Study on Strength Properties of Concrete with Admixture Containing Copper Slag at Various Proportions

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***Abstract*- This paper investigates the effect of concrete with iron slag as admixture using copper slag as fine aggregate replacement. Owing to the scarcity of river sand and expensiveness of cement materials in concrete, partial or full replacement of copper slag with sand as it is having silica content as sand and partial replacement of cement with iron slag were performed as it is having similar binding and chemical properties of cement. The test results were obtained for M30 mix by adding copper slag to sand in various percentages ranging from 0%, 20%, 40%, 60%, 80% & 100% at 10% iron slag as a replacement with cement in concrete which is approved by Indian Standards. All specimens were cured for 7, 28 days before compressive strength test, split tensile test and flexural strength test and optimistic percentage of copper slag and ferrous slag was found.**

***Keywords*- Copper slag, iron slag**

I. INTRODUCTION

The current concrete construction practice is thought unsustainable because, not only it is consuming enormous quantities of stone, sand, and drinking water, but also two billion tons a year of Portland cement, which is not an environment friendly material from the standpoint of energy consumption and release of green-house gases (GHG) leading to global warming (**G. Moriconi**). Furthermore, the resource productivity of Portland -cement concrete products is much lower than expected because they crack readily and deteriorate fast. Since global warming has emerged as the most serious environmental issue of our time and since sustainability is becoming an important issue of economic and political debates, the next developments to watch in the concrete industry will not be the new types of concrete, manufactured with expensive materials and special methods, but low cost and highly durable concrete mixtures containing largest possible amounts of industrial and urban byproducts that are suitable for partial replacement of Portland cement, virgin aggregate, and drinking water.

II. MATERIALS AND METHODOLOGY

A. Materials

1. **Cement**- The cement used in this study was 53 grade (KCP) ordinary Portland cement (OPC). It is brought from aishwarya enterprises near Rajivnagar, Vizag. The properties of cement used in given table no.1 and Tested as per IS 456:2000

Table 1. Properties of cement

Sl. No	Descriptions	OPC(53G)
1	Fineness (%)	4
2	Normal Consistency (%)	34
3	Setting Time (minutes) a) Initial b)Final	a)25 b)300

2. Fine Aggregate: The properties of fine aggregate used are given in Table 2.

Table 2. Sand properties

Description	Sand
Fineness Modulus	2.731
Zone	II
Specific Gravity	2.621

3**. Course Aggregate**- Aggregates exhibit chemical bond at the interface of aggregate and paste. Aggregate of 20mm and 10mm in size and triangular in shape were used in casting the specimens. The properties of coarse aggregate used in table No.3

Table 3. Properties of coarse aggregate

Description	Sand
Fineness modulus (%)	**2.78**
Zone	**II**

Specific Gravity	**2.83**
Particle size (mm)	**10 20**

4. Copper slag: Chemical composition of CS are given in Table 4 (Prasanna Kumar C)

Table 4. Properties of copper slag

Composition	% By Weight
Al_2O_3	3.01
MgO	0.9
CaO	0.2
Na_2O	0.95
K_2O	1.02
FE_2O_3	55
SIO_2	35
CU	1

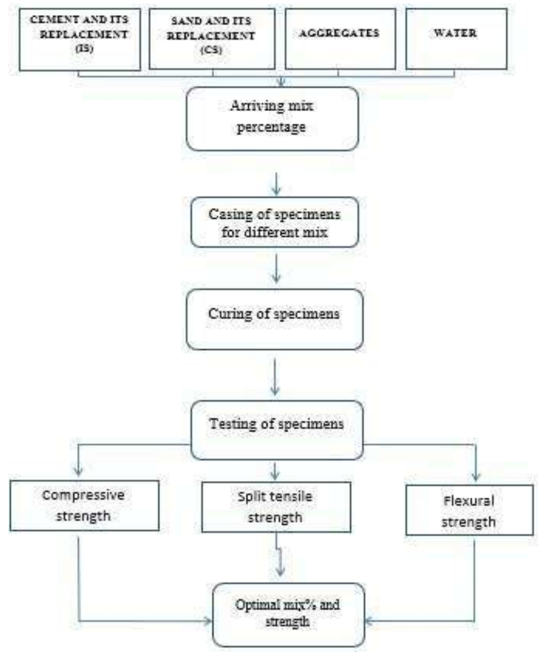
5. Iron slag: Chemical composition of Iron slag are given in Table 5 (Ayman M).

