International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 03 | Mar 2021 www.irjet.net p-ISSN: 2395-0072

COMPARATIVE STUDY ON STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE USING COPPER SLAG & GGBS

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Abstract - *Concrete is one of the major constituents in construction work. Many Waste products are used as aggregate for concrete to improve the strength and durability. GGBS is a one of the supplementary material to replace with cement to reduce the consumption of cement and Copper Slag is the By product material from the manufacturing of copper. A large quantity of copper slag disposed as a waste in landfills to make an affects to the environment. This study is to evaluate the possibility of usage of GGBS and Copper Slag. In this Study, the partial replacement of fine aggregate by using copper slag and GGBS to be compared with the proportion of 10%, 20%, 30%,40% and 50% with mix design of M60 Grade. Hardened concrete test such as compressive strength, tensile strength can be take. Replacement of GGBS is performed as High Performance concrete.*

Key Words: **Ground Granulated Blast Surface (GGBS), Copper Slag, High Performance Concrete**

1. INTRODUCTION

1.1 GENERAL

Civil engineering practice and construction works in India depend to a very large extent on concrete. Concrete basic constituents are cement, fine aggregate (sand), coarse aggregate (granite chippings) and water. Hence, the overall cost of concrete production depends largely on the availability of the constituents (and selected additives). The continuously growing construction industry has posed the possibility on depletion of natural aggregates in the future that would increase the cost of concrete material. So the need for replacement of present aggregates is a growing concern to meet the demand for aggregates in the structures. Thus alternative options are adopted for non-load bearing walls and non structural floors in buildings. Different alternative materials such as recycled aggregate, foundry sand, Copper slag, GGBS etc. In this project, use copper slag and GGBS as replacement of fine aggregate. The usage of GGBS is to make "High Performance Concrete" and the usage of Copper slag is to improve the strength and the results indicates that water demand reduced almost 20% by using copper slag compared to other mixtures.

1.2 SCOPE & OBJECTIVES

The scope of this project is to make a use of copper slag and GGBS is to replace on concrete to gain the strength as "High Performance Concrete".

The objective of this study is to evaluate the possibility of usage of GGBS and Copper Slag which results "High Performance Concrete".

To study the strength and durability of the concrete. Copper slag reduces the cost of concrete.

2. Materials used and its Properties:

2.1. Cement:

The Cement used in this study was Ordinary Portland cement (OPC) which is the most important type of cement. OPC cement of 53grade of cement use in this experimental work. Conforming weight of each cement bag was 50kg.The property of cement is shown in Table 1

Table 1: Properties of Cement

Physical Properties	*Value observed in investigation*
Specific gravity	*3.10*
Initial setting time (minutes)	*50*

2.2. Fine Aggregate

M-sand was used as Fine aggregate with fineness modulus of 2.85 and it should passing through IS Sieve 4.75mm. It should have fineness modulus 2.50- 3.50 and silt content should not be more than 4.The properties of Fine aggregate are shown below in Table 2.

Table 2: Properties of Fine Aggregate

S.NO	PROPERTY	VALUE
1	Specific gravity	2.62
2	Fineness modulus	2.50

2.3 Coarse Aggregate:

The coarse aggregate are the blue granite stone of which particles greater than 4.75mm they should be hard, strong, dense, durable and clean. It should be conical shape. Flaky pieces should be avoided. It creates much better bond between cement paste and the Aggregates. The properties of Coarse aggregate are shown below in Table 3.

Table 3: Properties of Coarse Aggregate

S.NO	PROPERTY	VALUE
1	Specific gravity	2.53
2	Water absorption	2.71%

2.4 Super Plasticizers

Super plasticizers are known as high range water reducers are chemical admixtures used where well dispersed particle suspension is required. Conplast used based on study of literature.

2.5 Ground Granulated Blast Slag

GGBS is a cementitious material and byproduct from the blast furnace. It is a mixture of iron ore, coke and limestone which heats at temperature about 1500C. GGBS is used in concrete as a partial replacement material to improve the performance as high. It may be to reduce the heat of hydration and to avoid retardation in cold weather.

Two major uses of GGBS are in the production of quality improved slag cement namely Portland Blast Furnace cement (PBFC) and High slag Blast Furnace cement (HSBFC). GGBS content ranging typically from 30 to 70% and in the production of ready mixed or site batched durable concrete. Concrete made with GGBS cement sets more slowly than conventional concrete, but also continuous to gain strength which gives results in lower heat of hydration and lower temperature rises and makes avoiding cold joints easier.

