Development of Strength Properties on the Partial Replacement of Cement with Copper Slag in Concrete

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Abstract: The OPC is one in each of the foremost ingredients used for the assembly of concrete. However among the context of magnified awareness with reference to over exploitation of natural resources to manufacture cement, associate eco friendly technology ought to be developed for the effective management of resources. With increase in demand of concrete, extra and extra new ways and new materials square measure being developed for production of concrete. Thence among this study an attempt has been created to see the behavior of concrete on replacement of cement associated with copper slag for concrete mix grade M25. Copper scum is associate industrial by-product material made up of the strategy of manufacturing copper. for every ton of copper production, about 2.2tones of copper scum is generated .during this project, properties of concrete are assessed by partly replacement of cement with Copper slag consequently within the vary of 1/3 (without Copper slag), 5%, 10%,15% and 20% for M25 mix. Concrete mixtures were made, tested under three types of curing like normal curing, wet surface curing at the ages of 3, 7, 28days curing periods and a new technique of accelerated curing and compared- in terms of destructive tests (compressive, split tensile strength).

Keywords: Copper Slag, Compressive Strength, Split Tensile Strength, Accelerated Curing, Wet Surface Curing Etc.

I. INTRODUCTION

In the present situation, as a result of continuous growth in population, rapid industrialization and the accompanying technologies involving waste disposal, the rate of discharge of pollutants into the atmosphere, copper slag are few of the industrial by-products which comes out from blast furnace during metal extraction process. Copper slag is made as a by-product of metallurgic operations in reverberator furnaces. For each ton of copper production, about 2.2tones of copper slag is generated. Originally foreign from Japan, copper slag was used as associate degree stuff for removing rust and marine deposits from ships through sandblasting. once repetitive utilization and use, the copper scum lost its original abrasive property and with no good use thereafter and was disposed in landfills. However, there are environmental problems relating to the natural process of serious metals into soil and ground-water, and thus were call lowland sites Industries found a completely distinctive methodology of encapsulating this waste into concrete thereby not exclusively removing the environmental concern but put together finding a accessorial and pregnant substitute for natural sand.

Copper slag is completely inert material and its physical properties square measure kind Of like cement. A laboratory study was administrated within the Institute to analyze the potential of victimization copper dross as a partial replacement of cement in concrete. The utilization of copper slag once grounded fine is used as a replacement for cement and concrete provides potential environmental furthermore as economic edges for all connected industries, notably in areas wherever a substantial quantity of copper dross is made. In several countries, there's a insufficiency of natural mixture that's appropriate for construction, whereas in alternative countries the consumption of mixture has augmented in recent years, because of will increase within the housing industry. In order to scale back depletion of natural mixture because of construction, unnaturally factory-made mixture and a few industrial waste materials is used as alternatives. The main objective of this paper is to work out the concrete strength of M25 Grade by partial replacement of cement from 0% to 20%. The design mix of M25 grade concrete was designed as per the tactic laid out in IS 10262-2009. Cubes of size 150mm×150mm×150mm, Cylinders of size 300mm×150mm were casted and tested for compressive strength, split lastingness(strength) take a look at once the completion of various solidifying periods a)water curing b)wet surface curing c)accelerated curing, this research was performed.

II. MATERIALS AND METHODOLOGY

A. Cement: Ordinary Portland cement 53grade from Hemadri gold company was used for this research.

B. Fine and coarse aggregate: Fine aggregate of ZoneII from Krishna River, amaravathi, Guntur (dt) and coarse

aggregates of sizes 20 mm and 10mm from Balaji stone crusher industry, Perecherla, Guntur

C. Copper slag: Copper slag from Venkateswara copper suppliers from vizag.

D. Water: Water is a vital ingredient of concrete because it actively participates within the chemical change with cement. Since it helps to make the strength giving cement gel, the standard and amount of water is needed to be looked into terribly fastidiously.

Physical properties of cement:

S.NO	PROPERTY	VALUE
1	Specific Gravity	3.13
2	Fineness of Cement by sieving	3.20%
3	Normal Consistency	32%
4	Setting Time a) Initial Setting time b) Final setting time	76min 265 min
5	Compressive Strength a) 3 days b) 7 days c) 28 days	26.3 N/mm^2 37.2 N/mm^2 53.35 N/mm^2

Physical properties(Sand conformed)	Zone-II as per IS :383-1973
Fineness modulus	2.37
Specific gravity	2.59

Coarse aggregates properties (Shape)	Angular
Surface texture	Rough
Specific gravity	2.88
Fineness modulus	6.815

Physical and chemical properties of copper slag:

