



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 6, June 2025

Strengthening Effect on Concrete by using Bagasse Ash as Replacement of Fly Ash for Eco-Friendly Concreting

Vaishnavi Sawant^{1*}, Prof. Dr. A. U. Bhalerao^{2*}

PG Student, Dept. of Civil Engineering, Dr. Vithalrao Vikhe Patil College of Engineering, Ahmednagar, India^{1*}

Professor, Dept. of Civil Engineering, Dr. Vithalrao Vikhe Patil College of Engineering, Ahmednagar, India^{2*}

ABSTRACT: Concrete remains the most widely used construction material in the world due to its versatility, strength, and durability. However, the production of its primary binder Portland cement is responsible for a significant share of global CO₂ emissions. In response to environmental concerns, researchers and engineers have increasingly sought sustainable alternatives through the use of supplementary cementitious materials (SCMs), such as fly ash, a by-product of coal combustion. This thesis explores the strengthening effect of Sugarcane Bagasse Ash (SCBA) as a partial replacement for fly ash in M25 grade concrete, with a focus on enhancing concrete performance while promoting eco-friendly construction practices. SCBA, an agro-industrial by-product rich in pozzolanic materials, offers a sustainable alternative to conventional cementitious additives such as fly ash. In this study, SCBA was used to replace fly ash at 0%, 5%, 10%, 15%, 20%, and 25%, and its impact on the compressive strength, split tensile strength, and workability of concrete was evaluated at curing ages of 7, 14, and 28 days.

KEYWORDS: Concrete, Bagasse Ash, Fly ash.

I. INTRODUCTION

Bagasse ash, derived from the combustion of sugarcane bagasse in sugar mills, emerges as a viable substitute. Abundantly available in sugar-producing regions, bagasse ash is rich in amorphous silica and possesses pozzolanic characteristics similar to fly ash. Its utilization in concrete not only provides a sustainable solution for waste management but also contributes to reducing the carbon footprint of construction activities. More importantly, recent studies have shown that bagasse ash has the potential to enhance the mechanical and durability performance of concrete, particularly when used as a replacement for fly ash.

This research focuses on investigating the strengthening effect of bagasse ash as a replacement for fly ash in concrete mixtures. The study examines key parameters such as compressive strength, workability, durability, and microstructure of concrete made with various proportions of bagasse ash in place of fly ash. Through experimental analysis, the research aims to identify the optimal replacement levels and understand the mechanisms behind the performance improvements. By promoting the use of agricultural waste in concrete production, this research contributes to the broader goals of sustainable construction, resource efficiency, and eco-friendly infrastructure development. The findings are expected to support the transition toward greener materials in the construction industry, especially in regions where bagasse ash is readily available and fly ash is becoming scarce.



Fig 1 Bagasse and Bagasse Ash



Fig 2 Fly Ash

Bagasse Ash

The sugar industry is one among the well-established industries in India which is a boon to farmers. As per the statistics of the Indian Sugar Mill Association, around 538 sugarcane factories are in operation in the country presently. In this century, most of the sugar industries in India have been developed as self-sustained ones by various means. It is one among the industries that generate electricity and export the excess to the government through the power grid.

Fly Ash

Fly ash is a residue of the burning of coal during the generation of electricity in thermal power plants and is collected from the flue gases using electrostatic precipitators (ESP). Class F fly ash is normally produced from burning anthracite or bituminous coal.

There are two types of fly ash:

- **Class F:** It is the burning of harder, older anthracite and bituminous coal that typically produces class F fly ash.
- **Class C:** Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties

II. PROBLEM STATEMENT

The construction industry heavily relies on concrete, a material whose production significantly contributes to environmental pollution due to high carbon emissions, particularly from the use of cement and fly ash. Fly ash, though a common cement substitute, is a byproduct of coal combustion and its availability is decreasing with the global shift towards cleaner energy sources. Meanwhile, bagasse ash, an agricultural waste produced from sugarcane processing, is often underutilized and disposed of in ways that harm the environment. This research aims to investigate the strengthening effects of using bagasse ash as a partial or full replacement for fly ash in concrete. The goal is to evaluate its impact on the mechanical properties of concrete, while promoting eco-friendly and sustainable construction practices by utilizing agricultural waste.

