Partial Replacement of Fine Aggregate by Copper Slag

CHANDAN C S[1], MALLESH KUMAR K V[2], NAVYASHREE G[3], VIVEK G[4], YASHAS T R[5]
[1, 2, 3, 4, 5] *Department of Civil Engineering CIT. Gubbi, Tumkur*

***Abstract*—This project presents the usage of Copper Slag for the partial replacement of Fine aggregate the experimental procedure will be conducted for the replacing percentage of 25%,30%,35%,100%. For each concrete mix, nine cubes (150mm X 150mm X 150mm) will be casted. For this above replacement percentage M25 mix will be prepared. The main objective of this project is to know the compressive strength of partial replaced concrete. To evaluate the strength, compressive strength test will be conducted. Also expecting result showing that the compressive strength of concrete is generally improved when it is compared with the conventional mix, with the increase of copper slag up to a certain percentage beyond which the strength reduces.**

***Index Terms*— Copper Slag, Fine Aggregate, Concrete, Strength, Workability, Density**

I. INTRODUCTION

The utilization of industrial waste or secondary materials has encouraged the production of cement and concrete in construction field. New by-product and waste materials are being generated by various industries. Dumping or disposal of waste material causes environmental and health problems. Therefore, recycling of waste is a great potential in concrete industry. For many years, by-products such as fly ash, silica fume and slag were considered as waste materials. Concrete prepared with such material showed improvement in workability and durability compared to normal concrete and has been used in the construction of power, chemical plants and under-water structures.

Copper slag is an industrial by-product material produced from the process of manufacturing copper. For every ton of copper production, about 2.2 tonnes of copper slag is generated. It has been estimated that approximately 24.6 million tons of slag are generated from the world copper industry. Although copper slag is widely used in the sand blasting industry and in the manufacturing of abrasive tools, the remainder is disposed of without any further reuse or reclamation.

The use of copper slag in the concrete industry as a replacement for cement can have the benefit of reducing the costs of disposal and help in protecting the environment. Even though several studies have been reported on the effect of copper slag replacement on the properties of Concrete, further investigations are necessary to obtain a comprehensive understanding that would provide an engineering base to allow the use of copper slag in concrete. The results indicated that the water demand reduced by almost 22% at 100% copper slag replacement compared to the control mixture. The strength and durability of HSC were generally improved with the increase of copper slag content in the concrete mixture.

II. OBJECTIVES OF THE STUDY

- Submit your manuscript electronically for review. prepare it in two-column format, including figures and tables(untill it don't fit properly and data is not visible). Variable speed limit control One of the primary objectives is to reduce the environmental impact of the construction industry by recycling waste materials like copper slag instead of disposing of them in landfills. This contributes to sustainable resource management and reduces the demand for natural sand and gravel.
- By using copper slag as a substitute for fine aggregate, valuable natural resources can be conserved. This helps in preserving natural sand and gravel reserves, which are finite resources.
- To study the properties of concrete, compressive strength test with partial replacement of fine aggregate with copper slag in concrete.
- Evaluate the effect of copper slag addition on the high strength concrete.
- Comparison of the strength of conventional concrete with the experimental mixes.

III. METHODOLOGY

1) Mix Design

2) Proportioning the Mix
3) Testing and Quality Control
4) Construction
5) Quality Assurance
6) Performance Evaluation

Materials
1. Cement
2. Coarse aggregate
3. Fine aggregate
4. Copper slag

CEMENT

PPC cement, or Portland Pozzolana Cement, is a type of cement widely used in construction. It is composed of pozzolanic materials, such as fly ash, volcanic ash, or calcined clay, along with Portland cement clinker. Pozzolanic materials are finely divided siliceous or aluminous materials that react with calcium hydroxide in the presence of water to form compounds possessing cementitious properties.

PPC cement offers several advantages over ordinary Portland cement (OPC), including higher resistance to sulfate and chloride attacks, reduced heat of hydration, improved workability, and enhanced long-term strength. It is commonly used in structural concrete, masonry, plastering, and various other construction applications.

Overall, PPC cement provides a sustainable alternative to OPC by utilizing industrial by-products, thereby reducing environmental impact and contributing to the efficient use of resources.

