iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 9 **Issue:** IV **Month of publication:** April 2021

**DOI:** https://doi.org/10.22214/ijraset.2021.33552

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 9 Issue IV Apr 2021- Available at www.ijraset.com*

# Experimental Study on Utilization of Copper Slag for Replacement with Different Percentage of Concrete

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***Abstract:*** ***The continue progression of concrete construction could reducing the utilization of naturally occurring resource and minimize the impact of pollutants on surroundings atmosphere. Recently more quantity of Copper Slag is obtained in processing of production of steel in plants and copper producing industry with an important impact on environment and humans. This project describes the feasibility of using the Copper Slag in concrete production as half substitution of cement. Dumping unwanted substances directly to the atmosphere could increase ecological problem. Therefore recycle this unwanted substances has been focused. This unwanted substances or waste product could be use to obtain another products or it could also be use like admixtures. Thus naturally obtained resource are used more professionally so that atmosphere is safe against waste deposition. And copper slag is an industrial waste that is obtained by manufacturing process of copper. but records analysizing that 1tonne of copper manufacture leads to production of 2.25 tones of copper slag. while copper slag is generally adopted for various purposes like land filling and abbrasive tools preparation, low quality tools and railway ballast materials. Inspite of all these application all over the world only 18 % of copper slag is used remaining 82% comes under wastage. but if We adopted this material as substitute in construction material it will have a promising future. At the same time the remaining 82 % waste copper slag have added value in construction industry and at land filling problem will get solve. Therefore the scientifically or industrial community must commit towards more sustainable practices. There is different reusable or recyclable product for industrial by-product, both are used in new phase or in practical applications. This unwanted substance which is obtain by industry is dump in nearby land so that fertility of soil is spoiled. The chemical, mechanical, physical properties of unwanted substances are examined. In INDIA, copper slag is used as partial substitution in concrete mix and its effects. Slump cone and compressive strengthening test of freshen and hardened concrete were also examined.***

***Keywords:*** ***Copper Slag, half substitution, compressive strengthning, concrete material.***

## I. INTRODUCTION

The importance of cement concrete in present society can't be thought little of. Solid Structures of Concrete Presents in all places, such as structures, streets, bridges, and dams. There is no avoidance the effect of concrete utilization makes on your regular day to day existence. Concrete is a mixed compound composed of space filler and a fastening. A combination of Cement, Sand (fine Aggregate), Aggregate (Course Aggregate) and water is standard concrete. As fastening materials, cement plus lime are typically used, while the sand ring binder is blended the same as fine aggregates and trampled stones, rocks, busted bricks, clinker is used like coarse aggregates. In addition to water, the concrete with cement, fine aggregates along with coarse aggregates mixed up in a suitable proportion is called cement concrete Mixer. Cement is blended as a fastening substance in this form of concrete, sand like fine aggregates and gravel, crushed stones as coarse aggregates.

An Investigation relating to find out the utilization of byproducts to enhance the functions of concrete has been about for many years. In the most current years, the researchers have been finding out to reuse industry by-products for example: - (i) fly ash, (ii) silica fume, (iii) ground granulated blast furnace slag, (iv) glass cullet, etc., in concrete manufacturing and civil applications. The usage of these resources in concrete comes from the environmental constraints inside the secure disposal of these products. Big interest is being focused on the environment and safeguarding of natural possessions and recycling of waste materials. Various industry are produce a important amount of products which integrate residue for example:- (i) broken aggregates (ii) broken asphalt concrete (iii) foundry sand (iv) copper slag (v) fly ash (vi) glass cullet (vii) polyethylene terephthalate (viii) HDPE.

## II. MATERIALS

The materials used in the concrete mixture projects are cement, fine aggregate, coarse aggregate, copper slag, as described in detail below:

1) *Cement:* Cement is the most important component of concrete, since the binding medium for the distinct ingredients is created. Produced from naturally occurring raw materials and then mixing with toxic waste or underground. OPC 53 grades of Ordinary Portland cement (OPC) conforming to IS12269-1987 was used for the analysis.
2) *Fine Aggregate:* Aggregates that cover almost 70 to 75 % concrete volume are often used in more than one way as inert ingredients. This is well known now a day, however, that the (i) physical (ii) chemical (iii) thermal properties of aggregates drastically affect the property of 23 mm and concrete results. To extract all pebbles, fine aggregates (sand) use as fresh dry sand sewn in a 4.75 mm sieve.
3) *Coarse Aggregate:* For making concrete, coarse aggregate is used. They are generally in form of irregular broken stone, or gravel that naturally occurs. Coarse aggregates are called material that is wide to be held at 4.75 mm sieve size. Up to 40 mm may be its maximum span.
4) *Water:* For the preparation of concrete, water plays an important role as it engages in a chemical reaction with cement. In the presence of water gel is formed which helps increase the concrete's strength. For mixing, portable water is usually considered satisfactory. The pH value of water should not be lower than the maximum allowable values expressed in the following concentrations.

a) *Limits of Acidity:* Not more than 5 ml of 0.02 NaOH should be needed to neutralize a 100 ml solution of water using phenolphthalein as an indicator. The test details are as stated in IS 3025.
b) *Limits of Alkalinity:* Using a mixed indicator, neutralizing a 100 ml solution of water does not need more than 25 ml of 0.02 natural H2SO4. The specifics of the tests are as stated in IS 3025.
c) *Percentage of Solids:* When measured in compliance with IS 3025, the maximum allowable limits of solids are as set out in IS 3025.

