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# Comparative Analysis of Physical and Mechanical Properties of Various Masonry Bricks

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**Abstract**: *This project looks into and compares the physical and mechanical properties of seven types of masonry units: clay brick, fly ash brick, Porotherm brick, three-hole brick, interlock brick, solid block, and AAC (Autoclaved Aerated Concrete) brick. The study looks at three main factors: compressive strength, water absorption, and density. These are important for figuring out how long bricks will last and how well they will work in different types of construction. We used standard lab methods to test each type in the same way. According to the results, solid blocks showed high compressive strength, while AAC bricks showed low density and high water absorption. Interlocking and porotherm bricks demonstrated a good weight-to-strength ratio. The selection of suitable masonry units based on structural requirements, environmental conditions, and material efficiency is made easier by this comparative analysis.*

**Keywords**: masonry units

## I. INTRODUCTION

Among the oldest and most popular building materials in the world are bricks and masonry units. Even with the introduction of contemporary materials, their function in creating long-lasting, secure, and energy-efficient structures is still vital. Numerous brick varieties, each with special qualities and benefits, have been created and embraced in response to the growing demand for affordable and environmentally friendly building. The objective of this project is to compare the mechanical and physical characteristics of various masonry bricks, with an emphasis on density, compressive strength, and water absorption. Traditional clay bricks, fly ash bricks, porotherm bricks, three-hole bricks, solid blocks, and aac (autoclaved aerated concrete) bricks are among the bricks chosen for this study. The raw materials, manufacturing processes, and structural performance of these types, which are frequently utilized in both residential and commercial construction, vary greatly. This study aims to give engineers, architects, and builders relevant information for choosing appropriate bricks for particular building requirements by examining and contrasting these attributes. In order to ultimately inform material selections based on strength, durability, moisture resistance, and weight, the objective is to assess how these various masonry units perform under identical testing conditions.

### 1.2 Materials

- Clay Brick
- Fly Ash Brick
- Porotherm Brick
- Three-Hole Brick
- Solid Block
- AAC (Autoclaved Aerated Concrete) Brick


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### 1.2.1 Clay Brick

Good compressive strength allows for load-bearing applications, and thermal insulation helps regulate indoor temperatures.
Durability for long-lasting construction; fire resistance, which ensures the safety of structures
Architectural design's aesthetic appeal

#### 1.2.1.1 Benefits of Clay Brick

High Durability: Able to withstand aging, weathering, and pests.
• Good Compressive Strength: Fit for structures that support loads.
Maintaining indoor temperatures is aided by thermal insulation.
• Fire Resistance: Non-flammable, improving the safety of buildings.
• Low Maintenance: Over time, little maintenance is needed.
• Eco-friendly: composed of recyclable materials and natural materials.
• Aesthetic Appeal: Provides a timeless and classic look.

### 1.2.2 FLYASH BRICK:

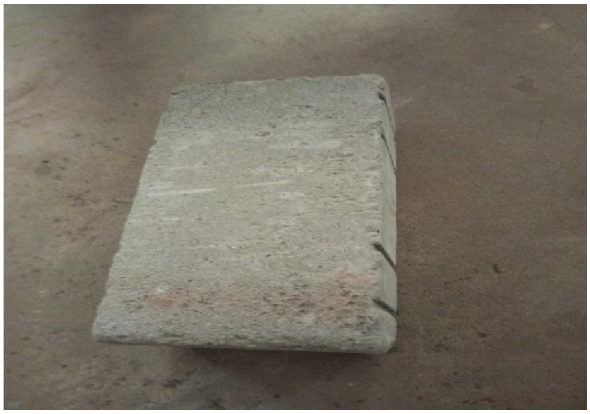

**Fig 1.2 Flyash Brick**

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• Building walls and partitions in both low-rise and high-rise structures using fly ash, an environmentally friendly substitute for conventional clay bricks

The

• Lightweight structural elements to lower overall dead

• A smooth surface for less wood in the plastering Better soundproofing and thermal insulation in structures

