Utilization of Granulated Blast Furnace (GBF) slag for replacement of river sand in civil construction

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SUITABILITY OF BF SLAG FOR REPLACEMENT OF RIVER SAND IN CIVIL CONSTRUCTION

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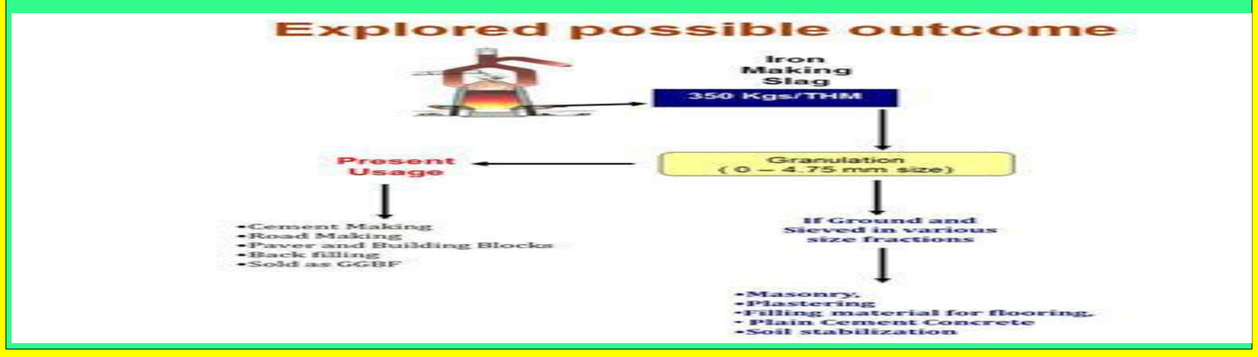
INTRODUCTION

Increasing needs of infrastructural development and declining supply of river sand due to its indiscriminate mining have led to explore other alternate material for construction purpose to reduce the consumption of scarce and expensive river sand. R&D RINL has taken initiative in this environmental concern and assessed the suitability of GBF Slag as an eco-friendly alternative to river sand .The chemical and physical properties of Granulated Blast Furnace (GBF) slag is more stable and consistent than those of river sand. Approximately BF slag production is one third of total hot metal produced. With a view to utilize BF slag in civil construction, the possibility of use of GBF slag as fine aggregate as replacement to river sand is taken up for study.

OBJECTIVE AND SCOPE

To assess the suitability of VSP BF slag as replacement of river sand in line with IS 383 for production of concrete for use in civil constructions

Scope covers various characterization of BF slag, carrying out tests as per guidelines of IS-383, lab scale experiment for M25 grade of concrete at various level of BF Slag and testing of its strengths, plant level trial.



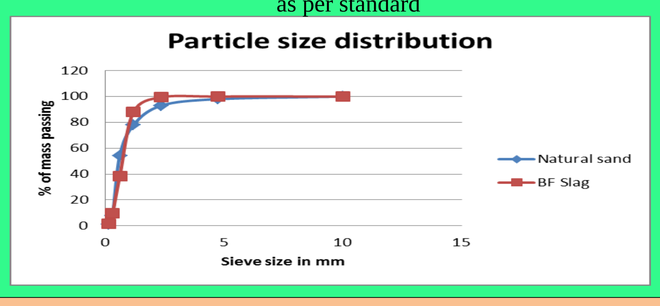
Typical chemical composition of VSP GBF slag

Constituents(%)	BF Slag
Al2O3	15.24
SiO2	37.14
FeO	0.26
TiO2	0.65
CaO	37.51
MgO	7.68
MnO	0.09
CaS	0.63

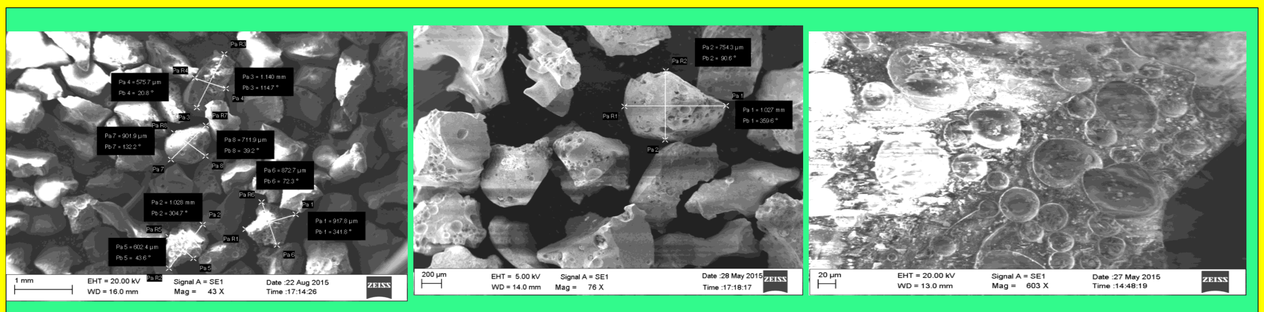
Sieve analysis of GBF slag

IS: Sieve Designation	Cumulative% BFS Retained	Passing	(% of passing) Zone-1	Zone-2	Zone-3	Zone-4
10.00 mm	0	100	100	100	100	100
4.75 mm	0	100	90-100	90-100	90-100	95-100
2.36mm	0.5	99.5	60-95	75-100	85-100	95-100
1.18mm	11.9	88.10	30-70	55-90	75-100	90-100
600 microns	61.7	38.30	15-34	35-59	60-79	80-100
300 microns	90.1	9.9	5-20	8-30	12-40	15-50
150 microns	98.3	1.70	0-10	0-10	0-10	0-15

