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To Study the Properties of Concrete with Partial Replacement of Aggregates with Industrial and Construction Waste

Achal Jain[1], Er Nitin Thakur[2]

[1]M. Tech Scholar, [2]Assistant Professor, Department of Civil Engineering,
[1,2]Om Institute of Technology and Management, Hisar, Haryana, India

ABSTRACT

Natural resources are depleting worldwide while at the same time the generated wastes from the industry are increasing substantially. The sustainable development for construction involves the use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways conserving the environment. So, this paper presents the results of an experimental investigation carried out to evaluate the mechanical properties of concrete mixtures in which fine aggregate (sand) was replaced with Copper Slag (CS) while coarse aggregates was replaced by recycled concrete aggregate (RCA) from demolished structure. Both the fine and coarse aggregate were replaced with percentages 0% (for the control mixture), 10%, 20%, 30%, of Copper Slag by weight. Tests were performed for properties of fresh concrete and hardened Concrete. Slump test was conducted to determine the workability of the various design concrete mix. Compressive strength and split tensile strength were determined at 7, 28 days of curing. The results indicate that workability decreases slightly with increase in Copper Slag percentage, though workability for the sample were within the prescribed limit for M25 concrete. Test results indicate significant improvement in the strength properties of plain concrete by the inclusion of CS alone while a reverse trend in observed for increasing percentage of RCA in the sample. The synergistic effect of CS and RCA on the designed sample concrete revealed that the percentage of CS is the more decisive factors than the percentage of RCA in deciding the performance of the concrete in terms of compressive and tensile strength. The outcomes of this research work showed that Copper slag and recycled concrete aggregate can be effectively used in structural concrete as a replacement of fine aggregate (sand) and coarse aggregate respectively. Futher, it substantiate towards sustainable construction approach because of its dual advantage of controlling menace of solid waste disposal along with its subsequent environmental pollution and increasing the cost efficiency and carbon efficiency of the product.

KEYWORDS: *Copper Slag, Recycled aggregate, Concrete, Workability, Compressive strength*

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INRODUCTION

Concrete comprising of cementitious substances, fine aggregate, coarse aggregate also, water. Presently days the cost of these materials are expanded in this way, we have to analyze an approach to diminish the building materials cost particularly concrete. One of the ongoing headway in development industry is substitution of materials in concrete. The substitution of materials offers cost decrease, vitality funds and security of condition. Concrete is one of the real upsets ever of. Many surprising landmarks were manufactured utilizing concrete. Be that as it may, now daily in the present situation the regular assets are being depleted to manufacture the concrete wilderness. Prior to common assets are totally exhausted, it is smarter to pick other elective assets for binder, fine aggregate and coarse aggregate.

Copper slag is a resultant element achieved while matte smelting as well as during copper refining. The typical managing choices for copper slag are recovering, recycling the metal, producing other elements like asphalt pavements, railroad ballast, road-base construction, tiles, glass, abrasive tools, cutting tools, and roofing granules. Although rising speed of re-using copper slag, the massive level of its output in a year is discarded to landfills/junkyards. Among the best likely uses for re-using copper slag is in concrete manufacturing. The usage of copper slag in the cement generation, concrete and mortar generation as basic elements for fine and coarse aggregates, clinker, and cement replacement, have been investigated by a lot of researchers. Copper slag is used in cement and concrete offers impending atmosphere along with it some economic advantages to every similar manufacturers, specifically in places

LITERATURE REVIEW

D. Priyadharshini et al (2018) studied on the use of copper slag and recycled aggregate in concrete as a fine aggregate and coarse aggregate. In this study M 40 Mix is designed by using copper slag and recycled aggregate in concrete. With addition of copper slag in concrete, the compression strength was increased up to 60% and then a decrement was seen. The strength was increased to 40.75 N/mm^2 after the complete replacement of sand with copper slag. The split tensile strength was increased with the addition of copper slag in concrete similar to compressive strength.

M. Kiruthika (2018) studied on the concrete properties by using copper slag and silica fume as a partial replacement with cement and aggregates. In this work, Mix M 20 was designed by using copper slag at 15 to 45 % with 15 % interval and silica fume at 10 % replacement and the results shows that the compressive strength is increased by 20 % and also the split tensile strength is increased by 15 %.

Pothula Naveen Kumar et al (2018) studied on the use of copper slag in normal concrete and steel fibre reinforced concrete. In this study, Tests were conducted with 1% addition of hooked end stee1 fibres having aspect ratio 60 and replacement of F.A by 0%, 10%, 20%, 30%, 40%, 50%, 60%, copper slag with increase in 10% up to where optimum strength is obtained. And the results shows that the compressive strength is increased by 7 %, split tensi1e are increased up to 68 % and flexura1 strength is increased up to 50 % in steel fibre reinforced concrete.