Sl.No	Physical Properties	Copper slag
1	Particle shape	Irregular
2	Appearance	Black and glassy
3	Type	Air cooled
4	Specific gravity	3.71
5	Percetage ofvoids%	43
6	Bulk density g/cc	2.06
7	Fineness modulus of copper slag	3.47
8	Water absorption%	0.15 to 0.20
9	Moisture content	0.1
10	Initial setting time	90 min
11	Final setting time	275 min

Sl.No	Chemical component	% Of Chemical component
1	Sio_2	25.84
2	Fe_2	68.29
3	Al_2o_3	0.22
4	Cao	0.15
5	Na_2o	0.58
6	K_2O	0.23
7	LoI	6.59
8	Mno_3	0.22
9	Tio_2	0.41
10	So_3	0.11
11	CuO	1.20
12	Sulphide sulphur	0.25
13	Insoluble residue	14.88
14	Chloride	0.018

III. MIX PROPORTION

A. Target Mean Strength of Concrete

For a tolerance factor of 1.65 and using table 1, the obtained target mean strength for the given grade of concrete

$$f_{ck} = f_{ck}+1.65*s$$

where, f_{ck} = target average compressive strength at 28 days f_{ck} = characteristic compressive strength at 28 days and s = standard deviation

From table 1, standard deviation, s = 4.00 N/mm^2 Therefore, Target strength = 25 + 1.65 x 4.00 = 31.60N/mm^2

The mix proportions then becomes

Water	Cement	Fine Aggregate	Coarse Aggregate (60% + 40%)
165	347.36	713.55	1263.10 (757.90 + 505.20)
0.475	1	2.05	3.63

Quantities obtained for 1m^3 of concrete with replacement of cement with copper slag:

Design mix	Water	Cement	Sand	coarse aggregate		Copper slag
				10 mm	20 mm	
0%	165	347.36	713.55	505.2	757.9	0
5%	165	330	713.55	505.2	757.9	17.36
10%	165	312.64	713.55	505.2	757.9	34.72
15%	165	295.28	713.55	505.2	757.9	52.08
20%	165	277.92	713.55	505.2	757.9	69.44

IV. RESULTS AND DISCUSSIONS:

A. Strength: Compressive strength: Compression take a look at is conducted on the cube specimens victimisation 300T compression testing machine. The cube was placed within the compression testing machine and therefore the load on the cube is applied at a relentless rate up to the

failure of the specimen and therefore the final load is noted.

In this investigation the cubes are casted and tested under different types of curings with the replacement of cement by copper slag from 0% to 20% at the ages of 3days,7days and 28days curing period for water curing and wet surface curing by using gunny bags and steam curing under accelerated curing tank which is a new technique and gives 28days of strength within 28hours.

a. Under normal curing:

Serial no:	Designation of mix or % replacement	Strength N/mm2			Remarks
		3 days	7 days	28 days	
1	0%	16.66	24.93	33.35	
2	5%	17.97	26.77	36.04	
3	10%	18.79	28.17	37.98	
4	15%	19.29	28.88	38.39	
5	20%	18.08	27.2	36.49	

b. Strength values under wet surface curing:

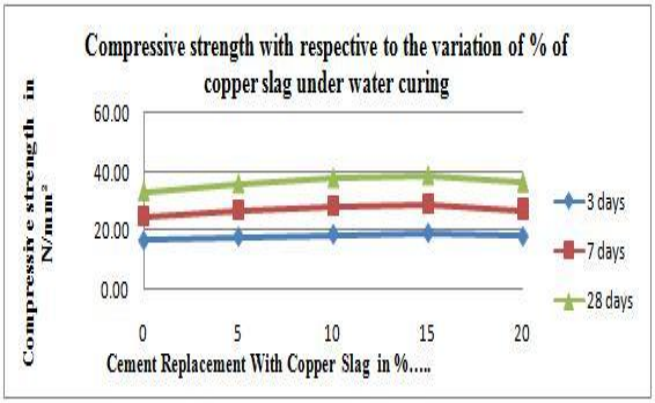
Serial no:	Designation of mix or % replacement	Strength N/mm2			Remarks
		3days	7 days	28 days	
1	0%	14.99	22.63	30.21	
2	5%	16.26	24.21	32.43	
3	10%	17.06	25.35	34.59	
4	15%	17.47	26.03	35.03	
5	20%	16.33	24.61	32.84	