Table 1 Mix Design - M25

| Cement | Fine aggregate | Coarse Aggregate | water |
|--------|----------------|------------------|-------|
| 317 | 960 | 991 | 169 |

Concrete cubes, 150mm x 150mm x 150mm are casted for testing of specimen. All the specimens were prepared in accordance with Indian Standard Specification IS 516-1959

Cement = $0.005198 \times 317 = 1.64$ Kg
 Sand = $0.005198 \times 960 = 4.99$ Kg
 Coarse agg = $0.005198 \times 991 = 5.15$ Kg
 Fly Ash = 0.41 Kg (25% of cement)

Table 2 Mix proportion for Cube

| % Of Bagasse Ash | Cement | Fine Aggregate | Coarse Aggregate | Fly Ash | Bagasse Ash |
|------------------|--------|----------------|------------------|---------|-------------|
| 0 | 1.23 | 4.99 | 5.15 | 0.41 | 0 |
| 5% | 1.23 | 4.99 | 5.15 | 0.3895 | 0.0205 |
| 10% | 1.23 | 4.99 | 5.15 | 0.369 | 0.041 |
| 15% | 1.23 | 4.99 | 5.15 | 0.3485 | 0.0615 |
| 20% | 1.23 | 4.99 | 5.15 | 0.328 | 0.082 |
| 25% | 1.23 | 4.99 | 5.15 | 0.3075 | 0.1025 |

III. RESULTS AND ANALYSIS

Testing Of Cube



Fig 3 Cube Casting



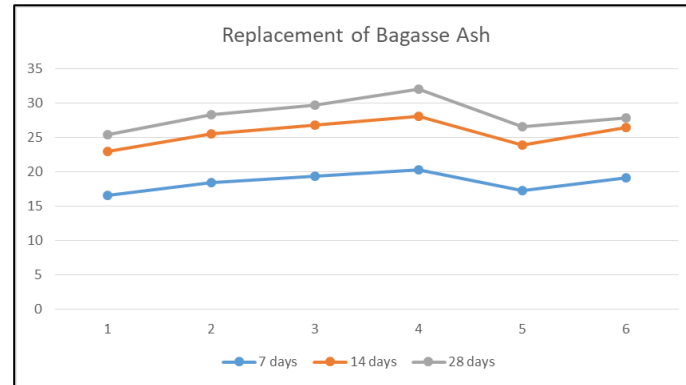
Fig 4 Cube Testing

Compressive Strength

As per mix design at the time of cube casting. After 7 days, 14 days, 28days of curing the results are following. Concrete specimens are prepared with SCBA replacing fly ash at incremental levels of 0%, 5%, 10%, 15%, 20%, and 25% by weight of cementations material. The aim is to determine the optimal replacement percentage that achieves the best balance between mechanical performance and sustainability.

Table 3 Compressive Strength

| % Of Bagasse Ash | 7 days | 14 days | 28 days |
|------------------|----------|----------|---------|
| 0 | 16.536 | 22.896 | 25.44 |
| 5% | 18.384 | 25.464 | 28.284 |
| 10% | 19.308 | 26.736 | 29.7 |
| 15% | 20.268 | 28.068 | 31.992 |
| 20% | 17.232 | 23.856 | 26.508 |
| 25% | 19.12752 | 26.48016 | 27.8334 |