- The chemical and physical properties of groundwater shall be tested in conjunction with the soil investigation and if there is no water found to comply with the necessities of IS 456-2000, it shall be clearly specified in the tender documents that contractor has to organize for the construction of good quality water indicating the source.
- Water is to be found satisfactory for mixing as well as curing. For curing water shall not, however, create on the surface any undesirable stain or unsightly deposit.
- For mixing or curing, sea water must not be used.
- Water available for every source is to be tested before start any construction work and every three months thereafter until the end of work. In the case of groundwater, different test can also be performed for a separate drawdown point.

5) *Copper Slag:* It is a by-product of the method of smelting and refinement of copper. They produce a significant amount of (i)non-metallic dust (ii) soot (iii) rock (iv) refineries draw metal from copper ore. Copper slag, an industrial waste collected from Sterlite Industry Limited. Tuticorin and Tamilnadu smelting and processing process of copper. Nearly four tonnes of copper are collected as a waste and its disposed of to the environmental impacts of the land cause. It can then be reused as concrete materials. When copper metal produced by the extraction process is produced in refining plants, copper slag is created in large quantities in the production of copper metal. For every 1 ton of copper produced, approximately 2-2.5 tonnes of copper slag is produced. Production of concrete has many environmental benefits for example waste recycling and resolve disposal problems. Concrete is wide utilized in the development of superior structures like high rise buildings, long-span bridges, etc. So, it must have higher workability, it has better mechanical property than those of typical concrete. In order to produce concrete with good mechanical properties, silica fume and fly ash that are assume as waste materials used one of the most constituent. Concrete production with that material gives upgrading in workability compared to traditional concrete.

## III. PROBLEM FORMULATION

In all parts of the world, natural resources are diminishing and waste from industries is rising at the same time. Eco-friendly and reliable building production includes the use of non-conventional and diverse waste materials and the recycling of waste materials to minimize environmental pollution and to reduce uses of natural resources. The concrete mixture consists mostly of fly ash, which is also useful for preserving the heat of the concrete hydration temperature to save the cement. A mixture called concrete of water, aggregate, sand and cement is a complex material which is used in buildings and developments.

We use copper slag as a partial substitute to minimize the use of cement, thereby minimizing uses of natural source in building, so that copper slag is used as one of the alternative materials in concrete. It is the waste product of iron or steel plants made from copper. The only sector where the safe uses of copper slag feasible is the building industry. When placed into concrete as a substitute material, it decreases the emissions of the atmosphere, the issue of space and therefore reduces the cost of concrete. When copper metal produced by the extraction process is produced in refining plants, copper slag is created in large quantities in the production of copper metal.

## IV. LITERATURE SURVEY

*1)* Sukhoon Pyo et. al. [2016] they directed investigation utilizing as a recent development on impact testing system that sudden release strain energy to produce pulses. Three fiber classes were estimated, a distorted fiber and two additional sorts of straight fiber. Test impact answer was assessed regarding first breaking power, post-breaking strength, and energy incorporation force and strain power. The test results indicate that examples with distorted fiber typically show genuinely preferable mechanical capacities over examples with straight fiber for the arrangement of strain rates estimated. All UHP-FRC arrangement experienced show additional rate sensitivities in energy consideration power, ordinarily made considerably more energy dissipative under expanding strain rates.

*2)* Y. S. Tai et. al. [2016] they examined the mechanical actions of high working steel fibers embedded in UHPC at different pullout speeds the experiment variables were steel fiber style matrix ingredients, and addition rates. In exacting, five variety of high strength steel fiber were used and five pullout rates from quasi-static to impact rates were applied. In addition, the effect of decreased quantity of glass fine particles, as key matrix constituent, on pullout behavior was explored. Investigational outcome explain that the addition reply of all of the fiber types exhibit increasingly rate sensitivity as the addition speed enlarges and turn into important through impact loading. It is mainly important in the soft and warped fibers and smallest amount in the hooked fibers. Also, examines electron microscope analyses are offered and used to make clear the machinery of rate augmentation from a microscopic perspective.

*3)* Anju Ramesan et. al. [2015] they studied about suitability of functions of light weight concrete with plastic aggregate. the appropriateness of recycled fibers as coarse aggregate in concrete by performing different experiments similar to workability by slump test, compressive force of cube and cylinder, splitting tensile power analysis of cylinder, flexural strength of R.C.C Beams, to find out the function and performance in concrete. Cause of substitution of coarse aggregate with different percentages (0% to 40%) of plastic aggregate on behavior of concrete was investigational analysis and the finest particle replaced with of coarse aggregate was achieved. The outcome explained that the addition of plastic aggregate to the concrete combination enhanced the material goods of the resulting mixture.

*4)* Sahil Verma et. al. [2015] they investigated about the use the waste fiber crushed bottles of suitable volume in concrete with partial substitution of fine aggregates and it have the potential of dumping of massive quantities of the catastrophic waste in a beneficial way. The environmental effects can be substantially reduced by proper encapsulation of these waste plastic bottles. The analysis also provides the similarity of compressive strength of normal conventional concrete with the concrete made from the partial substitution of aggregates with Polyethylene Terephthalate bottles. Therefore concrete with waste polymers could be utilized as an efficient plastic waste organization performance in future.

*5)* B. Patnaik et .al. [2015] they learned about the power and durability elements of cement having copper waste as a partial replacement of sand and results have been introduced in this paper. Two various types of Concrete Grade (M20 and M30) were utilized with various extents of copper slag substitution (0 to half) in the solid concrete. Strength and Durability properties, for example, Compressive Strength, Split Tensile Strength, Flexural Strength, Acid Resistivity and Sulfate Resistivity were assessed for both blends of cement concrete. test results clarifies that the strength elements of cement concrete has better having copper slag as a halfway substitute of Sand (up to 40%) in cement concrete however as far as of stability the solid concrete discovered to be low impervious to corrosive assault and better opposition against sulfate attack.

