

# Experimental Investigation on the Development of Interlocking Building Bricks Incorporating Fly Ash

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**Abstract** - The use of interlocking brick masonry has become increasingly popular in many countries as a substitute for traditional bricks. Researchers have continuously worked to develop interlocking bricks that are lightweight, economical, and capable of performing well in harsh environmental conditions. In this regard, an experimental study has been conducted. This project presents the findings of an investigation where properties such as Specific gravity test & water absorption test, and density were examined by using different proportions of fly ash. In the present time, it is important to convert waste materials into useful resources and adopt environmentally friendly technologies for sustainable development. Due to the rapid growth in population and the increase in construction activities, along with improvements in living standards, the demand for building bricks is rising steadily.

**Key Words:** Interlocking Masonry, Low-Cost Construction, Fly Ash, Waste Utilization.

## 1. INTRODUCTION

Interlocking mortar less brickwork has greatly enhanced the speed and efficiency of construction activities while minimizing the requirement for highly skilled labor. These types of bricks are becoming widely used in many countries as a substitute for traditional bricks because they support environmentally friendly and sustainable construction methods. Unlike conventional bricks, interlocking bricks are specially designed so that they can easily fit and lock into each other without the use of mortar between the layers during building. This design makes the construction process simpler, saves time and money, and makes it an effective solution for modern sustainable construction practices..

### 1.1 Research Gap

Although fly ash is a major industrial waste produced from thermal power plants and its disposal causes environmental pollution and health hazards, its effective and large-scale utilization in construction materials is still limited. There is a lack of sufficient research and practical implementation on converting fly ash into durable, eco-friendly building materials such as interlocking bricks.

Therefore, more studies are required to develop methods for efficiently using fly ash in brick production while ensuring adequate strength, durability, and environmental safety.

### 1.2 Objectives

1. To utilize fly ash (an industrial waste from thermal power plants) in the manufacturing of interlocking bricks.
2. To develop eco-friendly and sustainable building materials using fly ash.
3. To study the compressive strength of interlocking bricks made with different percentages of fly ash.
4. To evaluate the density and durability of the produced bricks.
5. To reduce environmental pollution by converting industrial waste into useful construction materials.
6. To provide a cost-effective alternative to conventional building bricks.

### 1.3. Source of Fly Ash

About 70–75% of power plants in India operate using coal as their primary fuel. These thermal power stations produce nearly 226 million tonnes of fly ash every year. Fly ash is generated when coal is burned in thermal power plants and industries that use coal as fuel, releasing ash, smoke, and gases such as CO<sub>2</sub>. In power plants and industries, fly ash is collected and separated from flue gases using equipment such as cyclone separators. The collected fly ash can then be utilized as a raw material for the production of building bricks.

## 2. Literature review

R. K. Watile et.al (2016) had studied the use of interlocking bricks masonry has gained rapid popularity as an alternative to conventional bricks for sustainable housing. R. K. Watile et.al had carried out an experimental investigation in which the compressive strength, water absorption and density were investigated by using varying percentage of fly ash, stone dust, and sand with different mix proportion. A manmade fibre, glass fibre reinforce polymer (GFRP) utilize as

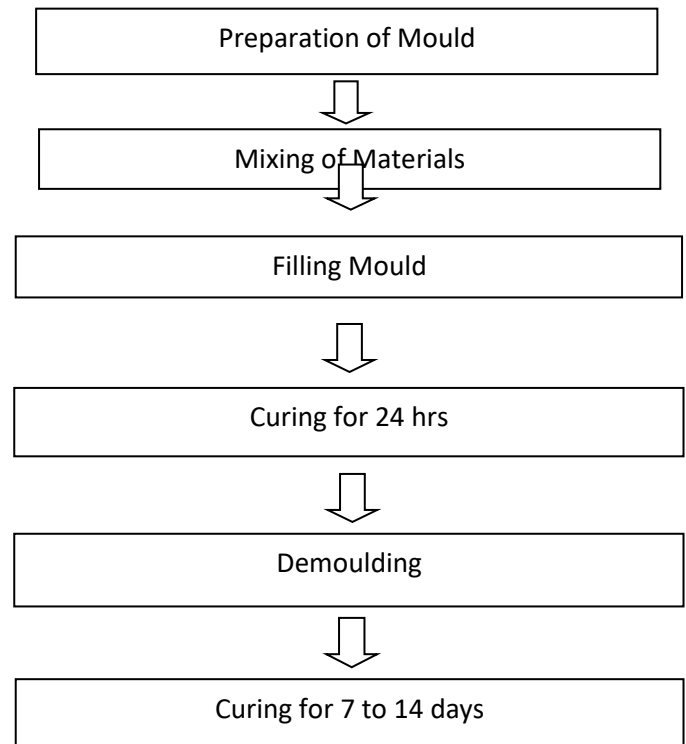
reinforcing material to produce the interlocking blocks which gives appreciable results were studied. There experimental results compared with that ordinary burnt clay brick and interlocking brick found durable in aggressive environments and have sufficient strength for their use in sustainable building construction.

