International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 12 | Dec 2024 www.irjet.net p-ISSN: 2395-0072

# Experimental Study of Light Weight Interlocking Brick Based On Mixed Material Variation Design

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**Abstract -** *In many foreign countries, interlocking brick masonry is rapidly becoming a preferred alternative to traditional bricks for environmentally friendly buildings. The researchers have always challenged to make interlocking brick light weight, low cost and improve the performance against aggressive environment. An experimental effort made in this concern. The experimental study gives the results of light weight interlocking brick based on mixed material variation for Dimension, Weight Test, Water Absorption Test, Compressive Strength Test and Density testing were carried out and the test result is compared with standard interlocking brick specimen which were subjected to prior research in the laboratory by using varying percentage of fly ash, stone dust with different mix proportion. In comparison of standard interlocking bricks specimen with light weight interlocking bricks has some advantages such as high compressive strength, less density, durability and low cost. It is eco-friendly. After the several researches project involving the strengthening and reducing the weight of interlocking bricks by using fly ash in the interlocking bricks. Then the test has shown improvements in strength, density, durability compared to standard interlocking brick specimen and Light weight interlocking bricks. The benefit of using fly ash is used to reduce the weight of interlocking bricks. The brick is moulded with dimension of (300 x 150 x 125mm) with curing continuously for 28 days. Then the brick was finally tested using a compression testing machine. The fly ash ash gives more compressive strength, less density and durability as compared to the standard interlocking brick specimen.*

***Key Words***: **Interlocking Bricks, Fly Ash, Compressive Strength, Water Absorption, Density.**

## 1.INTRODUCTION

As per G20 2024 report India has emerged as the fastest developing major economy within the world. And together with that India's populace is developing quickly and is right now the foremost populated nation within the world. For India's developing economy and populace requests to boost the public infrastructure speculation, an rise in family venture in genuine bequest and development industry.

A wide variety of materials are utilized within the development industry. When considering their application in divider components, customary burnt clay bricks are the foremost basic building materials for houses development. Be that as it may, the quick development in today's development industry has obliged the gracious engineers in looking for a modern building technique that will result in indeed more noteworthy economy, more effective and solid as an elective for the ordinary brick. In a tropical nation like India the burnt clay brick is the foremost fundamental building fabric for development of houses. It is detailed that the prerequisite of bricks for development movement sums to be more than 140 billion numbers yearly.

### 1.1 The aim of study

To do experimental study of light weight interlocking brick based on mixed material variation design.

### 1.2 The objective of study

1. To produce light weight interlocking brick. 2. To determine optimum compressive strength of light weight interlocking brick. 3. To determine water absorption of light weight interlocking brick. 4. To determine density of light weight interlocking brick.

### 1.3 The scope of study

The proposed interlocking light weight bricks allows for a quick and cost effective construction. It's over comes the conventional clay bricks, which couldn't bear the stress as they cannot transfer the seismic load across the structure equivalently. And act as a good earthquake resistance structure. It's allowed exposed brick wall construction and gives good aesthetic view, improved constructability, performance and cost as well resulting to alternative for sustainable construction industry.

## 2. METHODOLOGY

### 2.1Introduction of Methodology

The first step in studying is to schedule your study time. The activities were planning due to time required to make sure the product will be completed in schedule time. The point of the technique inquire about is to attain the destinations of consider as expressed in this chapter.

### 2.2 Material of Light Weight Interlocking Brick

In our study, we used three basic materials in order to produce the light weight interlocking brick that are Ordinary Portland cement (OPC), fly ash, fine aggregate (dust). These materials were fundamentally characterized in compliance with Indian standards. All materials are available locally in Maharashtra.

#### 2.2.1Cement

Cement is a material used in construction that binds other materials together by setting, hardening, and adhering to them. Ordinary Portland cement of 53 grade were used satisfying all the IS: 12269-1987 requirements was used in making the bricks.

#### 2.2.2Fly Ash

One of the industrial wastes is fly ash, fine-grained gray produced by burning coal, which is recovered from the final combustion of coal. In this study, Class F y ash was used, and it contains low content of CaO and exhibit pozzolanic properties and having specific gravity of fly ash is 2.76 was used. The fly ash was collected in dry state from the Paras Thermal power station.

