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AN EXPERIMENTAL INVESTIGATION ON STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE BY COPPER SLAG AND CEMENT BY FLY ASH

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ABSTRACT:- ***Copper slag is a byproduct of copper extraction by smelting. During smelting impurities become slag which float on the molten metal. Slag that quenched in water produces angular granules which are disposed as a waste material. And fly ash produced by burning of powdered coal. In this experiment we are replacing cement with fly ash and sand with copper slag to study about the strength properties of M_{50} grade concrete. In this investigation we are using the fineness ratio's percentages as 20% of fly ash as replacement of cement and 0%, 20%, 40%, 60% of copper slag as replacement of sand. Where the replacement of fly ash is same at all percentage replacements of fine aggregate. Comparative study is carried out by compressive test, split tensile test, and flexural test after 7 days and 28 days. From the experimental investigation it is observed that replacement of 40% of fine aggregate by copper slag and cement by fly ash improvement in strength up to 5%.***

A mix proportion of 1:1.45:2.63 (Plain concrete)with a water cement ratio of 0.35 is designed to give M50 grade concrete and the details of investigations and discussions of the test results are presented here in.

I. INTRODUCTION

Concrete is a widely used construction material forvarious types of structures due to its durability. The use of concrete is unavoidable, at the same time the scarcity of aggregates is also increasing now-a-days. Natural resources are depleting worldwide at the same time the generated wastes from the industries 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 reducing the consumption of natural resources.

For many years by products such as fly ash, silica fume, and slag were considered as waste material. Copper slag is one of the materials that is considered as a waste material and industrial passive material which could have been used in construction industry as partial replacement of fine aggregates in mix design. Particle sizes of copper slag are of the order of the sand and have a potential for the use as fine aggregate in concrete. Hence by 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.

II. EXPERIMENTAL INVESTIGATION

A. General

In the experimental program, cube,cylinder,prism were casted using M-50grade of concrete in the ratio 1:1.45:2.63 with water cement ratio 0.35. Fine aggregate is replaced by copper slag and cement is replaced by fly ash from 45%to 60% and the test conducted were compressive strength,split tensile strength, flexural strength.

B. Material properties

1) Cement

The ordinary Portland cement of 53 grade is used in accordance with IS: 12269-1987. Properties of this cement were tested and listed here.

- Fineness of cement = 2.5%
- Specific gravity if cement = 3.15
- Standard Consistency of cement= 34%

- Initial setting time = 30 minutes
- Final setting time = Not more than 10 hours

2) Coarse aggregate

Crushed stone aggregate of 20mm size is brought from nearby quarry. Aggregates of size more than 20mm size are separated by sieving. Tests are carried to find out the

- Specific gravity = 2.71
- Fineness modulus = 7.17

3) Fine aggregate

Locally available fresh sand, free from organic matter is used. The result of sieve analysis confirms it to Zone-II (according to IS: 383-1970).The tests conducted, and results plotted below.

- Specific gravity = 2.55
- Fineness modulus = 3.06

4) Copper Slag

The copper slag which we used had collected from a dealer of 'Hindustan copper limited' at Vishakhapatnam. The wholesale price of the copper slag is about ₹650/ton. The test results of copper slag are as follows.

- Specific gravity = 3.65
- Fineness modulus = 4.39

Fig.1. Copper slag

5) Fly ash

The copper slag which we used had collected from a dealer of ‘Ethios enviro solutions private limited' at Ahmedabad, at a whole sale price of ₹950/ton. The test results of copper slag are as follows.

- Specific gravity = 2.475
- Fineness modulus = 2.28
- Consistency = 35%

Fig.2. Fly ash

6) Super plasticizer

Conplast SP430 is used where a high degree of workability and its retention required. It facilitate production of high quality concrete.The properties of Super plasticizer are as follows.

- Specific gravity = 1.20-1.21
- Recommended dosage= 0.6-1.5 Liters/100kg cement

7) Water

Generally potable water should be used. This is to ensure that the water is reasonable free from such impurities as suspended solids, organic matter and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value, etc.

