

# Experimental Study on Partial Replacement of Fine Aggregate using Copper Slag

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**Abstract** - Many countries are witnessing a rapid growth in construction industry which involves use of natural resources for the development of infrastructure. Copper slag is considered as waste material and can be used as replacement of fine aggregates. Many researchers have investigated the use of copper slag in the production of cement, mortar and concrete has raw materials for clinker cement replacement, coarse and fine aggregates. The use of copper slag in cement and concrete provides potential, environmental as well as economic benefits for all related industries, particularly in areas whereas considerable amount of copper slag is produced. By using the copper slag in construction field, the chance of getting pollution due to copper slag will be reduced and it will be the cost effective method for any construction industry.

**Key Words:** Infrastructure, Clinker, Copper Slag, Concrete, Pollution, Industry.

## 1. INTRODUCTION

We Know there is great demand of aggregates mainly from civil engineering industry for road and concrete construction. But nowadays it is a very difficult problem for the availability of fine aggregates. So researchers developed waste management strategies to apply for replacement of fine aggregates for specific need. Natural resources are depleting worldwide while at the same time, the generated waste from the industry are increasing substantially. The sustainable developments for construction involves the use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment. Copper slag is one of the materials that is considered as a waste material which could have a promising future in construction industry as partial or full substitute of either cement or aggregates. It is a by-product obtained during the matte smelting and refining of copper.

### 1.1 Material Requirements

The basic materials required for making concrete are cement, water, fine aggregate and coarse aggregate. Along with these copper slag is also added. Various tests were conducted on each materials. For cement, tests like fineness of cement, standard consistency, initial and final setting time of cement

were conducted. Tests for aggregate such as sieve analysis, specific gravity, impact test etc were done.

Finally, tests on fresh concrete like compaction factor test and slump test were conducted.

### 1.2 Copper Slag

Copper slag is a by- product obtained during the matte smelting and refining of copper. Copper slag used in this work is brought from Blastline industries Pvt. Ltd, Angamaly, kerala. The quantity of copper slag used were 30%, 40% and 50% by weight of fine aggregates.

## 2. METHODOLOGY

Initially, various literature reviews were collected for the study. The properties of cement, fine aggregate and coarse aggregate were determined to obtain the mix design. Mix design can be defined as the process of selecting ingredients of concrete and determining their relative proportion with the objective of producing concrete of certain minimum strength and durability as economically as possible. Two types of concrete mixes are normally used in the construction field. For normal works nominal mix is used whereas for very important structures designed mix is used. The target strength was found to be 31.6 N/mm<sup>2</sup>. The mix design obtained was 1:1.11:2.65

The next objective were casting, curing and testing of specimens. Casting requires batching, mixing and compaction of concrete. Weigh batching is the correct method of measuring the materials. For important concrete invariably, weigh batching system is adopted. A simple spring balance or the common platform weighing machines also can be used for smaller works. When weigh batching is adopted, the measurement of water must be done accurate. Addition of graduated bucket in terms of litres will be sufficient for small work. Mixing of concrete is most invariably carried out by machine, for reinforced concrete work. Machine mixing is not only efficient, but also economical, when the quantity of concrete is to be produced is large.

Compaction of concrete is the process adopted for expelling the entrapped air from the concrete. Each layer is compacted by hand or by vibration. The number of strokes per layer required to produce the specified conditions vary according to the type of the concrete. Cubes, beams and cylinders are

made by adding copper slag as a substitute for fine aggregate for about 30%, 40% and 50%. Each of 3 numbers are made and these were tested. These specimens were cured in water for 7 days, 14 days and 28 days. The test were conducted as compression, split tensile, flexural tensile test.

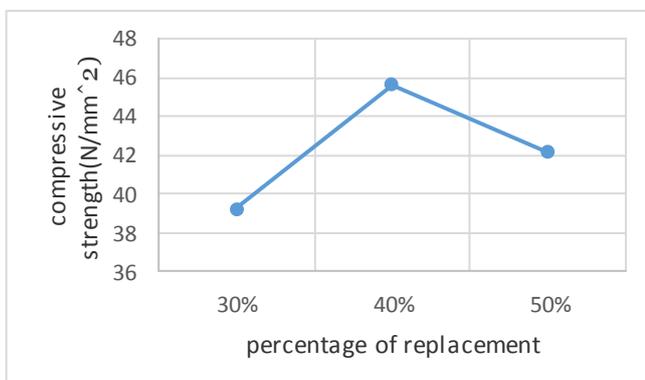
**Table-1:** Size of Moulds

Shape of Test Specimen	Size in mm
Cube	150×150×150
Cylinder	150Φ×300
Beam	500×100×100

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are quantitatively related to its compressive strength. The systems of loading used in finding out the flexural tension are central point loading and third point loading. In case of symmetrical two point loading where the bending moment is maximum. Since two point loading yield a lower value of modulus of rupture than the centre point loading, this test was performed on the beams specimens.

Splitting test is an indirect method to determine the tensile strength of concrete. The apparatus used for finding splitting tensile stress were any compression testing machine of sufficient capacity and capable of applying load at specific rate. The compressive strength gradually increases from 0%, 30%, 40% replacement of copper slag and decreases for 50% replacement of copper slag. The 28 days average compressive strength obtained for copper slag mix concrete shows 0.45% to 23.6% increase in compressive strength when compared to control mix concrete.

The 28 days average split tensile strength obtained for copper slag mix concrete shows 16.61% to 34.98% increase in split tensile strength obtained for copper slag mix concrete shows 27.78% to 38.89% increases in flexural strength when compared to control mix concrete. Concrete incorporating copper slag exhibits good mechanical properties and therefore upto 40% by weight of natural sand can be replaced by copper slag.



**Chart -1:** 28<sup>th</sup> day compressive strength

### 3. CONCLUSIONS

The basic material tests results showed that the properties of copper slag is similar to that of the natural sand and can be used as natural sand. The control mix of mix for M25 grade and the replacement of copper slag by 30%, 40%, and 50% by weight of natural sand were designed. The optimum level of replacement of copper slag we had found to be 40% and the results were better than that of control mix. The workability of fresh concrete increases with increase in the replacement of copper slag content for the same dosage of super plasticizers. The compressive strength gradually increases from 30%, 40% replacement of copper slag and decreases for 50% replacement of copper slag.

Concrete incorporating copper slag exhibits good mechanical properties and therefore upto 40% by weight of natural sand can be replaced by copper slag.

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