Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 01, January -2018

STUDY ON UTILIZATION OF COPPER SLAG ON THE STRENGTH OF CONCRETE

Swapnil Prasad Verma[#1](*Student M.E structure Engg.*), **Prof. Deepak Rastogi**[*2]

[#*]*Civil Engineering Department, Madhav Institute of Technology & Science, Gwalior, M.P.*

Abstract: *In this paper, research has been carried out on the effect of copper slag on the compressive strength of both M20 and M25 Concrete. Cement was partially replaced by copper slag and tests were carried out to examine the strength Properties of concrete. The test results shows that the compressive strength of concrete will be improved, Cement is partially replaced by Copper Slag in various proportions i.e 4%, 8%, 12%, 16% & 20% and then compared with designed mix grade concrete. The concrete cubes were tested for compressive strength after 7 days, 14 Days and 28 days of curing. Then analyze the variation between strengths with conventional concrete.*

I. Introduction

Various workers conducted experimental work on properties of Concrete using Industrial Waste. This experimental work is an effort to develop the awareness & importance of industrial waste management & its utilization in productive manner in construction industry. Large amounts of industrial waste or by-products accumulate every year in the developing countries. Nowadays utilization of secondary materials is being encouraged in construction field. Major research works are being carried out pertaining to the effect on concrete characteristics due to inclusion of foreign substances as raw material. Copper slag is one of such materials that can be considered as a waste material which could have a promising future in construction industry as partial substitute of cement. The main environmental impact produced by slag disposition is a change in land use and the visual pollution of the landscape. On the other hand, under certain weather conditions, leaching can occur, depending on the characteristics of the solution, the composition, and the final crystalline structure of the solid slag. In this experimental work efforts have been made to replace cement with copper slag for two different mix designs viz. M20 and M25 grade. The concrete cubes have been tested for compressive strength. The results have been compared with the conventional concrete. Currently, about 2600 tons of Copper slag is produced per day and a total accumulation of around 1.5 million tons per year.[2] Copper slag reduces the water absorption by 33.59% and chloride ion penetrability decreases by 77.32%. The copper slag reduces the pH value of concrete by3.04% [3]. R.R. Chavan et al., 2013, replaced copper slag with sand of 0 to 100% in concrete. The results

II. Materials Used

The materials used for the preparation of concrete are as follows:-

a) ***Cement:***. The cement used in this study was Ordinary Portland cement of 53 grade (ultratech) conforming to IS12269-1987.

Table1: Properties of cement

Properties	Value
Specific gravity of cement	3..15
Initial setting time	35 minutes
Final setting time	330 minutes
Normal Consistency	32%

b) ***Fine Aggregate:*** The fine aggregate (sand) used was clean dry sand sieved in 4.75 mm sieve to remove all pebbles. The grading zone of fine aggregate was zone II as per IS specifications. However, it's currently well recognized that physical, chemical and thermal properties of aggregates considerably influence the properties and performance of concrete.

Table 2: Properties of fine aggregate

Properties	Value
Specific Gravity	2.60
Grading Zone	Zone II
Fineness Modulus	3.75
Water absorption	0.6%

c) ***Coarse Aggregate:*** Coarse aggregate are used for making concrete. They may be in the form of irregular broken stone or naturally occurring gravel. Material which are large to be retained on 4.75mm sieve size are called coarse aggregates. Its maximum size can be up to 40 mm.

Table 3: Properties of coarse aggregate

Properties	Values
Type	Crushed
Specific Gravity	2.94
Size of Aggregates	20mm
Fineness Modulus	7.07
Water absorption	0.219%

d) ***Water****:* Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Portable water is generally considered satisfactory.

e) ***Copper Slag:*** It was procured from Taj Abrasive Industries, Fatehpur, Uttar Pradesh .Copper slag is a by-product material, obtained during copper smelting and refining process in iron or steel plants. Obtained copper slag is further crushed such that the maximum particles were in the range of 600microns and 150 microns.

