Studies on Laboratory Investigation on Strength Properties of Concrete with Partial Replacement of Sand by GBFS

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Abstract— The present study focuses on the partial replacement of Sand by waste material or by-product from manufacturing processes. The ground granulated blast furnace slag (GBFS) is a waste product from iron manufacturing industry, which may be used as partial replacement of sand in concrete because it has little cementitious properties. In this experimental work the compressive strength, flexural strength tests were conducted by adding ground granulated blast furnace slag (GBFS) in various percentage was 0%, 25%, 50%, 75% and 100% to the weight of sand . From the test results it can be conclude that strength of the concrete increases with the increase of GBFS upto 50%. In this experimental work sixty cubes and sixty prism were casted and tested the maximum increased strength obtained up to 50% replacement of sand by GBFS compared to conventional concrete. The optimum replacement of GBFS is 75% which has marginal decrease in strength compared to 50%. But 75% replacement strength nearly matching with conventional concrete and 100% replacement has marginal decrease in strength compared to conventional concrete.

Key words: Cement, Natural Sand, GBFS Sand, Aggregate

I. INTRODUCTION

The most needed building material in the construction industry is concrete. The rapid increase in the annual consumption of natural aggregates due to the expansion of the construction industry worldwide means that aggregate reserves are being depleted rapidly, particularly in desert regions. It has been reported that, if alternative aggregates are not utilized in the near future, the concrete industry will globally consume 8-12 billion tons of natural aggregates annually after the year 2010. In India, natural river sand (fine aggregate) is traditionally used in mortars and concrete. However, growing environmental restrictions to the exploitation of sand from riverbeds have resulted in a search for alternative sand, particularly near the larger metropolitan areas. This has brought in severe strains on the availability of sand forcing the construction industry to look for an alternative construction material. A number of studies have been conducted concerning the protection of natural resources, prevention of environment pollution and contribution to the economy, by utilization of industrial by-products and waste materials in making concrete. The one major by-product of the steel industry is slag. Steel slag will lead to a sustainable concrete design and a greener environment.

II. EXPERIMENTAL PROGRAMME

A. Objectives:

It is aimed to study the performance of GBFS sand in the concrete with respect to the strength and durability properties.

Objectives of the experimental investigation are as follows:

- To study the mechanical properties such as compressive strength, flexural strength of concrete at the end of 7, 14 and 28 days of curing period using GBFS as fine aggregate at different replacement levels. The percentage replacement levels of river sand with GBFS used were 25, 50, 75 and 100.
- To compare the mechanical properties of GBFS concrete with that of conventional concrete.
- To determine the optimum replacement of GBFS by natural sand.

1) Materials used:

The materials used in this experiment were cement, GBFS, fine aggregate, coarse aggregate and water.

2) Cement:

OPC 53 grade cement from a single batch will be using throughout the course of the project work. The properties of cement used are shown in table

3) Fine Aggregate:

Locally available river sand belonging to zone II of IS 383-1970[15] will be using in this project work. The sieve analysis data and physical properties of fine aggregates used.

4) Coarse Aggregate:

Crushed ballast stone of size 12mm and 20mm down conforming to IS 383-1970[15]. Sieve analysis data and physical properties of coarse aggregate of 12mm are shown in table and that of 20mm are used.

5) Water:

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

6) GBFS:

Granulated steel blast furnace slag used in this present investigation was procured from JSW steel plant, Bellary and is shown in Fig.1 Both natural sand and GBFS sand belonged to zone II gradation mentioned on IS 383-1970

7) Mix Proportion of Concrete:

Sand replacement levels of 0%, 25%, 50%, 75% and 100% were used in the Investigation. Different mix proportion used are shown in table.

Material Used	**Sand replacement by GBFS**				
	0%	**25%**	**50%**	**75%**	**100%**
Water	197	197	197	197	197

Cement	438	438	438	438	438
GBFS	0	169.25	343.5	522.75	707
Sand	667	507.7	343.5	174.25	0
Coarse aggregate	1162	1162	1162	1162	1162
Density of concrete	2464	2474	2484	2494	2504

Table 1: Mix proportions for different mixes for water cement ratio = 0.45

Fig. 1: View of Granular slag sand & natural sand

Fig. 2: Curing of 28 days specimens

III. RESULT AND DISCUSSION

A. Compressive Strength:

The result of compressive strength test are tabulated in Table 2 From the result it was observed that the compression strength of the concrete increases with increase in the replacement level of sand by GBFS sand up to 50% , beyond 50% replacement levels there was a marginal decrease in the strength of the concrete.

