Study on fresh and hardened properties of concrete using Activated carbon powder as a partial replacement.

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Abstract: Concrete is the most versatile and commonly used construction material in the world. The production of large quantities of concrete requires extensive amounts of natural resources. Over the last several decades, research has been focusing on cement replacement materials. This study investigates the use of activated carbon as a partial replacement in concrete. Activated carbon eliminates the presence of pores in conventional concrete, which enhances the performance of concrete. This research focuses on physical & mechanical properties of concrete. In the present study, activated carbon has been used in partial replacement of cement by 2%, 4%, 6%, 8% & 10% by the weight of cement. Workability of fresh concrete, Compressive strength of Cubes & split tensile strength were evaluated after 7,14 & 28 days of curing. Based on the test results, the performance of concrete using activated carbon are assessed.

Keywords: Concrete, Activated Carbon, Compressive strength, split tensile strength, cubes, cylinder.

INTRODUCTION

Concrete is referred as a composite material with relatively high compressive strength, but significantly lower tensile strength [1]. At present, due to many reasons, the concrete construction industry is not sustainable [2]. Firstly, it consumes large quantities of unadulterated materials which can remain for upcoming generations [4]. Secondly, the principal binding agent in concrete is Portland cement, the production of which is a major contributor to greenhouse gas emissions that are implicated in global warming and climate change [4]. Being a versatile material, presence of pores in concrete proves to be a major problem since ever it was discovered [3]. Pores in turn attract water that leads to various ill effects such as freezing and thawing, acid intrusion, decreased resistance to chloride ion, reduced compressive strength etc [1]. By taking this problem into consideration, a study is made to minimize/ eliminate the pores present in the concrete using activated carbon powder, Due to their extremely minute size they can fill the pores thereby it is expected to achieve the required benefits [3].

MATERIALS

Cement: Ordinary Portland cement of 53 grade (BIRLA) conforming to IS 8112-1989 is used. The basic properties of cement were tested and the results are as mentioned below:

Table 1 – Initial test results for Cement

Test conducted	Result obtained
Specific gravity	3.15
Standard Consistency	35%
Initial setting time	55 mins
Final setting time	2hr 50 mins
Fineness	3.53%

Fine aggregate: In this experimentation, Manufactured sand of size below 4.75mm conforming to zone II of IS 383-1970 was used as fine aggregate. The basic properties of FA were tested and the results are as mentioned below:

Table 2– Initial test results for Fine aggregate

Test conducted	Result obtained
Specific gravity	2.60
Water absorption	1.45%

Coarse aggregate: In this study, natural crushed stone with 20mm down size was used as coarse aggregates. These aggregates were tested as per the regulations described in IS 383-1970. The basic properties of CA were tested and the results are as mentioned below:

Table 3 – Initial test results for Coarse aggregate

Test conducted	Result obtained
Specific gravity	2.735
Water absorption	0.39%

Activated carbon: Activated carbon was purchased from India mart at the cost of ₹25/Kg. Its physical appearance is that of a dark, finely separated pellet or powder. The basic properties of activated carbon were tested and the results are as mentioned below:

Table 4 – Initial test results for Activated carbon

Test conducted	Result obtained
Specific gravity	1.33
PH value	6
Appearance	Black Powder
Total surface area	500 m2/gm

OBJECTIVES OF THE PROJECT

Main objective
- To study the feasibility of using Activated carbon in concrete.

Specific Objectives
- To study the variations in workability of concrete using activated carbon.
- To study the variations in compressive strength of concrete using Activated carbon at 7,14 &28 days.
- To study the variations in split tensile strength of concrete using Activated carbon at 7,14 &28 days.
- To evaluate the advantages & disadvantages of using Activated carbon in concrete.

METHODOLOGY

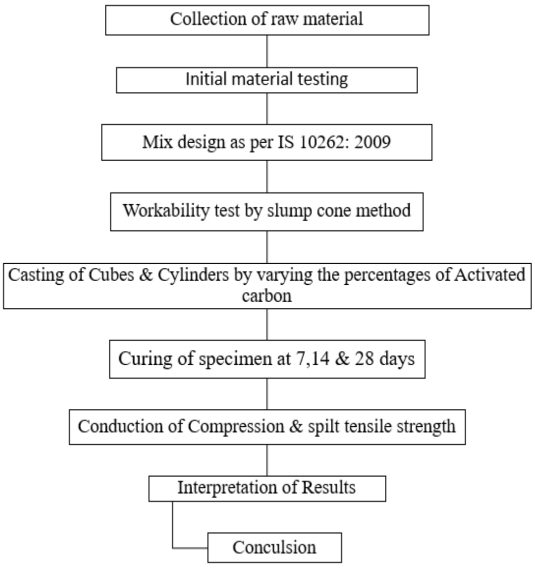

Fig 01 Sequences of operations followed for experimentation

RESULT AND DISCUSSION

Workability by slump cone test:
The concrete immediately after mixing was tested for workability by slump cone & the following observations were recorded.