COARSE AGGREGATE

Coarse aggregates refer to irregular and granular materials such as sand, gravel, or crushed stone, and are used for making concrete. In most cases, Coarse is naturally occurring and can be obtained by blasting quarries or crushing them by hand or crushers. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

FINE AGGREGATE

M sand, or manufactured sand, is a type of sand produced by crushing hard granite or basalt rocks into fine particles. It is an alternative to natural river sand and is widely used in construction activities such as concrete production, plastering, and bricklaying.

M sand offers several advantages over natural river sand, including consistent particle size distribution, higher strength, better durability, and reduced impurities

In construction, M sand is commonly used as a substitute for river sand in concrete mixtures, mortar, and plastering applications. Its uniformity in particle size and shape ensures better workability and strength characteristics in concrete.

COPPER SLAG

Copper slag, which is the waste material produced in the extraction process of copper metal in refinery plants, has low cost, and its application as a fine aggregate in concrete production reaps many environmental benefits, such as waste recycling, and solves disposal problems. Copper slag is a by- product of copper extraction by smelting. During smelting, impurities become slag which floats on the molten metal. Slag that is quenched in water produces angular granules which are disposed of as waste or utilized as replacement material.

QUANTITY OF MATERIALS CALCULATION

Volume of Cube = 0.15mx0.15mx0.15m Wet volume = $0.003375m^3$

Dry volume = 1.54

For 8 cubes = 8x0.003375= $0.027m^3$

Quantity Calculation for M25 grade (1:1:2)

CEMENT = 1/1+1+2 x0.027x1440x1.54

cement = 14.96 kg

FINE AGGREGATE=1/1+1+2x0.027x1600x1.54

Density of FA = 1600 kg/m^3 FA = 16.63 kg

COARSE AGGREGATE=2/1+1+2x0.027x1800x1.54

Density of CA -1800kg/m^3 CA=37.42kg

WATER CONTENT (M25 -0.55)

W/C= 14.96 x 0.55

W/C = 8.22 L or kg

Partial replacement of fine aggregate by copper slag

Fine aggregate = 16.63 kg For -25%

= 16.63x25/100
=4.15 kg For-30%
= 16.63x30/100
= 4.98 kg
For- 35%
=16.63x35/100
=5.82 kg For-100%
= 16.63 kg
Quantity of Materials Required
CEMENT - 59.84 ~ 60 kg
FINE AGGREGATE - 34.94 ~ 35 kg
COARSE AGGREGATE - 149.68 ~ 150 kg
COPPER SLAG - 31.58 ~ 32 kg
WATER CEMENT RATIO - 33L or kg
QUANTITY OF MATERIALS FOR VARIOUS MIXES

Sl.No	Percent of copper slag	Cement(kg)	Coarse Aggregate(kg)	Fine Aggregate(kg)
1	0	14.96	37.42	16.63
2	25	14.96	37.42	12.48
3	30	14.96	37.22	11.65
4	35	14.96	37.22	10.81
5	100	14.96	37.22	16.63

IV. RESULTS AND DISCUSSIONS

Compressive Strength of Concrete
Compressive Strength of concrete is describes as the load that causes the failure of a standard specimen divided by the area of cross section in uniaxial compression underneath a given rate of loading. The compressive strength test is done on standard cube specimens using CTM or UTM.

In order to determine the compressive strength cube mould of size 150 150 150 mm were casted. The cubes were casted for different percentage of copper slag ranging from 0 percent

to 30 percent. Then the cubes are kept curing for 28 days. Three samples were tested at each concrete mixture. The compression test is done according to the specification IS 516:1959.

The compressive strength is calculated using the formula, Compressive strength (N/mm^2) = P/A Where,
P – Ultimate Load (N)
A – Loaded area of the cube

UTM

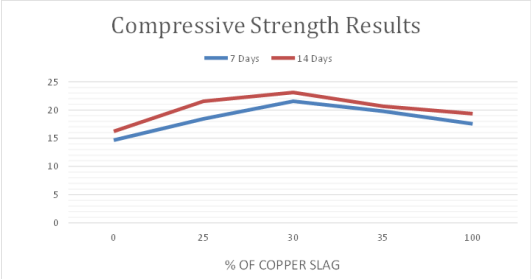
TESTING OF SPECIMENS
The measured compressive strength of the cubes shall be calculated by dividing the maximum load applied to the cubes during the test by the cross sectional area.

