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RESEARCH ARTICLE

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EFFECT OF COPPER SLAG AS A PARTIAL REPLACEMENT OF FINEAGGREGATE ON THE PROPERTIES OF CEMENT CONCRETE

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ABSTRACT

This paper presents the results of an experimental investigation on the properties of concrete using copper slag as partial replacement of fine aggregate. In the present study the experimental investigations are carried out to evaluate the strength and durability characteristics of concrete by replacing the cement with Silica fume and fine aggregate with copper slag of various proportions. Silica fume and Copper slag are the materials that is considered as a industrial waste which can be used in construction Industry. It could have a promising future in construction industry as partial substitute of either cement or aggregate. Many researchers have already found that it is possible to use silica fume and copper slag as a concrete aggregate. But not much research has been carried out concerning durability and corrosion studies. Based on the properties of material used in concrete, mix design (M30) was done and the proportions of the mix was presented. Based on the mix proportion, trial mix was prepared and cube compressive strength at 7 days was found out. This result showed that about 60% of the 28 days cube compressive strength was attained during seven days of curing.

Keywords: Copper slag, compressive strength, tensile strength.

I. INTRODUCTION

In India, there is great demand of aggregates mainly from civil engineering industry for road and concrete constructions. But now a days it is very difficult problem for available of fine aggregates. So researchers developed waste management strategies to apply for replacement of fine aggregates for specific need. Natural resources are depleting worldwide while at the same time the generated wastes from the industry are increasing substantially. The sustainable development for construction involves the use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment. The rapid increase in the natural aggregates consumption every year due to the increase in the construction industry worldwide means that the aggregates reserves are being depleted rapidly, particularly in desert countries such as Arebian Gulf region. It has been reported that, without proper alternative aggregates being utilized in the near future, the concrete industry globally consume 8-10 billion tones of natural aggregates after some years. Many industrial wastes such as stone dust, silica fume, blast furnace slag and copper slag is pollutive; hence require proper collection, disposal and storage. Application of these

materials in concrete is environmentally friendly and economically beneficial. The most common type of slag produced in metallurgical is blast furnace slag. Long term performance records in manufacturing blended cement, light weight aggregates and Pozzolans for Portland cement have demonstrated blast furnace iron and steel slag to be economical and durable. Copper slag has been used in Canada approximately 45% in base construction, rail road ballast and engineered fill.

Copper slag is one of the materials that is considered as a waste material which could have a promising future in construction industry as partial or full substitute of either cement or aggregates. It is a by- product obtained during the matte smelting and refining of copper. To produce every ton of copper, approximately 2.2–3.0 tons copper slag is generated as a by-product material. In India copper slag is producing by Sterlite Industries Ltd (SIL), Tuticorin Tamil Nadu. It is producing Copper slag during the manufacture of copper metal. Currently, about 2600 tons of Copper slag is produced per day and a total accumulation of around 1.5 million tons [6]. If we are able to use the copper slag in place of natural sand then we can successively obtain a material to replace the sand, which is eco-friendly and cost effective. Hence there is a growing need to find the alternative solution for the slag management. In the present study, it is proposed to study the effect of addition of copper slag mixed with natural sand in concrete.

II. Materials and Methods Cement

Ordinary Portland cement 43 grade was used throughout the experimental investigations. The cement satisfied the requirements of Indian Standard Specification IS: 4031- 1988. The test results are listed in the Table 1.

Table 1.0 Physical Properties of cement

S.No	Properties	Values
1.	Specific gravity	3.15
2.	Standard consistency	32%
3.	Initial setting time	36 min
4.	Final setting time	254 min
5.	Fineness	3%

Fine and Coarse Aggregates

Coarse aggregates of 20mm down size and fine aggregates of Zone II were used from urban area of Tamil nadu. The test results on fine and coarse aggregate are presented in the following table 2.0 and 3.0.

