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# Experimental Study on the Use of Sugarcane Bagasse Ash and Recycled Aggregates for Sustainable Concrete Production

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## ABSTRACT

This study looks at using Sugarcane Bagasse Ash as a replacement for some of the cement and Recycled Coarse Aggregate s as a substitute for coarse aggregate in concrete. The goal is to reduce the harm to the environment by lowering the amount of carbon used and saving resources. Concrete mixes were made by replacing cement with SCBA at 0%, 5%, 10% and 15% and coarse aggregate with RCA at 0% and 10%. The concrete specimens were then. Tested for strength at 7, 14 and 28 days using standard methods. The results show that the mix with 10% SCBA and 10% RCA is the choice for balancing strength and being good for the environment. This mix was strong with a strength of 15.5 MPa at 7 days and 24.5 MPa at 28 days. Using 10% SCBA of some of the cement did not make the concrete much weaker at first but it got stronger later on because of the way the SCBA reacts. However, using 15% SCBA made the weaker. Using 10% RCA also made the concrete a little weaker. It was still strong enough when used with 10% SCBA.

## 1. INTRODUCTION

The construction industry is. That's causing a huge demand for natural resources like cement and aggregates. This is really hurting the environment. We're running low on materials. At the time we're producing a lot of waste from farming and construction which is a big problem. Some of these wastes like Sugarcane Bagasse Ash and Recycled Coarse Aggregate are becoming really important. They can help make construction more eco-friendly. Sugarcane Bagasse Ash is great because its rich in silica which makes concrete stronger and last longer. Sugarcane Bagasse Ash has a lot of silica. Recycled Coarse Aggregate is an alternative to natural aggregates. It helps reduce waste from

construction and demolition sites. Using Sugarcane Bagasse Ash and Recycled Coarse Aggregate together is an idea. It helps conserve resources and reduces pollution. This study is about replacing some cement with Sugarcane Bagasse Ash and some aggregate with Recycled Coarse Aggregate in M25 grade concrete. The goal is to see how strong the concrete is when we replace 5%, 10% and 15% of the cement, with Sugarcane Bagasse Ash. We also want to use Recycled Coarse Aggregate. This study aims to find a way to make eco-friendly concrete that doesn't cost too much. We don't want to make it weaker. We want to use Sugarcane Bag asse Ash and Recycled Coarse Aggregate to make concrete techniques.

## 2. EXPERIMENTAL INVESTIGATIONS

Concrete specimens were prepared to evaluate the effect of partial replacement of cement using waste sugarcane bagasse ash and recycled aggregate. The experimental program included preparation of control mix and modified concrete mixes with different replacement levels.

### *A. Material Used*

**Cement, Water and Aggregates:** Concrete was prepared using the conventional mix of cement, aggregates and water. For the whole study, Ordinary Portland Cement grade 53, following IS 12269:1987, was used as the binder. The fine aggregate was natural river sand with particles passing through the 4.75 mm sieve and falling under the Zone II grading according to IS 383:2016. As coarse aggregate, crushed angular stone was chosen, conforming to IS 383:2016 with a nominal maximum size of 20 mm (passing the 20 mm sieve and retained on the 4.75 mm sieve). The physical properties of fine and coarse aggregate were determined in line with IS 2386 (Part I_ IV):1963. Mixing and curing of concrete specimens was performed using potable water that meets the requirements stipulated in IS 456:2000.

**Sugarcane Bagasse Ash (SCBA):** From nearby sugar mills came the sugarcane bagasse ash examined here. After collection, drying followed by fine grinding took place to boost how it reacts. Through a 90-micron mesh it passed, making sure particles stayed consistent. High in silica, this material shows pozzolanic behaviour - helping concrete gain strength and last longer. Replacing cement partly, it entered mixes at levels of 5%, then 10%, finally 15%.

**Recycled Coarse Aggregate (RCA):** Construction and Demolition Waste was used to create a recycled Coarse Aggregate (RCA), which must be cleaned of various impurities and adhered mortar. Compared to Natural Aggregates, RCAs tend to have higher water absorption. This study evaluated the use of RCA as a partial replacement of Natural Coarse Aggregate in the amount of 10% in order to encourage sustainable design and building practices.

### *B. Mixed proportion and Testing of specimen*

**Mixed design:** The mix design for concrete was carried out as per IS 10262 guidelines for M25 grade concrete. The materials used include Ordinary Portland Cement, natural sand as fine aggregate, and crushed stone as coarse aggregate. In this study, fine aggregate was partially replaced with waste Sugarcane Bagasse Ash and Recycled Coarse Aggregate and at different percentages. The replacement levels were selected to evaluate the effect of waste materials on the strength properties of concrete. A control mix was prepared without any replacement, and modified mixes were prepared with varying percentages of Sugarcane Bagasse Ash and Recycled Coarse Aggregate and plastic. The mix design was kept constant for all mixes except for the replacement of fine aggregate. No chemical admixture was used in the present study.

