# Experimental Study on Behaviour of Carbon Black on Partial Replacement with Cement

**G. Divya[1] Mr. MD. Ismail[2]**
[1]P.G Student [2]Assistant Professor
[1]Pydah Engineering College, India [2]Chaitanya Engineering College, India

*Abstract*— Concrete is the essential construction material used for many applications in the construction industry. Though it is used worldwide, it has its ill effects like the presence of pores and micro-cracks. These ill effects lead to acid intrusion and less resistance to atmospheric attack. As a result, its durability and strength get reduced. The current tendency in the world is to find new materials at lower cost which can guarantee better performances during their incorporations in the concrete. Usage of waste materials for construction purpose enhances the traditional methods of construction. The effect of addition of carbon black powder, a waste from rubber industry as a filler material in concrete is investigated. Study on workability and mechanical properties like split tensile strength, flexural strength and compressive strength of concrete specimens containing various percentages of carbon black were carried out. The effect of added carbon black to cement in concrete mix was studied. This was achieved by replacing cement in different concrete mixes containing 5, 10, 15 and 20% of carbon black to cement. Carbon black as a filler enhances the performance of concrete.

***Keywords:*** Carbon Black, Cement, Fly Ash, Mechanical Properties

## 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.

## III. EXPERIMENTAL PROCEDURE

Raw materials required for the concrete use in the present work are

- Cement
- Coarse Aggregates
- Carbon black waste
- Fine aggregate
- Water

### *A. Carbon Black*

Carbon black used for the present study is finely divided powder. The specific gravity of carbon black was determined by density bottle approach, and it was once found to be 1.03. The pH value is 6 and this indicates that carbon black is almost an inert material. The sources of carbon black are mainly from rubber industry, petrochemical plant and oil plant. The particle size of carbon black was found to be 0.05 micrometer.

## IV. RESULTS

### *A. Fresh Properties:*

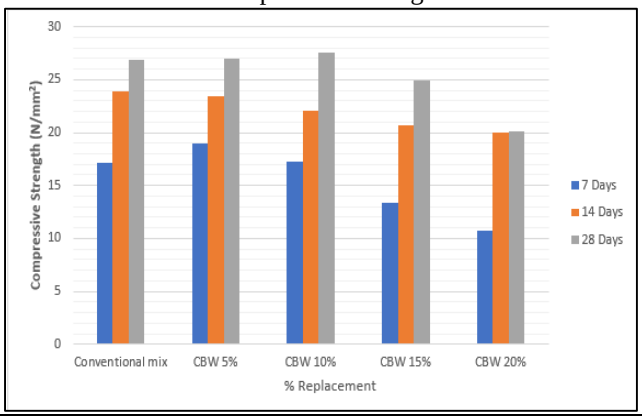
The following are the results obtained in various laboratory tests carried out in this study:

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

Table 1: Workability of concrete

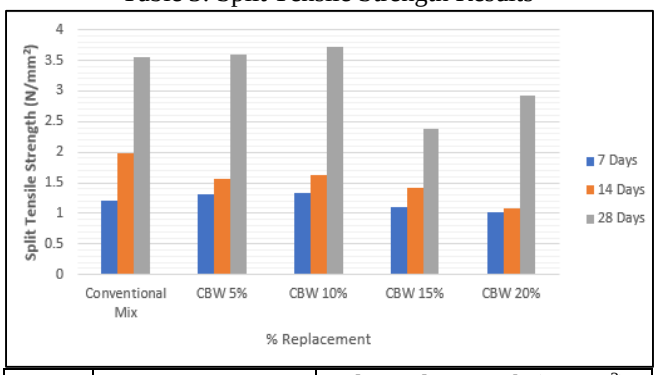
| S. No | Mix | Compressive Strength ($N/mm^2$) | | |
|---|---|---|---|---|
| | | 7 Days | 7 Days | 28 Days |
| 1 | Conventional mix | 17.14 | 23.92 | 26.91 |
| 2 | CBW 5% | 18.95 | 23.42 | 27.01 |
| 3 | CBW 10% | 17.22 | 22.12 | 27.52 |
| 4 | CBW 15% | 13.42 | 20.64 | 24.93 |
| 5 | CBW 20% | 10.69 | 20.02 | 20.07 |

