International Journal For Technological Research In Engineering
Volume 4, Issue 6, February-2017 *ISSN (Online): 2347 - 4718*

AN EXPERIMENTAL STUDY ON THE CONCRETE PROPERTIES M20 DUE TO ADDITION OF COPPER SLAG

Mohit Sain[1], Mohit Kansal[2], Mukesh Kumar[3]
[1]M. Tech Scholar, [2,3]Asst. Professor
Department of Civil Engineering, Prannath Parnami Institute of Management & Technology,Hisar (Haryana)

Abstract: ***Many researches has been currently going to Modify and improved the concrete properties by the addition Of different types of materials. This research work mainly consists of two main parts. M20 concrete was used to determine various mechanical properties. First part of the thesis consists of substituting sand partially by copper slag in concrete. For sand replacement, seven test groups (including control mixture) were constituted with replacement of 0% (control specimen), 10%, 20%, 30%, 40%, 50% and 60% copper slag with sand in each series. Concrete cubes, cylinders, RCC beams and Columns were cast and tested in laboratories. The optimum proportion of replacement was found by conducting the following tests.***

Keywords: ***Copper Slag, Compressive Strength, Flexural Strength and Split Tensile Strength.***

I. INTRODUCTION

The poor and unsatisfactory performance of conventional concrete under aggressive environmental conditions has necessitated the researchers and engineers to look for new concrete composites. The innovative use of concrete must contemplate explorations of areas , in use of new shapes, materials and technique of construction. Concrete is such a versatile material that such attempts of contemplation are quite possible. In modern age one cannot think of construction work without concrete. Plain concrete has two major deficiencies; a low tensile strength and allow strain at fracture. The tensile strength of concrete is very low because plain concrete normally contains numerous micro cracks. Copper slag possesses mechanical and chemical characteristics that qualify the material to be used in concrete as a partial replacement for Portland cement or as a substitute for aggregates. For example, copper slag has a number of favourable mechanical properties for aggregate use such as excellent soundness characteristics, good abrasion resistance and good stability. Copper slag also exhibits pozzolanic properties since it contains low CaO. Under activation with NaOH, it can exhibit cementations property and can be used as partial or full replacement for Portland cement. The utilization of copper slag for applications such as Portland cement replacement in concrete, or as raw material has the dual benefit of eliminating the cost of disposal and lowering the cost of the concrete. The use of copper slag in the concrete industry as a replacement for cement can have the benefit of reducing the costs of disposal and help in protecting the environment. Despite the fact that several studies have been reported on the effect of copper slag replacement on the properties of Concrete, further investigations are necessary in order to obtain a comprehensive understanding that would provide an engineering base to allow the use of copper slag in concrete.

II. LITERATURE REVIEW

As we know the properties of concrete gets improved due to the incorporation of copper slag. Large no. of papers have being published which tells about the compressive strength, flexural strength and split tensile strength of concrete according to their opinion. Al-Jabri et al (2009)[1] has investigated the performance of high strength concrete (HSC) made with copper slag as a fine aggregate at constant workability and studied the effect of super plasticizer addition on the properties of HSC made with copper slag. Two series of concrete mixtures were prepared with different proportions of copper slag. Al-Jabri (2009a)[2] has investigated the effect of using copper slag as a replacement of sand on the properties of high performance concrete (HPC). Eight concrete mixtures were prepared with different proportions of copper slag ranging from 0% (for the control mix) to 100%. Al-Jabri et al (2011)[3] investigated the effect of using copper slag as a fine aggregate on the properties of cement mortars and concrete. Various mortar and concrete mixtures were prepared with different proportions of copper slag ranging from 0% (for the control mixture) to 100% as fine aggregates Byung Sik Chun et al (2005)[4] conducted several laboratory tests and evaluated the applicability of copper slag as a substitute for sand of sand compaction pile method. Caroline Morrison et al (2003)[5] reported that Ferro-silicate slag from the Imperial Smelting Furnace production of zinc can be used as a replacement for sand in cementitious mixes. Isa Yuksel and Turhan Bilir (2007)[6] presented the results of research aimed at studying the possible usage of bottom ash (BA) and granulated blast-furnace slag (GBFS) in production of plain concrete elements. Mobasher et al (1996)[7] investigated the effect of copper slag on the hydration of cement based materials. Upto 15% by weight of copper slag was used as a Portland cement replacement. Ramazan Demirbog and Rustem Gul (2007)[8] investigated the use of Blast furnace slag aggregates (BFSA) to produce high-strength concretes (HSC). Teik-Thye Lim and Chu (2006)[9] conducted a study on the feasibility of using spent copper slag as fill material in land reclamation. Tixier et al (1997)[10] worked on the effect of copper slag on the hydration of cement based materials. Upto 15% by weight of copper slag was used as aPortland cement

replacement.

