A REVIEW STUDY ON THE PROPERTIES OF CONCRETE BY USING COPPER SLAG AND RECYCLED AGGREGATES

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Abstract: This paper presents a review study on utilization of Copper slag and recycled coarse aggregates in concrete production and its effect on the concrete. The development of construction materials have posed problems and challenge that initiated worldwide research programs and continued conventional and non conventional applications leading to ultimate economy. And In the recent revision of IS: 456 2000, one of the major points discussed is the durability aspects of concrete. The use of concrete is unavoidable, at the same time the scarcity of aggregates are also increasing now a days. Utilization of industrial soil waste or secondary materials has been encouraged in construction field for the production of cement and concrete because it contributes to reducing the consumption of natural resources. Concrete prepared with such materials showed improvement in workability and durability compared to normal concrete and has been used in the construction of power, chemical plants and under-water structures.

Keywords: Workability of concrete, Compressive strength, Split tensile strength, Recycled Aggregates, Copper slag.

1.0 INTRODUCTION

Concrete is a development material comprising of cementitious material, fine aggregate, coarse aggregate also, water. Presently days the cost of these materials are expanded in this way, we have to take a look at an approach to diminish the cost of building materials 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 concrete is an idea of utilizing eco-accommodating materials in concrete, to make the framework more supportable. Green 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 can be utilized to deliver new items or can be utilized as admixtures with the goal that regular assets are constrained and utilized all the more proficiently and 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].

1.2 HISTORY OF STUDY

The use of admixtures to increase the structural properties of construction material is not a new process. It ranges more than 5000 years from the season of Egyptian pyramids to show day brightening concrete improvements. Around 3000 BC, Egyptians utilized mud blended with straw to give more quality. Later in 300 BC, the antiquated Romans utilized a material that is amazingly near present day bond to manufacture huge numbers of their compositional wonders. The Romans additionally utilized creature items in their concrete as an early type of admixtures. Later in 1939, the prologue to steel substituting asbestos was set aside a few minutes yet at that period it was not fruitful. In 1890, the expansion of gypsum when granulating clinker to go about as a retardant to the setting of the solid was presented in the USA. In 1985, the silica seethe and different superplasticizers were acquainted as an admixture with enhance the quality. After that different admixtures, for example, fly slag, Copper Slag, Egg shell powder, metakaolin and rice husk fiery debris, steel or optical filaments are acquainted with enhance the mechanical properties of cement.

1.3 COPPER SLAG

Copper slag is a mechanical side-effect material created from the way toward assembling copper. For each ton of copper creation, about 2.2 huge amounts of copper slag is produced. It has been evaluated that around 24.6 million tons of slag are produced from the world copper industry. Despite the fact that copper slag is generally utilized in the sand impacting industry and in the assembling of grating apparatuses, the rest of discarded with no further reuse or recovery [7].

Figure 1.2: Copper slag

1.3.1 ADVANTAGES OF COPPER SLAG

Following are the various advantages of copper slag in concrete:

1. It reduces the cost of construction by saving the cost of material.
2. It reduces the permeability.
3. It reduces the demand of natural assets.
4. Reduces the environmental impact due to quarrying and aggregate mining
5. It also reduces the heat of hydration in concrete.
6. Use of copper slag has helped in waste management and dumping of industrial wastes.
7. Due to low water absorption and due to glassy surface of copper slag the workability of concrete is increased.
8. High toughness of copper slag contributes to increased compressive strength.

1.4 RECYCLED AGGREGATES

Construction materials are increasingly judged by their ecological characteristics. Concrete recycling gains importance because it protects natural resources and eliminates the need for disposal by using the readily available concrete as an aggregate source for new concrete or other applications. . The states that do use recycled concrete aggregate (RCA) in new concrete report that concrete with RCA performs equal to concrete with natural aggregates. Most agencies specify using the material directly in the project that is being reconstructed. Recycling of concrete is a relatively simple process.

Figure 1.3: Recycled aggregates

2.1 LITERATURE STUDY

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. The compression strength was increased with the addition of copper slag in concrete upto 60% and then it was found to be decreased. For the full replacement of sand with copper slag, the strength was increased to 40.75 N/mm2.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 properties of concrete 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 split tensile strength is increased upto 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 steel 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 tensile are increased upto 68 % and flexural 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% and 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 properties of concrete 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 replaced by Silica Fume for 5%, 10% and 15%. The test results shows that there was more 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 and cement mortar as replacement 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 Effect of Copper Slag 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 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+100S)%,(10CS+90S)%,(20CS+80S)%, (30CS+70S)%, (40CS+60S)%, (50CS+50S)%, (60CS+40S)%, (70CS+30S)%, (80CS+20S)%, (90CS+10S)%,(100CS+0S)% The plan M25 grade concrete for half substitution of CS demonstrates the HPC attributes. (8)

