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Experimental Study Of Sugarcane Bagasse Ash In Concrete

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Abstract: Sugarcane bagasse is a fibrous by-product of the sugar refining process. The residual sugarcane, known as bagasse, is burned at high temperatures under uncontrolled conditions to produce ash after the juice from the sugarcane has been extracted. Ordinary Portland cement is acknowledged as a significant building material everywhere in the world. Today, scientists are working on methods for utilizing industrial or agricultural waste as a source of raw materials for industry. As industrial wastes including blast furnace slag, fly ash, and silica fume are being used as supplemental cementing materials, this waste use would not only be inexpensive but may also result in foreign exchange profits and environmental pollution reduction. There is currently an effort to use a significant amount of bagasse ash, sugar industry waste, and bagasse biomass fuel in the electric generation business. Waste reduction research has been centred on using industrial and agricultural waste generated by industrial processes for economic, environmental, and technological objectives., sugarcane bagasse ash is a fibrous by-product of the sugar refining process. Silica and aluminium ions are the major components of bagasse ash. In this study, we replace cement with sugarcane bagasse ash in concrete. The replacement of cement is carried out at different percentages, such as 10%, 15%, and 20%, and its impact on the characteristics of concrete such as compressive strength, and workability will be examined.

Keywords: Sugarcane Bagasse Ash, Compressive Strength, Workability, Concrete

1. INTRODUCTION:

One of the main crops grown in more than 110 nations is sugarcane, with a total production of more than 1500 million tons. Only in India, about 355 million tons of sugarcane are produced annually, producing 10 million tons of waste sugarcane bagasse ash. Approximately 40–45 percent of the fibrous residue left over after economical sugar has been extracted from sugarcane and is used in the same industry as fuel for boilers to generate heat, which leads to leaving 8–10 percent of ash (also known as sugarcane bagasse ash). SCBA contains a high amount of silicon, aluminum, and calcium oxides. After steel and aluminum, cement is the third most energy-intensive material produced in tones. The cement industry uses raw materials that are high in silica, alumina, iron, and calcium. As a result, this industry has been actively involved in researching ways to use waste products in cement manufacturing as both a secondary fuel and a raw material. Sugar production is India's most important agricultural industry. Initiatives are emerging worldwide to control and regulate the management of by-products, residuals, and industrial waste to protect the environment from environmental contamination and preserve and care for natural areas. Because of increasingly stringent environmental regulations, the use of recycled materials as concrete ingredients has recently gained popularity. Since the early 1980s, there has been an enormous demand for mineral admixture, and this demand is expected to grow even more in the future. In addition, in this modern age, each structure has its intended purpose, and thus modification in traditional cement concrete has become necessary to meet this purpose. This situation has resulted in extensive concrete research, which has resulted in mineral admixture being used as a cement replacement to increase workability in most structural applications. If some raw materials with similar compositions can be replaced by the weight of cement in concrete, the cost can be reduced without compromising the quality. As a result, sugarcane bagasse ash (SCBA), a major by-product, can be used as a mineral admixture. In any industry, the difference between the products and the wastage is the way of using them and with a small investment, most of the waste can be used and can be treated too as by-products. One such potential usage is often recognized by many researchers from the agricultural waste called sugarcane Bagasse of sugar industries which by burning results in sugarcane Bagasse ash (SCBA). Sugarcane is an important agricultural plant that grows in hot climates. Brazil and India are the world's two largest sugarcane-producing countries, with Brazil producing over 719 million tons and accounting for one-third of total sugarcane production. Despite the numerous uses of bagasse, including the production of wood, papers, animal feed, and thermal insulation materials, a large amount of bagasse remains unused, resulting in ash. When used correctly, SCBA can help promote green technology. A few studies on ashes obtained directly from industries have been conducted to investigate pozzolanic activity and their suitability as binders, partially replacing cement. Despite the variety use of bagasse, for the production of wood, papers, animal food, and thermal insulation, statistics show that about one million tonnes extra of Sugarcane Bagasse Ash remain in the country. Sugarcane contains approximately 30% bagasse, while the sugar recovered is approximately 10%, and the bagasse produces approximately 8% bagasse ash as waste. As sugar production increases, the quantity of Sugarcane Bagasse Ash produced will also be large and disposal will be a problem.

