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EXPERIMENTAL INVESTIGATION ON STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH COPPER SLAG AND QUARRY DUST

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ABSTRACT

This work reports an experimental procedure to investigate use of Copper Slag and Quarry Dust as partial replacement for Fine aggregate. The Copper Slag (CS) and Quarry dust in concrete provides environmental as well as economic benefits for all related industries. Because of the scarcity of fine aggregate for the preparation of mortar and concrete, partial replacement of Copper Slag and Quarry Dust with Fine aggregate have been attempted. Copper Slag is the by-product obtained during matte smelting and refining of Copper Slag. The strength characteristics of conventional concrete and slag replaced concrete such as compressive strength, split tensile strength and flexural strength has to be determined. In this work concrete were tested by adding Copper Slag and Quarry Dust to Fine aggregate in various percentages ranging from 0%, 10%, 20%, 30%, 40%, 50%. M_{40} Grade concrete specimens were cured for 7 to 28 days and to be tested for compression strength, split tensile strength and flexural strength.

KEYWORDS: Copper slag, Quarry dust, concrete, compressive strength, split tensile strength, flexural strength.

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I. INTRODUCTION

Concrete is the most popular building material in the world. However, the production of cement has diminished the limestone reserves in the world and requires a great consumption of energy. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but over use of the material has led to environmental concerns, the depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmentally friendly substitutes for cement and river sand that are preferably by products. Quarry dust has been proposed as an alternative to river sand that gives additional benefit to concrete. Quarry dust is known to increase the strength of concrete over concrete made with equal quantities of river sand, but it causes a reduction in the workability of concrete.

Granulated copper slag (or) copper slag which is a by-product of metallurgical operations in Sterlite industries (India) Ltd., Tuticorin was used for the experimental investigation. For every tone of metal production, about 2.2 ton of waste slag is generated. Dumping or disposal of such huge quantities of slag cause environmental and space problems. During the past two decades, attempts have been made by several investigators and copper producing units all over the world to explore the possible utilization of copper slag. The physical and mechanical properties of granulated copper slag shows that it can be used to make products like coarse and fine aggregates, cement, fill, ballast, roofing granules, glass, tiles etc.

II. NEED FOR REPLACEMENT OF FINE AGGREGATE

Large scale efforts are required for reducing the usage of the raw material that are present, so that large replacement is done using the various by-product materials that are available in the present day. The other material that can be used is quarry dust which is made while in the processing of the Granite stone into aggregates, this is formed as a fine dust in the crushers that process the coarse aggregates, which is used a earthwork filling material in the road formations majorly. Many studies are made with several other materials which gave the concrete to be a material

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made of recycled material but the parameters that are primary for the material was not satisfied. The properties of concrete in fresh and hardened state are studied in the various papers that are used as a reference for this. Some of the properties are workability, compressive strength are the major one that are considered.

III. SCOPE AND OBJECTIVE

1. To limit the usage of fine aggregate and its consumption

2. To make the use of waste from sterlite industries

3. The integrated approach of working on safe disposal and utilization can lead to advantageous effects on the ecology and environmental also. It can be effectively used as replacement for fine aggregate.

4. Cost of construction is considerably limited

IV. MATERIALS&METHODOLOGY

CEMENT:

Ordinary Portland Cement (43 Grade) with 28% normal consistency with specific surface 3300 cm^2/g conforming to IS 8112-1989 is used.

Table 1: Properties of Cement

S.NO	Property	Value
1	Specific Gravity	3.15
2	Fineness test	3.57%
3	Consistency test	34%

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FINE AGGREGATE:

The natural fine aggregates are river sand is used. Medium size sand of passing through IS sieve of size 4.75 mm.

Table 2: Properties of Fine Aggregate (River Sand)

S.No	Property	Value
1	Specific Gravity	2.7
2	Fineness modulus	2.82

COARSE AGGREGATE:

Crushed granite conforming to IS 383 – 1987 was used. Coarse aggregate passing through 20mm and retained on 16mm sieve was used.

