STUDY OF CONCRETE STRENGTH BY USING BLAST FURNACE (BF) & BASIC OXYGEN FURNACE (BOF) SLAG IN REPLACEMENT OF FINE AGGREGATE (NATURAL SAND)

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ABSTRACT

This paper reports the effect of Blast furnace (BF) and Basic oxygen furnace (BOF) slag on the properties of concrete. In this study, Blast furnace (BF) and Basic oxygen furnace (BOF) slag is physically characterized and separately replaced by 100% with Natural river fine aggregate and normal weight coarse aggregate, Ordinary Portland cement and drinking water were used to produce M_{20} concrete. The fresh properties of concrete like slump test and hardened properties like compressive strength of cubes for 7 and 28 days curing were carried out. The test results indicated that fresh and hardened properties of the concrete increases as the replacement of Blast furnace (BF) and Basic oxygen furnace (BOF) slag by Natural River sand. From this study it is observed that Blast furnace (BF) and Basic oxygen furnace (BOF) slag could be used as alternative construction material for natural sand in cement concrete applications.

Key Words: Alternate fine aggregate, Blast furnace (BF) slag, Basic oxygen furnace (BOF) slag, Compressive strength, workability.

I. INTRODUCTION

Concrete is a composite material composed of coarse granular material the aggregate or filler embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. It may be also defined as concrete is a homogeneous mixture of cement, fine aggregate, coarse aggregate, and water. An ever-evolving world requires innovative construction methods. One of the most widely used materials for construction is concrete. This is due not only to the wide range of applications that concrete offers, but also its great strength, affordability, durability, and versatility. Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it is able to be molded to virtually any form or shape. Concrete is also designed to

permit reliable and high quality fast-track construction. Structures built with concrete are more durable and can be engineered to withstand earthquakes, hurricanes, typhoons and tornadoes. This is an amazing advancement. Concrete is an incredibly useful and flexible building material without which modern architecture and construction would not be possible. Composed of cement, sand and coarser aggregates, concrete can easily be poured into forms and molds to create any number of shapes, yet quickly hardens to become a durable stone-like material. It is used in buildings, foundations, bridges, footings, roads and in many other applications. The Concrete Industry is very large consumer of natural resources like sand, gravel, crushed rock, etc as building material. Environmental restrictions of sand extraction from river beds have resulted in search for alternative sources of fine aggregate, particularly near the larger metropolitan areas. In this context we have conducted a study to check feasibility of use of Blast furnace (BF) and Basic oxygen furnace (BOF) slag as alternate to river sand in cement concrete.

II. OBJECTIVE OF WORK

Conduct laboratory experimental investigations for M_{20} grade concrete to evaluate effect of replacing Blast furnace (BF) and Basic oxygen furnace (BOF) slag with natural fine aggregate produced cement concrete (by weight of total fine aggregate). A comparison of these mixes property was studied with reference to 100% Blast furnace (BF) and Basic oxygen furnace (BOF) slag (as fine aggregate) mix. By preparing cubes to assess the performance of mix in fresh properties as well as hardened concrete properties.

III. MATERIAL PROPERTIES

3.1 Tests on Cement

Ordinary Portland cement conforming to IS: 8112-1989 was used. The properties are determined as per relevant Indian standards and the test results obtained are shown in table 1

Table -1: Physical Properties of Cement

Test	Result
Specific Gravity	3.15
Normal consistency (%)	29
Initial setting time(min)	150
Final setting time(min)	375
Fineness of cement (%)	1

3.2 Tests on Aggregates

3.2.1 Fine Aggregates (Sand)

Natural river sand as fine aggregate was used. The properties are determined as per relevant Indian standards and the test results obtained are shown in table 2.

Table -2: The Test Results on Fine Aggregate

Test	Result
Specific Gravity	2.62
Fineness modulus	2.96
Particles finer than 75 Micron (%)	1

3.2.2 Blast Furnace (BF) Slag

Blast furnace slag from JSW steel industries was used. The properties are determined as per relevant Indian standards and the test results obtained are shown in table 3.

Table -3: The Test Results on Blast Furnace Slag

Test	Result
Specific Gravity	2.54
Fineness modulus	1.10
Particles finer than 75 Micron (%)	1

3.2.3 Basic Oxygen Furnace (BOF) Slag

Basic Oxygen furnace slag from JSW steel industries was used. The properties are determined as per relevant Indian standards and the test results obtained are shown in table 4.

Table -4: The Test Results on Blast Oxygen Furnace Slag

Test	Result
Specific Gravity	3.41
Fineness modulus	1.21
Particles finer than 75 Micron (%)	1.80

3.2.4 Coarse Aggregates

Normal weight course aggregate was used. The properties are determined as per relevant Indian standards and the test results obtained are shown in table 5.

Table -5: The Test Results on Fine Aggregate

Test	Result
Specific Gravity	2.69
Crushing value (%)	23.54
Impact value (%)	29.90
Flakiness Index (%)	3.85
Elongation Index (%)	5.6

IV. MIX PROPORTIONING

According to IS 10262: 2009, the mix design was done for M_{20} concrete.