For 7 days curing period, the strength of the concrete is increased about 4.83%, 11.77% and 5.40% for 25%, 50% and 75% decreased about 3.48% for 100% replacement level respectively when compared with that of conventional concrete.

For 28 days curing period, the strength of the concrete increased about 4.11%, 14.86% and 14.77% for 25%, 50% and 75% decreases about 0.06% for 100% replacement level respectively when compared with that of conventional concrete. At 75% replacement levels of sand the compressive strength of both GBFS concrete and control concrete were similar. From the results the optimum sand replacement level with GBFS was found to be 75%. The variation of the compressive strength with the age of the curing period and variation of the replacement proportion are shown in Fig 3 and Fig 4 respectively. The failure pattern of cubes is shown in the plate.

Designation	**Compressive strength in N/mm2**		
	7 days	**14 days**	**28 days**
GS 0%	35	42	45.17
GS 25%	36.78	44.94	47.11
GS 50%	39.67	49.3	53.06
GS 75%	37	47.17	53
GS 100%	33.78	39.5	45.2

Table 2: Compressive strength of cubes

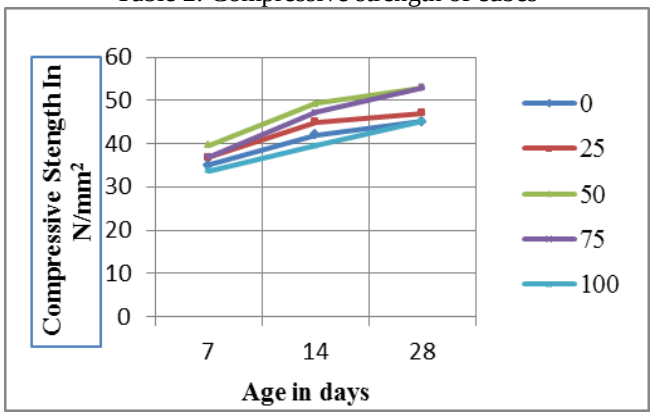

Fig. 3: Compressive strength V/s Age in days

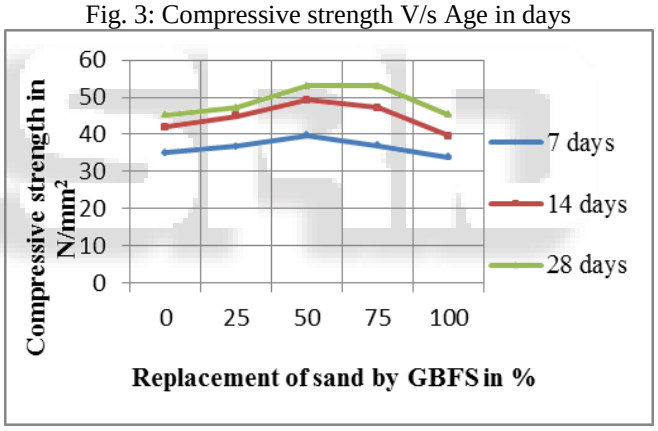

Fig. 4: Compressive strength V/s Replacement of sand by GBFS

B. Flexural Strength:

The results of flexural strength test are tabulated in Table 3 .From the result it was observed that the flexural strength of the concrete increases with increase in the replacement level of sand by GBFS up to 50%, beyond 50% replacement level there was a marginal decrease in the strength of the concrete.

For 7 days curing period, the strength of the concrete is increased about 5%, 7.04% and 2.86% for 25%, 50% and 75% decreased about 8.82% for 100% replacement level respectively when compared with that of conventional concrete

For 28 days curing period, the strength of the concrete increased about 7.33%, 9.88% and 0.35% for 25%, 50% and 75% decreases about 8.63% for 100% replacement level respectively when compared with that of conventional concrete. At 75% replacement levels of sand the flexural strength of both GBFS concrete and control concrete were similar. From the results the optimum sand

replacement level with GBFS was found to be 75%. The variation of the compressive strength with the age of the curing period and variation of the replacement proportion are shown in Fig 5 and Fig 6 respectively. The failure pattern of cubes is shown in the plate.

