International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-2, April 2022
https://doi.org/10.55524/ijirem.2022.9.2.63
Article ID IJIR-2266, Pages 408-413
www.ijirem.org

Impact of Copper Slag and Waste Glass Powder Replacement for Fine Aggregate in Concrete

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ABSTRACT- Nowadays there is a lack of River sand and also increment of lots of restrictions on river sand mining and its transportation. For that it becomes necessary to find an alternative for river sand. It is beneficial to find the by-product so that its cost is comparatively less and also it can be usable. For that the Copper Slag and waste glass are the best alternatives. By using copper slag and waste glass in concrete we can reduce environmental pollution as well as we can reduce the cost of concrete also. Copper slag and waste glass can possess the physical, chemical and mechanical properties that can be used in concrete as a partial replacement for fine aggregates. Copper slag and waste glass is one of the materials that can be considered as a waste material which could have a promising future in the construction industry as a partial or full substitute of any two either cement or aggregates. During the investigations the M30 grades of concrete was prepared and examined at a fresh and hardened stage respectively. Then different mixes were prepared containing 0%, 7.5%, 12.5% and 17.5 % and as partial replacement of fine aggregates with copper slag and 0%, 7.5%, 12.5% and 17.5 % as a partial replacement of fine aggregates with crushed glass waste together in different combinations. The properties which were examined are workability of the different mix by slump test, compressive strength of solidified concrete cube specimens, split tensile strength of solidified cylinder specimens, flexural strength of solidified beam specimens , abrasion test and acid attack as per the IS code Form the results of compressive strength, split tensile strength and flexural strength, the concrete shown higher value at 12.5% replacement of fine aggregate by using copper slag and crushed waste glass on replacement of fine aggregate i.e. sand . We conclude that, by using copper slag and waste glass powder as replacement for fine aggregate in concrete increases the density of concrete. Hence, 12.5 % replacement of copper slag is the optimum proportion for replacing fine aggregate and helps to utilize the waste product in turn helps to protect the environment.

KEYWORDS- Copper Slag, Waste Glass Powder, Fine Aggregate.

I. INTRODUCTION

For quite a long while, it has been noticed that the volume of waste materials from building destinations and ventures differs enormously, and that this number is rising consistently[1]. The development of this trash brings on some issues all over the planet. Since most of the materials are disposed of in landfills or unlawfully unloaded, the ecological impact of this trash may now be reduced by utilizing it. Squandering the executives is one of the essential issues in any general public, and it has become evident that legitimate waste administration works on the personal satisfaction [2]. The fundamental thought of waste administration is "decreasing new creation and tracking down ways of reusing and reuse existing." Anything that can't be reused or reused should be put in a safe and practical way. Reusing old materials is the demonstration of reusing them into new merchandise to keep away from the misuse of usable materials [3]. Reusing or reusing disposed of glass and copper slag is a green technique for dispensing with them from the waste stream. The utilization of squashed glass rubbish and copper slag as fine total would be gainful to the economy also. In particular, the safeguarding of regular materials is basic for naturally mindful and manageable development that is likewise financially powerful[4]. This sort of development includes the utilization of minimal expense materials that have no hindering ecological effect [5].

A. Copper Slag

Copper slag is an industrial by-product substance created during the copper manufacturing process that has nearly identical physical, mechanical, and chemical qualities as copper. Sand can be used as a substitute for river sand. Copper slag is a byproduct of the operation of reverberator furnaces, which are used to manufacture copper [6]. These furnaces can hold a considerable quantity of concentrate, up to 300 tonnes at one time. Impurities combine to generate a less dense liquid, which floats on top of the copper melt [7]. These impurities, which include iron, silica, and lime, combine to produce slag. The slag is scraped off the top, and the melted substance, which contains up to 50% copper, is known as matte[8]. The copper matte is sent through the

converter, which forces air into it. The air pushes the silica back into the copper matte, where it collects the remaining impurities and produces additional slag. The slag is scraped off again and cooled by air [9]. The slag is crushed in stages using jaw and impact crushers and then screened to create an angular and uniform particle shape.

B. Crushed Glass Waste

Glass recycling is the process of converting waste glass into usable things. The primary issue with utilising crushed glass as aggregate in Portland cement concrete is expansion and cracking induced by alkali silica reactivity in the glass aggregate [10]. Locally accessible waste glass was collected and ground into glass powder. Glass trash is a particularly brittle substance. Before incorporating glass powder into concrete, it must be pulverised to the proper size. Glass is a popular commodity that may be found in a variety of forms, including containers, jars, windows and windscreens, lamps, cathode ray tubes, and so on. These items have a finite lifespan and must be utilised to prevent environmental issues [11]. The use of waste glass in building will not only reduce waste concerns, but will also create a new supply for construction. The numerous materials that are consumed to substitute fine aggregates are as follows:

- Crushed stone
- Ceramic dust
- Coal dust
- Marble dust
- Copper Slag

C. Objective of the Study

To study the properties of M30 grade of concrete by partially replacing fine aggregate with copper slag and glass powder respectively.

