



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJIRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 2, February 2022

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569



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# Experimental Investigation & Analysis by Use of Copper Slag as a Partial Replacement of Fine Aggregate in M25 as a Light Weight Concrete

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**ABSTRACT:** Today's world is facing challenging and unsolved environmental problem such as global warming, forest destruction and lack of resources. In order to solve these environmental problems, resources recycling have to be done in environmentally safer methods. As there is a vast scarcity the production of aggregates for concrete the recycled materials have great demand. At this stage copper slag, an industrial byproduct generated during smelting and refining of copper can be a partial alternative for fine aggregate where its world annual generation is about 33 million tons. The project looks through the use of copper slag as partial replacement to sand and natural sand for the designed M25 grade mix concrete. compressive strength responses of above alternatives performed. The present study mainly focuses on investigating the effect of using copper slag as a replacement of fine aggregate on the strength properties. In this report, M25 grade concrete was used and tests were conducted for various proportions of copper slag replacement with sand of 40%, 80% and 100% in concrete. In the first case along with replacement of copper slag with sand there is an attempt is made to replace the cement with 50% fly ash similarly in second case for 30% replacement of cement with fly ash replacement and in the third case with no replacement of cement with fly ash. The obtained results were compared with those of nominal concrete made with ordinary Portland cement and sand. Further split tensile strength and flexural strength studies were also performed to check its durability aspects.

**KEYWORDS:** copper slag, FA= fly ash, sand replacement, compression, flexure, split tensile.

## I. INTRODUCTION

Concrete is the world's most ancient, capable, durable and reliable construction material. After water, concrete is the most used material, which required large quantities of fine aggregate. As there is great demand of aggregates mainly from civil engineering industry for road and concrete baring constructions. Hence, it is necessary to find an alternative material to the existing most expensive, most resource consuming fine aggregate. Copper slag is one of the materials that are considered as a waste material which could have a property of promising future in construction industry as partial or full substitute of either cement or aggregates. It is a by-product obtained during the process of copper refining. As the copper settles down in the smelter, it has a higher density, impurities that stay in the top layer and then are transported to a water basin with a low temperature for solidification. The end product is a solid, hard material that goes to the crusher for further processing.

As earlier said copper slag is a granular grassy material which is similar with those of characteristics of fine aggregate or sand with all its basic properties. As copper slag is a high-density material it increases the self-weight of concrete there by increases the strength and toughness against the various kinds of loads. By this it can also be stated that the property of toughness and rigidness can be increased in the concrete by using copper slag in the concrete and various researches are going on in the world to make use of copper waste in concrete.

## II. MATERIALS AND METHODS

Materials used in the experimental works are OPC 53 grade cement, natural coarse aggregate, fine aggregate free from clay, class f-fly ash, Copper slag and super plasticizer.

### 1. CEMENT

Ordinary Portland cement of OPC grade 53 confirming to IS 8112-1989. Various physical properties were performed as per IS-4031 PART 11-1988.

### 2. SAND

The aggregate size is lesser than 4.75 mm is considered as fine aggregate. Sand confirming IS 383 1970 comes under zone II is used.

### 3. COARSE AGGREGATES

The aggregate size bigger than 4.75 mm, and 20mm downsize is considered as coarse aggregate.

### FLY ASH

Class F- Fly ash was procured from Raichur Thermal power plant (RTPS). RTPS is a coal-fired electric power station located at Raichur district of the state of Karnataka, India.

### COPPER SLAG

The slag is a black glassy and granular in nature and has a similar particle size range of sand which indicates that it could be tried as replacement with sand in cementitious mixture. Copper slag used in this work was brought from Sterlite Industries Ltd (SIL), Tuticorin, Tamil Nadu, India. SIL is producing Copper slag during the manufacture of copper metal.



Khalifa S. Al-Jabri, Abdullah H. Al-Saidy, Ramzi Taha et. All [2016] (Quaboos university oman) "EFFECT OF COPPER SLAGS A FINE AGGREGATE ON THE PROPERTIES OF CEMENT MORTARS AND CONCRETE" In this study the author had clearly discussed about the effects of the copper slag in the concrete. The author had worked on M20 mix design and has incorporated the copper slag in percentages from (20 % to 60%).

Sukhoon Pyo et. al. [2016] they studied the straight tensile action of UHP-FRC at strain variation varies as of 90 to 146/s. The tests are conducted using a recently developed impact testing system that uses suddenly released strain energy to create an impact pulse.

Dr. A. Leema rose et. Al. [2015] they find out solution and addition of copper scum use in concrete raises the density in concrete mixture scum by load of fine aggregate exchange 30% of replacement. It is also accomplished that the concrete through copper slag gains more strength than the manage concrete.

Vishwa B Tipashetti et. al. [2014] they investigate on dissimilar strength tests on concrete having sandstone admixtures and copper slag as partial substitution of cement and sand individually. In this description, M30 assessment of concrete was designed and examinations were intended for with varied rates of sandstone admixtures with copper slag. The compressive strength is enlarged up to 10-20% merge of stone admixture and copper slag contains concrete when contrasted with normal concrete.