Ali Mohd (2018) did the comparative study on recycled aggregate in concrete. This paper intends to assess the information gathered from overview, 70% of the respondents have given the Explanations behind not embracing reusing of waste from Construction. From this examination it very well may be presumed that 25%RCA square having more quality than regular, yet half RCA square quality too adequate.

Muqtar Ahmed et al (2017) studied on the strength properties of concrete by using copper slag and Rice husk ash. In this study, fine aggregates are replaced with Copper slag ranging 0%, 10%, 20%, 30% & 40% also the cement with rice husk ash as 15 % of its weight. The effect of Rice Husk Ash and Copper Slag on mechanical properties of concrete were analyzed and compared with normal concrete. The maximum compressive, spilt tensile and flexural strength got 30% replacement of Copper slag as fine aggregate and it is found that as percentage of copper slag is increasing in the mix, the percentage of voids decreases & also it absorbs less water that found with sorptivity.

Md. Arshad Hussain et al(2017) studied on the effects on the concrete properties by using copper slag and micro silica. In this study M 30 mix was designed by using copper slag at 0%, 25%, 50% and 75% with fine aggregates and Cement is substituted by Silica Fume for 5%, 10% and 15%. The test results shows that there was much improvement in the flexural strength of concrete at 25% replacement of copper slag with 10% Silica Fume when compared to control mixes.

K. Bhanu Prakash Reddy et al(2016) studied on the use of copper slag in concrete along with cement mortar as substitute of sand. This investigation work predominantly comprises of 2 primary components. Concrete was wont to check various mechanical properties. First a piece of the theory comprises of work sand by copper filth in cement for determinant quality properties. For sand substitution, seven check groups (counting the executives blend) were authentic with substitution of third (control example), 20%, 40%, half, 60%, eightieth and 100% copper filth with sand in each arrangement.

S. Muneera et al (2016) studied on the Use of Recyc1ed Aggregate in Concrete. In this study the natura1 concrete is rep1aced by recyc1ed coarse aggregates at different percentages of 10%, 20%, 30%, 40%, 60%, 75%, 100%. Various tests such as slump test, compaction factor test, split tensi1e strength, compression test have been conducted in this study. The average reduction in compressive strength is near1y 5- 10%. This reduction in compressive strength is attributed to the decrease in adhesive strength between the RCA aggregates and the cement binder.

Deepika K P et al (2016) did the experiment study on the utilization of copper slag as a partial replacement of fine aggregate in concrete. The present examination for the most part centers around researching the impact of utilizing copper slag as a substitution of fine total on the quality properties. In this report, M25 grade concrete was utilized and tests were led for different extents of copper slag supplanting with sand of 40%, 80% and 100% in concrete.

MATERIALS AND METHODS

Cement

Cement is a folio, a material used in construction which solidifies, sets, and holds fast other varying materials to bond with them altogether. Bond is only here and there utilized individually, but is used to bond rock and sand with each other. Cement mixes with fine aggregates produces brick work mortar, or with rock and sand, produces concrete. OPC of grade 43 is used here.

Sand

By meeting the requirement of zone IV as per IS:383-1970, local sand is used. It has sieved through 4.75 mm sieve and the greater particles are removed. Specific fine aggregates gravity of 2.64.

Copper Slag

Copper slag material is a type of blasting grid formed from granulated slag from metal smelting processes. It is collected from S.S traders, Jalandhar. The properties of copper slag Copper slag Properties

Sr. No	Properties	Parameters
1.	Specific Gravity	3.83 gm/cm^3
2.	Electric Conductivity	4.8
3.	Size	0.2 mm upto 3.0 mm
4.	Chloride Content	< 0.0002 %

Recycled Coarse Aggregates

The process of preparing an initial aggregate used for the study this. As is known, the sources of aggregate used consisted of a cube-cube removed after the concrete compressive strength tests performed on the cube. Crushing process begins with a cube Machine Jaw Crusher is used only to solve the cube into smaller chunks according to the desired aggregate size.

Water

Water is required for the hydration of concrete and to give usefulness amid blending and to setting. Consumable faucet water was utilized for the solid planning and for restoring of examples. The ph estimation of water is 7.0.

RESULTS AND DISCUSSION

Workability of Concrete

A high workability in concrete is desirable as it ensures full compaction (100%) needed to mix, handle, compact and mould concrete to any shape like plastic. In other words, workability or the plastic nature of fresh concrete is an important parameter to enable maximum strength for concrete. The workability of the concrete was measured in terms of the slump value in the present study.

