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# MANUFACTURING AND TESTING OF BAMBOO-EMBEDDED CONCRETE BRICKS

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**Abstract -** *Traditional concrete bricks are the most basic building material used in construction. A number of research have taken considerable measures to improve the strength and durability of bricks by making them from a variety of materials. Before we started utilizing steel to support structures, bamboo was the primary material used in construction. Bamboo is still utilized to construct houses and other constructions in rural and underdeveloped places today. Bamboo has a skewed perception among the general public. It is often associated with shaky constructions. However, this is far from the case. Without the use of specialized tools or equipment, bamboo is simple to cut, handle, repair, reposition, and maintain. It's also non-polluting, light, and thanks to its elasticity, offers greater seismic protection. When comparing bamboo to steel, it is clear that bamboo has greater tensile strength. Bamboo is also effective for thermal insulation and has the added benefit of being fire resistant. This study aims to demonstrate that by using bamboo to reinforce bricks, the strength of the bricks may be increased and this will be accomplished by comparing compression, hardness, soundness, and water absorption test results between bamboo-embedded bricks and ordinary concrete bricks. Because bricks are the building blocks of any construction activity, increasing the strength of bricks by reinforcing it with bamboo increases the buildings' ability to endure natural disasters while also increasing their longevity.*

***Key Words*: Bamboo, Concrete Bricks, Construction, Buildings, Compressive Strength, Sustainability**

## 1.INTRODUCTION

Buildings are intended to withstand natural disasters at all times. They can't always cope with the overwhelming forces of tragedy, and their performance suffers as a result. Bricks are the most important building materials in the construction industry. The breakdown of bricks is one of the many reasons for buildings and constructions falling. For human activity and growth, sustainability is a fundamental and crucial goal. By addressing current and future requirements, we must optimize human well-being and quality of life without endangering it.

Prior to the adoption of steel, bamboo was employed as a key component in building construction. One obscure truth about bamboo plants, sometimes known as the "poor man's lumber," is that they release 30% more oxygen into the atmosphere than other plants, which is a good enough reason to grow them while our globe faces increasing air pollution and ozone depletion. Bamboo is being promoted by environmental organizations because of its many beneficial features and ability to emit oxygen.

**Fig-1: Bamboo Cutting Into Pieces**

Its strong tensile strength, compression resistance, and bending properties make it a particularly promising material in the building area. Bamboo is seen as a viable replacement to lumber by designers. Bamboo wooden panels have a natural look and feel to them. Bamboo flooring, cabinets, and other household products are more durable and less expensive. Researchers created a composite that is stronger than carbon fiber by weaving bamboo with epoxy. This gives us optimism that one day, bamboo can be used to build an alternative to carbon fiber. The most significant advantage is that it is 100 times less expensive than carbon fiber. Because of its inexpensive cost, vast availability, and strength, bamboo has been used in the construction of shelters and huge disaster relief projects.

Some of the examples are:

- Flood resistant houses in Vietnam
- Housing for earthquake victims in Nepal
- Temporary accommodation in Thailand for Burmese refugees

When it comes to tensile strength, bamboo outperforms steel. Tensile strength of steel is 1618-kilogram force per square centimeter. Bamboo, on the other hand, outweighs steel by a significant margin, weighing in at 1969-kilogram force per square centimeter. This is because there are several elements to consider when determining a material's strength. Tensile strength is described as an object's resistance to breaking or splitting when under tension. Yes, bamboo is stronger than steel in this circumstance because its molecular structure is more tightly packed than steel's. Apart from replacing steel, bamboo might also be used to replace plastic pipes in construction, according to researchers.

However, we do not intend to employ bamboo as a primary reinforcement material, use it as a substitute for carbon fibre, or replace plastic pipes with bamboo. We simply wanted to highlight bamboo's tensile strength when compared to steel and other materials, as well as its sustainability. As a result, we chose to incorporate bamboo inside the bricks. To begin, we cut the bamboo into appropriate lengths in order to reinforce it within the brick. Then, with the bamboo that we had cut out, we proceeded to the brick factory and manufactured the bricks that we required. Before putting them through testing, we let them cure for a month. We acquired regular bricks to compare the values after testing with our brick specimens.

