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Study on the Strength Comparison of two design mixes by Partial replacement of Copper slag

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Abstract : *In this study, investigate the performances on the Strength parameter of concrete by with of copper slag waste in concrete mixture. Copper slag employed in a various type of construction applications in which concrete material is one of them. A test was performed to examine the strength and durability performances of concrete consisting copper slag as a substitute of sand and cement results have been presented in this Study. Two different types of Concrete Grade (M25 & M30) were used with different proportions of copper slag substitution (0 to 20%) in the concrete. Strength & Durability properties such as Compressive Strength, Split Tensile Strength, Flexural Strength, were evaluated for both mixes of concrete. Copper slag replaced at the concrete with 5%, 10%, 15% & 20% of fine aggregates and cement were compared with Conventional concrete. In this experimental work was using M25 and M30 mix. Test results shows that the strength performances of concrete has improved having copper slag as a partial substitution of Sand and cement (0 to 20%) in concrete however in conditions of stability the concrete establish to be low resistant to acid attack and high resistance against Sulphate attack. Then analyze the variation between values of results with conventional concrete.*

Keywords: *Copper slag, Partial Replacement, compressive strength, concrete material.*

I. Introduction

Before this study, various investigations have been found the solutions on concrete composite materials. Natural resources are decreasing from the world and increasing wastes from industries generated simultaneously. The eco friendly and reliable development for construction consist the use of non conventional and different waste materials, and recycling of waste material for reducing emissions in environments and decreasing the use of natural resources. River Sand is common form of fine aggregate used in the manufacturing of concrete. However because of increased cost and large scale depletion of sources alternatives for river sand are being considered. In this experiment, we were mixed Copper slag as partial substitution with sand. Copper slag is the slag which is generated from Copper Industries which has similar physical and chemical properties of sand and utilized as replaced with sand. Copper slag is a waste product produced during production and refining of copper metal. This will helping to resolving the major issue such as depleting the natural resources, major concern of industrial waste disposal and decreased cost of construction. This will help in resolving a major concern of industrial waste disposal along with decreased cost of construction.

II. Material Description

Materials

The materials used in the projects for making concrete mixture are cement, Fine aggregate, coarse aggregate, copper slag, are detailed describe below:

Cement: Cement is by far the primary constituent of concrete, in that it performs the binding substance for the discrete ingredients. Prepared out of naturally generating raw materials and sometimes blended or interground with industrial wastes. The cement used in this study was OPC 53 grades Ordinary Portland cement (OPC) conforming to IS12269-1987.

Fine Aggregate: Aggregates which engage nearly 70 to 75 percent quantity of concrete are sometimes observed as inert ingredients in more than one sense. However, it is now well recognized that physical, chemical and thermal properties of aggregates substantially influence the properties and performance of concrete. The fine aggregate (sand) used was clean dry sand was sieved in 4.75 mm sieve to take out all pebbles.

Coarse Aggregate: Coarse aggregate are used for building concrete. They could be in the form of unequal broken stone or naturally occurring gravel. Materials that are large to be maintained on 4.75mm sieve size are named coarse aggregates. Its highest size may be up to 40 mm.

Water: Water is a main component of concrete as it actively contributes in the chemical reaction with cement. Since it helps to perform the strength giving cement gel, the amount and quality of water is essential to be looked into very carefully. Portable water is generally considered satisfactory.
Copper Slag: Copper slag which is an industrial waste generates from smelting and refining process of copper from Industry. Copper slag is mixed in the concrete as replacement material of fine aggregate. It is the waste product of copper produces from iron or steel plants.

III. Experimental Procedure

The estimation of concrete with copper waste and Fine aggregates used as substitute of aggregate materials is completed during concrete specimen testing. Concrete include cement, water, fine aggregate, coarse aggregate. Concrete is replaced with alternative materials by varying percentage of replacement. The copper slag is used as partial replacement for fine aggregate and Cement in the range of 5%, 10%, 15% and 20% by weight of sand and cement and its optimum level is to be found. For testing the strength of normal and other variation mix totally 180- cubes of size 150x150x150mm were casted for compression strength test. Then 45- beam of size 700x100x100mm is casted for flexural strength testing. For testing the Split tensile strength 45- cylinders of 150mmx300mm are casted as per mix design proportions. Once 24hours completed from casting the concrete specimens are de-moulded and allowed for continuous curing in a tank with portable water. The specimen are taken and tested at required 7_{th} day, 14_{th} day, 28_{th} day & 50_{th} day from curing for compression test at 7_{th} ,14_{th}, 28_{th} & 50_{th} day and flexural, tensile & durability test at 28_{th} day from curing. Then compare the Strengths of M25 & M30 design mixes.

