

# EXPERIMENTAL STUDY OF BAMBOO REINFORCED BEAM

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**Abstract:** Bamboo is a gigantic monster grass utilized as development material structure early occasions. Bamboo is eco-accommodating and normally accessible material. During the develop thing process bamboo gives oxygen and during assembling process steel discharge CO<sub>2</sub> which is contaminating condition. The solid has high compressive quality. i.e., steel is utilized to fortification the solid. The privately sourced materials as a swap for customary steel support explicitly, bamboo (*Dendrocalamus strictus*) is on the most appropriate material that might be utilized as fortification bar in concrete. Bamboo sticks were prepared for around 2 to 3 weeks and they were utilized as fortification. Water protection from bamboo applying is tar in bamboo and sprinkle the sand because of holding the solid. Solid blend structure for M40 grade concrete has been found according to plan necessity of IS 10262:2009. Conventional Portland concrete utilized and bamboo support solid beam were casted. The beam were single reinforced and to be full supplanting with bars of bamboo can restoring period 28days for comparisons and tried on UTM. This examination primarily concentrating on to decrease the expense of materials which are used for development reason especially steel. Steel is the material which is utilized for a wide range of support in section, bar and piece. The fundamental inconvenience of this material that it effectively consumes when it cooperates with dampness and because of this impact, its quality is likewise incredibly diminished and it prompts sturdiness issue in structures. For diminishing this impact, we use the bamboo rebars as a support in the spot of steel for not exclusively to expand toughness property yet in addition to improve the use of minimal effort and proficient materials for development reason. This investigation gives bamboo as a potential material to be utilized as fortification for low burden bearing structures.

**Index Terms:** Bamboo, Concrete mix, Flexural strength, Reinforcement, RCC Beam.

## I. INTRODUCTION:

Bamboo has a long and settled convention as a structure material all through the world's tropical and sub-tropical districts. It is broadly utilized for some types of development, specifically for lodging in provincial zones (P. Sharma et al, 2014). Bamboos are monster grasses and not trees as normally accepted. They have a place with the group of the Bambusoideae. The bamboo culm, when all is said in done, is a round and hollow shell, which is separated by transversal stomachs at the hubs. Bamboo shells are orthotropic materials with high quality toward the path parallel to the strands and low quality opposite to the filaments individually (Khosrow Ghavami, 2004). Bamboos are the absolute quickest developing plants on the planet, because of a special rhizome-subordinate framework. Certain types of bamboo can grow 35 creeps inside a 24-hour time frame, at a pace of 0.00003 km/h (a development of around 1 millimeter (or 0.02 inches) like clockwork). Bamboos are of remarkable monetary and social noteworthiness in South West Africa, being utilized for building materials, as a nourishment source, and as an adaptable crude item. Bamboo has a higher compressive quality than wood, block or concrete and an elasticity that adversaries steel. (wikipedia ). In the present society, most structures are fabricated utilizing such materials as steel fortified concrete and basic steel. Steel fortifying bars are commonly utilized as fortification in cement to make up for shortcoming of cement in pressure. Despite the fact that steel fortification is an entirely reasonable material for supplementing solid's low elasticity, there are numerous troubles, for example, financial aspects, procedure and effectiveness that is should have been tended to. To conquer these issues, numerous researchers and architects have been attempting to search out new materials for expanding the ductile limit of cement. In particular, bamboo is one of the most reasonable materials to fill in for strengthening bar in concrete. Among others, Jigar K. Sevalia et al, 2013, assessed the achievability of the utilization of Bamboo as fortification in solid individuals and saw that Plain Cement Concrete Beam flopped all of a sudden with no earlier notice. It was likewise announced that Doubly Reinforced Beam performed more flexibly than Singly Reinforced Beam while performing flexural tests and that Modulus of Elasticity of the Doubly Reinforced Beam is more than twice of Modulus of Elasticity of the Singly Reinforced Beam. J. O. Akinyele et al developed façade boards made of rattan stick fortifications and steel fortifications. In light of the test results, it was presumed that the lower break width framed after disappointment in the rattan stick fortified board gave it advantage over the steel strengthened board, since it has lower space for the entrance of water which is the fundamental operators of erosion. This work planned for evaluating the appropriateness of bamboo as support in concrete with goals of searching out new materials for expanding the malleable limit of cement. Additionally, it looked to know whether bamboo would be discovered reasonable as fortification in solid which would limit the general expense of steel bar. The examination concentrated on the appraisal of the flexural properties of bar made with bamboo and steel fortification and compressive quality of solidified cement.