The tested sample satisfies the requirement of grading Zone II as per standard



S. No	Test Conducted	Results	Requirements
1.	Sulphate as SO3, % max.	0.55	Max 0.22
2.	Chloride content, percent, max	0.016	Max. 0.04
3.	Water absorption, percent	3.50	5
4.	Specific gravity	2.15	2.1 to 3.2
5.	Coal and lignite (%)	nil	Max. 1.0
6.	Clay lumps (%)	nil	Max.1.0
7.	Materials finer than 75µm IS sieve (%)	1.0	Max.3.0
8.	Soft fragments (%)	nil	--
9.	Shale	nil	Max 1.0
10.	Total Deleterious material %(except mica)	1.0	Max.5.0
11.	Alkali aggregate reactivity (mill moles/litre.) (a)Reduction in Alkalinity of 1.0 N NaOH (b) Silica dissolved	300.00 57.93	The tests are carried out as per IS 2386.The samples do not indicate potential deleterious degree of Alkali reactivity



GBF particles with 43X | GBF particles with 76X | GBF particle surface 600X

EXPERIMENT

The samples containing different levels of as received GBF slag (0%, 25%, 50%, 75% and 100 %) as replacement of fine aggregate (river sand) were put into a mixing keeping others unchanged

After mixing thoroughly at ambient temp., 150mm x 150mm x 150mm size cubes (8 nos.) were made for the study as per standard procedure.

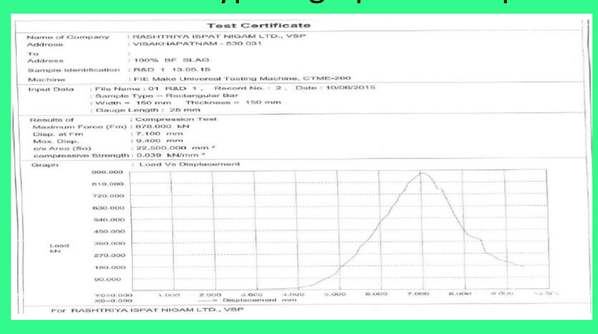
After water curing of samples for 7 days and 28 days, the compressive strength was tested

Typical Design mix of M25 concrete of $1m^3$

Sl. no	Aggregate	Quantity
1	Slag cement (33 grade IS 455)	373 kg
2	Water	168 liter
3	Coarse aggregate (-20mm)	797 kg
4	Coarse aggregate(-10mm)	468 kg
5	Fine aggregate	621 kg

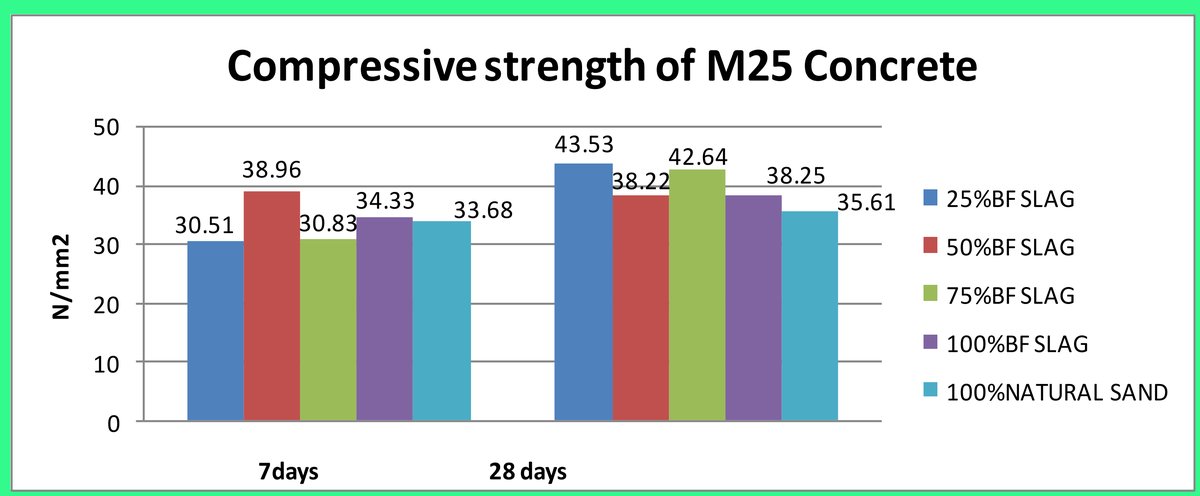
RESULTS AND DISCUSSION

Typical graph of compression test load vs displacement



CCS tested with 100% GBF slag concrete (28days curing)

CCS tested with 100% sand concrete (28days curing)



Comparison of CCS with different composition

CONCLUSIONS:

1.Using GBF slag as a replacement of fine aggregate(river sand) might prove an economical and environmental friendly.

2.Sieve analysis and particle size distribution of GBF slag of VSP is similar to normal river sand as per IS-383(Zone-II).

3.The Results of 25%, 50%, 75% and 100% replacement of river sand with blast furnace slag has given acceptable Cold Crushing Strength (CCS) in 7 days and 28 days of curing

4.The use of blast furnace slag (as fine aggregate) as a replacement for river sand has given higher compressive strength.

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