

STRESS STRAIN BEHAVIOUR OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH COPPER SLAG

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ABSTRACT-

Copper slag is considered to be a waste product and the land for its dumping is increasing day by day showing a serious impact on environment. The uses of copper slag in construction field are more when compared to its other uses.

The main objectives of this project are described as below:

- i) To study the feasibility of use of copper slag as fine aggregate in concrete.*
- ii) To compare the stress strain behavior of copper slag replaced concrete with conventional concrete at different percentages of replacement.*
- iii) The scope of the work is to know the stress-strain behavior of concrete in which copper slag is replaced with fine aggregates by 0%, 10%, 20%, 30%, 40% & 50% in M25, M30 & M35 grades of concrete.*

Keywords -- Copper slag, impact on environment, stress strain behavior, *partial replacement*,

I. INTRODUCTION

Concrete is a widely used construction material for various types of structures due to its durability. The use of concrete is unavoidable, at the same time the scarcity of

aggregates is also increasing day by day. Natural resources are depleting worldwide. At the same time the generated wastes from the industries are increasing substantially. Utilization of industrial solid waste or secondary materials has been encouraged in construction field for the production of cement and concrete because it contributes to reduce the consumption of natural resources. For many years by products such as fly ash, silica fume, and slag were considered as waste material. Later they have been successfully used in the construction field for partial or full replacement of fine aggregates and coarse aggregates. Hence the utilization of copper slag which has low cost and its application as a replacement of fine aggregate in concrete production have many environmental benefits such as waste recycling and solve disposal problems.

SOME ADMIRABLE BENEFITS OF CONCRETE:

A few benefits of concrete which are noteworthy are given below:-

Low maintenance: Due to highly durable nature of concrete low maintenance is required.

Low energy consumption: In comparison with steel, aluminium, glass and plastics, the energy spent to create a concrete facility is often an order of magnitude less than that needed to create a comparable amount of a competing material.

USES OF COPPER SLAG:

- Copper slag has gained popularity in the construction industry to be used as a fill material.
- Copper slag can also be used as a building material, formed into blocks.
- Copper slag is widely used in the sandblasting industry and it has been used in the manufacture of abrasive tools.
- Copper slag is widely used as an abrasive media to remove rust, old coating and other impurities in dry abrasive blasting due to its high hardness (6-7 Mohs), high density (2.8-3.8 g/cm) and low free silica content.

METHODOLOGY ADOPTED:

All the cylinder specimens will be tested in a digital Universal Testing Machine and the respective load v/s displacement curves for the cylinders were obtained for each cylinder. The curves help in knowing the behaviour of concrete at different loading stages. This behaviour of concrete containing copper slag as partial replacement of fine aggregate will help in knowing the feasibility of using copper slag as concrete constituent.

The experimentation is to be carried over on the concrete cylinder specimens by testing them over digital Universal Testing Machine of 30T capacity. The specimens are subjected to continuous tensile load and the respective stress-strain curves are obtained through a digital computer for the respective specimens.

PROPERTIES OF HARDENED CONCRETE

WITH COPPER SLAG:

- STRENGTH PROPERTIES:** Copper slag concrete exhibits adequate strength development characteristics both at early and later ages.
- YOUNG'S MODULUS OF ELASTICITY:** The modulus of elasticity of Copper Slag concrete is somewhat higher than the modulus of elasticity of normal concrete

II. LITERATURE REVIEW

- RR Chavan & D B Kulkarni (2013):** Conducted experimental investigations to study the effect of using copper slag as a replacement of fine aggregate on the strength properties and concluded that Maximum Compressive strength of concrete increased by 55% at 40% replacement of fine aggregate by copper slag and flexural strength increased by 14 % for 40% replacement.
- Al-Jabri et al. (2009):** It was examined that there was almost 5% increase in the concrete density, when copper slag was used as a sand replacement, whereas the workability increased substantially with an increase in copper slag content. This was attributed to the low water absorption and glassy surface of copper slag.
- Khanzadi et al. (2009):** It was examined that an increase of about 10–15% compressive strength and an increase of 10–18% splitting tensile strength had occurred when a limestone coarse aggregate was replaced by copper slag coarse aggregate in high strength concrete.
- Pazhani et al. (2010):** Found that the slump value for 100% replacement of fine aggregate with copper slag increased from 60mm to 85mm. It showed that the water consumed by the copper slag during mixing was very less as compared with river sand.
- Sudarvizhi et al. (2011):** Suggested that copper slag and ferrous slag can be used as sand replacement till 80%. She also stated that 100% replacement of sand by copper slag and ferrous slag would not be advisable due to slight bleeding tendency. Therefore, it may be preferable to avoid the use of CS as the only fine aggregate in concrete mixes. It may be necessary to add conventional sand (and finer materials such as fly ash and stone dust) also in order to improve the

particle size distribution of the concrete mix to get the cohesiveness and satisfactory workability.