*6)* Chinmay Buddhadev et. al. [2015] they learned about the other source of river water ways sand by sand is conceivable in solid concrete mixture. For M 20 and M 25 evaluation concrete, the ideal sand trade extent is by and large 20-25%. In addition, for the most part the sand can be substitute till 30-40% by sand in material. The trading of sand by foundry sand in solid concrete expands the compressive power, split ductile power, flexure force and modulus of flexibility. Commonly the investigational assessment is found for solid concrete evaluation. Further examination ought to be discover with respect to M 35 and M 40 level solid concrete, which could be valuable for multi-story structures, development of expressway, freeways, and so on where strength necessity is high.

*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 9 Issue IV Apr 2021- Available at www.ijraset.com*

## V. MATERIAL AND METHODOLOGY

### A. *Material Description*

The various materials which is used in this project for making concrete mixture are

*1)* Cement
*2)* Fine aggregate
*3)* Coarse aggregate
*4)* Copper slag

It described in details below:

### B. *Materials Used*

*1)* *Cement:* it's one of the very important materials of concrete, because this creates binding intermediate with other ingredients. Prepare out of natural occur raw material, blended or inter-ground with industrial wastes. Cement which is used for this analysis was OPC 53 grades conforming to IS 10262.

Figure 3.1. Cement

The properties of cement used is shown in 3.1 Table.

Table 3.1 Properties of cement

| Properties | Value |
|---|---|
| Grade of Cement | OPC(53 grade) |
| Sp. gravity of cement | 3.15 |
| Initial setting time | Not least than 30 min |
| Final setting time | Not least than 60 min |
| Normal Consistency | 31.5% |

*2)* *Fine Aggregate:* In any concrete mixture approximately 70 to 75 % volume of concrete having fine aggregates. Its sometime views as inert material in it. but, its attain various properties in it like physical, chemical and thermal properties. significantly control the property and performance of concrete. The fine aggregate was used as clean or dry sand which were passes through the 4.75 mm size sieved to removed out all the pebbles and dirty particles from it.

Figure 3.2 Fine Aggregate

The different Properties of F.A. are given below in table 3.2.

Table 3.2 Properties of F.A.

| Properties | Value |
|---|---|
| Specific Gravity | 2.60 |
| Fineness Modulus | 3.74 |
| Water absorption | 0.6% |

3) *Coarse Aggregate:* Coarse aggregate is also use for preparing concrete. They generally found in broken form of irregular size stone or natural occurring gravel. particles which does not pass through 4.75mm size sieve is known as coarse aggregates. Its minimum and maximum size is 9.75mm and 37.5mm.

Figure 3.3 Coarse aggregate

Properties of C.A. are given below in table 3.3.

Table 3.3 Properties of C.A.

| Properties | Values |
|---|---|
| Specific Gravity | 2.94 |
| Size of Aggregate | 20 mm |
| Fineness Modulus | 7.08 |
| Water absorption | 0.219 |
| Aggregate Impact value | 15.2% |
| Aggregate Crushing value | 22.5% |

4) *Water:* water is very useful in the formation of concrete mixture because it participates in heat of hydration process with cement. In presence of water the gel is form which helps in increase the strengthening of concrete. Almost any naturally available water which is used for drinkable purpose and having no taste or odour should be used for mixing. Water available from lakes, ponds, and streams are containing marine life which is usually suitable for concrete mixture. Water which is used for mixing, preparing concrete and curing should be fresh or free from harmful substance of alkalis, salt, acids, organic matter, oils, sugar and any other matters which can be harmful to the life of other building materials like stones, bricks, concrete structure. Portable water is usually used for satisfactory addition. PH value of constructional water should not be less than 6 to 8 for concrete construction if its value less than its permissible limit than it's harmful for other building materials and there are various concentration given below.

a) *Limits of Acidity:* If water is highly acidic then its effect the concrete so to reduce the effect of acid take 100ml solution of water and used phenolphthalein as indicator and it shall not required more than 5ml of 0.02 normal NaOH and complete detail of this test is given in IS 3025.

b) *Limit of Alkalinity:* If water is more alkaline so it's also effect the working of concrete so to neutralize it take 100ml solution of water and using mixed indicator. it doesn't required more than 25ml of 0.02 normal $H_2SO_4$ and complete detail of this test is given in IS 3025.

c) *% of solid:* Max. permitted limit of any solids when its tested should be classified under IS 3025

Table 3.4 Maximum limits of solids in water

| Types of solids | Limits |
|---|---|
| Organic solids | 200 mg/litres |
| Inorganic solids | 3000 mg/litres |
| Sulphates | 400 mg/litres |
| Chlorides | 2000 mg/litres for concrete not contain embed steel, and 500 mg/litres for R.C.C. works |
| | 2000 mg/litres |

The naturally available ground water should be tested along with soil investigation as well as physical and chemical properties. if water is not found up to the requirements of IS 456 – 2000, the tender documents should obviously specify that the contractors have to arranged excellent quality of water which is suitable for construction and different source indicating the properties.

- Water is to be found suitable for mixing and curing. However, it is use for mixing and curing purpose should not be producing any unpleasant stains or unsightly particle deposition on the surface.
- Sea or marine water can't be useful for concrete mixing and curing
- Water available from any source should be tested before starting any construction work and subsequently tested in every 3 months till the ending of construction work. In case of ground water, testing is generally done for various points of drawdown. Water available from any source should be tested in summer season before monsoon and again in summer season.

5) *Copper Slag:* it's an industrial waste product which is obtains during refining and copper smelting process. As refineries done waste metal produced out from copper ore, they generate huge vol. of dust,rock,soot. And it's produce from refining of copper and smelting process from Strelite Industries Ltd., Tuticorin, and Tamilnadu. Almost 4 tonnes of copper is produce as a waste product which is dispose on the lands causes' environmental impact. So this could be reuse like concreting materials.

