EXPERIMENTAL INVESTIGATION ON PROPERTIES OF CONCRETE WITH BAGASSE ASH AND COPPER SLAG

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Abstract : Durability of concrete and economy has made it the world's most used construction material. It is basically consists of four components: cement, water, aggregates and admixture. Development of infrastructure necessitity production of large quantities of cement and usage of natural resources. Initiatives are emerging worldwide to strike a balance between the developments in infrastructure and prevention of the environment from contamination by reusing the industrial wastes. Thus, requirements for more economical and environmental-friendly cementing materials have extended interest in partial replacement of cement with Sugarcane Bagasse ash (SBA) at 5%, 10%, 15% and partial replacement of sand by Copper slag (CS) at 30%, 40%, 50%. Compressive strengths of cube specimens were found at 7th, 28th & 56th days, Tensile strength of cylindrical specimens were found at 28 & 56days and The flexural strength of specimens were found at 28day.The results indicate that addition of SBA and CS improve the mechanical properties of concrete.

Keywords: – Sugarcane Bagasse Ash, Copper slag, Cube compressive strength, Tensile strength & Flexural strength.

I.INTRODUCTION

Any development should aim to meet human needs while preserving the environments that these needs can be met not only in the present, but also for future generations. The field of sustainable development can be conceptually broken into three constituent parts of Environmental sustainability, Economic sustainability and sociopolitical sustainability. Natural resources are depleting worldwide while at the same time the generated wastes from the industry are increasing substantially. The sustainable development for construction involves the use of nonconventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways to conserve the environment. Due to the recent researches in the field of concrete technology it is possible to utilize industrial byproducts as well as other waste materials in the production of normal concrete and high strength concrete as partial or full replacement of cement or aggregate. Also, it has been demonstrated that many of the produced concrete made with wasteland industrial resources possesses superior properties compared with the conventional concrete in terms of strength, performance and durability.

II LITERATURE REVIEW

Srinivasan.R et al, found the Experimental study on bagasse ash in concrete a partially replacement of cement with SBA at 0, 5, 15 and 25%.Up to 10% of the compressive strength, split tensile strength and flexural strengths increase and beyond that, strength was found to decrease.

Shruthi.H et al, found the replacement of cement with SBA at 5, 10, 15 and 20% for M_{25} grade concrete with water to cement ratio of 0.5 Up to 10% of the compressive strength, split tensile strength and flexural

strengths increase and beyond that, strength was found to decrease.

Lavanya.R et al, found the Experimental study on the compressive strength of concrete by partial replacement of cement with SBA as a partially replaced for up to 30% of cement with varying w/c ratio of 0.35, O.4, 0.45.The found to maximum strength properties increase at 15% with 0.35 w/c ratio.

Brindha.D et al, found the Utilization of copper slag as a partial replacement of fine aggregate in concrete of Copper slag at 5, 10, 15, 20, 30, 40 and 50% for M_{25} grade concrete. Up to 40% of the compressive strength, split tensile strength and flexural strengths increase.

Balakrishna.B et al, found that Flexural behavior of beams with partial replacements of fine aggregate with CS for M_{40} grade of concrete. Optimum replacement in strength at up to 40% increases.

Deepak.R et al, foud the Experimental study on flexural behavior of reinforced concrete beams by replacing fine aggregate with Copper slag replace at 35, 40 and 45% and concrete mix of M_{30}.The optimum level of replacement of copper slag was found to be 40%.

III MATERIAL USED IN CONCRETE

Concrete is an artificial material, which is made up of cement, fine aggregate, coarse aggregate and water. An attempt has been made to replace cement by Bagasse ash and sand by Copper slag with different percentage of replacement.

A. Cement

Cement is a binding material in concrete which binds the other materials to forms a compact mass. For this the research work, 53 grade Ordinary Portland Cement (OPC).Table 1 gives the properties of the cement used.

Table.1 Properties of Cement

Particulars	Test Value
Fineness	5%
Specific gravity	3.15
Consistency	33%
Specific gravity	3.15
Initial setting time	55 min
Final setting time	255 min

B. Sugarcane bagasse Ash

Bagasse is a by-product from sugar industries which is burnt to generate power required for different activities in the factory. The burning of Bagasse leaves Bagasse ash as a waste, which has a pozzolonic property that can potentially be used as a cement replacement material. The Bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness. The higher silica content in the Bagasse ash was is the main cause for these improvements. Although the silicate content may vary from ash to ash depending on the burning conditions and other properties of the raw materials including the soil on which the sugarcane is grown, it has been reported that the silicate undergoes pozzolanic reaction with the hydration products of the cement and results in a reduction of the free lime in the concrete. Table 2 gives the comparison between the chemical composition of SBA and OPC.

Table 2 Chemical Composition SBA and OPC

S.No	Oxides	SBA (%)	OPC (%)
1	SiO_2	67.81	20.98
2	Al_2O_3	19.41	5.24
3	Fe_2O_3	3.85	3.92
4	CaO	4.03	62.85
5	MgO	1.11	1.76
6	Na_2O_3	0.35	0.28
7	SO_3	0.66	2.36

C. Fine aggregate

Sand is classified according to the shape of its particles. Usually, the natural river sand is used as fine aggregate. The specific gravity of the fine aggregate was found to be 2.62. By conducting sieve analysis, it was found that sand confirms to grading zone II as per IS 383:1970 and fineness modulus of sand was found as 2.71.

