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RESEARCH ARTICLE

Experimental Investigation on the Properties of Concrete with Carbon Black and PET.

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Abstract

The New trends of construction methods sometimes cause harmful effects on environment though they are effective to mankind. Reuse of waste materials acts eco friendly also prevents exploitation of resources. Usage of such materials for construction purpose enhances the traditional methods of construction. In this paper presents an experimental investigation on the effect of PET (Polyethylene Terephthalate) on various strength properties. The strength properties of M40 grade concrete are studied with 0%, 10% and 20% of PET. There is decrease in strength when the ratio of PET to fine aggregate was increased. So that the PET percentage is taken as constant, the Carbon Black as a partial replaced by cement with 0%, 10%, 20%, and 30%. The strength properties were again studied and its results are compared to conventional concrete.

Introduction:-

Concrete is a mixture of naturally, cheaply and easily available ingredients as cement, sand, aggregate and water. Cement is occupied second place as most used material in the world after water. The rapid production of cement creates big problems to environment. First environment problem is emission of CO_2 during the production process of the cement. The CO_2 emission is very harmful which creates big changes in environment. According to the estimation, 1 tone of carbon dioxide is released to the atmosphere when 1 tone of ordinary Portland is manufactured. As there is no alternative building material which totally replace the cement. The search for any such material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact. Substantial energy and cost savings can result when industrial by products are used as a partial replacement of cement. Fly ash, Ground Granulated Blast furnace Slag, Rice husk ash, High Reactive Meta kaolin, silica fume are some of the pozzolonic materials which can be used in concrete as partial replacement of cement. In this project the PET as a partial replacement of fine aggregate and Carbon Black as a partial replacement of Cement.

Materials and Methods:-

Material used:-

Cement:-

Cement is the most important constituent of concrete, in that it forms the binding medium for the discrete ingredients made out of naturally occurring raw materials and sometimes blended with industrial wastes. The quantity required for this work was assessed and the entire quantity was purchased and stored properly in casting yard. The cement used in this experimental investigation is 53 grade OPC conforming to IS 12269: 1987.

Fine aggregate:-

Fine aggregate used in this investigation is clean river sand without impurities like clay, shell and organic matters. It is passing through 4.75mm sieve. The fine aggregate were tested, as per Indian Specifications IS 383-1970. The fine aggregate used in this investigation was clean river sand and conforming Zone II.

Coarse aggregate:-
The material retained on 4.75mm sieve is termed as coarse aggregate. Crushed stone and natural gravel are the common materials used as coarse aggregate for concrete. Well graded angular aggregate is use and the maximum size of aggregate is 20 mm. the coarse aggregate were tested as per Indian Specifications IS 383-1970.

Pet:-
The waste plastic is being among the most prominent. The waste polyethylene Terephthalate bottles are recycled and used in industries for different purpose. The recycled waste plastics in different forms are being use in pavements, bridges, floors, dams and many other civil engineering works. The advantage of using waste plastic in concrete not only solves the problem of their safe disposal but also improves the basic properties of concrete like compressive strength, tensile resistance; impart resistance, permeability, flexural strength, thermal insulation, etc.


Figure.1 PET

Carbon Black Powder:-
Carbon black is virtually pure elemental carbon in the form of colloidal particles that are produced by incomplete combustion or thermal decomposition of gaseous or liquid hydrocarbons under controlled conditions. Its physical appearance is that of a black, finely divided pellet or powder.

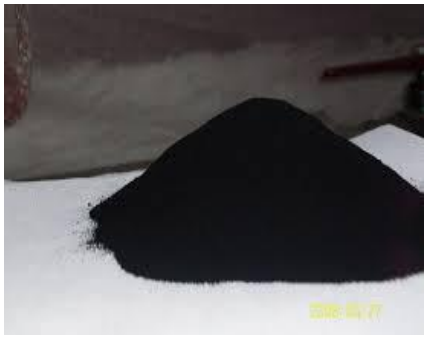
Figure.2 Carbon black powder

Mix design:-
The mix design of M40 grade concrete is calculated using IS 456-2000 and IS 10262-2009. The material required as per design are given in Table:1

