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***Research Article***

# Investigation Of Mechanical Properties Of Concrete Composed Of Bagasse Ash And Lime

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***Abstract –*** The impact of lime and sugarcane bagasse ash on the mechanical qualities of concrete is examined in this study. We created several samples with varying proportions of lime and bagasse ash, and we tested their tensile, flexural, and compression strengths. The findings demonstrate that adding lime and bagasse ash to concrete generally enhances its mechanical qualities, including its resistance to ammonium nitrate attack and increases its compressive, tensile, and flexural strengths. Thus, in this investigation, a 1:2:4 ratio of concrete was made by substituting 5% of the cement's weight with bagasse ash and 10% with lime or 10% of the cement's weight with bagasse ash and 10% with lime. In this study, bagasse ash and lime were used in varying proportions to the cement weight to make cubes of 6" by 6" by 6", a cylinder with a diameter of 6" and a height of 12", and beams measuring 20" by 4" by 4". These were all prepared and correctly cured in a curing tank. Findings indicated that adding 10% lime and 5% bagasse ash to concrete improved its mechanical qualities.

*Keywords- Sugarcane Bagasse Ash And Lime Fractional Replacement In Cement, Compressive Strength, Split Tensile Strength And Flexural Strength.*

# I. INTRODUCTION

A man-made building material, concrete is most frequently utilized to build different types of civil engineering structures [1, 2]. Ordinary Portland Cement (OPC) concrete is ideal for typical construction projects and is used in many structural applications. However, certain of its limitations have made it challenging to meet specific needs, particularly when it comes to complicated structures' strength and longevity. To satisfy the demands of sophisticated and complicated structures, there has been a significant growth in the necessity for the development of high-strength and high-performance concrete [3]. A significant amount of cement is needed to manufacture High-Strength Concrete (HSC), and cement production is thought to be the most energy-intensive step in the concrete production process [4]. Cement replacement materials (CRMs) are favorable when used in partial substitution of cement due to their mechanical and microstructural properties, in addition to their economic benefits [5]. The goal of extending the service life of concrete structures has led to a rise in the usage of CRMs in concrete [6]. There are numerous commercially available CRMs that may be applied on concrete. A by-product of sugar mills, SCBA is discovered through burning bagasse, which was first produced during the extraction of sugar from sugarcane. Properties of volcanic ash have been investigated, and improvements in crushing strength, durability, and water resistance in specific quantities have been identified in mortar and concrete [7].

# II. PROBLEM STATEMENT

In our region fertilizer plants and sugar mills produce lime and bagasse ash respectively in bulk amounts which causes harmful effects on the environment.

# III. AİM AND OBJECTİVES

This study aims fundamentally to determine the effects of Bagasse Ash and Lime on concrete strength and ammonium nitrate attack by fractional replacement of cement. Following are objectives to achieve this aim.

- To investigate the compressive strength and tensile strength of bagasse ash and limestone fine concrete.
- To investigate optimal mix designs with properties of bagasse ash and limestone fines to achieve desired mechanical properties and durability characteristics.
- To investigate the resistance of bagasse ash and limestone fine concrete to chemical attacks.
- Provide recommendations for the practical application of bagasse ash and limestone fines in sustainable concrete production.

# IV. MATERIALS AND METHODS

## 4.1 Mix Proportion

In this study, M15 grade of concrete was prepared with ratio of 1:2:4.

Table 1: Details of mix proportion of each cube

| Concrete Mix | Cement (gram) | Sand (gram) | Aggregate (gram) | Water (gram) | Lime (gram) | Bagasse Ash (gram) |
|---|---|---|---|---|---|---|
| **Simple Concrete Mix** | 1122 | 2720 | 4830 | 783.68 | 0 | 0 |
| **Concrete Mix with 10% Lime and 5% Bagasse Ash** | 953.7 | 2720 | 4830 | 783.68 | 112.2 | 56.1 |
| **Concrete Mix with 10% Lime and 10% Bagasse Ash** | 897.6 | 2720 | 4830 | 783.68 | 112.2 | 112.2 |

Table 2: Details of mix proportion of each cylinder

| Concrete Mix | Cement (gram) | Sand (gram) | Aggregate (gram) | Water (gram) | Lime (gram) | Bagasse Ash (gram) |
|---|---|---|---|---|---|---|
| **Simple Concrete Mix** | 1761 | 4000 | 7800 | 1233 | 0 | 0 |
| **Concrete Mix with 10% Lime and 5% Bagasse Ash** | 1496.85 | 4000 | 7800 | 1233 | 176.1 | 88.05 |
| **Concrete Mix with 10% Lime and 10% Bagasse Ash** | 1408.8 | 4000 | 7800 | 1233 | 176.1 | 176.1 |

### 4.2 Testing of the Specimens

In this study, compressive strength, split tensile strength and flexural strength tests of concrete were conducted on different percentages of cement replacement.