Figure 3.4 Copper slag

Table 3.5 Chemical properties of copper slag

| Chemical Component | % of chemical Component |
|---|---|
| SiO2 | 37.26 |
| Fe2O3 | 47.45 |
| Al2O3 | 3.95 |
| CaO | 2.38 |
| Na2O | 0.65 |
| K2O | 2.62 |
| Mn2O3 | 0.086 |
| TiO2 | 0.33 |
| SO3 | 2.75 |
| CuO | 1.12 |

*C. Methodology*

The motive of this study was to evaluate the property of concrete. And its contain Fine aggregates, coarse aggregate, cement and copper slag.

To analysis the different essential aspects like compressive strengthening of concrete no of Cubes preparing with the help of Concreting materials and replacing cement with different % of copper slag. In freshen state the workability parameter like slump test was study. In hardened state the strengthening test like compressive strength was study. The analysis was done for mix design of concrete-M20 and M25 grade. In this lesson, concrete cubes was casted for testing were of dimensions of 150×150×150 mm.

The study of this project is fully based on the experimental work. In this section of the dissertation, following steps are adopted during experimental work:

*1)* To build any structure first we need to build its base or foundations. Likewise first of all M20 and M25 grades of concrete are prepared according to the "INDIAN STANDARDS CODE" IS 10262:2009.

*2)* In the preparation of mix design for M20 and M25 grade of concrete having various physical properties of materials like specific gravity, nominal size, water holding capacity, fineness Modulus etc. are required, also some other aspect were involve like exposure condition of atmosphere sun and water, material mixing technique etc. are to be assumed in accordance with INDIAN STANDARD CODE IS 456:2000.

*3)* Later then analyze the working quality of various materials in a suitable proportion, and it's time for selection of the materials for concrete.

*4)* Always keeping in mind that according to "INDIAN STANDARDS" materials which is selected that is aggregate Conforming/fill the different parameters as per IS 383:1970 and 53 grade OPC according to IS 12269:1987 is taken.

*5)* Selected materials are mixed in a fixed proportion as per mix design to obtain the preferred strength. Sampling & analysis of concrete is carried out according to IS 1199:1959.

*6)* IS 2386 (Part 1): 1963 method is used for test of aggregate

Especially for shape and size of aggregates.

*a)* Two main important experiment were perform on concrete are

- Slump cone test
- Compressive strength test

*b)* Standard mould of 150 mm x 150 mm x 150 mm sizes firstly cleaned and then oiled after this mixture is fill in this moulds.

*c)* After 24 hours cubes are unbolted from the moulds and placed into the curing tank which is filled with fresh water at 27 ± 2°C for 28 days.

*d)* After 28 day of curing no of cubes placed into compressive strength machine for final test who giving the actual strengthening of concrete i.e. test performed as per the guidance of "INDIAN STANDARD CODE" IS 516:1959.

*D. Testing of Cement*

The physical test results on OPC are as follows.

*1)* *Fineness of Cement:* A sample of cement weighing 1000gm was taken in I.S. sieve no. 9 (90 micron ) the lump, if any were broken down carefully with the fingers without applying external force. The cement sample is sieved continuously for 10 minutes by manually. The residue left on sieve was weighed. Fineness of cement was 2.5.

Table 3.6 Fineness of Cement

| Sr. No. | Weight of cement | Wt. of residue left on sieve | Finer on 90 micron sieve |
|---|---|---|---|
| 1. | 1000gm | 2.8% | 97.2% |
| 2. | 1000gm | 2.7% | 97.3% |
| 3. | 1000gm | 1.8% | 98.2% |

2) *Standard Consistency of Cement:* Vicat apparatus with 10mm diameter plunger was used to find standard consistency. A cement sample of 400gm was taken and a paste with weighed percentage of water was prepared for the trial. The paste of cement is preparing and fill in vicat apparatus mould within 3 to 5 min. after that completely filled the mould. It was sharked to eject out the air. Apparatus having plungers of 10mm dia. Or length of 50mm. And bring downward in contact with upper face of paste and rapidly release allowing to sink into paste under its self weight. Take some amount of this and noting the depth of penetration of plunger. The procedure is repeated again and again till the plunger penetration shown 5-7 mm from the bottom.

Table 3.7 Standard consistency test for cement

| Wt. of Cement | Quantity of water added (ml) | Penetration from bottom (mm) |
|---|---|---|
| 400 | 120(30%) | 7 |
| 400 | 128(32%) | 6 |
| 400 | 136(34%) | 4 |
| • Standard Consistency of Cement = 32% | | |

3) *Setting Time of Cement*

a) *Initial Setting Time of Cement:* Setting time is also conducted by vicat apparatus. Firstly Prepared a fresh cement paste by addition of 0.85 P (standard consistency) % of water. Started stop watch at instant, the water is adding to cement. Then paste is formed of adding water, and then fills it into vicat apparatus mould. The mould is kept on nonporous plate and put under the needle in the vicat apparatus. Lower the needles smoothly till its come in touch with surface of paste & quickly release allow its to penetrate into sample and note the penetration after every minute. Report the procedure until needles fail to cement paste for 5 $\pm$ 0.5 mm. measured from bottom of mould. Stop the watch and note the time.

b) *Final Setting Time of Cement:* Replacing needle of instrument by needle with annular attachment. And releases the needle till it makes an impression. The time beyond between the moment that water is adding to cement and when the needle only makes impression is considered as final setting time.

