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A Review on Partial Substitution of Copper Slag with Sand in Concrete Material

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***Abstract*— The main objective of this review study is to gather various examination studies available by different researchers for waste utilization of copper slag in concrete through various techniques. Concrete is used in huge amount almost the world over mankind has a requirement for infrastructure. Waste materials increases day by day and creates pollution in the environment. Researchers studied to reuse the useful waste into the concrete like steel slag, copper slag and polymer wastes by using this process we can make concrete economical by replacing waste materials through fine aggregates. Sand is a natural resources and depletion of sand is a big issue for environment. So it is necessary to protect environment and reduction of waste by recycling and reusing of waste materials. This survey study based on the concrete performances by replacing copper slag and to find out the optimum solution of waste replacement in concrete by studying various authors researches and reviews. The primary objective of this paper is to study the application of copper slag as an alternative replacement material of sand. Also studies the result of substitution of Fine aggregate with copper slag on mechanical performances of concrete**.

Keywords*— Copper Slag, Concrete, Sand Replacement, Compression Strength

I. INTRODUCTION

In India, there is big requirement of aggregates mostly from civil engineering industry, for road and concrete production. But nowadays it is a very complex difficulty for accessibility of fine aggregates. So the researchers developed waste management plans to relate for substitute of fine aggregates for specific needs. Natural resources are decreasing in all over the world and increasing wastes from industries generated simultaneously. The eco friendly and reliable development for construction consist the use of non conventional and different waste materials, and recycling of waste material for reducing emissions in environments and decreasing the use of natural resources. The mixture of concrete mainly consist fly ash for saving the cement also useful to maintain heat of hydration temperature of concrete. Mixture of water, aggregate, sand and cement called concrete, it is a composite material that uses in constructions and developments. In Present Scenario one of the most important replacing materials for fine aggregates is copper slag. It produces when copper metal produced by extraction process then copper slag is generated in large amount in the production of copper metal. About 2-2.5 tonnes of copper slag produced for each 1 ton of copper production. Utilization of copper slag in concrete has many environmental benefits for example waste recycling and resolve disposal problems. Copper slag consists mechanical and chemical properties that is eligible as the material to be used in production of concrete as a partial replacement as a substitute for aggregates. Mechanical property of copper slag has good sound characteristics, good abrasion resistance and good stability for aggregate use. Here an effort has been completed to accumulate the various studies done on the replacement of copper slag in fine aggregate to judge the strength of concrete.

II. LITERATURE REVIEW

G. Esakki Muthu et. al. [2016] investigated the micro formation of cement mixture with green sand and copper slag like a substitute of fine aggregate. The replacement of green sand and copper slag will be regularly from 10%, 20%, and 30% by the weight of fine collection. The results obtained in this research point to that the main function of copper scum and green sand in mortar as alternate material for river Sand gives options for the consumption of this huge waste materials as an alternative material that is environmentally sustainable and appropriate for the building manufacturing.[1]

Mr. Neel P. Patel et. al. [2016] they investigated the feasible employ of copper scum for the fractional exchange of sand. Since copper scum is a more density material and contains around 45% of Fe2O3. Depend on restricted investigational analysis concerning Slump Value, Compressive potency, Flexural potency and UPV Test of Concrete for M-35 and M-40 Grade made from Metal industries waste.[2]

Mankare Ulka S et. Al. [2016] optimize solution regarding the capacity of Bagasse residue as a cement exchanging material that is comparable to that of Portland Pozzolana Cement and Copper slag as a fine collection exchanging material. The functions of these contaminants have then been evaluated together at the clean and solidification state. The results of the current research illustrates with the intention of 10% substitute of the Portland Pozzolana Cement by Bagasse residue and 40% exchange of the fine aggregate by Copper scum reached a advanced compressive potency, split tensile force and Flexural power and at experiment ages of 7 and 28 days.[3]

Dr. A. Leema rose et. Al. [2015] they find out solution and addition of copper scum use in concrete raises the density in concrete mixture. The raise in density results in augment of self weight of the concrete the results of compressive test prove that the potency of the material raises with respect to increasing the addition quantity of copper scum by load of

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fine aggregate exchange 30% of replacement. Thus, the recommended percentage substitute of aggregate element by copper scum is 30%. It is also accomplished that the concrete through copper slag gains more strength than the manage concrete.[4]
Chinmay Buddhadev et. al. [2015] they studied about the alternate of river sand by sand is possible in concrete mix, the optimum sand exchange proportion is generally 20-25%. Moreover, generally the sand can be replaced till 30-40% by sand in material. The exchanging of sand by foundry sand in concrete increases the compressive force, split tensile force, flexure power and modulus of flexibility. Usually the experimental analysis is carried out for concrete grade. Further investigation should be find out regarding M 35 and M 40 grade concrete, which could be useful for multi-storey buildings, construction of bridges, expressways, etc. [5]