R.K. Watile, S.K. Deshmukh, H.C. Muley (2014) et.al. have carried the experimental work, by using rice husk ash and clay as a raw material for the brick and the size of brick was 190x90x90 mm, with 3 kg weight of the brick. They have casted two different types of bricks, first brick with rice husk ash and clay as a raw material for the brick, they have added rice husk ash up to 80% with interval of 10%, clay up to 40% by interval of 10% and for second brick, they have casted with rice husk ash, lime and gypsum as raw material for the brick.

S. Pareek. —Gainful Utilization of Marble Waste (2007) have carried the experimental work by using, laterite soil, plastic (PET) and bitumen as a raw material for the brick i.e. poly ethylene terephthalate as a plastic, size of the brick was 20x10x10cm, and weight of brick as 3kg, they have carried test on the index properties of the soil, and they have also carried test for bitumen, they have replaced the soil up to 80% by the plastic and bitumen by keeping the bitumen content constant (2%), and varied the proportion of plastic content by the increment of 8%, they concluded that maximum compressive strength as 7.20 MPa, water absorption as 1.824% and for second brick they have varying the bitumen content, and keeping plastic constant in soil, with bitumen up to 10%, interval of 2% and 70% as optimum plastic content by the weight of the soil,

Swapnil H Patil (2016), had studied on interlocking stabilized soil bricks. Materials used were Red soil, Cement, Water, Sand and Fly ash. Method used for casting the Interlocking Soil Bricks: Manual casting & Casting by Hydraulic Press Machines, Size of brick were (230mm x100mm x100mm) (230mm x 150mm x 100mm) Tests conducted were Water absorption and Compression strength on stabilized bricks. Authors conclude that if brick are prepared of ISSB bricks on site then it reduces the transportation cost and time. Maximum compressive strength for 10% cement & soil 2.65kg with compressive strength as 2.42 N/mm<sup>2</sup> and water absorption as 21.70%.

### 3. Methodology



#### 3.1 Preparation of mould

- A special mould is required for the production of interlocking bricks.
- Two different types of moulds are needed so that the gaps in the wall can be properly filled using single bricks during the wall construction process.

#### 3.2 Mixing of materials

- The materials should be combined in the correct proportions. An incorrect mix can alter the weight of the bricks, either increasing or decreasing it, which in turn affects their overall strength.

#### 3.3 Filing of mould

- The mould should be filled with the correct proportion of materials.
- An appropriate quantity of material must be added to the mould.
- The mould must be in good condition, as any damage can lead to bricks of incorrect size.

#### 3.4 Curing for 24 hours

- After filling the mould, the bricks should be cured for 14 hours.
- This curing process helps to improve the strength of the bricks.

- Once cured, the bricks should be removed from the mould.
- After demoulding, an additional 14 hours of curing is necessary to ensure the bricks remain stable and undamaged.

### 3.5 Demoulding of brick

- Bricks should be removed from the mould only after a proper curing period of 14 hours.
- Care must be taken during demoulding to prevent the bricks from cracking or breaking.
- After demoulding, the bricks must undergo an additional curing process to ensure their strength and stability.

### 3.6 Curing for 7 & 14 days

- Curing is essential to achieve optimal strength in the bricks.
- After demoulding, the bricks must be kept for curing to ensure durability and stability.
- This ensures uniformity in the bricks, which contributes to the construction of strong and well-aligned walls.

## 4. Testing

### 4.1 Tests to Be Conducted

- Specific gravity test
- Compression test
- Water absorption test

#### 4.1.1 Specific gravity test

Specific gravity is a key characteristic of cement, as it is closely related to its density and flow properties. It is an important factor in determining the cement’s overall density. If the specific gravity exceeds 3.19, it indicates higher moisture content, which can negatively impact the mix quality and the bonding strength.

