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EXPERIMENTAL STUDY OF BAGASSE ASH AS PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

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ABSTRACT

*Our project is about use of Sugarcane Bagasse Ash which is a byproduct extracted from sugarcane industry. When juice is extracted from sugar pulp, the bagasse is packed in graphite crucible air tight and placed inside electric control furnace burnt at temperature of 1200C for 5hours to obtain black ash. The composition is Siliceous Oxide and Alumina. Bagasse Ash is light material and high oxidation compound compared with cementing compounds. We have taken M30 grade concrete, for this grade we have casted cubes of size 150mm*150mm*150mm and cylinders 150mm*300mm. We have replaced cement with sugarcane bagasse ash of 2%, 4%, 6% and conducted tests for obtaining compressive strength for cubes and split tensile strength for cylinders. We obtained an optimum percentage of 2% it is that from locally available cheap materials like sugarcane bagasse ash, we obtained high workability and strength unlike cement sugarcane bagasse ash is environmental friendly too.*

Key words: Bagasse Ash, Cement in Concrete, Sugarcane Bagasse

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INTRODUCTION

Cement is general sense of word, can be described as a material with an adhesive and cohesive properties which make it capable of bonding mineral fragments into a compact mass. This definition encompasses a large variety of cementing material. Concrete is the most popular engineering material in the field of civil engineering. It is an artificial compound generally made by mixing of binding material, fine aggregates, coarse aggregates, water and admixtures in suitable proportions. The increased demand for the usage of huge quantity of concrete is to increase in cost of binding material (cement) and depletion of natural sources of fine aggregate which in turn increases cost of concrete. This prompted civil engineering to use SUGARCANE BAGASSE ASH as a partial replacement material for cement. The matrix is usually 22-34% of total volume freshly mixed concrete before set is known as wet or green concrete whereas after setting is harden concrete.

1. FUNCTION OF CEMENT ENGINEERING IN GLOBAL URBANIZATION

1.1. The Infrastructure Crisis

The unprecedented changes that have occurred in the world and society during the latter half of the last century have placed almost insatiable demands on the construction industry in terms of the world's material and energy resources. Continue population growth and evolutionary industrialization have resulted in an endless stream of global urbanization It took the world population until the year 1804 to reach the first one billion; yet the increase from 5 to 6 billion has taken just 12 years. It is now estimated that the world's population will increase from 6 billion now to 8 billion by 2036 and 9.3billion by 2050.reach the first one billion; yet the increase from 5 to 6 billion has taken just 12 years. It is now estimated that the world's population will increase from 6 billion now to 8 billion by 2036 and 9.3billion by 2050. This explosion into an urban way of life will continue to demand enormous resources and supply of construction materials required to build the infrastructure - such as housing, transportation, education, power, water supply and sanitation utilities - the basic facilities needed to support life in these mega cities and big cities.

The impact of global urbanization and world industrialization is not merely on the demand for construction materials; a more insidious implication is on world energy demands, which again impinges finally on the construction industry. In the present context of the world, some 25% of the world's population lives in the industrialized world, and they account for nearly 75% of the global energy consumption.

On an approximate basis, materials consume some 20-25% of the world's total energy budget. If it is now assumed that a doubling of the present population will entail an increase in the global energy consumption to only double the present level, then the demand for construction materials will place an impossible burden on the environment. In the last 25 years there have been 30% reductions in CO_2 emissions as per the report published on 2006 by some reputed companies. This kind of independent evaluation is intended for adoption of more fuel efficient kiln processes.

The growing demand for cement (±4.7% yr) will outstrip all projected CO_2 emissions reductions plans. By 2050, cement demand is projected to be 5.5Gt/yr, an increase of140% above 2005 consumption. Illustrates an ominous "Business as Usual"(BAU) scenario up to the year 2050. Current and future cement and CO_2 emissions are with both BAU and best available practice (BAP) scenarios. The International Energy Agency (IEA) estimates that maximizing efficiencies through best available practices and maintaining a 0.7 clinker factor would reduce CO2 emissions to 0.8 tons per ton of cement produced. It is widely accepted that by 2050 carbon trading and capture and storage technology will be important strategies in global emissions management.