III. MATERIALS USED

CEMENT: Ordinary Portland cement of 43 grade has been used in this experimental work. OPC 43 grade of ULTRATECH cement has been used after investigate the strength of cement at 28 days as per IS 4031-1988. The various properties of the cement are described in Table 1.

FINE AGGREGATES: Locally available river sand passed through 4.75mm IS sieve has been used in the preparation of GFRC. It confirms to IS 383-1970 which comes under Zone I. The physical Properties of sand like Fineness Modulus, Specific Gravity and water absorption are 3.49, 2.67 and 2.31% respectively.

COARSE AGGREGATES: The Coarse aggregate are obtained from a local quarry has been used. The coarse aggregate with a maximum size 20mm having a specific gravity 2.89. In this experimental work coarse aggregate of 20mm are used The physical Properties of coarse aggregates like Fineness Modulus, Specific Gravity are 7.13, 2.89 respectively.

COPPER SLAG: 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

WATER: - Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalis, salts and sugar, organic substances that may be deleterious to concrete. As per IS 456- 2000 Potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly, potable tap water was used for the preparation of all concrete specimens.

Table 1: Properties of cement

Sr. No.	Characteristics	Experimental value
1	Consistency of cement (%)	33%
2	Specific gravity	2.98
3	Initial setting time (minutes)	35
4	Final setting time (minutes)	282
5	Compressive strength (N/mm^2) (i) 3 days (ii) 7 days (iii) 28days	 27.56 40.57 48.96
6	Soundness (mm)	1.00
7	Fineness of Cement	5%

IV. EXPERIMENTAL PROGRAMME

In this section, copper slag based specimens has been tested for the compressive strength, flexural strength and split tensile strength. COMPRESSIVE STRENGTH TEST: To examine the compressive strength of copper slag specimen, cube of 150mmX150mmX150mm has been used in this experimental work 30-40 cubes has been casted to determine the compressive strength. firstly cement and sand are mixed uniformly in dry condition . Secondly coarse aggregates are added in this mixture . Now copper slag also added according to mix proportion to get the resultant mixture of M20 grade. Required dosage of water was added in the course of mixing. Through mixing was done until concrete appeared to be homogeneous and of desired consistency. Now cube moulds were filled with concrete in three layers and after each layer, concrete was compacted with temping rod . The moulds surface level should be plane with trowel . The cube moulds were demoulded after 24 hours then they were placed in water tank containing portable water and were left for curing. After that the specimen are tested at 7 days and 28 days at compression testing machine (CTM) as per IS 516-1959

Fig. 1 Cube Under Compression Testing Machine (CTM)

SPLIT TENSILE STRENGTH TEST:-

To examine the tensile strength of copper slag specimen, cylinder of size 150mmX300mm has been used in this experimental work . 30-40 cylinders has been casted. The cylinder moulds were demoulded after 24 hours and transferred to curing tank for 28 days.After that cylinders were tested horizontally under compression testing machine (CTM).

Fig. 2 Cylinder Under CTM

FLEXURAL STRENGTH TEST:- To examine the flexural strength of copper slag specimen, beam of size 150mmX150mmX70mm has been used in this experimental work. 30-40 beams has been casted to determine the tensile strength. The beams specimens of different proportions were demoulded after 24 hours and transferred to the curing tank for 28 days . After that, beams were placed to the two point loading machine on which we apply the load manually. Note down the load value at which cracks starts developing on the beam.