Table 4: Physical properties of copper slag

Serial N0.	Properties	Results
1	Specific Gravity	3.79
2	Colour	Black
3	Fineness	2.46
4	Form	powder

III. Experimental Procedure

The aim of the Experiment was to assess the properties of Concrete made with copper slag and to study the important aspect that is compressive strength. The studies were carried out for two mix designs of concrete, that is, M20 and M25 grade. Concrete include cement, water, fine aggregate, coarse aggregate. The specimen used for the tests were Cubes. The waste Copper slag is used as partial substitution for Cement in the range of 0%, 4%, 8%, 12%, 16% and 20% as per its weight and its optimum level is to be found. For analyzing the copper slag and other variation mix totally 108 cubes of size 150x150x150mm were casted for compression strength test. Once 24hours completed from casting the concrete specimens are opened and allowed for continuous curing in a tank with portable water. The specimen are taken and tested at required 7th day, 14th day & 28th day from curing for compression test at 7day, 14th day & 28th day from curing. Then compare the Strengths of M20 and M25grade. Ratio of Mix Design taken for M 20 is 0.5:1:3.54:1.92, and Mix proportion ratio for M25 is 0.45:1:1.7:3.1.

Table 5: Quantities of materials (M20 grade) [0.5:1:1.9:3.54]

Percentage Copper Slag	Weight of Cement (kg/m^3)	Weight of Copper Slag (kg/m^3)	Weight of Water(kg/m^3)	Weight of C.A. (kg/m^3)	Weight of F.A. (kg/m^3)
0%	360	0	180	1277	693
4%	345.6	14.4	180	1277	693
8%	331.2	28.8	180	1277	693
12%	316.8	43.2	180	1277	693
16%	302.4	57.6	180	1277	693
20%	288	72	180	1277	693

Table 6: Quantities of materials (M25 grade) [0.45:1:1.7:3.1]

Percentage Copper Slag	Weight of Cement (kg/m^3)	Weight of Copper Slag (kg/m^3)	Weight of Water(kg/m^3)	Weight of C.A. (kg/m^3)	Weight of F.A. (kg/m^3)
0%	400	0	180	1265	686
4%	384	16	180	1265	686
8%	368	32	180	1265	686
12%	352	48	180	1265	686
16%	336	64	180	1265	686
20%	320	80	180	1265	686

IV. Results and Discussion

In this study the concrete is tested to calculate the compressive strength. The main aim of the project is to monitor the developed strength attained by the concrete at various testing days from curing. Generally proper casting and curing of concrete will augment the strength of the concrete. For this project each test is carried out with 3 samples for every mix ratio and tested at required curing time. Then the average values are used for the investigations. The series of testing actions are detailed below:

Slump Cone Test: This experiment is executed to confirm the workability of newly casted concrete. This test independently executed on newly casted concrete and the Cement replacing with Copper slag to find the workability. The slump is very valuable in identifying variations in the consistency of design mix of various proportions; it is a measure of consistency of the fresh concrete. This test is conducted immediately after the concrete has been made.

Table 7: Slump value of Concrete Mix (M 20grade)

% Replacement	Slump Value
0%	29mm
4%	28mm
8%	28mm
12%	27mm
16%	26mm
20%	26mm

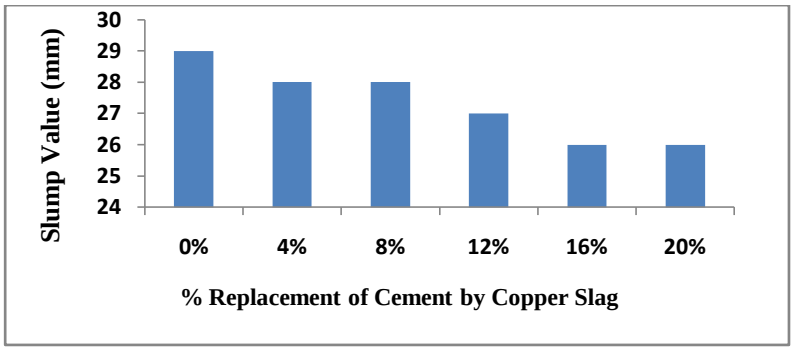

Figure 1: Slump Variations of Concrete

Compressive Strength Test

Concrete is weak in tension and strong in compression so the concrete should be strong to attain high compression. In this study for each mix 3-samples were tested and the average strength is compared with design mix of M20 and M25 grade. Compressive strength test finds out the high amount of compressive load a material can bear below facture limit. The results of compressive strength after 7day, 14th day & 28th day are shown in table 7.