Sugarcane Bagasse Ash (SCBA) has recently been tested in some parts of the world for its use as a cement replacement material. The bagasse ash was found to improve some properties of the paste, mortar, and concrete including compressive strength and water tightness in certain replacement percentages and fineness

2. OBJECTIVE: -

1. To utilize the waste obtained from the sugar mill in the form of sugarcane bagasse ash in concrete production.
2. To reduce the area employed by the dumps of Bagasse Ash
3. To reduce the initial price of concrete by using bagasse ash as a partial replacement.
4. To identify the potential application of sugarcane bagasse in concrete application
5. To study the effect of sugarcane bagasse mixed with fresh concrete as a retarder

3. LITERATURE REVIEW: -

1. **Bangar Sayali S. et. al (2017) [1]**

For their research the bagasse ash is sieved through a sieve of size 150 microns and a passing out fraction is used in concrete as a partial replacement of cement in the ratio of 2% 4%, 6%, 8% & 10% by weight of the cement. Ordinary Portland Cement 53 grade cement is used in their research work. Further, the effect of replacement of cement by bagasse ash on properties like workability for fresh concrete is examined and for hardened concrete compressive strength at the age of 7 days and 28 days were determined and they concluded that with partial replacement of cement in concrete with SCBA strength of concrete can be increased with reduction in the use of cement. They even concluded that Bagasse Ash's best use is with addition in cement rather than landfilling.

2. **Lathamaheswari et. al (2017) [2]**

They conducted a study on concrete by replacing cement with sugarcane bagasse ash in the percentage of 2.5%, 5.0%, 7.5%, 10%, and 12.5% and they observed in their research that the workability of concrete has not been very much affected by increment in replacement of cement with SCBA. They concluded that cement can be replaced with SCBA up to a maximum limit of 10%. When the cement was partially replaced by SCBA in concrete, the compressive strength and tensile strength increased with the increase in the replacement level up to 10% but the flexure strength increased at the replacement of 12.5%

3. **Prashant et. al (2013) [4]**

For their research, they replaced the sand with bagasse ash partially in the ratio of 10%, 20%, 30%, and 40% by volume of fine aggregate and found that as the percentage of bagasse ash increases sorptivity coefficient also increases. The porous nature of SCBA and the impurities present in it make the concrete permeable concrete they use ordinary Portland cement of 53 grade they tested compressive strength at hardened concrete at the age of 7 days and 28 days. They concluded that if bagasse is used in its purest form then it can prove to be a better replacement for cement and a fraction of fine aggregate i.e.10% and 20% can be effectively replaced with bagasse ash without considerable loss of workability and strength properties.

4. **U.R Kawade et. al (2013) [7]**

For their research, they have partially replaced in the ratio of 0%, 10%, 15%, 20%, 25% and 30% by weight of cement in concrete. The properties of fresh concrete are tested like the lump cone test and for hardened concrete compressive strength at the age of 7,28,56 and 90 days. The test result indicates that the strength of concrete increase up to 15% SCBA replacement with cement.

They prepared cubes of M20, M30, and M40 grades of concrete and observed that cement can be successfully replaced with SCBA up to 15%. The partial replacement of SCBA increases the workability of concrete because which superplasticizer is not required

The market offers many uses for bagasse, including the production of woodland, animal foods, thermal expansion, etc. Many bagasse is left unused and is discarded as a landfill. The use of technology is the government's primary concern. fly ash Industries are directed by the Ministry of the Environment to Take the fly ash out and utilize it to make cement and tiles. such as bricks. Given that our country is developing, additional infrastructure is needed, for greater the need for cement in the infrastructure is likewise very strong. Hazardous gases like CO_2 are produced during cement manufacture. It harms the environment and has a negative impact on people's health the residents

5. **Lavanya et. al (2012)** [3]

They examined the partial replacement for cement in conventional concrete at 10% 15% 20% 25% 30% and for various water-cement ratios such as 0.35, 0.41 and 0.45.

The tests were conducted as per the Bureau of Indian Standards (BIS), IS 516-1959 codes to evaluate the suitability of SCBA for partial replacements of up to 30% of cement with varying water cement (w/c) ratio. The Compressive strengths (7, 14, and 28 days) were determined by Indian Standards. The results obtained from the conducted experiment lead to the conclusion that bagasse ash can enhance the overall strength of concrete up to 15% replacement with a w/c ratio of 0.35. The experiment also highlights that bagasse ash is a valuable pozzolanic material that has the potential to be utilized as a substitute for cement to some extent.