D. Copper slag (CS)

In the separation of copper, slag is a by-product obtained during the smelting and refining of copper. The major constituent is sulphides and oxides of iron and copper. They also contain oxides such as SiO_2, Al_2O_3, CaO and MgO, which are either present in original concentrate or added as flux. Table 3 gives the properties and chemical composition of copper slag.

Table 3 Properties and Chemical Composition of Copper Slag

S.No	*Property*	*Values*
1.	*Appearance*	*Black glassy granules*
2.	*Shape*	*Granular*
3.	*Specific gravity*	*3.6*
4.	*Chloride content water soluble*	*11ppm*
5.	*Bulk Density*	*1.8*
6.	Fe_2O_3	*56.4%*
7.	SiO_2	*28.7%*
8.	*Cao*	*2.1%*
9.	Al_2O_3	*3%*
10.	*Free moisture*	*1.3%*

E. Coarse aggregate

The important parameters of coarse aggregate that influence the performance of concrete are its shape, texture and the maximum size. Since the aggregate is generally stronger than the paste, its strength is not a major factor for normal strength concrete. From the sieve analysis if is found that aggregates are confirming to single sized aggregates of nominal size 20mm. The specific gravity was found to be 2.67

F. Water

The water used to make concrete must be clean and free from organic matter. Water acceptable for drinking is preferable for making concrete. Salt water may be used if fresh water is not readily available, but it will reduce the strength of concrete by about 15 percent. Enough water is needed for the hydration reaction too much water leads to a reduction in strength. Hence only the quantity of water needed is to be added. During the current research, cement was replaced with SBA.

III. MIX DESIGN

In this investigation concrete mix design M40 was designed based on IS 10262 – 2009. This code presents a generally applicable method for selecting mixture proportion. Mix Design are given below in table 1. The quantity of material used in this study details are given below in table.

Mix proportions

Cement	Fine Aggregate	Coarse Aggregate	W/C
1	1.7	2.4	0.4
1	2.1	2.7	0.5

Notations of specimens

Mix proportions *all values are in kg/m3

Notations	Phosphogysum %	W/C
NA1	0	0.4
PH1	10	0.4
PH2	20	0.4
PH3	30	0.4
NA2	0	0.5
PH4	10	0.5
PH5	20	0.5
PH6	30	0.5

VI. METHOD OF EXPERIMENT

It is important that the constituent material of concrete remain uniformly distributed within the concrete mass during the various stages of handling and that full compaction is achieved, and making sure that the characteristics of concrete which affect full compaction like consistency, mobility and compatibility are in conformity with relevant codes of practice. The tests were carried out in accordance with relevant IS Standards. The aggregates were tested for physical properties such as specific gravity and particle distribution test. All the mixes were prepared by mixing the concrete in laboratory mixer with water. For compressive strength 72 NOS cube specimens of size 150 mm x 150 mm x 150 mm, for flexural strength studies, 72 NOS prism specimens of size 100 mm x 100 mm x 500 mm and 72 NOS cylinder specimens of size 300 mm height and 150 mm diameter for split tensile strength studies were prepared. For durability properties specimens were cast and cured for 28 days as per standard curing methods.

V. ANALYSIS AND TEST RESULT:

Compressive Strength Test

The results of the compressive tests of various concrete mixes at the age of 7, 14, 28 days are given in Table below

Mix	Compressive strength in N/mm2		
	7 days	14 days	28 days
NH1	19.6	30	36.88
PH1	20.31	31.10	38.22
PH2	11.21	17.17	21.11
PH3	9.91	15.17	18.66
NH2	18.5	29.3	36
PH4	18.3	28.91	35.55
PH5	11.5	18.07	22.22
PH6	10.3	16.30	20

Tensile Strength Test

The split tensile test is a method of determining the tensile strength of the results of the split tensile tests of various concrete mixes at the age of 28 days are given in Table below

Replacement of cement with phosphogypsum, %	Water-cement ratio	Split tensile strength, N/mm^2
0%	0.4	2.263
	0.5	2.348
10%	0.4	2.475
	0.5	2.178
20%	0.4	2.065
	0.5	1.839
30%	0.4	1.641
	0.5	1.697

VI. CONCLUSION

- Compressive strength and splitting tensile strength has its maximum value at 10% replacement of cement with phosphogypsum, it reduces if the percentage replacement is more than 10%.Thus the optimum amount of phosphogypsum to be added to concrete is 10%.
- There will be significant reduction in the cost of concrete if phosphogypsum is added to it. The scarcity of cement and its increased cost are serious problems faced by construction industry. Use of phosphogypsum in concrete will be an appropriate solution to these problems
- The stack of phosphogypsum dumped by the fertilizer plants is a serious waste disposal problem. Effective utilization of phosphogypsum in concrete reduces the intensity of problems caused by its dumping.
- Thus phosphogypsum which is a by-product of fertilizer plant and chemical industries can be effectively utilized by partial replacement of cement in concrete with phosphogypsum. This method is surely a step toward sustainable development and is important in engineering, environmental and economic point of view.

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