

# Use of Bamboo Ash as A Partial Replacement of Cement in Fly Ash Bricks

Dr. Naseeruddin Haris<sup>1</sup>, Hrutuja Bhojar<sup>2</sup>, Pallavi Dahat<sup>3</sup>, Faisal Pasha<sup>4</sup>, Sohail Diwan<sup>5</sup>, Tahir Sheikh<sup>6</sup>,  
Maaviya Quereshi<sup>7</sup>, Pratik Dhoke<sup>8</sup>

<sup>1</sup>Professor Department of Civil Engineering, Anjuman College of Engineering & Technology, Nagpur,  
Maharashtra, India

<sup>2, 3, 4, 5, 6, 7, 8</sup>Student, Department of Civil Engineering, Anjuman College of Engineering & Technology,  
Nagpur, Maharashtra, India

**Abstract :** The present high cost of construction materials in the country calls for alternative materials which will also be suitable for construction work. In this study, normal Fly Ash bricks was compared with partially replaced bamboo ash with cement in fly ash bricks which contained varying percentage of bamboo ash contents. The percentage of bamboo ash was varied in steps of 5% up to a maximum of 10%. The use of partially replace bamboo ash with cement in fly bricks helps in meeting the demand and requirement of cement used in the construction process by stakeholders and the public which does not have additional cost to procure rather lowering the cost when compared to ordinary Portland cement which in turn help to reduce over dependent on cement in order to produce more housing units to meet infrastructural projects and create employment opportunities.

## I INTRODUCTION

Fly ash brick is a composite element consisting fly ash, cement, water and sand. As a construction materials bricks are very essential material but due to high cost of conventional construction material is a dominating factor affecting housing system around the world. This has necessitated research work into alternative materials in the construction field. Since the cost of cement is many times more than the cost of other ingredients in concrete making. Recently, attention is mainly directed to use of as little cement as possible constituent with adequate strength and durability. Little research has been carried out to study the bamboo leaf waste as a pozzolanic material. Dwivedi (2006) reported the reaction between calcium hydroxide and bamboo leaf ash for four hours of reaction using the differential scanning calorimetric technique. They have been used to produce concrete having almost the same behavior as normal concrete. Most of the fly ash brick produced today are a multi component product containing one or more admixtures in addition to the

four basic components which is fly ash, cement, sand and water. For every component, one usually as several choices that could influence the cost of the end product and its behavior in service. Among the constituent components, however, cement or cementations materials as a whole, play a vital role in producing strong and durable concrete. Utilization of these waste materials is a partial solution to environmental and ecological problems. Use of these also helps in reducing the cost of brick production by reducing the quantity of cement used. Consequently, this study presents the suitability of using bamboo leaf supplementary cementations material. This work investigates the effect of bamboo leaf Ash on the Partial replacement of cement in Fly ash and their performance on various.

- The Properties of Bamboo Leaf Ash:

Bamboo leaf ash is a byproduct of burning bamboo leaves. Bamboo is a type of grass that grows abundantly in tropical and subtropical regions of the world. In countries such as India and China, bamboo leaf ash has been used for centuries in traditional medicine and as a cleaning agent. In recent years, scientists have discovered that bamboo leaf ash can also be used as an admixture in construction materials. When added to fly ash, another byproduct of coal burning, bamboo leaf ash improves the properties and durability of fly ash bricks. The high silica content in bamboo leaf ash makes it an excellent pozzolanic material, which means it has the ability to react with water and form cementitious compounds. As a result, Fly ash bricks made with bamboo leaf ash have been found to be stronger, more durable, and more resistant to water than traditional fly ash bricks. Furthermore, using bamboo leaf ash as an admixture in fly ash bricks can reduce the amount of waste generated from coal burning and decrease the environmental impact of construction project

- Chemical composition:

A crucial aspect of the bamboo leaf ash's potential as a supplementary material for fly ash bricks lies in its chemical composition. Bamboo leaves are rich in organic compounds, with an average cellulose content of 35-45% and lignin content of 15-20%. Moreover, bamboo leaves are abundant in calcium oxalate, which is often used in the synthesis of various materials due to its favorable properties, including high thermal stability and chemical reactivity. Upon burning bamboo leaves at high temperatures, the organic matter decomposes to release carbon dioxide and water, and the minerals undergo chemical transformations. As a result, bamboo leaf ash contains varying amounts of silica, alumina, iron oxide, and calcium oxide. The presence of these compounds in the ash can affect its performance in terms of compressive strength, Water absorption, and durability. Studies have shown that fly ash bricks containing bamboo leaf ash had improved strength and lower water absorption compared to conventional bricks made only with fly Ash. Therefore, the chemical composition of bamboo leaf ash plays a significant role in determining its suitability as a supplementary material for producing high-quality fly ash bricks.

