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AN EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE BY USING SUGARCANE BAGASSE ASH

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ABSTRACT

Increasing demand and consumption of cement investigators, researchers and scientist made in examination of alternate binders that are biodegradable and contribute towards waste management. The construction industry is the foremost consumer of natural resources which led to exhaustion of good quality natural sand (fine aggregate). This situation constrains us to explore alternative materials for cement and fine aggregate. Sugarcane bagasse ash is a left-over industrial byproduct which is used as a replacement of both natural sand and cement.

The use of industrial and unindustrialized(agricultural) waste produced by industrial processes has been the attention on waste reduction. Juice is dig out(extracted) from sugar cane then ash is produced by burning. This research scrutinizes the possibility of using sugarcane bagasse ash as partial replacement of specific ingredients in concrete. In this paper SCBA has been chemically and substantially categorized and partially replaced fine aggregate in the ratio of 0%, 10%, 20%, 30% and 40% and 10% by the weight of cement in concrete. The mix proportion for M25 grade concrete was derived. Our study gave an effective result for the replacement. We could get a satisfactory concrete with SCBA content of 10% and 30% replacement for cement and fine aggregate respectively.

KEYWORDS: Bagasse Ash, concrete, Compressive strength, partial replacement.

INTRODUCTION

Initiatives are developing worldwide to control and regulate the supervision of sub-products, residuals and industrial wastes in order to preserve the environment from contamination. A good solution to the problem of recycling agro industrial excess would be by burning them in a controlled environment and use the ashes (waste) for more polite means. Utilization of such wastes as cement and fine aggregate replacement materials may reduce the cost of concrete production and also minimize the harmful environmental effects with disposal of these wastes.

Sugarcane is one of the foremost crops grown in all over countries and its entire production is over 1500 million tons. After the extraction of all efficient sugar from sugarcane, large fibrous excess is obtained. When bagasse is burnt in the boiler of cogeneration plant under controlled conditions, sensitive amorphous silica is formed due to the combustion process and is present in the remaining ashes known as Sugarcane Bagasse Ash. This amorphous silica content makes bagasse ash as a useful cement replacement material in concrete. Each ton of sugarcane producesaround 25.65% of bagasse (at a moisture content of 50%) and 0.61% of residual ash. The excess after combustion presents a chemical composition controls by silicon dioxide (sio2). From the past investigates it is found that the bagasse ash comprises of the properties of nature sand.

But these ashes are produced under unrestrained and non-uniform burning conditions with temperatures rising above 1000°c resulting in a manifestation of the matter .In this study the bagasse ash is planned to use as the partial replacement for cement and fine aggregate in-order to utilize the wastages and to protect the atmosphere from the hazards. Sugarcane bagasse ash is normally used as manure in sugarcane plantation.

NEED AND ADVANTAGES

Need of sugarcane bagasse ash (SCBA) usage:

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1. Each ton of cement produces around about one ton of CO_2 and cement industry is answerable for the release of about 5% of CO_2 worldwide.
2. Has an effective impact in the economical point of view.
3. When used as replacement for cement in concrete, it reduces the problem associated with their clearance.
4. Decrease in the release of greenhouse gases.

Advantages of sugarcane bagasse ash

Land pollution

Predominantly the ash disposal problem from sugar industry is reduced since it is usually disposed off in open land area.

Economy

Due to the non-availability of fine aggregate, the worth of natural sand which is used as fine aggregate has increased by three wrinkles in the past few months. Hence the overall price involved in the construction is reduced.

Future demand

Partial replacement will also help in meeting the increasing demand for fine aggregate in future.

EXPERIMENTAL INVESTIGATION

In this experimental work, a total of 45 numbers of concrete samples were casted. The typical size of cube 150mm×150mm×150mm is used. The mix design(procedure) of concrete was done according to Indian Standard guidelines for M25 grade.

Based upon the quantities of component of the mixes, the numbers of SCBA for 0, 10, 20, 30% and 40% replacement by weight of sand and fixed replacement of 10% by weight of cement were estimated. The ingredients of concrete were thoroughly mixed in mixer machine till uniform consistency was achieved. Before casting, machine oil was smeared on the inner surfaces of the cast iron mould.

