

# **Experimental Investigation on Effective Replacement of Cement and Fine Aggregate by Copper Slag**

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**ABSTRACT:** Copper slag is considered as one of the waste materials which can have a promising future in construction industry as partial or full substitute of either cement or totals. For every ton of copper creation, about 2.2 huge amounts of copper slag is produced. This slag is as of now utilized for some, reasons like land filling, construction of abrasive tools, roofing granules, cutting tools and rail street balance material, which are not high value added application. These applications use just about 15% to 20% of copper slag produced and staying material is dumped as a waste. With the end goal to decrease the collection of copper slag and furthermore to give an elective material to sand and cement a methodology has been done to explore the utilization of copper slag in cement for the partial replacement of sand and cement.

Numerous analysts have officially thought that it was conceivable to utilize copper slag as a solid total, since copper slag has comparative molecule measure attributes prone to that of sand. Fine grained powder of copper slag can be utilized as a valuable cementing material to concrete and in cement clinker production. This look into was performed to create particular trial information on the potential utilization of copper slag as sand and cement replacement partially in cement.

This examination work basically comprises of two primary parts. M20 concrete was utilized to decide different mechanical properties. Initial segment of the proposition comprises of substituting sand partially by copper slag in cement. For sand replacement, seven test gatherings (counting control blend) were comprised with replacement

## **I. INTRODUCTION**

The usage of modern waste or optional materials has empowered the creation of cement and cement in construction field. New results and waste materials are being produced by different ventures. Dumping or transfer of waste materials causes ecological and medical issues. In this manner, reusing of waste materials is an extraordinary potential in solid industry. For a long time, results, for example, fly fiery remains, silica smoke and slag were considered as waste materials. Concrete arranged with such materials indicated enhancement in functionality and strength contrasted with ordinary cement and has been utilized in the construction of intensity, concoction plants and submerged structures. Over late decades, concentrated research thinks about have been done to investigate all conceivable reuse techniques. Construction waste, impact heater, steel slag, coal fly fiery debris and base cinder have been acknowledged in numerous spots as elective totals in dike, streets, asphalts, establishment and building construction, crude material in the fabricate of conventional Portland cement brought up by Teik thye luin et al (2006). Copper slag has mechanical and compound attributes that qualify the material to be utilized in concrete as a partial

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replacement for Portland cement or as a substitute for totals. For instance, copper slag has various ideal mechanical properties for total utilize, for example, great soundness attributes, great scraped spot obstruction and great strength revealed by (Gorai et al 2003). Copper slag additionally displays pozzolanic properties since it contains low CaO. Under enactment with NaOH, it can show cementitious property and can be utilized as partial or full replacement for Portland cement. The usage of copper slag for applications, for example, Portland cement replacement in cement, or as crude material has the double advantage of wiping out the expense of transfer and bringing down the expense of the solid. The utilization of copper slag in the solid industry as a replacement for cement can have the advantage of decreasing the expenses of transfer and help in ensuring the earth. In spite of the way that few examinations have been accounted for on the impact of copper slag replacement on the properties of Concrete, assist examinations are fundamental with the end goal to acquire a complete understanding that would give a building base to permit the utilization of copper slag in cement

Copper slag is a mechanical side-effect material created from the way toward assembling copper. For each ton of copper ent of 0% (control example), 10%, 20%, 30%, 40%, half and 60% copper slag with sand in every arrangement. Solid 3D shapes, barrels, RCC shafts and Columns were thrown and tried in research centers. The ideal extent of replacement was found by directing the accompanying tests.

### II. BACKGROUND OF COPPER SLAG

KB Exports International, Vijaywada is the primary backup of Vedantha Resources open constrained organization (PLC), an expanded and incorporated FTSE 100. The yearly turnover of KBEI, Vijaywada, India is Rs.13, 45 crores. KBEI, a main maker of copper in India, spearheaded the assembling of constant cast copper streets and built up India's biggest copper purifying and refining plant for generation of world class refined copper. KBEI is the maker of copper slag (Figure 1.1) amid the fabricate of copper metal. Directly, around 1500 tons of copper slag is delivered every day and an aggregate amassing of around

1.1 million tons.



