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CONCRETE TO INCREASE BEHAVIOUR OF CONCRETE TO INCREASE ITS STRENGTH BY COPPER SLAG

PUSHKRAJ S. KURKURE[1], DR. C. K SHRIDHAR[2]

[1]PG Student , Department of Civil Engineering K.C.T.LT.G.N. Sapkal College of Engineering, Nashik
[2]HOD Department of Civil Engineering K.C.T.LT.G.N. Sapkal College Of Engineering ,Nashik
pushkrajkurkure7@gmail.com

INTRODUCTION

GENERAL

The gap between the aggregate particles is filled and held together by coarse granular material (the fine and coarse aggregate or filler) that is contained in a hard matrix of material (the cement or binder). Building foundations, brick or block walls, roads, bridges, overpasses, airports, parking garages, dams, pools, reservoirs, pipes, footings for gates, fences, and poles, as well as boats, all need concrete. Nearly everywhere that humankind needs infrastructure, concrete is employed invast quantities.
Tonne for tonne, more concrete is used globally than is utilised for aluminium, copper, wood, plastics, and wood combined. The only material used more frequently in the modern world than concrete is water that is found in nature. The foundation of a sizable commercial sector is concrete. By 2015, it is anticipated that ready-mix concrete, the largest subset of the global concrete business, will generate more than $100 billion in revenue. If you merely take into account the value of the ready-mixed concrete sold each year, the production of concrete in the United States is a $30 billion per year industry.

Need of copper slag in the construction industry

The aggregates typically account for about 75% of the concrete volume and play a substantial role in different concrete properties such as workability, strength, dimensional stability, and durability. Conventional concrete consists of sand as fine aggregate and gravel, limestone or granite in various sizes and shapes as coarse aggregate. There is a growing interest in using waste materials as alternative aggregate materials and significant research is made on the use of many different materials as aggregate substitutes such as coal ash, blast furnace slag, and copper slag aggregate. This type of use of waste material can solve problems of lack of aggregate in various construction sites and reduce environmental problems related to aggregate mining and waste disposal. The use of waste aggregates can also reduce the cost of thncrete production.

Copper Slag

A byproduct of copper metal smelting and refinement is copper slag. The copper slag utilised in this project was imported from Tamilnadu and Tuticorin, India's Sterlite Industries Ltd (SIL). A total of approximately 1.5 million tonnes of SIL are produced daily. It is obtained as a byproduct of copper's metal smelting and refining. As a byproduct material, about 2.2–3.0 tonnes of copper slag are produced for every tonne of copper produced. Three benefits come from using copper slag to replace Portland cement and create aggregates, including the elimination of air pollution issues. Before being used for other applications, the countermined copper slag must be adequately cleaned or processed to meet certain recycling requirements.
Because of the significant number of heavy metals present in its oxide, copper slag is harmful to the environment. Slag is created again as a consequence of those processes as the separated impurities are collected, removed, and other substances added to the pure metal that melt and enrich it. This kind of slag is produced depending on the metal processing method used to cool the melted bulk. The creation of grains that are the size of granulated copper slag. This substance behaves like Portland cement when the conditions are right because of its composition, which also gives it great hydraulic

Problem statement

Copper slag is bad for the environment since it contains a lot of heavy metals in its oxide. when a result of such procedures, slag is produced once more when the purified metal is melted and enriched while the separated impurities are collected, eliminated, and added to. Depending on the technique

employed to cool the molten majority of the metal, this type of slag is formed. the production of grains with granules of copper slag's size. When the circumstances are appropriate, this substance behaves like Portland cement due to its composition, which also provides it excellent hydraulic properties.

Objective

1. This project's main goal is to investigate the potential use of copper slag in future building construction and road surfacing. Therefore The following tests are run to ensure that the project will achieve its overall goal.Slump cone test
2. Compaction factor test.
3. Vee densitometer
4. Flow table test

Scope of project work

The city of Nashik is expanding at the quickest rate in all of India, therefore construction is picking up speed. The Sand is a crucial component of building construction. Natural sand is not economically feasible because it is scarce and expensive. Finding a substitute for real sand is therefore preferable. Sand aggregate is a superior substitute for copper slag. It is more affordable to employ copper slag in concrete construction than natural sand because of this. Copper slag boosts concrete's resilience and creates high-performance concrete when used in building.CHAPTER 02 LITERATURE REVIEW

Literatures

Mohammed Nadeem, Arun D. Pofale (2012)
The project at hand is a "Experimental Investigation of Using Copper Slag as an Alternative to Fine Aggregates (Coarse and Fine) in Concrete." These projects provide the findings of experimental research done to determine the effects of using slag in place of coarse and fine aggregate on various concrete qualities. The main goal of this study was to locate alternate sources of good quality aggregates, which are rapidly running out due to India's brisk construction industry. Use of slag, a waste industrial byproduct of the manufacturing of iron and copper, offers a wonderful chance to use it as a substitute for commonly accessible aggregates (coarse and fine) in all concrete applica

