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EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF COPPER SLAG AS FINE AGGREGATE IN CONCRETE

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Abstract : Concrete is used in large quantities almost everywhere mankind has a need for infra structure. The amount of concrete used worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminum combined. Concrete is also the basis of a large commercial industry. Copper slag is the material which is considered as a waste material, which can have a bright future in construction industry as partial replacement of either fine aggregates. When it is introduced in concrete as a replacement material, it reduces the environmental pollution, space problem and also reduces the cost of concrete. In production of every ton of copper, approximately 2.2–3.0 tons' copper slag is generated as a by-product material. The addition of copper slag will slightly increase the tensile strength of concrete, flexural strength of concrete.

Keywords: Copper slag, Compressive strength, Split tensile strength

I. INTRODUCTION

Concrete is a composite material composed of water, coarse aggregate, fine aggregate embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. Concrete is used in large quantities almost everywhere mankind has a need for infra structure. The amount of concrete used worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminum combined.

An ever-evolving world requires innovative construction methods. One of the most widely used materials for construction is concrete. This is not only due to the wide range of applications that concrete offers, but also its great strength, affordability, durability, and versatility. Structures built with concrete are more durable and can be engineered to withstand earthquakes, hurricanes, typhoons and tornadoes. This is an amazing advancement. Concrete is an incredibly useful and flexible building material without which modern architecture and construction would not be possible.

The ease with which structural concrete elements can be formed into a variety of shapes and sizes has been a reason for its success. It is usually the cheapest and most readily available material on the job. The fire resistance of concrete is perhaps the most important single aspect of offshore safety and, at the same time, the area in which the advantages of concrete are most evident.

II. METHODOLOGY

The methodology explains about the step by step procedure that is going to be done in the project.

The study includes casting of 3 cubes, 3 beams and 3 cylinders for comparing mechanical and structural behavior of concrete with partial replacement of copper slag as fine aggregate. To know the compressive strength of cubes, flexural strength using beams and split tensile strength of concrete using cylinders are tested and noted by taking the values. Finally, workability are checked using slump cone test to study ease of mixing, placing, compacting and transporting.

III. MATERIALS USED IN CONCRETE

3.1 CEMENT: Cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. In this project work 33, grades Ordinary Portland Cement are used.

3.2 FINE AGGREGATE: It is defined as: "Aggregates are the inert materials that are mixed in fixed proportions with a Binding Material to produce concrete".

3.3 COARSE AGGREGATE: Coarse aggregates are any particles greater than 4.75mm but generally range between 3/8 and 1.5 inches in diameter.

3.4 COPPER SLAG: Copper slag is the material which is considered as a waste material, which can have a bright future in construction industry as partial replacement of either fine aggregates. It is a by- product obtained during the matte smelting and refining of copper. The construction industry is the only area where the safe use of waste material (copper slag) is possible. When it is introduced in concrete as a replacement material, it reduces the environmental pollution,

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space problem and also reduces the cost of concrete.

3.5 WATER: Water is then mixed with this dry composite, which produces a semi-liquid that workers can shape (typically by pouring it into a form).