Figure 1.1 Appearance of copper slag sample

This slag is presently being utilized for some reasons. It is a shiny granular material with high particular gravity molecule sizes. The different fantasies about copper slag is appeared in Table 1.1. The span of the molecule is of the request of sand and can be utilized as a fine total in cement. To diminish the aggregation of copper slag and furthermore to give an elective material to sand and cement, a methodology has been done to explore the utilization of

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copper slag in cement for the partial replacement of sand and cement.

### III. PRODUCTION OF COPPER SLAG

Copper slag is a side-effect acquired amid the matte purifying and refining of copper has been accounted for by Biswas and Davenport (2002). The real constituent of a refining charge are sulfides and oxides of iron and copper. The charge likewise contains oxides, for example, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> CaO and MgO, which are either present in unique focus or added as transition. It is Iron, Copper, Sulfur, Oxygen and their oxides which to a great extent control the science and physical constitution of purifying framework. A further essential factor is the oxidation/decrease capability of the gases which are utilized to warmth and liquefy the charge expressed by Gorai et al (2002). Because of this procedure copper-rich matte (sulfides) and copper slag (oxides) are shaped as two separate fluid stages. The expansion of silica amid refining process frames unequivocally fortified silicate anions by joining with the oxides.

This response produces copper slag stage, while sulfide from matte stage, because of low inclination to frame the anion buildings. Silica is added straightforwardly for the most entire disconnection of copper in matte which happens at close immersion fixation with SiO<sub>2</sub>.

The slag structure is balanced out with the expansion of lime and alumina. The liquid slag is released from the heater at 1000-1300°C. At the point when fluid is cooled gradually, it frames a thick, hard crystalline item, while a granulated shapeless slag is framed through fast cementing by pouring liquid slag.

### IV. EXPERIMENTAL PROCEDURES

#### Compressive Strength Test

Concrete solid shapes of size 150mm×150mm×150mm were thrown with and without copper slag. Amid throwing, the 3D shapes were mechanically vibrated utilizing a table vibrator. Following 24 hours, the examples were demoulded and exposed to restoring for 28 days in compact water. Subsequent to relieving, the examples were tried for compressive strength utilizing pressure testing machine of 2000KN limit. The most extreme load at disappointment was taken. The normal compressive strength of concrete and mortar examples

Ultimate compressive load (N)

$$\text{Compressive strength (N/mm}^2\text{)} = \frac{\text{Ultimate compressive load (N)}}{\text{Area of cross section of specimen (mm}^2\text{)}} \quad (5.1)$$

The tests were completed on an arrangement of triplicate examples and the normal compressive strength values were taken.

#### Split Tensile Strength Test

Concrete cylinders of size 150 mm distance across and 300mm length were thrown with consolidating copper slag as partial replacement of sand and cement. Amid throwing, the cylinders were mechanically vibrated utilizing a table vibrator. Following 24 hours, the examples were demoulded and exposed to restoring for 28 days in convenient water. Subsequent to relieving, the barrel shaped examples were tried for split tensile strength utilizing pressure testing machine of 2000kN limit. A definitive load was taken and the normal split tensile strength was computed

2P

$$\text{Split tensile strength (N/mm}^2\text{)} = \frac{2P}{\pi LD} \quad (5.2)$$

Where,

P=Ultimate load at failure(N) L=Length of cylindrical specimen (mm)D=Diameter of cylindrical specimen (mm)

The tests were carried out on a set of triplicate specimens and the average tensile strength values were taken. was ascertained by utilizing the accompanying condition 5.1

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## Compressive Strength Test Compressive strength test on concrete cubes

The effect of copper slag substitution as a fine aggregate on the strength of concrete is given in Table 6.2, which presents the average 7 and 28 day cube compressive strength of concrete. A total number of 42 mortar specimens were cast and tested shown in Figure 6.1. The unconfined compressive strength values of concrete mixtures with different proportions of copper slag tested at 7 and 28 days are also plotted in Figure 6.2.