Graph 1 Compressive Strength

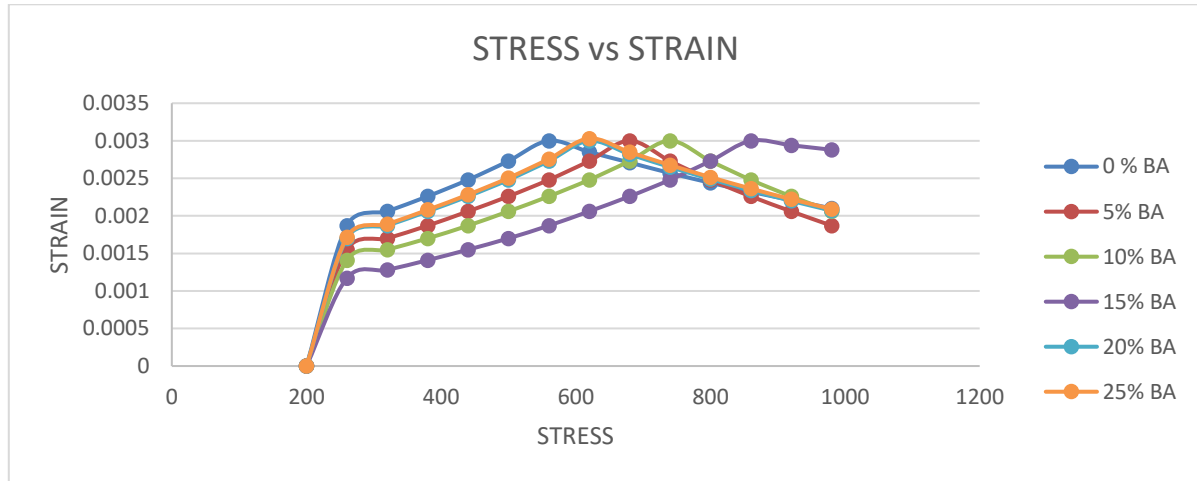
This study investigates the effect of replacing fly ash with sugarcane bagasse ash (SCBA) in M25 grade concrete at varying percentages (0%, 5%, 10%, 15%, 20%, and 25%). The compressive strength of concrete was tested at 7, 14, and 28 days. Results show a consistent increase in strength up to 15% replacement, with a peak compressive strength of 31.99 MPa at 28 days. Beyond 15%, strength declined slightly, indicating that 15% SCBA is the optimal replacement level for enhancing compressive strength while promoting eco-friendly concrete.

Stress Vs Strain

For normal weight concrete, the maximum stress is realized at compressive strain ranges from 0.002 to 0.003

Table 4 Stress Vs Strain

| STRESS vs STRAIN | | | | | | |
|------------------|----------|----------|----------|----------|----------|----------|
| STRESS | 0 % BA | 5% BA | 10% BA | 15% BA | 20% BA | 25% BA |
| 200 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 |
| 260 | 1.87E-03 | 1.55E-03 | 1.41E-03 | 1.17E-03 | 1.70E-03 | 1.72E-03 |
| 320 | 2.06E-03 | 1.70E-03 | 1.55E-03 | 1.28E-03 | 1.87E-03 | 1.89E-03 |
| 380 | 2.26E-03 | 1.87E-03 | 1.70E-03 | 1.41E-03 | 2.06E-03 | 2.08E-03 |
| 440 | 2.48E-03 | 2.06E-03 | 1.87E-03 | 1.55E-03 | 2.26E-03 | 2.28E-03 |
| 500 | 2.73E-03 | 2.26E-03 | 2.06E-03 | 1.70E-03 | 2.48E-03 | 2.50E-03 |
| 560 | 3.00E-03 | 2.48E-03 | 2.26E-03 | 1.87E-03 | 2.73E-03 | 2.76E-03 |
| 620 | 2.85E-03 | 2.73E-03 | 2.48E-03 | 2.06E-03 | 3.00E-03 | 3.03E-03 |
| 680 | 2.71E-03 | 3.00E-03 | 2.73E-03 | 2.26E-03 | 2.82E-03 | 2.85E-03 |
| 740 | 2.57E-03 | 2.73E-03 | 3.00E-03 | 2.48E-03 | 2.65E-03 | 2.68E-03 |
| 800 | 2.44E-03 | 2.48E-03 | 2.73E-03 | 2.73E-03 | 2.49E-03 | 2.51E-03 |
| 860 | 2.32E-03 | 2.26E-03 | 2.48E-03 | 3.00E-03 | 2.34E-03 | 2.36E-03 |
| 920 | 2.21E-03 | 2.06E-03 | 2.26E-03 | 2.94E-03 | 2.20E-03 | 2.22E-03 |
| 980 | 2.10E-03 | 1.87E-03 | 2.06E-03 | 2.88E-03 | 2.07E-03 | 2.09E-03 |



