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ASSESSMENT OF MECHANICAL PROPERTIES OF CONCRETE STRENGTH USING COPPER SLAG

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ABSTRACT:

Concrete is widely used in all types of infrastructural applications because it offers considerable strength at a relatively low cost. The popularity of the concrete is due to the fact, that from the common ingredients, it is possible to tailor the properties of concrete to meet the demands of any particular situation. Concrete is an Artificial Stone resulting from hardening of rationally chosen mixture of cement, fine aggregate, coarse aggregate and water.

The advances in concrete technology have paved the way to make the best use of locally available materials by judicious mix proportioning to produce concrete satisfying the performance requirements. This concrete is the most widely used construction material in the world, with about two Billion tons of utilization worldwide during each year.

Natural Sand available from River beds, pits etc., was readily used as fine aggregate in all types concrete mixes. Due to rapid urbanization, there is a huge demand / requirement of natural sand (as fine aggregate) for the construction industry, thereby natural resources of sand was getting depleted day by day, have brought pressures to reduce consumption through the use of supplementary materials. The sustainable development in the construction industry involves the use of non- conventional and innovative materials and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways for conserving the environment.

Copper slag (by-product material produced during the process of manufacturing Copper), is one of the waste material which could have a promising future in construction industry as partial substitute of fine aggregate in concrete mixes. Hence an attempt has made to study the Compressive Strength, Split tensile Strength and Flexural Strength of concrete using different proportions of Copper Slag in concrete mixes to finalize the optimum % of mix which can yield better strength properties. The results presented in this thesis, form part of an investigation on the use of Copper slag as partial substitute/ replacement for natural sand as fine aggregate in concrete.

I. INTRODUCTION

At present scenario, as a result of continuous growth in population, rapid industrialization and the accompanying technologies involving waste disposal, the amount of discharge of pollutants into the atmosphere. Copper scum is one in all the economic wastes, that comes out from furnace throughout metal extraction method. it's created as a by-product of metallurgic operations in reverberatory furnaces. The uses of copper scum in the cement and concrete provides a potential environmental in addition as economic edges for all connected industries Due to rapid urbanization, the huge requirement of fine aggregate i.e., natural sand for the production of concrete in construction industry, which led to the continuous mining of natural sand from river beds. These results in lot of environmental issues like lowering of water table, erosion of nearby lands, increased pollution, etc..

Thus, our project is to utilize the copper scoria by the replacement for fine mixture for maintaining the economy and increasing the strength of concrete. By this project, we will conjointly solve the matter of disposal of this sort of business waste. Different types of slag according to the property can be utilized in different purposes.

Composition of Concrete

- Ordinary Portland Cement (OPC)
- Aggregates
- Sand
- Water
- Copper Slag

NEED FOR PRESENT WORK

The demand for natural sand is quite high in developing countries since the available sand is not able to meet the demands of construction sector, because natural sand takes millions of years to form and it is not replenishable. Due to continuous dragging of the sand from watercourse beds reduces the water head, results in less percolation of rain water in to the bottom. This results in lower H_2O level, which ends in deficiency of beverage.Hence there's associate degree imperative have to be compelled to establish an acceptable substitute for natural sand, that ought to be eco-friendly and cheap. On the opposite hand, massive quantities of dross created as a by-product of scientific discipline operations, leading to environmental considerations with its disposal.Hence, there's a raised have to be compelled to explore the chance of utilization of business waste materials in creating concrete. this can cause the property concrete style and greener surroundings.

OBJECTIVES

- To study the mechanical properties of concrete of M40 grade, replacement of natural sand with copper slag with totally different proportions.
- To check the mechanical properties of concrete which incorporates compressive and split lastingness at seven days and twenty eight days of solidification.

II. LITERATURE REVIEW

Some of the studies were represented below.

R. R. Chavan & D.B. kulkarni (2013) conducted the experimental investigations to study the effect of using copper slag as are placement of fine aggregate on the strength properties and concluded that the Maximum Compressive strength increased by 55% at 40% replacement of fine aggregate by copper slag and flexural strength increased by 14% for 40% replacement.