Table 4: Properties of GGBS

S.NO	PROPERTY	VALUE
1	Specific Gravity	2.9
2	Bulk Density (Gm/Cm^3)	1100

2.6 Copper Slag

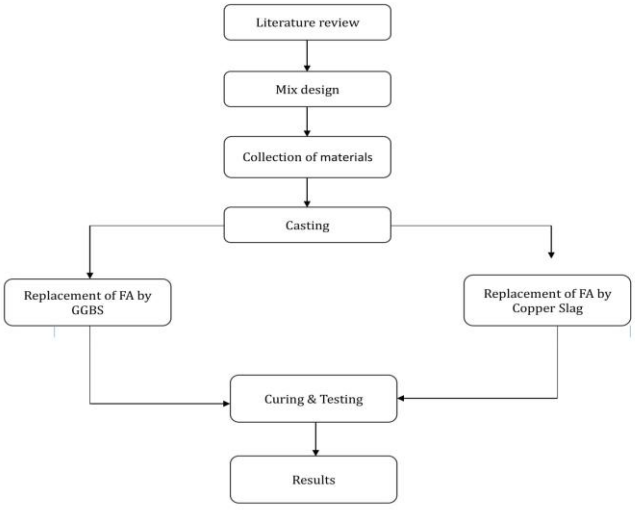
The utilization of solid waste is the challenge for the civil and environmental to utilize the waste from different industry to the sustainable development with cost concern of the present materials.

The use of copper slag in the production of cement, mortar and concrete as mixed with lime stone powder, dust, cement replacement use as partial replace of coarse and fine aggregates. The usage of this slag reduces the usage of primary materials as well as reduces the construction depth which in turn reduces energy demand in building.

Table 5: Properties of Copper Slag

S.NO	PROPERTY	VALUE
1	Specific Gravity	4.12
2	BulkDensity (Gm/Cm^3)	2.31
3	Water Absorption	0.40%

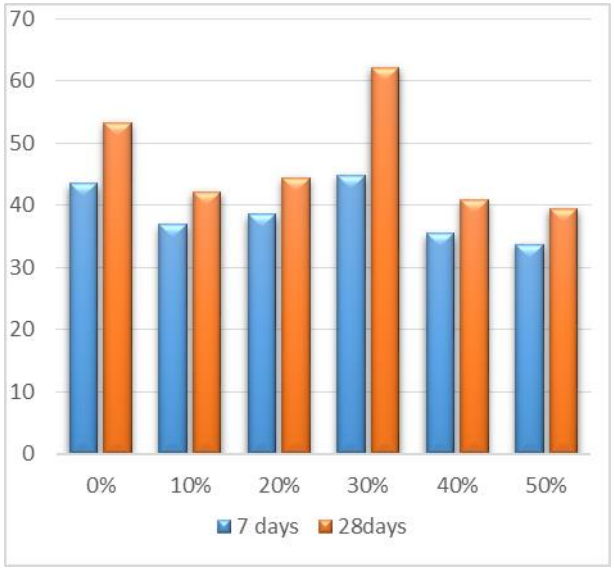
3. METHODOLOGY



4. RESULT AND DISCUSSION

4.1 Compressive Strength Test

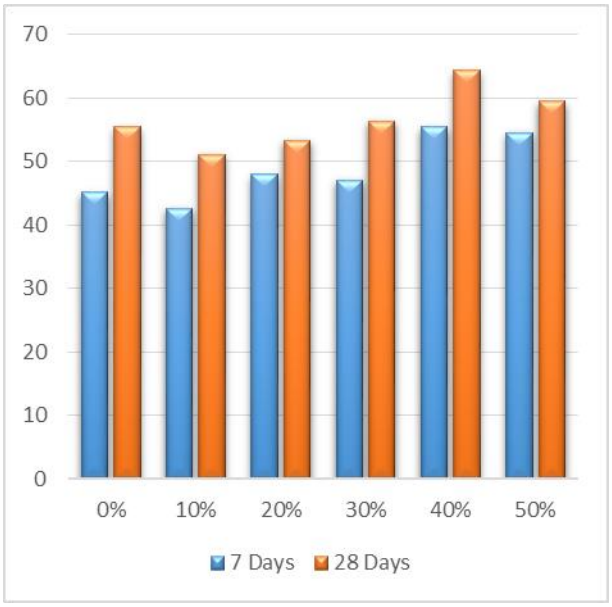
Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform and partly because most of the desirable properties of concrete are qualitatively related to its compressive strength. The strength of concrete is usually defined and determined by the crushing strength of 150mm x 150mmx150mm, at an age of 7 and 28 days. The mould and its base rigidly clamped together so as to reduce leakages during casting.