Table 5 – Test results on variation workability by slump cone

Sl. No	% Variations in AC Powder	Slump in Cm
1	0	29
2	2	28
3	4	28
4	6	27.5
5	8	26.5
6	10	26

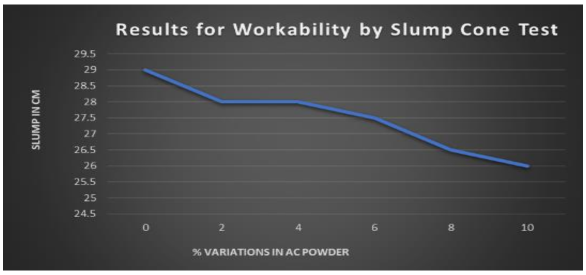

Fig 02–Graphical results on workability by slump cone

Compressive Strength test:
Compressive strength test was carried on the specimens after a curing period of 7, 14, 28 days and the following observations were made.
The variation of compressive strength at a period of 7 days are as represented in the tabulate form below.

Table 6 –Test results for Compressive strength at 7 days

Sl. No	% Variation	Area of Cube in mm^2	Failure load in KN (P)	Compressive strength $\frac{P}{A}$ N/mm^2
1	0	22500	301	13.3
2	2		520	23.1
3	4		526	23.37
4	6		423	18.8
5	8		410	18.2
6	10		318.5	14.15

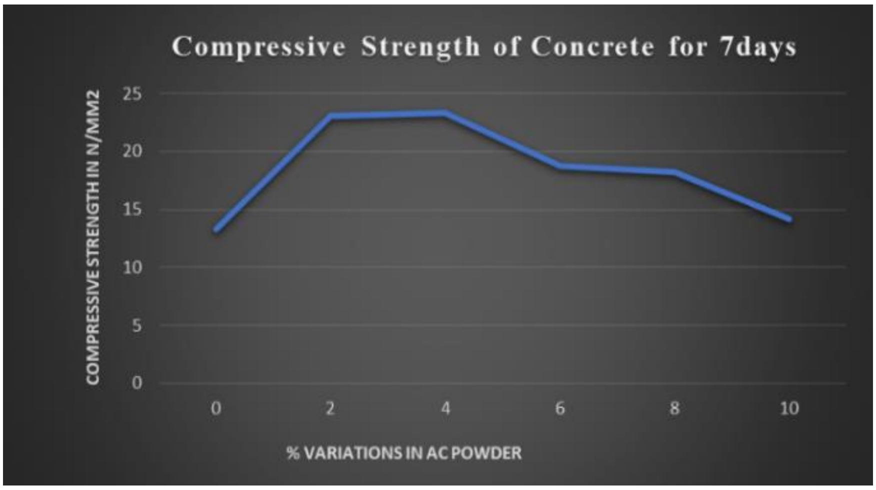

Fig 03 – Graphical results for variation in Compressive strength at 7 days

The variation of compressive strength at a period of 14 days are as represented in the tabulate from below.

Table 7– Test results for Compressive strength at 14 days

Sl. No	% Variation	Area of Cube in mm^2	Failure load in KN (P)	Compressive strength $\frac{P}{A}\ N/mm^2$
1	0	22500	396	17.6
2	2		510	22.66
3	4		520.8	23.14
4	6		390	17.33
5	8		383	16.88
6	10		381	16.93

