

# Replacement of Steel with Bamboo as Reinforcement

Bhosale Mahesh Bhimarao<sup>1</sup>, Dr. Santosh K Patil<sup>2</sup>

<sup>1</sup>Post graduate Student Department of Civil Engineering, KJ College of Engineering, Maharashtra, India

<sup>2</sup>Professor Department of Civil Engineering, KJ College of Engineering, Maharashtra, India

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**Abstract** – This paper is the study of the comparison of cost, double shear, flexural strength & tensile strength of bamboo reinforcement with regularly used steel reinforcement. Recently Global warming is the major issue on which we want to focus. Generally in construction steel reinforcement is used but we know that the production of steel is very harmful for nature. The cost of steel is very high so that the middle class peoples are unable to use steel reinforcement. The construction industry is mainly depending on cost of project. The cost of project is mainly depends upon factors such as labour cost and material cost. So for reducing the cost of project we can replace the material such as we can use bamboo as reinforcement. Bamboo is effective material for construction due to its low cost, high strength, earthquake resistant, light weight, etc. By replacing this we can achieve our main objective that cost effective construction and we can also encourage the use of natural products by which we reduce the pollution impact on nature.

By conducting the various tests and analyzing the result we say that we can use the Bamboo as reinforcement in various structural elements where load intensity is less such as Roof slab for security cabin, toilets, car parking etc. and achieve our objective.

**Key Words:** Cost effective, Bamboo reinforcement, Double shear, Flexural strength, Tensile strength, light weight, earthquake resistance.

## 1. INTRODUCTION

In human civilization the construction industry is an integral part. We know that the cost of any construction project is mainly depending on financial factors such as cost of labours and material [1, 6]. We know that concrete is mostly used construction material which having different advantages like its availability, low cost, fire resistance etc. But it has low tensile strength. For getting tensile strength we provide steel reinforcement [2]. For load bearing structures the steel reinforced concrete is used [10]. Recently Global warming is the major issue so the main disadvantage of steel is its production [3]. The cost of steel reinforcement will be increasing in future and the production will be shortening [4]. We know that there are many projects which are working on concept 'low cost building' because any person from middle class family can construct the building [1]. For that we want to find some alternatives. To tackle this environmental issue we have to use sustainable material. For

that we can use the eco friendly Bamboo as a reinforcement [1]. The treated bamboo species shows very good potential for production of different component parts and it will successfully used for various structural and non-structural applications in the construction [7]. According to study Bamboo is renewable resource which having same characteristics by high strength to the weight ratio. The growth of Bamboo is faster [8]. Bamboo is the perennial grass which having various shapes and size according to contractors requirement [3]. In world the various forest of bamboo species has been found in tropic and sub-tropic zones which having latitude of 40degree south. The bamboo forest cultivation is better in the temperature range is from 20 to 30 degree Celsius [8]. Within one day the different species of bamboo are grow 35inches tall. This bamboo shows some similar properties like steel reinforcement which is used in construction [9]. The high yielding property is a main advantage shown by bamboo reinforcement [7]. The different physical and mechanical properties of bamboo are varies from different species from different soils [5]. For better development bamboo is being processed as reinforcement by typical bar sizes which will be used instead of steel reinforcement [10]. Bamboo is very good in tension having the tensile strength from 50% to 75% of that steel reinforcement [5]. As per study it was found that the modulus of elasticity is approximately one third of mild steel [6]. The main factor in deciding the life of bamboo is the moisture content which is depending on height of bamboo, its location and the seasoning period [5].



Fig -1: Bamboo Sample used as reinforcement

## 2. MATERIALS AND METHODS

Materials were collected for both Steel Reinforced and Bamboo Reinforced concrete. Materials needed for Reinforcement cement concrete are fine aggregate, coarse aggregate, steel rod, cement, bamboo and water.

### Fine aggregate/Sand

Fine aggregate which is known as Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e. a soil containing more than 85% sand-sized particles (by mass).

