A COMPARATIVE STUDY ON EFFECT OF BASIC OXYGEN FURNACE SLAG AND IRON CUTTING WASTE ON STRENGTH PROPERTIES OF CONCRETE

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Abstract

Production of residues from industries and construction sector has increased during last few years. Much of these wastes have been thrown to land fill, without considering its potential for reuse and re-cycling as well. The aim of this practical work, is to study the properties and the respective strength that is (compressive strength) gained by M-20 Grade of concrete mix, prepared under controlled condition. The laborites test have follow the IS Standards. The results vary according to the proportions of supplementary constituent added to the mix. The substitution of cement concrete with basic oxygen furnace slag (BOFS) and then followed by iron cutting waste (ICW), produces a significant increase in compressive strength in both the cases i.e., by adding basic oxygen furnace slag & iron cutting waste.

The above said waste material not only makes the concrete mix prepared, suitable for use, but also improves the strength of mix and makes the mix economical as well. In the M-20 concrete mix, sand is replaced with BOF Slag and then with ICW in the varying range of 10%, 20% and 30% by weight. The test is carried out to evaluate the compressive strength of controlled M-20 Grade of mix after 7 and 28 days of casting.

Keywords: *Basic Oxygen Furnace Slag (B.O.F), Iron Cutting Waste (ICW) , Coarse and Fine Aggregate, Compressive Strength*

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1. INTRODUCTION

Nowadays vast research and development in the field of industries has transformed slag into modern industrial product which is effective and beneficial. Basic oxygen furnace slag (BOFS) is formed during the conversion of hot metal from the blast furnace into steel in a basic oxygen furnace. In this process the hot metal is treated by blowing oxygen to remove carbon and other elements that have a high affinity to oxygen. The slag is generated by the addition of fluxes, such as lime [stone] and/or dolomite that combine with silicates and oxides to form liquid slag. Some amounts of scrap are also added in order to control the temperature of the exothermal reactions. When the reaction process is complete, molten crude steel collects on the bottom of the furnace and the liquid slag floats on top of it. The crude steel and the slag are tapped into separate ladles/pots at temperatures typically above 1600°C. After tapping, the liquid slag in the pot can further be treated by injection of SiO_2 and oxygen in order to increase volume stability. The molten slag is then poured into pits or ground bays where it air-cools under controlled conditions forming crystalline slag. [1] It is observed that blast furnace and basic oxygen furnace slag could be used as alternative construction material for natural sand in cement and concrete application. In order to adjust the required technical properties for a specific use, different measures like weathering, crushing and/or sieving are performed on the crystalline slag. Basic oxygen furnace slag has increased skid resistance and high level of strength (described by the impact- and crushing value) compared to natural rocks (e.g. basalt) and thus makes it an ideal aggregate for road constructions and surface layers for high skid resistance. As like Basic Oxygen Furnace slag, the Iron Cutting Waste is being generated from the iron industries. Iron cutting waste is produced during the manufacturing process of galvanized iron steel pipe, at the stage of cutting. The cuttings are free of scale and are having consistent hardness and impart tensile strength to the concrete mix when added to it. It is one of the most common materials and is one of the least expensive co- products obtained during cutting process of steel pipes.

2. OBJECTIVE OF WORK

To present the development of the concept of partial replacement of sand with B.O.F slag & iron cutting waste.

To present the process of obtaining the B.O.F slag & iron cutting waste from the Iron Based Industries to assess the performance of BOF slag & iron cutting waste used in concrete mixtures with the different percentage of partial replacement of natural sand.

To compare the properties of BOF slag concrete and iron cutting waste concrete with the controlled concrete.

3. MATERIAL PROPERTIES

3.1 Tests on Cement

Ordinary Portland Cement (OPC) of 43 grade was used throughout the investigation. The tests were conducted to determine the properties of cement. Table -1 shows the physical properties of OPC which were evaluated from the experimental work.

Table 1- Physical properties of OPC

S.No	Property	Results
1	Fineness	3%
2	Soundness	1 mm
3	Setting time	Initial = 95 min , Final = 165 min
4	Specific gravity	3.15
5	Compressive strength	After 7 days = 34.2 MPa
		After 28 days = 44.22 MPa

3.2 Tests on Aggregates

3.2.1 Fine Aggregate (Sand)

The various properties of fine aggregates were assessed with IS 383:1970. Test Result Obtained are shown in Table -2

Table 2- Test Result of Fine Aggregate

Tests	Result
Specific Gravity	2.59
Fineness Modulus	2.67

3.2.2 Coarse Aggregates

The various properties coarse aggregates were assessed with IS 383:1970. Test Result Obtained are Shown in Table -3

Table 3- Test Result of coarse aggregate

Test	Result
Specific Gravity	2.64
Fineness Modulus	7.84

3.2.3 Basic Oxygen Furnace (BOF) Slag

Blast Furnace slag from "Bassi Steel industries" was used. The Properties were determined in the laborites and the obtained test results are shown in Table -4

