# An Expeimental Study on Copper Slag Concrete

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**ABSTRACT**

In India, there is great demand of aggregate in Civil Engineering Industry especially for road and concrete construction. Now a day the availability of fine aggregates becomes a major problem. Copper slag is an industrial by-product material produce during the process of manufacturing of copper. Researchers studied to reuse the useful waste into the concrete like copper slag 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 project environment and reduction of waste by recycling and reusing of waste materials. Hence we have selected the copper slag as fine aggregate to balance the both waste management and construction material. Copper slag is an excellent by-product, which retain its original properties. Concrete cubes will be casted by replacing fine aggregate with copper slag and compressive strengths can be checked for 7 and 28 days.

**1.INTRODUCTION**

Concrete is used in gargantuan amount almost all around the world over human race has a requirement for organization. For the preparation of concrete, we need cement, fine aggregate and coarse aggregate. The fine aggregates come from river sand which is natural resource.

polymer wastes by using this process we can make concrete cost-effective by replacing waste materials through fine aggregates. Copper slag can be used in concrete production as a partial replacement for sand. Copper slag is used as a building material, formed into blocks. Material like copper slag can be used as one which can reduce the cost construction.

Copper slag is an industrial product obtained during matte smelting and refining of copper, by using copper slag in concrete, we can the environmental pollution as well as we reduce the cost of concrete. Copper slag can possess the physical, chemical and mechanical properties that can be used in concrete as a partial replacement for fine aggregate. From the environmental point of view, the main problem of smelters is the generation of gaseous and solid pollutants, the latter so-called copper slag (CS). The world year production of slag from the copper industry arises to 24.6M ton. There is thus a need for environmental friendly technologies, in order to mitigate the negative effects of copper smelting. 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.

Excellent mechanical and physical attributes of copper slag make it a potential source of fine aggregate.

**SCOPE**

Copper slag can be used in concrete production as a partial replacement for sand. It can also be replaced by fine aggregate very easily and has an application in concrete as a admixture. Material like copper slag can be used as one which can reduce the cost of construction.

**ADVANTAGES**

The primary advantage associated with using copperslag in construction is its cost-effectiveness. Copper slag is much cheaper than other aggregates, making it an attractive option for budget conscious builders and contractors. It is lighter than other types of slags, making it easier to transport and handle during construction projects. It gives excellent durability and strength to the concrete. It meet the most stringent environment and reduce the pollution.

**METHODOLOGY**

- Title Selection
- Literature Review
- Materials Collection
- Materials Testing
- Mix Design
- Replacement of Fine Aggregate with Copper Slag
- Curing of Specimen
- Testing of Specimen
- Result
- Conclusion

**MATERIALS CHARACTERISTICS**

**Cement -** Cement is a fine, soft powder used as a binder because it hardens after contact with water. It is produced from a mixture of limestone and clay. OPC cement are using 53 grade cement for concrete.

**M Sand -** The full form of M sand is Manufactured Sand. This is an artificial type of sand formed by crushing rocks or granite. It is used as a substitute of river sand. M-sand can be used for construction of walls with a cement to sand ratio of 1:3.

**Coarse aggregate -** Coarse aggregates are a construction component made of rock quarried from ground deposits. The usual range employed is between 9.5mm and 37.5mm in diameter Typically the most common size of aggregate used in construction is 20mm.

**Copper slag -** Copper slag is a by-product of copper extraction by smelting. During smelting, impurities become slag which floats on the molten metal.

**Fig.1 Copper slag**

Copper slag, which is the waste material produced in the extraction process of copper metal in refinery plants, has low cost, and its application as a fine aggregate in concrete production reaps many environmental benefits. Granulated copper slag is more porous and therefore has lower specific gravity and higher absorption capacity than air-cooled copper slag. The granulated copper slag is made up of regularly shaped, angular particles, mostly between

4.75 and 0.075 mm (No. 200 sieve) in size.

**Water -** Water is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water causes the hardening of concrete through a process called hydration.

**2.LITERATURE REVIEW**

**Ambrish E, Dhavamani Doss S, Shanmuganathan N. (2017)** Ambrish E, Dhavamani Doss S, Shanmuganathan N, investigated on the Partial Replacement of Copper Slag as Fine Aggregate. They reported that the utilization of copper slag in cement mortar and concrete is very effective and beneficial for all related industries, particularly in areas where a considerable amount of copper slag is produced. It proved both environmental as well as 6 technical benefits. They observed that the concrete strength is increased at 20% replacement of copper slag with concrete.

