Experimental Study on concrete using Copper Slag as Replacement Material of Fine Aggregate

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Abstract - *This paper reports the effect of concrete using copper slag as replacement of fine aggregate. In this project work, M25 grade of concrete was taken for concrete mix design. The properties and characteristics of materials for cement, fine aggregate, coarse aggregate and copper slag was studied for concrete mix design. The compressive, split tensile and flexural strength of concrete were studied for various replacements of fine aggregate by using copper slag that are 0%, 20%, 40%, 60%, and 80%. At 40% replacement of fine aggregate, the concrete gains higher compressive strength, at 7 and 28 days. The maximum split tensile strength and the flexural strength were also obtained at 40% replacement level at 28 days.*

***Key Words*: Copper slag, Replacement material, Fine aggregate, Concrete, Compressive strength, Split tensile strength, Flexural strength.**

1. INTRODUCTION

In India, by-products and waste materials are being generated by various types of industries. Disposal of waste materials effects the environment in various zones. Therefore, these waste materials can be recycled and it is great potential in construction industry. Many researches found that concrete made with wastes and by-products like fly ash, silica fume, copper slag etc acquires excellent properties than the conventional concrete in terms of strength, performance and durability. Hence, in this project, copper slag is taken to investigate its suitability as a replacement material for fine aggregate while making concrete.

Copper slag is an industrial by-product material produced during the smelting and refining process of copper, which can be used for a surprising number of applications in the construction field. It is also having similar physical properties of sand, considered as an alternative material to the river sand. It is the waste product material of copper. Disposal of this waste causes environmental pollution. The construction field is the only area where the safe use of waste material like copper slag is possible. When it is taken as a replacement material in concrete, it lessens the environmental pollution, space problem and also lessens the cost of concrete.

2. OBJECTIVES

The objective of this work is to investigate the properties of concrete with replacing fine aggregate by copper slag, and also to scrutinise the following:

1. To find the optimum proportion of copper slag that can be gained maximum strength and that proportion will be used as a replacement substitute material for fine aggregate in concrete.
2. To debrief the physical and chemical properties by use of copper slag for fine aggregate in concrete specimens.
3. To inspect the performance of concrete made with copper slag as replacement of fine aggregate.
4. To evaluate the compressive, tensile and flexural strength of concrete by using copper slag in concrete specimens.

3. MATERIALS USED

3.1. Cement:

In this project work**,** 43 grades Ordinary Portland Cement are used. The tests of cement are conducted to scrutinise the properties of cement as per IS 12269-1987.

Table -1: cement properties

Properties	Results
Initial setting time	35min
Final setting time	465min
Normal consistency	34%
Specific gravity	3.1

3.2. Fine aggregate:

The fine aggregate used in this study is river sand. It passing through IS sieves of size 4.75mm.

Properties	Results
Grading of sand	Zone 1
Specific gravity	2.44
Water absorption	0.8%

3.3. Coarse aggregate:

Locally available crushed granite coarse aggregate are used in this study, having the maximum size of 20mm.

Properties	Results
Specific gravity	2.6
Water absorption	1.0 %

3.4. Copper slag:

Copper slag is an industrial by-product material or waste produced during the process of copper smelting and refining of copper. It is also having same properties of sand and it can be used as one of the alternative material in concrete. It has threefold advantage in concrete like reduce the cost of dumping or disposal, also reduces the space problem and cost of construction.

Properties	Results
Specific gravity	3.20
Water absorption	0.65 %

3.5. Water:

In this experimental work, portable water is used for casting and curing of the concrete specimens.

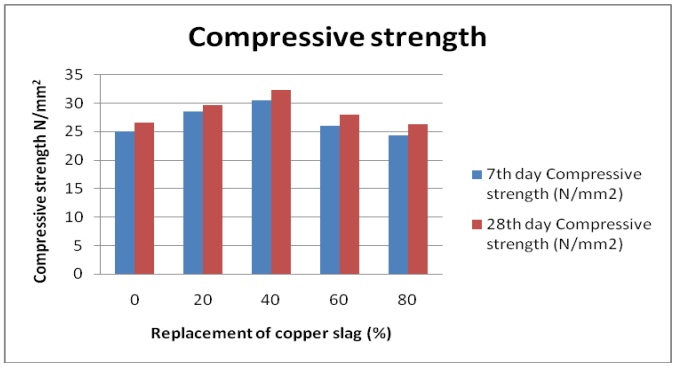
4. EXPERIMENTAL PROCEDURE

M25 grade of concrete is designed in accordance with the guidelines of code book IS 10262:2009 with replacement of fine aggregate by copper slag. The mix proportion obtained is 1:1.66:2.66 (C:FA:CA) with water cement ratio of 0.50. Copper slag is added at varying percentages of 0%, 20%, 40%, 60% and 80% by replacing fine aggregate. The compressive strength specimens are casted and cured in water for 7days and 28 days. The split tensile strength and flexural strength specimens are casted and cured in water for 28 days. After curing, they are tested for their respective strengths.