6. **R Srinivasan et. al (2010)** [5]

They studied the effect of SCBA obtained by controlled combustion of sugarcane bagasse in concrete by partial replacement of cement at the ratio of 0%, 5%, 10%, 15%, and 25%Fresh concrete tests like compaction factor test and slump cone test were undertaken as well as hardened concrete tests like

compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of 7 and 28 days were obtained They concluded that blended SCBA had higher compressive strength flexural strength tensile strength in comparison to that without SCBA up to the extent of 10% they also concluded that with the addition of more SCBA density of concrete may decrease and low-weight concrete will be produced and the result shows that the strength of concrete increased as percentage ag bagasse ash replacement increased.

7. **Sirirat Janjaturaphan et. al (2010)** [6]

They studied "The Pozzolanic Activities of Industrial Sugar Cane Bagasse Ash". They find out the chemical composition of the Sugarcane Bagasse Ash and compared them with the other pozzolanic material that is, rice husk ash and concluded that the SCBA is suitable for the partial replacement of cement**.**

4. METHODOLOGY

Collection of raw materials

Cement: -

Cement is a binding material used in construction that hardens, sets, and adheres to other materials to bind them together. It is a powdery substance made from a mixture of limestone, clay, and other materials, which are heated to very high temperatures in a kiln and then ground into a fine powder. For our project we have used Portland pozzolana cement.

Fine Aggregate: -

Fine aggregate is a granular material that is typically composed of sand, crushed stone, or gravel with a particle size of up to 4.75 millimetres (mm). It is commonly used in construction applications such as concrete production, asphalt mixtures, and bedding material for pipes and utilities.

Coarse Aggregate: -

Coarse aggregates are large-sized materials that are used in construction to provide strength and durability to the concrete mix. They are typically made up of crushed rocks, gravel, or recycled materials such as concrete, brick, or asphalt. The size of coarse aggregate is larger then 4.75mm, for this project we have used 20mm size of aggregate

Bagasse Ash: -

Bagasse ash is a by-product of sugarcane processing, and it is the residue left after burning sugarcane bagasse, which is the fibrous remains of the sugarcane stalks after juice extraction. Bagasse ash is a fine, grey powder that is rich in nutrients such as potassium, calcium, and magnesium, as well as silica and other trace elements.
Bagasse ash has a range of potential uses, including as a fertilizer, a soil amendment, a source of silica for the production of cement and other construction materials, and as an adsorbent for pollutants in water treatment.

Mix proportioning

The concrete mix used in the experimental program was designed using IS 10262 (2009) the replacement level of cement by SCBA was calculated at 10%, 15%, and 20%. for mix proportioning water – cement ratio kept constant that is 0.5 and the obtained was 1: 1.66: 2.54 {Cementous material: fine aggregate: coarse aggregate)

Mixing of Material: -

For our project we prefer hand mixing for concrete. All the materials mixed properly. We add 10% extra cement because of hand mixing

- Collect the material
- Mix the dry material
- Add water
- Continue mixing

Workability Check: -

Workability is a measure of the ease with which a concrete mixture can be mixed, placed, and finished without segregation or excessive bleeding. The workability of a concrete mix is an important consideration because it can impact the quality and strength of the finished concrete. to determine workability of concrete we preferred the slump cone test.

Preparation of cubes:

After preparing the mix as per mix design, the prepared max was poured in the cube of size 150*150*150 in three layers in cube and each layer is tamped properly with the help of temping rod. After filling the mould top surface of cube is well finished by trowel.

Demoulding: -

The prepared cube has been removed from mould after 24 hours. At the time of demoulding we have to be careful for the edges and corners of cube so that the edge of cubes doesn't get damaged.

Curing of cubes: -

As Curing plays an important role on development of strength and durability of concrete. After final setting of cubes, they are placed in curing tanks for designated period of 7days, 14 days and 28 days in order to analyze the effect of bagasse on properties of concrete by means of cube compressive strength test and flexural strength.

RESULT: -

During the experimental study several tests has been performed to determine the properties of aggregates, cement and concrete and the obtained results from those tests are given below.

Test on Aggregate: -

We have performed tests like specific gravity, Impact value, and Flakiness index value to determine the different properties of concrete.