IV. Results And Discussion

In this study the designed concrete is subjected to various tests to estimate the strength and other properties of the casted concrete. The main aim of the project is to monitor the developed strength attained by the concrete at various testing days from curing. Generally proper casting and curing of concrete will increase the strength of the concrete. For this project each test is carried out with 3 samples for every mix ratio and tested at required curing time. Then the average values are used for the investigations. The series of testing procedures are detailed below:

4.1. Compressive Strength Test

Concrete is weak in tension and strong in compression so the concrete should be strong to attain high compression. In this study for each mix 3-samples were tested and the average strength is compared with nominal mix of M25, M30 grade. Compressive strength test finds out the high amount of compressive load a material can bear below facture limit. The results of compressive strength at the age of 7, 14, 28 and 50 days are shown in table 4.

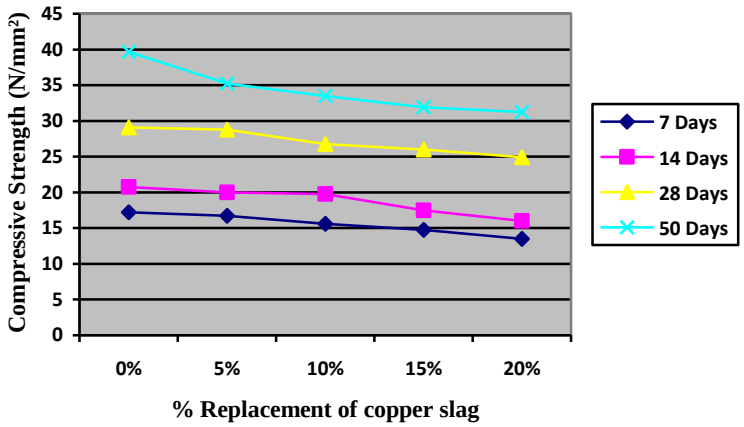
Table.1 Compressive Strength on Concrete M25 Cubes

Percentage Replacement	**Compressive Strength (N/mm²)**			
of Copper Slag	7 Days	14 Days	28 Days	50 Days
0%	17.20	20.77	29.10	39.68
5%	16.72	20	28.77	35.25
10%	15.59	19.75	26.75	33.5
15%	14.75	17.5	26	31.9
20%	13.5	16	24.9	31.24

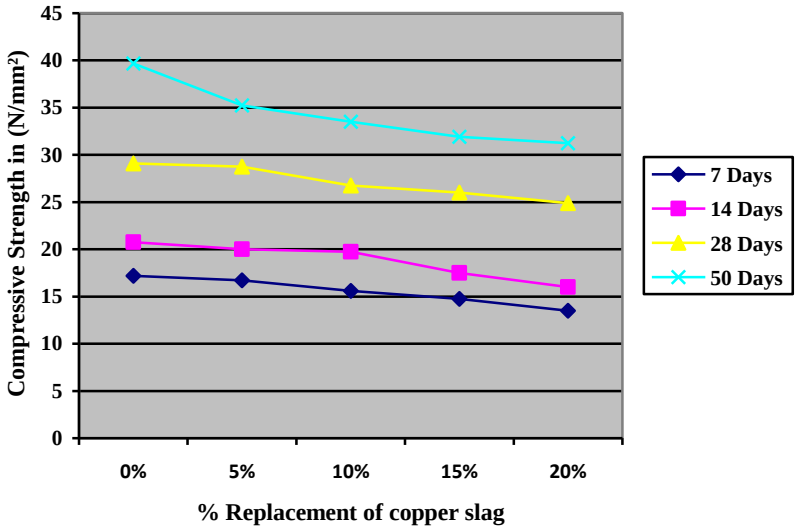
Table.2 Compressive Strength on Concrete M30 Cubes

Percentage Replacement	**Compressive Strength (N/mm²)**			
of Copper Slag	7 Days	14 Days	28 Days	50 Days
0%	17.20	20.77	29.10	39.68
5%	16.72	20	28.77	35.25
10%	15.59	19.75	26.75	33.5
15%	14.75	17.5	26	31.9
20%	13.5	16	24.9	31.24