Table 3.8 Initial and final Setting Time of Cement

| | |
|---|---|
| Cement (gm) | 400 |
| Water (ml) | 109 |
| Initial Setting Time (min) | 60 |
| Final Setting Time (min) | 240 |

Initial setting time = 60 minutes
Final setting time = 240 minutes [4 hours]

c) *Specific Gravity of Cement:* Specific gravity bottle is used to calculate sp. gravity of cement. First of all Weight the dry specific gravity bottle (w1) then filled the empty bottle with water and weight the bottle (w2). After that dry the bottle and filled it with kerosene which is free from water and weight (w3).some amount of kerosene filled in the bottle and introduce several quantity of cement is weighed(say about 65 gm.) and weighed it (w4) and filled that bottle with cement and weighed(w5).

Table 3.9 Specific Gravity of cement

| Observations | Sample1 | Sample2 |
|---|---|---|
| Weight of empty dry bottle, $w_1$ | 50 | 50 |
| Weight of bottle + water filled, $w_2$ | 150 | 150 |
| Weight of bottle + kerosene filled, $w_3$ | 129 | 129 |
| Weight of bottle + cement + kerosene, $w_4$ | 166 | 166 |
| Weight of cement, $w_5$ | 50 | 50 |
| Specific gravity $\left(\frac{w5(w3-w1)}{(w5+w3-w4)(w2-w1)}\right)$ | 3.03 | 3.03 |
| Mean Specific Gravity | 3.03 | |

*E. Sieve Analysis*

This experiment is perform to determine the % of various grain sizes available in the Fine Aggregate. This analysis was performing to calculate the distribution of coarse or large-sized particles, the hydrometer is a instrument which is use to calculate distribution of finer particles. As well as sieve analysis is also use to calculate particle size distribution of sand, coarse or fine particles which we can say gradation of material. Sieve analysis of aggregates is most important for control the production of concrete. Gradation is determine by sieve analysis, in which some quantity of aggregate sample is passing through no of series sieves and wt. retain in every sieves is expressed as in percentage of sample weight which compare with the grading limits specified.

A sieve is an apparatus which having round or square in shape with square openings, known either by their size (clear) of the opening or by number. The higher, the number, the smaller, the opening. The standard sizes of sieve for coarse aggregates are No.4, 3/8 in., ½ in., ¾ in., 1 in., 1 1/2 in., 2 in., and 2 1/2 in.

1) *Particle Size Analysis for F.A. and C.A. and Fineness Modulus:* The sample is brought to an atmospheric state prior weighing, sieving. Each sieve is shaken individually over fresh tray for some time which is not as much of 2 min. sieving is done in circular anticlockwise or clockwise directions. Find the weight of aggregates retained on every sieve taken in order.

Table 3.11 Particle size analysis of F.A. and fineness modulus

| Total weight of FA = 1000gm | | | | | | |
|---|---|---|---|---|---|---|
| Sr. No. | Sieve No. | Weight of FA Retained | Percentage Retained | Cumulative Percentage retained (%) | Percentage Passing (%) | Limits of zone II as per IS-383 |
| 1. | 4.75mm | 73 | 73 | 7.3 | 92.7 | 90-100 |
| 2. | 2.36mm | 38 | 111 | 11.1 | 88.9 | 75-100 |
| 3. | 1.18mm | 120 | 231 | 23.1 | 76.9 | 55-90 |
| 4. | 600micron | 242 | 473 | 47.3 | 52.7 | 35-59 |
| 5. | 300micron | 410 | 883 | 88.3 | 11.7 | 8-30 |
| 6. | 150micron | 91 | 974 | 97.4 | 2.6 | 0-10 |
| 7. | Pan | 26 | 1000 | 100 | 0 | - |
| REMARKS | | | Conforming to zone II of table 4 of IS: 383-1970 | | | |

Fineness Modulus of Fine aggregates = S*F*/ 100

Fineness modulus = 374.5/100 =3.74

Table 3.13 Particle size analysis for Coarse aggregate and fineness modulus

| Sr. No. | Sieve size (mm) | Weight retained (gms) | cumulative Weight retained | Cumulative% Weight Retained | % Weight Passing |
|---|---|---|---|---|---|
| 1. | 80 | 0 | 0 | 0 | 100 |
| 2. | 40 | 0 | 0 | 0 | 100 |
| 3. | 20 | 480 | 480 | 9.6 | 90.4 |
| 4. | 10 | 4440 | 4920 | 98.4 | 1.6 |
| 5. | 4.75 | 80 | 5000 | 100 | 0 |
| 6. | 2.36 | 0 | 5000 | 100 | 0 |
| 7. | 1.18 | 0 | 5000 | 100 | 0 |
| 8. | 600µ | 0 | 5000 | 100 | 0 |

Table No. 3.14 Sieve Analysis of Copper Slag.

| I.S. Sieve Size (mm) | Weigh Retained(kg) | Total weight retained(gm) | Total weight of passing(gm) | % of Passing | % of retained |
|---|---|---|---|---|---|
| 4.75 | 00.00 | 00.00 | 1000 | 100 | 00.00 |
| 2.36 | 89.00 | 89.00 | 911.0 | 91.10 | 8.900 |
| 1.18 | 405.0 | 494.0 | 506.0 | 50.60 | 49.40 |
| 0.6 | 384.0 | 878.0 | 122.0 | 12.20 | 87.80 |
| 0.3 | 82.00 | 960.0 | 40.00 | 4.000 | 96.00 |
| 015 | 18.00 | 978.0 | 22.00 | 2.200 | 97.80 |
| 0.075 | 10.00 | 988.0 | 12.00 | 1.200 | 98.80 |
| Pan | 12.00 | 1000 | 00.00 | 00.00 | 100.0 |

2) *Specific Gravity:* Specific gravity is define as ratio of mass of a substance either in liquid or solid state to the mass of an equal vol. of distilled water at 4ºC (39ºF). In the specific gravity determinations for aggregates, the average water temperature is 21ºC. Water at 21ºC weighs 998 kg/$m^3$. However, for ease of calculation, the mass of water used for metric concrete mix designs is 1000 kg/$m^3$. For the fine aggregate, the specific gravity is computed by dividing the mass (weight) of oven-dry sand in grams by the vol. of water displacing by the saturated surface in milliliters. For the coarse aggregate, the specific gravity is computed by dividing the mass (weight) of oven-dry material by the difference in mass (weight) of saturated surface dry aggregate and the mass (weight) of the same material immersed in water. To calculate it take 20mm aggregates weighing bucket is used and sp. gravity of 20 mm aggregates are found to be 2.94 that is given in 3.10 Table. Sp. gravity of sand is 2.60 that is given in 3.11 Respectively.