R. padmapriya, V.K. Bupesh Raja (2014)
The topic of this research was "Replacement of Fine Aggregate by Copper Slag in Concrete." The experiment's primary goal is to increase the use of environmentally friendly products across all industries, but especially in the building sector. It has become advantageous and widespread to use crushed sand in place of natural sand whenever possible. This aids in minimising potential ecological balance harm from too much sand. First, 28 days of compressive strength tests are performed on cubes of 150 mm x 150 mm x 150 mm with 20%, 40%, 60%, and 80% replacement of coarse aggregate by copper slag to determine the ideal percentage of copper slag to be replaced. The hexagonal shaped paver block specimens of side 125mm and height 80mm were cast using this ideal proportion of copper slag and examined for their compressive strength, split tensile strength, flexural strength, and water absorption tests. It has been discovered that substituting 25% M sand for river sand and 40% copper slag for coarse aggregate results in the strongest material, which is best suited for non-marine environments.

S.P Palanisamy, G. Maheswaran, M.G.L. Annaamalai (2014-15)
In this research they studied the “copper Slag to Improve the High Strength of Concrete.” A Copper slag is an industrial by-product of copper industry. It possesses the problem of disposal as waste and is of environmental concern. The results were compared with conventional concrete property can be maintained with advanced mineral admixtures such as copper slag powder as partial replacement of cement 0 to 40%. Experiments were conducted to determine the compressive strength; split tensile strength of concrete with various percentages of copper slag aggregate. Compressive strength of copper slag concrete with different dosage of slag was studied as a partial replacement of cement. From the experimental investigations, it has been observed that, the optimum percentage of copper slag for high strength concret.

METHODOLOGY

MATERIAL INVESTIGATION AND MIX PROPORTION

Cement

In this study, Ultratech 53 grade cement was employed. Ordinary Portland cement is made by thoroughly combining calcareous and argillaceous materials, burning at a temperature that causes clinkering, and then grinding the resulting clinker to create a cement that meets the chemical and physical requirements specified in IS: 12269-1987.
Getting raw materials is the initial step in the cement manufacturing process. Typically, raw materials are a mix of clay, sand, iron ore, lime stone, shell, or chalk. It is transported from mines close to the plant. When the raw materials are delivered to the cement plant, they are proportioned to produce cement

with a certain chemical make-up. 85% lime stone, 13% clay, and 2% latrite are crushed in raw mills to create powder. With the aid of air pressure, the powder is transported into the mixing chamber and combined. It is then kept in a storage compartment.

Consistency Test Vicat Apparatus

(Standard Consistency)Purpose:

According to IS 4031 - Methods of physical testing for hydraulic cement, it is used to determine the cement's standard consistency, initial setting, and final setting.

Brand Of Cement – Ultratech

Grade Of Cement – 53 Grade OPC

Observation Table:

Table no 3.1 Standard Consistency test

1	**Wt of sample in gm**	**300 gms**	**300 gms**	**300 gms**
2	**Water added in ml**	**85**	**86**	**86**
3	**Reading in mm**	**8**	**6**	**6**
4	**Water % for consistency**	**28.33**	**28.67**	**28.67**
5	**Selected consistency**		**28.67**	

Calculation:

% of water (P) = W/C x 100Where,

W = quantity of water added C

= quantity of cement used

Requirement

As per (IS 4031, part 5 1988, 2000) the standard consistency is obtained when theplunger penetrate to a point 33 to 35 mm from top of vicat mould.

Result

The percentage by weight of water required to make a paste of cement of normalconsistency is P = 28.67

Setting Time VICAT APPARATUS

(Initial setting time of cement)

Observation table

Table no 3.2 Initial and Final setting time of cement

1	**Starting time in hrs**	**10.10 am**
2	**Initial setting time in hrs**	**12.45 am**
3	**Final setting time in hrs**	**2.20 pm**
4	**Initial setting time in min**	**155 min**
5	**Final setting time in min**	**250 min**

Result

Initial setting time of given cement sample is 155min and final setting time is 250 min.

Requirement

As per IS the initial setting time shall not be less than 30 min and final setting time shallnot be greater than 10 hrs.

Fineness

Purpose:

To find out the quantity of course material present in cement.

Reference:

I.S.269-1989: specification for ordinary Portland cement and low heat cement

Apparatus:

90micron IS sieve, weighing balance with weight, tray, wire, brush etc.

Observation table

Table no 3.3 Fineness test

1	**Sample taken in W1 gm**	**100**	**100**	**100**
2	**Passing through is 90 micronSieve**	**98.14**	**97.99**	**98.04**
3	**Retained on is 90 micron sieveW2 gm**	**1.86**	**2.01**	**1.96**
4	**Fineness (%) (W2/W1 X100)**	**1.86**	**2.01**	**1.96**
5	**Average**			**1.94%**

Result

Percentage of residue of cement by dry sieving (i.e. fineness) is 1.94%.