### Coarse Aggregate

Aggregates are the most mined materials in the world. Aggregates are component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material.

**Table -1:** Properties of FA & CA

Sr.No.	Property	FA	CA
1	Specific Gravity	2.64	2.70
2	Fineness Modulus	3.24	7.40

### Steel

Steel is a vital component as it provides the required tensile strength to the reinforced concrete. It is preferred to any other tensile material because its physical properties are matched with those of concrete. Fe500 is used conforming to IS 456 – 2000.

### Cement

Cement is a binder, a substance that sets and hardens and can bind other materials together. The cement used in this experimental work is "Birla Super Cement."(OPC53).

**Table -2:** Properties of Cement

Sr.No.	Property	IS CODE 8112
1	Specific Gravity	3.12
2	Consistency	53
3	Initial Setting time	30min
4	Final Setting time	10hrs

### Bamboo

Bamboo being an eco-friendly material comes with a surprisingly good tensile capacity. It grows from 30cm to 1m per day in a standard 250 C to 500 C. It is easily available in large quantities in countries like India. After the seasoning

process bamboo can be used as a replacement to steel reinforcement.

### Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully.

## 3. SPECIMEN PREPARATION

The beams were designed having dimensions 750mm in length, 150mm in breadth, 150mm in depth and cover of 20mm. The reinforcement was provided according to the provisions adopted in Is SP34: Handbook on Concrete Reinforcement and Detailing. Bars of 12mm, 10mm and stirrups of 8mm at a spacing of 150mm are used in each 2 beam. The larger diameter 12mm bars are placed in the bottom row to resist the deflection effects.



**Fig -2:** Beam specimen Used for casting(Steel & Bamboo)



**Fig -3:** Beam specimen after casting

## 4. TESTING OF SPECIMEN

We have to compare those Steel as well as Bamboo reinforcement with the help of Tensile strength, double shear and Flexural strength.

### Tensile Test

The tensile test of Bamboo is carried out to find the limit of Proportionality, Young’s modulus of elasticity and elongation in the steel rod as the test is used for the bamboo for reinforcement.



Fig -4: Tensile test on Specimen

### Double Shear Test

The double shear test is performed on bamboo to find the shear strength in bamboo in the jointed area to resist the failure (12mm).

### Flexural Strength Test

All the beams are tested into Flexural Strength by the Universal testing machine. The beams were supported by Simply Supported over a span of 700mm the load were applied by 1/5th of its span. The load is applied continued until the deflection became excessive and readings were noted at first crack point and the ultimate load. While testing it was noted that Bamboo reinforced beams produced initial cracks without any cracking noise and their crack widths were small when compared to the steel reinforced beams.

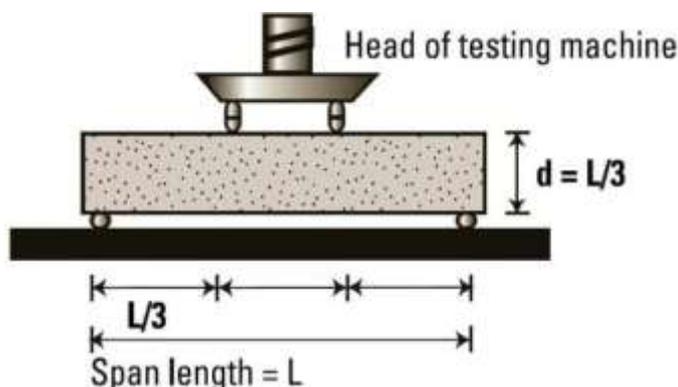


Fig -5: Flexural strength test

## 5. RESULT AND ANALYSIS

### Tensile test

Table -3: Tensile test on specimen

Specimen Type	Breaking Load in KN	Tensile Stress in N/mm <sup>2</sup>
Steel Reinforcement	55.4	505
Bamboo Reinforcement	34.7	290