**Fig-2: Moulding machine**

**Fig-3: Bamboo Bricks**

## 2. SCOPE AND OBJECTIVE

### 2.1 Scope

1. To identify the effect of enclosing bamboo inside the brick.
2. The strength and durability of the brick are evaluated on implementing the bamboo.

### 2.2 Objective

1. To compare between Ordinary and Bamboo brick in the aspects of strength.
2. To reduce the amount of concrete used for the manufacturing of bricks.
3. To reduce the cost of bricks.
4. Study the change in the properties of the brick while enclosing the bamboo.
5. Provide thermal insulation to the building.

## 3. METHODOLOGY

General methodology of the study

**3.1 LITERATURE REVIEWS:** The journals related to the topic are referred and collected. It helps to understand the various aspects of the project and hence lead to the progress of the project.

**3.2 SAMPLE COLLECTION:** The materials required are collected from different locations. The bamboo used in the study is young green which is collected from Peringzha 2km from Muvattupuzha town, Cement and other necessary things are collected from a shop at muvattupuzha.

**3.3 SAMPLE PREPARATION:** The bamboo collected is cut into 17cm long pieces and taken to a brick-making factory and then the brick is made by the method of machine molding enclosing 2 bamboo pieces inside.

**3.4 LABORATORY EXPERIMENTS:** The testing of bricks were done. The testing is done to determine as follows:-

- Crushing strength or compressive strength of the brick
- Water absorption Test
- Hardness Test
- Soundness Test

**3.5 COMPARISON OF RESULTS:** The results obtained by each test are observed for both ordinary and bamboo brick. The results are compared manually and the best result is identified.

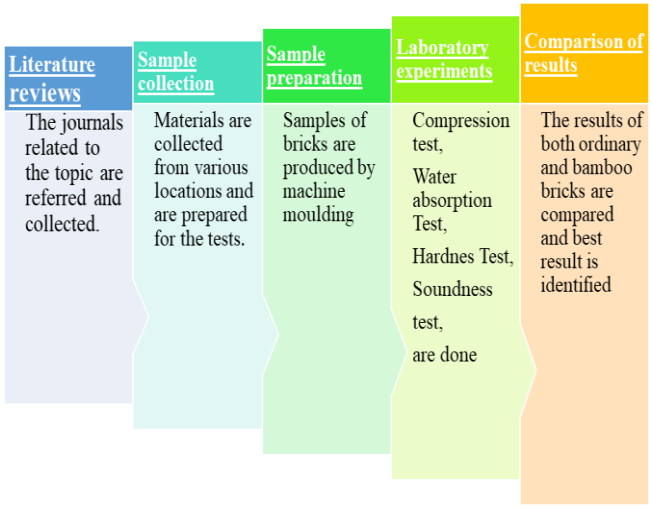


**Chart -1**: Methodology of the Study

## 4. RESULTS AND DISCUSSIONS

The following are the results of the test conducted to determine various strength parameters of bamboo bricks on comparison with ordinary bricks both having dimension of 300x200x150 mm.

### 4.1 COMPRESSIVE STRENGTH OF THE BRICK

The compressive strength of the brick sample increase when bamboo is enclosed in it. However, brick with bamboo enclosed inside shows more increase in compressive strength.

**Table -1 :** Compression strength of Bamboo Bricks on 300 x 150 mm size

| Dimension of Brick Length & Width in mm | Surface Area of Brick (L x B) in mm² | Total Load KN | Load N | Load in N/ mm² | Mean Load |
|---|---|---|---|---|---|
| 300 x 150 | 45000 | 310 | 310000 | 6.89 | |
| 300 x 150 | 45000 | 310 | 310000 | 6.89 | 6.81 |
| 300 x 150 | 45000 | 300 | 300000 | 6.67 | |

