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# Development and Performance Evaluation of Modified Bricks Using Rice Husk and Coal Ash

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**Abstract**

The construction industry is increasingly seeking sustainable and cost-effective alternatives to conventional building materials. This study focuses on the development of modified bricks using rice husk and coal ash as partial substitutes for traditional clay. Rice husk, an agricultural by-product, and coal ash, an industrial waste material, were incorporated to improve brick properties while reducing environmental impact. Brick samples were prepared and tested for compressive strength, water absorption, density, durability, and thermal insulation. The results indicate that the inclusion of rice husk reduces the weight of bricks and enhances thermal insulation due to increased porosity, while coal ash contributes to improved bonding and strength. The modified bricks demonstrated satisfactory performance compared with conventional burnt clay bricks. The utilization of agricultural and industrial wastes not only reduces production costs but also lowers environmental pollution and carbon emissions. The study concludes that rice husk and coal ash-based modified bricks can serve as a sustainable alternative construction material, particularly in regions where these waste materials are abundantly available.

**Keywords:** Modified Brick, Rice Husk, Coal Ash, Sustainable Construction, Compressive Strength, Eco-Friendly Materials.

## 1. Introduction

Bricks are one of the most widely used construction materials due to their durability, availability, and low maintenance requirements. However, conventional brick manufacturing consumes large quantities of natural clay and contributes to environmental degradation. The growing demand for sustainable construction materials has encouraged researchers to explore alternative materials that can partially replace clay.

Rice husk is an agricultural by-product generated during rice milling, while coal ash is produced in thermal power plants. The disposal of these wastes poses environmental challenges. Incorporating rice husk and coal ash into brick production offers a practical solution for waste management and sustainable construction. This study investigates the feasibility of producing modified bricks using rice husk and coal ash and evaluates their engineering properties.

## 2. Objectives

The objectives of the study are:

1. To develop modified bricks by replacing 8–15% of natural clay with rice husk and coal ash.
2. To utilize agricultural and industrial waste materials effectively.

3. To reduce environmental pollution associated with waste disposal.
4. To evaluate the compressive strength, density, water absorption, and durability of modified bricks.
5. To compare the performance of modified bricks with conventional burnt clay bricks.
6. To assess the suitability of modified bricks according to IS 2117:1991 standards.

## 3. Literature Review

Recent studies have focused on the utilization of agricultural waste and industrial by-products in brick manufacturing to improve sustainability and reduce environmental impact.

The incorporation of rice husk ash (RHA) and coal ash improves the microstructure of bricks through pore filling and pozzolanic reactions, thereby enhancing compressive strength and durability. These materials also contribute to thermal insulation and weight reduction.

Ani and Nahid (2022) investigated clay bricks containing 5–20% rice husk ash and reported that bricks with 5% RHA achieved the highest compressive strength of 8.401 N/mm². However, higher RHA contents increased water absorption and reduced density.

Another study on clay bricks containing 0–5% RHA found that 3% RHA yielded the best mechanical performance with a compressive strength of approximately 13.5 MPa and acceptable water absorption. Research on lightweight clay bricks demonstrated that increasing rice husk ash content increased porosity and water absorption while reducing density. Nevertheless, bricks containing 10–30% RHA satisfied standard requirements for lightweight construction.

Although several studies have examined rice husk ash and coal ash separately, limited research exists on their combined use in brick production. Therefore, further investigation is required to determine optimal proportions and long-term performance characteristics.

## 4. Materials Used

The materials used for brick preparation were selected according to **IS 2117:1991 – Manufacture of Hand-Made Common Burnt Clay Building Bricks**.

**Materials**

- **Clay and Cement:** Primary binding materials.
- **Sand:** Reduces shrinkage, warping, and cracking during drying and firing.
- **Rice Husk:** Agricultural waste used as a lightweight additive.
- **Coal Ash:** Industrial by-product obtained from thermal power plants.
- **Water:** Used for proper mixing and binding.

| Material | Percentage |
|---|---|
| Clay & Cement | 60–65% |
| Sand | 10–15% |
| Rice Husk | 8–12% |
| Coal Ash | 10–15% |

## 5. Experimental Programme

### Mixing Procedure

1. Dry mixing of clay, sand, rice husk, and coal ash.
2. Gradual addition of water until a uniform consistency was obtained.
3. Placement of the mixture into brick moulds.
4. Drying of moulded bricks under controlled conditions.
5. Firing or curing of bricks to achieve the required strength.

### Tests Conducted

The prepared brick specimens were tested for:

- Compressive Strength
- Water Absorption
- Density
- Durability
- Thermal Insulation
- Fire Resistance

## 6. Results and Discussion

### Comparison of Properties

| Property | Normal Brick | Modified Brick |
|---|---|---|
| Average Compressive Strength | 54.49 kg/cm² | 45.97 kg/cm² |
| Water Absorption | 15.03% | Less than 20% |
| Density | 1600–1900 kg/m³ | Lower than conventional brick |
| Thermal Insulation | Moderate | Improved |
| Durability | Good | Good |
| Fire Resistance | Good | Improved |

### Discussion

The addition of rice husk resulted in lighter bricks due to increased porosity. This reduction in density improved thermal insulation properties, making the bricks suitable for energy-efficient buildings.

Coal ash contributed to improved particle bonding and enhanced resistance to fire and weathering. Although the compressive strength of modified bricks (45.97 kg/cm²) was slightly lower than that of conventional bricks (54.49 kg/cm²), the values remained within acceptable limits for many construction applications.

Water absorption remained below the permissible limit of 20%, indicating satisfactory durability and resistance to moisture penetration.

The use of waste materials significantly reduces the environmental burden associated with their disposal and contributes to sustainable construction practices.

## 7. Conclusions

Based on the experimental investigation, the following conclusions are drawn:

1. Rice husk and coal ash can be successfully utilized in brick manufacturing as partial replacements for natural clay.
2. The modified bricks exhibited satisfactory compressive strength suitable for construction applications.
3. Rice husk reduced the overall weight of bricks and improved thermal insulation.
4. Coal ash enhanced bonding characteristics and fire resistance.
5. Water absorption remained within acceptable limits specified by standards.
6. The use of agricultural and industrial waste materials promotes sustainable development and reduces environmental pollution.
7. Modified bricks offer a cost-effective and eco-friendly alternative to conventional burnt clay bricks.

## 8. Scope for Future Work

The following areas can be explored in future research:

1. Optimization of rice husk and coal ash percentages for maximum strength.
2. Investigation of long-term durability under different environmental conditions.
3. Development of lightweight high-performance bricks.
4. Large-scale production and field implementation studies.
5. Incorporation of other agricultural and industrial waste materials.
6. Life-cycle assessment and economic feasibility studies.
7. Application of modified bricks in green building technologies.
8. Enhancement of thermal and acoustic insulation properties.

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