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STUDY ON EFFECT OF CHANGE IN FINENESS MODULUS OF COPPER SLAG ON THE COMPRESSIVE STRENGTH OF CONCRETE

Vamsi Pradeep I[1], Suresh Reddy S[2], Kishore Kumar M[3]

Assistant Professor, Department of Civil Engineering, BVRIT Narsapur, Hyderabad, A.P., India [1]

M. Tech Scholar, Department of Civil Engineering, GVPCOE, Visakhapatnam, A.P., India [2]

Assistant Professor, Department of Civil Engineering, GVPCOE, Visakhapatnam, A.P., India[3]

Abstract: A study pertaining to the effect caused on concrete, due to the change in source and fineness modulus of copper slag has been carried out. It was found that as the fineness modulus of copper slag increased, the compressive strength value of concrete in which cement was partially replaced by copper slag, decreased to some extent. Detailed results have been depicted in the later part of this paper.

Keywords: Slag, Compressive Strength, Fineness Modulus, Sieve Analysis

I. INTRODUCTION

Copper Slag has been procured from two different places in India. One sample has been taken from Sholapur, Maharashtra and the second sample was procured from Kolkata, West Bengal. Sieve analysis has been performed on both the samples and fineness modulus has been found out. The fineness modulus values were found to be different. The main aim behind the sieve analysis was that to find how copper slag blends with the ingredients of concrete and its impact on the compressive strength of concrete. The results pertaining to the compressive strength have been shown in table no. 7 & 8.

II. MATERIALS USED

A. Cement

Ordinary Portland cement of 53 grade with specific gravity of 3.15 has been used. The initial setting time and final setting time were found to be 33min and 315min respectively.

B. Fine Aggregate

Locally available natural river sand passing through 4.75 mm I.S. Sieve with a fineness modulus of 2.74, and water absorption of 1.5% in saturated surface dry (SSD) condition was used. The specific gravity of the sand is found to be 2.63 and was confining to ZONE-III.

C. Natural coarse aggregate

Crushed granite metal from local sources, passing through 20 mm and retained on 4.75 mm sieve was used as natural coarse aggregate. The fineness modulus of Natural Coarse Aggregate (NCA) is 6.56 and its water absorption is 0.94% in SSD condition. The specific gravity of coarse aggregate is found to be 2.71.

D. Water

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Potable fresh water available from local sources free from deleterious materials was used for mixing and curing of all the mixes tried in this investigation. W/C ratio is taken as 0.47 for M25 and 0.45 for M30 concrete.

E. Copper Slag

1. It was procured from an industry at Sholapur, Maharashtra. Its specific gravity was found to be 3.79. Bulk density was recorded as 1886 kg/ m^3. After sieve analysis the particle size distribution of the copper slag is shown in table 1. The fineness modulus was found to be 4.87.

2. It was procured from Kolkata based industry, West Bengal. Its specific gravity was found to be 3.62. Bulk density was recorded as 1830 kg/ m^3. After sieve analysis the particle size distribution of the copper slag is shown in table 2. The fineness modulus was found to be 4.75.

S. No	Sieve Size in mm	Weight Retained in gm	Total Weight Retained in gm	Total Weight Passing in gm	% Passing	% Retained
1	4.75	0	0	500	100	00.00
2	2.36	21	21	479	95.8	04.20
3	1.18	98	119	381	76.2	23.80
4	0.6	161	280	220	44	56.00
5	0.3	37	317	183	36.6	63.40
6	0.15	170	487	13	2.6	97.40
7	≤0.075	13	500	0	0	100.00

Table 1: Sieve Analysis for copper slag sample 1

S. No	Sieve Size in mm	Weight Retained in gm	Total Weight Retained in gm	Total Weight Passing in gm	% Passing	% Retained
1	4.75	0	0	500	100	00.00
2	2.36	49	49	451	90.2	09.80
3	1.18	117	166	334	66.8	33.20
4	0.6	142	308	192	38.4	61.60
5	0.3	23	331	169	33.8	66.20
6	0.15	144	475	25	5	95.00
7	≤0.075	25	500	0	0	100.00

Table 2: Sieve Analysis for copper slag sample 2

Property	Fine aggregate	Coarse aggregate	Copper Slag Sample 1	Copper Slag Sample 2
Specific Gravity	2.65	2.71	3.79	3.62
Fineness modulus	2.49	6.56	4.87	4.75
Water absorption %	1.07	0.94	0.4	0.3
Unit weight (kg/m^3)	1653	1710	1886	1830

Table 3: Physical Properties of raw materials in concrete

Mixes	Raw Materials in Kg per m^3				
	Cement	Sand	Copper Slag Sample 1	Aggregate	w/c ratio
0% CS	380	620	0	1370	0.49
5% CS	361	558	19	1370	0.49
10% CS	342	496	38	1370	0.49
15% CS	323	434	57	1370	0.49
20% CS	304	372	76	1370	0.49

Table 4: Concrete Mix Proportions of M25 grade

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Mixes	Raw Materials in Kg per m^3				
	Cement	Sand	Copper Slag Sample 2	Aggregate	w/c ratio
0% CS	410	650	0	1265	0.45
5% CS	389.5	585	20.5	1265	0.45
10% CS	369	520	41	1265	0.45
15% CS	348.5	455	61.5	1265	0.45
20% CS	328	390	82	1265	0.45

Table 5: Concrete Mix Proportions of M30 grade

III. EXPERIMENTAL DETAILS

The specimens 150x150x150 mm cubes were used for the Compression test. Three specimens were tested for the required age and mean value was taken.