**Table -2 :** Compression strength of Ordinary bricks on 300 x 150 mm size

| Dimension of Brick Length & Width in mm | Surface Area of Brick (L x B) in mm² | Total Load KN | Load N | Load in N/ mm² | Mean Load |
|---|---|---|---|---|---|
| 300 x 150 | 45000 | 180 | 180000 | 4 | |
| 300 x 150 | 45000 | 170 | 170000 | 3.78 | 3.89 |
| 300 x 150 | 45000 | 175 | 175000 | 3.89 | |

**Table -3 :** Compression strength of bamboo bricks on 300 x 200 mm size

| Dimension of Brick Length & Width in mm | Surface Area of Brick (L x B) in mm² | Total Load KN | Load N | Load in N/ mm² | Mean Load |
|---|---|---|---|---|---|
| 300 x 200 | 60000 | 576 | 576000 | 9.6 | |
| 300 x 200 | 60000 | 564 | 564000 | 9.4 | 9.467 |
| 300 x 200 | 60000 | 564 | 564000 | 9.4 | |

**Table -4 :** Compression strength of Ordinary bricks on 300 x 200 mm size

| Dimension of Brick Length & Width in mm | Surface Area of Brick (L x B) in mm² | Total Load KN | Load N | Load in N/ mm² | Mean Load |
|---|---|---|---|---|---|
| 300 x 200 | 60000 | 474 | 474000 | 7.9 | |
| 300 x 200 | 60000 | 468 | 468000 | 7.8 | 7.83 |
| 300 x 200 | 60000 | 468 | 468000 | 7.8 | |

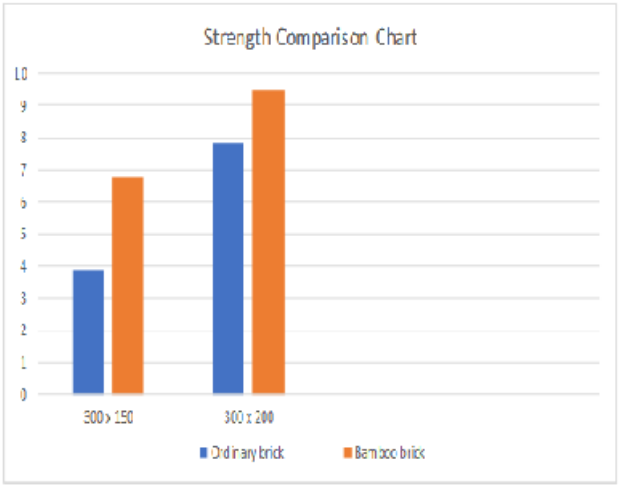


**Chart -2**: Compression strength Comparison Chart

All the samples undergo 28 days curing in water. After curing, all the samples are tested for Compressive Strength. We have tested the bricks on giving compression on two beds of the brick that is 300 x 150 mm and 300 x 200 mm. Experimental observations establish an increase in the compressive strength. Bamboo bricks when comparison with ordinary bricks shows comparably good results, while testing the brick in both dimension the position of bamboo was vertical.

Bamboo bricks shows a compressive strength of 6.81 N/mm$^2$ compared with ordinary bricks with 3.89 N/mm$^2$ , when applying compression at 300 x 150 bed of the brick, with these result comparison we observed that bamboo bricks have more compressive strength than ordinary bricks.

When the compression force is applied on 300 x 200 bed of the brick we observed that it has a compressive strength of 9.46 N/mm$^2$ compared with ordinary bricks with

7.83 N/mm$^2$ thus on comparison with both ordinary and bamboo bricks we observed more strength in bamboo bricks.

Hence we came to the conclusion that, On comparison of bamboo bricks with ordinary bricks we observed that bamboo bricks comes under the grade C (5.0) where its density is more than 1800 kg/m$^3$ which obeys the rules of solid concrete block as in **IS 2185 (Part 1):2005.**

