Experimental Study on Behaviour of Concrete by Partial Replacement of Cement with Carbon Black Ash

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Abstract— The use of conglomerate cement is becoming open space in these days liability to the tackles made by the professorate in the direction of enactment of resources, which are attainable in natural bountifully. The novel additions carbon black ash which is extracted from rubber tires, which is tried in recent times without any scientific study, was found to be sufficient. While, there is much to be done in order to draft the properties of the said additives. An attempt is made in the present work to investigate of these additives on the compressive strength, Split Tensile Strength and Flexural strength of cement concrete. The main purpose of this study to investigate the influence of additives to cement. The strength characteristics of the concrete (M25) were used with varying percentage of additives was worked out giving certain proportions by adding carbon black ash @ one inch in the percentage of 0%,5%,10%,15%,20% to the concrete mix and changes in strength and workability parameters were studied. In the present work, an effort is being made to use new additives as the ingredients of concrete and study the effects on M25 grade concrete. The scope of work is limited to find out the behavior of concrete in compression and tension.

Key words: Carbon Black Ash, Compression Strength, Split Tensile Strength, Concrete, Aggregate, Water Absorption

I. INTRODUCTION

Concrete today is the most versatile material for all types of construction works and has been used for innumerable construction works either as plain concrete or as reinforced cement concrete or as precast concrete or pre-stressed concrete or in many other forms. In building industry, the concrete is mainly used for beams, slabs, staircases, lintels, storage tanks, etc. Cement concrete is an artificial building material which is obtained by mixing together certain inert materials called coarse aggregate and fine aggregate with active constituents like cement and water. The mixture is in a plastic condition, when allowed to set becomes hard as stone. The strength of cement concrete depends on its ingredients, their relative quantities and the manner in which they are mixed and placed. By suitably adjusting the proportions of cement, coarse aggregate, fine aggregate and water it is possible to get the concrete of sufficient compressive strength for various uses. Because of high strength capability in compression, the concrete is considered to be a versatile material and it is used as a tough mix for road construction, as a rich mix for heavy structural members, namely columns, gravity dams, etc. and as a lean mix for foundation. For this reason and due to many other advantages, such as high durability, better appearance, ease of construction, economy, etc. the cement concrete is considered superior to other materials and hence is being extensively used for construction of modern structures. Plain cement concrete has very little tensile strength and hence to withstand the tensile forces it has to be reinforced in structures usually by steel. Cement concrete is classified into plain cement concrete, reinforced concrete, vibrated concrete, precast concrete, prestressed concrete.

II. LITERATURE REVIEW

Gaurav Navnit Nagavkar (2017) studied the effect on properties of concrete with partial replacement of additives with cement. Additives used were Carbon Black in varied percentages. It was observed that the addition of waste material and other admixtures in cement concrete enhances the compressive, tensile and flexure strength on the other hand it also makes concrete more economical and eco-friendlier.

Perviz Ahmedzade & Tacetinn Geckil (2017) studied the effect of carbon black on mechanical and electrical properties of asphalt mixture was investigated by the authors. Marshal stability test, creep stiffness, indirect tensile modulus and indirect tensile strength test were performed. Based on the value best result were obtained from the mixture with carbon black as filler. Result of investigation shows that carbon black improves both mechanical and electrical conductivity of asphalt mixture

B. Padma Priya & Pandeeswari (2016) investigated the effects of compressive strength of concrete by addition of Carbon Black up to 30%. Carbon Black was replaced by cement and proved to give higher value of compressive strength. The addition of PET (Polyethylene Terepththalate) lowered the strength of concrete and hence Carbon Black was added in order to increase the strength.

Sami Masadeh (2015) studied the corrosion of steel reinforcement after adding carbon black in concrete mix. It was achieved by inserting steel reinforcement in different concrete with different carbon black percentage. And sample was immersed in 3.5% chloride solution for next 6 month. It was observed that the corrosion rate decreases with increase in carbon black percentage by making the concrete dense.

Dr. G. Chitra et al. (2014) studied by including Carbon Black as an Additive in Conventional Concrete. Addition of carbon black beyond 8% is found to be not effective which was seen from the reduction of the performance of 12% and 15% samples. It was concluded that the addition of Carbon Black up to 5% as a filler will be very effective in concrete. Moreover, addition of 8% Carbon Black in the concrete shows excellent closure of pores and for water absorption.

Kharitas Yousef and Alnassar (2008) investigated the shielding property carbon powder was added to concrete made of hematite aggregate. Carbon powder was added in different percentage and it was found that the result of 6% (by wt.) of concrete could increase the strength by 15% and shielding effectiveness decrease for gamma and neutron with adding more percentage of carbon powder.

