EXPERIMENTAL STUDY ON MECHANICAL AND DURABILITY PROPERTIES OF CONCRETE WITH BAGGASSE ASH

M.Mahalakshmi[1], R. Janarthanan[2]

[1]PG Student, (CIVIL - Structural Engineering), [2]Assistant Professor
Sri vidya college of Engineering and Technology, Tamilnadu, India-626005

Abstract

A number of researchers today are focusing on ways of utilizing industrial and agricultural waste as a source of raw materials for production of construction products. Presence of silica in Sugarcane Bagasse Ash (SCBA) contributes to improved pozzolanic activity. The main objective of this research was to characterize the compressive strength of concrete for M30 grade by replacing cement with 15% Sugarcane Bagasse ash which is heated at 1100ºc. A comparative study between three different curing methods was carried out based o their compressive strength and durability properties.

***Keywords**: Concrete: Bagasse ash, Mechanical property & Durability property.*

1. INTRODUCTION

Concrete is widely used in construction of buildings, bridges and other structures. Great demand for building materials like cement and fine aggregate due to high cost and scarcity has made to find the alternatives with the use of waste materials, by products and recyclables. Cement are the important constituents in concrete. Almost three quarters of the volume of concrete is composed of aggregate. In this study recent development of composites sugarcane waste raw burned products has been used known as ash. In this paper bagasse ash which is a waste product, is used has a partial replacement of cement.

1.1 Material

Different waste materials as well as by-products are used as pozzolanic materials in concrete. Utilization of different supplementary cementitious materials for the production of blended cements contributes to achieving durable and sustainable concrete. Enormous quantities of sugarcane bagasse ash (SCBA) are obtained as by-product from cogeneration combustion boilers in sugar industries; this material has been described to be a suit-able supplementary cementations material for use in concrete in previous research studies. India is the second largest producer of sugarcane and large quantity of bagasse ash (67,000 tonnes/day) is directly disposed to nearest land which causes severe environmental problems. Rapid implementation of bagasse based new cogeneration plants (that are mandated by the government) is expected to substantially increase bagasse ash generation. The utilization of bagasse ash as a supplementary cementing material through systematic processing and characterization offers a profitable and environment-friendly alternative to its disposal.

2. SCOPE OF THE INVESTIGATION

The scope of the project is to use the bagasse ash as a partial replacement of cement and putting it into practical application in the field of Civil Engineering.

3. OBJECTIVE

To incorporate bagasse ash as an alternative construction material as cement in concrete. To study the strength properties and durability properties.

4. LITERATURE REVIEW

Imran and Anwar (2017) says that the fibers were burnt at different intervals of temperature 1100°C with 1,3,5 hours. Parameters studies carried out on grain size and percentage variation of chemical composition and also effect of temperature on weight and density variation in different hours are investigated. And they observed that length of particle size is decreased with increasing in time at constant temperature. The EDS says that BA were found, Si is rich and increases with increasing in time at constant temperature. These results indicated that the oxides will help to increase the strength of materials.

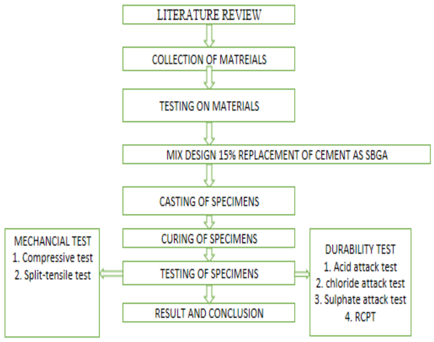
Rajasekar et al., (2018) carried out this study is to investigate the feasibility of utilizing sugarcane bagasse ash as a pozzolanic material as partial replacement from 5% to 20% in the production of Ultra High Strength Concrete (UHSC). Compressive strength, chloride penetration resistance and sorptivity tests were carried out. And they observed that Incorporation of Treated Bagasse Ash improves the workability, compressive strength, resistance to chloride ion penetration and decreases the rate of water absorption. It concludes that concrete mix with 15% cement replacement exhibited a superior performance.