Graph.1 Compressive Strength of Concrete M25



Graph.2 Compressive Strength of Concrete M30



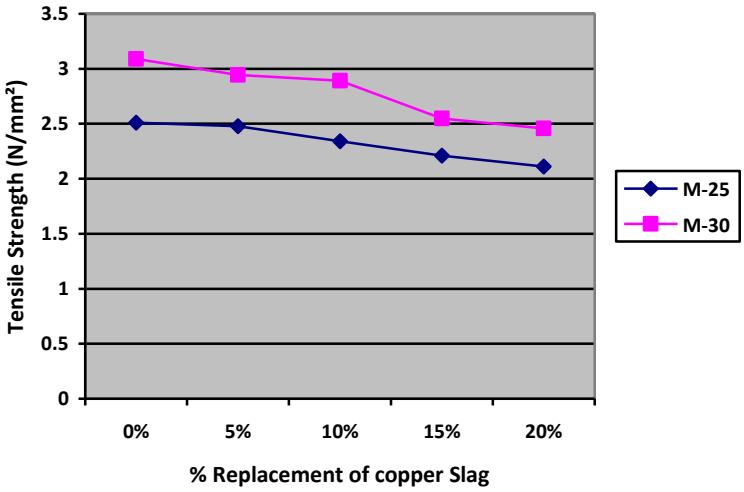
4.2. Split Tensile Strength Test

The split tensile strength of concrete is tested by casting cylinder of size 150mm x 300mm and is continuously cured for 28 days testing. Totally 45 cylinders were casted for normal M25, M30 grade and for 5%, 10%, 15% and 20% by weight partial replacement of copper slag for sand & cement. Three samples are tested and the average values are taken as tensile strength of concrete. The values of split tensile strengths are shown in table.

Table.3 Split Tensile Strength of Concrete at 28 Days

Percentage Replacement of Copper Slag	Split Tensile Strength (N/mm²)	
	M-25	M-30
0%	2.51	3.088
5%	2.479	2.944
10%	2.34	2.89
15%	2.21	2.547
20%	2.11	2.458

Graph.3 Split Tensile Strength at 28 Days



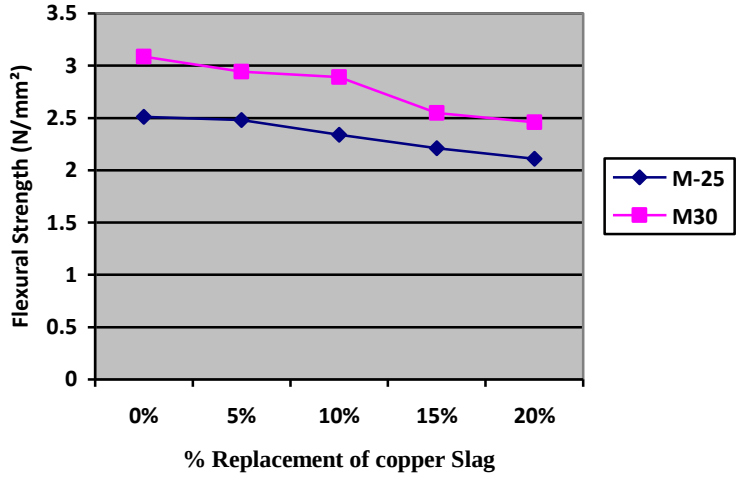
4.3. Flexural strength

Flexural strength also called as modulus of rupture. In concrete flexure is the bending moment caused by the applied load, in which a concrete beam has compression at top and tensile stress at the bottom side. Beams on testing will fail in tension due to its property and shear will appear on concrete. In this experimental works totally 45-beams of size 700 x 100 x 100 mm are casted of M25, M30 grades concrete and other percentage of replacements as for 5%, 10%, 15% and 20% by weight of copper slag with sand and cement. Then compare the values of both design mixes. The flexural values of various mixes are displayed in Table.5.

Table.4 Flexural Strength of Concrete at 28 days

Percentage Replacement of Copper Slag	Flexural Strength (N/mm²)	
	M-25	M-30
0%	2.51	3.088
5%	2.479	2.944
10%	2.34	2.89
15%	2.21	2.547
20%	2.11	2.458

Graph.4 Flexural Strength at 28 Days



4.4. Waste Management

Copper slag is mixed in the concrete as replacement material of fine aggregate. It is the waste product of copper produces from iron or steel plants. The safe disposal of this waste is lack, Costly and causes environmental Pollution. The construction industry is the only area where the safe use of Copper slag is possible. When it is introduced in concrete as a replacement material, it reduces the environmental pollution,

space problem and also reduces the cost of concrete. Many researchers had already establish, copper slag achievable use as a material in concrete. In this Experimental study Copper slag is used in concrete in the form of replacement material of fine aggregate. For this study, M25 and M30 grade of concrete is prepared and the test are conducted for various substitute of fine aggregate and cement using copper slag as 0%, 5%, 10%, 15%, 20% in concrete prepared with fine aggregate.

V. Conclusion

- A Copper slag is a type of waste mixed as a substitute to natural sand in concrete.
- From this investigation, the copper slag particles are waste of low cost material which would help to resolve solid waste disposal problem and protect environment from pollution.
- Cost of Concrete production reduces when Copper Slag is used as a fine aggregate in concrete.
- Copper Slag behaves similar to River Sand as it contains Silica (SiO2) similar to sand.
- Addition of Copper Slag increases the density of concrete thereby increasing the Self-weight.
- The Compressive Strength of Concrete with partial replacement of Sand with Copper Slag up to 20% can be comparable with conventional Concrete.
- Partial substitution of Copper waste in concrete with shows good resistance to sulphate attack.

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