S. Muneera et al (2016) studied on the Use of Recycled Aggregate in Concrete. In this study the natural concrete is replaced by recycled coarse aggregates at different percentages of 10%, 20%, 30%, 40%, 60%, 75%, 100%. Various tests such as slump test, compaction factor test, split tensile strength, compression test have been conducted in this study. The average reduction in compressive strength is nearly 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) studied on the properties and effects of copper slag in concrete. For this research work, M30 grade concrete was used and the tests were conducted for various proportions of copper slag replacement with sand of 0%, to100 % in concrete. The obtained results were compared with those of control concrete made with ordinary Portland cement and sand. 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. From the test results, it can be seen that compressive strength of copper slag concrete mixes with 10%, 20%, 30%, 40%, 50%, 60%, and 80 % fine aggregate replacement with copper slag, were higher than the control mix at all 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 outcomes show that Compressive quality also, flexural Strength is expanded because of high toughness 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)

Jagmeet Singh et al (2014) studied on the use of copper slag in concrete. The present examination surveys the fuse of copper slag in cement. The impact of copper slag as halfway substitution of bond on the compressive quality of cement has been examined. The hydration of bond with copper slag was researched through X-beam diffraction (XRD). Five cement blends (C0, C5, C10, C15 and C20) were made by supplanting bond with 5%, 10%, 15% and 20% of copper slag by mass individually. The water/concrete proportion in all the blends was kept at 0.43. Results demonstrated that the compressive quality of solid abatements as CS content increments for all restoring ages. The decrease in compressive quality is minor up to 10% of CS however past 10% of CS; there is noteworthy decrease in compressive quality because of the expansion in free water content in blends. (15)

Jitender Sharma et al (2014) studied on the properties of recycled coarse aggregates. In this a literature study is discussed on recycled aggregates. The Cost of Recycled Concrete Aggregate may be less than 20 to 30 % less than natural aggregate in some regions. By using the recycled aggregate the consumption of natural aggregate can be reduced. Indian construction industry today is amongst the five largest in the world and at the current rate of growth, it is slated to be amongst the top two in the next century. With the shortage as likely seen today the future seems to be in dark for the construction sector. [16]

M. C. Nataraja et al (2014) did the comparison study on the copper slag as a fine aggregate in concrete. . This paper displays the trial after effects of an on-going venture to create concrete with copper slag as a fine total. Maintainability and asset proficiency are getting to be expanding critical issues. Here the potential utilization of granulated copper slag, a moderately overwhelming material, as a substitution to sand in cement blends is investigated. The impact of supplanting fine total by copper slag on the compressive quality, flexural quality and split rigidity of cement are considered in this work. (17)

J. Ramesh Kumar et al (2013) studied on the various uses of copper slag and fly ash for the enhancement of strength properties of concrete. In this study, ten concrete mixes with different proportions of copper slag ranging from 0% to 75% and fly ash 6% to 30%were casted for the test. The optimum percentage for copper slag is 50 % and fly ash is 18 %.(18)

Hardik Gandhi et al (2011) studied on the use of recycled aggregates in the concrete. In this study, various properties of concrete are discussed. Recycled coarse aggregate have been used to replace virgin coarse aggregate. The properties of fresh as well as hardened concrete made of partial/full

replacement of recycled coarse aggregate are found out and the results are compared with that of concrete using virgin coarse aggregate. Various tests such as slump test, compaction factor test, Non-destructive test, compression test have been conducted in this study. The experimental results show that the compressive strength of concrete made of natural coarse aggregate and recycled coarse aggregate is approximately same. Hence the recycled aggregate can be used in concrete with partial or full replacement of natural coarse aggregate. (19)

Meenakshi Sudarvizhi et al (2011) studied on the Performance of Copper slag and ferrous slag as partial replacement of sand in Concrete. This work reports an exploratory strategy to explore the impact of utilizing CS and FS as fractional substitution of sand. The quality qualities of regular cement and slag cement, for example, compressive quality, rigidity were discovered .Six arrangement of solid blends were set up with various extents of CS and FS running from 0% to 100%. The test aftereffects of cement were acquired by adding CS and FS to sand in different rates going from 0%, 20%. 40%, 60%, 80% and 100%. (20)

K. S. Al Jabri et al (2006) studied on the high performance concrete containing copper slag as a fine aggregate. This paper presents results from a trial examination did to contemplate the potential utilization of copper slag as fine total on the quality of both typical and high quality cement. Solid blends were readied utilizing diverse extents of copper slag as halfway and full substitution of fine aggregates. (21)

Srinivas C. H et al studied on the Properties of Concrete Containing Copper Slag as a Fine Aggregate. This paper exhibits the after effects of a trial think about on different toughness tests on cement containing copper slag as halfway substitution of sand. In this report, M30 evaluation of cement was structured and tests were led with various level of copper slag as fine total in concrete. The outcomes demonstrate that strength increases with increases the copper slag rates. (22)

Conclusion

1. Addition of copper slag increases the density and thereby self weight and hence it is suitable for bearing structures like piers, abutments, heavy bridges and also in pavement construction etc,
2. The recycled aggregate can be used in concrete with partial or full replacement of natural coarse aggregate.
3. Compressive strength and flexural Strength was increased due to high toughness of copper slag and recycled aggregates.
4. The workability increases rapidly with increase in copper slag percentage.

5. Compressive strength and split tensile strength are increased due to high toughness of copper slag and recycled aggregates.
6. Replacement of recycled aggregates as coarse aggregate reduces the cost of making concrete.
7. By using copper slag as fine aggregate we can make environment more sustainable.

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