Suresh et al., (2017) carried out the experiment on Sugarcane bagasse ash pozzolanic admixture in concrete. This experiment investigated the possibility of using sugarcane bagasse ash as a partial replacement of cement in ordinary, lightweight, and self-compacting concretes. Specimens containing 5, 10, 15, 20, and 25% SCBA in addition to a control specimen were prepared to evaluate the mechanical properties of concrete specimens. The results indicated that improvements in strength and impact resistance in light-weight concrete are observed as compared with the control sample when cement was replaced with bagasse ash at 5%. It was also found incorporation of BA improved durability and quality.

Farshad et al., (2017) explained this research presents an extensive experimental study to investigate the possibility of using sugarcane bagasse ash (SCBA) as a partial replacement of cement in ordinary, lightweight, and self-compacting concretes. For this purpose, specimens containing 5, 10, 15, 20, and 25% SCBA in addition to a control specimen were prepared. To evaluate the mechanical properties of concrete specimens, compressive strength, tensile strength, impact resistance, workability, water absorption, and ultrasonic pulse velocity (UPV) tests were performed. The results indicated that improvements in strength and impact resistance in light-weight concrete are observed as compared with the control sample when cement was replaced with bagasse ash at 5%. It was also found incorporation of BA improved durability and quality of SCC.

Bahurudeenet al., (2015) studied that the experimental investigation has been carried out on the test specimens to study the strength properties in terms of compressive strength, heat of hydration, drying shrinkage and durability. This study analyzes that use of sugarcane bagasse ash in concrete prominently enhances its performance. It is found that Resistance of concrete against chloride and gas penetration significantly increased with increase in bagasse ash replacement. Surface resistivity of SCBA replaced concretes was found to be higher compared to control concrete due to excellent pozzolanic performance of SCBA.

5. METHODOLOGY



6. TESTING AND RESULT

6.1 MECHANICAL PROPERTIES

6.1.1 COMPRESSIVE STRENGTH

Compression strength of concrete with and without E-waste was conducted. The compression test was conducted as per IS 516 – 1959. The specimens (cube) of size 150 mm x 150 mm x 150 mm were kept in water for curing for 28 days and on removal were tested in dry condition and grit present on the surface. The load was applied without shock and increased continuously at a particular rate until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.

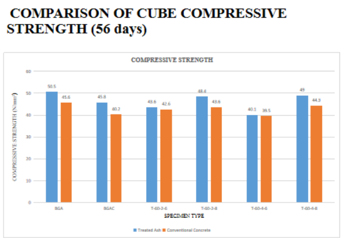
Compressive Strength = Load / Area (MPa or N/mm^2)

Table :1 Compressive Strength test

COMPRESSIVE STRENGTH TEST(56 days)

SPECIMEN TYPE	AVERAGE COMPRESSIVE STRENGTH (N/mm2)	
	Treated ash	Conventional concrete
BGA	50.5	45.6
BGAC	45.8	40.2
T60-2-6	43.6	42.6
T60-2-8	48.4	43.6
T60-4-6	40.1	39.5
T60-4-8	49	44.3

Graph: 1 Comparison of cube Compressive strength



6.1.2 CYLINDER TEST

The test was conducted as per IS 5816:1999. For tensile strength test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. In each category, three cylinders were tested and their average value was reported. The split tension test was conducted by using digital compression machine having 2000 KN capacity.

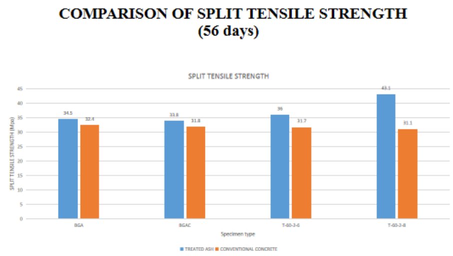
Split tensile Strength = (2P/∏DL) MPa

Table :2 Split Tensile Test

SPLIT TENSILE STRENGTH TEST(56days)

SPECIMEN TYPE	ADVERAGE SPLIT TENSILE STRENGTH (Mpa)	
	Treated ash	Conventional concrete
BGA	34.5	32.4
BGAC	33.8	31.8
T60-2-6	36	31.7
T60-2-8	43.1	31.1

Graph: 1 Comparison of Split Tensile strength



DURABILITY PROPERTIES

The ability of concrete to resist weathering action, chemical attack and abrasion and also to withstand the conditions for which it is designed without deterioration for a long period of years is known as durability. For the measurement of durability resistance of mixes, following tests were performed.