TABLE I. MATERIALS REQUIRED AS PER IS METHOD OF DESIGN

W/c ratio	Quantity of Materials (kg/m^3)		
	Cement	***Fine aggregate***	***Coarse aggregate***
0.4	380	678	1235

The properties of materials used are

- Specific gravity of cement = 3.15
- Specific gravity of fine aggregate = 2.79
- Specific gravity of coarse aggregate = 2.5

Preparation of test specimens:-

The required materials like Fly ash, Carbon black powder have been mixed as per the ratio in table 4.1. These materials are mixed together, and then they are conveyed to cube mould of size 150 mm* 150 mm* 150mm, cylinder mould of size 150mm*300mm. After casting, the specimens were kept for 24 hours and then demoulded. They were cured at water and 28 days.

Casting of cubes, cylinders and prism are shown in fig.3 (a), fig .3(b), and fig.3(c).

Figure.3(a) casting of cube

Figure.3(b) Casting of cylinders

Fig.3(c) Casting of prism

Test procedure:-

Compressive strength test:-

The test is conducted at surface dry condition. The specimens are tested at the age of 7 and 28days of curing under the Compression Testing Machine. The tests were carried out on a set of triplicate specimens and the average compressive Strength values were taken.

$$\text{Compressive strength (N/mm}^2\text{)} = \frac{\text{Max load at failure*1000}}{\text{Loaded surface area}}$$

Split tensile strength test:-

Splitting tensile strength test was conducted on concrete cylinders to determine the tensile nature of carbon black concrete. The cylinder specimen was placed on compression testing machine. The load was applied continuously without shock at a constant rate. The breaking load (P) was noted.

$$\text{Split Tensile Strength (N/mm}^2\text{)} = \frac{2*\text{Breaking load}}{\prod * \text{Dia of cylinder} * L}$$

Flexural strength test:-

Flexural strength test was conducted on concrete prism to determine the flexural nature of carbon black concrete. The load was applied continuously without shock at a constant rate. The breaking load (P) was noted.

$$\text{The flexural strength } f_b = PL/\, bd^2 \text{ N/mm}^2$$

The test set up for Compression test, Split tensile test and Flexural strength test are shown in figure.4(a), figure.4(b), figure.4(c) respectively.

Figure. 4(a) compression test set up

Figure.4 (b) split tensile set up

Figure.4 (c) Flexure test set up

Results and Discussion:-

Compressive strength test:-

The compressive strength of the specimens with different percentage of carbon black and PET is given in Table II from Figure5. It is clear that concrete specimen with 30% has given better results when compared to the control specimen. This shows that carbon black filler increase the strength of concrete. Among all concrete cubes, 30% carbon black concrete shows the best result.

TABLE II COMPRESSIVE STRENGTH @ 28 DAYS

Mix	*Compressive strength @ 28 days (N/mm^2)*	*Mix*	*Compressive strength @28 days (N/mm^2)*
M40	46.87	P_{20} CB_0	42.51
P_{10} CB_0	42.93	P_{20} CB_{10}	45.14
P_{10} CB_{10}	43.28	P_{20} CB_{20}	46.01
P_{10} CB_{20}	44.11	P_{20} CB_{30}	48.15
P_{10} CB_{30}	44.86		

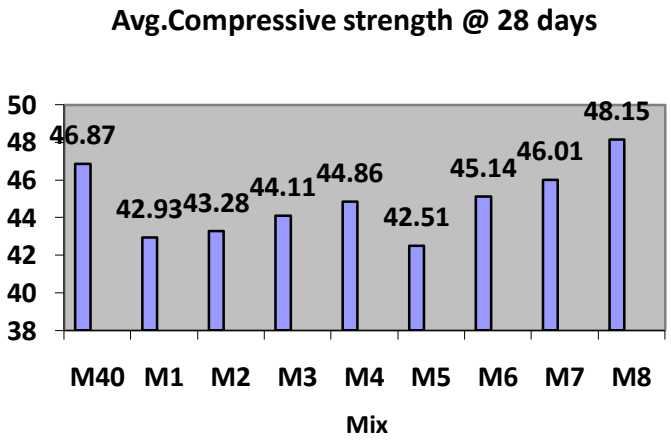

Fig.5 Average compressive strength

Split tensile strength test

The Split Tensile Strength test results are in the Table III from Figure 6. The Split tensile strength of the cylinder is seen to be increasing till the 30% of the carbon black. The percentage of the carbon black with30% is found to be reasonable with high split tensile strength compared to the other percentages.