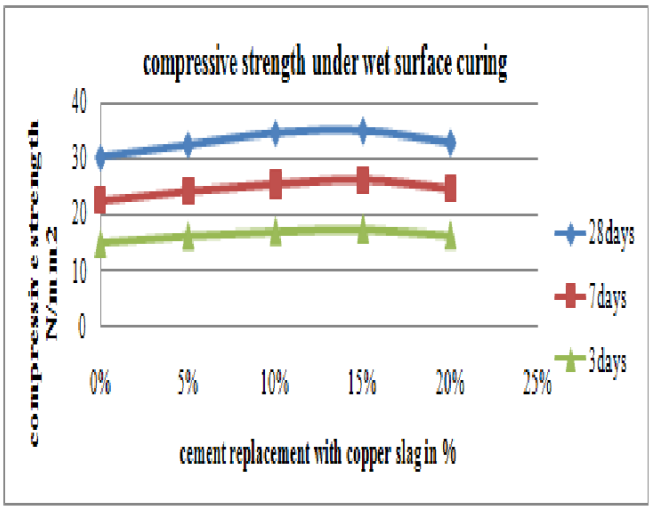
c. Strength values under Accelerated curing tank:

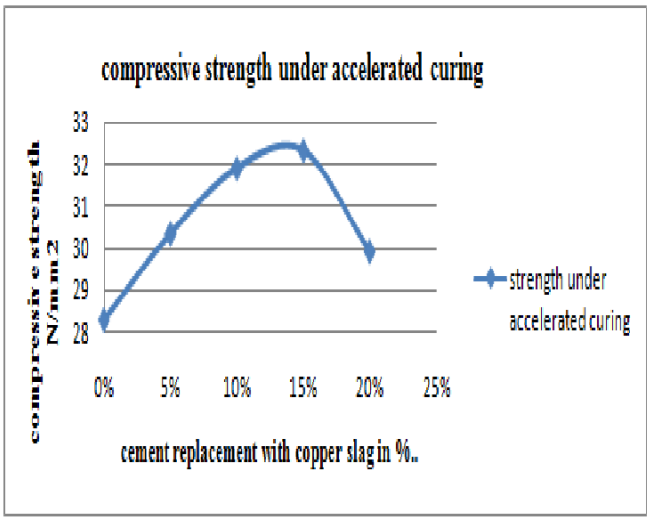
Serial no:	Designation of mix or % replacement	Strength under accelerated curing tank (N/mm2)	Remarks
1	0%	28.28	
2	5%	30.34	
3	10%	31.9	
4	15%	32.33	
5	20%	29.92	

B. Variation of Compressive strength of concrete with % replacement of cement with copper slag

From above tables which are shows the values of compressive strength of concrete, the compressive strength of concrete for the partial replacement of cement with copper slag increased in the order of 0%, 7.46%, 5.11%, and 2.37% for 0%, 5%, 10% and 15% of replacement and decreased by 6.60% for 20% replacement respectively. And it is observed that there is a)decrease of (15%-20%) strength under accelerated curing when compared to normal water curing b) decrease of strength values under wet surface curing (8.8-10%) strength when compared to normal curing. Graphical representation is below







C. Split tensile strength:

Split tensile strength is performed on the specimes of cyllinderical type by using100T UTM. The cylinders ready for testing ar one hundred fifty metric linear unit in diameter and three hundred metric linear unit height. when noting the burden of the cylinder, diametrical lines ar drawn on the 2 ends, such they're within the same axial plane tested at the ages of 3,7,and 28days under water curing and wet surface curing and also tested under accelerated curing under the replacement of cement with copper slag from 0% to 20%.

A. Strength values under normal curing tank:

Serial no:	Designation of mix or % replacement	Strength N/mm2			Remarks
		3 days	7 days	28 days	
1	0%	1.34	2.29	3.48	
2	5%	1.48	2.48	3.77	
3	10%	1.6	2.65	3.99	
4	15%	1.69	2.72	4.1	
5	20%	1.5	2.45	3.65	

B. Strength values under wet surface curing:

Serial no:	Designation of mix or % replacement	Strength N/mm2			Remarks
		3 days	7 days	28 days	
1	0%	1.2	2.06	3.13	
2	5%	1.33	2.232	3.39	
3	10%	1.44	2.38	3.59	
4	15%	1.52	2.44	3.69	
5	20%	1.35	2.2	3.28	