- To calculate the compressive strength on the additional of fine aggregate with copper slag and waste glass.
- To fix the split tensile strength on the replacement of fine aggregate with copper slag and waste glass.
- To regulate the flexural strength on the additional of fine aggregate with copper slag and waste glass.

II. METHODOLOGY

An experimental program was planned to investigate strength properties of concrete with crushed glass waste and copper slag as partial replacement of fine aggregates. Concrete mix samples containing percentage replacement by crushed glass as 0%, 7.5%, 12.5%, and 17.5% and percentage replacement of copper slag as 0%, 7.5%, 12.5% and 17.5% were used in this study. The concrete mixes for the investigation of different percentages of concrete using crushed glass waste and copper slag were designated as MS00, MS01, MS02 and MS03. The experimental study was divided into the following stages:

- Mix Design according to IS 10262-2009.
- Workability test of concrete mixes.
- Strength tests on specimens.

A. Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability, and workability as economically as possible is termed as concrete mix design. Mix design is prepared as per IS 10262:2009.

B. Requirements of Concrete Mix Design

Following data is required for mix proportioning:

- Grade of concrete which is to be designed.
- Type of cement, maximum and minimum amount of cement and maximum water-cement ratio to be used.
- Type of aggregate and maximum size of aggregate.
- Workability and method of transporting and placing.
- Exposure conditions and maximum temperature of concrete at the time of placing.
- Early age strength requirements.
- Whether an admixture is to be added and if so, its type and conditional requirements.

C. Workability

"The property of concrete that determines the quantity of helpful internal work, necessary to provide full compaction i.e. workability is that the quantity of energy to beat friction whereas compacting, additionally outlined because the relative ease with that concrete will be mixed, transported, moulded and compacted"[12]. Workability is taken into account as property of concrete with its ability to combine, handle, and transport and most significant, inserting of concrete with a minimum loss of Homogeneity. varied factors that result workability are; water content of the concrete combine, quantity of cement & its properties, combination grading (size distribution) , nature of combination particles (texture, porosity, shape etc.), temperature of the concrete combine and surroundings, humidness of the surroundings, mode of compaction, technique of placement of concrete of transmission of concrete. Some take a look ats carried for determinative the workability of concrete square measure slump test, compaction issue take a look at and Vee-Bee consist meter technique [13]. We have a tendency to used slump take a look at in laboratory to work out workability. The importance and significance of workability square measure explained as under:

In terribly easy words we will say that workability of concrete suggests that the flexibility to figure with concrete. A concrete is alleged to be possible if:

- It will be handled while not segregation.
- It will be placed while not losing homogeneity.
- It will be compacted with specific effort.
- It will be finished simply.

Concrete will be placed without delay while not segregation or separation, during a mass dam might be entirely infeasible during a skinny support. Possible concrete compacted by suggests that high frequency vibrators would be infeasible if vibrators couldn't be used and hand tamping were needed. Concrete having appropriate workability for a pavement may

well be unsuitable to be used during a heavily bolstered section.

D. Detail of Specimens

Concrete cube of size 150 mm x 150 mm x 150 mm were forged for determinant the compressive strength of concrete [14]. A cylindrical concrete specimen having dimension one hundred fifty millimeter linear unit diameter and 300mm height were forged to see the split lastingness of concrete and Beam concrete specimen having dimension one hundred millimeter linear unit and five hundred millimeter linear unit were forged to see the flexural strength of concrete[15].
During the assembly of molds to be used purpose, the joint in between the section of the mold wherever coated with oil and similar coating of the mold with oil at contact surface to make sure that no suspension is at liberty throughout filling of mould and compaction of mould [16]. Also, the inside surface of mould coated with mould oil prevents adhesion of concrete and mould throughout re-moulding. The check specimen's area unit forged in such the way as manufacturing full compaction of concrete with neither segregation nor injury [17]. The compaction is finished with a tamping rod by filling the mould in 3 layers [18]. All the specimens were cured by golf stroke them in water for seven days and twenty-eight days before testing [19-20].

E. Tests on Hardened Concrete

Following tests are conducted to check hardness properties of concrete:

- Compressive strength test
- Split tensile strength test
- Flexural strength test.

Figure 1 shows the compression testing machine, Figure 2 shows the split tensile strength apparatus & Figure 3 shows the flexural strength apparatus.

