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EXPERIMENT STUDY ON STRENGTH CHARACTERISTICS OF CONCRETE USING BAGASSE ASH

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Abstract - *The present study focuses on the utilization of Sugarcane Bagasse Ash as replacement material for cement in concrete production. Sugarcane Bagasse ash contains high amorphous silica content and aluminum ion. For experimental investigations, Sugarcane bagasse ash and its chemical properties are obtained from Madhi sugar factory, Gujarat .Ordinary Portland cement was partly replaced by sugarcane bagasse ash in the ratio of 0%, 5%, 10%, and 15% by weight and the influence of Sugarcane bagasse ash as a partial replacement material has been examined on hardened concrete with tests for Compressive strength, Split tensile strength, Flexural strength for M25 grade of concrete. The result shows that the strength of concrete increased as percentage of bagasse ash replacement increased up to certain percentage. Beyond that optimum level the strength of concrete begins to decrease drastically. The highest strength was obtained at 10% Sugarcane bagasse ash replacement*

***Key Words*: Sugarcane bagasse ash, Pozzolanic property, Amorphous Silica, Strength**

1. INTRODUCTION

Ordinary Portland cement is recognized as a major construction material throughout the world. Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste, utilization would not only be economical, but may also result in foreign exchange earnings and environmental pollution control. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as Supplementary cement replacement materials. Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties. A few studies have been carried out on the ashes obtained directly from the industries to study pozzolanic activity and their suitability as binders, partially replacing cement.

The main composition of bagasse ash is siliceous oxide (sio_2), which reacts with free lime from cement hydration pozzolanic property of sugarcane bagasse ash (SCBA) came from the silicate content of the ash. The silicate undergoes a pozzolanic reaction with the hydration products of the cement and results a reduction of the free lime in the concrete. Therefore, study attempts to make use of the sugarcane bagasse ash in India as a pozzolanic material to replace cement. Thus it is possible to use sugarcane bagasse ash as cement replacement material to improve quality and reduce the cost of construction such as mortar, concrete pavers, concrete roof tiles and soil cement interlocking block.

The main components of raw bagasse are silica (60–75%), K_2O , CaO and other minor oxides including Al_2O_3, Fe_2O_3, and SO_3 . Low specific gravity (1.8–2.1) of raw bagasse ash may be due to of large amount of lightweight unburnt particles . The pozzolanic activity of SCBA mainly depends on its particle size and fineness.

1.1 AIM AND OBJECTIVE

The aim of study is to evaluate the performance and suitability of baggase ash in concrete with as alternative for cement

To evaluate the compressive strength, split tensile strength, and flexural strength of concrete with replacement of cement with bagasse ash

The objectives of experimental study are:

- Study on strength characteristics of M25 grade concrete with replacement of 0%, 5%, 10% and 15% of cement by bagasse ash
- To determine the %, strength of concrete at 7, 28 days
- To study the effect of cement in concrete by pozzolonic material that is Bagasse ash
- To find out the optimum percentage of Bagasse ash that can effectively replaces the cement by weight without any adverse effect on properties of hardened concrete.

2. MATERIALS USED

2.1 CEMENT

Locally available 53 grades ordinary Portland cement (OPC) of ULTRATECH brand has been used in the present investigation for all concrete mixes. The cement used was fresh and without any lumps.

2.2 FINE AGGREGATE

Fine sand should consist of natural sand or crushed stone sand. It should be hard, durable and clean and be free from organic matter etc. Fine Sand should not contain any appreciable amount of clay balls and harmful impurities such as alkalis, salts, coal, decayed vegetation etc. Locally available river sand is used in experiment which is passing through 4.75mm IS sieve and retained on 75 micron IS sieve.

Table-1: Properties of fine aggregate

Properties	Results
Specific gravity	2.65
Water absorption	1.34%
Maximum size	4.75

2.3 COARSE AGGREGATE

Aggregate generally occupy 70% to 80 % of volume of concrete and therefore it have an important influence on its properties of concrete. Coarse aggregate was used of size 20mm conforming to IS 383 is used. Good-quality of aggregate which is clean, hard, strong, have durable particles, and be free of absorbed harmful chemicals, coatings of clay, or other contaminates that can affect hydration of cement or reduce the paste-aggregate bond.