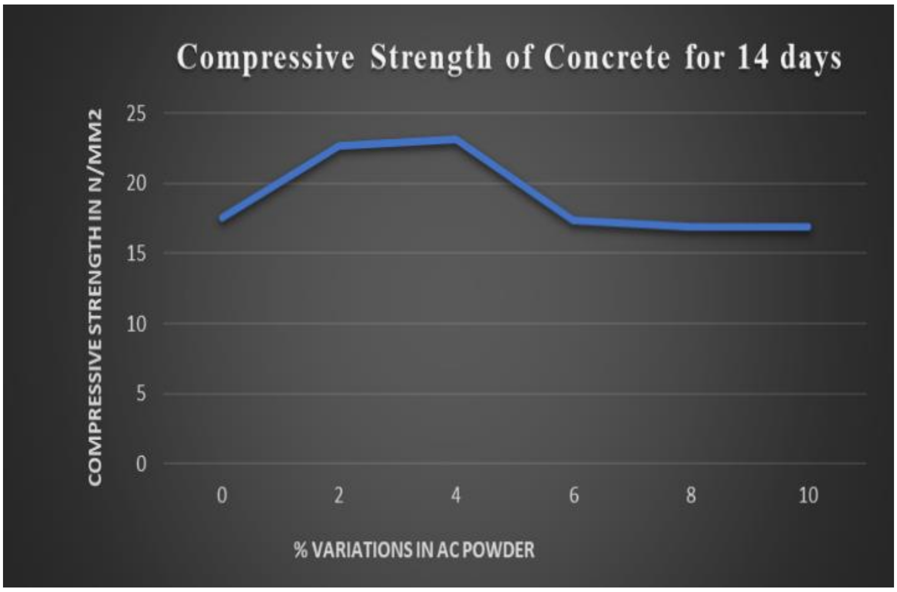

Fig 04 – Graphical results for variation in Compressive strength at 14 days

The variation of compressive strength at a period of 28 days are as represented in the tabulate from below.

Table 8 – Test results for Compressive strength at 28 days

Sl. No	% Variation	Area of Cube in mm^2	Failure load in KN (P)	Compressive strength $\frac{P}{A}$ N/mm^2
1	0	22500	454	20.17
2	2		488.92	21.73
3	4		493.65	21.94
4	6		450.9	20.04
5	8		447.075	19.87
6	10		364.5	16.20

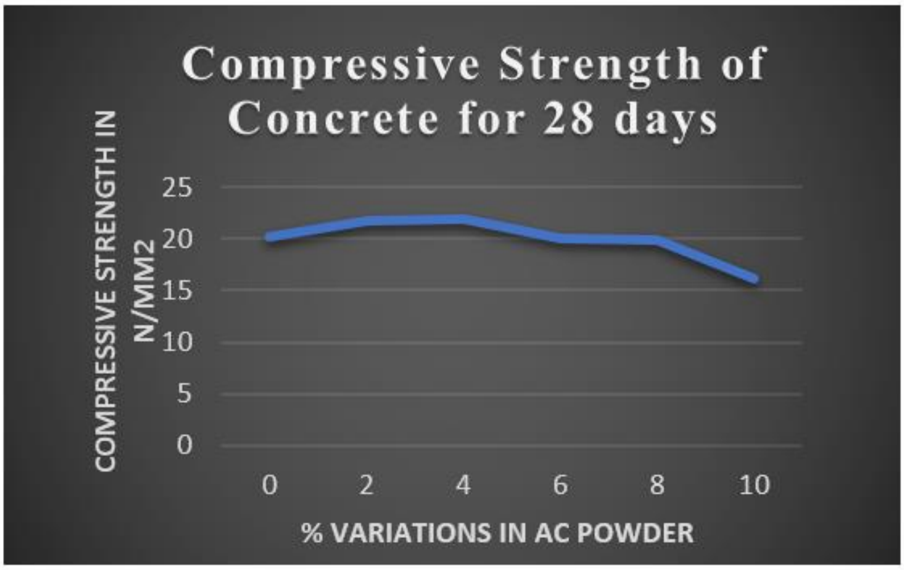

Fig 05 – Graphical results for variation in compressive strength at 28 days

Split Tensile Strength:

This test was carried on the cylinder specimens of 150mm dia & 300mm height after a curing period of 7, 14, 28 days and the following observations were made.

The variations of compressive strength at a period of 7 days are as represented in the tabulated form below.

Table 9 – Test results for Split tensile test at 7 days

Sl. No	% Variation	Dimension of the Cylinder	Failure load in KN (P)	Split tensile strength $\frac{2P}{\pi 2L}$ N/mm^2
1	0	150X 300mm	156.9	2.21
2	2		159.7	2.25
3	4		161.8	2.28
4	6		157.6	2.23
5	8		156.2	2.2
6	10		152.6	2.15

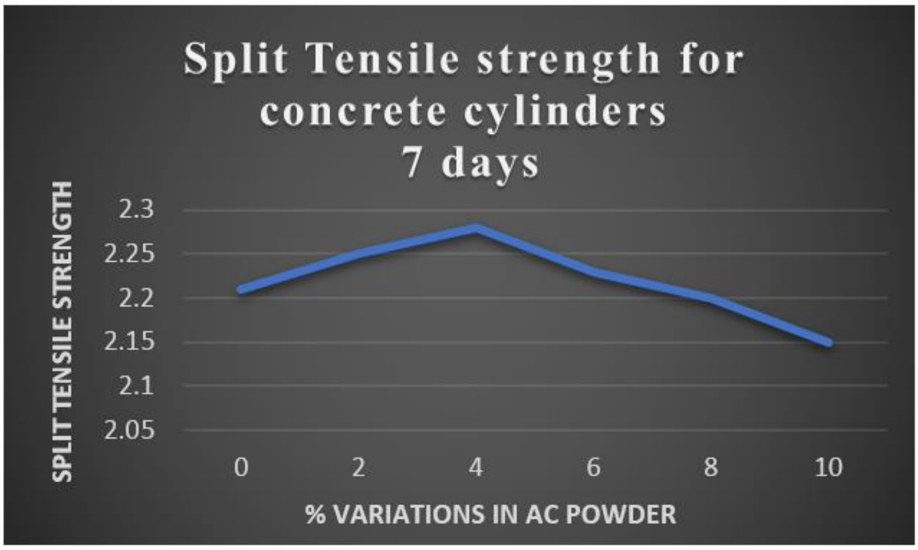

Fig 06 – Graphical results for variation in Split tensile test at 7 days

The variations of compressive strength at a period of 14 days are as represented in the tabulated form below.