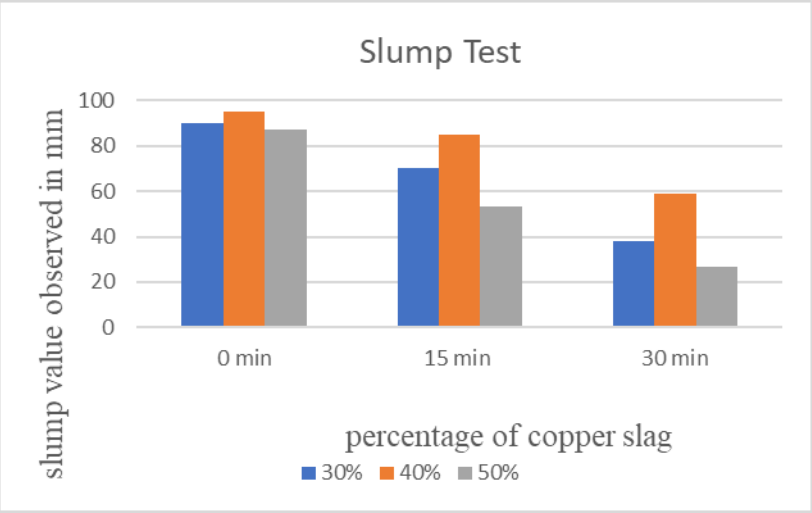
IV. RESULTS AND DISCUSSIONS

4.1 SLUMP TEST RESULTS

Table 4.1.1: Slump Value Results

Sl No	Time in min	%copper slag added	Materials used in (kgs)				W/C ratio	Water added in ml	Slump observed in mm
			Cement in kg	M sand in kg	Coarse aggregate in kg	Copper slag in kg			
1	0	30	3.126	1.425	6.25	3.325	0.4	1250	90
	15		3.126	1.425	6.25	3.325	0.4	1250	70
	30		3.126	1.425	6.25	3.325	0.4	1250	38
2	0	40	3.126	1.9	6.25	2.85	0.4	1250	95
	15		3.126	1.9	6.25	2.85	0.4	1250	85
	30		3.126	1.9	6.25	2.85	0.4	1250	59
3	0	50	3.126	2.375	6.25	2.375	0.4	1250	87
	15		3.126	2.375	6.25	2.375	0.4	1250	53
	30		3.126	2.375	6.25	2.375	0.4	1250	27

Graph 4.1.1: Slump Value for 30%, 40%, 50% of copper slag Addition



The slump value for the conventional concrete is 90 mm, with the addition of copper slag of 30%, 40% and 50% correspondingly slump values are 90, 95 and 87mm respectively. For 50% addition of copper slag there is reduction in slump value to 87 mm, due of the increase in the specific surface area of the copper slag results in increase in the water absorption. Hence there is decrease in the workability.

4.2 COMPRESSIVE STRENGTH TEST RESULTS

Table 4.2.1: Compressive Strength Test Result

Specimen No.	Specimen-1 (Mpa)	Specimen-2 (Mpa)	Specimen-3 (Mpa)	Average Result (Mpa)
No. of Days	7 days	14 days	28days	
30%copper slag	26.8	37.53	40.67	35

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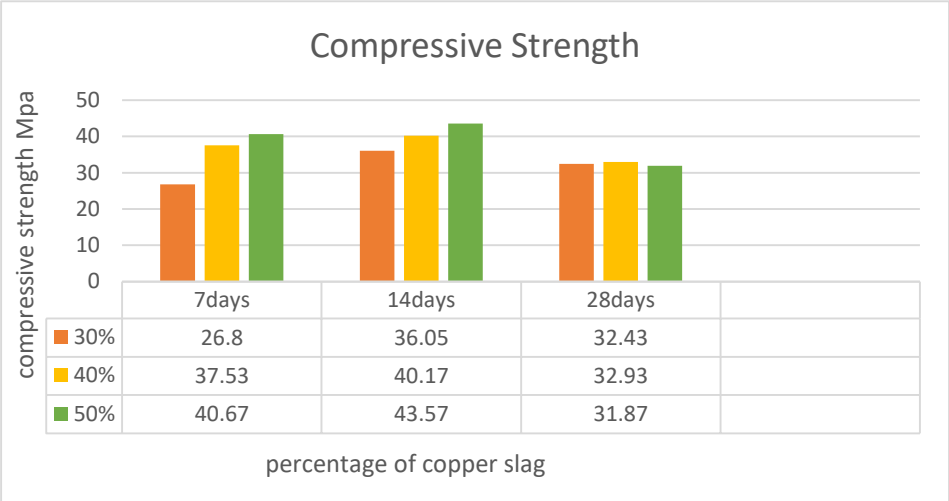
Addition				
40% copper slag Addition	36.05	40.17	43.57	39.93
50% copper slag Addition	32.43	32.93	31.87	32.41