Al-Jabri KS et al, studied the impact of Copper dross substitutions as fine sand on the strength and sturdiness of HSC. Concrete mixtures with completely different proportions of Copper dross (ranging from third to 100% replacement) were ready and Concrete samples were tested to assess the properties of concrete made at different solidifying ages. The results showed that workability hyperbolic considerably with rise of Copper dross content within concrete mixture thanks to the tide absorption and glassey surface of Copper dross compared with natural sand.

Najimi et al (2011) investigated the performance of copper dross in concrete in sulfate answer. Associate in Nursing investigation which is experimental on growth measurements, compressive strength degradation and small structural analysis were conducted in sulfate answer on concretes by exchange third, 5%, 100 percent and 15 August 1945 of cement with copper dross waste. The results of this study stressed the effectiveness of copper dross in rising the concrete resistance against sulfate attack.

III. EXPERIMENTAL INVESTIGATION

MATERIALS

The materials used for the present study are cement, fine aggregate(Natural sand), coarse aggregate, Copper Slag and water. The materials were testing and casting according to the IS code specifications. The materials used for casting were discussed below in detail.

1. OPC (ordinary Portland cement)-53 grade
2. Coarse aggregate of size 20mm
3. Natural sand
4. Copper Slag
5. Water

1. OPC (ordinary Portland cement)

Cement could be a fine mineral powder factory-made with terribly precise processes. Mixed with water, this powder transforms into a paste that binds and hardens once submerged in water. as a result of the composition and the fineness of the powder might vary, cement has completely different properties relying upon its makeup. Cement is the main component of concrete. It's highly economical and high-quality construction material which is used in construction projects worldwide. The Cement selected for this experimental work is the Ordinary Portland Cement of 53-Grade (Ultra-Tech Brand). This brand of cement is most widely used in the construction industry in India. The Physical properties of the cement i.e., initial setting and final setting times, Specific gravity, fineness and consistency has to be checked, before conducting the Mix-design.

Methods of physical tests for hydraulic cement.

Table 1: Physical properties of ordinary Portland cement

S. no	Property	Test Methods	Test Results	IS Standards
1	Normal consistency	Vicat apparatus (IS:4031 Part-4)	30%	
2	Specific gravity	Specific gravity bottle (IS:4031 Part-4)	2.9	
3	Fineness	Sieve test on sieve no.9 (IS:4031 Part-4)		7.33%
4	Initial setting time Final setting time	Vicat Apparatus (IS:4031 Part-5)	7 minutes 590 minutes	Not less than 5 minutes Not more than 600 minutes

2. Coarse aggregate

In the present study, locally available Coarse aggregate of size 20mm was used. The Specific gravity, Sieve analysis and Fineness Modulus have to be checked.

Table 2:Physical properties of coarse aggregates

S. No	PROPERTY	METHOD	TEST RESULTS
1	Specific gravity	Pycnometer (IS:2386 Part 3-1986)	2.75
2	Water Absorption	(IS:2386 Part 3-1963)	0.5%

3. Fine Aggregate – Natural sand

Locally available natural sand was used. Its Specific gravity, Sieve analysis and Fineness Modulus need to be checked. The Sieve analysis has to be conducted to classify the sand belonging to which Zone (I to IV), as per IS 383:1970. As sand grading becomes progressively finer, the grading changes from Zone-I to IV.

Table 3: Observations for sieve analysis

Size	Wt. of sand retained (gms)	Percentage of sand retained (%)	Cumulative percentage of sand retained (%)	Cumulative percentage of sand passed (%)
4.75mm	3	0.3	0.3	99.7
2mm	46	4.6	4.9	95.1
1mm	393	39.3	44.2	55.8
600 microns	301	30	74.2	25.8
300 microns	231	23	97.2	2.8
150 microns	23	2.3	99.5	0.5
Pan	0	0	99.5	0.5

4. 4 Fine Aggregate – Copper Slag:

The analysis of the Copper dross needs to be conducted, to see its Chemical composition. at the same time the tests to see the Physical properties of the Copper dross i.e. relative density, Sieve analysis and Fineness modulus needs to be conducted.

