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Partial replacement of sand by copper slag for concrete mix

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Abstract - *The diminishment in the origin of natural sand and the prerequisite for lessening in the expense of creation concrete generation has brought about the expanded need to recognize substitute material to sand as fine total in the creation of cement. Copper slag, by item is that substitute material utilized as an option of sand. Copper slag is a by-item made amid copper purifying and refining process. As refineries draw metal out of copper mineral in vast volume and can be utilized as a part of a shocking number of utilizations in the building and the mechanical fields.*

Numerous studies are made with a few different materials which gave the concrete to be a material made of reused material however the parameters that are essential for the material was not fulfilled. There are numerous endeavors have been made to examine the properties of cement and to research a few properties of copper slag the suitability of those properties to empower them to be utilized as fractional trade material for sand in cement up to 80%-100%. Copper slag is considered as one of the waste materials which can have a promising future in the development business as incomplete or full substitution of either concrete or material. For every ton of copper creation, around 2.2 tons of copper slag is produced. This slag is at present utilized for some reasons such as area filling, development of rough devices. These applications use just around 15% to 20% of copper slag created and the remaining material is dumped as a waste.

Numerous analysts have officially thought that it was conceivable to utilize copper slag as a concrete total, since copper slag has comparative molecule size qualities liable to that of sand. Fine grained powder of copper slag can be utilized as a supplementary concreteifying material to concrete and in bond clinker creation. This examination was performed to produce particular exploratory information on the potential utilization of copper slag as sand and bond substitution halfway in cement.

Key Words: Concrete, Sand, Copper slag.

1.INTRODUCTION

In India, there is great demand of sand mainly in civil engineering industry for cement concrete, road and building constructions. Now days it's very difficult issue for access of fine materials. Therefore analysts created waste administration techniques to use for substitution of fine material for a selected would like. The sudden increment in the regular material utilization consistently because of the expansion in the development business overall implies that the material stores are being drained quickly, especially in desert nations, for example, Arabian Gulf locale. It has been accounted for that, without legitimate option material being used sooner rather than later, the concrete businesses internationally expend 8-10 billion tons of regular material after a few years. Numerous mechanical wastes for example, stone dust, silica rage, and impact heater slag and copper slag is pollution; thus require legitimate gathering, transfer and capacity. Copper slag generated from copper refineries are considered as a waste material which could be used in the production of concrete as partial or full substitution of either bond or material. *For every ton of copper production, around 2.2 tons of copper slag is produced. Only 15% to 20% of copper slag are used in different applications like area filling, development of rough devices and the remaining material is dumped as a waste. Keeping in mind the end goal to lessen the amount of copper slag gives an option material to sand and bond a methodology has been done to research the use of copper slag in cement for the partial substitution of sand and concrete.* In the present study, it is proposed to think about the impact of expansion of copper slag blended with coarse sand in cement.

1.1 High performance and high strength concrete

Conventional concrete has so many quality and performance issues like bleeding, segregation, transportation and negative impact on environment due to emission of CO_2 by the manufacturing of cement. Also, the compressive strength of conventional concrete without admixtures is up to a particular limit. Admixtures lowers the water cement ratio, makes the concrete frost resistant, rainfall and hence increasing the compressive strength. So far as emission of CO_2 from manufacturing of cement is considered, some substitutes with comparable strength like pozzolana, rice husk, silica exhaust can be used by partially replacing the amount of cement. Also slag generated from metal refineries can be used by partially replacing the amount of sand like copper slag. The size of copper slag is similar to that of sand and it has good bond making property with cement.

1.2 Composite Material

Composite materials are produced using two or more individual materials with different physical or chemical properties and the produced material has different qualities from the combining materials. There are different types of composite material depending upon the utility of the object and the strength required. One constituents of composite materials is fiber sheets or particles which increases the strength of the combined particle after being implanted in base material which is known as the lattice stage. The prime elements of the framework are to exchange stresses between the strengthening filaments/particles and to shield them from mechanical and/or ecological harm while the nearness of strands/particles in a composite enhances its strength and other properties, for example, quality, and firmness and so on. RCC (Reinforced cement concrete) is a composite material prepared by implanting steel bars in concrete. Reinforced composite material can be prepared by two methods- particle reinforced composite method and fiber reinforced composite method. Fiber reinforced composite method increases the concrete strength, durability and makes it resistance from frost.