### 1.2.2. FLYASH BRICK'S BENEFITS

• Eco-Friendly: By using fly ash, an industrial waste, pollution is decreased in the environment.
• Lightweight: This makes handling easier and lessens the dead load on structures.
• Uniform Shape and Size: This promotes quicker construction and uses less mortar.
• High Strength: Fits well with both load-bearing and non-load-bearing walls.
• Low Water Absorption: This improves wall durability and lessens moisture.
• Improved Thermal Insulation: Assists in controlling interior temperatures.
• Smooth Surface Finish: This reduces the need for plastering and lowers finishing expenses.
• Fire and Sound Resistant: This improves building comfort and safety.

### 1.2.3 THREE HOLE BRICK:

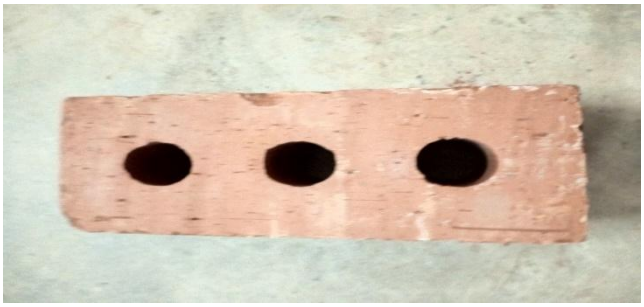

**Fig 1.3 Three Hole Brick**

Three-hole bricks are used primarily in construction for the following reasons:

• Better thermal performance because of air gaps in the holes;
• Better mortar bonding because of holes that allow better adhesion;
• Non-load-bearing and partition walls in residential and commercial buildings;
• Cost-effective construction because of reduced material usage;

### 1.2.3.1 THREE-HOLE BRICK BENEFITS:

• Lightweight: Less dead load on structures and easier to handle.
• Better Mortar Grip: Holes facilitate a stronger mortar bond, increasing the strength of the wall.
• Cost-effective: Because it uses less material than solid bricks, production and transportation expenses are reduced.
• Improved Thermal Insulation: Heat transfer is lessened by air pockets inside holes.
• Faster Construction: Because of its lightweight nature, it can be handled and laid more quickly.
• Uniform Shape: This guarantees clean, aligned brickwork.

### 1.2.4 AAC BRICK

Reducing the overall weight of buildings, particularly high-rise construction;
supplying thermal insulation for energy-efficient buildings;
and using lightweight structural and non-structural walls in residential, commercial, and industrial buildings

• Soundproof walls are perfect for apartments, schools, and hospitals.
• Faster construction because of bigger block sizes and simpler handling; • Fire-resistant construction in safety-critical structures

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**Fig:1.4 AAC Brick**

**1.2.4.1 AAC BRICK BENEFITS**:

- Lightweight: Compared to conventional bricks, they are up to three times lighter, which lowers structural load.
- Superior Thermal Insulation: Lowers energy expenses and helps maintain interior temperature.
- Fire Resistant: This improves building safety by withstanding high temperatures.
- Sound Insulation: Perfect for locations that are sensitive to noise, such as hospitals and schools.
- Faster Construction: Construction is accelerated by larger size and ease of workability.
- Eco-friendly: low carbon footprint; made from recyclable, non-toxic materials.
- Resistant to Mold and Pests: The inorganic composition keeps insects away.

**1.2.5 POROTHERM BRICK:**

**Fig 1.5 Porotherm Brick**

- The main purposes of porotherm bricks in construction are:
- Wall systems that use less energy in homes and businesses
- In multi-story buildings, load-bearing and non-load-bearing walls
- Thermal insulation to reduce heating and cooling needs
- Because they are lightweight and uniform in shape, their construction is quicker and cleaner.
- Sustainable construction with environmentally friendly clay-based materials
- Hollow construction to enhance heat resistance, sound absorption, and dead load reduction

**1.2.5.1 POROTHERM BRICK BENEFITS:**

- Lightweight: This feature makes it perfect for high-rise buildings because it lessens dead load on the structure.
- Superior Thermal Insulation: Preserves warmth in the winter and coolness in the summer.
- Eco-Friendly: Made with recycled materials and natural clay, it uses little energy during production.