## Bamboo Characteristics

Bamboo is mammoth grass, not a tree. Bamboo culms are a tube shaped shell separated by strong transversal stomachs at hubs and make them charming properties, for example, high quality toward the path parallel to the strands, which run longitudinally along the length of the Culm, and low quality toward a path opposite to the filaments. The thickness of filaments in cross-area of a bamboo shell fluctuates with thickness just as tallness. Fiber appropriation is more uniform at the base than at the top or the center. This is on the grounds that bamboo is exposed to greatest bowing worry because of wind at the top part of the Culm. Bamboo is a characteristic Functionally Evaluated Material (FGM). It is a composite with various leveled structure. The quality of bamboo is more noteworthy than a large portion of the timber items.

## Comparison between Bamboo and Steel:

The quality of bamboo is more noteworthy than most timber items which are favorable, yet it is roughly a large portion of the elasticity of steel. Bamboo is effectively open as it develops in pretty much every tropical and subtropical locale; this brings down the expense of development and expands the quality of the structures that would some way or another be unreinforced. One significant issue with bamboo is that it draws in living creature, for example, growths and bugs. Bamboo is more inclined to creepy crawlies than different trees and grasses since it has a high substance of supplements. So as to battle this issue, it gets important to get bamboo shield it from nature. Steel doesn't have this issue yet it likewise should be covered so as to shield it from rusting. Bamboo is extremely light in weight contrasted with steel. Because of its low modulus of flexibility, bamboo can split and redirect more than steel fortification under similar conditions. These perspectives put bamboo on the rundown of practical development materials.

## Advantages of Bamboo:

Bamboo has a decent quality.  
 Bamboo is an adaptable.  
 Bamboo has a seismic tremor opposition limit.  
 Bamboo is light weight.  
 Bamboo is financially savvy than steel.  
 Bamboo is effectively accessible.

## Hindrance of Bamboo:

Bamboo burst into flames rapidly.  
 Bamboo's quality relies upon the period of bamboo.  
 Quality goes diminishes as the expansion in age.  
 Moisture content legitimately influences the quality of bamboo.  
 Bamboo has less holding with concrete.  
 Bamboo has a less solid.

## Bamboo Strength towards Bonding

As on account of steel rebar with ribs in it, which encourage appropriate holding with the solid, bamboo also ought to have appropriate attachment with the solid.

The holding quality depends on this cement property of concrete and the compressive powers that are shaped on the outside of the fortifying bars. An untreated bamboo influences the holding quality in the accompanying way.

- a) By pushing the solid away, by the growing of bamboo material.
- b) By the development of voids inside the solid.
- c) By development of breaks as the results of void arrangement.

## Toughness of Bamboo Material

- Its property of being a characteristic item make it progressively presented to natural operators and creepy crawlies. A cure against this is to experience bamboo restoring.
- The relieving procedure empowers the treatment of mugginess content and the starch inside it, which is the primary explanation behind creepy crawly fascination. The restoring is powerful just if the picked bamboo is right one. As referenced in the determination of bamboo.
- The restoring of bamboo should be possible either by:
  1. Relieving on spot
  2. Drenching process
  3. By warming
  4. Smoke restoring

The treatment must be done when the bamboo is in a dry state so the infiltration experiences in the correct manner. The conservation treatment done on bamboo to deal with toughness factor ought to have no impact on the concoction piece. The treatment itself should last, without being washed away under high water conditions assuming any.

- Durability is a significant worry for bamboo material. The physical and substance properties of bamboo are discovered high with low substance of mugginess inside it. This low substance would keep away shape in bamboos.
- Bamboo fortification is discovered more sturdy than steel on the off chance that it has experienced appropriate medicines.

## II. LITERATURE REVIEW

Sanjeev Gill, Dr. Rajiv Kumar, bamboo can use as fortification. Bamboo is modest substitute for steel since bamboo develops a lot quicker and is inexhaustible source following 56 years. Water retention in bamboo is legitimately influence the quality of bamboo. Rigidity of bamboo is great so it very well may be use as a fortification. The conduct of bamboo as a support is same as plain steel bar [1].

I. K. Khan, it is discovered that the rigidity of bamboo is around one portion of the mellow steel. The elasticity of bamboo is 132 N/mm<sup>2</sup> [2].

