

## Proficient Understudy of Copper Slag as Fine Aggregate in Portland Pozzolana Cement

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### ABSTRACT

Copper slag obtained during smelting to extract copper metal from the ore. The review of the characteristics of copper slag encourages several applications such as for manufacture of cement, in aggregates, Landfill, glass, tiles etc. Many researchers have already found it is possible to use copper slag as a concrete aggregate. The workability and strength characteristics were assessed through a series of test on different mix proportions at 10% incremental copper slag by weight replacement of sand. M35 grade concrete was used and the tests were conducted for various proportions of copper slag replacement with sand of 0%,10%,20%,30%,40%,50%,60%,70%,80%,90%,100% in concrete. Then the concrete were cured for 7, 28, 60 and 90 days. Then they were tested for compressive strength, split tensile strength, and flexural strength. Finally the results were compared with the concrete made with the Portland Pozzolana cement (PPC) and fine aggregate (sand).

**Keywords:** *Copper slag, PPC, compressive strength, split tensile strength and flexural strength.*

### 1. INTRODUCTION

The development of construction material have posed problem and challenges that initiated worldwide research programs and continued conventional and non-conventional application leading ultimate economy. Researchers developed waste management strategies to apply for advantages for specific needs. Therefore, now a day's incorporation of secondary material is being encouraged [1]. The government of India has targeted to reduce the industrial by product from the disposal. Harmful effects of concrete on environment can be reduced by producing good and durable concrete by using industrial by product [2]. Where copper slag is one the waste material which can be used as the replacement of fine aggregate in construction which will reduce damage to the environment due to the waste resulting from the copper manufacturing process and helps in saving natural resources [3].

### MATERIAL AND SOURCES

Material collection is the important step in the project. The material for the project is obtained from various resources is tabulated below.1.

**Table1. Material And Sources**

S.No	Materials	Source
01	Cement	Ultra tech cement
02	Fine aggregate	Karur sand
03	Copper slag	Sterilite industries, Tuticorin,
04	Coarse aggregate	Rock gravel

### **BULK DENSITY**

The bulk density gives valuable information regarding the shape and grading of the material. The bulk density of copper slag is more of about 2.21 where for fine aggregate it is 1.53. Higher the bulk density lower is the void content to be filled by sand and cement. The sample which gives the supreme bulk density is taken as right sample for making economical mix.

### **WATER ABSORPTION**

Water absorption is less in copper slag of about 0.41 where fine aggregate of about .7. Lesser the water absorption more will be the durability of concrete.

### **SPLIT TENSILE TEST**

For testing split tensile strength concrete cylinder of size 150 mm diameter and 300mm height were casted with different percentage of copper slag. The mould were properly cleaned and oiled then the concrete is filled in three layer then each layer is compacted using tamping rod. It is cured for 7, 28, 60 and 90 days. The load is applied until the failure occurs and failure lode is noted. The split tensile strength is calculated using the formula

$$\text{Split tensile strength} = \frac{2P}{\pi LD}$$

Where,

**P=Failure load**

**D=Dia of cylinder**

**L= Length of cylinder**

The split tensile strength for various percentage of copper slag Table.2 given below.

**Table.2.Split Tensile Of Cylinder**

S.No	Specimen		Split Tensile Strength (N/Mm <sup>2</sup> )		
	FA	CS	7 <sup>TH</sup> DAY	28 <sup>TH</sup> DAY	60 <sup>TH</sup> DAY
1	100	0	4.23	4.89	5.29
2	90	10	5.01	5.17	5.86
3	80	20	5.13	6.23	6.37
4	70	30	5.29	6.93	6.96
5	60	40	6.24	7.25	7.89

6	50	50	6.02	7.02	7.85
7	40	60	5.17	6.13	7.11
8	20	80	4.19	5.09	6.21
9	0	100	3.03	3.10	4.17

From the Fig.1 the split tensile strength of concrete with 40% surrogating fine aggregate by copper slag has the maximum split tensile strength. In that 7<sup>th</sup> day, 28<sup>th</sup> day, 60<sup>th</sup> day and 90<sup>th</sup> day. On surrogate concrete the 7th day split tensile strength is 6.24 N/mm<sup>2</sup> where the conventional concrete is about 4.23 N/mm<sup>2</sup>. In 28<sup>th</sup> day it is about 7.25 N/mm<sup>2</sup> where conventional concrete is about 4.89 N/mm<sup>2</sup>. In 60<sup>th</sup> and 90<sup>th</sup> day it is about 7.89 N/mm<sup>2</sup> and 8.06 N/mm<sup>2</sup> where the conventional concrete is 5.29 N/mm<sup>2</sup> 6.02 N/mm<sup>2</sup>. The replaced concrete has more split tensile strength than the conventional concrete. Above 40% replacement of copper slag the split tensile strength start decreasing but 50%, 60% and 80% of copper slag replacement gives more split tensile strength than the conventional concrete. From the result we can clinch that split tensile strength is increased at 40% replacement of fine aggregate by copper slag.

