

# An Experimental Study on Replacement of Steel with Bamboo as Reinforcement

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**Abstract** - The construction industry is an integral part of the human civilization. It has been the identity of the human race in the ladder of development. The glory of a construction is mainly determined by the financial factors. The cost of a project is mainly influenced by two factors, namely labour and material. Since labour is indispensable as it affects efficiency, alternatives can be made for the materials used. Researchers have recommended alternatives for materials like cement and sand. But there has not been a strong replacement for reinforcement used. It is high time to provide such replacements; therefore this article focuses on the possibilities in replacement of reinforcement with seasoned bamboo. This may sound weird, but as a matter of fact, seasoned bamboo shows positive results in tests. Various tests such as tensile test, double shear and flexural tests have been conducted on the bamboo specimen and were found to produce favourable results. Also, this idea serves as a measure of rescue for the massive pollution produced by the steel production. By the test results and analysis, it is found that bamboo can be used as an alternative for reinforcement and can be brought to use.

**Key Words:** Bamboo, Reinforcement, Tensile Test, Double Shear and Flexural Test

## 1. INTRODUCTION

In the present scenario, there are many projects being undertaken based on 'low cost buildings', 'rapid construction' and 'increasing the strength of the structure'. The main motive behind the low cost building projects is that it happens to be only a dream to the middle order populace. The factors that influence the cost of a construction are labour and materials. By efficient supervision the workforce can be manipulated. But alternatives should be introduced in order to tackle the market price of the conventional materials. By various researches, alternatives have been found to be used in concrete. But no proper alternative has been recommended for the steel reinforcement. Firstly, we need to understand the necessity for using reinforcement in concrete. As it is already known, concrete is weak in tension and strong in compression. Reinforcement is provided to strengthen the concrete in tension. This was suggested by Joseph Monier, who introduced the concept of reinforcement. The reason behind the success of steel being used as reinforcement is that the physical properties of both steel and concrete cope up. The main disadvantage in steel is that, its production is one of the most polluting and hazardous. To tackle this a sustainable solution must be provided. Thus, as a responsible engineer, following the

ethics of engineering, it is our foremost duty to do our best not to confront mother nature. Thus we suggest the replacement of steel reinforcement with eco friendly bamboo.

## 2. EXPERIMENTAL SETUP

We have done an experimental study on the Steel reinforced concrete with bamboo reinforced concrete. Here we replace the steel into bamboo as reinforcement in concrete. Thus it reveals about the strength of bamboo reinforced concrete.

### MATERIAL COLLECTION

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

#### Cement

A cement is a binder, a substance that sets and hardens and can bind other materials together. The word "cement" can be traced back to the Roman term opus caementicium, used to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder.

PROPERTY	IS CODE 8112
Specific Gravity	3.12
Consistency	53
Initial setting time	30 minutes
Final setting time	10 hours

#### Sand

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.

Property	Fine Aggregate	Coarse Aggregate
Specific Gravity	2.64	2.70
Fineness modulus	3.24	7.40
Water absorption (%)		1.76

**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.

**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

**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 25° C to 50° 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.

**SPECIMEN PREPARATION**

The beams were designed to take a load of about 100 kN, 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 SP34.Bars of 12mm(2 Nos),10mm(2 Nos) and stirrups of 8mm(6 Nos) 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.



Fig1: Beam Specimen

The M25 grade concrete was prepared by hand mixing. With the help of the wooden mould, the beam is casted using. Casted beam is then unmolded and was cured for 7 days and 28days. 6 samples of each material were taken.



Fig 2: Curing of Concrete

**TESTING OF SPECIMEN**

Due to replacement of steel into bamboo for the purpose we have comparative of those two material test like Tensile, Double Shear and Flexural Strength.

**a)Tensile Test**

Tensile test of bamboo is carried for to find the Limit of proportionality, Yield strength, Young’s modulus of elasticity and elongation in the rod steel, as the test is used for the bamboo for reinforcement.

**Table 1: Tensile Strength of Specimen**

Sl. No	Specimen Type	Breaking Load in KN	Tensile Stress in N/mm <sup>2</sup>
1	Steel	57.35	507.08
2	Bamboo	32.64	288.6

**b)Double Shear Test**

Double shear test on bamboo to find the shear strength in bamboo in the jointed area to resist the failure (12mm)