#### 2.2.3Stone dust

The finest kind of crushed stone is called stone dust, or stone screens. Stone dust creates a hard, water-resistant surface when applied alone. When used with a larger stone it acts as a binding agent because of its ability to form a strong, non porous surface. Powder form stone dust available locally used in moderate quantity for preparing the bricks. Its small size allows the bricks to maintain their correct form, especially the corners and edges.

#### 2.2.3Water

Plane Ordinary tap water was used for both mixing the constituents of the bricks as well as for the curing of bricks. Water requirements depend on the following factors:

• Production – water consumption depends on water-to-cement ratios

• Curing – depends on duration in days (minimum 7days). The potential strength of any Ordinary Portland Cement (OPC) product will be maximized by curing under moist conditions. The highest rate of reaction (hydration) between cement and water takes place in the first three to seven days, which therefore require proper curing/attention (BS 5328-1:1997 and BS 5628 3:2005).

### 2.3 Material of Light Weight Interlocking Brick

The second steps in our project methodology, we used Hydraform shape which is the simplest type of interlocking brick see in fig. 1 in shape, when interlocked makes a tongue and grooved joint at the sides and top and bottom. Being free to slide along the course horizontally, it can be pushed along to achieve tighter perpends (vertical joints) see in fig. 2 Hydraform brick is moulded by pressing along its length from the ends. It is also a solid brick, The length, wider and thicker of the interlocking brick in size of (300 x 150 x 125mm). The stability of the wall built from the Hydraform bricks is not provided by the locking mechanism but by the width and weight (massiveness) of the brick. Moreover the compression must be sufficient to allow a fresh brick to withstand the squeezing forces occurring when it is manually moved from machine to the curing area.

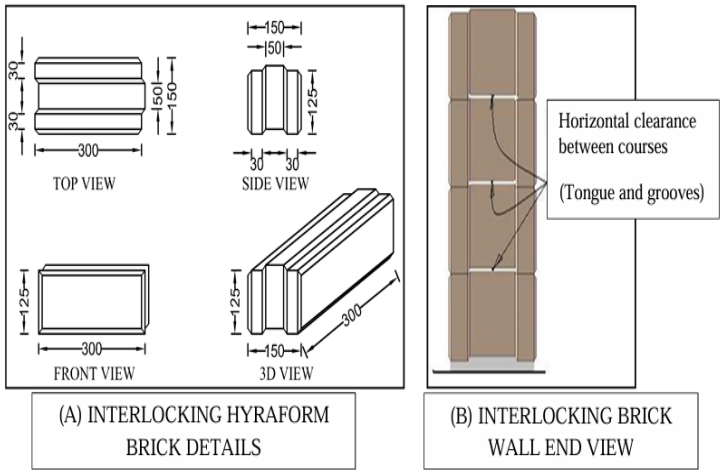



**Fig -1**: A & B Hydraform Brick

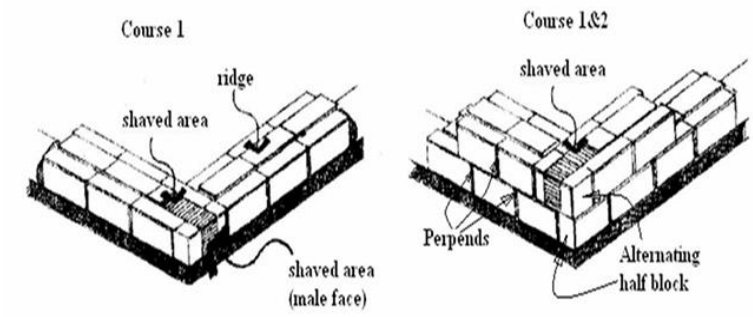



**Fig -2:** Typical Hydraform Interlocking Brick – laying

### 2.4 Mix design for Light Weight Interlocking Brick

In this experimental study two standard specimen as per IS 2250:1981 was suitably designed for M5 grade, M3 grade of mortar and four sample mix design were used to identify the optimum mix design for Light weight interlocking brick. The mix design was done based on the proportion of various

materials like cement, fly ash and stone dust. The first standard specimen sample mix design for (1:6) contains 16.67% of cement and 83.33% of stone dust. This type of interlocking brick is named as S1. The second standard specimen sample mix design for (1:8) contains 12.50% of cement, 87.50% of stone dust. This type of interlocking brick is named as S2. The standard specimen mix design is given in Table no.1