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• Quicker Construction: Wall construction is accelerated by larger size and ease of handling.
• Sound Insulation: A hollow structure reduces outside noise.
• Great Power

### 1.2.6 SOLID BLOCK:

**Fig 1.6 Solid Brick**

• When building, solid blocks are utilized for:
Because of their high compressive strength, load-bearing walls in buildings;
basement construction, retaining walls, and foundation work
• Sturdy constructions, like boundary walls and industrial buildings
• Fire and soundproof partitions
• Providing stability where there is a high need for structural load
• Using clay bricks instead of traditional ones for quicker and more robust construction

### 1.2.6.1 SOLID BLOCK BENEFITS:

• High Compressive Strength: Perfect for heavy structures and load-bearing walls.
Durability: enduring and impervious to inclement weather.
• Fire Resistance: Non-flammable materials increase building security.
• Sound Insulation: A dense structure lessens the transmission of noise.
• Quicker Construction: A larger size uses fewer joints to cover a larger area.
• Cost-effective: Over time, it lowers labor expenses and mortar usage.
• Pest Resistant: Inorganic materials deter pest infestation.

## 1.3 Goals

• To evaluate and contrast the mechanical and physical characteristics of different kinds of masonry bricks.
• To assess solid concrete blocks, fly ash, clay, three-hole, porotherm, and used bricks.
• To evaluate important characteristics such as density, compressive strength, and water absorption
• To ascertain whether each type of brick is appropriate for a given construction application.
• To offer data-driven suggestions for choosing the right masonry units for construction projects.

## 1.4 Scope:

The study examines six different kinds of masonry units, including solid concrete blocks, fly ash bricks, three-hole bricks, used bricks, clay bricks, and porotherm bricks.
• Concentrates on assessing physical characteristics, such as density, water absorption, and thermal conductivity.
• Examines mechanical characteristics, particularly durability and compressive strength.
Using both empirical observations and standard laboratory data, performance characteristics are compared.

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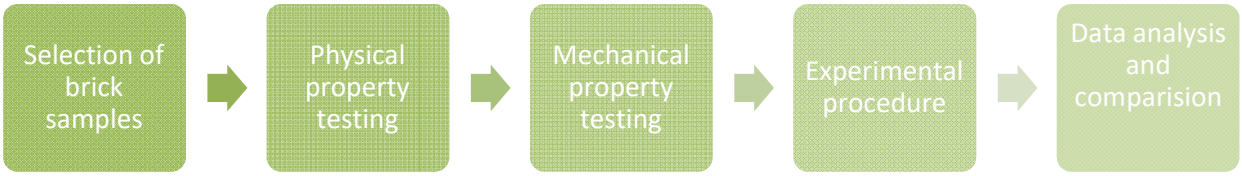
• Intended to assist in the selection of materials for applications that are load-bearing and those that are not.
• Specialized or ornamental masonry units are not included in the analysis, which is restricted to brick types frequently used in contemporary construction.
• Engineers, architects, builders, and students studying construction are the target audience for the results.

## II. METHODOLOGY




## III. LITERATURE REVIEW

1. Goyal, S., & Siddique, R. (2011)
"Strength properties of various bricks with industrial by-products"
Published in Construction and Building Materials, this study compared traditional clay bricks with those made using fly ash and other waste materials. Results showed fly ash bricks have improved compressive strength and reduced water absorption.
2. Rajput, P.S., & Yadav, R.K. (2015)
"Comparative Study on AAC, CLC and Flyash Bricks" – IJERA
This study analyzed AAC blocks for lightweight construction and found them suitable for thermal insulation but lower in compressive strength than conventional bricks.
3. Deboucha, S., & Hashim, R. (2011)
"A review on bricks and stabilized compressed earth blocks" – Scientific Research and Essays
This review highlighted the benefits of Porotherm (hollow clay) and compressed bricks in terms of reduced density and better thermal performance.
4. Kumar, R. (2017)
"Comparative Study of Fly Ash Brick and Clay Brick" – IJCIET
The study concluded that fly ash bricks perform better in terms of compressive strength and durability, with added environmental benefits.
5. Arumugam, R., et al. (2018)
"Comparative Study on Properties of Clay Brick and Fly Ash Brick" – International Journal of Engineering & Technology
This work evaluated both bricks under the same test conditions and showed fly ash bricks absorbed less water and offered higher strength.
6. IS 1077:1992 – Common Burnt Clay Building Bricks – Specification
This Indian Standard provides classification and specifications for clay bricks including dimensions, strength, and water absorption.