**Table -5 :** Grades of bricks as per IS 2185 (Part 1):2005

| Type | Grade | Density of Block kg/m$^3$ | Minimum Average Compressive Strength of Units N/mm$^2$ | Minimum Compressive Strength of Individual Units, N/mm$^2$ |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Hollow (open and closed cavity) load bearing unit | A(3.5) | Not less than 1 500 | 3.5 | 2.8 |
| | A(4.5) | | 4.5 | 3.6 |
| | A(5.5) | | 5.5 | 4.4 |
| | A(7.0) | | 7.0 | 5.6 |
| | A(8.5) | | 8.5 | 7.0 |
| | A(10.0) | | 10.0 | 8.0 |
| | A(12.5) | | 12.5 | 10.0 |
| | A(15.0) | | 15.0 | 12.0 |
| | B(3.5) | Less than 1 500 but not less than 1 100 | 3.5 | 2.8 |
| | B(5.0) | | 5.0 | 4.0 |
| Solid load bearing unit | C(5.0) | Not less than 1 800 | 5.0 | 4.0 |
| | C(4.0) | | 4.0 | 3.2 |


**Fig 4 :** Compression testing machine with Bamboo Bricks

### 4.2 WATER ABSORPTION TEST OF THE BRICK

Water absorption test was conducted for the determination of the percentage of water absorption by the brick. Initially, the brick samples were dried in the oven at 100 degree Celsius for 24 hours. The samples were then left to cool down before been immersed in the water tub for another 24 hours. The weight of samples was taken before and after the samples were immersed in the tub in order to determine the percentage of the water absorption. This test was conducted at the age of 28 days.

| Weight of Dry Brick (W1) | Weight of Wet Brick (W2) | Water Absorption Percentage (%) | Mean value (%) |
|---|---|---|---|
| 17 | 18.1 | 6.47 | 6.85 |
| 17 | 18.2 | 7.05 | |
| 17 | 18.2 | 7.05 | |

The water absorption, being the average of three units, when determined in the manner prescribed in Annex E as per **IS 2185 (Part 1):2005** shall not be more than 10 percent by mass.

### 4.3 PHYSICAL PROPERTIES

#### 4.3.1 Hardness Test

In this test, an abrasion was made on brick surfaces. While a dint was made with the help of a fingernail on the surface of bricks, a very light impression was left on the concrete brick surface. Hence, this test concludes that bamboo concrete bricks are sufficiently hard.

#### 4.3.2 Soundness Test

In this test, two bricks were taken over and they were hit on each other. The bricks were strong enough and not broken and a clear ringing sound was produced. Hence, the bricks are risk-free to use.

## 5. CONCLUSIONS

Ultimately, we were able to complete our goal of creating and testing bamboo-embedded bricks. The brick specimens were subjected to two main tests, compression and water absorption. We also conducted hardness and soundness tests. The performance of bamboo-embedded brick specimens were superior to that of normal brick specimens. The compressive strength of the bamboo-embedded brick specimens was higher at 6.81 N/mm$^2$, than that of conventional brick specimens at 3.89 N/mm$^2$ and we discovered that bamboo bricks fall into the grade C (5.0) category and follow the solid concrete block regulations outlined in IS 2185 (Part 1):2005. The water absorption test on the bamboo-embedded brick specimens yielded an average of 6.85%. The bamboo-embedded brick examples weighted less than the typical concrete brick specimens when weighed. Less weight translates to more efficiency in finishing the project at a faster pace, resulting in more time savings. Furthermore, we discovered that bamboo-embedded bricks provide thermal insulation, allowing us to keep the house cool and comfortable. Overall, the tests revealed that bamboo-embedded bricks had greater strength than conventional bricks, and that substituting conventional bricks with bamboo-embedded bricks in building projects will result in increased project safety in the long run. We might have buildings that are more dependable and stronger, and that won't collapse in the event of a crisis, as well as a longer shell life. Bamboo is expensive when acquired in small numbers, but it is inexpensive when acquired in bulk, hence when considering bamboo-embedded brick manufacture, bamboo should be obtained in bulk. The fundamental goal of any project is to achieve sustainability and economic viability, which we can confidently state we achieved because promoting bamboo-embedded bricks would minimize other materials and so lower the cost of the brick while considerably boosting its strength.

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