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Mechanical Characteristics of Copper Slag - Incorporated High Strength Concrete

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Abstract- *Due to its diverse mechanical qualities, the copper slag-infused high strength concrete beam emerged as the most effective material. This study examines the effects of substituting copper slag (CS) for river sand as a fine aggregate in self-compacting concrete using an experimental design (SCC). Eleven different copper slag mix proportions, ranging from 0% (for the control mix proportion) to 100%, are used to make the concrete. The slump test, U-tube, 17-funnel, and L-box were test procedures used to examine the properties of fresh concrete. Workability, density, longevity, compressive strength, and tensile strength of concrete mixtures are all assessed. The findings demonstrate that using copper slag as a fine aggregate reduces the density increase of high-performance concrete by 3%.*

Key Words: **High strength concrete, copper slag, replacement, river sand, self-compacting concrete, mix.**

1. INTRODUCTION

Waste disposal in the modern era is a difficult problem that has led to enormous dumpsters popping up everywhere. Reusing and recycling waste materials is the best answer to this waste management issue. Another such substance obtained from the blast furnace is copper slag, which is used in the production of copper. In India, 2.5 to 3 tonnes of slag trash are created for every 1017 pounds of metal removed. Concrete is a useful application for this waste.

It can significantly lessen the loss of river sand's natural sources. The copper slag is purchased from Sterlite Industries in Tuticorin and substituted for fine aggregates.

Compression strength was examined for different percentages of 0%, 20%, 40%, 60%, 80%, and 100%. This outcome yields the highest percentage replacement at which we can succeed.

2. LITERATURE REVIEW

2.1 G Murali Krishna, K. Nandini

The findings of an experimental programme to investigate the effects of using copper slag in place of fine aggregate on the strength properties are presented in this paper. Approximately 2.5 tonnes of copper slag are created during the matte smelting and refining of copper for every tonne of copper. Copper slag is one of the products that are considered trash but have a promising future in the construction sector as a partial or full replacement for fine aggregates.

2.2 K. Ganesh Kumar, Sumathi Rajan

This study explores the potential use of granulated copper slag from Sterlite Industries as a sand substitute in concrete mixtures. For this project, M25 concrete grade was selected, and the mix design was constructed using the IS method. The material properties for cement, fine aggregate, coarse aggregate, and copper slag were investigated for the aim of mix design. In this work, an attempt is made to ascertain how adding copper slag in place of fine aggregate impacts the material's compressive strength and split tensile strength.

2.3 Wei Wu, Weide Zhang

This study looked at the mechanical properties of high strength concrete that contained copper slag as a fine aggregate and concluded that, while using less than 40% copper slag as a sand substitute can result in concrete with high strength that is comparable to or better than the control mix, using more of it results in noticeably different behaviours. The workability and strength characteristics were assessed by a series of tests on six different mixing proportions at 20% incremental copper slag replacement of sand from 0% to 100%. The results showed that the concrete with less than 40% copper lag replacement had a higher or equivalent strength to the control specimen, and that its workability had even increased significantly.

2.4 Khalifa S. Al-Jabri, Makoto Hisada, Abdullah H. Al-Saidy, S.K. Al-Oraimi

This study examined the performance characteristics of high strength concrete (HSC) made with copper slag as a fine aggregate at constant workability as well as the effects of superplasticizer. Two sets of concrete mixtures were created using various proportions of copper slag. The first series consisted of six concrete mixtures with varying concentrations of copper slag at constant workability. The water content was altered in each mixture to make it equally workable as the control mixture. Twelve concrete combinations were made in the second series. Except for the

first mixture, the remaining eleven combinations were made using different ratios and without the use of a superplasticizer.

2.5 K. S. Al Jabri

To ascertain the effects of employing copper slag as fine aggregate on the strength of both ordinary and high strength concrete, experimental approaches were used in this study. Copper slag was used to concrete mixtures in various amounts to replace fine aggregate partially and entirely. The amount of weighted copper slag mixed with the sand in the concrete ranged from 10% to 100%.