Table No. 3.16 Sp.gravity of C.A.

| Size of aggregate | Specific gravity |
|---|---|
| 20mm | 2.94 |

Table No. 3.17 Sp.gravity of F.A. (sand).

| Size of aggregate | Specific gravity |
|---|---|
| 0.075mm-4.75mm | 2.60 |

3) *Water Absorption:* For 20 mm sizes coarse aggregates, sand & copper slag. The water absorption are determined by conventional method and seen to be 0.601, 2.55 and 0.20 and so on. It is seen that water absorption of Artificial Sand is very high as compared to copper slag or its produce effect on workability of mixture. The water absorption of coarse aggregates and sand is given below.

Table No. 3.18 Physical properties of C.A., F.A.

| Fineness modulus | | Specific gravity | | Water absorption | |
|---|---|---|---|---|---|
| C.A. | Sand | C.A. | Sand | C.A. | Sand |
| 7.08 | 3.74 | 2.94 | 2.60 | 0.219% | 0.60% |

*4) Mixed Design of M20 Grade of Concrete acc. To IS:10262(2009)& IS 456(2000)*

*a)* Grade of Concrete: M20
*b)* Types of Cement : OPC(Ultratech)
*c)* Max. nominal sizes of aggregate 20 mm
*d)* Minimum cement content 300 Kg/m³
*e)* Max. water cement ratio 0.55
*f)* Degree of Workability 25-50 mm (slump)
*g)* Atmospheric situation Mild

Table 3.23: Details of Concrete Mix Proportions

| Percentage Copper Slag | Weight of Cement ($kg/m^3$) | Weight of Copper Slag($kg/m^3$) | Weight of Water($kg/m^3$) | Weight of C.A. ($kg/m^3$) | Weight of F.A. ($kg/m^3$) |
|---|---|---|---|---|---|
| W | 340 | 0 | 170 | 1308 | 709 |
| 5% | 323 | 17 | 170 | 1308 | 709 |
| 10% | 306 | 34 | 170 | 1308 | 709 |
| 15% | 289 | 51 | 170 | 1308 | 709 |
| 20% | 272 | 68 | 170 | 1308 | 709 |
| 25% | 255 | 85 | 170 | 1308 | 709 |

*5) Mix Design of M25 Grade of Concrete acc. To IS:10262(2009)& IS 456(2000)*

*h)* Grade of Concrete: M25
*i)* Types of Cement : OPC(Ultratech)
*j)* Max. nominal sizes of aggregate : 20 mm
*k)* Minimum cement content 300 Kg/m³
*l)* Max. W.C.R. 0.55
*m)* Degree of Workability 25-50 mm (slump)
*n)* Atmospheric situation Mild

Table 3.27 Details of Concrete Mix Proportions

| Percentage Copper Slag | Weight of Cement ($kg/m^3$) | Weight of Copper Slag($kg/m^3$) | Weight of Water($kg/m^3$) | Weight of C.A. ($kg/m^3$) | Weight of F.A. ($kg/m^3$) |
|---|---|---|---|---|---|
| W | 378 | 0 | 170 | 1285 | 697 |
| 5% | 359 | 19 | 170 | 1285 | 697 |
| 10% | 340 | 38 | 170 | 1285 | 697 |
| 15% | 321 | 57 | 170 | 1285 | 697 |
| 20% | 302 | 76 | 170 | 1285 | 697 |
| 25% | 283 | 85 | 170 | 1285 | 697 |

## VI. COMPRESSIVE STRENGTH TEST

Concrete is weaker in tensioning zone or strong in compression zone. Therefore it shall be strong enough to attain high compression. In this study for each mixed 3 different sample were examined and average strengthening is compared with nominal mix of M20 & M 25 Mix. Compressive strength test finds out the high amount of compressive loading of a cube. That it could bear below facture limit. The results of compressive strengthening at the age 7, 14 & 28 days are shown in table 4.1.

Table 4.1 Compressive Strength at various stage of curing (M 20)

| Percentage Replacement of Copper Slag | Compressive Strength (N/mm²) | | |
|---|---|---|---|
| | 7 Days | 14 Days | 28 Days |
| 0% | 17.36 | 29.60 | 31.05 |
| 5% | 18.36 | 25.02 | 27.84 |
| 10% | 18.68 | 25.47 | 28.43 |
| 15% | 19.68 | 26.82 | 30.08 |
| 20% | 19.10 | 26.04 | 29.26 |
| 25% | 17.19 | 23.24 | 26.06 |

Most concrete structures are designed assuming that concrete processes sufficient compressive strength. And this is very important criteria for the purpose of structural design. To study the strengthening development of concrete in comparison to Conventional concrete, compressive strengthening experiment were conducted at the ages of 7, 14, & 28 Days