Pratish Kumar Singh, Aashish Jodhani, Abhay Pratap Singh, it is been discovered that bamboo in the vertical position is more solid than in even. Twisting of bamboo can be for all time bowed if heat, either dry or applied the weight. The sort of covering will rely upon the flavoring material is utilized. A brush coat or plunge layer of emulsion is valuable for treatment of bamboo. Bamboo strengthened solid bar configuration is like steel fortifying plan [13].

Anurag Nayak, Arehant S Bajaj, Abhishek Jain, Apoorv Khandelwal, Hirdesh Tiwari, bamboo can supplant the timber and other material in development work. At the point when prepared bamboo is utilized as strengthening material it ought to get a waterproofing covering to lessen expanding when in contact with concrete. Without some kind of covering bamboo will grow before the solid has created adequate quality. Bamboo fortification procedure is less expensive than steel support [8].

Dr. Ashok Kumar Gupta, Dr. Rajiv Ganguly, Ankit Singh Mehra, the thickness of bamboo is low which makes it exceptionally light material. Water retention limit is increment as increment in hub. Tractable pressure increment as increments in number hub [15].

Atul Agarwal, Bhardwaj Nanda, Damodar Maity, glue has incredible protection from water, oil and numerous other dissolvable. It see that holding quality at the interface of the bamboo solid composite is higher for glue [14].

Chandra Sabnani, Madhuwanti. Latkar, Utpal Sharma, utilize just bamboo indicating an articulated dark colored shading. This will guarantee that plant is in any event multi year old to get great quality. Regardless, just a slender covering ought to be applied. A thick covering will ointment the surface and debilitate the bond with the solid [12].

Ajinkya Kaware, Prof. U. R. Awari, Prof. M. R. Wakchaure, bamboo powerless at hub, most extreme disappointment happen at hub of the bamboo. Bamboo is frail in bond pressure subsequently it ought to be treat with epoxy covering to get bond pressure. Bamboo is feeble in shear so it can't utilize as a shear support. Rigidity of bamboo is great so it very well may be utilized as a support in R.C.C structure for ease lodging. The conduct of bamboo is same as the steel bar. Dampness of substance of bamboo is fluctuates as indicated by geology [9].

## III. MATERIALS:

### Concrete, Coarse Aggregate and Fine Aggregate:

Concrete is the one which made out of constituents, for example, concrete, total and water. These elements of cement are taken and their essential testicles are done according to IS codes. OPC (Ordinary Portland concrete) of 53 grade concrete were utilized according to IS 4031 (section 2, 3, 4). The coarse total were picked according to IS 2386[13, 14, 15] and size and state of 12 mm and precise shape were utilized for this work. Their properties are checked according to IS codes. In this work, we use for fine aggregate of size 4.75 mm and its properties are tried. The properties of concrete, coarse total and m-sand are arranged beneath

**Table 3.1 Properties of OPC 53 grade cement, CA, FA**

PROPERTIES	TEST RESULTS
Specific gravity	3.15
Consistency (%)	31.5
Fineness of cement (%)	9
Initial setting time (minutes)	35
Specific gravity of FA	2.74
Specific gravity of CA	2.74
Fineness modulus of CA	6

### Bamboo:

Bamboo has fundamental sorts yet as indicated by my task *Dendrocalamus strictus* is utilized. *Dendrocalamus strictus* it is otherwise called Male Bamboo, Solid Bamboo or Calcutta Bamboo is a tropical and subtropical bunching species local to Southeast Asia. This bamboo is widely utilized as a crude material in paper processes and has consumable shoots. Bamboos incorporate the absolute quickest developing plants on the planet, because of a one of a kind rhizome-subordinate framework. Certain types of bamboo can grow 91 cm (3 ft) inside a 24-hour time span, at a pace of right around 4 cm (1.5 in) 60 minutes (a development around 1 mm like clockwork, or one inch each 40 minutes). Giant bamboos are the biggest individuals from

the grass family. Bamboos are of outstanding financial and social importance in South Asia, Southeast Asia and East Asia, being utilized for building materials, as a nourishment source, and as an adaptable crude item. Bamboo has a higher explicit compressive quality than wood, block, or concrete and a particular rigidity those adversaries steel. The mechanical properties of bamboo are regularly twice to multiple times higher than those of customary timber. Be that as it may, legitimate vulnerabilities encompassing widespread guidelines and measures are avoiding a bamboo blast in numerous pieces of the world.