Table 2.0 Physical Properties of Fine Aggregate

S.No	Properties	values
1.	Specific gravity	2.72
2.	Bulking of sand	22%
3.	Fineness modulus	2.57
4.	Water absorption	0.75%
5.	Particle size range	0.15 to 4.75 mm

Copper Slag

Copper slag collected from the Sterlite Industries Ltd (SIL), Tuticorin Tamil Nadu. The physical and chemical properties of copper slag are mentioned in the table 4.0 and 5.0 respectively.

Table 4.0 Physical Properties of Copper

S.No	Properties	values
1.	Specific gravity	2.72
2.	Bulking of sand	22%
3.	Fineness modulus	8.01
4.	Water absorption	2.60%
5.	Impact value	30.75%

PREPARATION AND CASTING OF TEST SPECIMENS

Concrete cubes of size 150 × 150 × 150mm were casted for all the concrete mixes for compressive strength, 150 × 300mm size cylinders were casted for tensile strength, test cubes of size 150 × 150 × 150mm were casted. After 24 hours of casting the specimens were demouldedand put into water curing tank until 7, 14 and 28 days of testing for compression and tensile strength, the cylinders were demoulded after 24.

III. MIX DESIGN

The experiment is conducted by sand is replaced with copper slag in steps of 10% till the strength decreases and the optimum value of the replaced percentage is noted down. The concrete is designed for M30 grade and water cement ratio used for the experimental work is 0.5.

IV. RESULTS AND DISCUSSION

a. Compressive strength

Compressive strength test is the most common test to be conducted on hardened concrete as it is easy to perform. The tests are to be made on the compressive strength testing machine for both cube and cylindrical samples.

Table 6.0 Compressive Strength Variation

S.No	days	Compressive Strength (N/mm^2)			Average Compressive Strength (N/mm^2)
	Copper slag %	10	20	30	
1	7 days	20.89	19.11	20.44	20.15
2	14 days	22.32	21.31	23.54	22.32
3	28 days	24.65	23.31	25.61	24.56

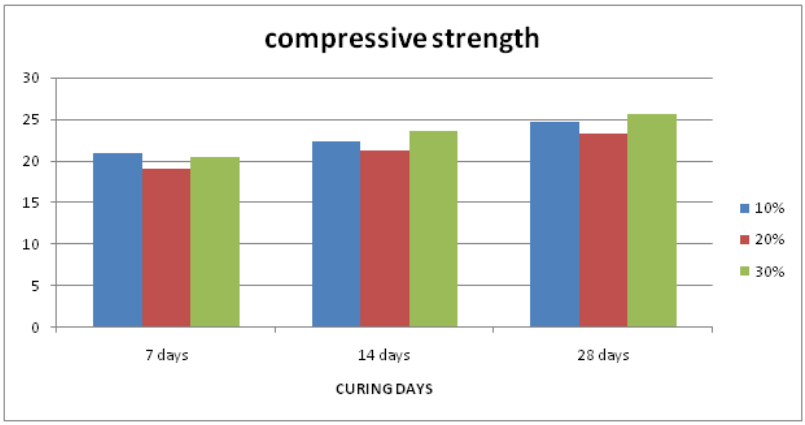


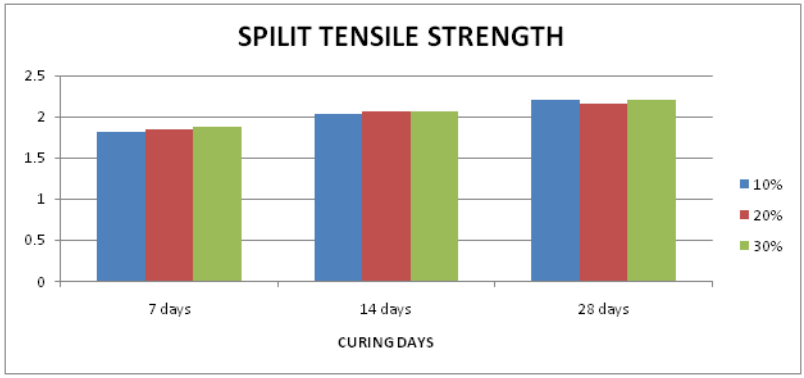
Fig. variations for compressive strength

B. Tensile Test

The split tensile strength test is to determining the tensile strength of the results of the high performance concrete mixes at the ages of 7, 14, 28 days as shown in table.