Table 8: Compressive Strength of Concrete Mix (M20 grade)

Percentage	After 7- days	After 14- days	After 28- days	% Increase in compressive strength in 28 days
0%	18.37	24.6	27.42	0
4%	19.36	26.04	28.94	5.54
8%	19.78	26.57	29.53	7.96
12%	20.78	27.92	31.02	13.13
16%	20.20	27.14	30.16	9.99
20%	18.19	24.44	27.16	-0.95

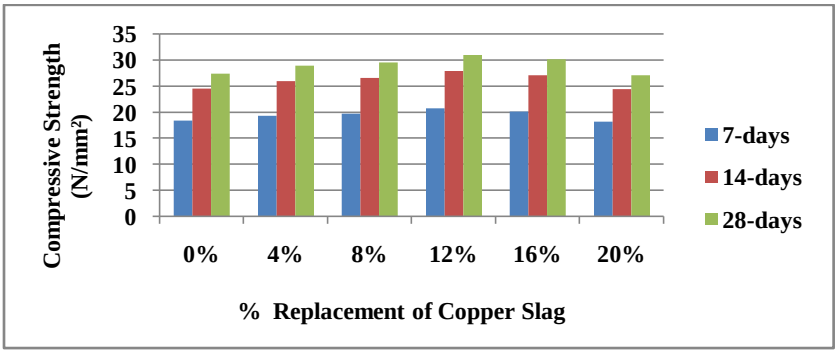

Figure 2: Variation in compressive strength at different % of Copper Slag (N/mm^2) for M20 grade

Table 9: Compressive Strength of Concrete Mix (M25 grade)

Percentage of Copper slag	After 7- days	After 14- days	After 28- days	% increase in compressive strength in 28 days
0%	20.82	27.97	31.82	0
4%	21.57	28.98	32.2	1.12%
8%	23.31	31.32	34.8	9.36%
12%	23.85	32.04	35.6	11.87%
16%	22.84	31.09	34.2	8.10%
20%	20.58	27.62	31.54	-0.9%

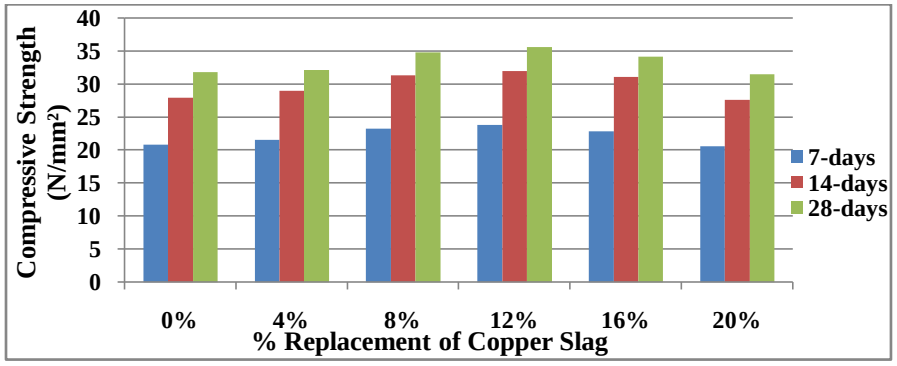

Figure 3: Variation in compressive strength at different % of Copper Slag (N/mm^2) for M25 grade

V. Waste Management

Copper slag is mixed in the concrete as replacement material of Cement. It is the waste product of copper produces from iron or steel plants. The safe disposal of this waste is Costly and causes environmental Pollution. The construction industry is the only area where the safe use of Copper slag is possible. When it is introduced in concrete as a substitute material, it decreases the environmental pollution, space problem and also reduces the cost of concrete. In this Experimental study Copper slag is used in concrete as a replicable material of cement. For this study, M20 and M25grade of concrete is prepared and the test are conducted for various substitute of cement using copper slag as of 0%, 4%, 8%, 12%, 16% and 20% in concrete prepared with Copper slag.