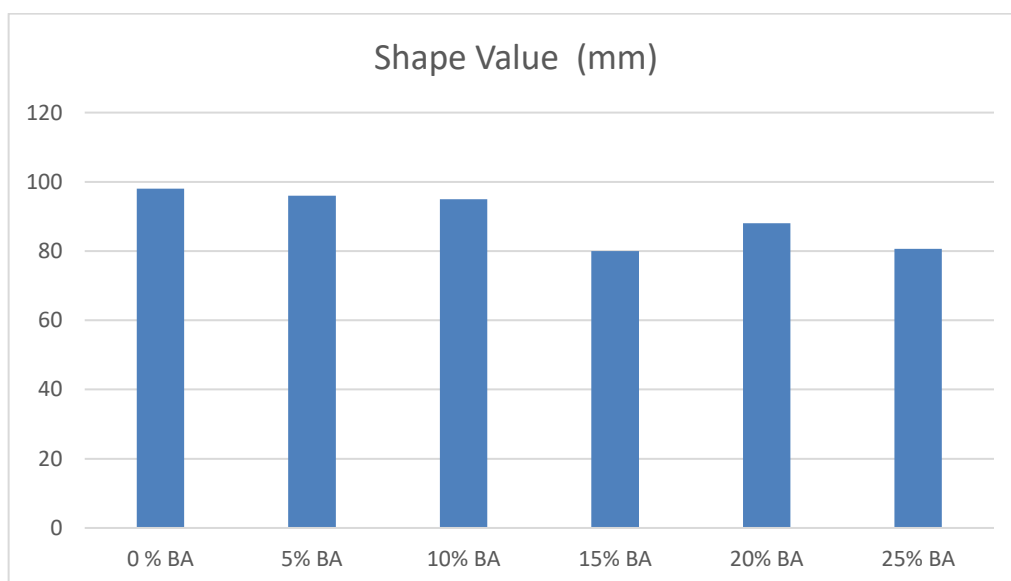
Graph 2 Stress Vs Strain

Workability Test

Slump test was carried out conforming to ASTM C143 on each mix to ascertain workability of **Bagasse Ash** up to 25% of fly ash as well as control mixtures. The results of slump tests are plotted

Table 5 Workability – Slump test

| Sr. No | % Of Bagasse Ash | Shape Value (mm) |
|--------|------------------|------------------|
| 1 | 0 % BA | 98 |
| 2 | 5% BA | 96 |
| 3 | 10% BA | 95 |
| 4 | 15% BA | 80 |
| 5 | 20% BA | 88 |
| 6 | 25% BA | 80.6 |



Graph 3 Workability – Slump test

There is gradual decrease in the slump values with an increase in BA in Fly Ash dose, which indicates that addition of BA content is associated with an increase in water demand. Thus some water reducing admixtures used to get required workability of concrete without compromising on strength.