Graph 4.2.1: 28th Day Compressive Strength Results

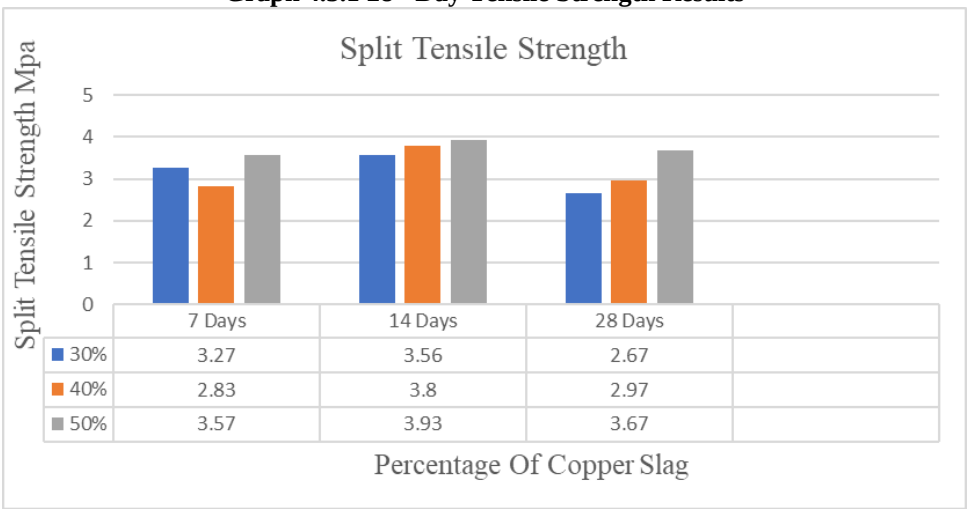


4.3 SPLIT TENSILE STRENGTH TEST RESULTS

Table 4.3.1 Split Tensile Strength Test Results

Specimen No.	Specimen No.1(Mpa)	Specimen No.2(Mpa)	Specimen No.3(Mpa)	Average result (Mpa)
No. of Days	7 days	14 days	28days	
30% copper slag Addition	3.27	2.83	3.57	3.22
40% copper slag Addition	3.56	3.80	3.93	3.76
50% copper slag Addition	2.67	2.97	3.65	3.10

Graph 4.3.1 28th Day Tensile Strength Results



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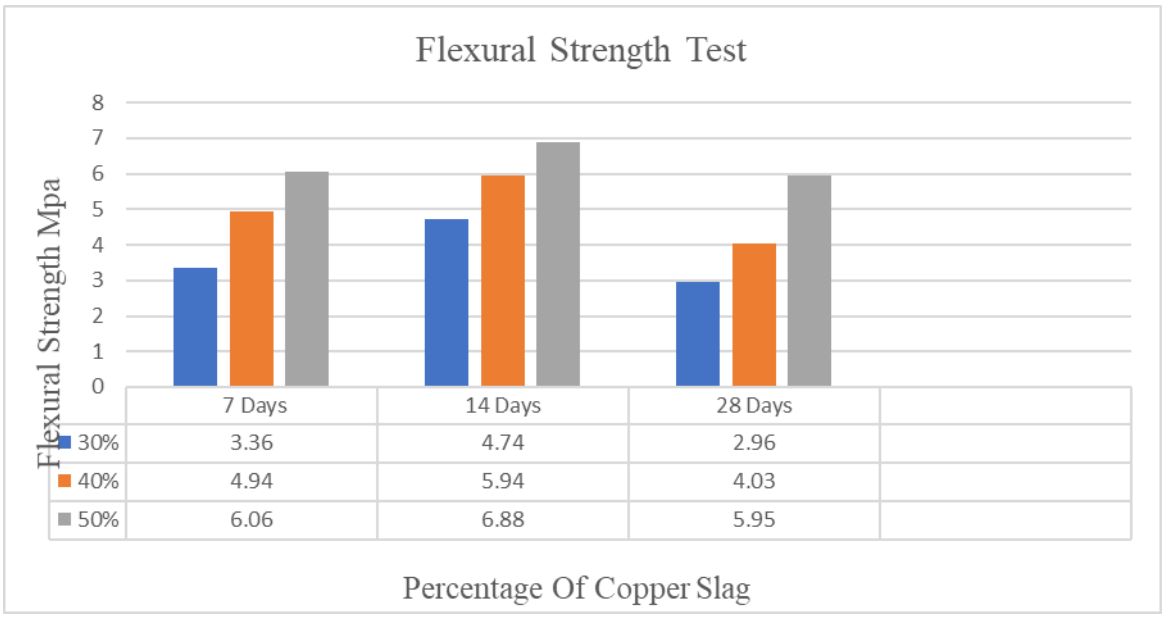
4.4 FLEXURAL STRENGTH TEST RESULT

Table 4.4 1 Flexural Strength Test Results

Specimen No.	Specimen No.1(Mpa)	Specimen No.2 (Mpa)	Specimen No.3(Mpa)	Average result (Mpa)
No. of Days	7 days	14 days	28days	
30%copper slag Addition	3.36	4.94	6.06	4.78
40% copper slag Addition	4.74	5.94	6.88	5.85
50% copper slag Addition	2.96	4.03	5.95	4.31

Graph 4.4.1 28th Day volume up to 40 %. Flexural Strength Results



V. CONCLUSION

Based on the test results, it is analyzed and the following conclusions were made:
It shows that the partially replaced concrete is in good workable condition rather than without super plasticizer. Later, with increase in percentage of copper slag the slump value Decreased. It was observed that the addition of copper slag slightly increases the compressive strength of concrete than conventional one. The addition of copper slag will slightly increase the tensile strength of concrete. Toughness of concrete also increases by the addition of copper slag. Addition of copper slag will increases the flexural strength of concrete.
As the percentage of copper slag is increased by more than 40%, there will be decrease in workability is observed. When the percentage of copper slag is added between 0%-40% there will be increase in workability but it was observed that reduction in workability when addition of copper slag exceeds more than 40%. Lastly, the addition of 40% copper slag in concrete is found to be optimum as well as effective and economical as it gives good compression, tensile, and flexural strength for the concrete.

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