A Review on Study of Partial Replacement of Fine Aggregate with Copper Slag and Cement with GGBS

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Abstract: The preservation of the environment and the conservation of natural resources are essential. The rapid expansion of industrialization has led to the production of a significant number of wastes in the industrial sectors, Copper slag and Ground Granulated Blast Furnace Slag (GGBS) are industrial by-product materials produced from the process of manufacturing copper and iron. By utilizing materials that are typically regarded as waste products, such as copper slag and GGBS use of these materials not only lowers construction costs but also lessens their negative environmental effects. In this study, partial replacement of Sand with Copper Slag and Cement with GGBS was taken into consideration. The attributes of concrete have been evaluated by partially replacing cement with GGBS and sand with Copper Slag in an experimental study to analyse the workability and strength characteristics of hardened concrete. For the M25 mix, the cement has been proportionately replaced by GGBS in the following ranges: 0% (without GGBS), 5%, 10%, 15%, and 20% by weight of cement. For the M25 mix, the copper slag has taken the place of the sand in the following proportions: 0% (without copper slag), 10%, 20%, 30%, and 40% by weight of cement. Concrete mixtures were created, tested, and compared to standard concrete in terms of compressive, flexural, and split tensile strength.

Keywords — Copper slag, GGBS, Workability, Compressive strength, Split tensile strength, Flexural strength.

1.INTRODUCTION

For the construction of various substructures and high-rise buildings, concrete is the best essential material. It is the most commonly utilised man-made building material worldwide. Ton of concrete is produced for every person on the planet every year. Infrastructure development is more prevalent in these areas, especially in developing nations like India. Sand is the main raw material used as fine aggregate in the production of concrete and is combined with cement, coarse aggregate, water, and other ingredients. The typical supplies of river sand are gradually running out. The lack of this crucial component material of concrete is currently affecting the construction industry.

Copper slag and GGBS are a couple of the industrial by-products that come out of the blast furnace during the metal extraction process in the current scenario as a result of continuous population growth, rapid industrialization, and the accompanying technologies involving waste disposal, the rate of pollution discharge into the atmosphere. Natural aggregate that is suited for construction is scarce in many nations, but aggregate use has expanded recently in other nations as the construction industry has grown in those nations. Artificially generated aggregate and other industrial waste materials can be utilised as substitutes to lessen the depletion of natural aggregate due to construction. Therefore, while looking for alternatives, copper slag and GGBS are regarded as the finest choices.

2. OBJECTIVES OF THE STUDY

In the investigation described here, sand and cement are partially replaced in the concrete mix with copper slag and GGBS. Based on investigations of concrete mix, the ideal dose range of this Copper slag & GGBS is selected. The main goal of this research is to evaluate the performance of a concrete mix including copper slag and GGBS and compare it to a control mixture. This is anticipated to offer:

- To partially substitute Copper slag and cement GGBS for sand in concrete since it has a direct impact on construction's economics.
- To develop and proportion the concrete mix for M25 grade concrete in accordance with IS: 10262:2009's recommendations.
- By partially substituting sand with copper slag and cement GGBS in one phase, it is possible to determine the volume proportions of concrete mixtures.

- By partially substituting the sand 0% to 40% with Copper Slag and the cement 0% to 20% with GGBS compared with controlled concrete, then plotting the relevant graphs individually in a subsequent phase, it is possible to verify the variation of Compressive Strength, Split Tensile Strength, and Flexural Strength results.
- Copper and steel slag waste disposal that is environmentally beneficial.

3. LITERATURE REVIEW

Sachin P. L, Nmamit, Nitte (2017)

This study details how industrial wastes can be used as a viable building material and how this affects construction costs can be decreased, and trash disposal can be accomplished safely. In their study, fine aggregates were partially replaced by copper slag (20%) and cement was partially substituted by GGBS (10%, 20%, and 30%). For both the 7- and 28-day curing periods, the strength characteristics, such as compressive strength and tensile strength, will be confirmed. The test will yield the most appropriate findings.

M. Pavan Kumar, Y.Mahesh (2015)

In their study, partial replacement of Sand with Copper Slag and Cement with GGBS was taken into consideration. The attributes of concrete have been evaluated by partially replacing cement with GGBS and sand with Copper Slag in an experimental study to analyse the workability and strength characteristics of hardened concrete. For the M25 mix, the cement has been proportionately replaced by GGBS in the following ranges: 0% (without GGBS), 5%, 10%, 15%, and 20% by weight of cement. For the M25 mix, the copper slag has taken the place of the sand in the following proportions: 0% (without copper slag), 10%, 20%, 30%, and 40% by weight of cement. Concrete mixtures were created, tested, and compared to standard concrete in terms of compressive, flexural, and split tensile strength.

Shanmuga Nathan N (2017)

In this study, the use of copper slag as a partial substitute for fine aggregate was presented. Experiments are being done for replacement percentages of 10%, 15%, and 20%.M25 grade concrete is utilised for the above replacement percentage. This project's major goal is to determine the strength and longevity of concrete that has been partially replaced. Various tests were run to gauge the strength and durability. These outcomes led to the inclusion of copper slag to concrete, which boosted the strength of the concrete.