Table 3: Properties of Coarse Aggregate

S.No	Property	Value
1	Specific Gravity	2.65
2	Fineness modulus	3.75
3	Water Absorption	10.13%
4	Particle shape	Angular
5	Impact value	3%

COPPER SLAG

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Copper slag is a by-product material produced from the process of manufacturing copper. As the copper settles down in the smelter, it has a 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. Utilization of copper slag in applications such as Portland cement substitution and/or as aggregates has threefold advantages of eliminating the costs of dumping, reducing the cost of concrete, and minimizing air pollution problems.

Table 4: Properties of Copper slag

S.No	Property	Value
1	Specific Gravity	3.68
2	Fineness modulus	2.7

QUARRY DUST

The Quarry Dust is the by-product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes. Quarry Rock Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Quarry dust is fine rock particles. When boulders are broken into small pieces quarry dust is formed. It is gray in color and it is like fine aggregate. Quarry dusts are produced during the extraction and processing of aggregates. The utilization of quarry fines is seen as a way to minimize the accumulation of unwanted material and at the same time to maximize resource use and efficiency.

Table 5: Properties of Quarry Dust

S.No	Property	Value

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1	Specific Gravity	2.69
2	Fineness modulus	3.51

WATER

Water is an important ingredient of concrete. As general guidance, if the water is fit for drinking and it is fit for making concrete. Water containing a small sum of salt is not suitable for concrete. pH is between 6 and 8 the water is accepted to be suitable. The best way to use the water from a particular sources and concrete is made. Concrete is suitable for 7 and 28 days strength.

V. EXPERIMENTAL PROGRAM

The basic mix proportions were modified for using Copper Slag and Quarry Dust as partial replacement for fine aggregates. Six Concrete mixes with different of CS and QD ranging from 0% to 50% were considered.

FRESH CONCRETE TEST:

Workability (Slump test)

A slump of 25mmis generally provides good workability of concrete. Throughout the project, no more extra amount of water needed to get slump. Moisture content and absorption of ingredients were taken into account for calculating the amount of water needed. Table shows the measured slump and the amount of water needed to obtain the slump during the project.

Table: 6

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NO	Wt. of Concrete (kg)	W/C	Vol. of water (ml)	Hts.from bottom after removal of slump,H_2 (mm)	Hts.of slump, H_1 (mm)	Slump (H_1-H_2)
1.	9.13	0.4	550	270	300	30

Height of slump =30mm

STRENGTH TESTING PROCEDURE

The standard size of concrete cube is 150mm X 150mm X 150mm and concrete beam of size 700mm X 150mm X 150mm and cylinder specimen of 150mm diameter and 300mm height were cast to determine the compressive strength and flexural strength and split tensile test of the concrete at 7 days and 28 days. The specimens were de-mould after casting and they are cured for 7 days and 28 days.

COMPRESSIVE STRENGTH TEST

The specimen are tested in a compression testing machine at the completion of 7 days and 28 days.

TABLE: 7

% OF REPLACEMENT	7 DAYS	28 DAYS

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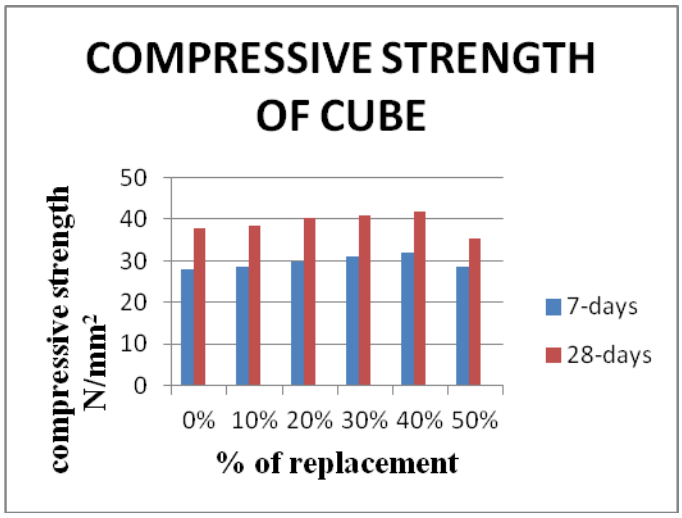
0%	28.1	37.7
10%	28.67	38.54
20%	29.9	40.43
30%	31.04	40.99
40%	31.85	41.87
50%	28.56	35.29

GRAPH: 1



SPLIT TENSILE STRENGTH TEST

In this test a cylindrical specimen is placed horizontally between the loading surfaces of a compression testing machine. The load is applied until failure of the cylinder along the vertical.

