IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 10, Issue 1, October 2021
Impact Factor: 5.731

Experimental Study on Strength Characteristic of Concrete by Partial Replacement of Fine Aggregate with Copper Slag

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Abstract: *An exploratory examination was led to consider the impact of utilizing copper slag as a fine total on the properties of bond mortars and cement. The utilization of copper slag in bond and solid gives potential common correspondingly as budgetary focal points for every single related industry. For this investigation work, M30 grade concrete was used and tests were driven for various degrees of copper slag replacing with sand of 0(for the control mix) to half in bond. A substitution of up to 40-half copper slag as a M-sand substitution yielded for all intents and purposes indistinguishable solidarity to that of the control mix. In any case, expansion of more copper slag brought about quality decrease.*

Keywords: Copper slag, Fine aggregate, compressive strength, Flexural strength

I. INTRODUCTION

Numerous nations are seeing a quick development in the development business which includes the utilization of common assets for the improvement of the framework. Normal assets are exhausting worldwide while in the meantime the produced squanders from the business are expanding considerably. The practical improvement for development includes the utilization of non-traditional and creative materials, and reusing of waste materials so as to repay the absence of normal assets. So specialists created squander the board systems to apply for trade of fine totals for development industry. Copper slag is a result of copper extraction by purifying. It is hard, strong and furthermore sporadic fit as a fiddle. Appearance is of dark and gleaming. Size of the molecule fluctuates from 0.075mm to 4.75mm. Copper section performs comparative or better contrasted with regular sand. To pass on 1ton of copper 2.2-3.0 ton of copper slag is made as result. It is basically utilized as a grating for metals to evacuate coatings or works of art, because of its hardness, strainer dispersion and harsh surface, mostly in the maritime business. The other primary preferred standpoint of utilizing such materials is to decrease the expense of development. Copper slag additionally contains molybdenum in measure of 0.4%. It likewise contains high solidarity to weight proportion. It contains exceptionally poisonous components like arsenic, barium, cadmium, copper lead and zinc which may make contamination soil condition

II. MATERIAL USED AND PROPERTIES

2.1 Cement

The cement used in this study was ordinary Portland cement. Ordinary Portland cement-53 grade of Chettinad cement brand is being used in this study.

2.2 Fine Aggregate

Produced sand was utilized as fine total. The span of made sand (M-Sand) is under 4.75mm. M sand is ideally utilizing for development exercises. Barely any focal points in M Sand are, residue content is 90% less contrasted with

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stream sand. Higher solid quality contrasted with stream sand utilized for cementing. Despite the fact that M Sand utilizes regular coarse totals to shape, it makes less harm condition when contrasted with stream sand.

2.3 Coarse Aggregate

Coarse totals are any particles more prominent than 0.19 inch, however by and large range between 3/8 and 1.5 creeps in distance across. Ordinarily, coarse total sizes are bigger than 5 mm in English code. Uncrushed rock or stone which is the consequence of regular deterioration of characteristic rock or stone is commonly characterized as coarse total. About all characteristic total start from bed rocks.

2.4 Copper Slag

Copper slag (CS) is a consequence of copper extraction by refining. Amid refining, pollutions move toward becoming slag which drifts on the liquid metal. The good physic-mechanical qualities of copper slag can be used to make the items like bond, fill, stabilizer, rough, total, material granules, glass, tiles and so forth. The utilization of copper slag to supplant iron powder as iron modifying material encourages concrete generation and diminishes or disposes of the need of mineralizes. The execution testing results showed that bond delivered by utilizing copper slag performed shockingly better than utilizing iron powder. Since the principle synthesis of copper slag is SiO2 and Fe2O3, it has low softening point and could diminish the calcination temperature for the assembling of bond clinker. The utilization of copper slag as a pozzolanic material in conventional Portland bond and its impacts on the hydration and properties of mortar and cement have been introduced in a few articles.

Table 1: Properties of Fine Aggregate

Sr. No	Properties	Values
1	Specific gravity	3.57
2	Water absorption %	0.14
3	Fineness modulus	2.69
4	Bulk density, g/cc	0.14

III. Experimental Work

3.1 Sieve Analysis

The first and the basic test conducted for experiment is sieve analysis. Various sizes of sieves are being used as per IS.

Table 2: Sieve Analysis Of M Sand And Copper Slag

Sieve (mm)	Percentage passing		Grading for zone II as per IS:383-1970
	Sand	Copper slag	
4.75	100.00	100.00	90-100
2.36	92.00	97.80	75-100
1.18	21.00	79.40	55-90
0.60	41.00	44.10	35-59
0.30	72.00	8.40	8-30
0.15	92.00	2.40	0-10
Pan	0.00	0.00	-

3.2 Mix Proportion

Solid blends with various extents of Copper slag utilized as a fractional substitute for fine totals were set up so as to explore the impact of Copper slag substitution on the quality ordinary cement. Solid blends were set up with various extents of Copper slag. The extents of Copper slag added to solid blends were as per the following: 0% (for the control blend), 10%, 20%, 30%, 40%, half, and 60%. The control blend was intended to have an objective multi day compressive quality of 30 N/mm2 (M30), utilizing a water-to-binder proportion of 0.45.