2. PROJECT OBJECTIVE

The main objective of the present investigation is:

1. To obtain the influence of sugar cane bagasse ash on various strength properties of M30 grade concrete.
2. Compressive strength, split tensile strength of M30 grade concrete prepared using different proportions of sugarcane bagasse ash are to be obtained and the results are to be obtained and the results are to be compared with that of controlled concrete.

3. PROPERTIES OF SUGARCANE BAGASSE ASH

3.1. SUGARCANE BAGASSE ASH

Sugarcane bagasse ash is a by-product of sugar factories found after burning of sugarcane bagasse which itself is found after the extraction of all economical sugar from sugarcane. The disposal of this material is already causing environmental problems around the sugar factories.

The production process generates bagasse as a waste, which is used as fuel to stoke boilers that produce steam for electricity cogeneration. The final product of this burnimgos residual sugarcane bagasse ash (SBA), which is normally used as fertilizer in sugarcane plantations.

In this study, bagasse ash sample was collected from Nava Bharat sugar factory Samalkota and its chemical properties are investigated. The bagasse ash was then ground until the particles passing the 0.3micrometers sieve size reach about 85%and the specific surface area about 4716 cm2/gm. Ordinary Portland cement and Portland pozzolana cement were replaced by ground bagasse ash at different percentage ratios. Normal consistency and setting time of the pastes containing Ordinary Portland cement and bagasse ash from 5% to 30% replacement were investigated. The compressive strengths of different mortars with bagasse ash addition were also investigated. The test results indicated that up to 10% replacement of cement by bagasse ash results in better or similar concrete properties and further environmental and economical advantages can also be exploited by using bagasse ash as a partial cement replacement material.

Figure 1 Sugarcane Bagasse Ash

4. REVIEW OF LITERATURE

Ganesan et al., studied the effects of SCBA content as partial replacement of cement (0-30%) on physical and mechanical properties of hardened concrete. and resistance to chloride ion penetration. The test results indicated that SCBA is an effective mineral admixture up to 20%replacement was advantageous.

Otuoze et al. concluded that SCBA was a good pozzolana for concrete cementation and partial blends of it with OPC could give good strength development and other engineering properties in concrete. The replacement of cement by SCBA was 0-30% and in accordance with American and Brazilian Standards all tests were carried out.

Lavanya et al.examined the partial replacement for cement in conventional concrete. The tests were conducted as per Bureau of Indian Standards (BIS), IS 516-1959 codes to evaluate the suitability of SCBA for partial replacements up to 30% of cement with varying water cement (w/c) ratio.

Somna et al.. Studied the utilization of a pozzolanic material to improve the mechanical properties and durability of recycled aggregate concrete. Ground bagasse ash (GBA) was used to replace Portland cement at the percentages of 20, 35, and 50 by weight of binder. SCBA used to replace natural coarse aggregate not more than 25% by weight.

Kawade et al. studied the effect of use of SCBA on strength of concrete by partial replacement of cement at the ratio of 0%, 10%, 15%, 20%, 25% and 30% by weight for compressive strength. If some of raw material having similar composition can be replaced by weight of cement in concrete then cost could be reduced without affecting its quality. It was found that the cement could be advantageously replaced with SCBA up to maximum limit of 15%.

5. EXPERIMENTAL WORK

5.1. MATERIALS AND THEIR PROPERTIES:

The properties of various materials used in making the concrete are discussed in the following sections.

Cement

The Ordinary Portland Cement of 53 grade is used specifying all the properties from IS12269-1987.

Coarse Aggregate

The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 are being used. The Flakiness and Elongation Index were maintained well below 15%. Physical property evaluation and gradation of coarse aggregate were carried out and the test results are presented below: Aggregates are the major ingredients of concrete. They constitute 70-80% of the total volume, provide a rigid skeleton structure for concrete, and act as economical space fillers.