III. MIX DESIGN AND QUANTITY OF MATERIALS

Based on the values obtained from above tests a mix proportioning design for the concrete of M50 grade is done using IS code method. For M50 grade mix design is 1:1.45:2.63 and w/c ratio is 0.35

Grade of concrete	Cement (kg/m^3)	F.A (kg/m^3)	C.A (kg/m^3)	Water (lit/m^3)
M 50	448	653.46	1182.47	158

IV. TEST RESULTS

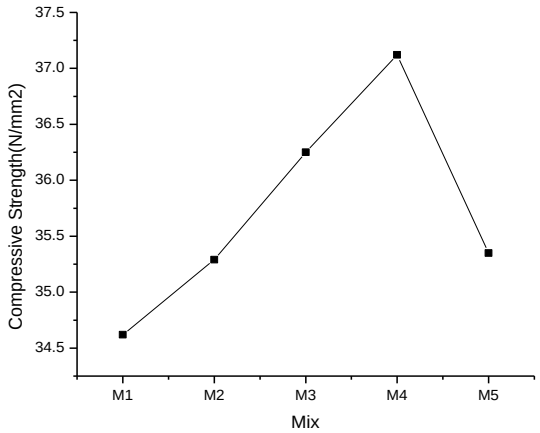
Compressive strength, split tensile strength and flexural strength tests were conducted and details of these tests are given in the following sections.

1. Compressive strength of concrete:

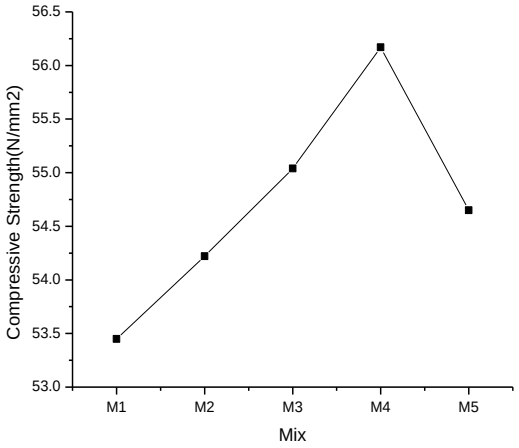
Results of compressive strength test:

Mix	7 days	28 days
M1	34.62	53.45
M2	35.29	54.22
M3	36.25	55.04
M4	37.12	56.17
M5	35.35	54.65

Graphical representation of compressive strength of 7 days and 28 days:



Graph1.Compressive strength for7 days



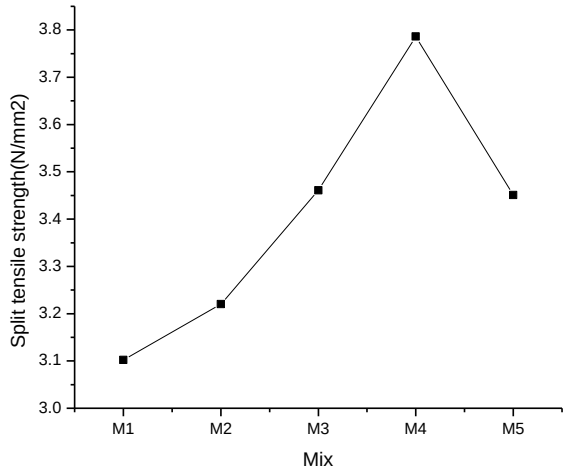
Graph 2. Compressive strength for 28days

2. Split tensile strength of concrete:

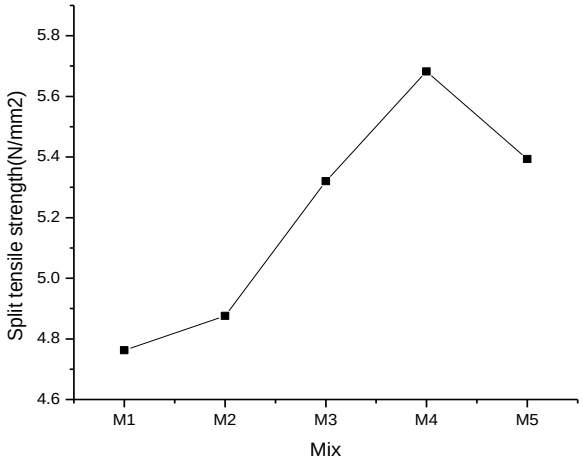
Results of split tensile strength test:

Mix	7 days	28 days
M1	3.10	4.76
M2	3.22	4.88
M3	3.46	5.33
M4	3.79	5.69
M5	3.45	5.40

Graphical representation of split tensile strength of 7 days and 28 days:



Graph 3. Split tensile strength for7 days

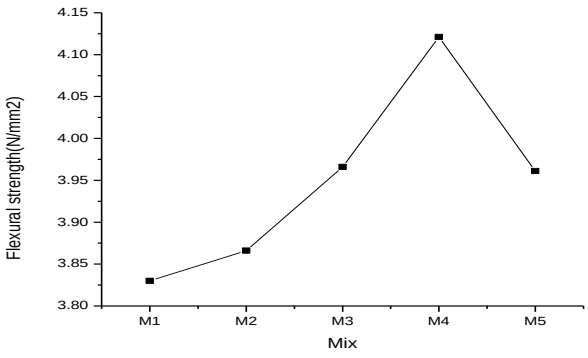


3. Flexural Strength of Concrete:

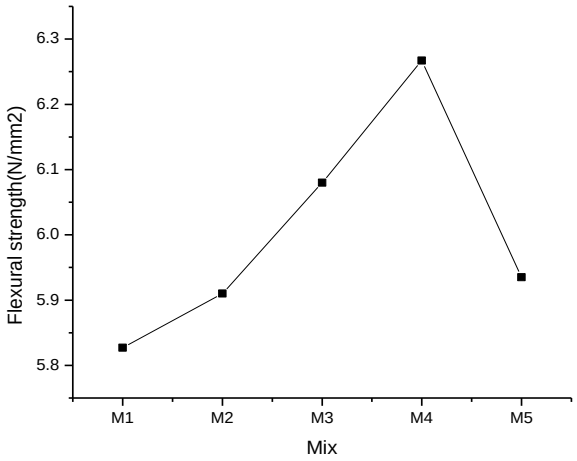
Results of split tensile strengthtest:

Mix	7 days	28 days
M1	3.83	5.83
M2	3.86	5.91
M3	3.97	6.08
M4	4.12	6.27
M5	3.96	5.93

Graphical representation of flexural strength of 7 days and 28 days:



Graph 5. Flexural strength for 7 days



Graph 6. Flexural strength for 28 days

V. CONCLUSIONS

i) Compressive strength of concrete constantly increases up to 40% Copper Slag (CS) replacement with Fine aggregate but further decreases if the %CS replacement increases. When compared no nominal concrete the compressive strength of concrete increased up to maximum of 56.17 Mpa for M50 grade at 40% CS replacement.

ii) Split Tensile strength of concrete constantly increases up to 40% CS replacement with Fine aggregate but further decreases if the %CS replacement increases. When compared no nominal concrete the compressive strength of concrete increased by a maximum of 10% for M50 grade at 20% CS replacement.

iii) Flexural strength of concrete constantly increases up to 40% CS replacement with Fine aggregate but further decreases if the %CS replacement increases. When compared no nominal concrete the flexural strength of concrete increased by a maximum of 8% for M50 grade at 40% CS replacement.

iv) It is concluded that the concrete, at an optimum of 40% CS replacement with fine aggregates and 20% fly ash with cement can achieve desirable higher strengths than that of nominal concrete.

v) The minimum strength required for M50 grade of concrete is achieved by utilizing CS up to 60% replacement with Fine aggregates.

VI. FUTURE RECOMMENDATIONS

[1] Using Copper Slag up to 100% replacement with Fine aggregates and checking out whether the minimum strength required for M40 and M50 grades of concrete can be achieved.
[2] Checking out the feasibility of utilization of Copper slag as Coarse aggregates and finding the Strength characteristics of Concrete.
[3] Similar studies can be carried out by replacing cement with silica fume and GGBS.

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