Experimental Study of Concrete Strengths By Partial Replacement of Cement With Ggbs and Natural Sand by Copper Slag

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Abstract- *Now a days very vast quantity of concrete is being use all over world. Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Copper slag and GGBS are mechanical waste products in copper and iron industry respectively. Using this products, results in cost reduction of concrete and disposal solution of large waste products. In this review attempt was made to reduce usage of cement and sand content by saving cost of concrete and studied experimental behavior for strengths of M40 grade of concrete for combination of ground granulated blast furnace slag (GGBS) and Copper Slag(CS). Experimental studies were performed on plain cement concrete and combination of GGBS and Copper Slag. Total 60 specimens were casted. Four trial mix was taken as maintaining GGBS 30% and varying Copper Slag by 10%, 20%, 30% and 40% respectively. A comparative analysis has been carried out for concrete in relation to Workability, Compression strength, Split Tensile strength and Flexural strength at 7,14,28 days with conventional concrete. It was observed that replacement of cement by 30% GGBS and sand by 30% CS got maximum strength than Conventional Concrete.*

Keywords- GGBS, Copper Slag, Workability, Compression strength, Split tensile strength, Flexural strength

I. INTRODUCTION

Concrete has basic naturally, easily available ingredients as cement, sand, aggregates and water[5]. After water, cement is vastly used material in the world. But this continuous use and production of cement results in large amount of CO_2 emission which creates lots of environmental harmful changes. 1 tone of CO_2 is emitted for production of 1 tone of ordinary Portland cement [5]. Similarly natural sand is used in concrete in billion tons daily. Now a days very shortage of natural sand is being seen. Government of India has restricted to bring out sand from river but many sources are illegally doing sand business. This leads to lower the bed of rivers. Also the cost of natural sand is high which increases cost of the concrete. Copper slag is a waste product of copper extraction by refining. Slag that is extinguished in water produces precise granules which are discarded as waste. Copper slag can be utilized as a part of concrete creation as a halfway swap for sand. Copper slag is utilized as a building material, shaped into pieces. To produce every ton of copper, approximately 2.2–3.0 tons copper slag is generated as a by-product material [8]. In Oman approximately 60,000 tons of copper slag is produced every year. Ground-granulated blast furnace slag (GGBS) is obtained by quenching molten iron slag (a waste product of iron and steel making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. From structural point of view, GGBS replacement enhances lower heat of hydration, higher durability and higher resistance to sulphate and chloride attack when compared with normal ordinary concrete. On the other hand, it also contributes to environmental protection because it minimizes the use of cement during the production of concrete. The beneficial use of waste products in concrete technology has been well known for many years and significant research has been published with regard to the use of materials such as coal fly ash, pulverized fuel ash, blast furnace slag and silica fume as partial replacements for Portland cement. Such materials are widely used in the construction of industrial and chemical plants because of their enhanced durability compared with Portland cement. The other main advantage of using such materials is to reduce the cost of construction.

In this paper, an experimental investigation of optimum usage of GGBS and CS in concrete was carried out. The optimum values and efficiency of GGBS and copper slag were determined for concrete with various cement dosages by the compressive strength, split tensile strength and flexural strength results.

II. MATERIALS

2.1 Cement
The cement used in this study was Ordinary Portland cement of 43 grade(Ultratech).

Table 2.1. Physical Properties of cement

Sr. No	Test	Result
1	Fineness	3.63%
2	Specific gravity	3.15
3	Standard consistency	29%
4	Setting time Initial Final	 140 min 250 min

2.2 Fine Aggregates

In this study, River sand from Bhima river is used. Specific gravity is 2.78

2.3 Course aggregates

Coarse aggregate utilized is locally accessible crushed angular aggregate of size 10mm and 20mm.

2.4 GGBS

GGBS is an industrial waste product from the blast furnace used to make iron.

Table 2.2. Properties of GGBS

Sr. No	Constituents	Result
1	Fineness	398m2/kg
2	Specific gravity	2.88
3	Initial setting	192min
4	SO3	0.28%
5	Cl	0.001%
6	Moisture	0.04%
7	Sulphide sulphur	0.54%

2.5 Copper Slag

Copper slag is a industrial waste product material created from the way toward manufacturing copper. Specific gravity of copper slag was 3.45.

Table 2.3. Chemical composition of Copper Slag

Sr. No	Constituents	Percentage
1	Cao	4.36
2	Ni	0.03
3	Al2O3	0.90
4	Fe	55
5	MgO	1.88
6	Cu	1.5
7	S	1.91

2.6 Admixture

In this experiments, Admixture used was PC super plasticizer BASF 8352

III. EXPERIMENTAL PROGRAM

3.1 Sample Preparation

C.C : Conventional concrete

Sample S1: 10% CS + 30% GGBS
Sample S2: 20% CS + 30% GGBS
Sample S3: 30% CS + 30% GGBS
Sample S4: 40% CS + 30% GGBS

3.2 Mix design

Mix Design for M40 decided for this review is mentioned bellow.[9]

Table 2. : M40 Mix Design

	C.C	S1	S2	S3	S4
Cement	430	301	301	301	301
GGBS	-	129	129	129	129
Sand	850	765	680	595	510
CS	-	85	170	255	340
10mm	450	450	450	450	450
20mm	640	640	640	640	640
admixture	3.8	3.1	3	2.8	2.4

3.3 Methodology and Testing Program

Five concrete samples as above were prepared. The constituents were weighed in separate buckets. The materials were mixed in a rotating pan. The mixes were compacted using compaction rod. The slump of the fresh concrete was determined. The specimens were demoulded after 24 hr, cured in water and then tested at room temperature at the required age. Total 60 specimen were casted. For each sample, 6 cubes were casted and tested after 7,14,28 days. 4 cylinders were casted and tested after 7, 28 days and 2 beams were casted and tested after 7,28 days.