Fine Aggregate

Locally available free of debris and nearly riverbed sand is used as fine aggregate. The sand particles should also pack to give minimum void ratio, higher voids content leads to requirement of more mixing water. In the present study the sand confirms to zone I as per Indian standards.

(BIS: 10262, BIS: 383). The specific gravity of sand is 2.62. The bulk density of fine aggregate is 1715 kg/m3.Those fractions from 4.75 mm to 150 micron are termed as fine aggregate.

6. LABORATORY TESTS AND RESULTS

Various tests were carried out in the laboratory for finding the strength and durability and other important properties of the concrete used during the study. Slump cone test, Compaction test, compressive strength and split tensile strength were conducted and the details of these tests are given in the following sections.

Sieve size (mm)	**Weight retained (gm)**	**Percentage Weight retained (gm)**	**Cumulative Percentage of weight retained**	**Cumulative percentage of weight passed**
		(gm)		
4.75	22	0.6	0.6	99.4
2.36	32	0.76	1.32	98.68
1.18	144	3.6	4.92	95.08
600 µ	973	12.28	17.2	82.8
300 µ	2000	57.5	74.7	25.3
150 µ	1170	24.1	98.8	1.2
75 µ	480	1.2	99.99	0.01
Pan	5	0.033	100	0
Total			**297**	

Fineness modulus =297/100 = 2.97

RESULT: Hence the Fineness modulus of sand is calculated as2.97

6.1. EXPERIMENTAL PROCEDURE

SLUMP CONE TEST: In all over the world the test on fresh concrete are widely used .though the slump test won't consider the workability of concrete but helpful in detecting the deviations in the uniformity of a mix of given nominal proportions.

Figure 3 Slump test

6.2. WORKABILITY OF FRESH CONCRETE

Workability depends on water content, aggregate (shape and size distribution), cementicious content and age (level of hydration) and can be modified by adding chemical admixtures, like super plasticizer. Raising the water content or adding chemical admixtures increases concrete workability.

Table 2

SERIAL NO	PHYSICAL PROPERTIES	RESULTS
1	FINENESS OF CEMENT	1.2%
2	SPECIFIC GRAVITY OF CEMENT	3.16
3	NORMAL CONSISTENCY	32%
4.	INITIAL SETTING TIME(minutes)	40
5	FINAL SETTING TIME(minutes)	600
6	COMPRESSIVE STRENGTH	55.66 N/mm^2

7. COMPRESSIVE STRENGTH

Compressive strength of cement is the most important property. It is determined by ducting compression tests on standard 50 mm mortar cubes in accordance with ASTM C 109.In general, cement strength (based on mortar-cube tests) cannot be used to predict concrete compressive strength with great degree of accuracy because of many variables in aggregate characteristics, concrete mixtures, construction procedures, and environmental conditions in the field.

Table 3

% SCBA in Concrete	Slump (mm)
0%	75mm
2%	122mm
4%	148mm
6%	171mm

Figure.4 Testing of compressive strength of specimen

Table 4 Compressive Strength Results For 7 Days Curin

SL.NO	CUBE	COMPRESSIVE STRENGTH N/mm²			
		0%	2%	4%	6%
1	A	21.25	26.29	20.56	17.33
2	B	26.30	25.80	20.26	16.02
3	C	24.64	24.89	19.92	15.79
	AVG	24.06	25.66	20.24	16.38

