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EXPERIMENTAL INVESTIGATIONS ON COMPRESSIVE STRENGTH OF COPPER SLAG IN CONCRETE

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ABSTRACT

The main objective comprises application of copper slag as fine aggregate replacement in concrete. As copper slag is cheaper in cost and is available in larger quantities, this could be convincingly used as a partial replacement with sand. Due to the advancement in concrete technology, there has been a reduction in the burden of pollutants in the environment. Leaving the waste materials to the environment directly can cause environmental problem. M30 concrete mix design has been selected and concrete cube specimens of standard size and replacement percentage ranging between 0 to 60% have been casted and tested and their relative compression strength has been analysed.

Keywords: copper slag, partial replacement, compression strength.

INTRODUCTION

Concrete is most common among the modern construction materials. Concrete is a material used in building construction, Concrete is an artificial material which has wider application in construction industry. The basic ingredients of concrete are cement, sand, coarse aggregate and water. Since the cost of sand have increased due to increased cost of production and or increased demand, there is an urgent need to replace them partially or wholly by cheaper materials. In this project an attempt has been made to search the effects of partial replacement of sand by copper slag as it is a waste product and a cheaper material.

Although natural fine aggregates are most suitable material used in both conventional and modern concrete, their quantity is continuously being depleted all around the world. The vast growth in construction industry increases the demand for such material. On the other side the industrial waste has been increasing substantially, use of non-conventional and reusing waste materials can reduce the natural resource depletion.

Aggregates are the major content of concrete. They occupy 70% of the concrete. Almost every country is facing greater demand for aggregate in construction industry. In order to get some alternative material artificial materials and waste materials from other industries matching the property of aggregate are selected and experimented to implement in real time construction. The waste generated by the industries are increasing rapidly due to the demand and some waste are not permitted to dispose like other solid waste so this point has been focused on utilization of this waste as usable material. The main advantage in using the generated waste reduces the cost of concrete production

Copper slag

Copper slag is a byproduct generated from refining of copper and it is also considered as a waste material. For every ton of refined copper, about 2.2 to 2.5 tons of waste slag is produced, which could be used as a replacement material for aggregates in concrete. Thus, copper slag possesses similar properties that of the sand. Using copper slag as a replacement of aggregate reduces the concrete production cost to a great extent. Silica present in the copper slag varies from 25% to 30% which is the main constituent present in natural aggregate used for concreting. The presence of copper in copper slag is about 0.2% which is not harmful. The following table gives us about some test properties of copper slag versus fine aggregate.

Table-1. Copper slag test properties.

S. No.	Test	Result
1	Water absorption	0.636%
2	Specific gravity	3.36
3	Fineness modulus	4.33

Table-2. Fine aggregate test properties.

S. No.	Test	Result
1	Water absorption	1.122%
2	Specific gravity	2.61
3	Fineness modulus	4.70

From above we can see that water absorption rate of copper slag is much less than that of the fine aggregate. The specific gravity of the copper slag is found to be higher than that of the fine aggregate which increases the density of concrete. Fineness modulus results shows that both copper slag and fine aggregate exhibits similar granular properties.

Experimental program

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to compressive strength.

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M30 concrete mix was used with a constant water cement ratio 0.45 and the mix proportions used for casting is 1:1.61:2.74. The grade of cement OPC 53 and the aggregates used are for this casting is crushed stone from quarry. The percentage replaced for fine aggregate by copper slag is 20, 40 and 60. The test was performed at the age of 7 days.

The compressive strength test was carried out on a total of 6 specimens of standard size of 150x150x150 mm cube which is cured for 7 days using a compression testing machine of 200 tons capacity. The compressive strength of the specimen is found by gradual application of load over the cross sectional area of the specimen. The point of loading at which the specimen fails is noted and corresponding load value is obtained. The failure load divided by the area over which the load is applied yields the compressive strength of the specimen.

The percentage replaced for fine aggregate by copper slag is 20, 40 and 60. The test was performed at the age of 7 days. The specimens were kept in water until the time of testing and the tests were carried out on the surface dry specimens. Table-3 shows the mix design details for all replacement percentages. Table-4 shows the compression test for specimens containing fine aggregate replaced by copper slag.