6. **Wei Wu et al. (2010):** Found that the smooth glassy surface texture and low moisture absorption, the excellent compressibility of copper slag can improve the workability and dynamic behaviour of the concrete respectively, but the presence of excess water, the higher fineness and ferric oxide content decrease the quasi-static compressive, flexural and tensile splitting strength, and recommended that less than 40% copper slag as sand substitution can achieve a high strength concrete that comparable or better than the control mix

III. EXPERIMENTAL INVESTIGATION

Experimental Programme:

Materials Used:

The materials used in this investigation are...

- ❖ OPC.
- ❖ Fine Aggregate
- ❖ Coarse aggregate
- ❖ Water.
- ❖ Copper Slag

CEMENT:

S. No	Property	Test results
1	Normal consistency	32%
2	Specific gravity	3.12
3	Initial setting time	40 minutes
4	Final setting time	210 minutes
5	Fineness	2%

Physical properties of cement

FINE AGGREGATE:

S. No	Property	Value
1	Specific gravity	2.66
2	Fineness modulus	3.78
3	Bulk density	1412
4	Fineness modulus	3.78

Physical properties of fine aggregate

COARSE AGGREGATE:

S. No	Property	Value
1	Specific gravity	2.64
2	Fineness modulus	7.14
3	Bulk density	1672N/ m ³
4	Nominal maximum size	20 mm

Physical properties of coarse aggregate

COPPER SLAG:

S. No	Property	Value
1.	Specific Gravity	3.56
2.	Fineness Modulus	4.55

Properties of Copper Slag

IV. RESULTS

S. No	Mix	Copper Slag Proportion	Cross Sectional area (mm ²)	Ultimate Load of Failure (KN)
1.	M20	0%	17671.46	220.13
2.	M20	10%	17671.46	277.76
3.	M20	20%	17671.46	191.36
4.	M20	30%	17671.46	383.70
5.	M20	40%	17671.46	251.96
6.	M20	50%	17671.46	365.7

M20 Mix

S. No	Mix	Copper Slag Proportion	Cross Sectional area (mm ²)	Ultimate Load of Failure (KN)
1.	M30	0%	17671.46	330.82
2.	M30	10%	17671.46	290.30
3.	M30	20%	17671.46	337.86
4.	M30	30%	17671.46	393.84
5.	M30	40%	17671.46	234.92
6.	M30	50%	17671.46	109.64

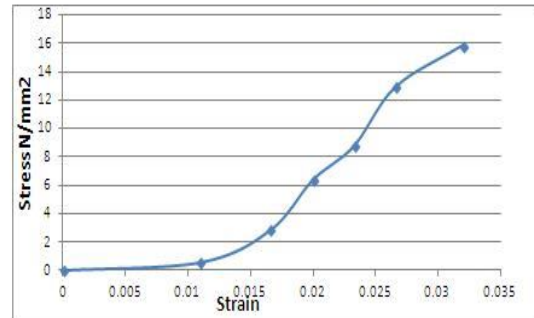
M30 Mix

S. No	Mix	Copper Slag Proportion	Cross Sectional area (mm ²)	Ultimate Load of Failure (KN)
1.	M40	0%	17671.46	399.78
2.	M40	10%	17671.46	288.50
3.	M40	20%	17671.46	233.50
4.	M40	30%	17671.46	390.42
5.	M40	40%	17671.46	246.44
6.	M40	50%	17671.46	399.72