C. Strength values under Accelerated curing tank:

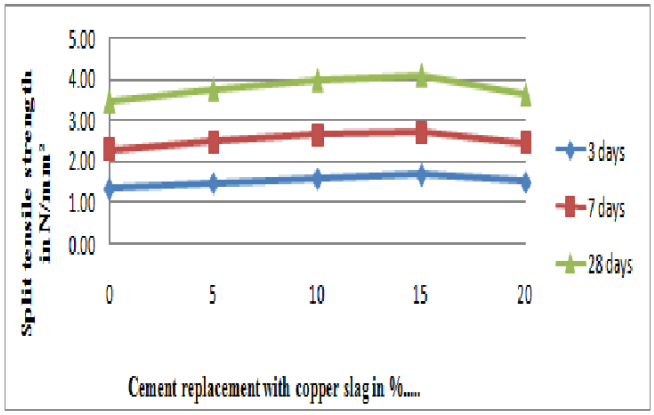
Serial no:	Designation of mix or % replacement	Strength under accelerated curing tank (N/mm2)	Remarks
1	0%	2.95	
2	5%	3.2	
3	10%	3.39	
4	15%	3.48	
5	20%	3.1	

D. Above Tables shows that Variation of split tensile strength with % replacement Cement with copper slag

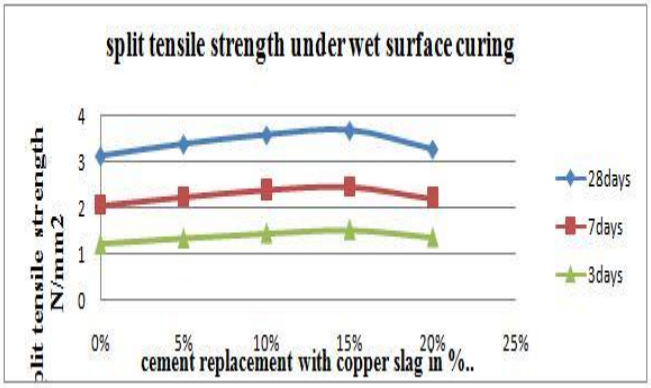
When compared to normal concrete, The Split tensile strength of concrete for the partial replacement of cement with copper slag increased in the order of 0%, 7.69%, 5.51%, and 2.68for 0%, 5%, 10%, and 15% replacement and decreased by 12.33% for 20% replacement respectively. The split tensile strength of concrete increased along with compressive strength with replacement of cement with copper slag as it densifie the mix more together due to fineness of copper slag.

V. GRAPHICAL REPRESENTATION A.

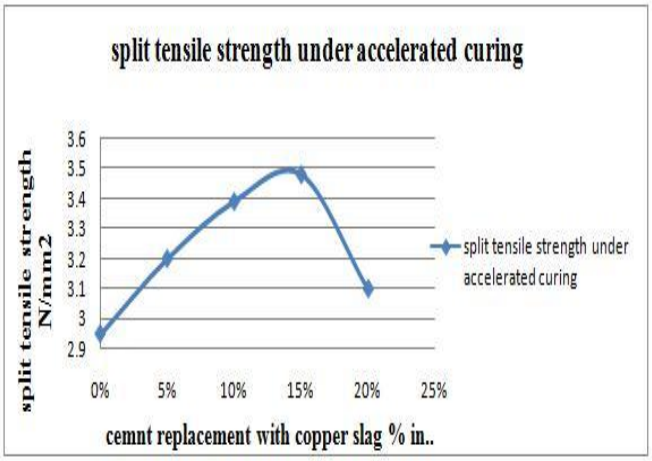
Under water curing



B. Under wet surface curing:



C. Under accelerated curing:



VI. CONCLUSIONS

Results are analyzed to derive useful conclusions regarding the workability, strength characteristics of concrete on partial replacement of cement and sand with copper slag for M25 grade.

1. The density of the copper slag concrete is found to be higher than the normal aggregate concrete.
2. When compared to normal concrete, strength variation in all the copper slag concrete mixes is observed to be marginal.
3. For concrete made with replacement of cement with copper slag, the compressive strength increases as the

% of replacement increases and all the mixes reached the target mean strength.

4. The recommended optimum % replacement of cement with copper slag is about 15%.
5. The maximum compressive strength of copper slag is about 33 to 38 N/mm2 respectively, with the replacement of cement with copper slag in the range of 5 to 20% with increment of 5% for each mix.
6. The maximum compressive split tensile strength and were achieved at 15% replacement of cement with copper slag.
7. There is an increase of compressive strength was achieved around 15.11% compared to control concrete mixes. Similarly, for split tensile strength test, the strength was increased to 17.82% compared to control mixes.
8. From the above results, copper slag concrete can be considerable as an alternative to cementiuous material and found to be potential.
9. By substitution the cement with copper dross thepavements reduction within the consumption of cement may be achieved.
10. By reducing the consumption of cement and sand, the ecology of the world may be improved tremendously and also the pollution owing to the assembly of cement also can be reduced.

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