- High silica content:

Bamboo leaf ash has a high silica content, which is an essential component for the manufacturing of Fly ash bricks. The silica content in fly ash bricks helps in the formation of the cementitious material that binds the bricks together, resulting in high compressive strength. The carbon content in fly ash reduces the amount of cement required, making it a sustainable choice for construction. The high silica content in fly ash also enhances the durability and resistance of the bricks, making it ideal for high-stress applications. The use of bamboo leaf ash as a source of silica in fly ash bricks provides a sustainable and eco-friendly alternative to conventional methods. The incorporation of bamboo leaf ash also helps in waste management and reduces the environmental impact of bamboo waste. The production of fly ash bricks using bamboo leaf ash is an innovative technique that not only provides high-quality building materials but also contributes to sustainable development. Therefore, the use of bamboo leaf ash in fly ash bricks can be considered a groundbreaking development in the construction industry that promotes sustainable manufacturing practices.

## II. PROCEDURE

This study concentrated on investigation of Performance of Partially replaced bricks with bamboo leaf ash and pure cement (100% of cement) as a control sample. The Tests include compressive strength test and water absorption test. Five samples were of the same mix design with bamboo leaf ash as cement replacement that serves as an Unconventional mixes which comprises of 5% and 10% of the total weight of ordinary Portland cement. The methodology followed in this study involved the preparation and testing of fly ash bricks with varying amounts of bamboo ash added as a partial replacement for cement. The first step was to source the materials needed, including fly ash, cement, bamboo ash, sand, and water. The materials were then mixed in the required proportions, with the amount of bamboo ash varying across the different batches of bricks. The mixture was then poured into molds and cured for a period of 14 days in a controlled environment. After curing, the bricks were subjected to various tests to determine their physical properties, such as compressive strength, water absorption, and density. The data obtained was then analyzed and compared with the standard specifications for fly ash bricks, as well as with the results from the different bamboo Ash percentages. This methodology allowed for a thorough investigation of the effect of bamboo ash replacement on the properties of fly ash bricks. Manufacturing fly ash bricks with bamboo ash involves several steps, the first being the collection of bamboo ash from sources such as bamboo-based industries or local rural areas. The bamboo ash is then mixed with fly ash, cement, water, and sand in specific proportions to make the fly ash bricks. The mixture is poured into molds and left to dry naturally or in a drying chamber. Once the bricks are dry, they are removed from the molds and stacked to be cured for a specific period, usually a week, under controlled conditions of temperature and humidity. The curing process allows the fly ash bricks to gain strength and stability. Quality control is maintained by testing the bricks for compressive strength, water absorption, density, and durability. The methodology of manufacturing fly ash bricks with bamboo ash presents a sustainable option for waste management, reduces the consumption of resources, and provides an additional source of revenue, making it an attractive option for the construction industry. The main and most important phase for

making fly ash brick is to mix the raw material as well. The quality and strength depend on the mixing process. There are different types of materials that will be mixed in the following ideal materials.

- Fly Ash
- Sand
- Cement
- Bamboo ash (5%, 10%)
- Crusher Dust
- Water

### III. MATH

Manufacturing fly ash bricks with bamboo ash involves several steps, the first being the collection of bamboo ash from sources such as bamboo-based industries or local rural areas. The bamboo ash is then mixed with fly ash, cement, water, and sand in specific proportions to make the fly ash bricks. The mixture is poured into molds and left to dry naturally or in a drying chamber. Once the bricks are dry, they are removed from the molds and stacked to be cured for a specific period, usually a week, under controlled conditions of temperature and humidity. The curing process allows the fly ash bricks to gain strength and stability. Quality control is maintained by testing the bricks for compressive strength, water absorption, density, and durability. The methodology of manufacturing fly ash bricks with bamboo ash presents a sustainable option for waste management, reduces the consumption of resources, and provides an additional source of revenue, making it an attractive option for the construction industry.

- Mixing ratio and preparation of materials

Mixing ratios and preparation of materials are crucial factors that directly impact the quality and strength of fly ash bricks. The physical and chemical properties of each raw material must be analyzed to determine the optimal mixing ratio and preparation method. For example, the high pozzolanic nature of bamboo ash indicates that it can be partially replaced with Portland cement, a highly effective binder. The mixing ratio of cement and bamboo ash in the raw mixture must be carefully controlled to avoid chemical imbalances that can weaken the brick's structure. Additionally, the particle size and distribution of raw materials must be evaluated to ensure uniformity and consistency in the mixture. The mixing process also plays a crucial role in the quality and strength of the final product. Lumps and clumps in the raw mixture must be broken down and dispersed during the mixing process to ensure homogeneity and uniformity. These factors, along

with others, must be carefully considered and controlled during the preparation and mixing of raw materials for fly ash brick manufacturing.

The main and most important phase for making fly ash brick is to mix the raw material as well. The quality and strength depend on the mixing process. There are different types of materials that will be mixed in the following ideal materials.

- Fly Ash
- Sand
- Cement
- Bamboo ash (5%,10%)
- Crusher Dust
- Grit 4 mm to 8 mm
- Water

These all materials can be used in fly ash brick making machine.

In the mixing process, after adding sludge, lime, and gypsum with some water it is suggested to mix well and appropriately. After that add a proportion of sand and fly as above mentioned. And mixed it for some time till it is not mixed properly. With this our basic raw material manufacturing process comes to an end.

