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Experimental Investigation of Properties of Concrete with Partial Replacement of Fine Aggregates through Copper Slag and Coarse Aggregates by Recycled Aggregates

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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. The fine aggregates (sand) was replaced with percentages 0% (for the control mixture), 10%, 20%, 30%, 40%, 50%, 60%, 80%, and 100% of Copper Slag by weight. Tests were performed for properties of fresh concrete and Hardened Concrete. Compressive strength and Flexural strength were determined at 7, 28 and 56days. The results indicate that workability increases with increase in Copper Slag percentage. Test results indicate significant improvement in the strength properties of plain concrete by the inclusion of up to 80% Copper slag as replacement of fine aggregate (sand), and can be effectively used in structural concrete. Also as percentage of Copper Slag increased the density of concrete increased. The workability of concrete increased with increase in percentage of copper slag. Toughness of copper slag is found to be more, which increases the compressive and flexural strength of concrete.

KEYWORDS: *Copper Slag, Concrete, Compressive strength, Fine Aggregate, Flexural strength, Replacement etc*

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INTRODUCTION

One of the main development elementis 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 [1].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 [4].

Green or natural concrete is an idea to utilize ecological accommodating elements in concrete, to form a framework more supportable. The natural concrete is all the time and furthermore shabby to create, on the grounds that for instance, waster items are utilized as a fractional substitute for aggregates and cement, charges for the transfer of waste are maintained a strategic distance from, vitality utilization underway is lower, and toughness is more noteworthy. This solid ought not to be mistaken for its shading. Waste could be used to deliver new products or could also be used as admixtures with the goal that regular assets are constrained and use more efficientlyalso the nature is shielded from squander stores. Inorganic remaining items like stone residue, smashed marble squander are utilized as green totals in concrete. This task outlines the different endeavors' in progress to enhance the ecological invitingness of cement to make it appropriate as a "Green Building" material[5].

The Portland Pozzolona cement (PPC) is one of the significant fixings utilized for the arrangement of concrete. Shockingly, generation of cements prompts discharge of a lot of CO_2 gas into the air, a noteworthy benefactor for greenhouse impact and the worldwide warming. Hence it is required either to mission for another material or somewhat supplant it by some other material. Conveying concrete in huge aggregate in assembling plants particularly impacts the greenhouse gasses release [2]. There are numerous elective assets like fly ash, marble powder, GGBS, reused aggregates and so on. In this setting it's smarter to pick the locally accessible materials for substitution [4].

On the other sides, the utilization of sand in development results in exorbitant sand mining which is frightful. Because of quick development in development action, the accessible wellsprings of natural sand are getting depleted. Likewise, great quality sand may must be transported from long separation, which adds to the cost of development. Along these lines, it is important to supplant normal sand in concrete by a substitute material either somewhat or totally without bargaining the quality of concrete [3].

Industrial waste or auxiliary material usage supports the creation of concrete and cement in industry field. Latest results and discarded resources are nowadays produced by different enterprises. Discarding or transfer of such materials in bulkcreates natural and medical issues. In this manner, reusing of waste materials is an incredible potential in solid industry. Since some time, side-effects, like fly fiery debris; silica smoke and slag were considered a waste materials. Concrete arranged with such materials demonstrated enhancement in functionality and toughness contrasted with ordinary cement and has been utilized in the development of intensity, synthetic plants and submerged structures [7].

Copper slag is one of the mechanical side-effect caused during the assembling of copper. In each ton of copper creation, a huge amounts of copper slag is produced. It was calculated that around 24.6 million tons of slag are produced in the world copper industry. Despite the fact that copper slag is generally utilized in the sand impacting industry along with the assembling of grating apparatuses, the rest of discarded with no further reuse or recovery.

Today copper slag is produced in the amount of approximately thirty three million tones yearly around the world in which India provides around six to 6.5 zillion tones. Half of the copper slag is often utilized as instead of natural sand of to get concrete and mortar with essential functionality, longevity, durability, and strength. In India research was examined by the Central Road Research Institute (CRRI) proven that copper slag might be utilized in a from of partial substitute for river sand as good substance in concrete as much as half of it in pavement concrete with no damage of flexural and compressive strength and this kind of concretes displayed approximately twenty % higher power compared to that of typical cement concrete of the very same quality.

RESEARCH OBJECTIVES

1. To calculate the Optimum content of copper slag in concrete.
2. To find out the values of strength properties like flexural strength, 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.