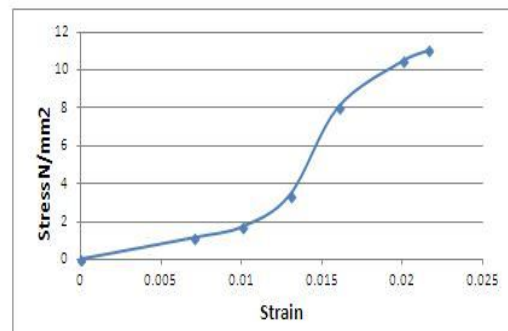
M40 Mix

V. GRAPHS

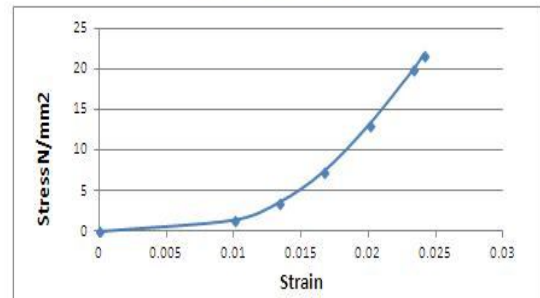
M20 10% Copper Slag



M20 20% Copper Slag



M20 30% Copper Slag



VI. CONCLUSIONS

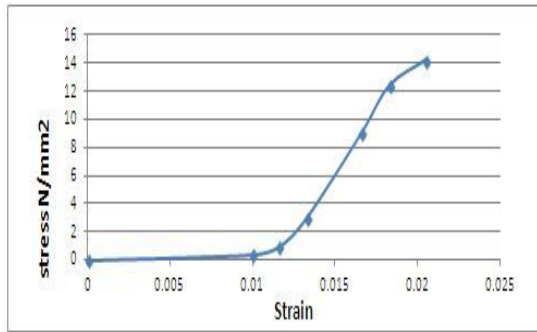
According to the thesis and test results, the following conclusions were observed and presented here:

1. In all the 3 grades of mixes (i.e., M20, M30, M40), optimum percentage of copper slag replacement w.r.t. fine aggregate that gave maximum compressive strength is 30%.
2. The above graphs plotted as stress v/s strain explained the behaviour of concrete when fine aggregate is partially replaced with fine aggregate.
3. The replacement of fine aggregate with copper slag above 30% did not give improvised strength results.
4. Usage of copper slag in construction industry is proved to be economical and also eco-friendly as the reduction of slag materials (wastes) is encouraged hence it adds to the cost recovery.

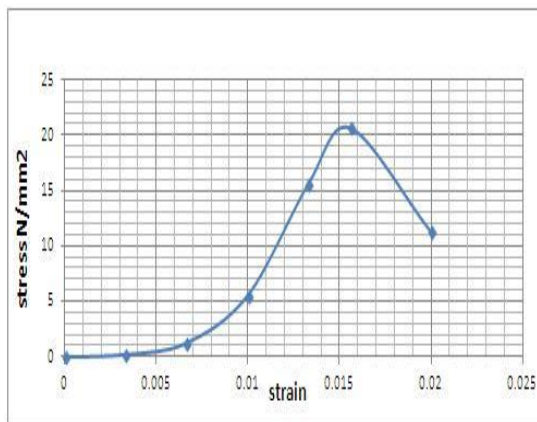
VII. REERENCES

- [1]. Brindha, D and Nagan, S (2010). "Utilization of copper slag as a partial replacement of fine aggregate". *International Journal of Earth Sciences and Engineering*, Vol.3, No.4, pp.579-585
- [2] Wei Wu, Weide Zhang, Guowei Ma "Optimum content of copper slag as a fine aggregate in high strength concrete" *Materials and Design*, Elsevier science Ltd, Vol. 31, 2010, pp. 2878–2883.
- [3] Khalifa S Al-Jabri, Abdullah H Al-Saidy, RamziTaha, "Effect of copper slag as a fine aggregate on the properties of cement mortars and concrete", *Construction and Building Materials*, Vol. 25, 2011, pp. 933 – 938
- [4] Meenakshi Sudarvizhi, S. and Ilangovan, R. "Performance of copper slag and ferrous slag as partial replacement of sand in concrete", *International Journal of Civil and Structural Engineering*, Vol.1, No.4, 2011.
- [5] Chavan, R.R. and Kulkarni, D.B. "Performance of copper slag on strength properties as partial replacement of fine aggregate in concrete mix design", *International Journal of Advanced Research and Studies*, Vol.2, No.4, pp.95-98, 2013.
- [6] IS: 10262 – 2009, Concrete Mix Proportioning, Bureau of Indian Standards, New Delhi.

M20 40% Copper Slag



M20 50% Copper Slag



M30 0% Copper Slag

