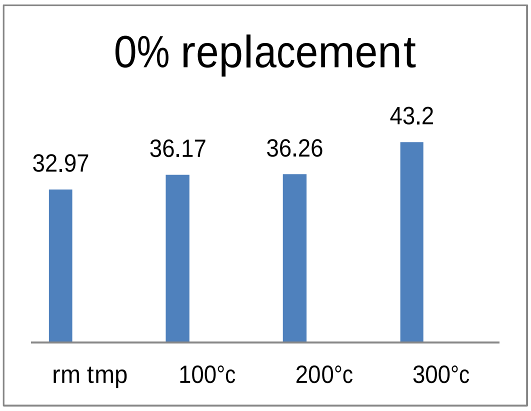
Tab: 6 split tensile strength at 100ºc

Sample	Average value (N)	Fc (N/mm^2)
0%	120	1.69
25%	100	1.41
50%	100	1.41
75%	90	1.27
100%	90	1.27

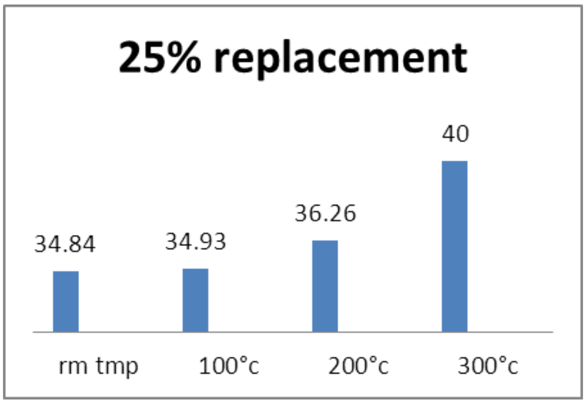
Tab: 7 split tensile strength at 200ºc

Sample	Average value (N)	Fc (N/mm^2)
0%	100	1.41
25%	100	1.41
50%	80	1.13
75%	70	0.99
100%	70	0.99

Tab: 8 split tensile strength at 300ºc



Compressive strength (Mpa)



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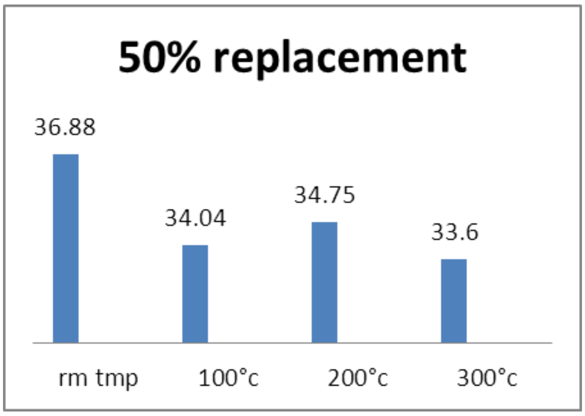

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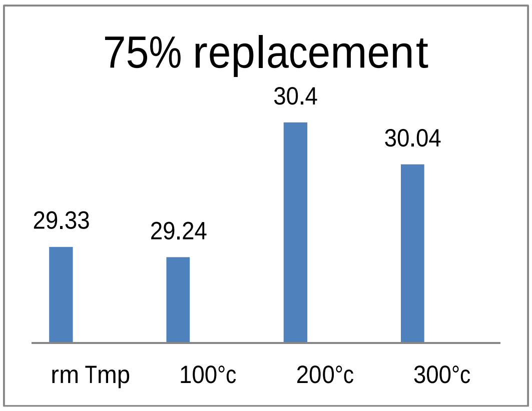

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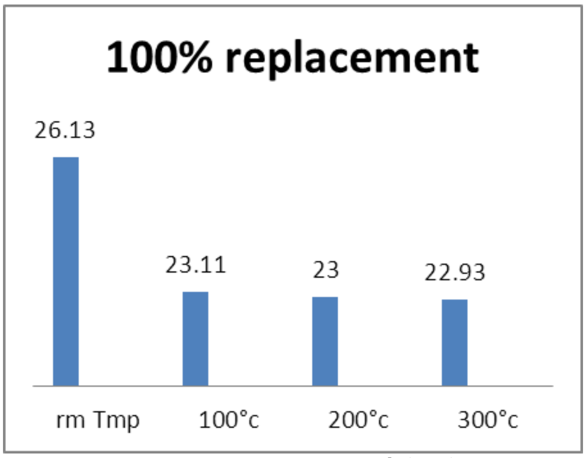

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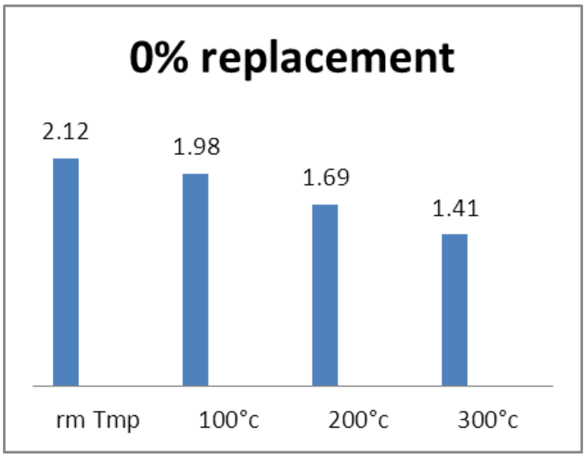