Table 10 – Test results for Split tensile test at 14 days

Sl. No	% Variation	Dimension of the Cylinder	Failure load in KN (P)	Split tensile strength $\frac{2P}{\pi 2L}\ N/mm^2$
1	0	150X 300mm	217.7	3.07
2	2		221.2	3.12
3	4		228.3	3.23
4	6		223.3	3.16
5	8		215.5	3.04
6	10		213.4	3.01

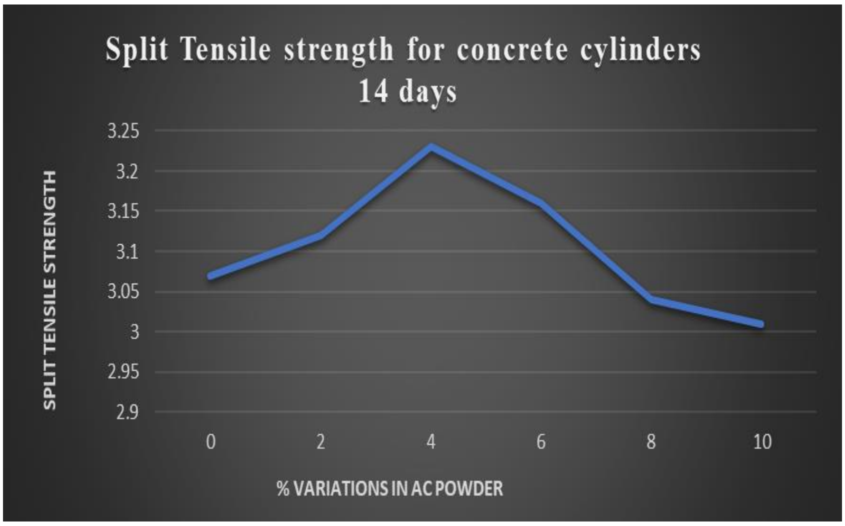

Fig 07 – Graphical results for variation in Split tensile test at 14days

The variations of compressive strength at a period of 28 days are as represented in the tabulated form below.

Table 11 – Test results for Split tensile test at 28 days

Sl. No	% Variation	Dimension of the Cylinder	Failure load in KN (P)	Split tensile strength $\frac{2P}{\pi 2L}$ N/mm^2
1	0	150X 300mm	255.88	3.62
2	2		265.07	3.75
3	4		267.89	3.79
4	6		249.52	3.53
5	8		240.33	3.4
6	10		197.92	2.8

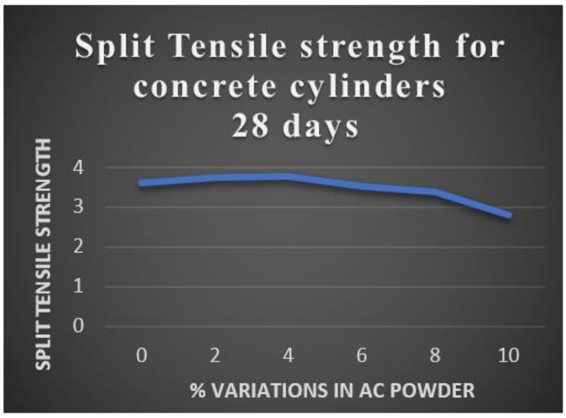

Fig 08 – Graphical results for variation in Split tensile test at 28 days

CONCLUSION

Concrete is the widely used material after water, but the production of concrete requires enormous amount of cement whose production leads to atmospheric pollution. In this regard using sustainable materials can help in achieving global materials can help in achieving global sustainability. Using Activated carbon in concrete helps in achieving light weight concrete, increasing the percentage of activated carbon would reduce the thermal CO_2 (Carbon dioxide) emission and it is said that activated carbon reduces the content of NOX (Nitrogen dioxide) from the atmosphere.

From our experimental results

1. Activated carbon reduces the presence of pores from conventional concrete.
2. As you increase the percentage of activated carbon in concrete, workability decreases.
3. A maximum of 4% of Activated carbon by the weight of cement is observed to increase the compressive strength & split tensile strength.

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