A Study on the Partial Replacement of Fine Aggregate with Copper Slag by Observing the Compression, Split Tensile and Flexural Properties

V. Sushma
M.Tech Student, Department of Civil Engineering, Visvodaya Engineering College, Kavali

Dr. T. Suresh Babu
Professor, Department of Civil Engineering, Visvodaya Engineering College, Kavali.

K.V.Manikanta
Research Coordinator, Department of Civil Engineering, Visvodaya Engineering College, Kavali

M Anvesh Kumar
Assistant Professor, Department of Civil Engineering, Visvodaya Engineering College, Kavali

M Praveen Kumar
M.Tech Student, Department of Civil Engineering, Visvodaya Engineering College, Kavali

ABSTRACT:
Many researchers have investigated the use of copper slag in the production of cement, mortar and concrete as raw materials for clinker, cement replacement, coarse and fine aggregates. The use of copper slag in cement and concrete provides potential environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of copper slag is produced. This project report reviews the characteristics of copper slag and its effects on the engineering properties of cement, mortars and concrete. By using the copper slag in construction field, the chance of getting pollution due to copper slag will be reduced and it will be the cost effective method for any construction industry.

Kewords:
Concrete, Copper Slag, Aggregates.

1. INTRODUCTION
In India, there is great demand of aggregates mainly from civil engineering industry for road and concrete constructions. But now 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. As the copper settles down in the smelter, it has higher density, impurities stay in the top layer and then are transported to a water basin with a low temperature for Solidification. The end product is a solid, hard material that goes to the crusher for further processing. Copper slag is a by-product obtained during the matte smelting and refining of copper. Copper slag used in this work was brought from Sterlite Industries Ltd(SIL), Tuticorin, Tamil Nadu, India. The use of copper slag in cement and concrete provides potential environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of copper slag is produced.

1.1 Copper Slag: Properties
i. Copper slag (CS), the glassy material, produced during matte smelting and copper conversion was previously considered waste and disposed as landfill. It has been estimated that for every ton of copper production about 2.2-3 tons of slag are generated.
ii. Copper slag, a copper production residue, shows in its chemical composition high contents of aluminum, silica and iron oxides, similar to that of cement.
iii. Additionally, its hardness and gradation seems to indicate its suitability for use as alternative aggregate for applications in construction products.
iv. Aggregate is the main constituent of concrete, occupying more than 70% of the concrete matrix. Slag containing < 0.8% copper are either discarded as waste or sold cheaply.

1.1.1. Physical properties of Copper Slag

Physical properties	Copper slag
Appearance	Black glassy granules
Colour	Black
Grain shape	Granular
pH	6.6 – 7.2
Water soluble chloride content	11 PPM
Specific gravity	3.5 – 3.8
Bulk density	1.9 gm/cc
Hardness	6 – 7 MOH scale

1.1.2 Chemical properties of CS

S.No	Chemical Component	%Of Chemical Component
1.	SiO_2	25.84
2.	Fe_2O_3	68.29
3.	AlO_3	0.22
4.	CaO	0.15
5.	Na_2O	0.58
7.	K_2O	0.23
8.	LoI	6.59
9.	MnO_3	0.22
10.	TiO_2	0.41
11.	SO_3	0.11
12.	CuO	1.20
13.	Sulphide Sulphur	0.25
14.	Insoluble Residue	14.88
15.	Chloride	0.018

2.USE OF COPPER SLAG

The Central Electro Chemicals Research Institute, a Council of Scientific and Industrial Research, India had been consulted to confirm the leaching behavior of copper slag and to obtain the recommendations from CECRI.

The major uses of Copper Slag can be:

i. Using copper slag as a raw material for the manufacture of OPC.
ii. Using copper slag as a blending material for the manufacture of PSC.
iii. Understanding the leaching behavior of copper slag and confirm the suitability of using the same in cement manufacturing
iv. Copper slag has also gained popularity in the building industry for use as a fill material.
v. Contractors may also use copper slag in place of sand during concrete construction.
vi. Copper slag can also be used as a building material, formed into blocks.