Table 5. Properties of iron slag

constituent	Composition (%)
Al_2O_3	2
MgO	5
CaO	45
SiO_2	15
Feo	25

Fig. 1 Materials

B. Methodology



M40 mix design was prepared according to IS 12062: 2009 and proportioning is done

Table 6. Mix proportioning

S.NO.	% OF REPLACEMENT MATERIAL FOR CEMENT	% OF REPLACEMENT MATERIAL FOR SAND	CEMENT (kg/m^3)	IRON SLAG (kg/m^3)	COARSE AGGREGATE (kg/m^3)	SAND (kg/m^3)	COPPER SLAG (kg/m^3)	WATER (LITRES)
1	0	0	425.73	0	1198.85	652.1	0	191.58
2	10	0	425.73	42.573	1198.85	652.1	0	191.58
3	10	20% IS	383.157	42.573	1198.85	521.68	130.42	191.58
4	10	40% CS	383.157	42.573	1198.85	391.26	260.84	191.58
5	10	60% CS	383.157	42.573	1198.85	260.84	391.26	191.58
6	10	80% CS	383.157	42.573	1198.85	130.42	521.68	191.58
7	10	100% CS	383.157	42.573	1198.85	0	652.1	191.58

III. EXPERIMENTAL WORK

A. Compressive Strength Test

Concrete is strong in compressive strength. For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15cm x 15cm x 15cm are commonly used

Fig.2 Compressive strength test

B. Split Tensile Strength Test

Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Fig.3 split tensile strength.

C. Flexural Strength Test

To determine the Flexural Strength of Concrete, which comes into play when a road slab with inadequate sub-grade support is subjected to wheel loads and / or there are volume changes due to temperature / shrinking

Fig.4 flexural strength

IV. RESULTS AND DISCUSSION

A. Compressive strength results

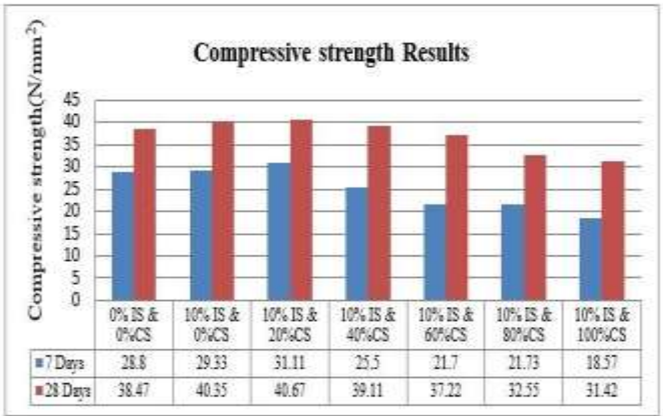
Table 7. 7 days compressive strength results

S No.	% Replacement MaterialsFor Cement With Iron Slag	% Replacement Materials For Sand	Compressive Strength(N/Mm^2)			
			Sample 1	Sample 2	Sample 3	Avg
1.	0	0	28.5	29	28.76	28.8
2.	10	0	28.04	29.24	30.71	29.3
3.	10	20	30.22	30.8	32.6	31.1
4.	10	40	25	26.9	24.67	25.5
5.	10	60	22.73	19.66	20.6	21.7
6.	10	80	22.6	18.12	19.6	21.7
7.	10	100	15.73	17.99	20.66	18.5

Table 8. 28 days compressive strength results

S No.	% Replacement MaterialsFor Cement	Replacement Materials For Sand(%)	Compressive Strength(N/Mm^2)			
			Sample 1	Sample 2	Sample 3	Avg
1.	0	0	38.4	38.8	38.22	38.4
2.	10	0	40.22	39.55	39.66	40.3
3.	10	20	39.62	40.66	40.82	40.6
4.	10	40	39.22	39.67	39.12	39.1
5.	10	60	36.55	37	38.2	37.2
6.	10	80	33.12	32.15	32	32.5
7.	10	100	31.66	32.1	31.09	31.42