M. R. Amarnaath et. al. [2015] they have experimented and investigate the result of copper scums by exchange it by the fine aggregates and investigates the properties of concrete. For the research they arranged five mix designs with special proportions of copper scum varies from 0% to 35% and 100%. Concrete mixture substance was evaluated for density, compressive force, tensile force, flexural potency and stability. The results specify that there is an augment in the concrete density of just about 5% with the augment of copper scum substance, while the workability improved quickly through raise in copper scum percentage. Calculation of up to 35% of copper scum as sand exchange has a similar strength with so as to the control mix. Though, further mixing of copper scum caused decrease in the strength because of a boost of the open water substance in the substance. The outcomes also explained that the surface water receiving reduced as copper slag amount raises up to 35% exchange; ahead of that level of replacement, the receiving time increases rapidly. So, it is recommended that 40 wt. % of copper scum can used as exchange of sand so as to find out concrete with good power and durability properties. [6]

Binaya Patnaik et. al. [2015] they studied about the strength parameter of concrete having copper slag as a substitute of sand and outcome have been presented by them. Two different kinds of Concrete Grade (M20 & M30) were used with different proportions of copper slag replacement (0 to 50%) in the concrete. Strength & Durability properties such as Compressive Strength, Split Tensile Strength, Flexural Strength, Acid Resistivity and Sulphate Resistivity were evaluated for both mixes of concrete. test results explains that the strength properties of concrete has better having copper slag as a partial substitute of Sand (up to 40%) in concrete but in terms of stability the concrete found to be low resistant to acid attack and better resistance against sulfate attack.[7]

Pranshu Saxena et. al. [2015] they studied about scope of replacement of fine aggregate from copper slag in concrete. Copper slag is a best substitute to sand as a blasting medium in industrial cleaning. With explode or forceful methods, industries are using copper slag to clean huge smelting equipment or furnaces. Copper slag waste can be utilized as alternative material one that can decrease the expenditure of construction. Their effort has been completed to compile the different studies made on the replacement of copper slag in fine aggregate to judge the strength of concrete. [8]

Srinivas C. H et. al. [2015] they studied about M30 grade of concrete was prepared and experiments were conducted with dissimilar proportion of copper slag as sand in concrete. The outcome specifies that workability raise with raises in the copper slag proportions. The Compressive Strength is amplified up to 8.63 % as compared to conventional concrete. The Rapid chloride diffusion test is performed to recognize the chloride ion penetrability. Also, accelerated corrosion procedure by galvano static weight loss method is performed to identify the corrosion rate of concrete. [9]
V. Sushma et. al. [2015] this study based on experimental investigation they conclude that the strength of concrete increases with cost effective and without depleting the natural resources.By doing this project they reduced the consumption of fine aggregate by 50% than conventional concrete, at this proportion concrete will give maximum strength. By replacing the fine aggregate with 50% copper slag the cost saving was found to be 20%. In the compressive strength feature we found the incremental modification which is 1.47 times more than the conventional concrete in the split tensile strength feature they found the incremental modification which is 1.73 times more than the conventional concrete.[10]
Vishwa B Tipashetti et. al. [2015] they investigate on dissimilar strength tests on concrete having sandstone admixtures and copper slag as partial substitution of cement and sand individually. In this description, M30 assessment of concrete was designed and examinations were intended for with varied rates of sandstone admixtures with copper slag. The compressive strength is enlarged up to 10-20% merge of stone admixture and copper slag contains concrete when contrasted with normal concrete. [11]
M. Ramesh et. al. [2014] this paper presents the experimental results of an on-going project to produce concrete with copper slag as a fine aggregate. Sustainability and resource efficiency are becoming increasing important issues. Now the possible use of granulated copper slag, a comparatively important material, as are placement to fine aggregates in concrete mix up is explored. The outcome of substituting fine aggregate by copper slag on the compressive strength, flexural strength and split tensile strength of concrete are analyzed in this study. The planned mix design technique was established to be acceptable for generating concrete with fine aggregates having contrasting belongings. [12]

Dr. T.Ch. Madhavi [2014] investigated the performances of substitution of Fine aggregate with copper slag on behavior of mechanical functions of concrete and the application of copper slag as a substitution replacement material of sand. Copper slag which is an industrial waste product can be used as replacement for cement with sand and contributes to the increase in various mechanical properties of concrete. Copper slag can be used up to 30% but when used ahead of 50% results in decrease in strengths. [13]

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M.C. natraja et. al. [2014] they studied about Mix design of concrete as a fine aggregate the investigational outcome of an continuing task to produce concrete with copper slag as a fine aggregate. Sustainability and reserve competence are becoming rising significant issues. Here the possible use of granulated copper slag, a relatively heavy material, as a replacement to sand in mechanical functions of concrete mixes is discovered. The consequence of substituting fine aggregate by copper slag on the concrete are studied in this work. The planned mix design technique was established to be acceptable for creating concrete with fine aggregates having complementary possessions. [14]