TABLE: 8

% OF REPLACEMENT	**7 DAYS**	**28 DAYS**

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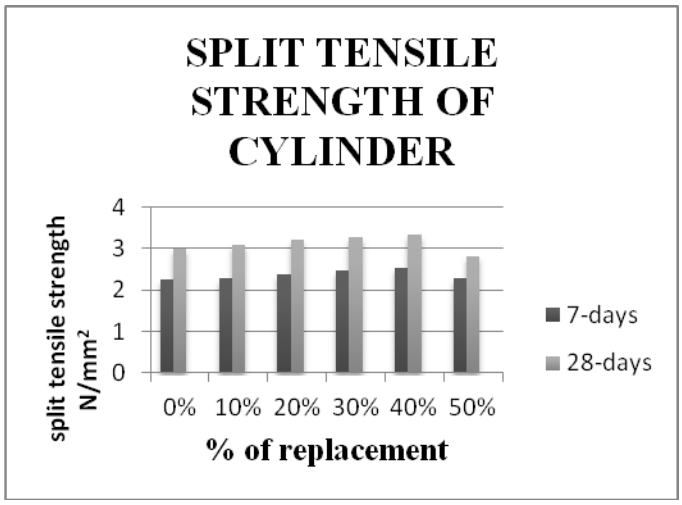
0%	2.248	3.00
10%	2.290	3.08
20%	2.392	3.23
30%	2.480	3.28
40%	2.548	3.35
50%	2.285	2.82

GRAPH: 2



FLEXURAL STRENGTH TEST:

The modulus of rupture depends on the dimension of the beam and the type of loading. The loading adopted is central or two-point loading the maximum fibre stress occurs below the point of loading where the bending moment is maximum.

TABLE:9

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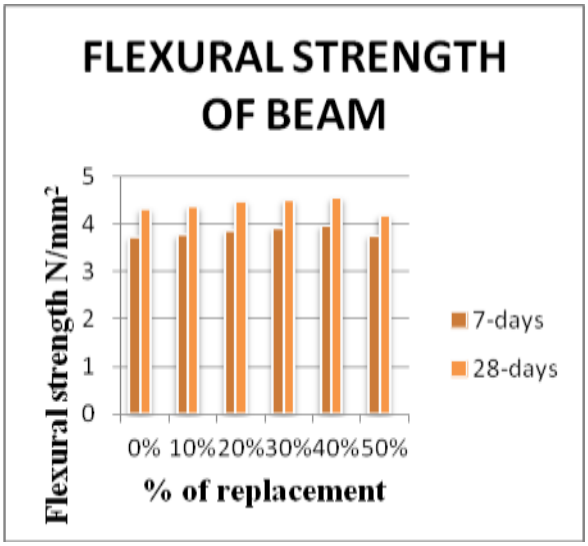
% OF REPLACEMENT	7 DAYS	28 DAYS
0%	3.71	4.29
10%	3.75	4.35
20%	3.83	4.45
30%	3.89	4.48
40%	3.95	4.53
50%	3.74	4.61

GRAPH: 3



VI. CONCLUSION

From the study of partial replacement of copper slag and quarry dust the following results are obtained.

1. The highest compressive strength was obtained 41.87 Mpa for a replacement of Fine Aggregate by 40%

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2. It is observed that the Split Tensile Strength of concrete 7 to 28 Days is higher for 40% of replacement fine aggregate by C.S and Q.D. Also split tensile strength is more than control mix in all % replacement.
3. More over target strength has been obtained from [30-40%] replacement ratio and a only gradually decrease is seen in full replacement of FA.
4. Hence, both C.S and Q.D can be partially replace. The use of natural sand without sacrificing strength.

Acknowledgment

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