Dr. T.Ch. Madhavi et. al. [2013] investigated the performances of substitution of Fine aggregate with copper slag on behavior of mechanical functions of concrete and the application of copper slag as a substitution replacement material of sand. Copper slag which is an industrial waste product can be used as replacement for cement with sand and contributes to the increase in various mechanical properties of concrete. Copper slag can be used up to 30% but when used ahead of 50% results in decrease in strengths.

### III. EXPERIMENTAL RESULTS

#### MATERIALS AND THEIR PROPERTIES:

The properties of various materials used in making the concrete are discussed in the following sections.

##### Cement:

The Ordinary Portland Cement of 53 grades is used specifying all the properties from IS12269-1987.

##### Coarse Aggregate:

20mm and 10mm coarse aggregate are selected by passing the aggregate through 20mm and 10mm sieves respectively. Particle shape of both the aggregate is angular. Different test are to be conducted like specific gravity, fineness modulus and water absorption. Coarse aggregate is dust free and free from surface moisture.

##### Fine Aggregate:

Natural Sand is selected as fine aggregate. Sand is sieved from 4.75 mm sieve and also washed to reduce the silt content. Here, water demand is slightly less for natural sand, which is therefore more preferable. The specific gravity, fineness modulus and water absorption test are conducted on Natural sand.

**EXPERIMENTAL PROCEDURE- SLUMP CONE TEST:** In all over the world the test on fresh concrete are widely used, though the slump test won't consider the workability of concrete but helpful in detecting the deviations in the uniformity of a mix of given nominal proportions.

#### WORKABILITY OF FRESH CONCRETE

Workability depends on water content, aggregate (shape and size distribution), cementitious content and age (level of hydration) and can be modified by adding chemical admixtures, like superplasticizer. Raising the water content or adding chemical admixtures increases concrete workability

#### STUDIES ON MIX PROPORTION AND WORKABILITY

Sr No	Mixed Details	% of copper Slag	W/C ratio	Workability
1	1:1.87:3.16	0	0.4	30
2	1:1.87:3.16	10	0.4	29
3	1:1.87:3.16	20	0.4	29
4	1:1.87:3.16	30	0.4	27
5	1:1.87:3.16	40	0.4	26

#### COMPRESSIVE STRENGTH

Compression test is the most pervasive test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the sought-after trait properties of concrete are qualitatively related to its compressive strength. The cube specimen is of the size 15 x 15 x 15 cm. The largest nominal size of the aggregate does not exceed 20mm, 10cm size cubes may also be used as an alternative.

### IV. CONCLUSION

Compressive strength and Split tensile strength increase with increase of copper slag Up to certain limit. Concrete acquires maximum compressive strength at 20% replacement of copper slag of M30 Grade concrete.

The maximum Split tensile strength for 28 days curing was obtained at 20% replacement of copper slag and 15% replacement of fly ash. The compressive strength of and split tensile strength of concrete decreases from 30% & 40% replacement of copper slag. The compressive strength of concrete was also found to be more than the target mean strength 36.6 N/mm<sup>2</sup>. Hence, it can be concluded that cement content can be reduced for the preparation of concrete by the use of copper slag is for sand and fly ash as cement replacement and considerable percentage increase in various strength properties of concrete can be obtained. The replacement of fine aggregate using slag in concrete increases the density of concrete thereby increases the self-weight of the concrete. The workability of concrete increased with the increase in copper slag content of fine aggregate replacement at same water cement ratio. Optimum strength is obtained





20% replacement of copper slag and 15% of fly ash. The copper slag and fly ash is a leftover material, so using these materials are economical for construction. In replacement 30% and 40% of copper slag and 15% of fly ash, there will be an occurrence of segregation.

## V. SCOPE FOR FUTURE RESEARCH

1. Further research has to be carried out on the reasons for increase in workability, increased compressive strength and tensile strength up to 20% COPPER SLAG.
  2. There is a scope to alter the mix proportions of concrete which may reduce the stripping time of concrete and faster strength gain.
  3. Different water cement ratios other than applied in this project can be tested.
  4. Mix designs which can offer much strength properties of concrete elements can be designed to with stand heavy load conditions
  5. Further research has to be carried out on the reasons for workability, durability characteristics of ordinary concrete, compressive strength and tensile strength with increase in % of fly ash and copper slag.
  6. Further research has to be carried when other pozzolanic materials are used other than the fly ash with copper slag.
  7. Further research has to be carried out on the shrinkage and the creep properties of ordinary concrete, when 20% COPPER SLAG and 15% FLY ASH added to Ordinary Concrete.
  8. Further research has been carried out reduction of Cost & Quantity of Cement, when 20% COPPER SLAG and 15% FLY ASH added to Ordinary Concrete.
- Further research has been carried out on the chemical reactions when COPPER SLAG and FLY ASH is added to cement.

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