Table- 2: Properties of coarse aggregate

Properties	Results
Specific gravity	2.69
Water absorption	0.26%
Maximum size	20 mm
Minimum size	12.5 mm
Impact value	18.62
Crushing value	6.52

2.4 SUGARCANE BAGGASE ASH

The sugarcane bagasse consists of approximately 50% of cellulose, 215% of hemi cellulose and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide ($SiO2$). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests. Carbon and iron affect the colour of the bagasse ash.

High carbon content changes the color to grey or black. High iron content produces a tin colored ash .The specific gravity of ash is given by manufacturer is 2.12.

Fig-1: Bagasse ash

Table - 3: Chemical Composition of SCBA

Components	MASS in %
Silica(sio_2)	58.62
Alumina(Al_2O_3)	14.95
Ferric oxide(Fe_2O_3)	12.25
Calcium oxide(CaO)	1.92
Sulpher trioxide SO_3	2.070
Magnesium oxide Mgo	2.090
Loss of ignition	1.080

3. MIX DESIGN

Concrete mix of M25 grade was designed by conforming to IS 10262-1982 method. The cement were replaced with bagasse ash by 0%, 5%, 10% and15% 0.43water cement ratio was kept constant.

Table -4: Mix proportion

	cement	Fine aggregate	Coarse aggregate	Water
Ratio	1	1.17	2.36	0.43
Mass Kg/m^3	445	523	1288	191.6

Mixes:

M1=100% of Cement+0% of BA+100% FA+100% CA

M2=95% of Cement+5% of BA+100% FA+100% CA

M3=90% of Cement+10% of BA+100% FA+100% CA

M4=85% of Cement+15% of BA+100% FA+100% CA

Where, BA = Bagasse ash

FA = Fine Aggregate

CA = Coarse Aggregate

4. CASTING, CURING AND TESTING OF SPECIMEN

Cement, fine aggregate and coarse aggregate of mix proportion 1:1.17:2.37 were taken corresponding to M25 grade concrete. Bagasse ash as partial replacement of cement. Batching of materials as per mix design is done by weigh batching. All ingredients are first dried mixed then water added. Machine mix is done to get homogenous mixture. Then the mixture is poured into specimens. Vibrators are used for compaction. After vibration the surface of specimen is leveled using trowel. Specimens are kept for drying for 24 hours and then specimen were demoulded. Specimens are then kept for curing. Curing is done 7,28 days.

Testing of specimen: The 6 cubes for each proportions were tested for compressive strength of size 150 × 150 × 150 mm. 4 cylinders for each proportions of size 150mm diameter and 300mm length were casted and used for testing split tensile strength and 4 beams for each proportions of size 500mm length, 100mm width and 100mm depth were casted and used for testing flexural strength at 7, 28 days curing.

4.1 COMPRESSIVE STRENGTH TESTS

Specimens of size 150 × 150 × 150 mm were casted for all the proportions and tested in compression testing machine. Capacity of machine is 2000KN.Compressive strength calculated by using equation,

$$F=P/A$$

Where, F= compressive strength in N/mm^2
P= maximum load in Newton
A= cross sectional area in mm^2

Table-5: Shows the average compressive strength at various proportions

Mix Proportions	7days compressive strength in N/mm^2	28days compressive strength in N/mm^2
0%	18.22	31.50
5%	19.023	33.20
10%	19.35	35.25
15%	18.78	32.23

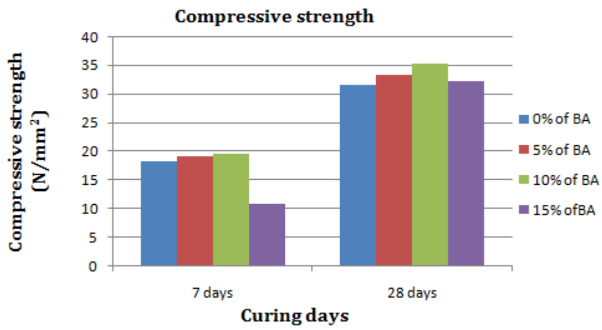

Fig-2: Average compressive strength for various proportions

4.2 SPLIT TENSILE STRENGTH TESTS

Specimen of size 150 mm diameters and 300mm length were casted. The test was conducted on the Compression Testing Machine. Cylinder specimens were placed under the Compression Testing Machine in a horizontal direction perpendicular to the direction in which they are casted. The tensile strength was found by using equation,

$$F = 2P/\Pi Ld$$

Where, F=tensile strength in N/mm^2

P = Maximum load applied

d = measured depth of specimen

L= Length of specimen

Table -6: Shows the average tensile strength of concrete at various proportions

Mix Proportions	7days Split tensile strength in N/mm^2	28 days Split tensile strength in N/mm^2
0%	1.48	2.11
5%	1.61	2.83
10%	1.8	3.07
15%	1.93	2.95

