

## Experimental Study on Bamboo as Reinforced Concrete and Compare the Strength, Durability of Conventional Clay Bricks with Light Weight Interlocking Bricks

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### ABSTRACT

The idea of using bamboo as possible reinforcement has gained popularity. Bamboo, as a fast growing renewable material with a simple production process, is expected to be a sustainable alternative for more traditional structural materials, such as concrete, steel and timber. The diminishing wood resource and reduction in natural forests, particularly in the tropics, have focused world attention on the need to identify a substitute building material that should be renewable, environment friendly and widely available. The tensile strength of bamboo fiber can be comparable to that of steel, and the average fracture toughness of bamboo can be higher than that of aluminum alloy. Bamboo grows at rapid rates, it almost grows to its full size in a few months and finishes developing within five years. Bamboo is the world's fastest growing woody plant. It grows approximately 7.5 to 40cm a day, with world record being 1.2m in 24 hours in Japan. Bamboo grows three times faster than most other species. Commercially important species of bamboo usually mature in four or five years in time.

### 1. Aim & Scope

Our aim through this project is to find a suitable Eco-friendly material that replaces present conventional materials which are in demand or in the path of demand [1-3]. A suitable material that can replace steel in construction field is Bamboo Through this paper, we are going to study and analyses about the utilization of Bamboo in construction field such as Reinforcement purposes, for structural elements, Bamboo constructions[4-5], etc.

### 2. Objectives

- (1) To reduce the weight of Interlocking blocks by using wet ash & Synthetic vegetable protein as admixture.
- (2) To determine the Compressive Strength of the block.
- (3) To compare Compressive strength of Ordinary Interlocking Blocks & Light Weight Interlocking Blocks.
- (4) To estimate the cost of ordinary interlocking block and light weight interlocking block

### 3. Methodology

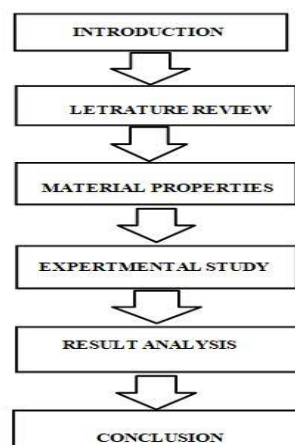
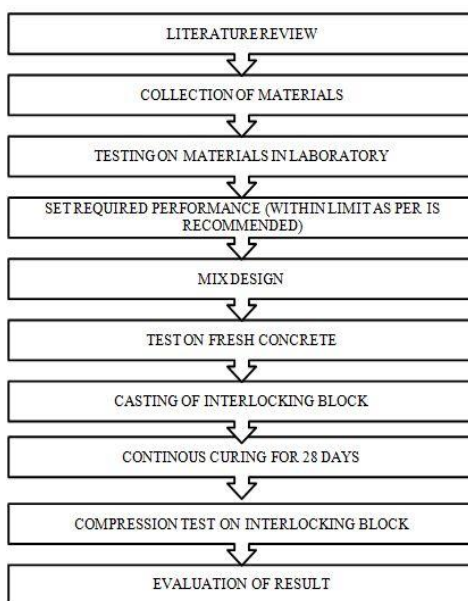


Fig.1. Methodology-1



**Fig.2.** Methodology-2 interlocking block

#### 4. Mix Design

Design of M30 Grade Concrete mix According to IS 10262:2009

Type of Cement: PPC

Specific Gravity of Cement: 3.05

Coarse Aggregate: 20 mm Crushed Granite Specific Gravity of Coarse Aggregate: 2.76 Specific Gravity of Fine Aggregate: 2.61 Degree of workability: 120 mm (Slump) Min. Cement Content: 320 kg/cubic m Max. Water Content: 0.40

Fck: 30

Standard Deviation: 5 N/mm square

#### 5. Properties of Bamboo

**Table 1.** Specific Properties of Bamboo

S.No	PROPERTY	VALUE
1.	Specific gravity	0.575 to 0.655
2.	Bond stress	5.6kg/cm <sup>2</sup>
3.	Safe working stress in shear	115 to 180kg/cm <sup>2</sup>
4.	Safe working stress in tension	160 to 350kg/cm <sup>2</sup>
5.	Safe working stress in compression	105kg/cm <sup>2</sup>
6.	Ultimate compressive stress	794 to 864kg/cm <sup>2</sup>
7.	Modulus of Elasticity	5.5 to 2.0 x10 <sup>5</sup> kg/cm <sup>2</sup>

## 6. Result Analysis

### 6.1. Preparation of Bamboo Reinforced Beam Element

To check the flexural strength of the beam reinforced with the Bamboo, Cement concrete flexural elements of the dimension 500x100x100 mm were prepared. The Bamboo strips used as reinforcement bars were of 470 mm long. When water comes in contact with the surface of the Bamboo, it swells. In order to prevent the swelling of the Bamboo waterproofing of the Bamboo was done by chemical treatments.