Figure 6.1 Compression test on CC and S40 specimens

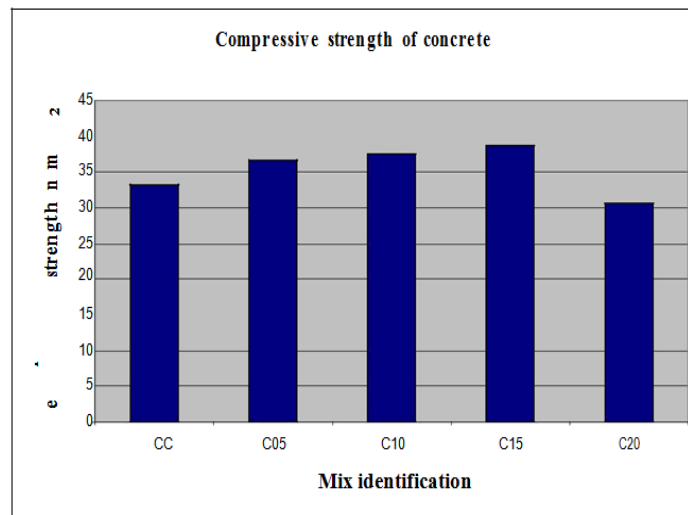


Figure 6.27 Compressive strength of concrete cubes for cement Replacement

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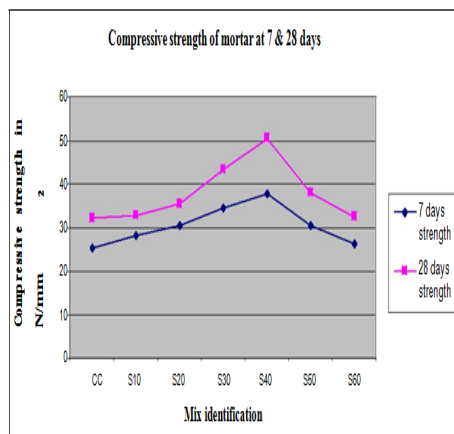
### 6.2.1 Compressive Strength Test

#### 6.2.1.1 Compressive strength test on mortar cubes

The measured compressive strength values are presented in Table 6.1.

**Table 6.1 compressive strength of mortar cubes**

S.No	Mix Identity	Ultimate load kN		Average ultimate load kN		Comp. strength N/mm <sup>2</sup>		% increase in strength at 28 days
		7 Days	28 Days	7 Days	28 Days	7 Days	28 Days	
1.	CC	126	152	126.00	160.33	25.21	32.08	---
		120	150					
		132	179					
2.	S10	130	152	140.67	164.67	28.14	32.94	2.68
		135	162					
		157	180					
3.	S20	140	160	152.33	176.67	30.47	35.34	10.16
		152	180					
		165	190					
4.	S30	167	200	172.33	216.67	34.48	43.35	38.26
		165	210					
		185	240					
5.	S40	175	235	188.33	251.67	37.68	50.35	56.95
		202	290					
		188	230					
6.	S50	158	201	152.33	190.00	30.47	38.01	18.48
		137	167					
		162	202					
7.	S60	132	175	130.67	162.33	26.14	32.48	1.25
		130	160					
		130	152					



**Figure 6.1A Compressive strength of mortar cubes Compressive strength test on concrete cubes**

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The impact of copper slag substitution as a fine total on the strength of concrete is given in Table 6.2, which displays the normal 7 and multi day shape compressive strength of concrete. An aggregate number of 42 mortar examples were thrown and tried appeared in Figure 6.1. The unconfined compressive strength values of concrete blends with various extents of copper slag tried at 7 and 28 days



**Figure 6.1** Compression test on CC and S40 specimens

**Table 6.2** Compressive strength test on concrete specimens

S. No	Mix Identity	Ultimate load kN		Average ultimate load kN		Comp.strength N/mm <sup>2</sup>		% increase in strength at 28 days
		7 Days	28 Days	7 Days	28 Days	7 Day	28 Days	
		1.	CC	460	770	453.33	745	
		480	720					
		500	750					
2.	S10	580	850	480	876.66	21.33		38.96
		600	880					
		560	900					
3.	S20	620	960	580	970.00	5.78		43.11
		630	970					
		650	980					
4.	S30	680	980	633.33	1006.67	27.15		44.77
		650	1000					
		675	1040					
5.	S40	560	1160	668.33	1055.00	29.70		46.8
		540	950					
		520	1055					
6.	S50	480	940	540.00	893.33	24.00		39.70
		465	860					
		490	880					
7.	S60	460	880	478.33	860	21.26		38.22
		480	840					
		500	860					

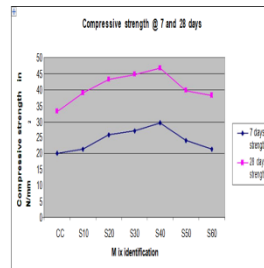
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**Figure 6.2 Compressive strength of concrete cubes**



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