The proportion of the materials in kilograms for each proportion (i.e., for 15 bricks in each proportion) is done as:

Specifications	Fly ash	Sand	Cement	Bamboo ash
Normal	30kg	10kg	2.500kg	Nil
Sample 1 (5% replacement of cement)	30kg	10kg	2.375kg	0.125kg
Sample 2 (10% replacement of cement)	30kg	10kg	2.250kg	0.250kg

- Curing and Drying Process

Curing of the bricks is a crucial step in the manufacturing process of fly ash bricks. Once the brick mixture has been thoroughly mixed and prepared, it is then poured into molds of proper shapes and sizes. The mixture is then left to cure for a specific time period before it is ready for removal from the molds. Typically, the curing process can take up to 24 hours to ensure optimal strength and durability of the bricks. During the curing process, the bricks are often covered with a tarpaulin or sprayed with water to maintain moisture levels and prevent cracking. After the curing process is complete, the bricks are removed from their molds and transferred to a drying area, where they can

continue to harden before reaching the ultimate strength. Quality control checks are performed during all stages of The manufacturing process to ensure the final product meets industry standards and specifications.

When a brick is made, it is stored in a very safe chamber and Then it is kept outside to dry for around 10-14 days in the sunlight.

- Test Performed on Bricks :
- Compressive Strength test of 0%, 5% and 10% Partially replaced Cement with bamboo Fly Ash Brick

Results from the study shows that fly ash bricks with 0, 5% and 10% replacement of cement with bamboo ash had compressive strengths of 12.02 MPa, 11.59 MPa and 9.69 MPa respectively.

Furthermore, it was observed that the compressive strength of fly ash bricks is shows no significant results as the 5% percentage of Bamboo ash replacement as compare to 0% normal Bricks .

In Compression Strength test at 5% replacement level, there was no significant difference in the compressive strength values as compared to the Normal sample. At 10% replacement levels, the compressive strength reduction was observed to be 20 to 22%, respectively..

So, The incorporation of bamboo ash up to 5% as a partial replacement for cement can be considered as an effective alternative for sustainable construction.

Fig no. 1 : Results of compression strength test

- Water absorption test on 0%, 5% and 10% Partially replaced Cement with bamboo Fly Ash Brick

Among the various types of fly ash bricks, the water absorption capacity plays a crucial role in determining its overall performance. The incorporation of bamboo ash in fly ash bricks is seen to have a significant effect on the water absorption capacity of the bricks.

Results from the study shows that fly ash bricks with 0, 5% and 10% replacement of cement with bamboo ash had water absorption capacity of 13.92% , 17.13 % and 21.83% respectively.

In water absorption test at 5% replacement level, there was no significant difference in the water absorption values as compared to the Normal sample. At 10% replacement levels, the water absorption was observed to be 20 to 22%, respectively as compare to 0% normal bricks

It was observed that as the percentage of bamboo Ash increased in the bricks, the water absorption capacity increase gradually.

So, The incorporation of bamboo ash up to 5% as a partial replacement for cement can be considered as an effective alternative for sustainable construction

Fig no. 2 : Results of water absorption test

#### IV. HELPFUL HINTS

It was observed that the compressive strength of fly ash bricks is shows no significant results as the 5% percentage of Bamboo ash replacement. Results from the study shows that fly ash bricks with 5% and 10% replacement of cement with bamboo ash had compressive strengths of 11.59 MPa and 9.69 MPa respectively. In Compression Strength test at 5% replacement level, there was no significant difference in the compressive strength values as compared to the Normal sample. At 10% replacement levels, the compressive strength reduction was observed to be 20 to 22%, respectively .So, the incorporation of bamboo ash up to 5% as a partial replacement for cement can be considered as an effective alternative for sustainable construction.

#### APPENDIX

Future research recommendations for the use of bamboo ash in fly ash brick production could include investigating the effects of different ratios of fly ash to bamboo ash on the brick's compressive strength and durability. Additionally, it may be beneficial to explore the potential of bamboo ash in other construction materials and applications, such as concrete and mortar mixtures. The chemical properties of bamboo ash could also be studied further, with a focus on identifying any potentially harmful elements that could negatively impact soil or groundwater. Finally, the feasibility of large-scale bamboo ash production and its impact on local economies and the environment could be assessed to determine if it could be a sustainable alternative to traditional construction,

#### ACKNOWLEDGMENT

The results of this study shows the possibility of using bamboo ash as a partial replacement of cement in the production of fly ash bricks. The mix ratios with 5%, and 10% of bamboo ash were successfully tested and compared with 0% replacement bricks.

The results from this study shows that 5% replacement of cement with bamboo ash is the most productive percentage giving the bricks optimal compressive strength and durability compared to the other percentages analyzed in this study. The use of bamboo ash not only contributes to sustainable development but also provides a solution to waste management issues by utilizing an agricultural waste product. However, despite the positive results, there is still a need for further research on the behavior of these bricks under different environmental conditions and long-term durability. Additionally, there is a need for optimization of combustion conditions to improve the quality of bamboo ash, particularly regarding particle size, pore structure, and chemical composition. To this end, we recommend more studies on the potential of bamboo ash, both alone and combined with other materials, in the production of building materials.

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