**Specific Gravity** = Weight of Substance (Wd) / Weight of an Equal Volume of Water (Ww)

$$= (W2-W1) / (W4-W1)-(W3-W2)$$

Flyash:

W1-0.659 Kg (weight of hydrometer)

W2-1.099 Kg (weight of hydrometer + fly ash)

W3-1.746 Kg (weight of hydrometer + fly ash+ water)

W4-1.522 Kg (weight of hydrometer +water)

Sr. No	Weight in KG
1	W1= 0.659
2	W2= 1.099
3	W3= 1.746
4	W4= 1.522

TABLE 1. SPECIFIC GRAVITY OF FLY ASH

Cement :

W1-0.661 Kg (weight of cyclometer)

W2-1.109 Kg (weight of cyclometer + cement)

W3-1.809 Kg (weight of cyclometer + cement+ water)

W4-1.523 Kg (weight of cyclometer +water)

Sr. No	Weight in KG
1	W1= 0.661
2	W2= 1.109
3	W3= 1.809
4	W4= 1.523

TABLE 2. SPECIFIC GRAVITY OF CEMENT

#### 4.1.2 Water absorption test

First, a brick is dried and its weight is recorded. It is then placed in water and kept immersed for 24 hours. After this period, the brick is taken out and weighed again. The increase in weight represents the amount of water absorbed by the brick. For first-class bricks, the water absorption should not exceed 20% of the dry weight of the brick.

$$\text{Water Absorption (\%)} = [(W_2 - W_1) / W_1] \times 100$$

Where:

W<sub>1</sub> = Weight of the dry brick (after drying in an oven for 24 hours at a temperature of 110–150 °C).

W<sub>2</sub> = Weight of the brick after it has been immersed in water for 24 hours.

#### Water absorption value (%)

Sr. No	W1 (in KG)	W2 (in KG)	[(W <sub>2</sub> - W <sub>1</sub> ) / W <sub>1</sub> ]	[(W <sub>2</sub> - W <sub>1</sub> ) / W <sub>1</sub> ] × 100
1	3.79	4.31	0.137	13.7
2	3.72	4.33	0.163	16.3
3	3.75	4.37	0.165	16.5

#### 4.1.3 Compression test

Concrete specimens are tested using a compression testing machine after curing for either 7 days or 21 days. The load is applied gradually at a rate of 140 kg/cm<sup>2</sup> per minute until the specimen fails. The compressive strength of the concrete is then determined by dividing

the load at failure by the cross-sectional area of the specimen.

**Compressive strength formula :**

Compressive strength =  
 Max. load applied (P) / Cross-sectional area (A)

**Compression strength test for 7 days**

Sr. no	Load	Surface area	Compressive Strength	Avg. Strength
1	49	22500	2.17	2.18
2	52	22500	2.31	
3	47	22500	2.08	

**Compression strength test for 14 days**

Sr. no	Load	Surface area	Compressive Strength	Avg. Strength
1	96	22500	4.26	4.09
2	92	22500	4.08	
3	89	22500	3.95	

**Compression strength test for 28 days**

Sr. no	Load	Surface area	Compressive Strength	Avg. Strength
1	158	22500	7.02	6.10
2	153	22500	6.80	
3	146	22500	4.48	

**5. Benefits**

- Utilizes fly ash, an industrial waste, which helps reduce environmental pollution.
- Reduces the use of clay and topsoil required for traditional bricks.
- Fly ash bricks often have good compressive strength and durability.
- These bricks generally absorb less water, improving their lifespan.
- Interlocking design allows quick assembly without extensive mortar use.
- Construction with interlocking bricks requires less skilled labor.
- Machine-made bricks provide better dimensional accuracy.
- Supports green building practices and waste management.
- Lower production and construction costs compared to conventional bricks.

**6. CONCLUSIONS**

The production of interlocking bricks using fly ash is a sustainable and eco-friendly construction method. It helps utilize industrial waste, reduces environmental pollution, and lowers construction costs. These bricks provide good strength, low water absorption, and faster construction due to their interlocking design. Therefore, fly ash interlocking bricks are a reliable and efficient alternative to traditional bricks.

- In conclusion, this study presents the development of interlocking bricks and confirms that they can be effectively used in masonry construction.
- The interlocking brick system is increasingly adopted as an alternative to conventional brick systems.
- The study also shows that interlocking bricks can be used for both load-bearing walls and non-load-bearing structures.

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