2.6 Mr. Suhas S. Malkhare, Prof. Atul B. Pujari

This paper presents an experimental investigation of the properties of concrete using copper slag as a replacement material for fine aggregates to enhance the properties of hardened concrete, such as compressive strength, split tensile strength, flexural strength, and ultrasonic pulse velocity. The current study recommended using industrial leftovers or used copper slag in place of fine particles in concrete. A water to cement mix ratio of 0.50 must be used for concrete of the M25 grade. In place of the fine aggregate, copper slag is used in amounts of 0%, 20%, 30%, 40%, 50%, 60%, 80%, and 100%.

2.7 K. Mahesh Babu, K. Sudhakar Reddy

This work explains the usage of substantial amounts of copper slag in concrete. By using copper slag, an industrial by-product, in place of river sand as the fine aggregate, the study encourages cleaner production. To make copper slag a useful resource, several studies have emphasised the variety of copper slag's qualities in this literature. There have been surprisingly few studies done on how copper slag performs in high strength concrete. The main objective of the ongoing research is to develop structural high strength concrete using copper slag. This investigation was done in two stages to determine the strength of concrete.

3. RESEARCH RESULTS AND DISCUSSION

The various testing is carried out at laboratories. consisted of replacing the fine aggregate in concrete mixtures with copper slag in the following weight proportions: 0% (for the control mix), 20%, 40%, 60%, etc.

Concrete samples were made, cured in a lab, and tested to assess the mechanical properties of fresh concrete, such as compressive strength and flexural strength, as well as split tensile strength needs.

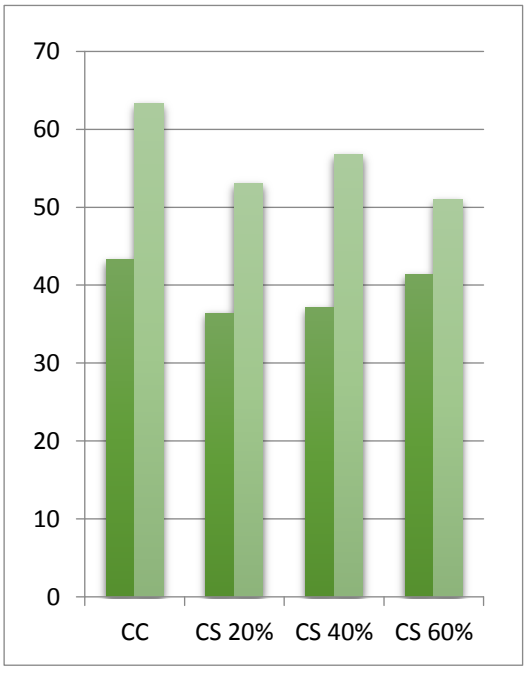
3.1 Physical Properties of Copper Slag & Fine Aggregate:

Sr No.	Properties	Copper Slag	Fine Aggregate
1	Specific Gravity	3.77	2.85
2	Agg. Crushing Value, %	10-21	-
3	Agg. Impact Value, %	8.2-16	-
4	Water Absorption, %	0.4	0.7
5	Particle Size, mm	<4.75	<4.75
6	Fineness Modulus	3.17	3.14

3.2 Effect on compressive strength of concrete: -

The outcome demonstrates the compressive strength of concrete mixtures in which 20%, 40%, and 60% copper slag is used in place of fine aggregate. Compressive strength increased steadily with age for all combinations. Although the compressive strength of CS40peak% is better than CS20and%'s CS60, at 56.71 N/mm2, it has only attained 83.09% of the desired strength.

The M60 grade of concrete design mix has the following compressive strengths at 28 days: CC is 68.25 N/mm2, and 40% replacement is 56.71 N/mm2.