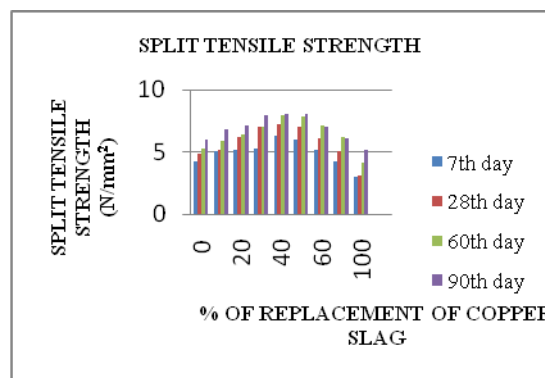


Fig.1.Replacement % Vs Split Tensile Strength

### FLEXURAL TEST

In order to determine the flexural strength of beam size 1000×150mm is casted using various percentage of copper slag. It is allowed to cure for 7, 28, 60, 90 days. The UTM testing machine may be set to any reliable type of sufficient capacity. three point load is given to the specimen until the failure occurs and the load is noted.

$$F_{cr} = PL/BD^2 \quad \text{Where,}$$

$F_{cr}$  = modulus of rupture

P = ultimate load in N

L = length of beam in mm

B = Average width of specimen in mm

D = Average depth of specimen in mm

The flexural strength of beam is Tabulated below in 3

Table.3. Flexural Strength of Beam

S.No	Specimen		Flexural Strength Of Beam (N/Mm <sup>2</sup> )			
	FA	CS	7 <sup>th</sup> DAY	28 <sup>th</sup> DAY	60 <sup>th</sup> DAY	90 <sup>th</sup> DAY

1	100	0	4.13	5.06	6.13	6.89
2	90	10	4.28	5.17	6.89	7.04
3	80	20	5.01	6.81	7.23	8.23
4	70	30	5.77	7.13	7.81	8.01
5	60	40	6.14	7.92	8.28	8.49
6	50	50	5.98	7.01	7.05	7.13
7	40	60	5.03	6	6.81	6.23
8	20	80	4.89	5.29	6.01	5.89
9	0	100	4.23	4.1	5.01	5.43

From the Fig.2 the flexural Strength of concrete with 40% surrogating fine aggregate by copper slag has the maximum flexural strength on 7<sup>th</sup> day, 28<sup>th</sup> day, 60<sup>th</sup> day, 90<sup>th</sup> day. On 7<sup>th</sup> day the split tensile strength is 6.14 N/mm<sup>2</sup>. On 28<sup>th</sup> day it is about 7.92 N/mm<sup>2</sup>. Whereas on 60<sup>th</sup> and 90<sup>th</sup> day it is about 8.28 N/mm<sup>2</sup> and 8.49 N/mm<sup>2</sup>. The replaced concrete has more flexural strength which is more than the conventional concrete.

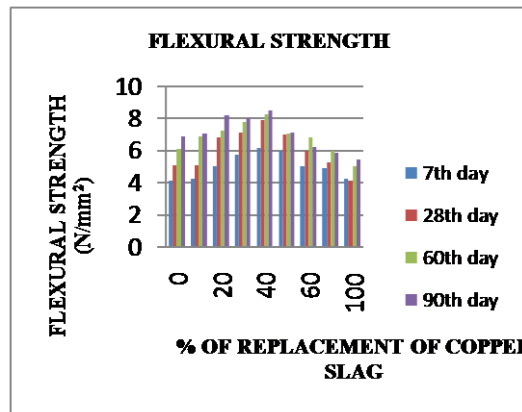


Fig.2.Replacement % vs Flexural Strength

From the result we can clinch that flexural strength is increased at 40% replacement of fine aggregate by copper slag

## CONCLUSION

1. The sieve analysis test proves that the copper slag can be surrogated for fine aggregate in concrete.
2. Water absorption in replaced concrete is lower than the conventional concrete.
3. As the surrogation of copper slag increases the workability of concrete decreases due to free water left in the concrete.
4. The copper slag has more specific gravity than fine aggregate which provide density to the concrete
5. The compressive strength on concrete increased by surrogating fine aggregate by 40% of copper slag
6. By surrogating 40% of fine aggregate by copper slag the split tensile strength is increased.
7. The flexural strength higher by 40% replacement of fine aggregate by copper slag.

8. Replacement of copper slag increases the self weight of concrete to the maximum of 15 to 20%.

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