**Table -1**: Standard Interlocking brick Mix Designs

| Sample Designation | Grade | Mix Design | Material Percentage | |
|---|---|---|---|---|
| | | | Cement | Stone Dust |
| S1 | M5 | 1:6 | 16.67% | 83.33% |
| S2 | M3 | 1:8 | 12.50% | 87.50% |

The first sample mix design for (1:3:4) contains 12.50% of cement, 37.50% of fly ash and 50% of stone dust. This type of interlocking brick is named as A1. The second sample mix design for (1:3.4:3.6) contains 12.50% of cement, 42.50% of fly ash and 45% of stone dust. This type of interlocking brick is named as A2. The third sample mix design for (1:3.8:3.2) contains 12.50% of cement, 47.50% of fly ash and 40% of stone dust. This type of interlocking brick is named as A3. And fourth sample mix design for (1:4.2:2.8) contains 12.50% of cement, 52.50% of fly ash and 35% of stone dust. This type of interlocking brick is named as A4. The sample mix design is given in Table no.2

| Sample Designation | Mix Design | Material Percentage | | |
|---|---|---|---|---|
| | | Cement | Fly Ash | Stone Dust |
| A1 | 1:3:4 | 12.50% | 37.50% | 50.00% |
| A2 | 1:3.4:3.6 | 12.50% | 42.50% | 45.00% |
| A3 | 1:3.8:3.2 | 12.50% | 47.50% | 40.00% |
| A4 | 1:4.2:2.8 | 12.50% | 52.50% | 35.00% |

## 2.5 Casting of Light Weight Interlocking Brick Specimen

After the collection and proportion of materials casting process is carried out. For casting of light weight interlocking brick the cement, fly ash and stone dust were used in varying mix proportions given in table no. 4 and table no. 5. The materials are proportioned by the weight batching. A pan mixer and hydraulic machine used for casting the bricks see in fig. 3. The mixer was thoroughly cleaned before the bricks were cast. To achieve the required workability, dry cement and stone dust were added, well mixed, and then clean drinking water was added. Following the pouring of the brick mix in a hydraulic machine, the bricks were removed and placed on a flat platform beneath the shed to dry. The blocks have geometric size of 300mmx150mmx125mm .This machine produces solid blocks of laterite composition mainly and stabilized with cement material.

**Fig -3**: Hydraulic Machine

## 2.6 Curing

Hardening of any concrete products requires the continued presence of water in the brick to enable cement to complete hydration process. After casting the bricks are allowed for surface dry for 24 hours in direct sunlight. Then cured normally for 28 days by spraying water four to five times in one day see in fig.4.

**Fig -4**: Curing of Interlocking Brick

## 3. TESTING

The casted interlocking bricks were taken out from water one day prior to the testing and were tested for compressive strength after 28 days.

## 3.1Dimensions Test

The dimensions of the interlocking brick specimens measured by an Vernier Caliper on day 28 see in fig. 5. As per IS:1077:1992, tolerance for brick when measured 20 bricks by arranging one beside another for length, width and height separately is ( 40mm) the result of bricks dimensions test. The brick passes the dimension test if its dimensions are within tolerance; if not, it fails.

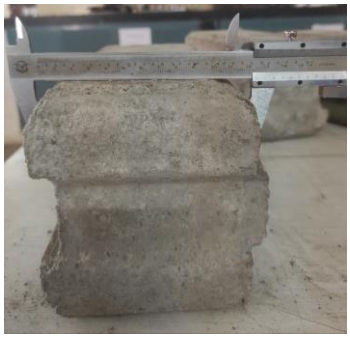


**Fig -5**: Dimension measured by an Vernier Caliper of Interlocking Brick

### 3.2 Weight Test

Weight of different proportions of interlocking bricks is measured with the help of digital weighing balance machine see in fig. 6.