2. METHODOLOGY

The first step in methodology is preparation of cubes and beams with sand and copper slag of M25 grades of concrete. There are two types of mix, one constituting cement sand and coarse aggregate and the other constituting partial replacement of sand by copper slag. The partial replacement of sand by copper slag starts from 20%, 40% up to 100% with 20% increase in each step. After the preparation of cubes and beams, performing destructive and non-destructive testing to assess the strength of beams, cubes and also the analysis of the mix batch which gives the information about the mix having highest strength out of the total mix. Cubes are tested for compressive strength by compression testing machine and beams are tested for flexural strength by flexural strength testing machine.

3.RESULT AND DISCUSSION

3.1 Selection of materials

In this study PPC cement was used for design mix. Fine aggregate of zone II having specific gravity = 2.66 is used with partial replacement of copper slag by 20, 40 and 60 %.

Figure- 1: Copper Slag

Specific gravity of copper slag used is 3.91 and hardness of the slag lies somewhere around 6 and 7 in Moh scale. The nominal size of coarse aggregate used is 10 mm having specific gravity 2.7. The M-25 grade mix design with ratio 1:1:2 was selected for w/c ratio 0.43.

Table- 1: Physical properties of copper slag

Physical Properties	Copper slag
Shape of Particle	Irregular
Looks	Black & glassy
Nature	Air cooled
Sp. gravity	3.91
Voids Percentage	43.20%
Modulus of Fineness	3.47
Internal friction Angle	51° 20’
Hardness	67 mohs
Absorption of Water	0.3 to 0.4%
Moisture	0.1%
Fineness	125 m^2 /kg

Table- 2: Chemical Analysis of copper slag

Chemical Component	**% Of Chemical Component**
SiO2	25.84
Fe2O3	68.29
Al2O3	0.22
CaO	0.15
Na2O	0.58
K2O	0.23
LoI	6.59
Mn2O3	0.22
TiO2	0.41
SO3	0.11
CuO	1.20
Sulphide sulphur	0.25
Insoluble residue	14.88
Chloride	0.018

3.2 Result

Table- 3: Compressive Strength of Cubes

Mix	Compressive Strength Mpa		
	7 Days	14 Days	28 Days
Normal M-25	23.97	28.88	34.82
20% C.S + 80% SAND	32.92	35.67	43.4
40% C.S + 60% SAND	23.96	25.11	37.08
60% C.S + 40% SAND	23.88	36.94	43.4
80% C.S + 20% SAND	22.88	25.18	31.89
100% C.S	28.99	28.85	38.17

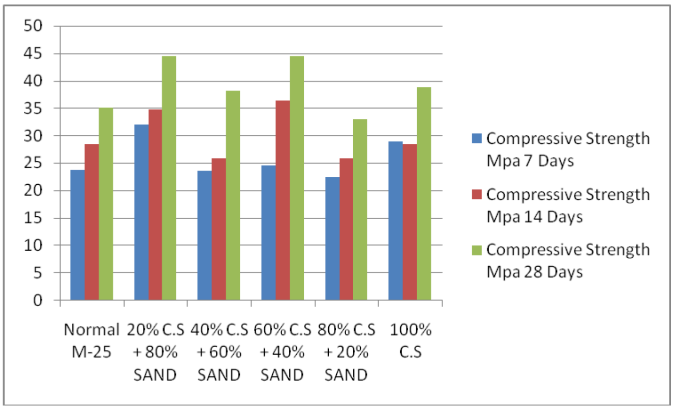

Figure- 2: Compressive Strength of Cube

Table- 5: Flexural Strength of beams

Mix	Flexural Strength (Mpa)
Normal M-25	0.94
20% C.S + 80% SAND	1.23
40% C.S + 60% SAND	1.22
60% C.S + 40% SAND	1.24
80% C.S + 20% SAND	1.15
100% C.S	0.89