Test Results on hardened concrete

These tests were conducted for 28 days and the results were tabulated in tables 7 and 8.

Replacement of Cement with Copper slag in %	Copper Slag Sample 1 compressive strength MPa	Copper Slag Sample 2 compressive strength MPa
0	29.63	29.63
5	31.11	34.51
10	32.47	36.82
15	34.82	38.66
20	27.41	30.03

Table 6: Compressive Strength of M25 Concrete mix

Replacement of Cement with Copper slag in %	Copper Slag Sample 1 compressive strength MPa	Copper Slag Sample 2 compressive strength MPa
0	35.11	35.11
5	35.85	37.48
10	37.48	38.25
15	39.25	41.37
20	32.15	33.82

Table 7: Compressive Strength of M30 Concrete mix

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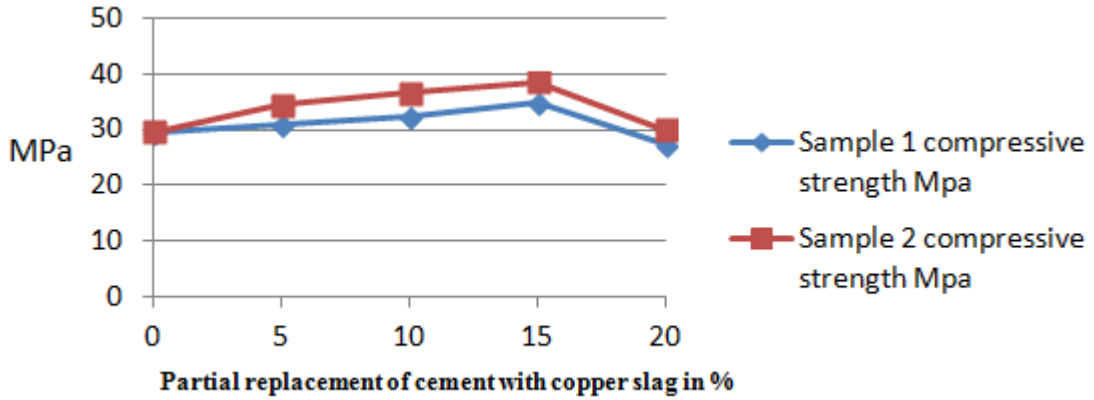

Fig.1. Comparison of Compressive Strengths of M25 mix design

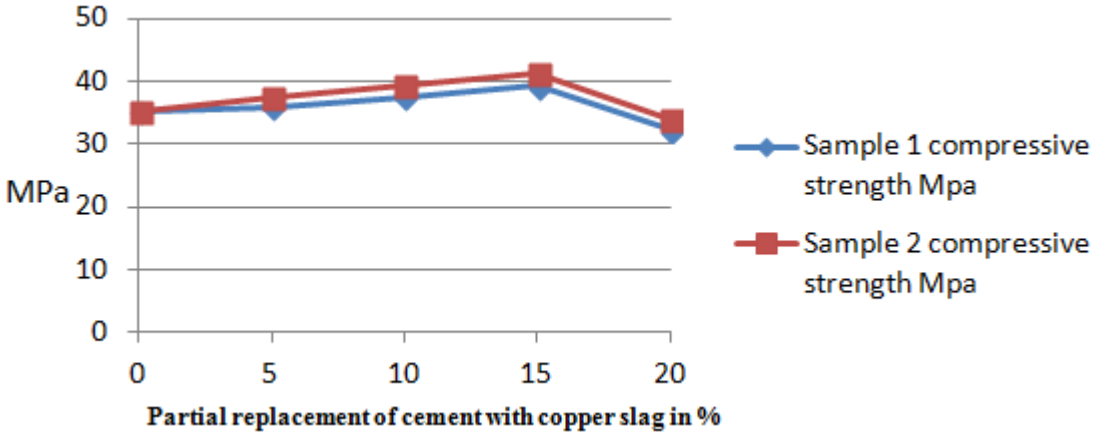

Fig.2. Comparison of Compressive Strengths of M30 mix design

IV. CONCLUSIONS

From the above graphs and tables, it's clearly visible that as the fineness modulus of copper slag increases the compressive strength of concrete, in which cement was replaced partially with copper slag, decreases.

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BIOGRAPHY

Mr I. Vamsi Pradeep is presently working as Assistant Professor in the department of Civil Engineering in B. V. Raju Institute of Technology, Narsapur, Hyderabad, AP. He has done his Graduation and Post Graduation from NIT, Warangal and Gayatri Vidya Parishad College of Engineering, Visakhapatnam, AP respectively. He was involved in a research related to MORTH, in IIT, Hyderabad. He has worked for Indian Railways (client) as Project Manager. During this tenure, he successfully accomplished construction of 16 bridges, earthwork for lying Railway tracks, earth retaining walls, construction of Railway Stations in Karnataka and Maharashtra. This is his third international publication. His area of interest is in the study of strength and durability properties of concrete using industrial waste or by-products. His mail-id is vamsi.projectmanager@gmail.com

Mr. S Suresh Reddy is an M. Tech Scholar at GVP College of Engineering, Visakhapatnam. His areas of interest are durability studies on concrete. His mail-id is sureshreddy.seelam@gmail.com

Mr. M Kishore Kumar obtained his master degree in Structural Engineering from PSG College of Technology, Coimbatore. He has been working as Associate Professor at the department of Civil Engineering in GVP College of Engineering, Visakhapatnam. His areas of interest are durability studies on materials, corrosion of reinforcement in concrete structures including prediction of residual and service life. His mail-id is mkkgvp@gmail.com