Table 4.2 Compressive Strength at various stages of curing (M 25)

| Percentage Replacement of Copper Slag | Compressive Strength (N/mm²) | | |
|---|---|---|---|
| | 7 Days | 14 Days | 28 Days |
| 0% | 19.72 | 26.87 | 30.72 |
| 5% | 20.47 | 27.88 | 31.21 |
| 10% | 22.21 | 30.22 | 33.81 |
| 15% | 22.65 | 31.04 | 34.54 |
| 20% | 21.64 | 30.09 | 33.21 |
| 25% | 19.48 | 26.62 | 30.24 |

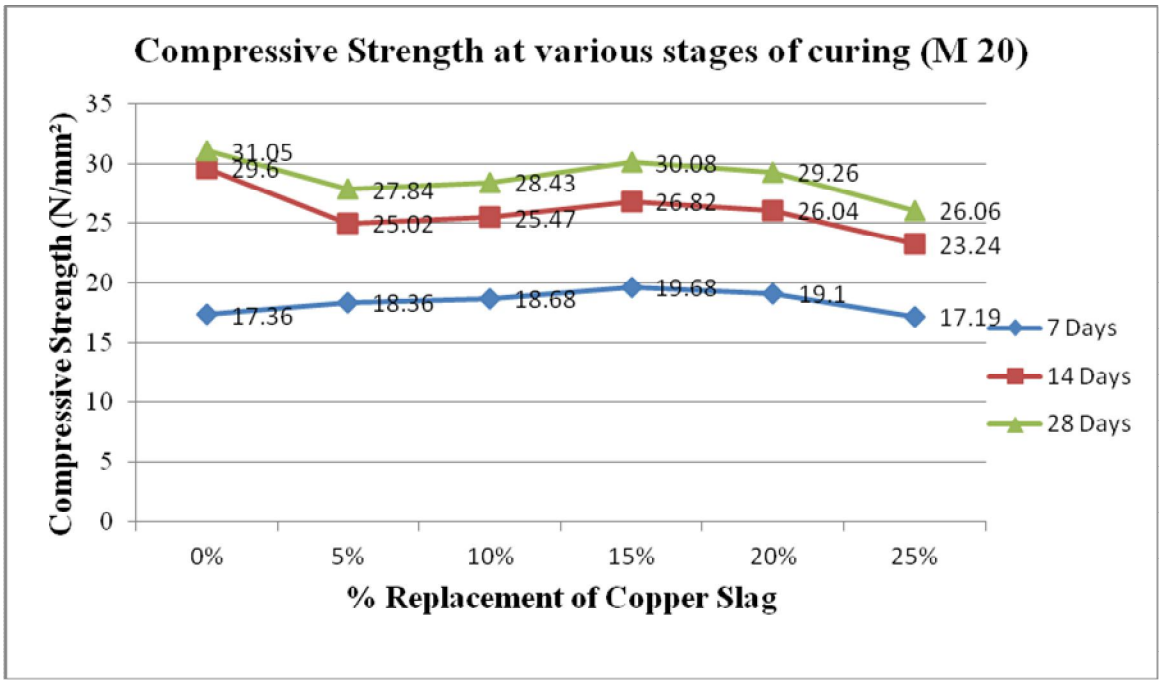



Figure: Compressive strength at various stages of curing (M20)

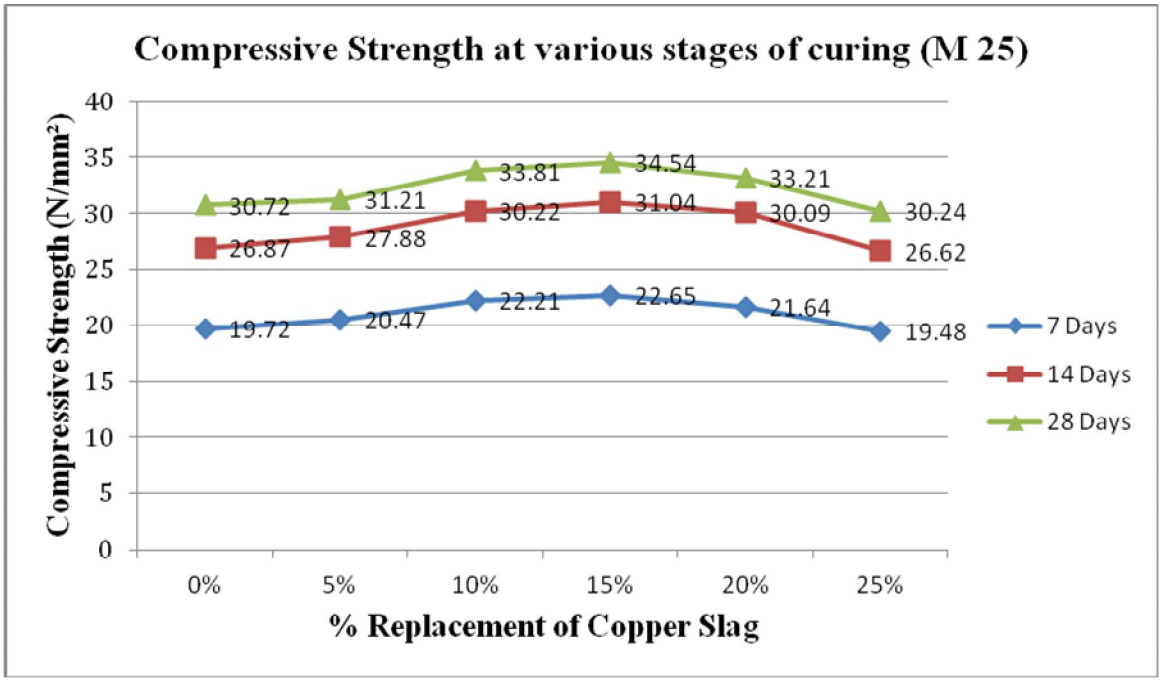



Figure: Compressive strength at various stages of curing (M25)

*A. Waste Management*

Copper slag is mixed in concrete mix as substitution material of Cement. It's one of the waste product of copper produces from iron or steel plants. The secure dumping of this industrial waste is costly and produces harmful atmospheric effect. In construction work, this is the only areas where it can be used. When it's mixed in concrete as replacing material, it over come land disposal problem, atmospheric pollution and also reduces concrete cost. Many researchers had already establish, copper slag achievable use as a material in concrete mix. In this analysis Copper slag is used in concrete in the form of replacement material of cement. For this study, M20 and M25 grades of concrete is prepared and the test are done for different substitute of cement using copper slag as 0%, 5%, 10%, 15%, 20% & 25% in concrete prepared with Cement.