3.TESTS TO BE CONDUCTED

3.1. Compressive Strength Test

For each set nine standard cubes were cast to determine 7-days,28 day and 90 days compressive strength after curing. Also nine no. of cube was casted to know the compressive strength of concrete. The size of the cube is as per the IS 10086 – 1982.

Figure 1: Showing Compressive testing machine

3.2. Split Tensile Strength

For each set 9 cylinders were casted and tested for 7 days, 28 days and 90 days for determining the split tensile strength for the optimum proportions of fly ash, silica fume replacements and steel slag additions.

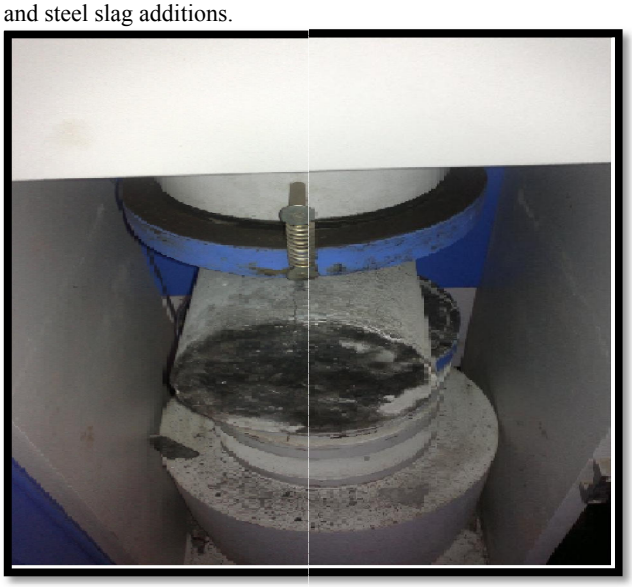


Figure 2: Showing split tensile strength testing

3.3.Flexural Test

It is the ability of a beam or slab to resist failure in bending. The flexural strength of concrete is 12 to 20 percent of compressive strength. Flexural strength is useful for field control and acceptance for pavement .but now a days flexural strength is not used to determine field control; only compressive strength is easy to judge the quality of concrete. To determine the flexural strength of concrete four numbers of prism were casting. Then it was cured properly.

Flexural strength = PL/BD^{2}; Where P is load;L= Length of

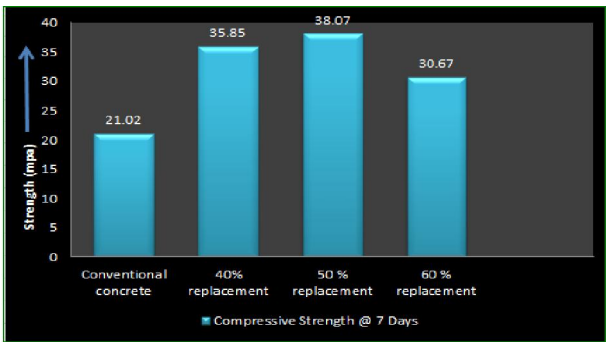
Prism;B = Breadth of Prism;D = Breadth of Prism.

Figure 3: showing flexural strength test

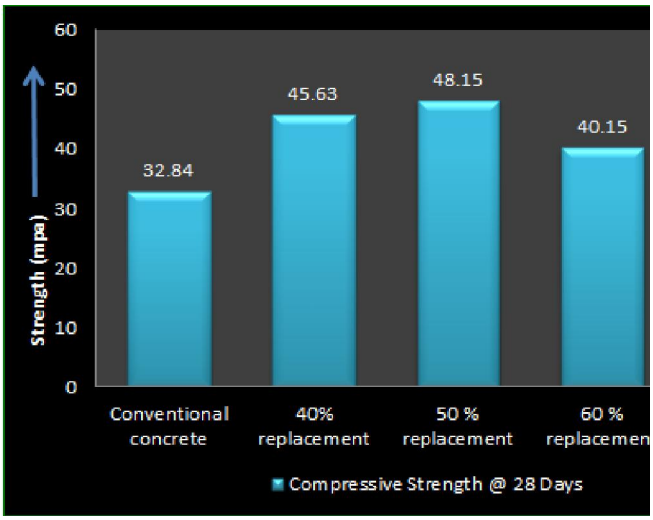
4.RESULTS

After testing the specimens the results are as follows:

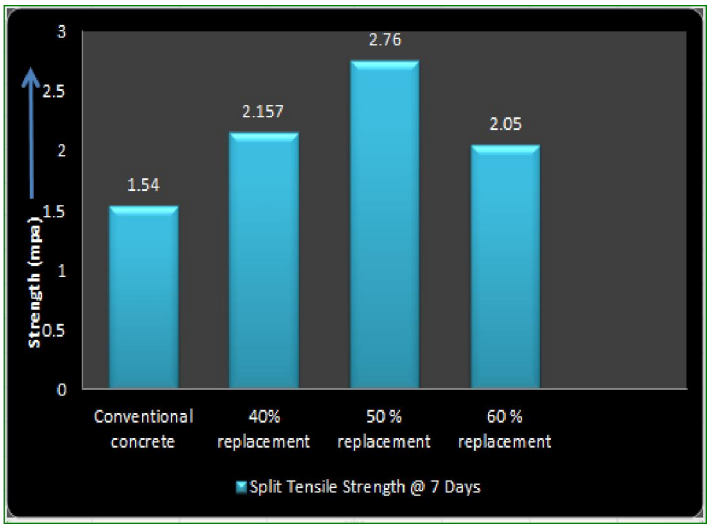
Compressive strength of concrete for 7 days



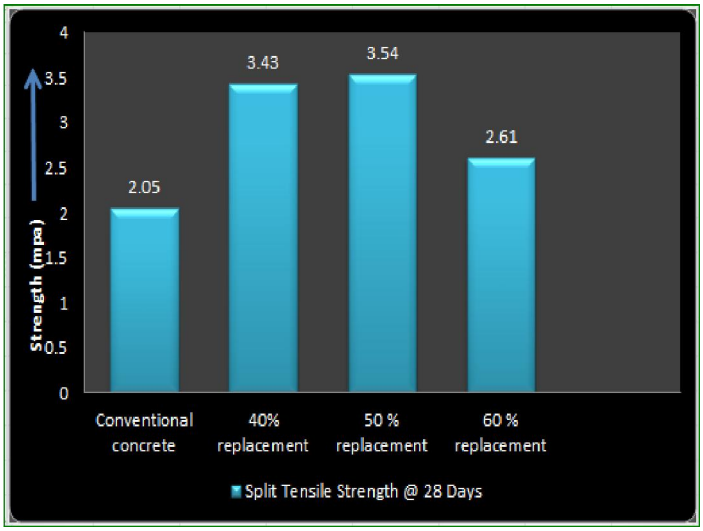
Compressive strength of concrete for 28 days



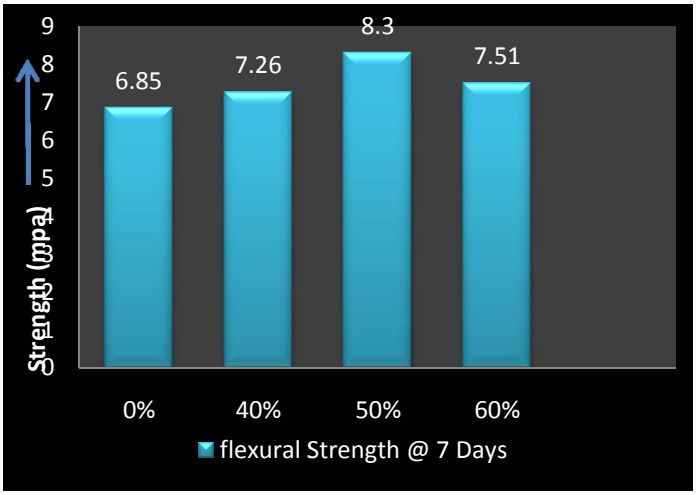
Split tensile strength of concrete for 7 days