VI. Conclusions

Based on the experimental investigation following assumptions are as follows:

- The compressive strength increased up to 12% replacement of copper slag for both M20 and M25 grade.
- The w/c ratio kept constant even as the surface area is increasing with increase in % of copper slag. This helped in reducing the unwanted bleeding and segregation in concrete.
- Partial substitution of Copper waste in concrete shows good resistance to sulphate attack. [M. Najimi et al. (2012)]

VII.FURTHER SCOPE OF WORK

- The same work can be extended to higher grades of concrete mixes with varying water/cement ratio. Copper slag can be effectively replaced in making bricks, hollow blocks and pavement blocks.
- Copper slag can be replaced along with fly ash, silica fume and granulated blast furnace slag in concrete and RCC members which can be tested for mechanical performances.

REFERENCES

1. A. O. Olanike, "A Comparative Analysis of Modulus of Rupture and Splitting Tensile Strength of Recycled Aggregate Concrete", American Journal of Engineering Research e-ISSN: 2320-0847, Volume-03, Issue-02, pp-141-147, 2014.
2. Anju Ramesan, Shemy S. Babu, Aswathy Lal, "Performance of light weight concrete with plastic aggregate", International Journal of Engineering Research and Applications, Vol. 5, Issue 8, August 2015, pp.105-110.
3. Binaya Patnaik, Seshadri Sekhar.T, Srinivasa Rao, "Strength and Durability Properties of Copper Slag Admixed Concrete" International Journal of Research in Engineering and Technology, e-ISSN: 2319-1163, p-ISSN: 2321-7308, Volume 4, Issue 1, Feb 2015.

4. Chinmay buddhadev, Jayesh kumar pitroda, Prof. Chetna m. Vyas, "A review of innovative use of copper slag and foundry sand in design mix concrete" Journal Of International Academic Research For Multidisciplinary, Impact Factor 1.625, ISSN: 2320-5083, Volume 2, Issue 12, January 2015.
5. Jeffrey W. Bullard , Hamlin M. Jennings, Richard A. Livingston, Andre Nonat, George W. Scherer, Jeffrey S. Schweitzer, Karen L. Scrivener, Jeffrey J. Thomas, "Mechanisms of cement hydration" , Elsevier 2011.
6. K. Wille, S. El-Tawil, A.E. Naaman, "Properties of strain hardening ultra high performance fiber reinforced concrete (UHP-FRC) under direct tensile loading", Elsevier, 2014.
7. Khalid Raza, Apoorv Singh, R. D. Patel, "Strength Analysis of Concrete by Using Iron Slag as A Partial Replacement of Normal Aggregate in Concrete", International Journal of Science and Research, ISSN: 2319-7064, Volume 3 Issue 10, October 2014.
8. Kittinun Sirijaroonchai, Sherif El-Tawil, Gustavo Parra-Montesinos, "behavior of high performance fiber reinforced cement composites under multi-axial compressive loading", Elsevier, 2010.
9. M.A.Rasheed, S. Suriya Prakash, "mechanical behavior of sustainable hybrid-synthetic fiber reinforced cellular light weight concrete for structural applications of masonry", Elsevier, 2015.
10. M.C.G. Juenger, Rafat Siddique, "Recent advances in understanding the role of supplementary cementitious materials in concrete", Elsevier 2015.
11. M. Etxeberria, E. Vázquez, A. Marí, M. Barra, "Influence of amount of recycled coarse aggregates and production process on properties of recycled aggregate concrete", Elsevier 2007.
12. M.Chockalingam, D.Jayganesh, J.Vijayaraghavan, Dr.J.Jegan, "Scope for Reuse of Copper Slag in Concrete", International Journal of Civil Enigneering and Technology, e-ISSN: 0976-6316, Volume 4, Issue 6, 2013.
13. P.F. Castro, A. Mendes Neto, "Assessing strength variability of concrete structural elements", 8th International Conference of the Slovenian Society for Non-Destructive Testing, Sep. 2005.
14. Pranshu Saxena, Ashish Simalti, "Scope of Replacing Fine Aggregate With Copper Slag In Concrete" International Journal of Technical Research and Applications, e-ISSN: 2320-8163, Volume 3, Issue 4, August 2015, PP. 44-48.
15. S.W. Tang, Y. Yao, C. Andrade, Z.J. Li, "Recent durability studies on concrete structure", Elsevier, 2015.