Fig. 3 Test Set Up for Beam

V. TEST RESULTS

COMPRESSIVE STRENGTH Compressive strength of concrete mixtures was measured at the ages of 7 and 28 days and shown in Table 2.There was an increase in compressive strength of cube concrete specimens produced with copper slag

TABLE 2: Compressive Strength Results

S.No	copper Slag	7 days	28days
1	S10	21.33	38.96
2	S20	25.78	43.11
3	S30	27.15	44.77
4	S40	29.70	46.80
5	S50	24.00	39.70
6	S60	21.26	38.22

From the above results, we observe that compressive strength of concrete increases due to incorporation of copper slag. From the plot we can say that compressive strength of concrete increases upto 41% with 40% copper slag

FLEXURAL STRENGTH: Table 3 shows the values of flexural strength of copper slag specimen beams at different mix proportions. Plot 5 shows the variations of flexural strength at 7 and 28 days.

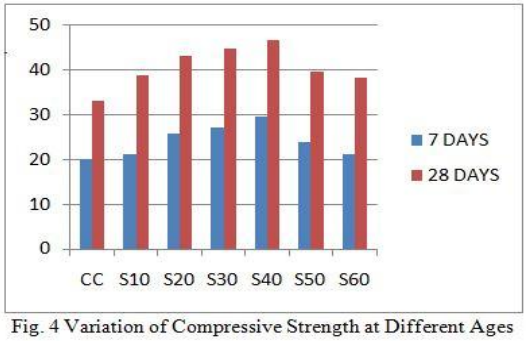

Fig. 4 Variation of Compressive Strength at Different Ages

TABLE 3: Flexural Strength Results

S.No	%C.S	7 days	28 days
1	CC	2.25	3.46
2	S20	2.58	3.86
3	S40	3.5	5.57
4	S60	2.4	3.64
5	S80	2.05	3.02
6	S100	1.75	2.70

The results obtained from the experiment showed that flexural strength of the copper slag specimen increased up to 40 % as compared with plain concrete.

SPLIT TENSILE STRENGTH: Split tensile strength of concrete mixtures was measured at the ages of 7 and 28 days as shown in Table 4. The results shows that in general, there is an increase in splitting tensile strength of cylinder concrete specimens with the addition of slag to the concrete at 28 days age.

TABLE 4: Split Tensile Strength Results

S.No	%Glass	7 days	28 days
1	S10	2.49	3.96
2	S20	2.6	4.01
3	S30	2.62	4.05
4	S40	2.76	4.09
5	S50	2.41	3.96
6	S60	2.60	4.01

From the above results, we observe that Split Tensile Strength of concrete increases due to incorporation of copper slag. From the plot we can say that Split Tensile strength of concrete increases up to 22% with 40 % slag specimen as compared to plain concrete.

VI. CONCLUSION

The following conclusions could be drawn from the present investigation.

1. The utilisation of copper slag in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of copper slag in fine aggregate and cement reduces the cost of making concrete.
2. Replacement of copper slag (100% replacement with sand) increases the self-weight of concrete specimens to the maximum of 15-18%.