7.1. Graphical representation of Compressive Strength Values

Graph: 1

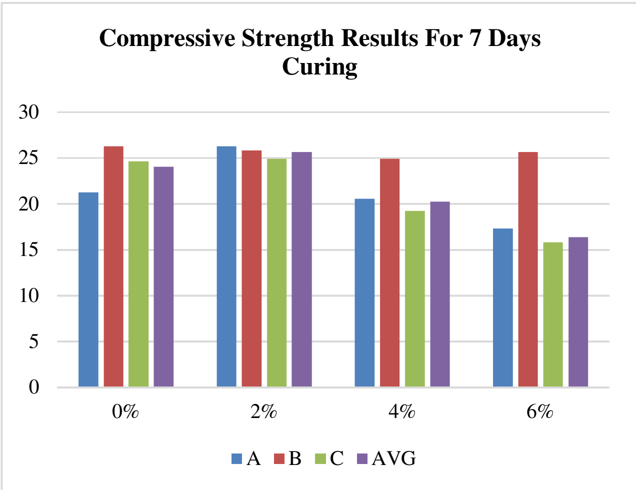
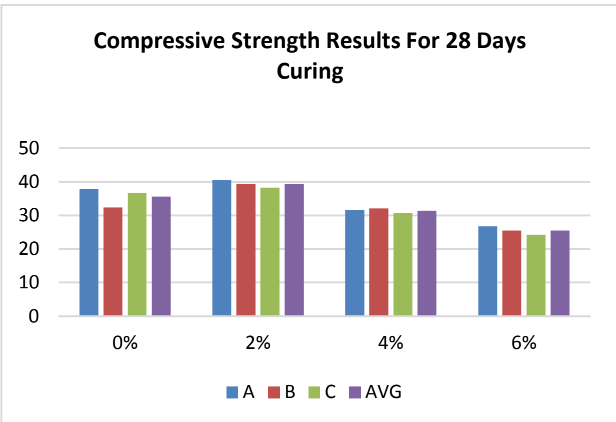
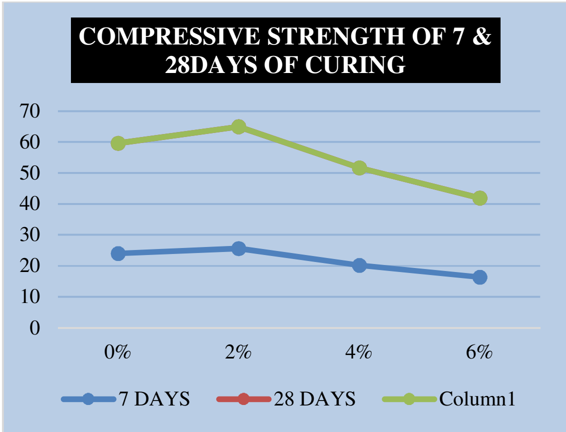


Table 5 Compressive Strength Results For 28 Days Curing

SL.NO	CUBE	COMPRESSIVE STRENGTH N/mm²			
		0%	2%	4%	6%
1	A	37.77	40.45	31.63	26.67
2	B	32.35	39.69	32.06	25.54
3	C	36.60	38.30	30.64	24.30
	AVG	35.57	39.30	31.44	25.50



Graph 2



Cumulative Graph 3

8. SPLIT TENSILE STRENGTH:

Testing for split tensile strength of concrete is done as per BIS 5816-1999. The test is conducted on automatic compression testing machine of capacity 3000kN as shown in fig. The cylinder is placed horizontally between the loading surfaces of compression testing machine and the load is applied till failure of the cylinder. During the test the plates of the testing machine should not be allowed to rotate in a plane perpendicular to the axis of cylinder Split tensile strength= 2P/ (ΠDL)

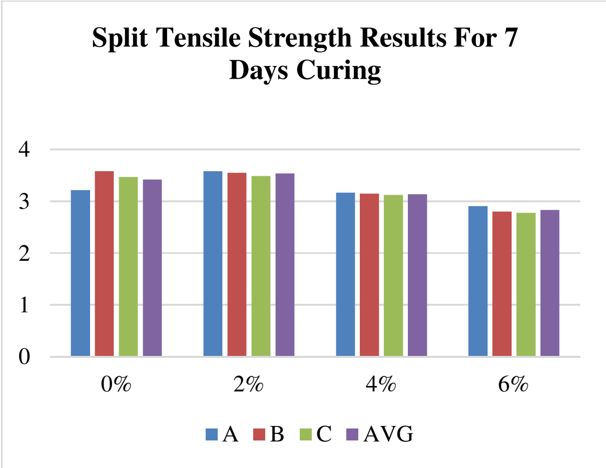
P = ultimate load, L= span of the specimen, D= width of the specimen.