Acid Attack

Sulphate Attack

Chloride Attack

RCPT

6.1.2.1 ACID ATTACK ON CONCRETE

The acid attack was carried out on the concrete cubes of size 100mm x 100 mm x 100mm. The concrete cubes were dried in normal room temperature of 27° C ± 2° C after 28 days of curing, the specimens were taken out and allowed to dry for one day and the weight (W_1) of cubes was noted.

The sulphuric acid solution was prepared by adding 3.0 % sulphuric acid of 1N (by volume of water) to 20 litres of distilled water. The concrete cubes were then immersed in 3.0% sulphuric acid solution for a period of 90 days. The observations were then made after 90 days from the date of immersion in sulphuric acid solution.

Compressive Strength = (P/A) MPa

Where,

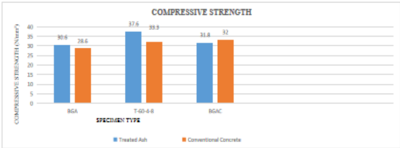
P = Ultimate load (load of failure) in Newton

A = Area of cube in mm^2

Loss of Weight = $\frac{(W1 - W2)}{W1} \times 100\%$

ACID ATTACK ON CONCRETE

S. No	Compression Strength in N/mm²	
	Conventional Concrete	Treated Bagasse ash
1	28.6	30.6
2	33.3	37.6
3	32	31.8

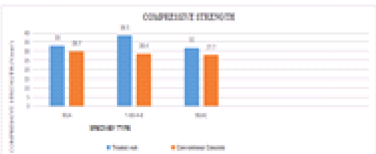


6.1.2.2 SULPHATE ATTACK ON CONCRETE

Sulphate attack test was carried out by using the concrete cubes of size 100mm x 100mm x 100mm. The concrete cubes were dried in normal room temperature after 28 days of curing and the weight (W_1) of the cubes was noted. The sodium sulphate solution was prepared by adding 5.0% sodium\ sulphate (by volume of water) to 50 liters of distilled water. In this experimental study, the concrete cubes were immersion in 5.0% sodium sulphate ($Na_2 SO_4$) solution for a period of three months. The observations were then made after for a period of 90 days from the date of immersion in the sodium sulphate solution. A characteristic whitish appearance was the indication of sulphate attack.

SULPHATE ATTACK ON CONCRETE

S. No	Compression Strength in N/mm²	
	Conventional Concrete	Treated Bagasse ash
1	29.7	33
2	28.4	38.5
3	27.7	32



6.1.2.3 CHLORIDE ATTACK ON CONCRETE

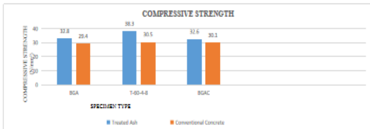
Chloride attack test was carried out the concrete cubes of size 100mm x 100mm x 100mm. The concrete cubes were dried in normal room temperature of 27° C ± 2° C after 28 days of curing and the weight (W_2) of the cubes was noted. The sodium chloride solution was prepared by adding 3.5% sodium chloride salt (by volume of water) to 50 liters of distilled water. In this experimental study, the concrete cubes were immersion in 3.5% sodium chloride (1N NaCI) solution for a period of three months. The observations were then made after for a period of 90 days from the date of immersion in the sodium chloride solution.

$Q=900(I_0 + 2I_{30} + 2I_{60}+ \ldots\ldots + 2I_{330} + I_{360})$

After taking out from the date of immersion and drying the cubes in normal room temperature for a period of 24 hours, the weight (W_1) of concrete cubes was noted.