Figure 1: Compression testing machine

Figure 2: Split tensile strength apparatus

Figure 3: Flexural strength apparatus

III. RESULTS

Figure 4 shows the Compressive strength of M30 concrete for 7 days, Figure 5 shows the Compressive strength of M30 concrete for 28 days, Figure 6 shows the Flexural strength of M30 concrete for 7 days, Figure 7 shows the Flexural strength of M30 concrete for 28 days, Figure 8: Split tensile strength after 7 days & Figure 9: Split tensile strength after 28 days.

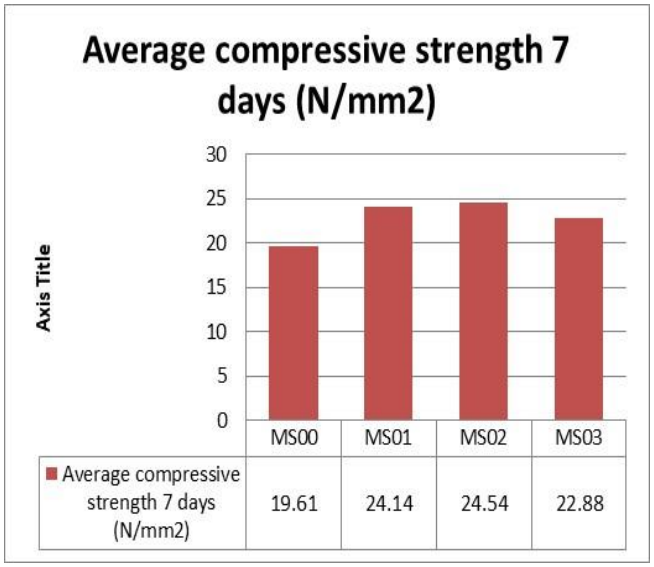

Figure 4: Compressive strength of M30 concrete for 7 days

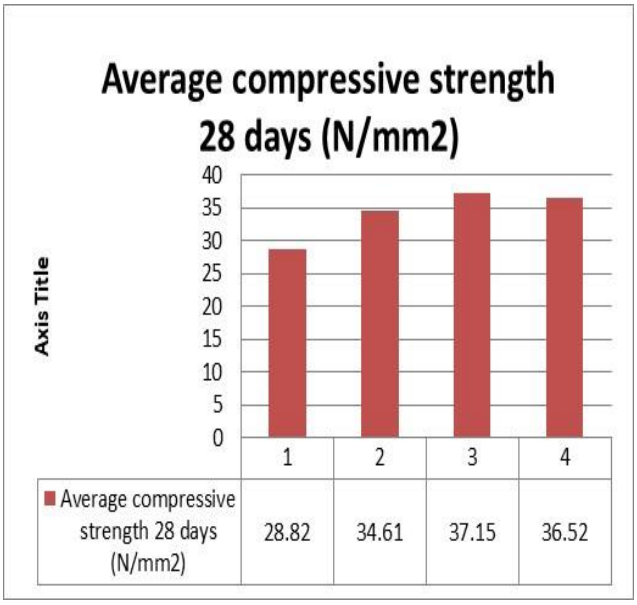

Figure 5: Compressive strength of M30 concrete for 28 days

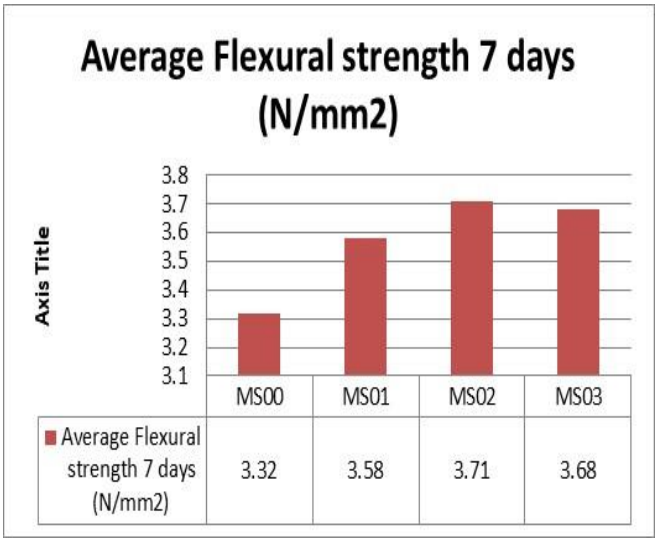

Figure 6: Flexural strength of M30 concrete for 7 days

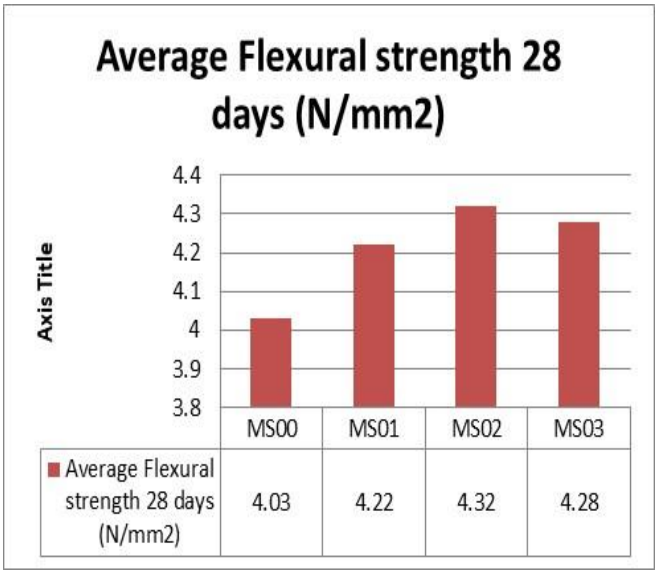

Figure 7: Flexural strength of M30 concrete for 28 days

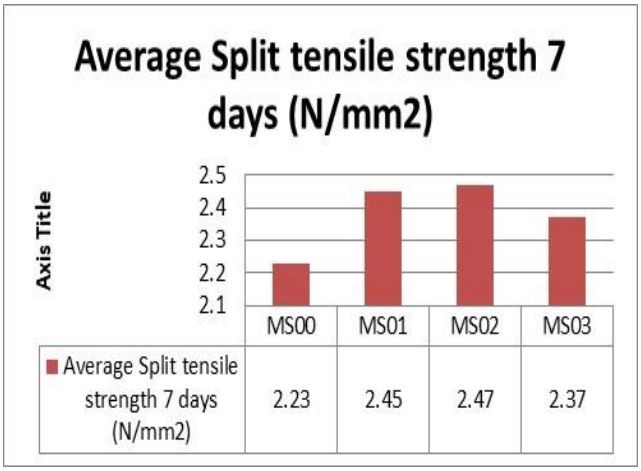

Figure 8: Split tensile strength after 7 days

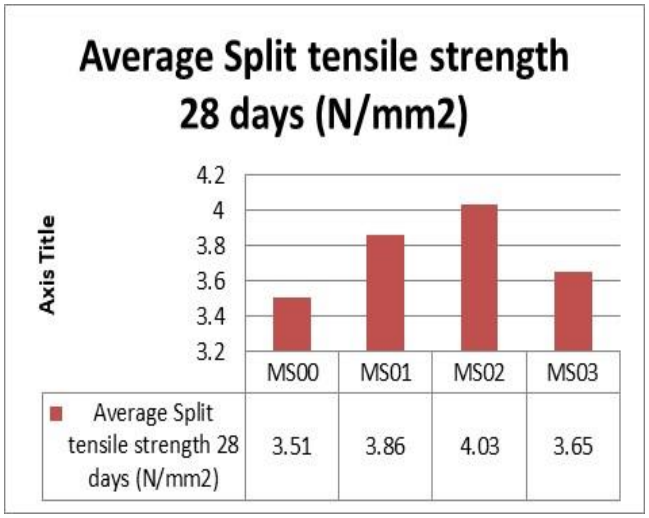

Figure 9: Split tensile strength after 28 days

IV. CONCLUSION

- The optimum compressive strength of M30 grade of concrete after 7 days was attained when there was 12.5% replacement of fine aggregate by each crushed glass powder and copper sage powder and was 24.54 N/mm2 and the maximum compressive strength after 28 days was attained when there was 12.5% replacement of fine aggregate by each crushed glass powder and copper sage powder and was 37.15N/mm2.
- The optimum split tensile strength of M30 grade of concrete after 7 days was attained when there was 12.5% replacement of fine aggregate by crushed glass powder and copper sage powder and was 2.47 N/mm2 and the maximum compressive strength after 28 days was attained when there was 12.5% replacement of fine aggregate crushed glass powder and copper sage powder and was 4.03 N/mm2.
- The maximum flexural strength of M30 grade of concrete after 7 days was attained when there was 12.5% replacement of fine aggregate by crushed glass powder and copper sage powder and was 3.71 N/mm2 and the maximum compressive strength after 28 days was attained when there was 12.5% replacement of fine aggregate crushed glass powder and copper sage powder and was 4.32 N/mm2.
- The slump value of the concrete was examined go on decreasing with the increase in the percentage of replacement of fine aggregate by each crushed glass powder and copper sage powder.
- The value of abrasion test go on decreasing with the increase in the percentage of replacement of fine aggregate by each crushed glass powder and copper sage powder.
- The resistance to the acid H2SO4 was inspected as well as was found increasing the increases in percentage of replacement.

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