Table Workability of Concrete

Designation	Mix	Slump in mm
M-0	Control	62
M-1	10 % CS	59
M-2	20 % CS	58
M-3	30 % CS	54
M-4	10 % RCA	60
M-5	20 % RCA	59
M-6	30 % RCA	57
M-7	10 % CS + 10 % RCA	58
M-8	10 % CS + 20 % RCA	54
M-9	10 % CS + 30 % RCA	49
M-10	20 % CS + 10 % RCA	54
M-11	20 % CS + 20 % RCA	52
M-12	20 % CS + 30 % RCA	46
M-13	30 % CS + 10 % RCA	51
M-14	30 % CS + 20 % RCA	48
M-15	30 % CS + 30 % RCA	42

Compressive Strength Test

The concrete strength depends on various aspects like the cement type, quality or proportion of copper slag, recycled aggregates and curing temperature. Compressive strength test was performed confirming to IS 516-1959 to achieve the test results for concrete cured with water under controlled laboratory condition at the curing age of 7 and 28 days. Three samples were tested at each curing age and the average values of the compressive strength

Compressive strength of Concrete cubes

Designation	Mix	Compressive1strength (Mpa)	
		7 Days	28 Days
M-0	Control	17.78	28.20
M-1	10 % CS	18.55	30.52
M-2	20 % CS	19.85	32.60
M-3	30 % CS	22.00	35.2.0
M-4	10 % RCA	17.40	27.57
M-5	20 % RCA	16.75	26.52
M-6	30 % RCA	15.68	24.67
M-7	10 % CS + 10 % RCA	18.18	29.80
M-8	10 % CS + 20 % RCA	17.48	28.30
M-9	10 % CS + 30 % RCA	16.57	27.35
M-10	20 % CS + 10 % RCA	19.18	32.10
M-11	20 % CS + 20 % RCA	18.56	30.20
M-12	20 % CS + 30 % RCA	17.51	29.05
M-13	30 % CS + 10 % RCA	21.3	33.95
M-14	30 % CS + 20 % RCA	20.42	32.60
M-15	30 % CS + 30 % RCA	19.12	31.45

Split Tensile Strength Test

The split tensile strength examination was performed to confirm to IS 516-1959 so as to achieve the value of concrete aged 7 days and 28 days. A Compression Testing Machine (CTM), of 1000KN capacity was used to test the cylinders. The outcomes are displayed in

Table: Split Tensile Strength of Concrete Cubes

Designation	Mix	Split tensile strength	
		7 Days	28 Days
M-0	Control	2.564	3.538
M-1	10 % CS	1.635	2.687
M-2	20 % CS	1.782	2.983
M-3	30 % CS	1.859	3.395
M-4	10 % RCA	1.392	2.237
M-5	20 % RCA	1.340	2.135
M-6	30 % RCA	1.254	2.098
M-7	10 % CS + 10 % RCA	1.549	2.415
M-8	10 % CS + 20 % RCA	1.487	2.343
M-9	10 % CS + 30 % RCA	1.356	2.233
M-10	20 % CS + 10 % RCA	1.583	2.767
M-11	20 % CS + 20 % RCA	1.509	2.652
M-12	20 % CS + 30 % RCA	1.407	2.525
M-13	30 % CS + 10 % RCA	1.848	3.218
M-14	30 % CS + 20 % RCA	1.781	3.132
M-15	30 % CS + 30 % RCA	1.675	2.898

Tests Done in Research

- Consistency and setting time of cement
- Specific Gravity of Aggregates
- Workability Test for fresh concrete
- Compressive strengthtest
- Split tensile strength test

Objectives

1. To calculate the Optimum content of copper slag in concrete.
2. To find out the values of strength properties like Split tensile strength, and compressive strength of the concrete having recycled aggregates and Copper slag
3. To find out some fresh characteristics of the concrete.

Conclusion

Following are the various conclusions drawn after the test performance on cube samples of concrete :

- By adding copper slag, density is increased and hence self-weight is also increased which makes it perfect to bear constructions like heavy bridges, pavement constructions, abutments, piers, etc.
- The recycled aggregate could be utilized with full or may be the partial replacement of natural coarse aggregate.
- The compressive strength of concrete increases by the addition of copper s1ag.
- The compressive strength of concrete decreases by the addition of recycled coarse aggregates.
- The optimum percentage of Copper slag is 30 % and 10 % for recycled coarse aggregates.
- High compressive strength is acquired after the addition of 30 % copper slag and 10 % recycled coarse aggregates for compressive strength.
- The split tensile strength of concrete decreases by adding copper slag.
- The Split tensile strength of concrete decreases through the addition of recycled coarse aggregates.
- The peak Copper slag percentage is 30% and 10% for recycled coarse aggregates.
- The maximum split tensile strength is achieved on M- 3 containing 30% Copper slag.
- The literature study concludes that the compressive strength increases with the toughness of recycled aggregates and copper slag.
- With the increase in percentage of copper slag the workability also increases rapidly.
- The values of compressive strength have also increased due to the toughness of recycled aggregates and copper slag.

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