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Copper Slag and Waste Glass Powder as Partial Replacement of Sand

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ABSTRACT

The construction industry worldwide faces a great demand of natural resources due to modernization of day-to-day life. To meet this increase in demand one must go for excessive mining of riverbed and that leads to natural imbalance. India is in a period of rapid development where natural resources are being used extensively. It will harm the future generation because many natural resources such as land, mineral wealth and water are non-renewable in the short term. Therefore, it is necessary to embark on an eco-friendly way of production to achieve sustainable development. The main objective of this investigation is to compare the strength parameters of the conventional concrete with the concrete having waste copper slag and glass powder incorporated in various percentages as partial replacement of fine aggregate. The M30 mix design was prepared and used for conventional as well as modified concrete. Total of 24 cubes were casted to examine the compressive strength of concrete, and 24 cylinders were casted to examine the split tensile strength of concrete, and 12 beams were casted to examine the flexural strength of concrete.

Keywords: Waste Copper slag, Glass powder, Compressive Strength

I. INTRODUCTION

Sand is a very useful material to have at your disposal when it comes to buildings and structures. It's versatile and affordable whilst also being strong and durable. Sand is used to make concrete, mortars, and plasters and can also be used for filing purposes.

When used in construction it provides bulk, strength, and stability to the other materials that it is used with such as asphalt, concrete, mortar, and cement. Its compressed structure makes it perfect for filling in voids and for levelling out floors.

For concrete and therefore for the construction industry, only marine sand can be used. The grains of desert sand are too round for the cement to adhere.

The erosion process in which rocks become sand takes several hundred years, and we are depleting our resources at a much faster rate. Soon there may not be enough sand for the construction industry, and the environmental consequences of sand extraction are enormous. Natural resources are decreasing in all over the world and increasing wastes from industries generated simultaneously. The ecofriendly and reliable development for construction consists the use of non-conventional and different waste materials, and recycling of waste material for reducing emissions in environments and decreasing the use of natural resources.

Copper slag is a massive metallurgical residue obtained from the transformation of copper ore concentrates into metallic copper in the smelters.

Around 4.5 million tons of copper slag is produced each year. Although copper slag is used in grit blasting and land filling, only 15 to 20% of it is being used as of 2015. Since this is a heavily wasted material, finding ways to use it in different industries can reduce overall waste. it is a granulated material with similar properties to sand, but with higher density and lower permeability.

Annually tons of waste glass is being generated all over the world. The glass waste remains unsustainable product being disposed as landfills, as it never decomposes in the environment.

Research shows that inclusion of glass waste in the form of glass powder with a grind size of grind size of less than 10 microns gives better strength or durability to the concrete slabs.

II. METHODS AND MATERIAL

Materials used in this experiment are Cement, Sand, Aggregate (20mm, 10mm), Waste Copper Slag, Glass powder, Super plasticizer (1% by weight of cement).

The mix proportions were calculated for M30 grade of concrete for w/c ratio of 0.43 respectively by using IS-10262-2009 method of mix design. Keeping w/c ratio and cement content as constant for control mix and by 0, 25, 40, 55 % replacement of sand.

TABLE I. Mix Proportions

MIX No.	Cement	WASTE COPPER SLAG	GLASS POWDER	SAND
M1	100%	--	--	100%
M2	100%	20%	5%	75%
M3	100%	30%	10%	60%
M4	100%	40%	15%	45%

In this experiment, the workability parameters such as slump value were studied. In hardened state, the strength tests such as compressive strength, split tensile strength and flexural strength were studied for each mix.

Some tests were done on cement, aggregate, waste copper slag. And the results are tabulated below.

TABLE II. Tests of cement

Tests on cement	Values	Referred IS Codes	Standard values
Fineness	8.33	IS 2386(Part 3) 1963	Less than 10
Specific gravity	2.96	IS 2720(Part-3)	3.15
Normal consistency	35%	IS: 4031 Part-4 (1988)	27-33%
Initial Setting time	40 min	IS 4031 Part-5 (1988)	30 minutes
Final Setting time	9 hrs approx.	IS 4031 Part-5 (1988)	10 hours

TABLE III. Test on aggregate

Test on aggregate	Value	Referred IS code	Standard value
Fineness Modulus (Fine Aggregate)	2.76, mediu m sand	IS 383-1970	2.6-2.9
Specific gravity	2.65, normal sand	IS 2386 PART 3 1963	2.65-2.67
Sieve Analysis	Zone - II	IS 383-1970	
Fineness Modulus (Coarse Aggregate)	7.049	IS 383-1970	

TABLE IV. Test on Copper Slag

Test on Copper Slag	Value	Referred IS code
Finenes s Modulu s	2.14	IS 2386 (Part 3) 1963
Specific Gravity	3.52	IS 2720 (Part-3)

III. RESULTS AND DISCUSSION

Table test for this investigation and the results are as follows:

TABLE V. Workability Test Results

MIX No.	SLUMP VALUE
M1	80mm
M2	85mm
M3	75mm
M4	75mm

The prepared concrete samples were tested after 7, 14, 28 days for compression test, split tensile strength and Flexural Strength.

TABLE VI. Compression test

MIX No.	Compressive Strength (N/mm²)		
	7 days	14 days	28 days
M1	18.22	26.66	35.11
M2	24.88	31.11	40.88
M3	19.55	27.55	37.77
M4	20.44	27.78	31.11

TABLE VII. Split Tensile Strength test

MIX No.	Split Tensile Strength (N/mm²)		
	7 days	14 days	28 days
M1	1.6	1.93	3.89
M2	1.69	2.26	5.65
M3	1.27	2.38	3.96
M4	2.26	2.12	2.40

TABLE VIII. Flexural Strength test

MIX No.	Flexural strength (N/mm²)		
	7 days	14 days	28 days
M1	2.2	2.9	3.43
M2	2.4	3.1	5.25
M3	2.2	3.4	4.29
M4	2.0	3.75	3.3

IV. CONCLUSION

- The compressive strength showed highest value for given design mix with 15% replacement of sand having 20 percent of copper slag and 5 percent of waste glass powder.
- Showing a compressive strength of 40.88 KN/mm2 about 15% more than the conventional concrete.

And after that there seem to be a slight decrease in compressive strength.

- Maximum split tensile strength and flexural strength showed with 20 % copper slag and 5% waste glass powder(M1 mix).
- No bleeding and segregation were observed with replacement of copper slag and waste glass powder upto 40% replacement.
- Therefore, it can be said that by replacing fine aggregate with 2 % of copper slag and 5% of waste glass powder gives strength more than the conventional concrete at 28 days for compressive strength, split tensile strength and flexural strength.

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