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A Comparative Study of Concrete Strength Properties by Using Copper Slag and Recycled Aggregates with Partially Replacement of Fine Aggregates and Coarse Aggregates

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***Abstract*: The overall utilization of characteristic sand as fine aggregate in mortar/solid generation is very high also, a few creating nations have experienced some strain in the supply of characteristic sand so as to meet the expanding needs of infrastructural advancement in late year. In numerous nations there is shortage of regular fine total which is appropriate for development. By and large, over the most recent 15 years, it has turned out to be evident that the accessibility of good quality normal sand is diminishing. The lack of the assets of normal sand opened the entryway for utilizing side-effects as fine total. Reuse of side-effects as an incomplete or full substitution of fine total in development exercises not just decreases the interest for extraction of normal crude materials, yet in addition spares landfill space. In this review paper, different writing concentrates done by different writers are discussed.**

***Keywords*: Copper slag, Concrete, recycled aggregates, Compressive strength.**

1. Introduction

High strength concrete (HSC) is widely used in the construction of high-performance structures such as high rise buildings, long span bridges, etc. So, it should have higher workability, good mechanical properties than those of conventional concrete. In order to achieve HSC with good mechanical properties, fly ash or/and silica fume which are considered as waste materials are used as one of the main ingredients. Concrete prepared with such materials showed improvement in workability compared to normal concrete. Use of some waste materials has been well documented in design specifications. New by-products and waste materials are being generated by various industries, dumping or disposal of these materials causes environmental and health problems. Therefore, recycling of waste materials has a great potential in concrete industry. Copper slag is an industrial by-product material produced from the process of manufacturing copper. It has been estimated that approximately 24.6 million ton of slag is generated from world copper industry. In the Sultanate of Oman, approximately 60,000 tons of copper slag is produced every year by Oman Mining Company. Although the majority of the produced copper slag is used in the sand blasting industry and in the manufacturing of abrasive tools, the remainder is disposed without any further reuse or reclamation. There are many mechanical and chemical characteristics that qualify copper slag to be used in the concrete as partial replacement of Portland cement or a substitute of aggregates. For example, copper slag has number of favorable mechanical properties to be used as an aggregate such as excellent soundness characteristics, good abrasion resistance and good stability. Also, copper slag exhibits pozzolanic properties since it contains a low content of CaO, and it can possess cementitious properties as CaO content increases or under activation of NaOH. Use of copper slag in concrete industry as replacement of cement or/and fine aggregates can have the benefit of reducing the costs of disposal and minimizing environmental pollution.

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.

3. Copper slag

Copper slag is a by-product obtained during matte smelting and refining of copper. The common management options for copper slag are recycling, recovering of metal, production of value added products such as abrasive tools, roofing granules, cutting tools, abrasive, tiles, glass, road-base construction, railroad ballast, asphalt pavements. Despite increasing rate of reusing copper slag, the huge amount of its annual production is disposed in dumps or stockpiles to date. One of the greatest potential applications for reusing copper slag is in cement and concrete production. Many researchers have investigated the use of copper slag in the production of cement, mortar and concrete as raw materials for clinker, cement replacement, coarse and fine aggregates. The use of copper slag in cement and concrete provides potential environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of copper slag is produced. This paper reviews the characteristics of copper slag and its effects on the engineering properties of cement, mortars and concrete.

Fig. 1. Copper slag

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. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality.

Fig. 2. Recycled aggregates

5. Literature review on copper slag and recycled aggregate

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.

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.

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.

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.

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.

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 was 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.

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.

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.

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 aftereffects 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. The proposed blend plan strategy was observed to be acceptable for delivering concrete with fine totals having differentiating properties.

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 %.

6. Conclusion

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

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. The compressive strength of concrete increases by the addition of copper slag.
4. The compressive strength of concrete decreases by the addition of recycled coarse aggregates.
5. The literature study concludes that Compressive strength and flexural Strength was increased due to high toughness of copper slag and recycled aggregates.
6. The workability increases rapidly with increase in copper slag percentage.
7. Compressive strength and split tensile strength are increased due to high toughness of copper slag and recycled aggregates.
8. Replacement of copper slag in fine aggregate reduces the cost of making concrete.
9. By using copper slag as fine aggregate we can make environment more sustainable.

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