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Table 3: Mix Proportion

Sr. No	Mix	Cement material (kg/m^3)	Aggregate		Water cement Ratio (kg/m^3)	Water
			Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)		
1	CS (0%)	440	754	1138	198	0.45
2	CS (10%)	440	754	1138	198	0.45
3	CS (20%)	440	754	1138	198	0.45
4	CS (30%)	440	754	1138	198	0.45
5	CS (40%)	440	754	1138	198	0.45
6	CS (50%)	440	754	1138	198	0.45

A. Testing Procedure

The designed concrete mixes were subjected to series of test in order to evaluate its strength and other properties. It is important to monitor development in strength in this project. For each mixes 3 concrete samples are being casted and are being tested at different cuing stage. The tests conducted on concrete are explained below.

3.3 Compressive Strength of Concrete

Compressive quality of solid block test gives a thought regarding every one of the attributes of cement. By this single test one judge that in the case of Cementing has been done appropriately or not. Compressive quality of cement relies upon numerous components, for example, water-bond proportion, concrete quality, nature of solid material, and quality control amid creation of cement and so forth. Different standard codes prescribes solid 3D shape as the standard example for the test. Or on the other hand block test two sorts of examples either 3D squares of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm relying on the span of total are utilized. For the majority of the works cubical molds of size 15cm x 15cm x 15cm are normally utilized. This solid is poured in the form and tempered legitimately so as not to have any voids. Following 24 hours these moulds are expelled and test examples are placed in water for relieving. These examples are tried by pressure testing machine following 7 days relieving or 28 days restoring. Burden ought to be connected slowly at the rate of 140 kg/cm2 every moment till the Examples comes up short. Burden at the disappointment isolated by zone of example gives the compressive quality of cement.

Compressive strength of concrete (fc) = Maximum compressive load (P) / cross sectional area (A)

3.4 Split Tensile Strength

One of the critical properties of cement is "rigidity" as auxiliary burdens make concrete powerless against ductile splitting. Rigidity of cement is much lower than its compressive quality (that is the reason steel is utilized to convey the pressure powers). It has been evaluated that rigidity of solid equivalents generally about 10% of compressive quality. To decide the rigidity, roundabout techniques are connected because of the trouble of the immediate strategy. Taking note of that the qualities acquired of these techniques are higher than those got from the uniaxial ductile test. These circuitous strategies are: 1-part barrel test and 2-flexural test. In this venture, the Part Elasticity test is finished.

It is the standard test, to decide the elasticity of cement in a backhanded way. This test could be performed as per IS:5816-1970. A standard test barrel of size 300mm X 150mm breadth is utilized. The compressive burden is connected oppositely and consistently along the length of barrel until the disappointment of the chamber along the vertical distance across.

Split tensile strength of concrete (ft) = $2P/\pi DL$

where, P = compressive load at failure

D = diameter of cylinder

L = length of cylinder

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3.5 Flexural Strength

The flexural quality is communicated as Modulus of Rupture (MR) in psi (MPa) and is controlled by standard test strategies ASTM C 78 (third-point stacking) or ASTM C 293 (Center-point stacking). Flexural MR is around 10 to 20 percent of compressive quality relying upon the sort, size and volume of coarse total utilized. It also states that a size of 100mm width, 100mm depth, and span of 500mm can be used if the maximum aggregate size used is not greater than 19mm.

IV. TEST AND RESULT

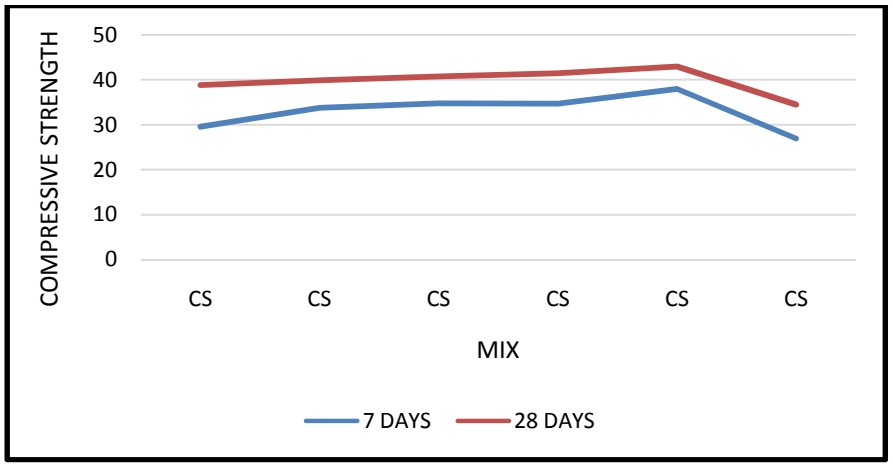
4.1 Compressive Strength Test Result

The outcome acquired by compressive strength result by addition of copper slag for 7days and 28days are given in the below listed

Table 4: Compressive Strength Results for 7 days and 28 days.