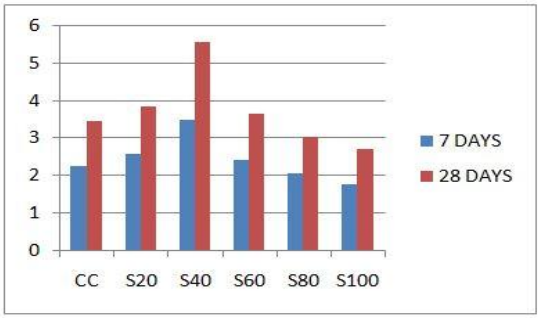

Fig. 5 Variation of Flexural Strength at Different Ages

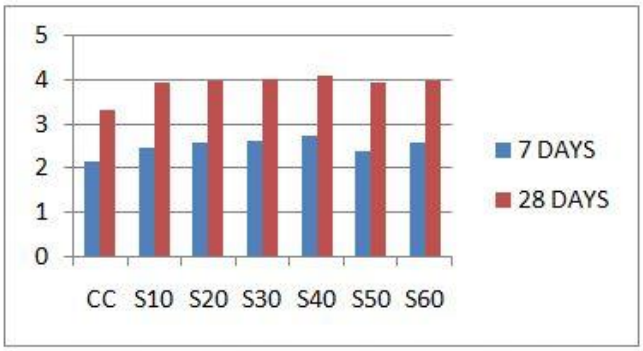

Fig. 6 Variation of Split Tensile Strength at Different Ages

3. The initial and final setting time of copper slag admixed concrete is higher than control concrete.
4. Water absorption of copper slag was 0.16% compared with 1.25% for sand. Therefore, the workability of concrete increases significantly with the increase of copper slag content in concrete mixes. This was attributed to the low water absorption and glassy surface of copper slag.
5. The results of compressive, split tensile strength test have indicated that the strength of concrete increases with respect to the percentage of copper slag added by the weight of fine aggregate up to 40% (S40). Further additions of copper slag caused reduction in strength due to an increase of free water content in the mix.
6. There was more than 60% improvement in the flexural strength of concrete beams with 40% (S40) copper slag replacement for sand. The flexural strength of beams were increased up to 60% (S60) replacement, when compared to control mixes. After that the strength was suddenly decreased to 12% for S80 mixes and 22% for S100 mixes. The reason for reduction in strength was, the low absorption properties of copper slag can leave excess water in concrete, which can cause excessive bleeding at higher copper slag content.
7. Utilisation of copper slag as Portland cement replacement in concrete and as a cement raw material has the dual benefit of eliminating the costs of disposal and lowering the cost of the concrete.
8. It was observed that, the copper slag replacement for sand is more effective than cement.

REFERENCES

[1] Al-Jabri, K. and Makoto Hisada. "Copper slag as sand replacement forhigh performance concrete", Cement & Concrete Composites, Vol. 31,pp. 483-488, 2009.
[2] Al-Jabri, K.S., Makoto Hisada, Abdulla, H.A, S.K."Performance of high strength concrete made with copper slag as afine aggregate", Construction and building materials, Vol.23,pp. 2132-2140, 2009.
[3] Al-Jabri, K.S., Abdullah, H., Al-Saidy and Ramzi Taha. "Effect ofcopper slag as a fine aggregate on the properties of cement mortars ndconcrete", Construction and Building Materials, Vol. 25, pp. 933-938,2011.
[4] Byung Sik Chun, Du Hee Park, and Hun Chul Jung "A Study on theApplication of Copper Slag as a Sand Substitute of Sand CompactionPile", proceedings of 15th international off shore and polar Engineering conference, 2005.
[5] Caroline Morrison, Rebecca Hoope, and Kevin Lardner, "The use offerro-silicate slag from ISF zinc production as a sand replacement in concrete", Cement and Concrete Research, Vol. 33, No. 12,pp. 2085-2089.
[6] Isa Yuksel and Turhan Bilir, "use of Industrial by-products to produce plain concrete elements", Vol. 21, No. 3, pp. 686-694, 2007.
[7] Mobasher, B., Devaguptapu, R. and Arino, A.M. "Effect of copper slag on the hydration of blended cementitious mixtures", Proceedings of the ASCE materials engineering conference, pp. 1677-1686, 1996.
[8] Ramazan Demirbog, and Rustem Gul, "Production of high strengthconcrete by use of industrial by-products", Building and Environment,Vol. 41, No. 8, pp.1124-1127, 2007.
[9] Teik Thye Luin, and Chu J. "Use of spent copper slag for landreclamation", waste management and research, Vol. 24, pp. 67-73,2006.
[10] 10.Tixier, R., Devaguptapu, R. and Mobasher, B. "The effect of copperslag on the hydration and mechanical properties of cementitiousmixtures", Cement Concrete Research, Vol. 27, No. 10, pp. 1569-1580,1997.
[11] Wu, W., Zhang, W. and Ma, G. "Optimum content of copper slag as a fine aggregate in high strength concrete", Material design, Vol.31, No.6, pp. 2878-2883,2010.
[12] IS : 1727 – 1967, "Indian Standard methods of test for pozzolanic materials", Bureauo of Indian standards, New Delhi.
[13] IS: 456-2000, "Indian standard code of practice for plain and reinforcement concrete", Indian Standard Institution, New Delhi.
[14] M. S Shetty,—Concrete Technology Theory and Practices‖, Chand & Company,New Delhi.
[15] www.civilengineering.com
[16] www.alibaba.com
[17] www.scincedirect.com
[18] www.nbmcw.com
[19] http://en.wikepedia.org/wiki/fibre_reinforced_concrete
[20] http://www.springerlink.com/content/66102625u668054