**Fig -6**: Digital Weighing Balance Machine

### 3.3 Water Absorption Test

The bricks, when tested in accordance with the procedure laid down in IS 3495 ( Part 2) : 1992 after immersion in cold water for 24 hours, water absorption shall not be more than 20 percent by weight up to class 12.5 and 15 percent by weight for higher classes. The test specimens shall be completely immersed in water at room -temperature for 24 h. The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water. They shall be removed from the water and allowed to drain for three minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth and immediately weighed (W2). Subsequent to saturation, all specimens shall be dried in a ventilated oven machine at 100||C to 115°C for not less than 24h see in fig.7 and cool the bricks to room temperature and weight (W1). Formula to calculate water absorbed by the bricks, using following formula.

$$\text{Water absorption in \% by weight} = \left(\frac{W2 - W1}{W1}\right) \times 100$$


**Fig -7**: Interlocking Brick Specimen place in Oven Machine

### 3.4 Compressive Strength Test

The specimen is then placed between plates of compression testing machine see in fig.8. Load is applied axially at uniform rate till failure. Maximum load at failure divided by average area of bed face gives us compressive strength.

$$\text{Compressive strength in N/mm2} = \frac{\text{Maximum load at failure in N}}{\text{Average area of the bed faces in mm2}}$$


**Fig -8**: Specimen placed in CTM

### 3.5 Brick Density

Three bricks taken at random from the samples shall be dried to constant mass in a suitable oven heated to 100 C to find the Mass of brick, in kg approximately. After cooling the bricks to room temperature, the dimensions of each brick shall be measured in meter (to the nearest millimeter) and the overall volume computed in cubic meters. The brick shall then be weighed in kilograms and the density of each brick is calculated.

$$\text{Density of brick (kg/m3)} = \left(\frac{\text{Mass of the brick in kg}}{\text{Volume of specimen in m3}}\right)$$

## 4. RESULT AND DISCUSSION

Different tests were conducted to study the behavior of interlocking brick and standard brick. This covers the behavior of specimen under each test.

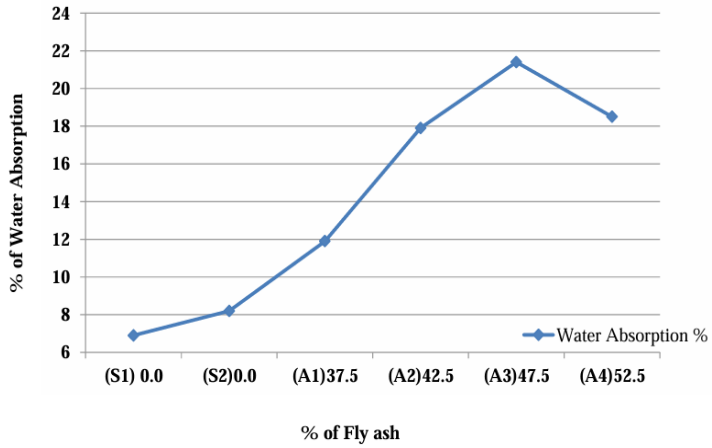
### 4.1 Dimensions Test

The dimensions of the each interlocking brick specimens are measured to the nearest millimeter by an Vernier Caliper on day 28.

### 4.2 Weight Test

Weight of interlocking bricks are measured to the nearest gram and may be varied based on the different proportions of fly ash and stone dust.