Table 4- Test Result of Basic Oxygen Furnace Slag

Test	Result
Specific Gravity	3.09
Fineness Modulus	2.81

3.2.4 Iron Cutting Waste (ICW)

Iron cutting waste from "JTL infra limited" Industries was used. The properties and test result obtained are shown in Table -5

Table 5- Test Result of Iron Cutting Waste (ICW)

Test	Result
Specific Gravity	3.34
Fineness Modulus	2.48

4. MIX PROPORTIONING

The concrete mix has been prepared as per the I S code 10262:2009.The various replacement proportions has been adopted for this experimental study i.e. 10%, 20%, 30%. Fine aggregate were replaced with Basic Oxygen Furnace Slag and Iron Cutting Waste. Table 6 shows the various quantities of concrete ingredients with respect to their replacement level.

Table -6 Various Mix Proportions of M 20 Concrete

Replacement %	Water Ltr/ m^3	Cement Kg/ m3	Fine Aggregate Kg/m3	Coarse Aggregate Kg/m^3	W/C Ratio	BOFS (kg/ m3)	ICW (kg /m3)
0%	192	386	680	1134	0.5	----	----
10%	192	386	612	1134	0.5	68	----
20%	192	386	544	1134	0.5	136	----
30%	192	386	476	1134	0.5	204	----
10%	192	386	612	1134	0.5	-----	68
20%	192	386	544	1134	0.5	------	136
30%	192	386	476	1134	0.5	-----	204

5. RESULT & DISCUSSION

5.1 Density of Mixes

Table- 7 shows that the average weight of control mix is 8.15kg. As the percentage of BOFS slag increases subsequently the average weight of mix increase also. The same synaerio is observed in the case of iron cutting waste. The maximum average weight of cube has been observed with 30% ICW mix i.e. 8.795kg

Table - 7 Densities of Mix Proportions

Particulars	Age of cubes (days)	Partial Replacement of fine Aggregate (%)	Average Weight (Kg)	Volume of Cubes (cum)	Mass Density of Concrete (Kg/m^3)
M_{20}	28	0%	8.15	0.003375	2414
M_{20}BOFS	28	10%	8.370	0.003375	2480
M_{20}BOFS	28	20%	8.588	0.003375	2544
M_{20}BOFS	28	30%	8.631	0.003375	2557
M_{20}ICW	28	10%	8.526	0.003375	2526
M_{20}ICW	28	20%	8.732	0.003375	2587
M_{20}ICW	28	30%	8.795	0.003375	2605

5.2 Compressive Strength

The 7 & 28 days compressive strength of controlled mix and treated concrete i.e. basic oxygen furnace slag and Iron cutting waste replaced with 10% fine sand are shown in figure -1.

The compressive strength increases as compared to control mix as the percentage of Basic Oxygen furnace slag and iron cutting waste is increased. After adding 10% BOF slag in the mix, there is an increase of 30% strength after 7 days, and 37.03% increase after 28 days similarly after adding ICW in the mix, there is an increase of 37% strength after 7days and 47.03% increase after 28 days

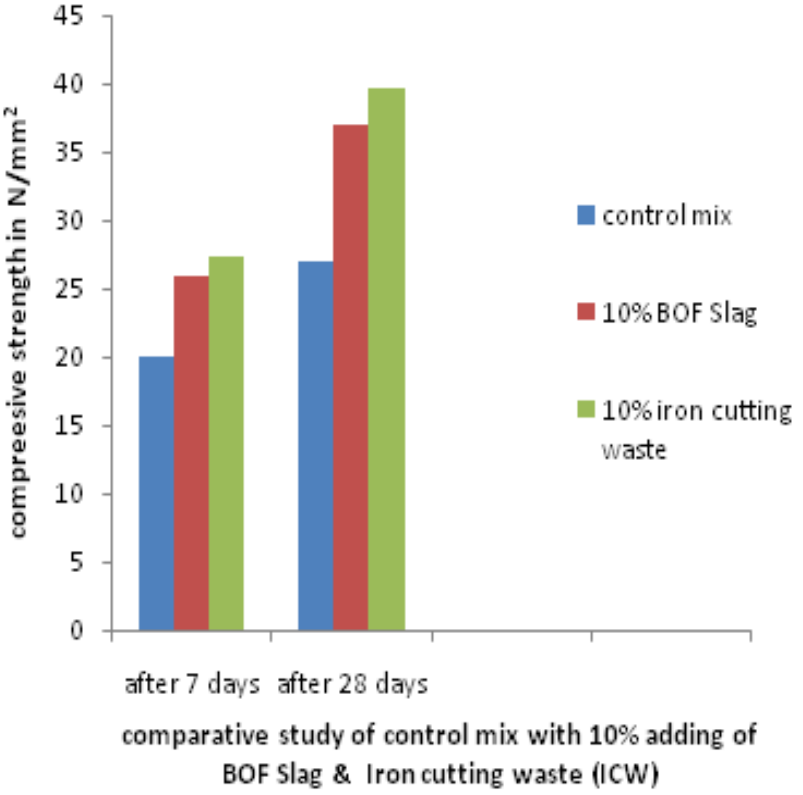
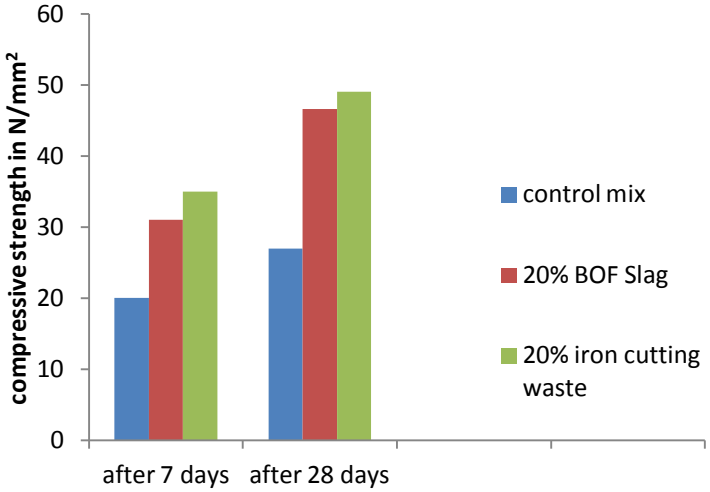