Requirement

According to IS 269 - 1989, rapid hardening cement's dry sieving fineness should not exceed 5% and conventional Portland cement's fineness should not exceed 10% by weight.Fine aggregate

The fine aggregate used in this investigation was clean river sand and the following testswere carried out on sand as per IS: 2386- 1968 (III).
The sieves are used for the determination of particle size distribution of fine aggregate bysieving. (As per IS 2386 part 1 – Methods of test for aggregates for concrete).

Sizes of sieves :

Sieves of the sizes 10mm, 4.75 mm, 2.36 mm, 1.8mm, 600 mic., 300 mic., and 150 mic.

Physical properties of copper slag

Copper slag has a comparable range of particle sizes to sand and is black, glassy, and granular in appearance. Indian slag has a specific gravity that ranges from 3.4 to 4.1. Copper slag has a bulk density that ranges from 1.9 to 2.15 kg/m3, which is nearly the same as the bulk density of typical fine aggregate. Copper slag's physical characteristics are shown in Table 4.5. Slag was determined to have less than 0.5% free moisture content. A gradation test on copper slag and sand revealed similar particle size distribution for both materials, as indicated in Table 4.4. Sand appears to have a larger fines content than copper slag, nevertheless.
According to ASTM C128 testing was done on copper slag and sand to evaluate specific gravity and water absorption. According to the findings in Table 4.2, copper slag has a specific gravity of 3.91, which is greater than that of sand (2.57) and OPC (3.12), and when utilised as a sand substitute, may lead to the manufacture of HPC with a higher density. Table 4.4 displays the sieve analysis result for different sand to copper slag ratios. According to Table 4.5, copper slag had a measured water absorption of 0.16% compared to 1.25% for sand.

Specific Gravity

IS: 2386 PART III

Specific gravity test for coarse aggregatePurpose :

The pycnometer is used to determine the specific gravity of aggregate as per IS 2386 partIII – Methods of test for aggregates for concrete.

OBSERVATION TABLE

Table No 3.16 Flakiness index

Sieve size(mm)		Wt. of Agg. 200 pieces (A) (gm)	Wt. of Agg. Pass through thk gauge (B) (gm)	Wt. of Agg. retained on thk gauge (C) (gm)	Total % age Flacky Agg. (D)=100 *(B/A) (%)	Wt. of Agg. retained on length gauge (E) (gm)	Wt. of Agg. Pass through length gauge (F) (gm)	Total %age elongated Agg. (G)= 100*(E/ E+F) (%)
Passing	Retained							
25.0	20.0	0	0	0	0.00	0	0	0.00
20.0	16.0	1919.5	65.5	1854	3.41	112	1742	6.04
16.0	12.5	997.5	67.5	930	6.77	176	754	18.92
12.5	10.0	484	43.5	440.5	8.99	107.5	333	24.40
10.0	6.3	195	27	168	13.85	48	120	28.57
Total wt.		3596	203.5	3392.5	5.66	443.5	2949	13.07

Max. Size: 20mmResult

Flakiness index (F.I) = Sum of D =5.66% Elongation index (E.I.) =

Sum of G = 13.07% Combined flakiness & Elongation index = 18.73%

Physical properties of coarse aggregate

Table No.3.17 Physical properties of coarse aggregate

Property	Value
color	Dark gray
Specific gravity	2.79
Water absorption	0.26%
Flakiness index	5.66%
Elongation index	13.07%

EXPERIMENTAL SETUP AND PROCEDURES

Experimental work

Workability: The ease with which a freshly mixed concrete or mortar may be handled and applied is referred to as workability. Concrete was made for a variety of mixtures. The slump cone test and the compaction factor test were performed on newly laid concrete.

Slump cone test: According to IS 1199, the slump test result is a gauge of how a compacted, inverted cone of concrete would behave when subjected to gravity. It gauges the concrete's consistency or moisture content.

Compacting factor test: According to IS 1199, the compacting factor test is used to assess the workability of fresh concrete [13]. The tool being utilised is a compacting factor tool.

RESULTS

Table 5.1 Test results for slump cone compacting factor

Replacement of fine Aggregate.	**Slump(mm)**	**Compacting Factor**	**Degree of Working**
0	**26**	**0.82**	**Low**
8	**27.5**	**0.86**	**Low**
16	**30**	**0.88**	**Low**
24	**32.5**	**0.50**	**Low**
32	**34.5**	**0.92**	**Low**

40	**36**	**0.96**	**Low**
48	**38.5**	**0.99**	**Low**

Table 5.2 Test result for Vee consitometer

Copper Slag (%)	Vee Bee Time (sec.)
0	13.6
8	12.4
16	12.1
24	10
32	9.4
40	9.1
48	8.6

CONCLUSION

From the Result and Discussion the following conclusions were made;

- Concrete's self-weight increases when copper slag is used as a fine aggregate replacement, increasing the density of the concrete.
- By replacing the fine aggregate with more copper slag while maintaining the same water-to-cement ratio, the workability of concrete is increased.
- Why The building sector is the only one where waste materials can be used safely, reducing environmental issues, space issues, and construction costs.

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