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 slagin concrete, the compression strength was increased upto 60% and then a decrement was seen. The strength was increased to 40.75 N/mm2 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.(1)

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 %.(2)

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 upto 68 % and flexura1 strength is increased upto 50 % in steel fibre reinforced concrete.(3)

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.(4)

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. (5)

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.(6)

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. (7)

Zine Kiran Sambhaji et al (2016)studied on the Copper Slag Effect as A Fine Aggregate on Properties of Concrete. The principle objective is to empower the utilization of these apparently squander items as a development material. In this particular paper , the impact of utilizing copper slag as a fine total on properties of bond mortars and cement different mortars and solid blends were set up with various extents of copper slag going from (0CS+l00S)%,(l0CS+90S)%,(20CS+80S)%, (30CS+70S)%, (40CS+60S)%, (50CS+50S)%, (60CS+40S)%, (70CS+30S)%, (80CS+20S)%, (90CS+l0S)%,(l00CS+0S)% The plan M25 grade concrete for half substitution of CS demonstrates the HPC attributes. The plan M25 grade concrete for 30% substitution of CS demonstrates the HPC attributes.(8)

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. (9)

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. (10)

M. V. PATIL et al (2015)analyzed on the qualities and also negative effects of copper slag in concrete. Because of this analysis work, M30 grade concrete was utilized as well as the assessments had been done for different ratios of copper slag replacing with sand of 0%, to 100% in concrete. The gotten scans have been in contrast to anyone of command concrete created using regular Portland cement and sand. Cube of dimension 150mm×150mm×150mm were utilized as well as tried at 7,28 as well as fifty six times of curing in water under controlled lab conditions. By the test results, it could be observed that compressive sturdiness of copper slag concrete mixes with 10%, 20%,30%, 40%, 50%, 60%, along with eighty % fine aggregate replacing with copper slag, were bigger compared to the management blend in any way ages. (11)

Dr. M. N. Bajad et al (2015) studied on the use of fly ash and recycled aggregate in the concrete. In this study, Mix was designed for the water cement ratio 0.5 and the cube samples were prepared by using rice husk ash upto 0 % to 40 %. The use of flyash and recycled aggregate increase the various strength properties of concrete. (12)

M. V. PATIL et al (2015) studied on the properties and effects of copper slag in concrete. This work reports a test system to explore the impact of utilizing CS as incomplete substitution of sand. Six arrangement of cement blends were set up with various extents of CS going from 0% to 100%. The test consequences of cement were acquired by adding CS to sand in different rates running from 0% to 100%. All examples were relieved for 7, 28, 56 days before pressure quality test. Cube of size 150 mm × 150 mm × 150 mm were used and tested at 7,28 and 56 days of curing in water under controlled laboratory conditions. Three samples were tested at each curing stage. The outcomes show that Compressive quality also, flexural Strength is expanded because of high sturdiness of copper slag.(13)

MAVROULIDOU M. et al (2015)studied on the properties of concrete containing waste copper slag as a fine aggregate replacement. The displayed research played out a lab consider on CEM-I concrete blends, containing water-cooled copper slag squander material as an inclined toward full substitution of fine concrete aggregates. A progression of tests were then performed at two diverse water to concrete proportions to examine the impact of copper slag content on notable solid properties including usefulness, solid shape compressive quality, malleable part quality, static modulus of flexibility in pressure, flexural quality and surface water retention.(14)

CONCLUSIONS

1. 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.
2. The recycled aggregate could be utilized with full or may be the partial replacement of natural coarse aggregate.
3. The compressive strength of concrete increases by the addition of copper s1ag.
4. The compressive strength of concrete decreases by the addition of recycled coarse aggregates.
5. The optimum percentage of Copper slag is 30 % and 10 % for recycled coarse aggregates.
6. High compressive strength is acquired after the addition of 30 % copper slag and 10 % recycled coarse aggregates for compressive strength.
7. The split tensile strength of concrete increases by adding copper slag.
8. The Split tensile strength of concrete decreases through the addition of recycled coarse aggregates.
9. The peak Copper slag percentage is 30% and 10% for recycled coarse aggregates.
10. High value of compressive strength is acquired after adding 30 % copper slag and 10% recycled coarse aggregates for split tensile strength
11. The maximum split tensile strength is achieved on M-3 containing 30% Copper slag only as a cement replacing material.
12. The literature study concludes that the flexural strength and compressive strength increases with the toughness of recycled aggregates and copper slag.
13. With the increase in percentage of copper slag the workability also increases rapidly.

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