Table 1 Test results of coarse aggregate

Impact Value	11.17%
Flakiness Index Value	16.188%
Specific Gravity of Coarse Aggregate	2.75
Specific Gravity of Fine Aggregate	2.70
Water Absorption Value	1.07 %
Abrasion Value	27.47 %

Test on Cement: -

Testing cement is important to ensure that it meets the required specifications and standards for use in construction.

Table 2 Test results of cement

Test name	Result
Consistency Value	33%
Initial Setting Time	42min.
Final Setting Time	493min.
Soundness Value	9mm

Test on concrete: -

To analyze the effect of SCBA on fresh as well as hardened properties of concrete several tests have been performed and the result of these tests are given below

Slump Value for Concrete: -

Slump value is a measure of the workability of concrete, and it refers to the amount of vertical settlement or deformation that occurs when a cone-shaped sample of concrete is moulded and then removed. The slump test is a widely used and simple test that can be used to determine the consistency and workability of concrete.

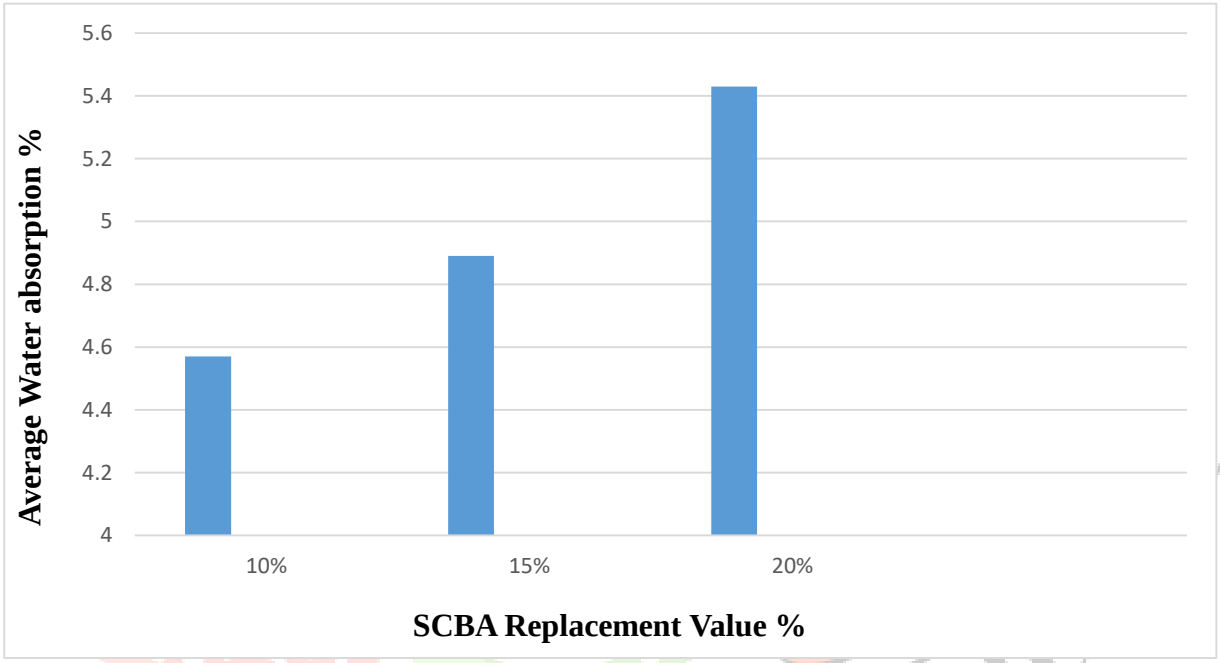
Table 3 Test results of slump value

SCBA Replacement %	Slump Value
Sample 1 (10% SCBA)	70 mm
Sample 2 (15% SCBA)	68 mm
Sample 3 (20% SCBA)	63 mm

Water absorption test on concrete: - Water absorption test is a commonly used test for determining the porosity and permeability of concrete**.**