Figure 2 Split tensile testing of concrete cylinder

8.1. Graphical representation of Split Tensile Strength Values

Table 6 Split Tensile Strength Results For 7 Days Curing

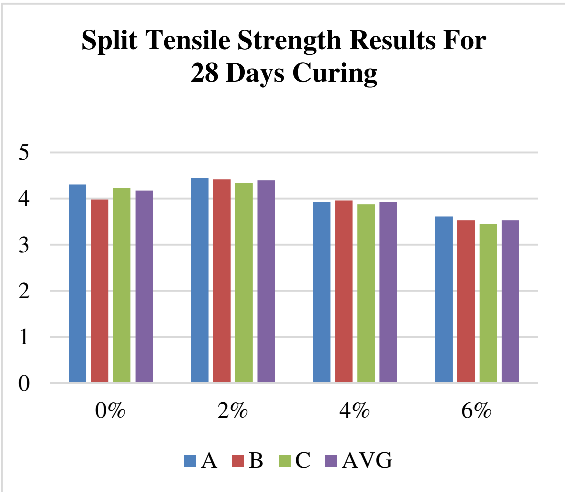
SL.NO	CUBE	SPLIT TENSILE STRENGTH N/mm^2			
		0%	2%	4%	6%
1	A	3.22	3.58	3.17	2.91
2	B	3.58	3.55	3.15	2.80
3	C	3.47	3.49	3.12	2.78
	AVG	3.42	3.54	3.14	2.83



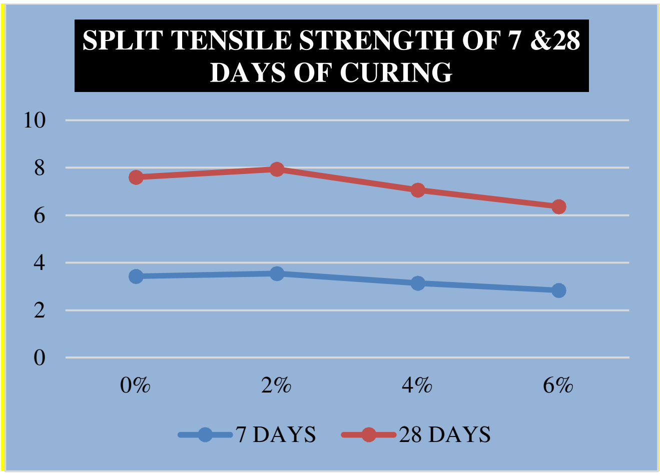
Graph 6

Table 7 Split Tensile Strength Results for 28 Days Curing

SL.NO	CUBE	SPLIT TENSILE STRENGTH N/mm^2			
		0%	2%	4%	6%
1	A	4.30	4.45	3.93	3.61
2	B	3.98	4.41	3.96	3.53
3	C	4.23	4.33	3.87	3.45
	AVG	4.17	4.39	3.92	3.53



Graph 7



Graph 8

9. CONCLUSIONS

- The slump decreases as the percentage of micro silica and nano silica increases. This is due to the specific surface area of micro silica and nano silica is much higher than cement and corresponding the water demand raises so that the slump decreases.
- It is also observed that while increasing the combine percentage of MS and NS the concrete become more cohesive and there is no problem of bleeding and segregation.
- The compressive strength and split tensile strength is maximum for $C_{88.5}M_{10}N_{1.5}$
- The compressive strength and split tensile strength is high at $C_{88.5}M_{10}N_{1.5}$ at all ages i.e. that are 7 days, 28 days and 56days.
- As the percentage replacement by micro silica and nano silica increases beyond the strength decreases. From this investigation the optimum proportion of mix is $C_{88.5}M_{10}N_{1.5}$.

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