Concrete was poured into the mould and compacted carefully using table vibrator. The top surface was over by means of a trowel. The specimens were removed from the mould after 24hours and then cured under water for a period of 7, 14 and 28 days. The samples were taken out from the curing tank just prior to the test. The compressive test was conducted using a 1000kN capacity compression testing machine. This test was lead as per the relevant Indian Standard specifications.

Material Details

The materials used in the investigations are

Cement

The cement is used as a binding material. In this study, the cement used as OPC 53 grade cement available from KCP Cement Company and it conforming as per IS 12269-1987.

Fine Aggregate

Aggregates for the concrete wereobtained from approved suppliers conforming to the specifications of IS 383 - 1970 and were chemically inactive(inert), spotless and robust. The fine aggregate was tested as per the limits which is specified in IS: 2386 (Part-3):1963. In this study, fine aggregate having a fineness modulus of 2.46 which is carried out by using sieve analysis and it confirming to zone 2.

Coarse Aggregate

Coarse aggregates will be machine-crushedone of black trap or equivalent black tough stone and shall be stiff, robust, dense, durable, spotless or procured from quarries approved by the consultant. In this study, crushed aggregate of size 20 mm in angular shape is used and it conforming to IS 383.

Sugarcane Bagasse Ash

It comprises high volume of sio2. Therefore, it is classified as a good pozzolanic material. SCBA can be used as aadd-on forcementitious material due to its pozzolanic property.

Sugarcane bagasse ash was collected from M/s Ponni Sugars (P) Ltd., Pallipalayam, Namakkal District of Tamil Nadu.

Water

A good potable wateravailable in the siteis used for the construction purpose which conforming to the requirements of water for concreting and curing as per IS: 456-2009.

Tables:

Table 1. Physical properties of cement

PROPERTY	VALUE
Specific Gravity	2.91
Standard consistency	32%
Setting time	
(i) Initial setting time	90 minutes
(ii) Final setting time	210 minutes
Fineness	2.5%

Table 2. Chemical composition of cement

COMPONENT	%
Sio_2	21.8
Al_2O_3	4.8
Fe_2O_3	3.8
CaO	63.3
SO_3	2.2

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MgO_3	0.9
P_2O_5	<0.04
Loss of ignition	2
Insoluble residue	0.4

Table 3.Physical properties of Fine aggregate

PROPERTY	VALUE
Specific gravity	2.54
Fineness modulus	2.46
Bulk density	1.65 kg/m^3
Type of sand	Medium sand (zone 2)

Table 4. Physical properties of Fine aggregate

PROPERTY	VALUE
Specific gravity	2.68
Density	1567 kg/m^3
Fineness modulus	7.682
Impact value	22.12% < 45%
Crushing value	24.44% < 45%

Table 5. Physical properties of sugarcane bagasse ash

PROPERTY	VALUE
Fineness modulus	2.12
Specific gravity	1.78

Table 6. Chemical composition of sugarcane bagasse ash

OXIDES	SCBA MASS %
Silica (Sio2)	68
Alumina (Al2O3)	3.05
Ferric Oxide (Fe2O3)	3.72
Calcium Oxide (CaO)	5.1
Magnesium Oxide (MgO)	1.15
Sulphur Tri Oxide (SO3)	0.67
Loss of Ignition	4.5

Table 7. Concrete mix design proportion (M25 grade)

MIX	CONCRETE MIX DESIGN PROPORTION					
	W/C RATIO	C	FA	CA	% OF REPLACE-MENT OF SCBA BY WEIGHT	
					C	FA
BA 0	0.46	1	1.24	2.76	0	0
BA 1	0.46	0.9	1.12	2.76	0.1	0.1
BA 2	0.46	0.9	0.99	2.76	0.1	0.2
BA 3	0.46	0.9	0.87	2.76	0.1	0.3
BA 4	0.46	0.9	0.74	2.76	0.1	0.4

RESULTS AND DISCUSSION

Slump Test

A high-quality concrete is one which has appropriate workability (around 65 mm slump height) inthe fresh condition. Basically, the greater the measured height ofslump, the improved the workability will be, indicating that the concrete flows easily but at the sametime is free from segregation. the slump achieved at the rate of 65 mm to 80 mm for the different mixes of SCBA. The workability is achieved by adding the super plasticizers.