Designation	Flexural strength in N/mm2		
	7 days	14 days	28 days
GS 0%	4.75	5.17	5.56
GS 25%	5.00	5.50	6.00
GS 50%	5.11	5.83	6.17
GS 75%	4.89	5.15	5.58
GS 100%	4.33	4.89	5.08

Table 3: Flexural strength of prisms

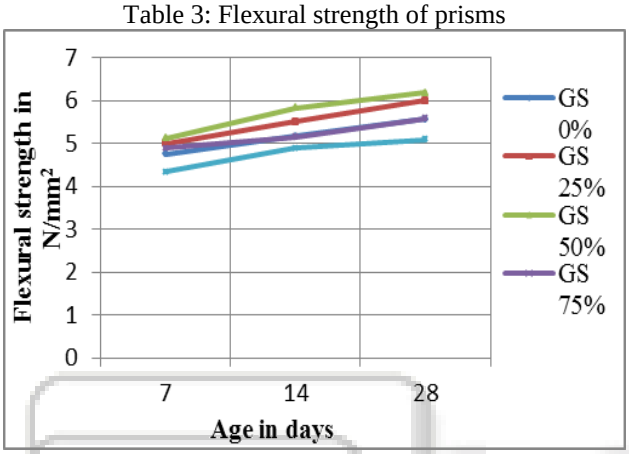

Fig. 5: Flexural Strength V/S Age in Days

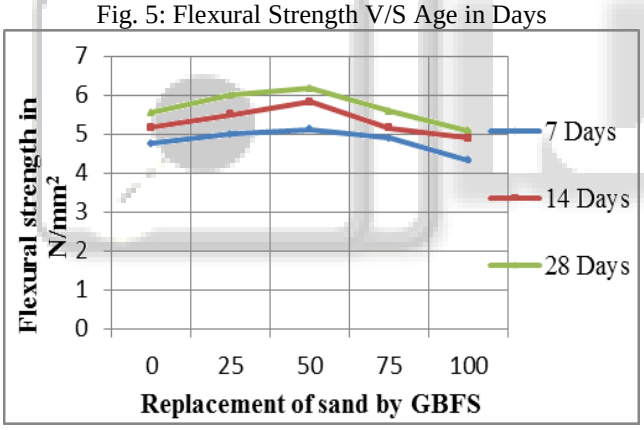

Fig. 6: Flexural strength V/s Replacement of sand by GBFS

IV. Conclusions

The experimental results obtained show that partial substitution of ordinary sand by granular slag gives better results over the verified range from 0, 25, 50, 75 & 100 % replacement. The conclusions are drawn as below.

1) From mechanical properties optimum sand replacement by GBFS was found to be 75%.
2) Compressive and flexural strength values showed increase up to 50% sand replacement level. At 75% sand replacement level mechanical properties were identical to that of control concrete. Beyond 75% all the strength values showed decrease when compared with that of control concrete.
3) The maximum percentage increase in compressive strength at 50% sand replacement was 14.86%. The corresponding increases in flexural and strength value were 9.88% for 28 days.
4) It can be concluded that concrete mix with sand replacement by GBFS sand will be an economical and environmentally sustainable option.

References

[1] Ansu John and Elson John "Study on the partial replacement of fine aggregate using induction furnace slag". American Journal of Engineering Research, Volume 4(2013), pp-01-05.
[2] Dongsheng Shi,Ping Han,Zheng Ma"Report of Experimented on compressive strength of concrete using Granulated blast furnace slag as fine aggregate". Advanced Materials Research .Vol.575 (2012), pp 100-103.
[3] Hisham Qasraw "Use of low Cao unprocessed steel slag in concrete as fine aggregate" Journal of Construction and Building material, Volume 23,Issue 2,February 2009, pp 1118-1125.
[4] IS: 8112-1989: Specification for 43-grade Ordinary Portland Cement, Bureau of Indian Standards, New Delhi,2001
[5] IS: 516-1959, Method of Tests for Strength of Concrete, Bureau of Indian Standard (Eleven reprint), New Delhi, 1985.
[6] IS: 383-1970: Specification for Coarse and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standards, New Delhi, 1993.
[7] IS 456-2000, Indian standard, plain and reinforced concrete-code practice.
[8] M.S.Shetty, Concrete technology text book