Gowram,V.Viharika Reddy (2018)

With the concrete blend grade M40, an effort has been made in the this review to restrain the cost of cement and sand. The mechanical performance of this concrete mixture by partially replacing it with cutting-edge mineral admixtures, namely Copper slag and GGBS. In this regard, it is thought to replace sand with copper slag and halfway replace cement with GGBS. In order to analyse the quality and workability of solidified concrete, an exploratory review has been conducted. The properties of concrete have been examined by partially replacing the cement with GGBS and the sand with Copper Slag. For the M40 mix, the cement has been substituted with GGBS in amounts of 0%, 5%, 10%, and 15% by weight of cement. Copper is used to replace sand in the M40 mix.

Baskaran, Karthick kumar ,Krishnamoorthy ,Saravana, Hemath Naveen K.S,Vinothan (2017)

The feasibility of using granulated blast furnace slag (GGBS) as a sand substitute in cement concrete is investigated in this research. Minimising the environmental issues caused by the mining of fine aggregate and the disposal of slag waste. For the usual w/c ratio of 0.4, the percentage of GGBS replacement to natural sand is 0, 5, 10, and 15%. In the w/c ratios of 0.4 and 0.6, GGBS completely replaces natural sand in the extended work. In this, we looked at the flow properties of different mixes and their compressive strengths over time. The substitution of GGBS for fine aggregate in the following ranges: 0% (without GGBS), 5%, 10%, and 15%. Concrete Complete mixing of the mixes was done before testing them to compare their compressive, flexural, and split tensile strengths to that of standard concrete.

K.SELVI, N.GOWSALYA(2020)

This study evaluates the possibility of usage of GGBS and Copper Slag. In this Study, the usage of GGBS for partial replacement of cement and Copper Slag for partial replacement offine aggregatewith the proportion of 10%, 20%, 30%, 40% and 50% with mix design of M30 Grade. Hardened concrete test such as compressive strength, tensile strength was observed. The resistance of sulphate attack determine with expose in sulphate solution which results less attack of acid was observed.

4. MATERIALS

Copper Slag

Copper slag is created as an industrial by-product as a result of the production of copper. 2.2 tonnes of copper slag are produced for every tonne of copper produced and generated. A rough estimate of the amount of slag produced by the global copper industry is 24.6 million tonnes. The majority of the copper slag is disposed of without being recycled or used again, despite the fact that it is frequently employed in the sandblasting industry and in the production of abrasive equipment. Copper slag Because of its unique mechanical and chemical properties, copper slag can be utilised in concrete as a partial or full replacement for Portland cement or as a substitute for fine aggregates.

Fig no.1 Copper Slag

Ground Granulated Blast-Furnace Slag (GGBS)

GGBS is a cementitious material whose main use is in concrete and is a by-product from the blast-furnaces used to make iron.
Blast-furnaces operate at temperatures of about 1,500°C and are fed with a carefully controlled mixture of iron ore, coke and limestone. The iron ore is reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is regularly tapped out as a molten liquid and must be quickly cooled in a lot of water if it is to be employed in the production of GGBS. Quenching generates granules resembling coarse sand and optimises the cementitious characteristics. The 'granulated' slag is next dried and processed into a fine powder. Although normally designated as 'GGBS' in the UK, it can also be referred to as 'GGBFS' or 'slag cement'.

GGBS offers great durability, reducing the likelihood of concrete thermal cracking, and it improves concrete's resistance to damage from alkali-silica reaction, sulphates and chlorides.

Fig no. 2 GGBS

Cement: Ordinary Portland cement of grade 53 is used for this experimental work.

Fine aggregate: The material which passes through BIS test sieve number 4 (4.75mm) is termed as fine aggregate usually natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregates. In our region fine aggregate can be found from bed of Krishna River. It conforms to IS 383 1970 comes under zone II.

Coarse aggregate: The material which is retained on BIS test sieve number 4 (4.75mm) is termed as coarse aggregate. The broken stone is generally used as a stone aggregate. Coarse aggregate used is locally available crushed angular aggregate of size 20mm and 10mm are used for this experimental work.

5. PROPOSED METHODOLOGY

Procedure

For the M25 mix, the cement has been proportionately replaced by GGBS in the following ranges: 0% (without GGBS), 5%, 10%, 15%, and 20% by weight of cement. For the M25 mix, the copper slag has taken the place of the sand in the following proportions: 0% (without copper slag), 10%, 20%, 30%, and 40% by weight of cement. Concrete mixtures were created, tested, and compared to standard concrete in terms of compressive, flexural, and split tensile strength.

6. CONCLUSIONS

In the current study an attempt has been made to minimize the cost of cement and sand with concrete mix grade M25 by studying the mechanical behavior of this concrete mix by partial replacing with advanced mineral admixtures such as Copper slag and GGBS in concrete mix. In this study, partial replacement of Cement with GGBS and Sand with Copper Slag considered. Experimental study is to be conducted to evaluate the workability and strength characteristics of hardened concrete, properties of concrete have been assessed by partially replacing cement with GGBS, and sand with Copper Slag. The cement has been replaced by GGBS accordingly in the range of 0% (without GGBS), 5%, 10%, 15%, and 20% by weight of cement for M25 mix. The sand has been replaced by Copper slag accordingly in the range of 0% (without Copper slag), 10%, 20%, 30%, and 40% by weight of cement for M25 mix. Concrete mixtures are to be produced, tested and compared in terms of compressive, flexural and split tensile strength with the conventional concrete.

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