EXPERIMENTAL INVESTIGATION ON COPPER SLAG CONCRETE

GOVINDASAMI.S[1], MADHUMITHA.V[2], BALAJI.S[3], YOGESHWARAN.N.S[4]

[1] Professor & Head, Department of Civil Engineering, Vel Tech High Tech Dr Rangarajan Dr Sakunthala Engineering College,Chennai- 600062, India. E-Mail: drsgovindasami@gmail.com

[2,3&4] Department of Civil Engineering, Vel Tech High Tech Dr Rangarajan Dr Sakunthala Engineering College, Chennai- 600062, India.

ABSTRACT

Protecting the natural resources with sustainable technologies is essential and mandatory to achieve sustainable development. In view of this, this study was carried out to protect the river sand and its quantity from its usage in the construction sector. So it was decided to use copper slag as fine aggregate through a characteristics study. A design mix of M25 was chosen and the copper slag concrete behavior was investigated to achieve the strength of M25. Hence, the replacement was done by 5%, 10%, 20% & 25%. In the proportion of 25 % of replacement of fine sand with copper slag, the concrete achieved its compressive strength and flexural strength as 29.38 N/mm^2 and 5.53 N/mm^2 respectively. So the copper slag concrete can be used in the construction activities as per its strength aspect and it will reduce the burden of disposal of copper slag waste. The use of copper slag will reduce the usage of river sand, reduce the cost of concrete and prevent the environmental degradation and ground water depletion.

Key words-Copper slag, investigation, mix, replacement, strength.

1. INTRODUCTION

As per the literature study, the copper slag was used by the researchers [3], [5], [8], [9], [10], [11] & [12] as replacing fine aggregate material and carried out research as effective use of copper slag and its behavior, performance. The comparative study also made by the researchers with the conventional concrete. Base on these literatures this study was focused on using waste material and conducting investigations based on the behavior of materials.

2. MATERIALS AND METHODS

The methodology involves lot of analysis for using the copper slag effectively. Visual inspection for the materials quality by appearance were carried out. Later, preliminary tests were done on the quality materials, for their strength, according to Indian Standards. The properties of copper slag is presented in the Table 1.

Table 1. Properties of copper Slag

Sl. No.	Property	Result
1	Shape and color	Angular irregular and black
2	Water absorption (%)	1.06
3	Specific gravity	3.65
4	Bulk density (g/cc)	4.23

Slump cone test was done to check the workability and consistency of the concrete mix prepared. The slump values were found to be 74.5 mm and 76 mm. Thus, it was a true slump.

Cubes and beams were casted following the mix proportion and varying the percentage of fine aggregate with copper slag by 0%, 5%, 10%, 15%, 20% and 25% respectively. The cube specimens were casted with a mould of standard dimension 150 mm × 150 mm ×150 mm and beam specimens were casted with a mould of standard dimension of 700 mm × 150 mm × 150 mm. The cube and beam are shown in Figure 1 & 2 respectively.

Fig. 1 Copper slag concrete cube of size 150 mm × 150 mm × 150 mm

Fig. 2 Copper slag concrete beam of size 700 mm × 150 mm × 150 mm.

3. RESULTS AND DISCUSSIONS

The casted specimens were cured separately for 7 days, 14 days and 28 days. These specimens were tested at the end 7, 14 & 28 days. The results of compressive and flexural strengths at 28 days of curing are shown in the table 2 & 3 respectively. It was observed that the required compressive and flexural strengths were achieved at 28 days of curing. Similar tests were obtained by the researchers [1], [2], [4], [6], [7] and results are justified.

Table 2. Compressive Strength of copper slag concrete

Sl. No.	Specimen/Proportion details (M 25)	Compressive strength in N/mm^2		
		7 days	14 days	28 days
1	0 % Copper slag	15.02	20.75	27.53
2	5 % Copper slag	12.12	21.48	23.13
3	10 % Copper slag	13.43	21.55	24.71
4	15 % Copper slag	14.44	21.78	25.69
5	20 % Copper slag	15.87	22.18	26.27
6	25 % Copper slag	17.64	23.47	29.38