4.1 Design Mix Proportion

Table -6: Mix Proportion of M_{20} Concrete

Water Ltr/m^3	Cement Kg/m^3	Coarse aggregate Kg/m^3	Fine aggregate Kg/m^3	w/c ratio
186	372	1050	800	0.5

4.2 Density of Mixes

Table -7: Densities of Mix Proportion of M_{20} Concrete

	Age of cubes in days	Average weight in Kg	Volume of cubes in cum	Density of concrete
M_{20}-1	28	8.10	0.003375	2400
M_{20}-2	28	8.39	0.003375	2486
M_{20}-3	28	8.87	0.003375	2628

M_{20}-1- Concrete made using natural sand

M_{20}-2- Concrete made using BF slag

M_{20}-3- Concrete made using BOF slag

V. TEST RESULTS AND DISCUSIIONS

5.1 Slump Test

Table -8: Obtained Slump Values of Concrete

	Slumps in mm
M_{20}-1	30
M_{20}-2	75
M_{20}-3	220

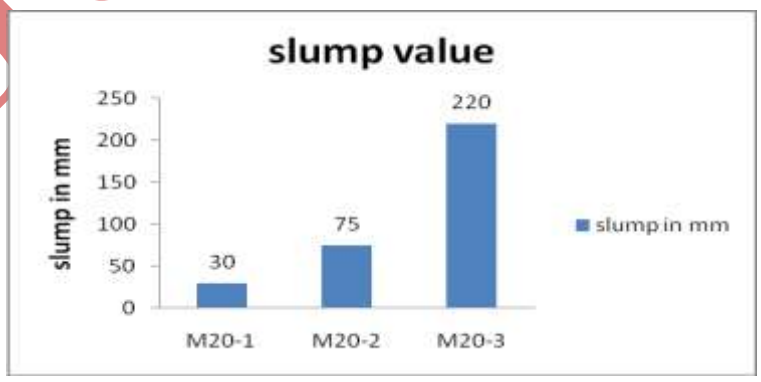

Chart -1: Obtained Slumps Values of Concrete

The Chart -1 indicates that, replacement of Blast furnace (BF) and Blast oxygen furnace (BOF) slag with natural river sand will increases the slump value.

5.2 Compressive Strength

Table -9 shows the average value of the compressive strength of M_{20}-1, M_{20}-2 and M_{20}-3 concrete. It is observed that there is a remarkable increase in the compressive strength of cubes after full replacement of Fine aggregate by BF and BOF slag.

Table -9: Obtained Compressive Strength Values of Concrete

Sample	Age of curing in days	Compressive strength in N/mm^2
M_{20}-1	7	20.97
	28	28.99
M_{20}-2	7	21.16
	28	28.82
M_{20}-3	7	23.22
	28	33.29

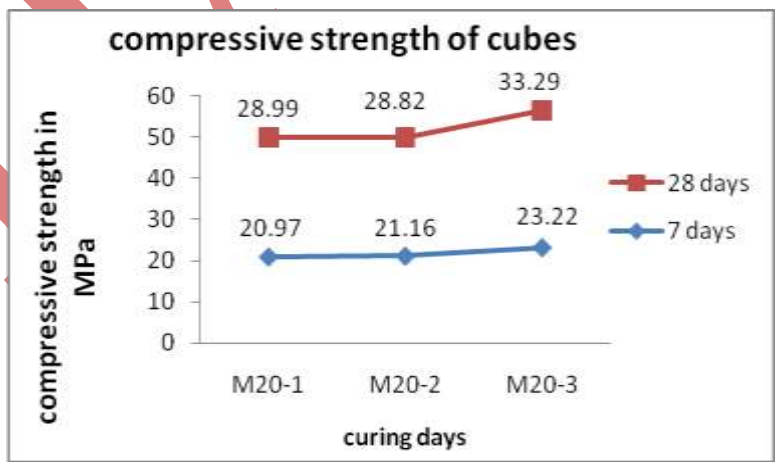

Chart -2: Obtained Average Compressive Strength Values of Concrete.

VI. CONCLUSIONS

From the present investigation, the following conclusion were drawn

- From the workability test, the concrete produced with BF slag (M_{20}-2) and BOF slag (M_{20}-3) based concrete gives higher slump value compare to natural sand (M_{20}-1) based concrete.
- From the obtained density, BF slag (M_{20}-2) and BOF slag (M_{20}-3) based concrete gives slightly greater density than concrete made with natural river sand (M_{20}-1).
- This comparative study indicated that Concrete produced by using BOF slag has yielded the greater Compressive strength when compared to Concrete produced by using BF Slag and natural river sand.
- Replacement of BOF slag and BF slag is possible only in the areas where its availability is abundant.
- It can be concluded that, the BF & BOF slag can be confidently and economically used in place of Natural Sand as fine aggregates to produce desired strength of Concrete as there is acute scarcity of natural sand, in the areas where BF & BOF Slag are abundantly available.

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