**Table 2: Shear Strength of Specimen**

Sl. No	Specimen Type	Breaking Load in KN
1	Steel	83
2	Bamboo	23.58

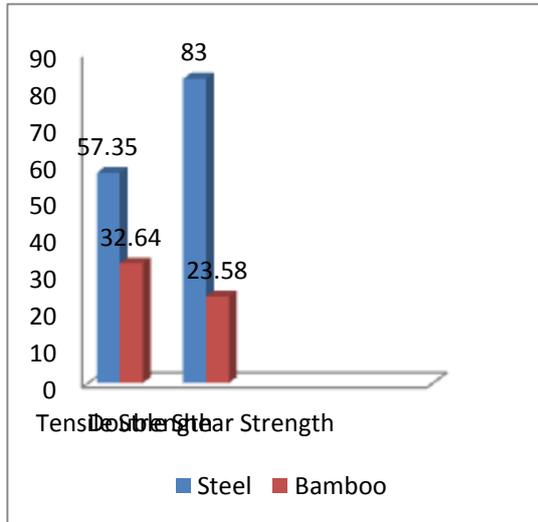


Fig 3: Comparison between Steel and Bamboo by Breaking Load in KN

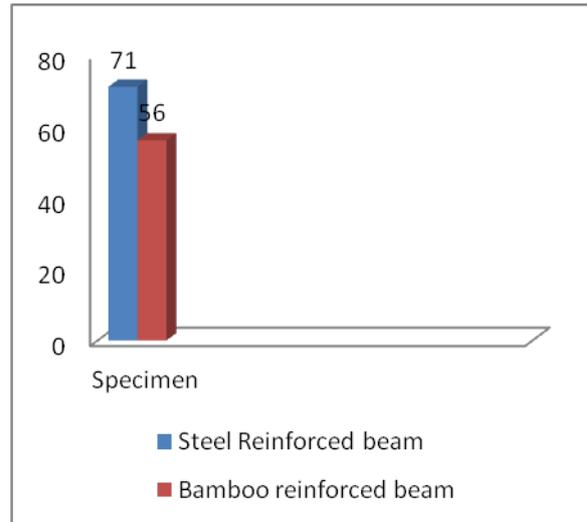


Fig 5: Comparison of Flexural Strength after 7 days

C) Flexural Strength

All the beams are tested into Flexural Strength by the Universal testing machine with a capacity of 1000KN. The beams were supported by Simply Supported over a span of 750mm the load were applied by 1/5<sup>th</sup> of its span.



Fig 4: Testing of Beam

The load application 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.

Table 3: Crack Load for 7 Days

Sl. No	Specimen Type	Identification Mark	Breaking Load in KN	Average in KN
1	Steel Reinforced Beam	B1.1	73	71
		B1.2	68	
		B1.3	72	
2	Bamboo Reinforced Beam	B2.1	58	56
		B2.2	55	
		B2.3	56	

Table 4: Crack Load for 28 days

Sl. No	Specimen Type	Identification Mark	Breaking Load in KN	Average in KN
1	Steel Reinforced Beam	B1.1	104	104
		B1.2	106	
		B1.3	103	
2	Bamboo Reinforced Beam	B2.1	86	84
		B2.2	83	
		B2.3	84	

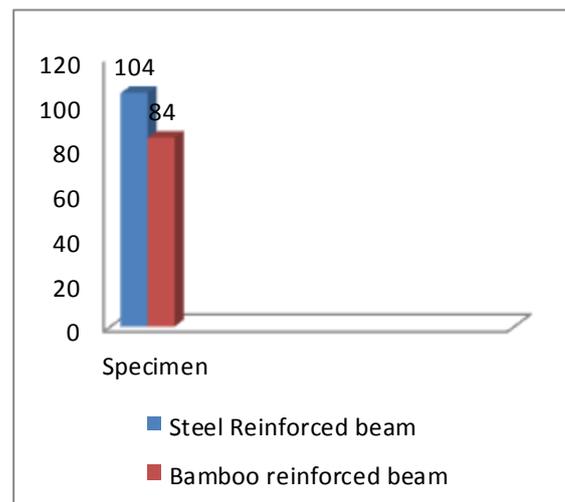


Fig 6: Comparison of Flexural Strength after 28 days

## RESULT AND DISCUSSION

As per the test results, it is inferred that

- Compared to steel, tensile and double shear results were low for bamboo (almost 50%).
- Bamboo reinforced concrete has attained flexural strength almost on par with steel reinforced concrete.
- The difference between tensile and double shear test results is because of density. The density of steel is 7850 kg/m<sup>3</sup> while that of bamboo is only 1655 kg/m<sup>3</sup>.
- When compared to steel, bamboo had high flexibility in nature and its deflection more.

## CONCLUSION

Bamboo, on using as reinforcement in concrete deflects more due to low density; but it attains flexural strength almost equivalent to Steel reinforced concrete.

Hence it can be used in member taking less load such as roof slabs of parking area, public toilets, watchman cabins and sunshades.

It also helps in cost effectiveness and reduces environmental effects that are cost by steel production.

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