## V. RESULTS

This study's main goal was to investigate the effects of lime and sugarcane bagasse ash on the mechanical qualities of concrete. A partial replacement of cement in the concrete mixture was made using lime and sugarcane bagasse ash. By weight of cement, 10% lime and 5% bagasse ash and 10% lime and 10% bagasse ash are substituted for the cement.

### 5.1 Compression Test:

A concrete compression test is a crucial procedure used to determine the compressive strength of concrete. Let’s break it down. The compressive strength of concrete refers to how many pounds per square inch (psi) it can handle when force is applied. It serves as a reliable indicator of how concrete will perform under heavy loads or internal pressures caused by factors like freeze-thaw cycles.

This test is performed on cube of partial replacement of cement with different percentages of lime and bagasse ash in concrete mixture and on simple concrete cube to compare strength.

Table 3: Compressive Strength of Cube

| Cubes | Compressive Strength (MPa) |
|---|---|
| Simple Concrete | 31.238 |
| 10% Lime and 5% Bagasse Ash | 37.733 |
| 10% Lime and 10% Bagasse Ash | 23.344 |


Figure 1: Graph showing Compressive Strength of concrete with respect to % of Lime and Bagasse Ash

After 28 days, the compressive strength of each mix, including those with varying amounts of lime and bagasse ash, was calculated. Table 3 illustrates the evolution of compressive strength for each set of Lime and Bagasse Ash content in relation to various Lime and Bagasse Ash percentages. Figure 1 provides a graphical representation of Table 3. Concrete's compressive strength increases when 10% lime and 5% bagasse ash are substituted for cement, and it reduces when 10% lime and 10% bagasse ash are substituted.

### 5.2 Split Tensile Test

The **split tensile strength** of concrete is a fundamental property that significantly affects the extent and size of cracking in structures. Concrete is inherentlybrittle and has low tensile strength. However, understanding its split tensile strength helps determine the load at which concrete members may crack. The test involves applying a diametral compressive load along the length of a cylindrical concrete specimen The load is continuously increased until the specimen fails (cracks).

.This test is performed on cylinders of partial replacement of cement with different percentages of lime bagasse ash in concrete mixture and on simple concrete cylinders to compare strength.

Table 4: Split Tensile Strength of Cylinder

| Cylinders | Split Tensile Strength (MPa) |
|---|---|
| Simple Concrete | 1.56 |
| 10% Lime and 5% Bagasse Ash | 1.69 |
| 10% Lime and 10% Bagasse Ash | 1.47 |