Compressive strength test

Compressive strength was done for the cube samples of size 150 mm x 150 mm x 150 mm. concrete cubes are casted with partial replacement of natural sand with sugarcane bagasse ash as 10%, 20%, 30% and 40% and fixed replacement of 10% by the weight of cement and it is verified at the age of 7,14 and 28 days. The test results are plotted in the graph is as shown in the figure 1.

Figure 1:

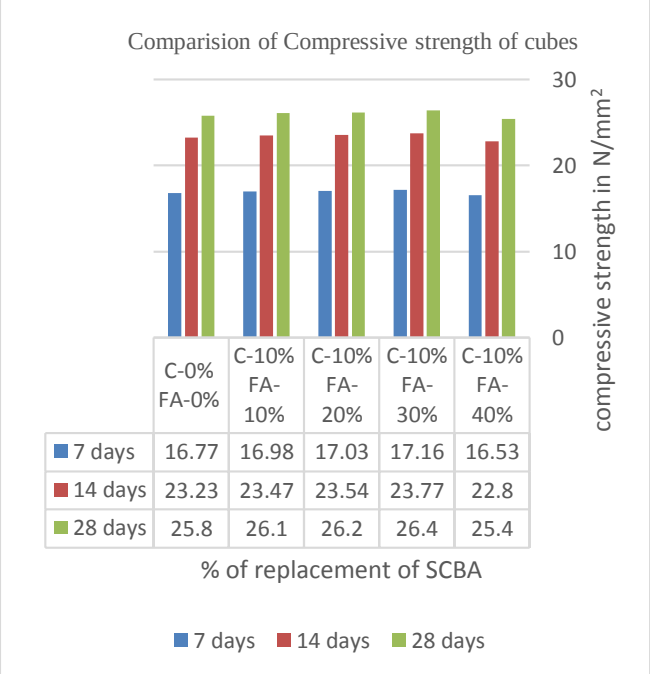

Fig.1 Comparision of Compressive strength of cubes for different % of SCBA

Compressive strength constantly increases as the curing period goes on increasing. Adding of increasing quantities of SCBA generally decreased the strength at a given age due to the greater porosity of the material as specified by higher water necessity. The highest compressive strength was achieved when

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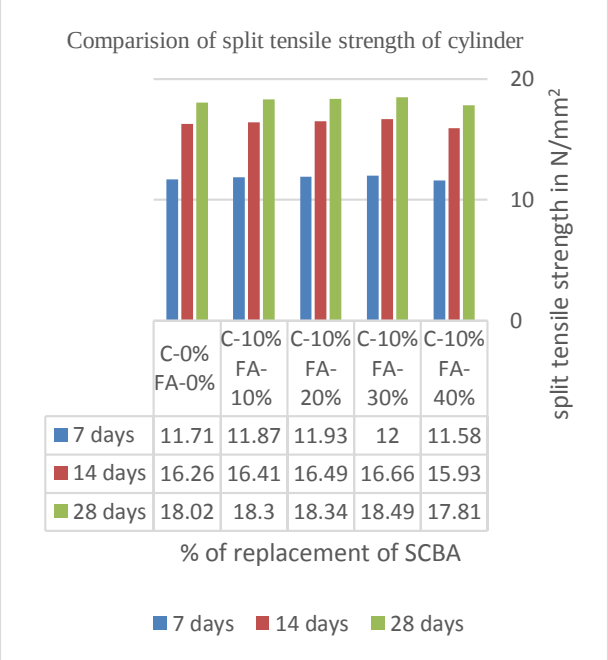
the mixture contained SCBA of 30% of fine aggregate replacement w/c ratio of 0.46.

Split tensile strength test

Split tensile test was done on cylinder specimens of size 150 mm in diameter and 300 mm in length.
The cylinder specimen with partial replacement is done which is carried out as same as the compressive strength and it is verified at the age of 7, 14 and 28 days The results are shown in Figure 2.