Table4: SIEVE ANALYSIS OF COPPER SLAG:

SIEVE SIZE (mm)	RANGE (%)
4.00 to +3.00	**2 to 4**
3 to+2.36	**3 to 12**
2.36 to +1	**40 to 50**
1 to +0.5	**15 to 30**
0.5 to +0.212	**6 to 12**
0.212 below	**0.2 to 1.0**

6. Water

Water with PH value of 7 should be used for this project work.

MIX PROPORTION

Mix Design For M40 Grade Of Concrete

Procedure for Mix Design for M40 Grade Concrete

The design procedure for Concrete mix of M40 grade as per IS 10262-2009

Table 5: Design stipulations

Design of grade	M40
Type of cement	OPC 53 grade (PENNA CEMENT)
Minimum cement content	320 kg m^3
Maximum cement content	450 kg m^3
Type of coarse aggregate	Crushed angular aggregate
Maximum nominal size of aggregate	20mm
Type of fine aggregate	Natural sand
Maximum water cement ratio	0.40
Workability	100 mm slump
Exposure condition	Severe
Degree of supervision	Good
Type of replaced fine aggregate	Copper Slag

Test Data For Materials

Tests conducted for materials used in Concrete i.e., specific gravity, water absorption and surface moisture content were conducted and the outcomes are tabulated below .

Table 6: Test data for the materials

Specific gravity of cement	2.9
Normal Consistency of cement	30%
Specific gravity of coarse aggregate	2.75
Water absorption of coarse aggregate	0.5%

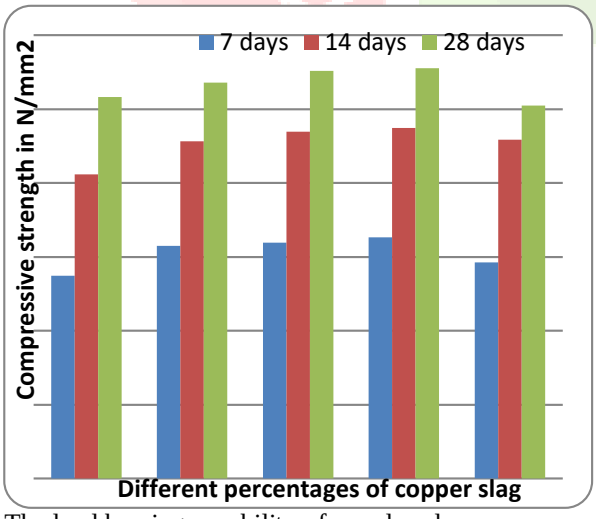
Mix proportions

Water	Cement	Fine aggregate	Coarse aggregate
174ltrs	438 kgs	631 kgs	1087 kgs
0.40	1	1.4	2.48

IV. EXPERIMENTAL RESULTS AND DISCUSSION

EXPERIMENTAL RESULTS

Load bearing capacity



The load bearing capability of a replaced copper scum cubes bit by bit increasing because the share of copper scum in concrete is accumulated. By the graph shown below, we are able to see that the strength of concrete cubes begin increasing from four-hundredth to hour replacement. At 60%replacement the strength of concrete is most. As pictured within the graph, the strength is reducing because the share of copper scum is accumulated over hour. therefore the hour replacement of fine mixture within the concrete production will be done.