A. Goldman and A. Bentur (1993) replaced Silica fumes by carbon black as alternate micro filler. Result indicated that Carbon Black is effective in modifying basic concrete matrix strength to an extent similar to silica fumes.

III. EXPERIMENTAL PROCEDURE

It was proposed to investigate the properties of concrete, cast with partial replacement of cement with bagasse ash in the ratio of 0%, 5%, 10%, 15% and 20% proportions and cured in water.

IV. RESULTS

A. *Fresh Properties*

The following are the results obtained in various laboratory tests carried out in this study:

	Mix	Slump (mm)
1	NORMAL MIX	90
2	CBA 5%	82
3	CBA 10%	80
4	CBA 15%	76
5	CBA 20%	74

Table 1: Slump Flow Test Results

S. No	Mix	Compressive Strength (N/mm^2)		
		3 Days	7 Days	28 Days
1	NORMAL MIX	14.14	26.92	36.91
2	CBA 5%	18.95	27.12	37.01
3	CBA 10%	17.22	27.42	37.52
4	CBA 15%	13.42	24.64	34.93
5	CBA 20%	10.69	20.02	30.07

Table 2: Compressive Strength Results at 3,7 & 28 days

S. No	Mix	Split Tensile Strength (N/mm^2)		
		3 Days	7 Days	28 Days
1	NORMAL MIX	1.2	1.98	2.56
2	CBA 5%	1.32	1.56	2.6
3	CBA 10%	1.33	1.62	2.72
4	CBA 15%	1.1	1.42	2.38
5	CBA 20%	1.02	1.09	1.92

Table 3: Split Tensile Results at 3, 7 & 28 days for Cylinders

S. No	Mix	Flexural Strength (N/mm^2)		
		3 Days	7 Days	28 Days
1	NORMAL MIX	2.82	4.62	5.86
2	CBA 5%	2.76	4.54	6.1
3	CBA 10%	2.72	4.52	6.32
4	CBA 15%	1.92	3.33	5.64
5	CBA 20%	1.9	3.12	4.82

Table 4: Flexural Strength Results at 3,7 & 28 days for Cylinders

B. *Strength Activity Index*

Strength Activity Index (S.A.I) is the ratio of 10% replacement levels of cement with CBA to the control expressed as a percentage. The S.A.I was conducted in accordance with ASTM C 311-12. The test of strength activity index is used to determine whether the pozzolana will result in an acceptable level of strength development when used with hydraulic cement in concrete (or) mortar.

Strength Activity Index was determined using equation

$$= \frac{F_{c.b.a} \times 100}{F_{o.p.c}}$$

FRc.d. aR =Average compressive strength of the three-specimen made with 10% CBA

= (37.52 x 100 /36.91) = 101.65 %

V. CONCLUSION & FUTURE SCOPE

A. *Conclusion*

1) There is a change in slump for CBA 5% has decreased 82 mm when compared with normal mix the slump 90 mm.
2) The slump for CBA 10%, CBA 15% and CBA 20% has reduced by 80mm, 76 mm and 74 mm respectively when compared with the normal mix.
3) To get the required slump admixtures must be considered.
4) The compressive strengths of CBA mixes at the age of 3 days was gradually decreases its strength when compared with normal mix due to pozzolanic activity.
5) It was observed that the compressive strength of CBA 5% and CBA 10% at the age of 7 days has reached its target mean strength; however, the compressive strength was increased when compared with normal mix.
6) It was observed that the compressive strength of CBA 15%, CBA 20% at the age of 28 days has decreases its compressive strength when compared with the normal mix.
7) The split tensile strength of mixes CBA 5% and CBA 10% at the age of 28 days has increases its strengths when compared with the normal mix.
8) The flexural strength of SCBA 5%, SCBA 10% at the age of 28 days has increases its strength when compared with the normal mix.
9) Finally, it was concluded that cement can be replaced with carbon black ash up to 10% without much loss its compressive strength.
10) Considerable decrease in compressive strength was observed from 15% cement replacement.
11) It has been shown in this study that 10% carbon black ash can be used as a partial cement replacement material with technical and environmental benefits.
12) To improve the strengths of CBA 15%, CBA 20% using chemical admixtures like micro silica and super plasticizers for improving the strength.

B. *Future Scope*

The experimental study can be carried out for higher strength concretes like M40, M50 and above.

This work was carried out on replacement of cement in concrete without adding any admixtures. The same work has carried out as using admixtures like Super plasticizers.

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