Table 7.0 Compressive Strength Variation

S.No	days	Split tensile strength (N/mm^2)			Average Compressive Strength (N/mm^2)
	Copper slag %	10	20	30	
1	7 days	1.82	1.85	1.87	1.85
2	14 days	2.03	2.07	2.07	2.04
3	28 days	2.21	2.15	2.21	2.21



CONCLUSION

The utilisation of copper slag in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of copper slag in fine aggregate and cement reduces the cost of making concrete. The workability of concrete increases significantly with the increase of copper slag content in concrete mixes. This was attributed to the low water absorption and glassy surface of copper slag. The initial and final setting time of copper slag admixed concrete is higher than control concrete. The results of compressive, split tensile, Flexural strength test have indicated that the strength of concrete increases with respect to the percentage of copper slag added by the weight of fine aggregate up to 30% (CS40). Further additions of copper slag caused reduction in strength due to an increase of free water content in the mix.

References

[1]. D. Brindha and s. Nagan (2010) "Utilization of Copper Slag as a Partial Replacement of Fine Aggregate inConcrete". International Journal of Earth Sciences and Engineering ISSN 0974-5904, Vol. 03, No. 04, August 2010, pp. 579-585.

[2]. D. Brindha and S. Nagan(2011) "Durability studies on copper slag admixed concrete". Asian journal of civil engineering (building and housing) vol. 12, no. 5 (2011) pages 563-578.

[3]. Khalifa S. Al- Jabri, Mackoto Hisada, Abdullah H. Al-Saidy and S.K.Al-Oraimi (2009) "Performance of high strength concrete made with copper slag as a fine aggregate" Construction and Building Materials 23(2009)2132-2140.

[4]. Kalifa S. Al-Jabri, Abdullah H. Al-Saidy and RamziTaha (2011) "Effect of copper slag as a fine aggregate on the properties of cement mortar and concrete". Construction and Building Materials 25(2011)933-938.

[5]. M. Najimi, J. Sobhani and A.R. Pourkhorshidi (2011) "Durability of copper slag contained concrete exposed to sulphate attack". Construction and Building Materials 25(2011)1895-1905.

[6]. R. Tixier, R. Devaguptapu and B. Mobasher (1997) "The effect of copper slag on the hydration and mechanical properties of cementitious mixtures".Cement and concrete Research, Vol. 27.No. 10.pp 1569-1580. 1997.

[7]. P. Shanmuganathan, P. Laxmipathiraj, S. Shrikanth, A. L. Nachiappan and A. Sumathi (2008) "Toxicity characterization and long-term stability studies on copper slag from the ISASMELT process". Resources, Construction Recycling 52(2008)601- 611.

[8]. A. M. Kalinkin, Sanjay Kumar, B. I. Gurevich, T. C. Alex, E. V. Kalinkina, V. V. Tyukavinkina, V. T. Kalinnikov and Rakesh Kumar (2012) "Geopolymerization behavior of Cu-Ni slag mechanically activated in air and in Co2 atmosphere". International Journal of Mineral processing 112-113 (2012) 101-106.

[9]. Antonio M. Ariño and BarzinMobasher "Effect of Ground Copper Slag on Strength and Toughness of Cementitious Mixes".aci materials journal.

[10]. Government of india ministry of mines Indian bureau of mines (2012) "Indian Minerals Yearbook" 2011(Part- I).