Figure-1. Testing of specimen.

Table-3. Mix design details.

S. No.	Cement (kg)	Fine aggregate		Water Content (Litres)	Weight of the coarse Aggregate (kg)	Copper slag (%)
		Sand (kg)	CS (kg)			
1.	425.73	616.54	88.18	191.58	1170.01	10
2.	425.73	548.03	176.37	191.58	1170.01	20
3.	425.73	479.53	264.56	191.58	1170.01	30
4.	425.73	411.02	352.75	191.58	1170.01	40
5.	425.73	342.52	440.9	191.58	1170.01	50
6.	425.73	274.01	529.13	191.58	1170.01	60

Table-4, 7 Days compressive strength results.

Specimen	Copper slag %	Load (kN)		Compressive strength (N/mm^2)
		I	II	
CS 0	0	580	570	25.55
CS 20	20	570	590	25.77
CS 40	40	630	610	27.56
CS 60	60	740	760	33.33

From the results we can observe that the compressive strength of the specimens with the copper slag replacements for fine aggregate tend to show increase in compressive strength compared to the control mix (25.55 MPa). It is seen from the Table-4 that the compressive strength of the specimen increases from 20 to 60 percentages. In that 60% replacement shows the highest compressive strength which was about 33.33 MPa where the control mix has 25.55 MPa indicating the increase in compressive strength is about 60%.

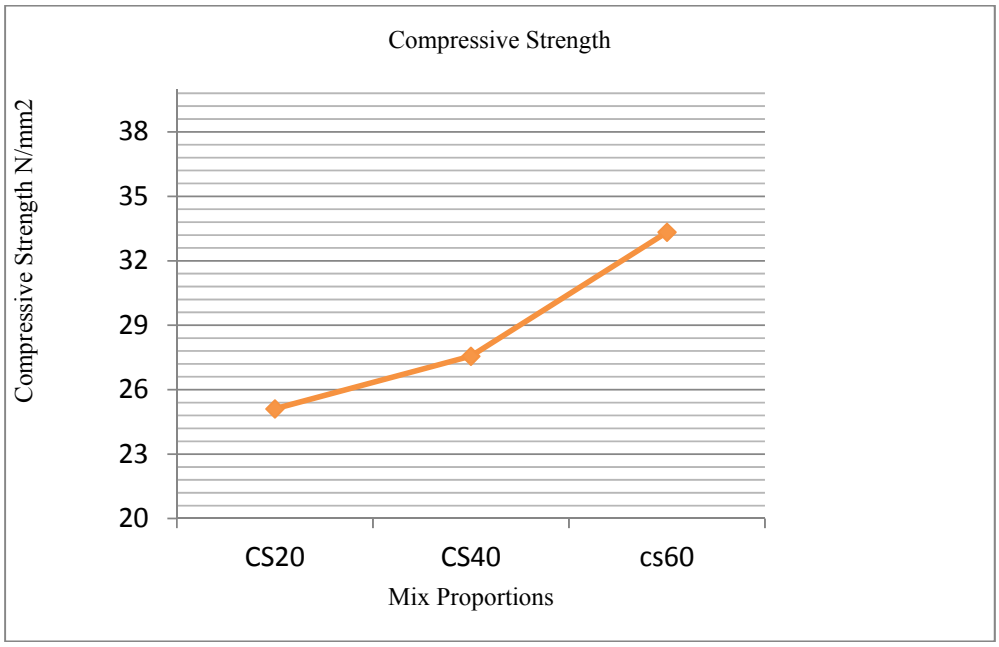

Figure-2. Compressive strength of specimen.

CONCLUSION

The following conclusions were observed from this study:

- It was observed that the partial replacement of copper slag as fine aggregate greatly increased the compressive strength at 20%, 40% and 60%.
- The copper slag replaced concrete indicates high strength due to its high toughness.
- The density of the concrete is to increase along with workability with increase in the copper slag content.

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