Graph 1: Compressive Strength (Copper slag)

Table 6: Test Results for Compressive Strength of Copper Slag Mix

CS (%)	7 days (N/mm²)	28days (N/mm²)
0%	43.5	53.3
10%	36.89	42.2
20%	38.6	44.4
30%	44.89	62.22
40%	35.5	40.88
50%	33.7	39.5



Graph 2: Compressive strength (GGBS)

Table7: Test Results For Compressive Strength of GGBS Mix

GGBS (%)	7 days (N/mm²)	28days (N/mm²)
0%	45.11	55.5
10%	42.66	51.1
20%	48	53.3
30%	47.1	56.4
40%	55.5	64.4
50%	54.6	59.5

4.2 Split Tensile Strength Test

For tensile strength test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. Split tensile strength was calculated as follows:

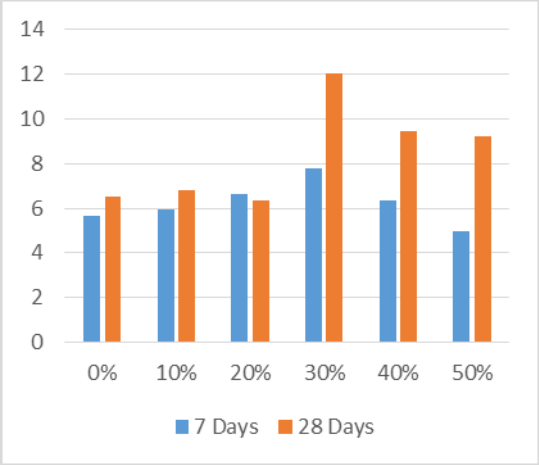
Spilt Tensile strength (MPa) = $2P / \pi DL$

Where, P = Failure Load (kN)

D = Diameter of Specimen (150 mm)

L = Length of Specimen (300 mm)

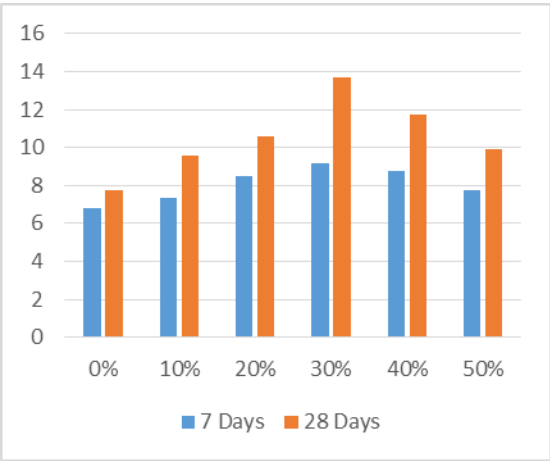
Test Results of splitting tensile strength for M60 grade of concrete. These cylinder specimens were left for 28days curing in a curing tank. After the course of curing, the specimens were ready for testing. All the cylinders were tested. Test Results of splitting tensile strength for M60 grade of concrete shown.



Graph 3: Split Tensile Strength (Copper Slag)

Table 8: Test Results For Split Tensile Strength of Copper Slag Mix

CS (%)	7 days (N/mm²)	28days (N/mm²)
0%	5.66	6.5
10%	5.94	6.79
20%	6.65	6.36
30%	7.78	12.03
40%	6.36	9.48
50%	4.95	9.2



Graph 4: Split Tensile Strength (GGBS)

Table 9: Test Results For Split Tensile Strength of GGBS Mix

GGBS (%)	7 days (N/mm²)	28days (N/mm²)
0%	6.79	7.78
10%	7.36	9.6
20%	8.49	10.6
30%	9.2	11.74
40%	8.77	13.72
50%	7.78	9.9

5. CONCLUSION

In summary of the above investigations, the following conclusions are made from the experimental results indicated following:

- Comparing the replacement of GGBS and replacement of Copper slag on concrete. Finally, the result get Replacement of GGBS attained higher strength compared to replacement of Copper slag.
- The compressive strength attained at 40% as 64.4N/mm² and the tensile strength attained at 40% as 13.72 N/mm²

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