Figure -1 Comparison of 7& 28 days compressive strength.

5.2.1 Compressive Strength

The 7 & 28 days compressive strength of controlled mix and treated concrete i.e. basic oxygen furnace slag and Iron cutting waste replaced with 20% fine sand are shown in figure-2.

By adding 20% basic oxygen furnace slag, there is an increase in strength i.e. 55% strength after 7 days and 72.59% strength after 28 days. Similarly by adding iron cutting waste, there is large amount of increase the strength i.e. 75% after 7 days & 81.85% after 28 days.



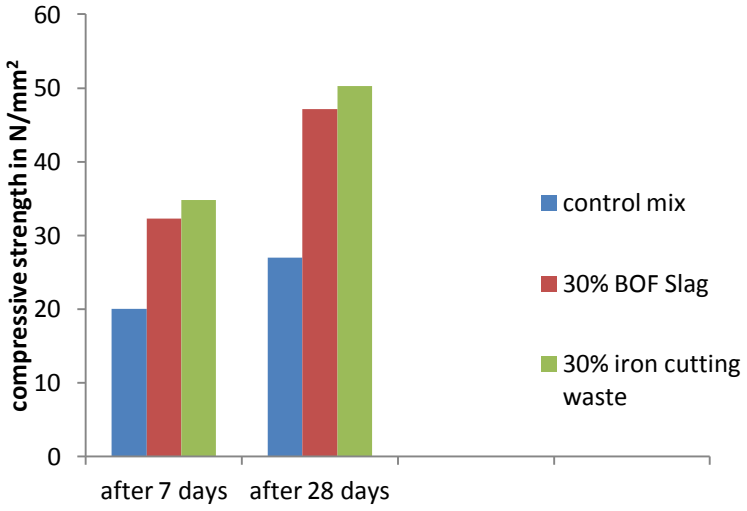
comparative study of control mix with 20% adding of BOF Slag & Iron cutting waste.

Fig- 2 Comparison of 7& 28 days compressive strength

5.2.2 Compressive Strength

The 7 & 28 days compressive strength of controlled mix and treated concrete i.e. basic oxygen furnace slag and Iron cutting waste replaced with 30% fine sand are shown in figure -3.

By adding 30% basic oxygen furnace slag, there is large amount of increase in percentage i.e. 61.4% after 7 days and 74.4% strength after 28 days. Similarly by adding iron cutting waste, there is also increase the strength i.e. 74% after 7 days & 86.29% after 28 days.



comparative study of control mix with 30% BOF Slag & Iron cuttimg waste (ICW)

Fig -3 Comparison of 7& 28 days compressive strength.

6. CONCLUSION

From present investigation, the following conclusion were drawn

1. The conducted test results revealed that the mass density of M_{20} grade of concrete under controlled conditions is least as compare to M_{20} concrete prepared with replacement of fine aggregate, with 10%, 20% 30% by weight of BOF Slag & ICW however, the mass densities of concrete prepared with composition of Iron Cutting Waste (ICW) shows an abrupt increase in the mass density as compared to BOFS concrete
2. Among BOFS and ICW, Iron Cutting Waste improves the strength of concrete with large amount.
3. From the above said points it is quite clear that both the raw material can be utilized to prepare a concrete mix with desired strength in an economical and safer way also the scarcity of natural sand is neutralized.

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