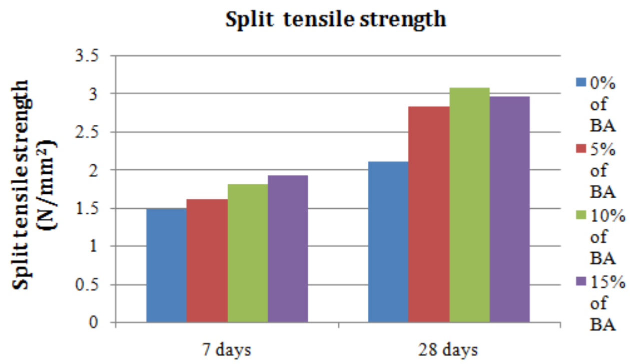

Fig-3: Average split tensile strength for various proportions

4.3 FLEXURAL STRENGTH TESTS

Concrete as we know is relatively strong in compression and weak in tension. Beams tests are found to be dependable to measure flexural strength property of concrete. The system of loading used in finding out the flexural tension is two points loading. The specimen placed in flexural testing machine in such a manner that the load to be applied to uppermost surface as cast in the mould. The flexural strength was found by using equation,

$$F = PL/bd^2$$

Where, F=Flexural strength in N/mm^2

P = Maximum load applied

L = Length of specimen

b = breadth of specimen

d = depth of specimen

Table -8: Shows the average flexural strength at various proportions

Mix Proportions	7days Split tensile strength in N/mm^2	28 days Split tensile strength in N/mm^2
0%	3.4	6.2
5%	3.75	6.9
10%	3.98	8.45
15%	3.45	7.1

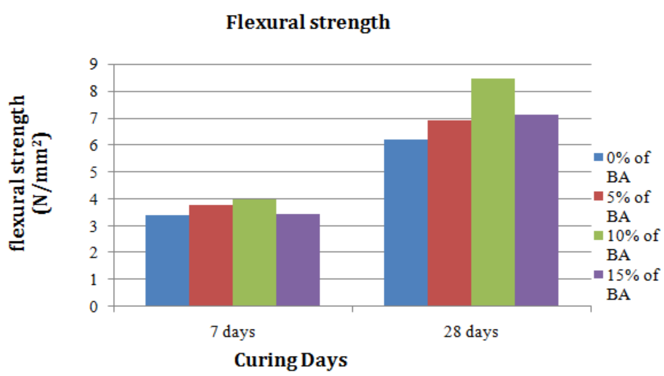

Fig-4: Average flexural strength for various proportions

5. RESULTS AND DISCUSSION

From the experimental analysis, it is an evident that at age of 7, 28 days fig 2,3,4 shows the compressive strength, split tensile strength and flexural strength increases as a percentage of Baggase ash is increased. For the further increases of Bagasse ash the strength decreased. Optimum strength obtained at 10% replacement of bagasse ash as cement.

6. CONCLUSIONS

Bagasse ash can be used as partial replacement for cement up to percentage of 5 and 10. More than the 10% replacement decreases in strength is seen. For optimum result the 10% replacement bagasse ash is good.

- The results showed that, the concrete with 10% SCBA replacement after 28 days of curing, showed maximum strength when compared to concrete with other percentage replacement mixes.
- As the flexural tensile strength of SCBA concrete is more it can be used in slabs beams etc., where higher flexural tensile strength is required.
- The density of concrete decreases with increase in SCBA content, thus low weight concrete can also be produced in the society with waste materials (SCBA)
- In the economic point of view, the cement replaced by SCBA saves money.
- It was clearly shown that SCBA is a pozzolanics material that has the potential to be used as partial cement replacement material and can contribute to the environmental sustainability.
- In addition its use resolves the disposal problems associated with it in the sugar industries and thus keeping the environment free from pollution.

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9. BIS IS 516-2004 Methods of test for strength of concrete.

10. BIS IS 383-2002 Specification for coarse and fine aggregate.

CODE BOOK

- IS CODE 10262:2009 for Concrete Mix Proportion