TABLE III SPLIT TENSILE STRENGTH FOR 7 & 28 DAYS

Mix	*Split Tensile strength @ 28 days (N/mm^2)*	*Mix*	*Split Tensile strength @28 days (N/mm^2)*
M40	3.48	P_{20} CB_0	2.81
P_{10} CB_0	2.96	P_{20} CB_{10}	3.26
P_{10} CB_{10}	3.03	P_{20} CB_{20}	3.48
P_{10} CB_{20}	3.11	P_{20} CB_{30}	3.64
P_{10} CB_{30}	3.24		

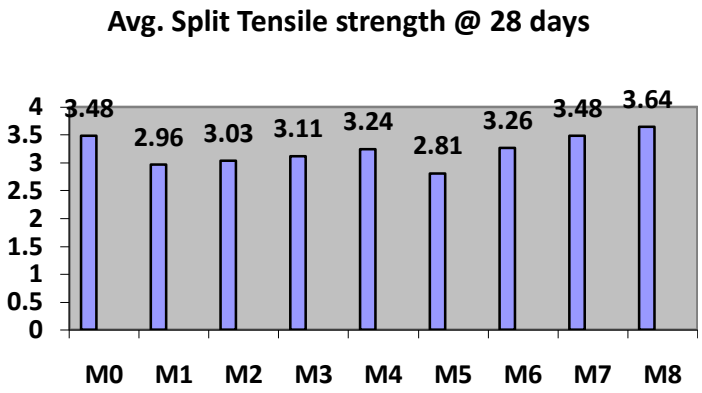

Fig 6 Average Split tensile strength

Flexural strength test:-

The Flexural strength results are in the Table IV from Figure 7. The flexural strength of the specimens will increased gradually with increase in the percentage of carbon black. The percentages of the carbon black with 30% will be reasonable than other percentages.

TABLE IV FLEXURAL STRENGTH FOR 28 DAYS

Mix	*Flexural strength @ 28 days (N/mm^2)*	*Mix*	*Flexural strength @ 28 days (N/mm^2)*
M40	4	P_{20} CB_0	3.5
$P_{10}CB_0$	3.75	P_{20} CB_{10}	4.00
$P_{10}CB_{10}$	4.25	P_{20} CB_{20}	4. 75
$P_{10}CB2_0$	4.5	P_{20} CB_{30}	5.25
$P_{10}CB_{30}$	4.75		

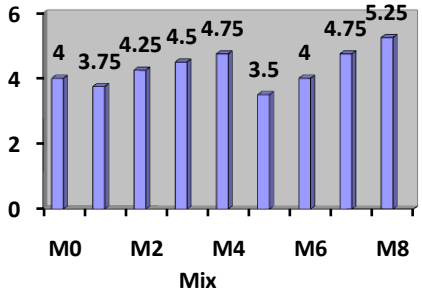

Fig.7 Flexural strength

Conclusion:-

1. In this project to utilize of carbon black powder and PET in concrete. The percentage of PET varied from 0%, 10% and 20% in M40 grade concrete.
2. If PET percentage is increased, the strength will be decreased. So Carbon Black is replaced by cement to increase the strength.
3. From compressive strength test result, it shows that when compare to conventional concrete and then percentage of Carbon Black in concrete. Among all concrete cubes, 30% carbon black concrete shows the better result.
4. From split tensile strength test and flexural strength result, it shows that compare to the conventional concrete, the specimen with 30% given better result.
5. Addition of PET beyond 20% is found to be not effective which can be seen the reduction in performance. From 20% PET imparts brittle characteristics to concrete.
6. Hence it can be concluded that the carbon black up to 30% as a replacement of cement will be very effective in concrete.

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