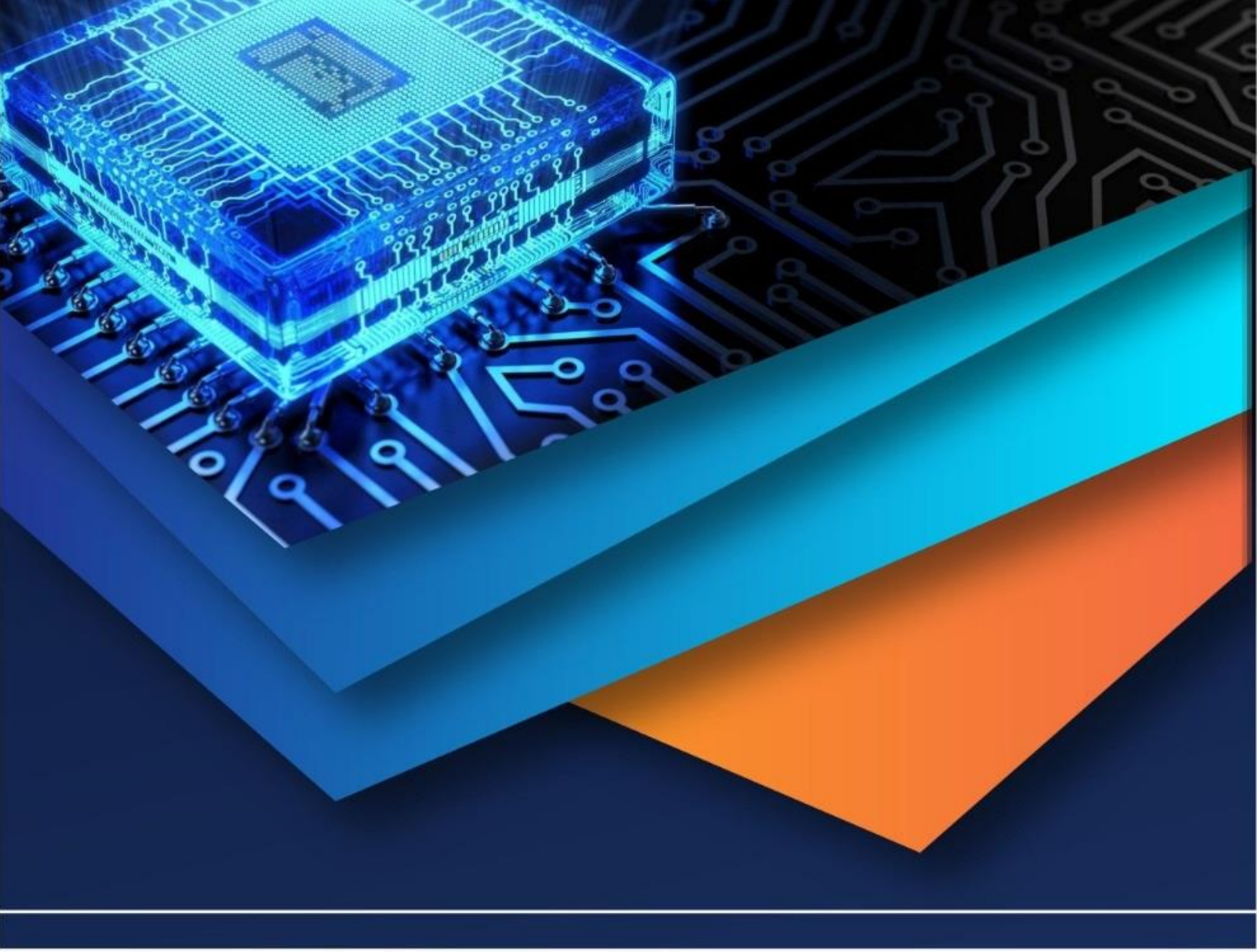
## VII. CONCLUSION

Based on the experimental investigation following assumptions are as follows:

*1)* A Copper slag is such type of waste used as a substitute to Cement in concrete.
*2)* From this investigation, the copper slag particles are waste of low cost material which would help to resolve solid waste disposal problem and protect environment from pollution.
*3)* Cost of Concrete manufacturing reduces when in concreting cement replaced by copper slag.
*4)* More Amount of Copper Slag increasing the density of concrete mix so its directly increase the Self-weight of concrete mix.
*5)* The Compressive Strengthening of Concrete mix with half substitute of cement with Copper Slag up to 20% can be comparable with conventional Concrete.
*6)* Partial substitution of Copper waste in concrete with shows good resistance against sulphate attack.

*A. Scope Of Future Work*

*1)* This research work was proposed to study the influence of copper slag put in M20 & M 25 mixes. And the similar words could be extended to higher grades of concrete mixed with varying water/cement ratio.
*2)* Copper slag could be successfully replaced by manufacture bricks, hollow blocks or pavement blocks.
*3)* While it have high shearing strengthening value so it could be useful for stabilization purpose.
*4)* It could be replacing with silica fume, RCC members, granulated blast furnace.



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