CHLORIDE ATTACK ON CONCRETE

S. No	Compression Strength in N/mm²	
	Conventional Concrete	Treated Bagasse ash
1	29.4	32.8
2	30.5	38.3
3	30.1	32.6



6.1.2.4 RAPID CHLORIDE PENETRATION TEST (RCPT)

The Rapid Chloride Penetration Test (RCPT) was performed as per ASTM C 1202 to determine the electrical conductance of the conventional concrete and the fine aggregate replacing 30% WFS with 0.5% carbon fibre at the age of 28 days curing and to provide a rapid indication of its resistance to the penetration of chloride ions.

The test method consisted of monitoring the amount of electrical current passed through 51mm thick slices of 102mm nominal diameter of cylindrical specimens for a duration of six hours. The Rapid Chloride Penetration Test apparatus consisted of two reservoirs. The specimen was fixed between two reservoirs (connected to the positive terminal of the direct current source) was filled with 0.3N sodium hydroxide solution and the other reservoir (connected to the negative terminal of the direct current source) with three percent sodium chloride solution. A DC of 60V was applied and maintained across the specimen was recorded at 30 minutes' interval for duration of six hours.

The total charge passed during this period was calculated in terms of coulombs using the trapezoidal rule as given in the ASTM C 1202,

$Q_s = Q_x / (3.75\ x)^2$

Q_s = charge passed (coulombs) through 95mm diameter specimen

Q_x = charge passed (coulombs) through x inch diameter specimen

X = diameter (inch) of the non-standard specimen

RAPID CHLORIDE PENETRATION TEST SETUP

S.No	RCPT values in Coulombs	Nature of Penetration
1	[illegible]	low
2	[illegible]	low
3	[illegible]	Very low

7. CONCLUSION

In this experimental investigation, concrete mix M30 has been designed. The concrete with bagasse ash as a partial replacement of cement for 15% are used and results have been evaluated. Incorporation of treated bagasse ash improves the compressive strength. All concrete specimens subjected to developed higher compressive strength.

For Durability properties with partial replacement of cement shows better results. From the result it can be inferred that the strength of concrete for 28 days in all the cases was lesser when compared to conventional concrete. This is because ash contains sugar. Sugar influences the setting time of concrete hence it takes more time for the concrete to attain the targeted strength. However, the final strength is greater when compared to conventional concrete. The strength of concrete was increased after 56 days when compared to conventional concrete.

8. REFERENCES

[1] Aburilli, K., Onchiri, R. 'characterisation of compressive strength of concrete blended with sugarcane bagasse ash', 'International journal of recent research in civil engineering', Vol 1, pp. 22-30.

[2] Bahurudeen, A., and Santana (2015)' Influence of different processing methods on the pozzolanic performance of sugarcane bagasse ash', in cement and concrete composites, Vol 56.

[3] Deepak, Bahurudeen, A, and. Gokul Dev, (2015)' Performance evaluation of sugarcane bagasse ash blended cement in concrete', cement and concrete composites, Vol 59, pp.77-88.

[4] Guilherme, C, Kimberly, E. Kurtis (2017)'Effect of mechanical processing on sugar cane bagasse ash pozzolanicity', in Cement and Concrete Research, Vol 97, pp. 41-49.

[5] Gar, S., Suresh, N. 'Sugarcane bagasse ash as a pozzolanic admixture in concrete for resistance to sustained elevated temperature', construction and building materials, Vol 153, pp. 929-936.

[6] Imran, B., Anwar, H. (2017) 'Characterisation of agricultural waste sugarcane bagasse ash at 1100°C with various hours'., ICMPC, Vol 5, pp. 3346-3352.

[7] Rajasekar, A., Arunachalam, K. andKottaisamy, M. Saraswathy, V. (2018) 'Durability characteristics of Ultra High Strength Concrete with treated sugarcane bagasse ash', in construction and building materials, Vol 171, pp. 350–356.

[8] Seyed, Z., Zareei, A., Farshad, and A. Nasrollah, B. (2018) 'Microstructure, strength, and durability of eco-friendly concretes containing sugarcane bagasse ash,' in construction and building materials, Vol 184, pp. 156-160.