Table 2: Compressive Strength Results



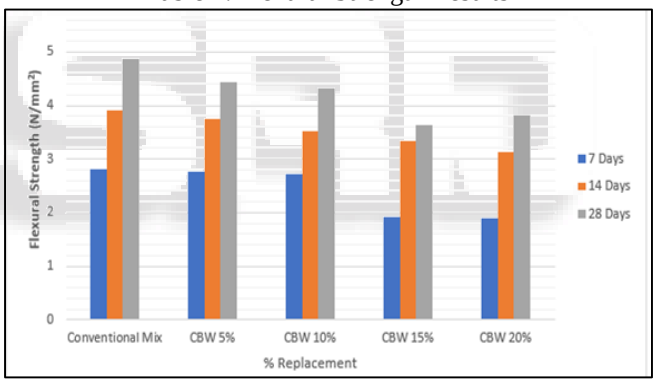

| S. No | Mix | Split Tensile Strength ($N/mm^2$) | | |
|---|---|---|---|---|
| | | 7 Days | 14 Days | 28 Days |
| 1 | Conventional Mix | 1.2 | 1.98 | 3.56 |
| 2 | CBW 5% | 1.32 | 1.56 | 3.6 |
| 3 | CBW 10% | 1.33 | 1.62 | 3.72 |
| 4 | CBW 15% | 1.1 | 1.42 | 2.38 |
| 5 | CBW 20% | 1.02 | 1.09 | 2.92 |

Table 3: Split Tensile Strength Results




| S. No | Mix | Flexural Strength ($N/mm^2$) | | |
|---|---|---|---|---|
| | | 7 Days | 14 Days | 28 Days |
| 1 | Conventional Mix | 2.82 | 3.92 | 4.86 |
| 2 | CBW 5% | 2.76 | 3.74 | 4.44 |
| 3 | CBW 10% | 2.72 | 3.52 | 4.32 |
| 4 | CBW 15% | 1.92 | 3.33 | 3.64 |
| 5 | CBW 20% | 1.9 | 3.12 | 3.82 |

Table 4: Flexural Strength Results




## V. STRENGTH ACTIVITY INDEX

Strength Activity Index (S.A.I) is the ratio of 10% replacement levels of cement with CBW 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% CBW.

= (27.52 x 100 /26.91) = 102.26 %

## VI. CONCLUSION & FUTURE SCOPE

### *A. Conclusion*

Based on the study, following conclusions can draw.

1) There is a change in slump for CBW 5% has decreased 82 mm when compared with normal mix the slump 90 mm.
2) The slump for CBW 10%, CBW 15% and CBW 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 CBW mixes at the age of 7 days was gradually decreases its strength when compared with normal mix due to pozzolanic activity.
5) It was observed that the compressive strength of CBW 5% and CBW 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 CBW 15%, CBW 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 CBW 5% and CBW 10% at the age of 28 days has increases its strengths when compared with the normal mix.
8) The flexural strength of CBW 5%, CBW 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 waste 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 waste can be used as a partial cement replacement material with technical and environmental benefits.
12) To improve the strengths of CBW 15%, CBW 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 can be carried out using admixtures like Super plasticizers.

## REFERENCES

[1] Padma Priya, Mrs. k. Pandeeshwari. M. E (2016) 'Experimental Investigation on the Properties of Concrete with Carbon Black and PET', International Journal of Advanced Research, 4(4),
[2] Dr. G. Chitra, P. Vetri Selvi, Dr. D. Vijayalakshmi (2014) 'Carbon Black as an Additive in Conventional Concrete', International Journal of Emerging Technology and Advanced Engineering, 4(3)
[3] Gaurav Nagavkar (2017) 'Effect on properties of concrete with partial replacement of additives cement', International Journal of Engineering Sciences and Research Technology, 6(2),
[4] Perviz Ahmedzade &Tacetinn Geckil (2017) "The Effect of Carbon Black On Mechanical and Electrical Properties Of Asphalt Mixture" Indian Journal On Engineering And Material Sciences, 4.
[5] Goldman and A. Bentur, "The influence of microfillers on enhancement of concrete strength",1993, Cement and Concrete Research 23.
[6] Perviz Ahmedzade & Tacettin Geckil, "Influence of carbon black on the mechanical and electrical properties of asphalt mixtures", 2007, Indian Journal of Engineering and Material Science, Vol 14.
[7] M.H. Kharita, S. Yousef and M. AlNassar, "The effect of carbon powder addition on the properties of hematite radiation shielding concrete",2008.
[8] L. Rejon, A. Rosas-Zavala, J. Porcayo-Calderon, V. M. Castano, "Percolation Phenomena in Carbon Black-Filled Polymeric Concrete", Sept, 2000, Polymer Engineering and Science.
[9] [9].Concrete Technology by M.S. Shetty IS: 2386 (part-1)-1963, "Methods of testing for aggregate for concrete".
[10] IS: 10262-2009, "Recommended guidelines for concrete mix design, Bureau of Indian standards", New Delhi, India.
[11] IS: 516-1959, "Indian standard methods of tests for strength of concrete, Bureau of Indian Standards", New Delhi, India.
[12] IS: 12269-2013, "Manufacture and chemical and physical requirements of 53 grade ordinary Portland cement".
[13] IS: 383-1970 "Specification for coarse and fine aggregates from natural sources for concrete."
[14] IS: 456-2000 "Code of practice for plain and reinforced concrete for general building construction."
[15] IS: 4031 – PART-3, "Determination of fineness of cement".
[16] IS: 2720 – PART-3 "Determination of Specific gravity of cement".