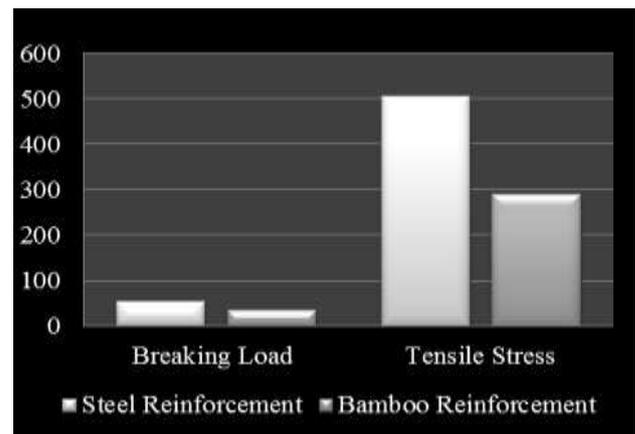


Chart -1: Tensile test on specimen

### Double shear Test

Table -4: Shear strength on specimen

Sr. No.	Specimen Type	Breaking Load in KN
1	Steel Reinforcement	84
2	Bamboo Reinforcement	28

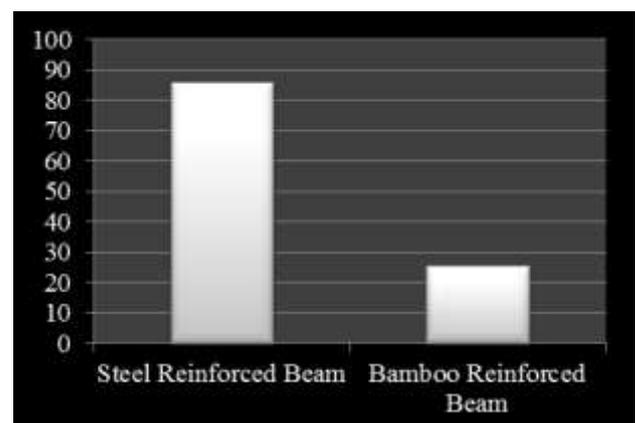


Chart -2: Shear strength on specimen

**Flexural Strength**

**Table -5:** Flexural strength after 7days

Specimen Type	Identification Mark	Breaking Load in KN	Average in KN
Steel Reinforcement	SR1.A	70	70
	SR2.A	68	
	SR3.A	72	
Bamboo Reinforcement	BR1.A	57	59
	BR2.A	60	
	BR3.A	59	

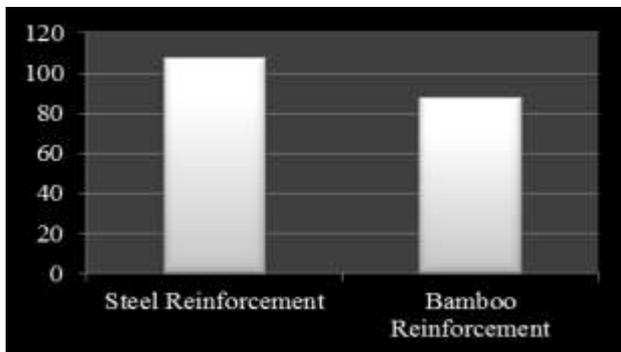


**Chart -3:** Comparison of Flexural strength after 7days

**Flexural Strength**

**Table -6:** Flexural strength after 28days

Specimen Type	Identification Mark	Breaking Load in KN	Average in KN
Steel Reinforcement	SR1.B	104	104
	SR2.B	105	
	SR3.B	103	
Bamboo Reinforcement	BR1.B	85	84
	BR2.B	83	
	BR3.B	84	



**Chart -4:** Comparison of Flexural strength after 28days

**6. CONCLUSION**

When we use bamboo as a replacement of steel, bamboo gain almost same flexural strength compared to steel reinforced concrete. Bamboo can be used in the members where load intensity is less such as Roof slab of parking area, Public toilets, Sunshades, Watchman cabin, etc.

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