Table 3. Flexural strength of copper slag concrete

Sl. No.	Specimen/Proportion details (M 25)	Flexural strength in N/mm^2		
		7 days	14 days	28 days
1	0 % Copper slag	2.75	3.68	3.97
2	5 % Copper slag	2.26	2.30	3.20
3	10 % Copper slag	2.30	2.68	3.57
4	15 % Copper slag	2.41	3.17	4.02
5	20 % Copper slag	2.58	3.63	4.52
6	25 % Copper slag	2.76	4.45	5.53

4. CONCLUSIONS

Based on the experimental investigation it was evident that copper slag can be utilized as a replacing material to fine aggregate. The design strength was achieved by the copper slag concrete through test results. The compressive strength of copper slag concrete increases as the percentage of replacement increases at all proportions and reached the target mean strength. The recommended optimum percentage of replacement of fine aggregate by copper slag is 25% according to this investigation. The higher specific gravity of copper slag increases the density of concrete, so pores are reduced than conventional concrete. The maximum compressive and flexural strength of copper slag concrete was about 29.38 N/mm^2 & 5.53 N/mm^2 respectively, with the replacement of fine aggregate by the copper slag in the range of 25%. Therefore, the river sand can be partially replaced by copper slag up to 25 % for the M25 grade concrete and copper slag concrete can be prepared. This concrete will reduce the cost of concrete and prove to be economical with quality.

REFERENCES

1. Almas Mevawala (2018), ‘Effective used of copper slag in concrete’, International Journal of Advance Engineering and Research Development, Vol.05, No.12, pp.114-123.
2. Chitra.R and Mohan.S.J (2017), ‘Replacement of cement and fine aggregate by copper slag and ceramic powder’, International Journal of Pure and Applied Mathematics, Vol.116, No.13, pp.229-234.

3. Deby Linsha.R, Kaviyarasi.P and Anbalagan.M, (2017), 'Experimental investigation on concrete using copper slag as fine aggregate with bacterial admixture'. International Journal of Emerging Technologies in Engineering Research (IJETER), Vol.05, No.12, pp.11-15.
4. Gowram Iswarya and Viharika Reddy (2018), 'Behaviour and experimental study on concrete as partial replacement of fine aggregate with copper slag and cement with GGBS', International Journal of Applied Engineering Research, Vol.13, No.07, pp.279-283.
5. Paresh Tiwari and Anil Kumar Saxena (2015), 'Partial substitution of copper slag with sand in concrete material concrete', International Journal of Engineering Research & Technology (IJERT), Vol.05, No.12, pp.212-215.
6. Priyadharshini.P and Sakthivel.R (2019), 'An experimental study on glass fibre reinforced self-compacting concrete using copper slag as a partial replacement of fine aggregate', International Journal of Scientific & Engineering Research, Vol.10, No.03, pp.178-186.
7. Rajasekhar.K and Leela Tejaswi.B (2017), 'Study on strength properties of concrete with partial replacement of fine aggregate with copper slag', International Journal of Engineering Research and Development, Vol.13, No.03, pp.48-56.
8. Selvaradjou and M Baskar.B (2019), 'Research on the effect of copper slag as a fine aggregate on the properties of concrete', International Journal of Recent Technology and Engineering (IJRTE), Vol.08, No.2S3, pp.619-623.
9. Sreelakshmi.S, Sruthi.K.P, Mohammed Munavvir.P and Mashad.V, (2016), 'Copper slag partially replaces fine aggregate in M25 concrete: A comparative study of compressive strength responses', International Journal of Science and Research (IJSR), Vol.05, No.11, pp.457-464.
10. Suhas.S.Malkhare and Atul.B.Pujari (2018), 'To study the performance of copper slag as partial or fully replacement to fine aggregates in concrete', International Journal of Research and Review, Vol.05, No.05, pp.102-109.
11. Thesarajan K.N.R, Subbaraj L, Priyavarshiny R and Ajitha Parvathy N (2020), 'Experimental investigation on partial replacement of silica fume and copper slag in concrete', International Journal of Applied Engineering Research, Vol.15, No.04, pp.409-414.
12. Vengadesh Marshall Raman.J, Rajesh.R and Sabari Velswaran.P (2019), 'Study on strength of high-performance concrete by partial replacement of fine aggregate by copper slag', International Journal of Applied Engineering Research, Vol.14, No.11, pp.2795-2798.