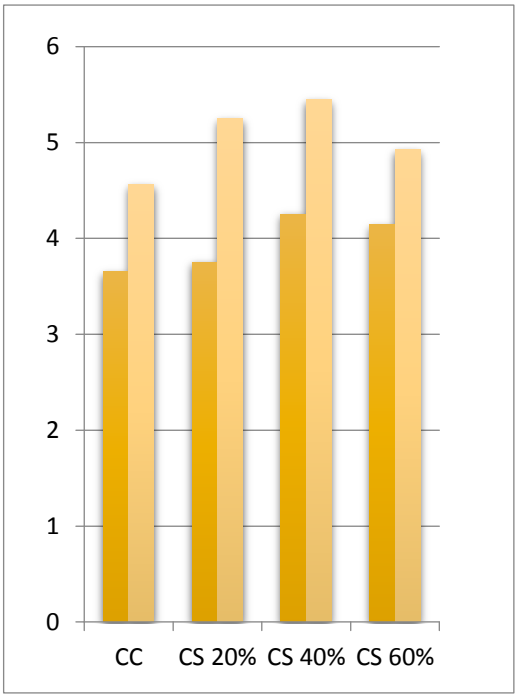


Graph 1: Compressive strength at 7 & 28 days

3.3 Effect on Split Tensile strength of concrete: -

All mixtures' Split Tensile strength grew steadily stronger as they aged. The highest split tensile strength, 5.45 N/mm2, was attained by CS40%.

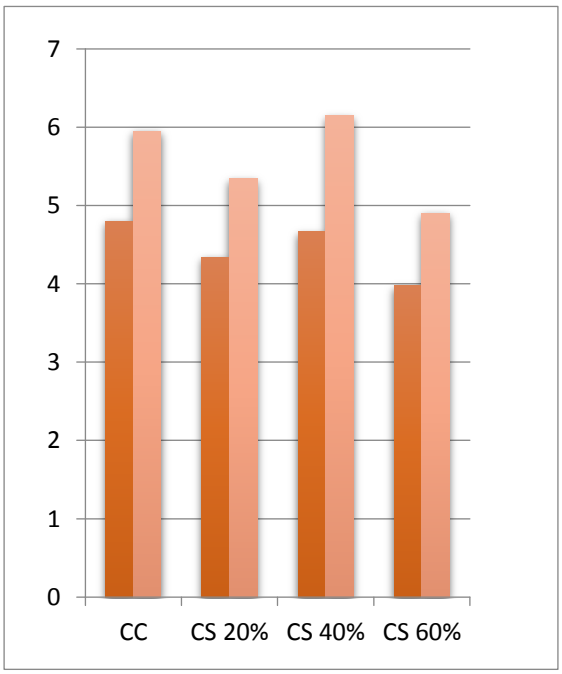
At 28 days, the split tensile strength of M60 grade concrete design mix was 4.56 N/mm2 for CC and 5.45 N/mm2 for 40% replacement. The split tensile strength of CS40% has risen by 19.51%.



Graph 2: Split tensile strength at 7 & 28 days

3.4 Effect on Flexural strength of concrete: -

The data below illustrates the flexural strength of concrete mixtures in which fine aggregate is replaced by 20%, 40%, and 60% copper slag, respectively. The flexural strengths of all combinations increased steadily with age. A maximum flexural strength of 6.15 N/mm2 was attained using CS40%. The concrete design mix grade M60 has the following flexural strengths at 28 days: 40% replacement equals 6.15 N/mm when CC is 5.95 N/mm2. Flexural strength of then CS40 has increased by 3.36%.



Graph 3: Flexural strength at 7 & 28 days

4. CONCLUSION

Therefore, we draw the conclusion that Copper Slag can be used as a building material and partially replace cement in the creation of high Strength Concrete. In both industrialised and developing nations, the use of HSC for construction has grown quite widespread, particularly for multi-story buildings. In accordance with the research papers, we will continue to cast the concrete blocks with 0%, 5%, 10%, 15%, and 20% replacement of cement by copper slag, depending on the requirement. After a 7- or 28-day curing period, various tests as well as a mechanical properties test will be undertaken.

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