IV. CONCLUSION

The experimental investigation on M25 grade concrete using sugarcane bagasse ash (SCBA) as a partial replacement for fly ash demonstrates that SCBA is an effective and sustainable supplementary cementitious material. The study evaluated key parameters such as compressive strength, split tensile strength, and workability, with SCBA replacing fly ash at 0%, 5%, 10%, 15%, 20%, and 25% by weight. From the results, it is evident that:

- Compressive strength increased consistently up to 15% SCBA replacement, reaching a maximum value of 31.99 MPa without admixture and 37.11 MPa with admixture at 28 days.
- Split tensile strength also peaked at 15% replacement, achieving 2.29 MPa, showing significant improvement over the control mix.
- Workability, measured through slump value, slightly decreased with increasing SCBA content, but remained within acceptable limits, especially with the aid of a plasticizer/admixture.
- The use of SCBA not only enhances the strength characteristics of concrete but also contributes to eco-friendly construction by recycling agricultural waste, reducing landfill pressure, and minimizing the use of industrial by-products like fly ash.
- Therefore, it can be concluded that 15% SCBA replacement for fly ash in M25 concrete, especially when combined with chemical admixtures, offers a technically viable and environmentally sustainable solution for the future of green building materials.

REFERENCES

- [1] Blessen Skariah Thomas et al. (2021) "Sugarcane bagasse ash as supplementary cementitious material in concrete – A review" *Materials Today Sustainability* (2021)
- [2] Duc-Hien Le & Yeong-Nain Sheen (2022) "Increasing durability of blended concrete using controlled-burning sugarcane bagasse ash as cement replacement" *Construction and Building Materials* (2022)
- [3] Blessen Skariah Thomas et al. (2021) "Sugarcane bagasse ash as alternate supplementary cementitious material in concrete" *Springer Link* (2021)
- [4] P. Jagadesh et. al. "Effect of processed sugarcane bagasse ash on compressive strength of blended mortar and assessments using statistical modelling" *Case Studies in Construction Materials* (2024)
- [5] Noor Yaseen et. al. "Exploring the potential of sugarcane bagasse ash as a sustainable supplementary cementitious material: Experimental investigation and statistical analysis" *Results in Chemistry* (2024)
- [6] Malcolm W. Clark et. al. "High-efficiency cogeneration boiler bagasse-ash geochemistry and mineralogical change effects on the potential reuse in synthetic zeolites, geopolymers, cements, mortars, and concretes" (2023)
- [7] Desmond. E. Ewa, et. al. "Sustainable subgrade improvement using limestone dust and sugarcane bagasse ash" *Sustainable Technology and Entrepreneurship* (2022)
- [8] Michel Barro et. al. "Characterization of sugar cane bagasse ash from Burkina Faso for cleaner cement production: Influence of calcination temperature and duration" *Results in Materials* (2022)
- [9] Mohamed Amin and Mohammed M. Attia "Effects of sugarcane bagasse ash and nano eggshell powder on high-strength concrete properties" *Case Studies in Construction Materials* (2022)
- [10] Roz-Ud-Din Nassar and Navdeep Singh "Strength, electrical resistivity and sulfate attack resistance of blended mortars produced with agriculture waste ashes" *Case Studies in Construction Materials* (2021)
- [11] Tareg Abdalla Abdalla and Asma Abd Elhameed Hussein "Strength, durability, and microstructure properties of concrete containing bagasse ash – A review of 15 years of perspectives, progress and future insights" *Results in Engineering* (2020)
- [12] Okan Karahan, Cengiz Duran Atis(2010) "The Durability Properties Of Polypropylene Fiber Reinforced Fly Ash Concrete", *Materials And Design*.
- [13] Maslehuddin Et. Al.,(1989)." Behaviour of Glass Fiber and Bottom Ash On Concrete", *International Journal Of Engineering Research And Technology (IRJET)* 2018 IJCRT ISSN: 2320-2882

- [14] Tarun R. Naik And Bruce W. Ramme, High Strength Concrete Containing Large Quantities Of Fly Ash, ACI Materials Journal, March-April (1989) 111-116.
- [15] Kothapalli Sindhu Rani1 , N.D Anusha,” Experimental Study Of Geopolymer Concrete By Using Glass Fibers” International Journal Of Professional Engineering Studies Volume Viii /Issue 1 / Dec 2016

IS Code

- [16] IS Code 383 2016 for course and fine aggregate
- [17] IS 456 : Plain and Reinforced Concrete



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details