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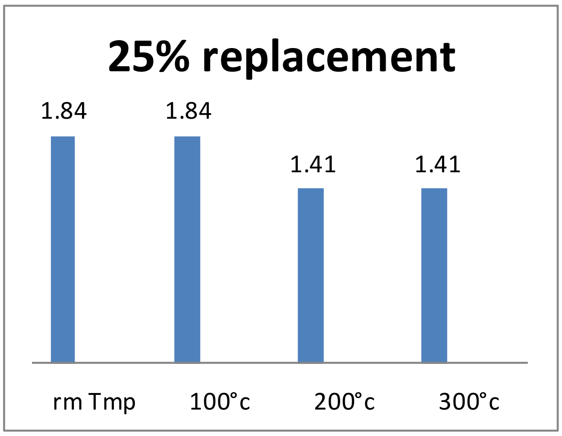

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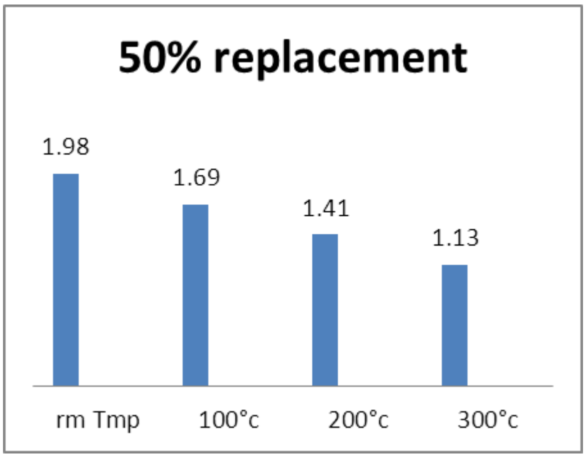

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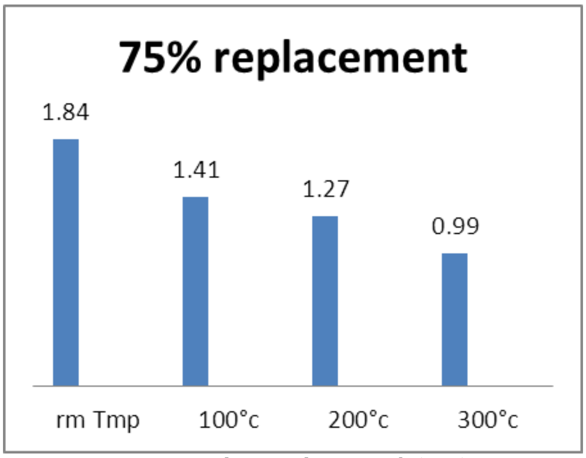

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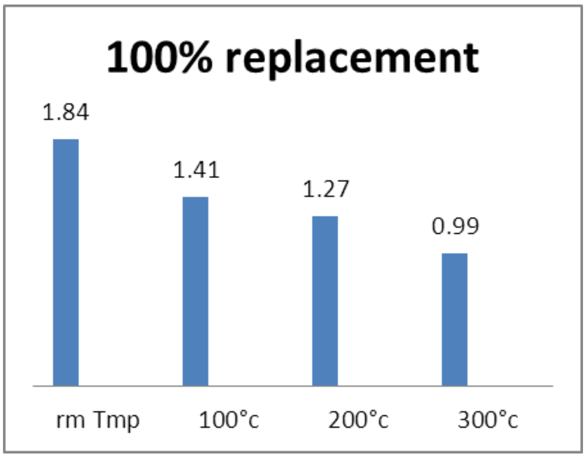

Split tensile strength (Mpa)

CONCLUSION

1. Workability of concrete was found to be good upto 50% of sand by GBFS.
2. Workability of concrete mix decreases above 50% replacements and almost lost its basic property of flow ability at 100% replacement.
3. At room temperature compressive strength gradually increases upto 50% replacement.
4. At 75% and 100% replacement of sand compressive strength decreased beyond designed strength of 30Mpa.
5. Compressive strength increases upto certain limit of replacement.
6. Maximum increase of compressive strength was attained at 50% replacement of sand at room temperature.
7. After 2hr duration at 100ºc compressive strength decreases as the percentage replacement increases.
8. Compressive strength decreased heavily at 75% and100% replacement at 100°C.
9. Compared to 100ºc compressive strength at 200ºc increases by small margin upto 50% replacement.
10. Compressive strength increases as the temperature increases upto certain percentage of replacement.
11. At 300°c temperature compressive strength increases more than that at 200ºc upto 50% replacement.
12. At room temperature split tensile strength of controlled specimen (0% replacement) was found to be more than any other percentage replacements.
13. At room temperature split tensile strength of all the percentage replacements was found to almost same
14. After 2hr at 100°c split tensile strength decreases gradually upto 100% replacement.
15. At 200ºc and 300°c split tensile strength decreases heavily compared to 100ºc.

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