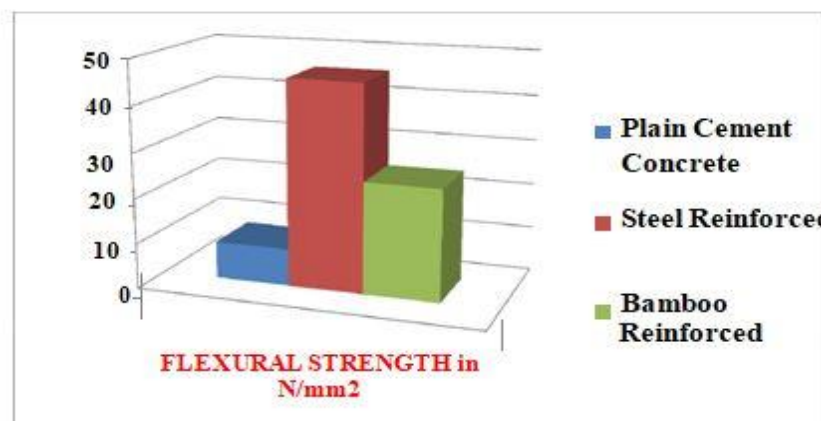
The chemical used are as follows:

- Araldite.
- Epoxy Resin.
- Coal Tar or Bitumen.

We have used Bitumen as a treating material. Bitumen coating were done on the surface of the Bamboo strips used for Reinforcement purpose. The dimensions of the bamboo strips used were of length 470mm and cross sectional area of  $100\text{mm}^2$  (10mm x 10mm). Steel Stirrups were provided at both ends of the beam and at centre of the beam. 8mm dia. rods were for stirrups. Also to achieve a grip of the Bamboo surface along with the concrete the sand coating was done on the surfaces of the Bamboo. To produce a reinforcement cage the Bamboo stirrups were used. To bind the Bamboo strips with the stirrups the steel binding wire was used. The plain cement concrete beam without any reinforcement also was prepared. Grade of concrete used is M25.



**Fig.3.** Bamboo Reinforced Beam



**Fig.4.** Bamboo reinforced Concrete Beam with Steel Reinforced and Plain cement Concrete Beams

## 6.2. Compression test on the Steel and Bamboo Reinforced Cement Concrete Column

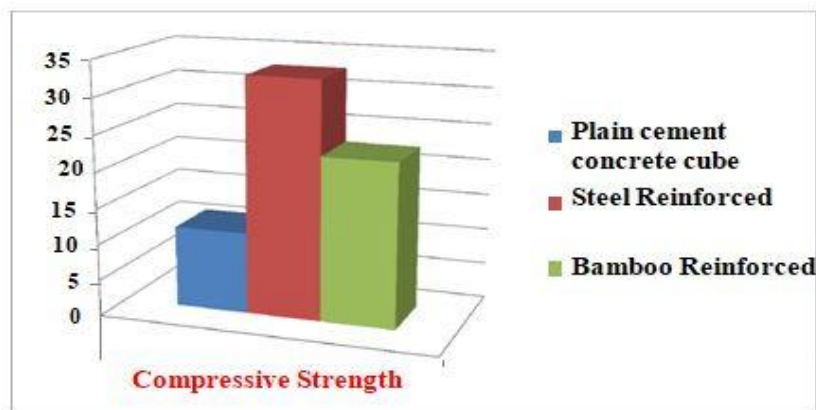
### 6.2.1. Preparation of Bamboo Reinforced Column Element

The compressive strength of the column reinforced with the Bamboo, Cement concrete column elements of diameter 150mm and height 300mm mm were prepared. The Bamboo strips used as reinforcement bars were of 270 mm long. Circular Steel Stirrups were provided at both ends and spiral stirrups provided with bamboo strips of very less thickness. 8mm dia. rods were for stirrups. Grade of concrete used is M25.

The reinforcement cage and the details of the reinforcement cage are shown in Fig 5.



**Fig.5.** Bamboo reinforced column



**Fig.6.** Comparison of Bamboo reinforced Concrete Column with Steel Reinforced and Plain cement Concrete Column

## 7. Conclusion

Based on our data & analysis done through our research i conclude that bamboo is good for low cost budget construction for ground floor only The water absorption test done on bamboo, bitumen coated bamboo is preferable. From the flexural test the bamboo reinforced specimens has very high strength as compared as PCC. And almost equal strength as compared to steel reinforced concrete so bamboo reinforced concrete used for Ground floor low cost construction and temporary buildings. From the obtained all results it is determined that as the Strength of the interlocking block increases and weight of the block reduced after the addition of admixtures, Wet ash increases compressive strength and synthetic vegetable protein reduces

the weight. Therefore lightweight blocks are constructed with 50% replacement of fine aggregate with wet ash and 0.5% addition of synthetic vegetable protein, Inter lock bricks do not need plastering work and it is aesthetically appealing. These are used for Moderate cost construction buildings for ground floor, first floor like low rise buildings.

### **7.1. Recommendations**

- (1) An extensive study to evaluate the behaviour of different types of bamboo is recommended as the bamboos types and their behaviour is at different regions of the world.
- (2) Long-term studies investigating the durability of Bamboo reinforced concrete should be conducted.
- (3) More tensile tests are suggested to investigate the relationship between the tensile strength of bamboo and its performance as reinforcement in concrete.
- (4) Beam tests with different percentage of Bamboo reinforcement should be investigated.

### **Declarations**

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#### ***Competing Interests Statement***

*The authors declare no competing financial, professional and personal interests.*

#### ***Consent for publication***

*Authors declare that they consented for the publication of this research work.*

#### ***Availability of data and material***

*Authors are willing to share data and material according to the relevant needs.*

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