Figure 2:



	C-0% FA-0%	C-10% FA-10%	C-10% FA-20%	C-10% FA-30%	C-10% FA-40%
7 days	11.71	11.87	11.93	12	11.58
14 days	16.26	16.41	16.49	16.66	15.93
28 days	18.02	18.3	18.34	18.49	17.81

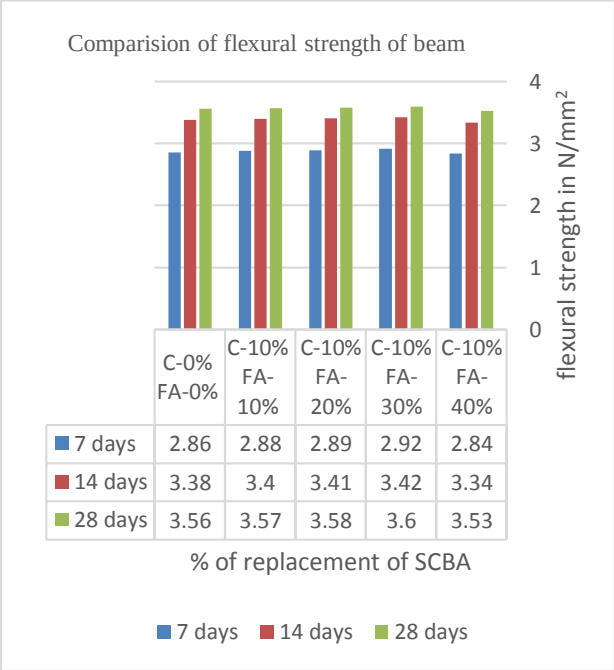
Fig.2Comparision of split tensile strength of cylinder for different % of SCBA

We observed that split tensile strength of cylinder decreases as the percentagereplacement of SCBA reaches 40%. But with 10 % of replacement of cement and 30% of the fine aggregate by SCBA gives greater strength compared to normal mix.

Flexural strength test

Flexural strength test was done on beam specimens of size 100 mm X 100 mm X 1000 mm. The beam specimen with partial replacement of natural sand with sugarcane bagasse ash as 10%, 20%, 30% and 40% and fixed replacement of 10% by the weight of cement and it is verified at the age of 7,14 and 28 days. The test results are plotted in the graph is as shown in the figure 3.We observed that the flexural strength of beam decreases after certain percentage replacement of SCBA. HoweverFlexural strength constantly increases as the curing period goes on increasing. The control mix had a flexural strength of 3.6 N/mm^2 at 28 days.But with 10 % of replacement of cement and 30% of the fine aggregate by SCBA gives greater strength compared to normal mix.

Figure 3:



	C-0% FA-0%	C-10% FA-10%	C-10% FA-20%	C-10% FA-30%	C-10% FA-40%
7 days	2.86	2.88	2.89	2.92	2.84
14 days	3.38	3.4	3.41	3.42	3.34
28 days	3.56	3.57	3.58	3.6	3.53

Fig.3Comparision of flexural strength of beam for different % of SCBA

CONCLUSION

From the experiments and investigationin this research work, we documented the following facts.

1. Due to non availability of natural sand at sensible cost as fine aggregate and cement in concrete for various motives, search for alternate material like SCBA which succeeds itself as a suitable standby for sand and cement at low cost.
2. SCBA have its place to zone lV as per IS code. Water constraint increased as the percentage of SCBA increased.
3. Compressive strength of 26.4 N/mm^2, split tensile strength of 18.49 N/mm2 and flexural strength of 3.6 N/mm^2 at 28 days is achived for M25.
4. Therefore, concluded that bagasse ash can increase the complete strength of the concrete when used up to a 10% cement and 30% fine aggregate replacement level with w/c ratio of 0.46.

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5. Bagasse ash is a valuable pozzolanic material and it can possibly be used as a partial replacement of both fine aggregate and cement. This could reduce the ecological complications and minimalize the requirement of land seal area to dispose SCBA.

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