**Workability Test:** The workability of the fresh concrete was checked using the slump test with a slump cone as specified in IS 1199:1959. The result of the test is used to show the ease with which the concrete will be handled and its consistency. Each of the mixtures with different proportions of sugarcane bagasse's ash was tested. From the results of the test, it was seen that there was a decrease in the slump test values with an increase in the percentage of sugarcane bagasse's ash used in the mix as shown in fig 1. The decrease in workability is because of the increase in water content due to the finer sugarcane bagasse's ash, as well as the decrease in cohesion between the other particles in the mixture owing. But all the mixtures were found to have a true slump, indicating that they have good workability.

**Compressive Strength:** Compressive strength tests were conducted on cube specimens as per IS 516:1959 as shown in fig 4 and 5. The specimens were tested at 7, 14, and 28 days using a compression testing machine. The average compressive strength values were calculated for each mix. The compressive strength of concrete increased with increase in replacement level up to 10 percent and decreased beyond that, as shown in Table 4. The maximum strength was obtained at 10 percent replacement for all curing periods. This is due to the pozzolanic action of sugarcane bagasse ash, which improves bonding and densifies the concrete matrix. At higher replacement levels, the strength decreases due to high amount of sugarcane bagasse ash. The results indicate that 10

Percent replacement is the optimum level for achieving maximum compressive

**TABLE 1:** slump values of concrete, compressive strength results of concrete

| Mix (0%) | Slump Value (mm) | type of slump | Mix (0%) | Slump Value (mm) | type of slump |
|---|---|---|---|---|---|
| 0% | 73 | True slump | 0% | 73 | True slump |
| 5% | 70 | True slump | 5% | 70 | True slump |
| 10% | 64 | True slump | 10% | 64 | True slump |
| 15% | 62 | True slump | 15% | 62 | True slump |
| **Mix SCBA (%)** | **Mix RCA (%)** | **7 Days (MPa)** | **14 days (MPa)** | **28 days (MPa)** | **Mix SCBA (%)** |
| 0% | 0% | 17.31 | 22.14 | 27.31 | 0% |
| 5% | 10% | 16.81 | 21.72 | 25.83 | 5% |
| 10% | 10% | 18.96 | 23.68 | 28.94 | 10% |

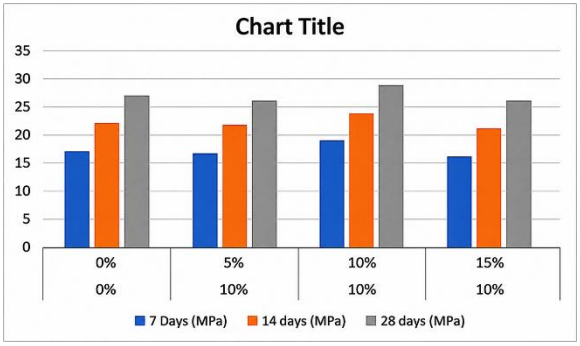


**Figure 2:** variation of compressive strength with % replacement

## CONCLUSION

The following are the conclusions drawn as a result of an experimental study on concrete wherein waste Sugarcane Bagasse Ash and Recycled Coarse Aggregate were utilized to replace sand partially as a substitute for sand: The workability of all mixes showed proper slumps and all were able to be worked by means of a variety of construction instruments. Increments in strength were observed until 10% replacement occurred. The peak compressive strength of 28.94 MPa occurred at a 10% replacement level. At 28 days, the strength of the control mix was 27.31 MPa. The 10% replaced mix showed greater compressive strength than the normal concrete mix.

## CHALLENGES AND FUTURE SCOPE

Using sugarcane bagasse ash (SCBA) as a cement replacement and recycled concrete aggregate (RCA) as a coarse aggregate substitute creates sustainable concrete. However, combined use introduces challenges like high water absorption, variable ash reactivity, and reduced stiffness, though it offers strong potential for eco-friendly structural applications.

Key Challenges

- High Porosity and Water Absorption: Recycled aggregates retain old, weak mortar, while SCBA demands careful grinding to manage surface area, increasing overall water absorption.
- Variable Pozzolanic Reactivity: Raw SCBA from sugar mills has inconsistent chemical composition and carbon content, requiring controlled incineration and mechanical grinding.
- Reduction in Mechanical Stiffness: High replacement levels of RCA and SCBA can lower the modulus of elasticity and early-age tensile strength.
- Workability Losses: Poorly processed ash and angular recycled aggregates can reduce mix fluidity, needing chemical admixtures.
- Ternary and Quaternary Blends: Combining SCBA and RCA with other industrial wastes (like fly ash or silica fume) to optimize strength and durability. Advanced Treatment Methods: Utilizing specialized pre-soaking, carbonation, or nano-modification of recycled aggregates to improve boundary bonding.
- Life Cycle and Cost Modeling: Scaling up regional life-cycle assessments to validate commercial structural use and lower carbon footprints.

If you want, let me know if you would like to focus on: The optimal percentage ratios for mixing SCBA and RCA Specific durability tests (acid, sulfate, or chloride penetration)Standard codal provisions (like IS or ACI) for green concrete
AI responses may include mistakes.

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