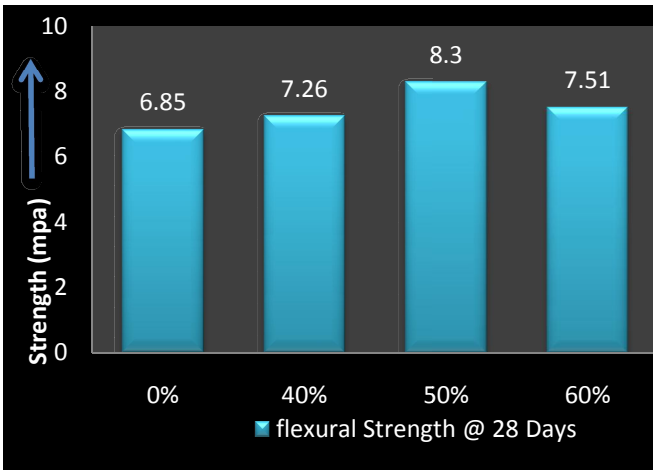
Split tensile strength of concrete for 28 days



Flexural strength of concrete for 7 days



Flexural strength of concrete for 28 days



5.CONCLUSIONS

Based on experimental investigation we came to conclude that the strength of concrete increases with cost effective and without depleting the natural resources.

- By doing this project we reduced the consumption of fine aggregate by 50% than conventional concrete, at this proportion concrete will give maximum strength.
- By replacing the fine aggregate with 50% copper slag the cost saving was found to be 20%.
- In the compressive strength aspect we observed the incremental change which is 1.47 times more than the conventional concrete
- In the split tensile strength aspect we observed the incremental change which is 1.73 times more than the conventional concrete

REFERENCES

[1] Alnuaimi AS,(2012), "Effects of Copper Slag as aReplacement for Fine Aggregate on the Behavior andUltimate Strength of Reinforced Concrete SlenderColumns", TJER,Vol. 9, No. 2, pp 90-102.

[2] Ariño Antonio M. ,BarzinMobasher,(1999), "Effect ofGround Copper Slag on Strength and ToughnessofCementitious Mixes", ACI Materials Journal, Vol. 96, No.1, pp 68-74.

[3] Barnett Stephanie J., Marios N. Soutsos, John H. Bungey,Steve G. Millard,(2007), "Fast-Track Construction withSlag Cement Concrete: Adiabatic Strength Developmentand Strength Prediction", ACI Materials Journal, V. 104,No. 4, pp 388-396.concrete and dry lean concrete with copper slag as fine

[4] Brindha D. And S. Nagan, (2011), "Durability Studies onCopper Slag Admixed Concrete", Asian Journal of CivilEngineering (Building and Housing), Vol. 12, No. 5, pp563-578.

[5] Brindha D.,Baskaran. T ,Nagan.S (2010), "Assessmentof Corrosion and Durability Characteristics of CopperSlag Admixed Concrete", International Journal Of CivilAnd Structural Engineering Vol 1, No 2, pp-192-211.

[6] Khalifa S. Al-Jabri , Abdullah H. Al-Saidy, RamziTaha(2011), "Effect of copper slag as a fine aggregate on theproperties of cement mortars and concrete",Construction and Building Materials,Vol. 25, pp. 933-938.

[7] MeenakshiSudarvizhi. S, Ilangovan. R (2011), "Performance of Copper slag and ferrous slag as partialreplacement of sand in Concrete", International JournalOf Civil And Structural Engineering ,Vol 1, No 4,pp.918-927.

[8] Wei Wu ,Weide Zhang , Guowei Ma(2010) "Optimumcontent of copper slag as a fine aggregate in highstrength concrete" ,Material and design,Vol.31,pp-2878-2883.