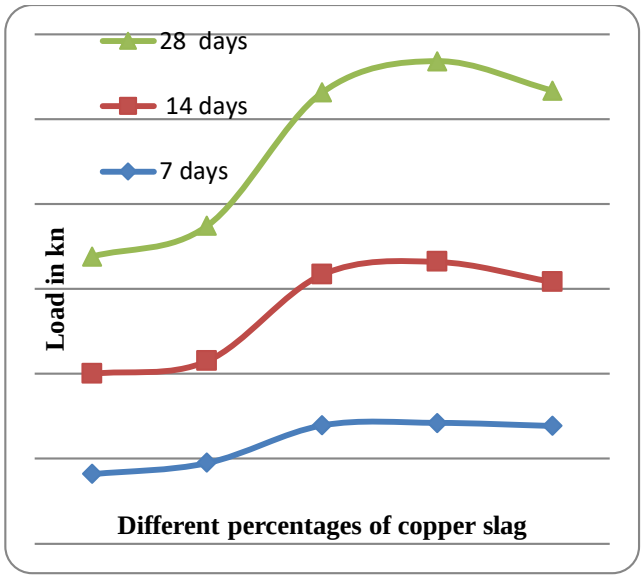


Fig 1: Graph of Load Bearing Capacity of Cubes

Results Of Compressive Strength Of Concrete Using 0-60% Of Copper Slag At 7-Days, 14-Days And 28-Days

%Replacement of sand with copper slag	M-25 Grade Concrete Mix		
	7-days	14-days	28-days
0%	27.44	41.16	51.63
20%	31.49	45.67	53.61
40%	31.91	46.91	55.17
50%	32.63	47.41	55.51
60%	29.26	45.85	50.46

Fig 2: comparison of compressive strength at different percentages of copper slag

Results Of Flexural Strength Of Concrete Using 0- 60% Of Copper Slag At 7-Days, 14-Days And 28-Days:

%Replacement of sand with copper slag	M-25 Grade Concrete Mix		
	7-days	14-days	28-days
0%	20.15	27.33	33.11
20%	5.78	25	43.11
40%	29.7	38.2	46.8
50%	24	32	39
60%	21.26	32.5	38.22

Results Of Split Tensile Strength Of Concrete Using 0-60% Of Copper Slag At 7-Days, 14-Days And 28-Days:

%Replacement of sand with copper slag	M-25 Grade Concrete Mix		
	7-days	14-days	28-days
0%	1.22	2.35	3.35
20%	2.35	3.67	4.01
40%	2.55	3.56	4.19
50%	1.85	2.67	3.96
60%	2.00	3.5	4.00

V. CONCLUSIONS

From the on top of result, it is all over that we tend to area unit planning to use the copper dross as an alternate of fine combination, the value of concrete production are going to be reduced and strength of hr replaced copper dross concrete are going to be raised to doubly the plain concrete strength.

Based on the experimental investigations carried out, the following conclusions were drawn:

- The behavior of Copper scum looks to be like stream Sand, for its use as fine mixture (partially or in blending) in Concrete mixes.
- Addition to the Copper dross (having higher Density) in Concrete will increase the density, thereby the self-weight of Concrete, (by concerning four.5% for five hundredth replacement).
- The results showed that the workability of Concrete exaggerated well with increase of Copper dross content within the concrete mixture thanks to the tide absorption, coarser (in nature than sand) and also the glassy surface of Copper dross, thereby the Strength properties additionally improved.
- The Compressive Strength of Concrete is such as the management confusion to five hundredth of Copper dross substitution, however they decrease with an extra increase in Copper dross contents (due to the rise of free water content within the mix).The early Compressive Strength of Concrete was not adversely affected by Copper Slag addition up to the proportion of 50%.
- Compressive Strength and Flexural Strength of Copper dross admixture Concrete, exaggerated because of high toughness of Copper dross.
- Replacement of Copper dross as fine mixture in concrete mixes, reduces the value of concrete production.
- The results showed that copper dross utilized in concrete, strength will increase 2 hundredth to hr then when it starts decreases.

SCOPE FOR THE FUTURE WORK

- Further analysis work is required to explore the result of Copper dross as fine mixture on the sturdiness properties of concrete, at aggressive atmosphere locations on coastal belt.
- As Copper dross contains quite five hundredth of the metallic element content, it's necessary to search out corrosion properties of Concrete having Copper dross (as partial replacement of fine aggregate).
- To investigate the performance of High Strength Concrete victimisation Copper dross as fine mixture with Super plasticizer.

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