**R R Chavan and D B Kulkarni (2013)** R R Chavan and D B Kulkarni has investigated the performance of high strength concrete (HSC) made with copper slag as a fine aggregate at constant workability and studied the effect conducted experimental investigations to study the effect of using copper slag as a replacement of fine aggregate on the strength properties and concluded that Maximum Compressive strength of concrete increased by 55 percent at 40 percent replacement of fine aggregate by copper slag and flexural strength increased by 14 percent for 40 percent replacement. Many researchers have investigated world widen the possible use of copper slag as a concrete aggregate.

**R. Elamaran, Srinivasan, Vimala (2019)** R. Elamaran, Srinivasan, Vimala, studied the compressive strength increased with increase in copper slag content up to a replacement level of 10%. Beyond the replacement level of 15% of sand with copper slag in concrete, a decrease in strength was observed. Hence addition of copper slag increased self weight of concrete.

**T.Ch. Madhavi (2014)** T.Ch. Madhavi reported the copper slag in concrete as replacement. The researchers found in his experiment that the copper slag is an industrial waste which can be used as a replacement for cement and sand and helps in increasing the mechanical properties of concrete. The use of copper slag can be done up to 30 percent exceeding its used beyond 50 percent decrease the strength.

**Sreelakshmi S, Sruthi KP, Mohammed Munavvir P, Mashhad V (2016)** Sreelakshmi S, Sruthi KP, Mohammed Munavvir P, Mashhad V investigated in the proportioning the concrete mix for type of job in hand is an essential part of any quality assurance plan. In this project river sand is replaced with M sand as fine aggregate material in concrete. And also in the selected mix, copper slag is partially replaced adorably from 10 percent up to 40 percent resulting a greater compressive strength than the nominal mix strength. And that the optimum percentage replacement of copper slag in fine aggregate is inferred as 40 percent. The comparative study result empowers the conclusion that all M sand mixes have higher compressive strength than mixes produced by using river sand. Being an industrial waste copper slag causes bad effects on environment and using it as a fine aggregate material in concrete this effects can be reduced and also can reduce the scarcity of good quality natural river sand due to depletion of resources and restriction due to environmental consideration has made.

**Shanmuga Nathan N (2017)** Shanmuga Nathan N investigated in the Partial Replacement of Copper slag as Fine Aggregate.M20 grade concrete is partial replacement of fine aggregate by copper slag. At 20% it shows high compressive strength. as the increase of slag above the 20% the strength has been decreased. they conclude that copper is an best by product which is used for construction and which improves the strength.

## CHARACTERISTICS OF MATERIALS

**Cement**

| Characteristics | Value specified by IS |
|---|---|
| Specific Gravity | 3.16 |
| Consistency (%) | 33% |
| Initial Setting Time | 30 (minutes) |
| Final Setting Time | 600 (minutes) |

**M Sand**

| Characteristics | Value specified by IS |
|---|---|
| Bulk density | 1.75 Kg/$m^3$ |
| Fineness modulus | 4.66 |
| Specific gravity | 2.67 |

**Coarse aggregate**

| Characteristics | Value specified by IS |
|---|---|
| Size | 20mm |
| Shape | Angular |
| Specific Gravity | 2.74 |

**Copper slag**

| Characteristics | Value specified by IS |
|---|---|
| Physical Form | Angular, Multifaceted |
| Bulk Density | 2009 kg/$m^3$ |
| Specific gravity at 25ºC | 3.5 |
| Grain Size | 0.2-2.4mm |

## TESTING

### COMPRESSIVE STRENGTH FOR COPPER SLAG

**Compressive strength after 7 days for cube**

| S.No | Mix Description | Compressive strength ($N/mm^2$) | Average Compressive |
|---|---|---|---|
| 1 | Conventional mix | 12.4 | 13.9 |
| | | 15.85 | |
| 2 | 5% | 30.15 | 27.1 |
| | | 24.12 | |
| 3 | 15% | 22.13 | 26 |
| | | 29.88 | |
| 4 | 20% | 20.88 | 20.3 |
| | | 19.77 | |

**Compressive strength after 28 days for cube**

| S.No | Mix Description | Compressive strength ($N/mm^2$) | Average Compressive |
|---|---|---|---|
| 1 | Conventional mix | 27.31 | 25.78 |
| | | 24.25 | |
| 2 | 5% | 29.88 | 32.21 |
| | | 34.55 | |
| 3 | 15% | 30.88 | 31.61 |
| | | 32.35 | |
| 4 | 20% | 37.32 | 34.93 |
| | | 32.55 | |