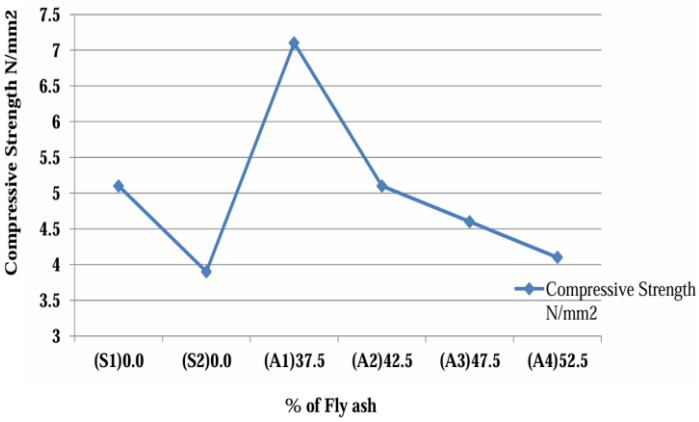
### 4.3 Water Absorption Test




**Graph -1**: % of Water Absorption v/s % of Fly ash

It is observed in the graph shown in graph 1 the water absorption of bricks increases with the increase in fly ash content replacing stone dust. Among the four samples of interlocking brick A1, A2, A3 and A4 Compared with standard brick A1 sample mix design bricks absorb 11.9 % of water only; it has less water absorption property. The average water absorption of A1 sample of interlocking blocks is found to be 11.9%, which is satisfied as per IS: 3495 (Part II) – 1992 which specifies the bricks should not absorb more than 20% of water and classified as 1st class bricks

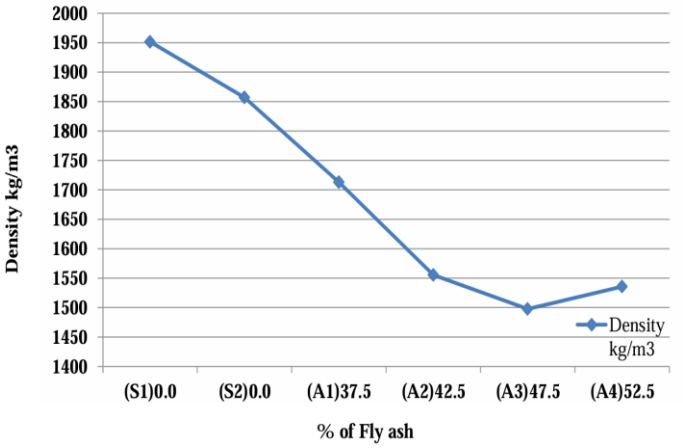
### 4.4 Compressive Strength Test




**Graph -2** Compressive Strength N/mm2 v/s % of Fly ash

The graph of average compressive strength of interlocking brick shown in graph 2 decreases with the increase in fly ash content replacing stone dust from 37.5 % to 47.5%. The average compressive strength of A1 sample of interlocking brick is found to be 7.1 MPa, which is satisfied the minimum average compressive strength of standard sample S1 is to be 5.1 MPa. The average compressive strength of interlocking brick A1 sample which is 7.1 MPa which is found to be greater than the compressive strength of standard bricks S1 which is 5.1 MPa.

### 4.5 Brick Density




**Graph -3** Density kg/m3 v/s % of Fly ash

It is observed that the water absorption and density are closely related to each other. As the water absorption of interlocking brick increases with the density of interlocking brick decreases. The graph of average density of interlocking brick shown in graph 3 decreases with the increase in fly ash content replacing stone dust. The average density of interlocking brick A3 sample is 1497.5 kg/m3 which is found to be lesser than the compressive strength of standard bricks S1 which is 1951.4 kg/m3. The density of interlocking bricks

was found to be 23 percent lesser than that of the standard bricks.

## 5. CONCLUSIONS

Based on the experimental investigation reported in this study, following conclusions are drawn:

1)The dimensional test is conducted on light weight interlocking bricks and standard interlocking bricks. The dimensional errors are found to be relatively small and under tolerance in interlocking bricks as per IS -1077(1992).

2) The water absorption of light weight interlocking bricks increases with the increased in % of fly ash content as compared to standard interlocking bricks but replacement of fly ash above 47.5%, water absorption decreases.

3) The average compressive strength of light weight interlocking bricks deceases with the increased in % of fly ash content as compared to standard interlocking bricks.

4) The density of light weight interlocking bricks decreases with the increased in % of fly ash content as compared to standard interlocking bricks but replacement of fly ash above 47.5%, density of interlocking bricks increases.

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