Testing of specimen

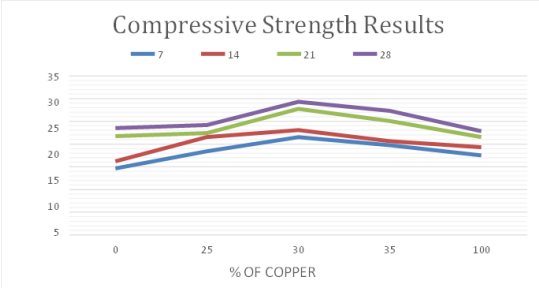
COMPRESSIVE STRENGTH RESULTS

Sl. No	Percent of copper slag (%)	7 Days (Mpa)	14 Days (Mpa)	21 Days (Mpa)	28 Days (Mpa)
1	0	14.66	16.22	21.77	23.55
2	25	18.44	21.55	22.44	24.22
3	30	21.55	23.11	27.77	29.55
4	35	19.77	20.66	25.11	27.33
5	100	17.55	19.33	21.55	22.88

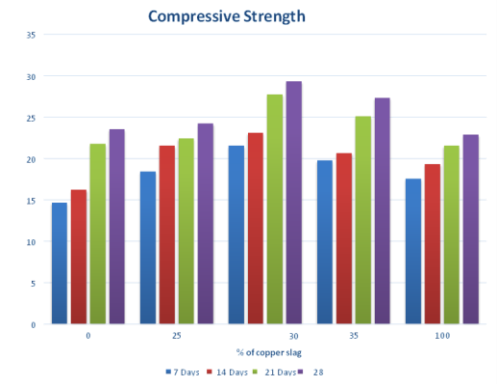
Graphical representation- Compressive Strength Test
The Compressive Strength (N/mm2) for 75 % Fine Aggregate and 25 % Copper Slag is18.44 and 21.55 when cured for 7 & 14 days.



The Compressive Strength (N/mm2) for 100 % Fine Aggregate and 0 % Copper Slag is 17.55, 19.33,21. 55and 22.55 when cured for 7, 14 , 21 & 28 days



TESTS RESULT OF CUBES FOR COMPRESSION



CONCLUSION

Artificial intelligence is currently the centre of attention Compared to the nominal mix, there was a slight increase in the concrete density of nearly 5% with the increase of copper slag content. The physical and mechanical properties of copper slag have maximum advantages. Therefore, replacement or reuse of it can be done in several manner. Based upon the results obtained it was concluded that 30 percent of copper slag can be used as replacement of fine aggregates. Replacement of copper slag in fine aggregate reduces the cost of making concrete.

Results can indicate that the use of copper slag (CS) in construction industries is presented as an alternative not only for improving the quality of mortars, but also for mitigation of the adverse effects of copper mining in the environmental and reducing the shortage of aggregates that exists while construction. Compared to nominal mix whenever replacement of copper slag by 25% of increase in the strength is by 2.84%, the replacement of fine aggregate 30% of copper slag 25.47%, the replacement of copper slag by 35% decrease in the strength is by 16.05%, the replacement of fine aggregate 100% is reduces in the strength of 2.84%.

Due to the physical and mechanical properties, of copper slag it has various reuse applications. Reuse of copper slag has the dual benefit of safe disposal and in construction resource management. Application in concrete as an admixture, replacement of cement and as a fine aggregate has very good scope. However, In the Present Study the limit of copper slag taken up to 35%.

REFERENCES

[1] P. Guruswamy Goud* , K.Teja Sri , P. Praveen , CH.Umakanth, A.Sravan Volume 6 Issue 3 ISSN: 2457-0826 Page 14-24© MANTECH PUBLICATIONS 2021.

[2] Jasmin Varghese Kalliyath, Jithin Thomas Joy, Jeny Merin Paul, Antony Mathew Vadakkel IJSTE - International Journal of Science Technology & Engineering | Volume 2 | Issue 12 | June 2016 ISSN (online): 2349-784.

[3] D.V.S. K Chaitanya, P. Neeharika International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8, Issue- 6S4, April 2019.

[4] Y.Ramakrishna reddy, T. Ramprasanna reddy ISSN 2348–2370 Vol.08,Issue.15, October-2016, Pages:2963-2966.

[5] Bhagya chand prajapati, Dr Rajeev Jain, Bharat