Mix	Compressive Strength (N/mm2)	
	7 days	28 days
CS (0%)	29.50	38.80
CS (10%)	33.72	39.89
CS (20%)	34.67	40.70
CS (30%)	36.88	41.44
CS (40%)	37.92	42.95
CS (50%)	26.87	34.44

Graphical Expression of Compressive Strength Results for 7 days and 28 days.



4.2 Split Tensile Test Result

The outcome acquired by split tensile strength by addition of copper slag for 28days are given in the below listed.

Table 5: Split Tensile Results for 7 days and 28 days

Mix	Split tensile (N/mm2)
	28 days
CS (0%)	3.01
CS (10%)	3.32
CS (20%)	3.07
CS (30%)	3.45
CS (40%)	3.66
CS (50%)	2.50

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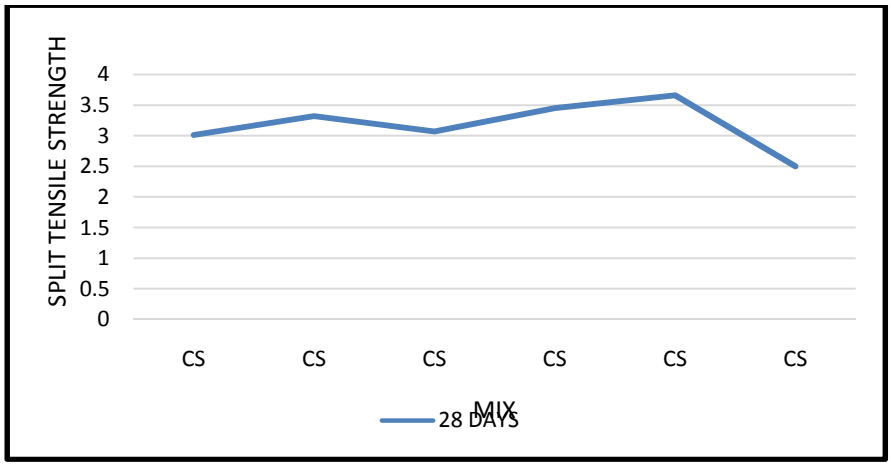
Graphical Expression of Split Tensile Results for 28 days.



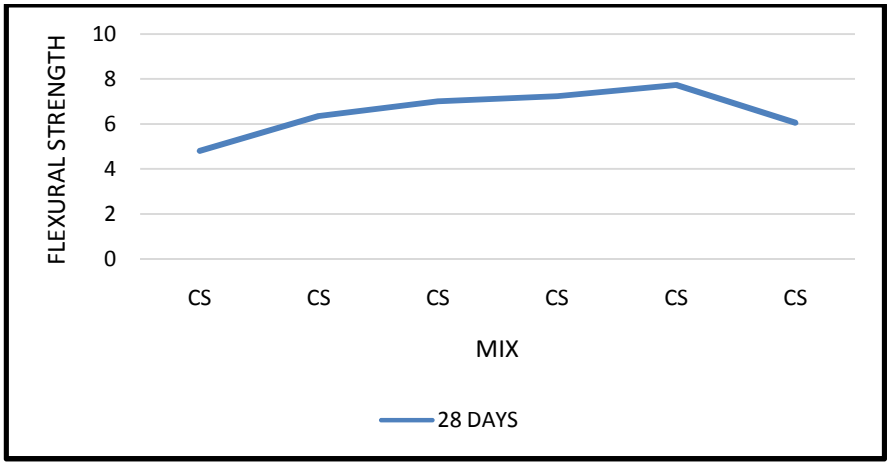
4.3 Flexural Strength Test Result

The outcome acquired by flexural strength by addition of copper slag for 28days are given in the below listed.

Table 6: Flexural Strength Results for 28 days

Mix	Flexural strength (N/mm2)
	28 days
CS (0%)	4.80
CS (10%)	6.35
CS (20%)	7.00
CS (30%)	7.23
CS (40%)	7.73
CS (50%)	6.05

Graphical Expression of Flexural Strength Results for 28 days.



V. CONCLUSION

From the results of compressive strength, has a higher value when copper slag is used instead of 40% fine aggregate. So recommended 40% of the fine aggregate can be replaced with copper slag.

- The split elasticity of solidified solid increments imperceptibly till 40% substitution of sand by copper slag.
- The workability of the concrete increases with the increase in replacement of CS with water cement ratio. Replacement of CS in fine aggregate reduces the cost of making concrete.

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- The improvement in the mechanical properties of cements entwining copper slag demonstrates that copper slag, an incident outcome of the copper business, can be used beneficially as partial replacement for fine aggregate in concrete.
- Referring to earlier conclusions 40% replacement of copper slag is the optimum replacement for natural sand which gives comparatively 45 to 55 percentage dense concrete with moderate slump which is applicable for routine construction work.

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