5. EXPERIMENTAL RESULTS

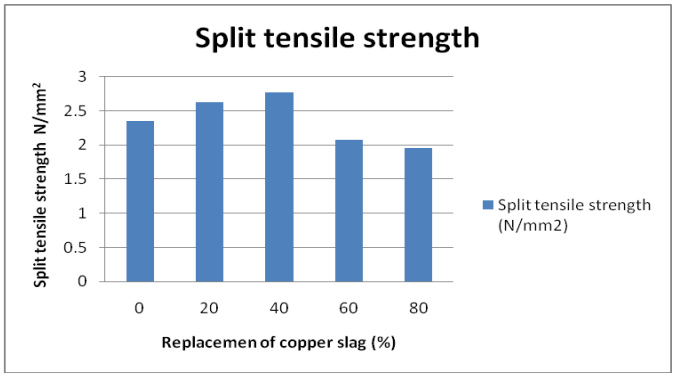
5.1. Compressive strength test:

Sl No	Replacement of fine aggregate by copper slag (%)	7th day Compressive strength (N/mm²)	28th day Compressive strength (N/mm²)
1	0	25	26.64
2	20	28.60	29.7
3	40	30.52	32.4
4	60	26	28
5	80	24.40	26.3



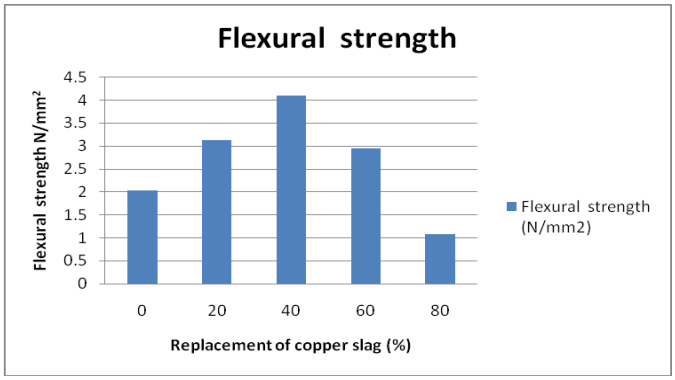
5.2. Split tensile strength:

Sl No	Replacement of fine Aggregate by copper slag (%)	Split tensile strength (N/mm²)
1	0	2.35
2	20	2.63
3	40	2.77
4	60	2.08
5	80	1.96



5.3. Flexural strength:

Sl No	Replacement of fine Aggregate by copper slag (%)	Flexural strength (N/mm²)
1	0	2.04
2	20	3.13
3	40	4.1
4	60	2.96
5	80	1.08



6. OBSERVATIONS AND DISCUSSIONS:

The compressive strength of 40% replacement of fine aggregate by copper slag for 28 days is 32.4 N/mm^2 and for 7 days is 30.52 N/mm^2 is higher as compared to conventional mix that are 25 N/mm^2 and 26.64 N/mm^2 for 7 days and 28 days respectively. It also observed that, after 28 days of curing, the split tensile strength and flexural strength are obtained for the same 40% replacement that are 2.77N/mm^2 and 4.1N/mm^2 is greater than conventional mix results, which are 2.35N/mm^2 and 2.04N/mm^2 respectively.

The maximum strength is obtained at 40% replacement of fine aggregate by copper slag, beyond 40% of replacement; the concrete gradually decreases its strength.

7. CONCLUSIONS

1. Form the results of compressive strength, split tensile strength and flexural strength, the concrete shown higher value at 40% replacement of fine aggregate by using copper slag.

2. We conclude that, by using copper slag as replacement for fine aggregate in concrete increases the density of concrete.

3. Hence, 40% replacement of copper slag is the optimum proportion for replacing fine aggregate.

REFERENCES

[1] Al-Jabri KS, Al-Oraimi SK: "Performance of High Strength Concrete made with Copper Slag as a Fine Aggregate". Section edition published 2009.

[2] IS 383: IS Specifications for fine and coarse aggregates from natural sources for concrete. Section edition published 1970.

[3] Reddy SS: "Utilization of copper slag as a partial replacement of fine aggregate in concrete". Section edition published 2013.

[4] Santha Kumar AR: Concrete technology. Oxford university press, engineering and computer Science. Section edition published 2006.

[5] Shetty MS (2006): Concrete technology, theory and practice. S chand and company limited, India.