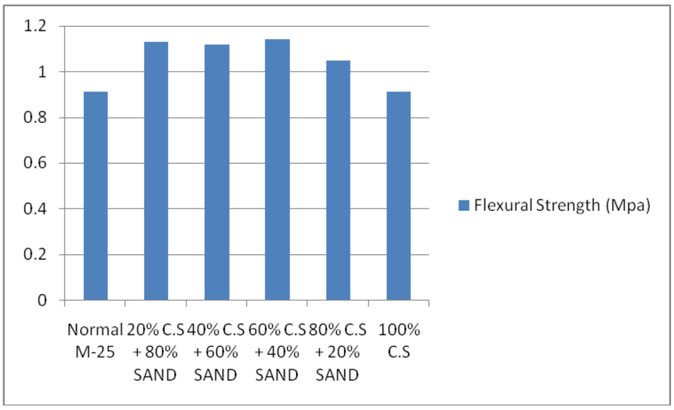

Figure- 3: Flexural Strength of Beam

Table- 5: UPV result of beams

Mix	UPV (M/sec)
Normal M-25	2.640
20% C.S + 80% SAND	2.545
40% C.S + 60% SAND	2.435
60% C.S + 40% SAND	2.685
80% C.S + 20% SAND	2.525
100% C.S	2.700

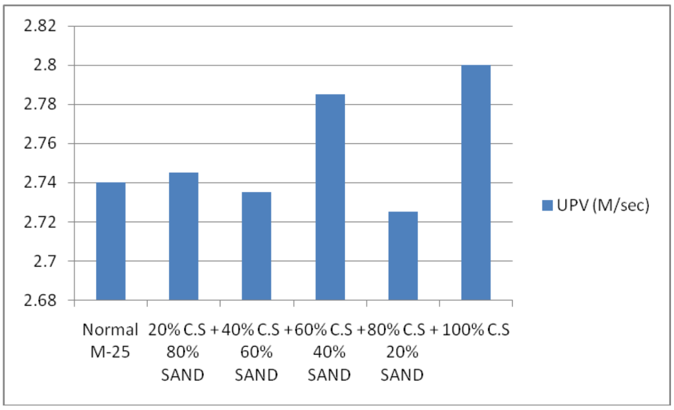

Figure- 4: Ultrasonic pulse velocity of beam

3.3 Discussion

Compressive Strength

It is attainable that the reduction in strength ensuing from increasing copper slag is attributable to raised voids because

of the very fact that copper slag possesses fewer fine particles than fine aggregate. It might even be as a result of the rise of the free water because the copper slag absorbs less water than the fine aggregate. From the check results, it will be seen that compressive strength of copper slag concrete mixes with 20% 40% 60% and 80 % of sand replacement with copper slag, were higher than the control mix at all ages. the best compressive strength was achieved by 20% replacement of copper slag that was found regarding

32 Mpa and compared with 23.67 Mpa for the control mixture. This implies that there's a rise within the strength of virtually 35.15% compared to the management combine at 7days. However, mixture with 80th replacement of copper slag gave all-time low compressive strength 22.44 Mpa that is sort of 5% below the strength of control mix.

Flexural Strength

Flexural strength continuing to extend with the rise within the copper slag percentages up to 60% only at 28 days however at that time it goes on decreasing with the rise within the copper slag percentages.

4. CONCLUSIONS

1. As the percentage of copper slag increases workability increases.

2. Maximum Compressive strength of concrete increased by 35 % at 20% replacement of fine aggregate, and up to 60% replacement, concrete gain more strength than normal concrete strength.

3. It is observed that up to 60% replacement of natural sand by copper slag, the flexural strength of concrete is increased by 20%. And all percentage replacement of fine aggregate by copper slag the flexural strength of concrete is more than normal mix.

4. Compressive strength and flexural Strength is increased due to high toughness of copper slag.

5. Replacement of copper slag in fine aggregate reduces the cost of making concrete.

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