R R Chavan et. al. [2013] they investigate the result of by copper slag as a substitution of fine aggregate on the strength functions. Copper slag is the waste material of generating through copper production. Copper slag is an important material that is measured as a waste that might have a capable prospect in building Industry as fractional or full alternate of aggregates. For this investigate work, M25 grade concrete was used and experiments were performed for different fractions of copper slag substitution with sand of 0 to 100% in Concrete. The achieved outcomes were balanced with those of conventional concrete made with OPC and sand. [15]

J. Ramesh Kumar et. al. [2015] they studied about the result of copper slag which is partially replaced by fine aggregate and the effect fly ash as partial replacement of cement on the actions of concrete. Outcome designate that here is a slight augment in the density of nearly 6% with the raise of copper slag content, while the workability enlarged with augment in copper slag proportion. Adding of up to 50% of copper slag as sand substitution yielded similar potency with which of the conventional mix. Though, further mixing of copper slag develops decrease in the strength because of raises of the free water substance in the mix. The strength has augmented just about 4% containing 18% fly ash and reduced with advance substitutions of cement with fly ash. [16]

Junwei Song [2014] they investigated copper slag content micro pozzolanic cause in the study. Workability of copper slag existing concrete is medium, but addition the suitable quantity of micro-aggregates can get better their workability considerably. The process of copper slag powder in mix cementitious materials is filling effect, action result and increase of rate effect. The filling outcome of copper slag can build matrix denser and the accelerating effect can speed up the early hydration. Experiment and investigation are made on the power of copper slag on strength and brittleness of concrete. Brittleness of concrete can decreased by adding copper slag, and system is analyzed.[17]

M.Chockalingam et. Al. [2013] they studied about scope for reuse of copper slag in concrete and research works have been done to evaluate the suitability of copper slag for reuse. They give the solution that Reuse of copper slag has the dual benefit of safe disposal and judicial resource management. Application in concrete as an admixture, replacement of cement and as a fine aggregate has very good scope in the future. [18]

Suresh T. et. Al. [2015] the use of copper slag (CS) in concrete provides ecological as well as financial profit for all connected industries, mainly in Foundry relate areas where a substantial quantity of CS is produced. Due to the shortage of fine aggregate for the building of mortar and concrete, partial substitution of CS with sand have been attempted. The experimental outcomes of concrete were achieved by adding CS to sand in different proportions varying from 0%, 15%, 30%. The outcome designate that workability enlarges with increase in CS percentage. The included approach of functioning on secure removal and consumption can lead to advantageous effects on the ecology and environmental also. [19]

J.SWATHI et. Al. [2015] they studied about the experimental investigation is to improve the characteristic strength of M40 grade concrete replaced with 20%, 40%, and 60% slag and find out the optimal percentage replacement. With this optimum slag level as constant the coarse aggregate is replaced with ceramic waste tiles by 10%, 20%, and 30% to have increased strength. [20]

M. V. Patil [2015] this study based on M30 grade concrete was employed and the experiments were conducted for various proportions of copper slag replacement with sand of 0%, to100 % in concrete. Replacement of copper slag in fine aggregate reduces the cost of making concrete. The obtained results were compared with those of control concrete made with ordinary Portland cement and sand. [21]

Sukhoon Pyo et. al. (2016) they studied the straight tensile action of UHP-FRC at strain variation varies as of 90 to 146/s. The tests are conducted using a recently developed impact testing system that uses suddenly released strain energy to create an impact pulse. Three types of fiber were considered, a twisted fiber and two other types of straight fibers. Specimen impact reaction was estimated in terms of primary cracking strength, post-cracking strength, energy carrying capacity and strain power. The test outcome point to that specimen with twisted fibers usually exhibit somewhat better mechanical properties than specimens with straight fibers for the variety of strain variation calculated. All UHP-FRC sequence tested explained exceptional rate sensitivities in energy absorption power, usually becoming much more energy dissipative under increasing strain rates. This feature highlights the prospective of UHP-FRC as promising cement based substance for impact- and blast-resistant functions. [22]

III. CONCLUSION

Copper slag can be employed as a substitute to ordinary sand in concrete. When copper slag is substituted with the same weight due to the fact more mortar is used to surround the aggregate therefore may workability will increase in terms of slump, though the compaction factor is extra or less similar comparable to with the purpose of the natural sand. Compared to the control mix, there was a small augment in the strength is because of copper slag. The workability enhanced with the mixing of copper slag. This augment in the workability with the augment of copper slag quantity is due to the small water absorption characteristics of copper slag and its glassy surface. With the substitution of cement with fly ash also tends to enlarge in workability with a negligible difference in the density.

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