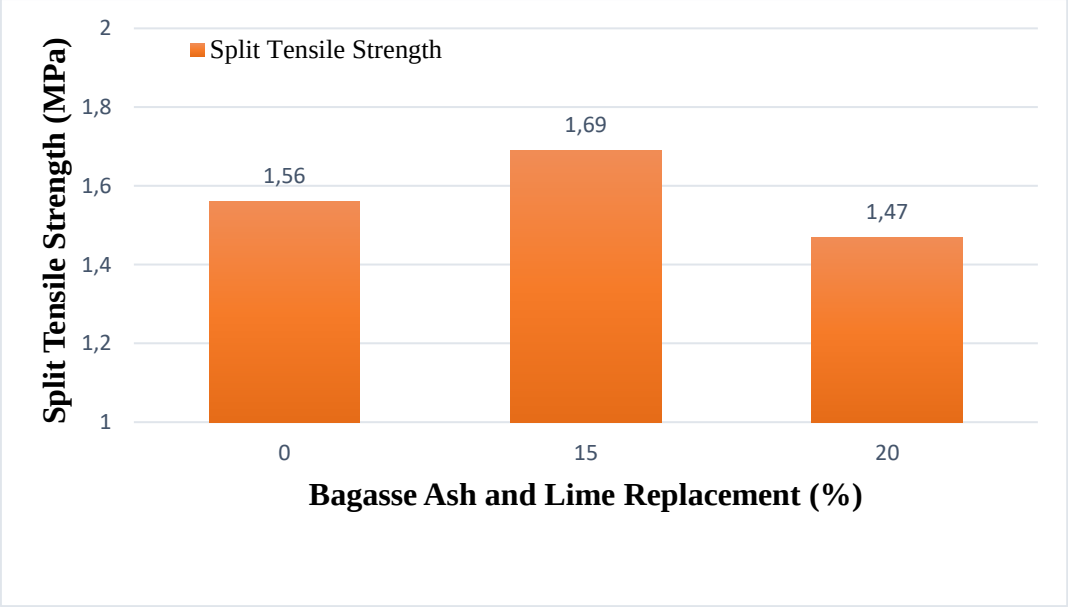


Figure 2: Graph showing split tensile strength of concrete with respect to % of Lime and Bagasse Ash

Table 4 presents the findings of the splitting tensile strength of concrete at 28 days with respect to various proportions of lime and bagasse ash. Figure 2 provides a graphical depiction of Table 4. Concrete's compressive strength rises when 10% lime and 5% bagasse ash are substituted for cement, and it falls when 10% lime and 10% bagasse ash are substituted.

### 5.3 Flexural Strength Test

The flexural strength test assesses the ability of a reinforced concrete beam to withstand bending forces. It is particularly relevant for scenarios where the beam experiences loads that cause bending, such as those encountered in road slabs or structural members.

The most common method is the three-point bending test. Here's how it works. The beam is placed horizontally on two supports, with a third point (the loading point) in the middle. A load is applied at the center of the beam, causing it to bend. The beam is loaded until it either fractures or reaches its yield point (where it starts to deform significantly).
This test is performed on beams of partial replacement of cement with different percentages of lime and bagasse ash in concrete mixture and on simple concrete beams to compare strength.

Table 5: Flexural Strength of Beams

| Beams | Flexural Strength (MPa) |
|---|---|
| Simple Concrete | 2.93 |
| 10% Lime and 5% Bagasse Ash | 3.48 |
| 10% Lime and 10% Bagasse Ash | 2.24 |


Figure 3: Graph showing flexural strength of concrete with respect to different % of Lime and Bagasse Ash

After curing at 28 days, the flexural strength of each mix, including those with varying amounts of lime and bagasse ash, was calculated. Table 5 illustrates the evolution of flexural strength for each set of Lime and Bagasse Ash content in relation to various Lime and Bagasse Ash percentages. Figure 3 provides a graphical representation of Table 5. Concrete's flexural strength increases when 10% lime and 5% bagasse ash are substituted for cement, and it reduces when 10% lime and 10% bagasse ash are substituted.

## VI. CONCLUSION

The experimental study on the compressive, splitting tensile strength and flexural strength of concrete, considering the use of bagasse ash and lime as a fractional replacement for cement, yields the following conclusions:

- The compressive strength, splitting tensile strength, and flexural strength of concrete increases at 10% lime and 5% bagasse ash and decreases at 10% lime and 10% bagasse ash. So mechanical properties of concrete enhance at 10% lime and 5% bagasse ash replacement with cement.
- The combined use of lime and bagasse ash in concrete mixes can further enhance the compressive strength due to their complementary effects on cement hydration and microstructural development.
- The combination of lime and bagasse ash can improve the overall microstructure of concrete by filling voids and increasing the density of the cementitious matrix.
- The presence of lime and bagasse ash in concrete can improve its resistance to chemical attacks, including those caused by ammonium nitrate, by enhancing the binding properties and reducing the permeability of the cementitious matrix.

- The pozzolanic reaction induced by lime and bagasse ash can help mitigate the detrimental effects of ammonium nitrate exposure by forming additional cementitious compounds and densifying the concrete microstructure, thereby reducing the likelihood of significant strength loss or structural damage.

Overall, the addition of lime and bagasse ash to concrete can positively influence its compressive strength and resistance to various types of chemical attacks, including those resulting from ammonium nitrate reactions.

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