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7. IS 12894:2002 – Fly Ash Lime Bricks – Specification
This standard details the performance requirements and testing procedures for fly ash bricks.
8. IS 2185 (Part 1):2005 – Concrete Masonry Units – Specification
Specifies solid and hollow concrete blocks, including minimum compressive strength, density, and moisture content.
9. IS 3495 (Parts 1 to 4):1992 – Methods of Tests of Burnt Clay Building Bricks
These standards guide the testing of water absorption, compressive strength, and other parameters for clay bricks

## III. MATERIALS AND METHODS

### 3.1. Selection of Bricks

- Clay Brick
- Fly Ash Brick
- Porotherm Brick
- Three-Hole Brick
- Solid Block
- AAC Brick

### 3.2. Sample Preparation:

Bricks of each type in standard sizes were gathered from trustworthy sources. Prior to testing, every sample was cleaned and allowed to come to room temperature.

### 3.3. Methods of Testing

3.3.1. Water Absorption Test: The bricks were first dried for 24 hours at 105–110°C in an oven before being weighed (dry weight).
• After being submerged in water for a full day, they were taken out, allowed to air dry, and weighed once more (wet weight)

| Type | Water Absorption(%) |
|---|---|
| Burnt clay Brick | 19.7 |
| Flyash Bric | 10 |
| Porotherm Brick | 12 |
| Three Hole Brick | 15 |
| AAC Brick | 13 |
| Solid Brick | 8 |

Table 3.1 water absorption

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### 3.3.2.Compressive Strength Test

Conducted using a Compression Testing Machine (CTM) as per IS 3495 (Part 1): 1992.
Each brick was loaded until failure, and the maximum load was recorded.
Compressive strength was calculated.

Fig 3.2 Compressive Strength Test

| Type | Compressive Strength |
|---|---|
| Burnt clay Brick | 5.5 |
| Flyash Brick | 8 |
| Porotherm Brick | 4 |
| Three Hole Brick | 5 |
| AAC Brick | 3.5 |
| Solid Block | 7 |

### 3.3.3. Density Test

Measured using the formula:
Dimensions of bricks were measured to calculate volume, and dry mass was used

| Type | Density($Kg/m^3$) |
|---|---|
| Burnt clay Brick | 1800 |
| Flyash Brick | 1850 |
| Porotherm Brick | 800 |
| Three Hole Brick | 1600 |
| AAC Brick | 650 |
| Solid Brick | 2200 |

### 3.3.4. Data Recording and Analysis

Tests were repeated for a minimum of three samples per brick type.
Average values were taken and results compared to assess performance across materials.

### 3.4 STANDARD SIZES AND PRICES OF BRICKS:

| Brick Type | Common Market Size (Mm) | Approx Price Per Unit (Inr) |
|---|---|---|
| Burnt clay brick | 228 x 115 x 76 | Rs 10 |
| Flyash brick | 229 x 107 x 76 | Rs 10 |
| Porotherm brick | 407 × 204 × 102 | Rs 55 |
| Three hole brick | 228 × 102 × 76 | Rs 10 |
| AAC brick | 610×203× 203 | Rs 60 |
| Solid block | 406 x 203 x 203 | Rs 42 |