Graph 1. Compressive Strength Results

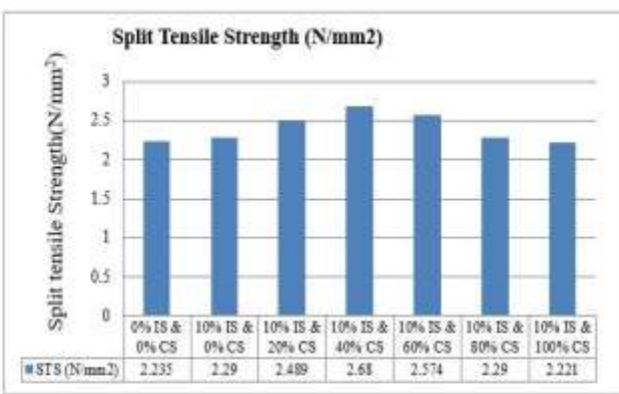


B. Split Tensile Strength Test Results

Table 9. 28 days Split tensile strength test results

S No.	% REPLACEMENT MATERIALS FOR CEMENT	% REPLACEMENT MATERIALS FOR SAND	SPLIT TENSILE STRENGTH(N/mm^2)
1.	0	0	2.235
2.	10	0	2.290
3.	10	20	2.489
4.	10	40	2.680
5.	10	60	2.574
6.	10	80	2.290
7.	10	100	2.221

Graph 2. Split tensile strength test results

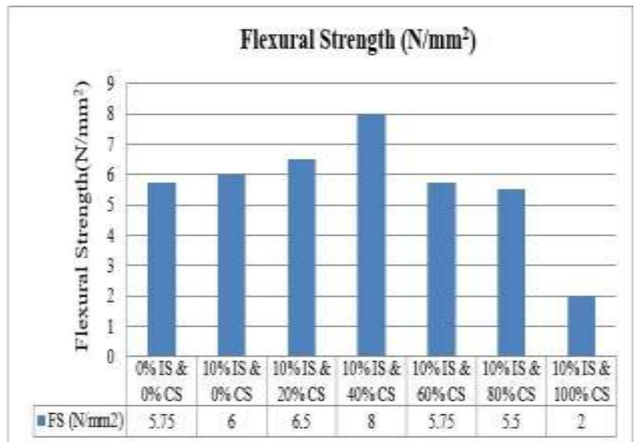


C. Flexural Strength Test Results

Table 10. flexural strength test results

S No.	% Replacement Materials For Cement With Iron Slag	% Replacement Materials For Sand With Coppper Slag	Flexural Strength (N/Mm^2)
1.	0	0	5.75
2.	10	0	6
3.	10	20	6.5
4.	10	40	8
5.	10	60	5.75
6.	10	80	5.5
7.	10	100	2

Graph 5. Flexural Strength Results



V. CONCLUSIONS

1. It has been observed according to published journals the strength has been increased at 40% replacement of sand with copper slag and even at 100% replacement there is no reduction in strength than conventional sample.
2. But according to the results obtained in this research it has been observed that the reduction in strength from 40% replacement of sand with copper slag compared to concrete containing 10% iron slag as cement replacement.
3. The compressive strength of concrete containing 20% copper slag as sand replacement and 10% iron slag as cement replacement has increased to 40.67 N/mm^2 which of the control concrete has its compressive strength as 38.67 N/mm^2.
4. The split tensile strength of concrete containing 20% copper slag as sand replacement and 40% iron slag as cement replacement has increased to 2.60 N/mm^2 which of the control concrete has its compressive strength as 2.235 N/mm^2.
5. The flexural strength of the concrete containing 40% copper slag as sand replacement and 10% iron slag as cement replacement has increased to 8 N/mm^2 which of the control concrete has its compressive strength as 5.75 N/mm^2.
6. Therefore, it has been concluded to use the copper slag as sand replacement in concrete to get sustainable and economical construction

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