Table 4 Test results of water absorption on concrete

SCBA Replacement %	Average Water absorption %
10%	4.57%
15%	4.89%
20%	5.43%



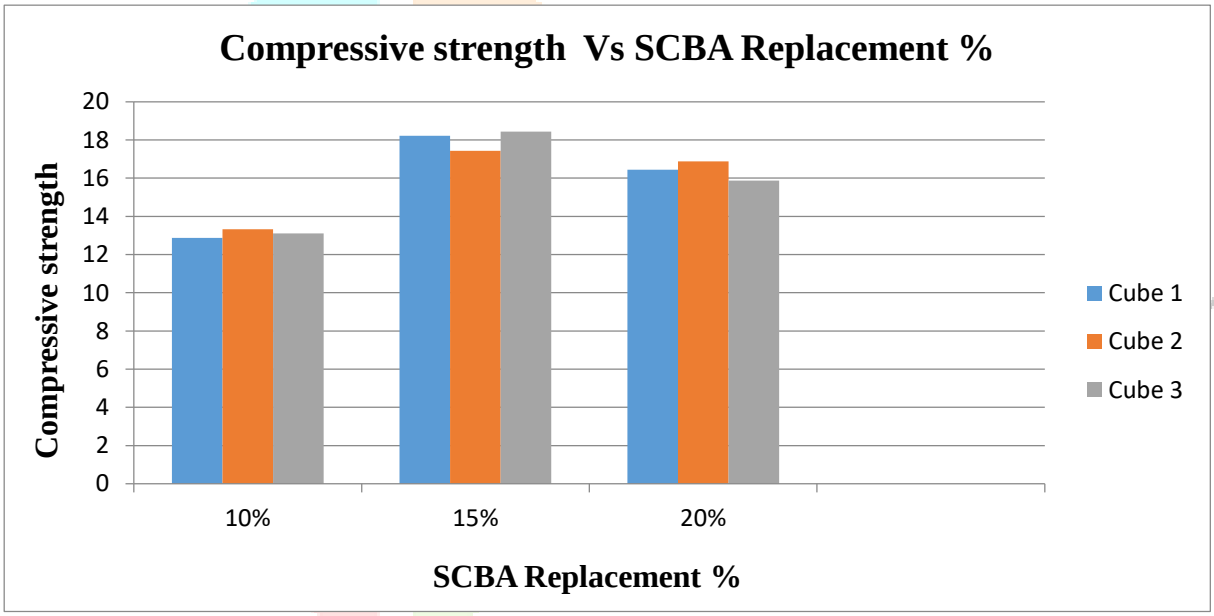
Compressive Strength Test: -

The compressive strength test is a common method used to determine the compressive strength of concrete. It measures the maximum compressive load that a concrete sample can bear before it fails and is an important measure of the quality and durability of concrete.

Compressive Strength (N/mm^2)

Table 5 Test results of compressive strength (N/mm^2)

SCBA Replacement %	Compressive strength at 28 days (Mpa or N/mm^2)			
Sample	**Cube1**	**Cube 2**	**Cube 3**	**Avg.**
10%	12.88	13.33	13.11	39.10
15%	18.22	17.77	18.44	17.92
20%	16.44	16.88	15.88	16.44



Conclusion: -

- **Workability** The addition of Sugarcane Bagasse Ash in concrete affects the workability of concrete, especially at high replacement levels. In our study, we have observed that the increase in the percentage of SCBA can lead to a decrease in workability, which may require the use of chemical admixtures or modified curing procedures. However, replacing up to 15% would not affect workability.
- **Durability:** The use of SCBA in concrete can improve its durability, especially in terms of resistance to sulphate and chloride attacks.
- **Compressive Strength:** The Compressive strength of concrete decreases with the increase in the percentage of bagasse ash, the reduction in strength may be attributed to the presence of clay, residual binder, and other impurities in a sugarcane bagasse ash. The degree of strength reduction depends on the proportion of sugarcane bagasse ash used in the mix. From our study, we have obtained that the replacement of 15% SCBA by cement gives adequate strength
- **Cost effective:** The use of sugarcane bagasse ash in concrete can be cost-effective as it is a waste material that would otherwise dispose of. The cost-effectiveness depends on the availability and transportation of sugarcane bagasse ash.

Future Scope: -

- sugarcane bagasse ash can be used in self-compacting concrete and the properties can be studied
- Sugarcane bagasse ash can also be replaced by fly ash in concrete
- The strength of sugarcane bagasse ash can be further studied by varying the water-cement ratio and by varying the percentage of bagasse ash.
- Optimization of bagasse ash content
- Long-term performance evaluation
- Combined use with other waste materials
- Industrial-scale production
- Applications in specific structures

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