### SPLIT TENSILE STRENGTH FOR COPPER SLAG

**Split tensile strength of cylinder for 7 days**

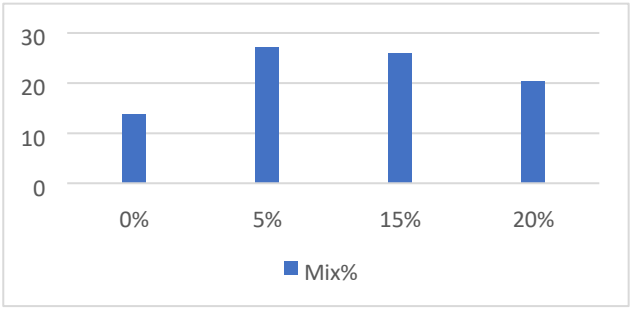
| Mix (%) | Split tensile strength (N/mm2) after 7 days | | Average compression strength after 7 days |
|---|---|---|---|
| | Specimen1 | Specimen2 | |
| 0% | 1.51 | 1.57 | 1.54 |
| 5% | 1.20 | 1.36 | 1.28 |
| 15% | 1.56 | 1.52 | 1.54 |
| 20% | 1.58 | 1.59 | 1.58 |

**Split tensile strength of cylinder for 28 days**

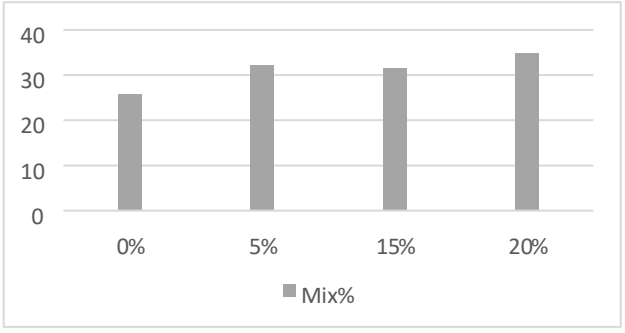
| Mix (%) | Split tensile strength (N/mm2) after 7 days | | Average compression strength after 7 days |
|---|---|---|---|
| | Specimen1 | Specimen2 | |
| 0% | 2.45 | 2.48 | 2.46 |
| 5% | 2.35 | 2.52 | 2.43 |
| 15% | 2.57 | 2.59 | 2.58 |
| 20% | 2.60 | 2.58 | 2.59 |

## RESULT

**Compressive strength after 7 days for concrete**




**Compressive strength after 28 days for concrete**



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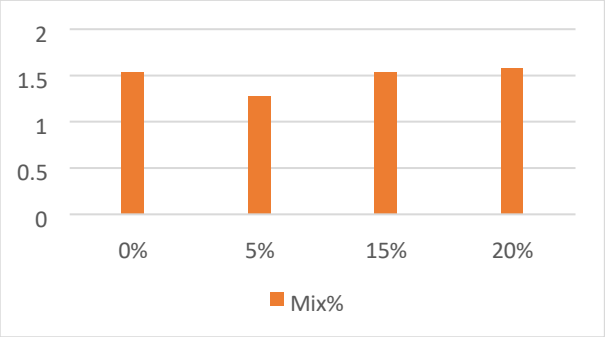
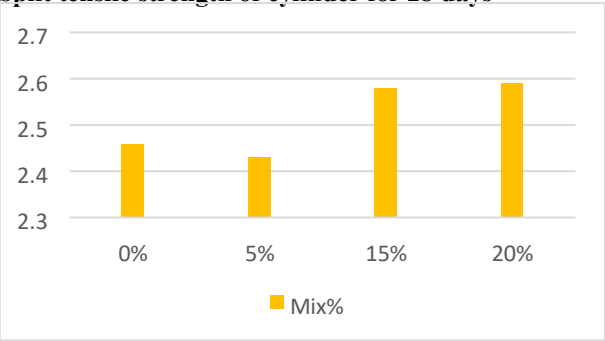



**Split tensile strength of cylinder for 28 days**




## CONCLUSION

In this project, an experimental study has been conducted on concrete by varying the percentage of copper slag as 0%, 5%, 15% and 20% respectively to study the increase in the compressive strength of concrete.

## COMPRESSIVE STRENGTH

After adding 15% Copper slag in the mix, there is an increase in the strength of cube after 7 days as compared to concrete without replacement. After 28 days there is enormous increase in strength as compared to the control mix. The optimum strength of cube is gain at 20% replacement for all 7 and 28 days respectively.

## SPLIT TENSILE STRENGTH

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The optimum strength of cylinder is gain at 20% replacement for all 7 and 28 days respectively.

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