Following tests were carried out on the concrete specimens:

3.3.1 Compression test

7, 14 and 28-day cube(150*150*150) compressive strength test was conducted on CTM. [9] as shown in figure

Fig : Compression test

3.3.2 Split tensile test

7 and 28-day cylinder(150*300) tensile (splitting) strength test was done on CTM.[9] as shown in Figure

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Fig : Split Tensile Test

3.3.3 Flexural Test

7 and 28-day beam (150-150-700) flexural strength test was conducted in UTM using a simple beam with one point load. [9]

IV. RESULTS AND DISCUSSIONS

4.1 Workability

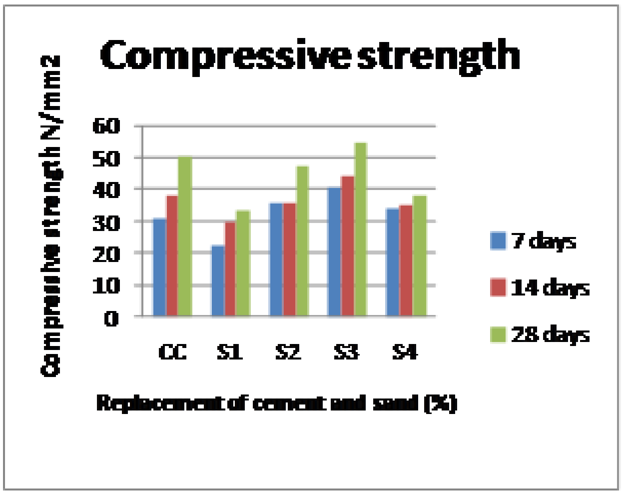
Table 4.1 Workability of concrete for copper slag and GGBS

% Replacement	Slump (mm)
C.C	95
S1	70
S2	89
S3	110
S4	135

4.2 Compressive strength

Table 4.2 Workability of concrete for copper slag and GGBS

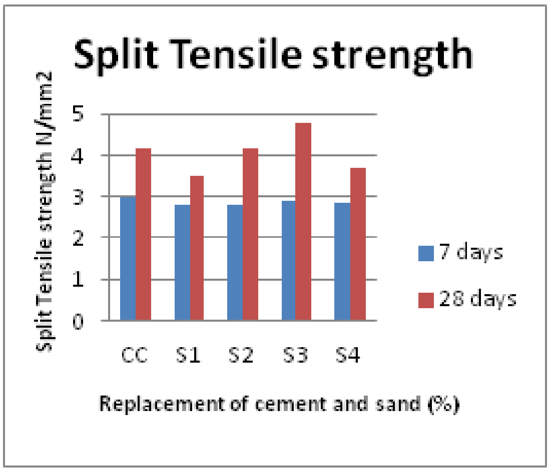
% Replacement	7 days N/mm2	14 days N/mm2	28days N/mm2
C.C	31.114	38.125	50.116
S1	22.112	29.885	33.215
S2	35.555	35.905	47.015
S3	40.325	44.215	54.795
S4	33.705	35.198	38.444



4.3 Split Tensile strength

Table4.3: Split tensile strength of concrete for copper slag and GGBS

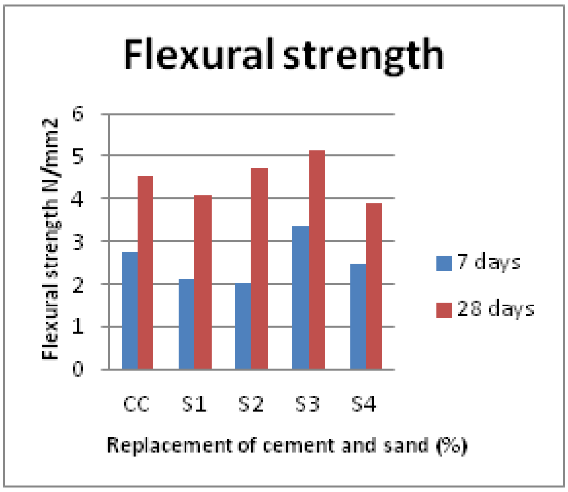
% Replacement	7 days (N/mm2)	28 days (N/mm2)
C.C	2.980	4.165
S1	2.795	3.525
S2	2.795	4.155
S3	2.890	4.750
S4	2.860	3.669



4.4 Flexural strength

Table4.4: Flexural strength of concrete copper slag and GGBS

% Replacement	7 days (N/mm2)	28 days (N/mm2)
C.C	2.750	4.530
S1	2.130	4.088
S2	2.044	4.710
S3	3.370	5.150
S4	2.480	3.911



VI. CONCLUSION

- It was observed that slump value was increased as content of copper slag increased in concrete.
- Highest strength was achieved for replacement of 30% GGBS and 30% Copper slag..
- Strength of concrete reduced for copper slag above 30%.
- Compressive strength was increased by 4.679 N/mm2 on 28thy day as compared to conventional concrete.
- Tensile strength was increased by 0.585 N/mm2 on 28th day compared with conventional concrete.
- Flexural strength was increased by 0.620 N/mm2 on 28th day compared with conventional concrete.

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