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### 3.5 COST COMPARISON OF BRICKS PER CUBIC METER:

| TYPE | APPROX. PRICE PER UNIT (Rs) | UNITS PER m3 | APPROX.PRICE PER m3(Rs) |
|---|---|---|---|
| Burnt clay brick | 10 | 526 | 5260 |
| Flyash brick | 10 | 537 | 5370 |
| Porotherm brick | 55 | 172 | 9460 |
| Three hole brick | 10 | 568 | 5680 |
| AAC brick | 60 | 40 | 2400 |
| Solid block | 42 | 60 | 2520 |

## IV. RESULTS AND DISCUSSION

| **Type** | **Compressive Strength (Mpa)** | **Water Absorption (%)** | **Density ($Kg/m^3$)** | **Approx.price Per $m^3$(Rs)** |
|---|---|---|---|---|
| Burnt clay brick | 5.5 | 19.7 | 1800 | 5260 |
| Flyash brick | 8 | 10 | 1850 | 5370 |
| Porotherm brick | 4 | 12 | 800 | 9460 |
| Three hole brick | 5 | 15 | 1600 | 5680 |
| AAC brick | 3.5 | 13 | 650 | 2400 |
| Solid block | 7 | 8 | 2200 | 2520 |

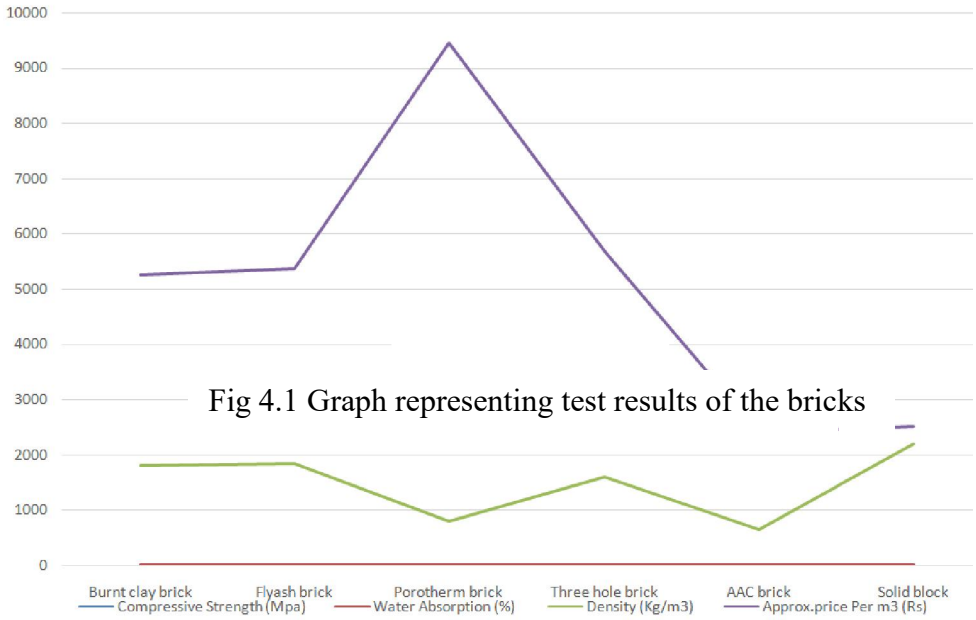


Fig 4.1 Graph representing test results of the bricks

### RESULTS

Significant differences in the physical and mechanical characteristics of clay, fly ash, porotherm, three-hole, AAC, and solid block bricks are revealed by comparison, and these differences have a direct impact on the bricks' suitability for various construction applications. Among the samples that were tested:

Fly ash bricks and solid blocks typically had higher compressive strengths, which made them perfect for load-bearing structures.

Porotherm and AAC bricks showed reduced water absorption and density, indicating their potential for lightweight and energy-efficient construction.

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Despite being traditional, clay bricks demonstrated a moderate level of strength and a higher capacity to absorb water, indicating limitations in environments that are prone to moisture.

Although their compressive strength was marginally lower than that of their solid counterparts, three-hole bricks demonstrated a balanced performance.

In general, no one type of brick is superior in every way. Thus, selection ought to be informed by particular

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