### Steel:

Today, steel creation utilizes both reused materials, just as the customary crude materials, for example, iron mineral, coal, and limestone. Two procedures; fundamental oxygen steelmaking (BOS) and electric circular segment heaters (EAF) represent for all intents and purposes all steel creation. Present day steelmaking can be separated into six stages: Iron making, Primary Steelmaking, Secondary Steelmaking, Continuous Casting, Primary Forming.

## IV. PREPARATION AND SELECTION OF BAMBOO REINFORCEMENT:

The accompanying variable ought to be considered in the choice of bamboo culms (entire plants) use as fortification in structures;

1. Utilize the main bamboo demonstrating a dark colored articulated shading. This will protect that the plant us at any rate three years of age.
2. Select the longest enormous breadth culms accessible.
3. Try not to utilize entire culms green, unseasoned bamboo.
4. Maintain a strategic distance from bamboo cut in spring or late-spring. These culms are commonly flimsier due to expanded fiber dampness content.

A) **Measuring:** Supports (split culms) are commonly more attractive than entire culms as support. Bigger culms ought to be part into braces roughly  $\frac{3}{4}$  inch wide. Entirety culms not exactly  $\frac{3}{4}$  inch in distance across can be utilized without parting.

(B) **Splitting:** The bamboo can he did by isolating the base with a sharp blade and afterward pulling a dulled edge through the culm. The dull sharp edge will compel the stem to part open; this is more attractive than cutting the bamboo since parting will bring about ceaseless filaments and a almost straight area. Table II shows the surmised net zone gave by entire culms and by  $\frac{3}{4}$ -inch-wide braces, just as the cross-sectional properties of standard distorted steel bars and wire work. Appeared beneath is a picture for how bamboo can be part in  $\frac{1}{2}$  or in  $\frac{1}{4}$  to be utilized in auxiliary individuals that are additionally disclosed to be utilized for planning pillars and sections.

(C) **Seasoning:** Whenever the situation allows, the bamboo ought to be sliced and permitted to dry and season for three to about a month prior to utilizing. The culms must be bolstered at customary dispersing to lessen distorting.

D) **Waterproof Coatings:** At the point when prepared bamboo, either split or entire, is utilized as fortification, it ought to get a waterproof covering to lessen growing when in contact with concrete. Without some kind of covering, bamboo will expand before the solid has created adequate solidarity to avert splitting and the part might be harmed, particularly assuming more than 4 percent bamboo is utilized. The kind of covering will rely upon the materials accessible. A brush coat or plunge layer of black-top emulsion is best. Local latex, coal tar, paint, weaken varnish, and water-glass (sodium silicate) are other appropriate coatings. Regardless, just a slender covering ought to be applied; a thick covering will grease up the surface and debilitate the bond with the solid.



Fig 4.1: Bamboo Reinforcement

### Types of beam and their plan:

The reason for this venture work is to decide the attainability of the utilization of Bamboo as fortification in solid, it is important to contrast its conduct with steel i.e. the customary support. In this venture work two size of shaft (100 x 100 x 500) mm were chosen. Bamboo reinforcement concrete (BRC) beam and steel reinforcement concrete (SRC) beam were casted for each size of beam. For both the spans of beam, same zone of support was given.

**Steel reinforced concrete (SRC) beam:** Steel bars of Fe 415 evaluation were chosen for strengthening SRC light emissions the sizes. The plan of the steel fortified cement (SRC) shaft is appeared beneath in forbidden structure.

**Table 4.1:** Design of steel reinforced beam

Types of beams	Steel reinforcement beam
Size of Beam	100 x 100 x 500 mm
Grade of Concrete	M40
Grade Of steel	Fe 415
Design Constants a) $P_{t,lim}$ b) $X_{u,lim}$	$P_{t,lim} = 1.19 \%$ $X_{u,lim} = 0.48d$
Percentage Reinforcement Provided	1.02 %
Reinforcement Provided	4 no. of 8 mm bars
Cover	25 mm

**Bamboo strengthened cement (BRC) bar:** The bamboo sticks were acquired from Rau, Madhya Pradesh. The bamboo sticks were prepared for around three weeks and afterward were utilized to strengthen the bamboo reinforcement concrete (BRC) beam. Separate structure criteria for BRC beam are not accessible. In this way, region of support gave in BRC beam were kept same as that gave in SRC beam to both the sizes.

**Table 4.2:** Design of bamboo reinforced beam

Types of beams	Steel reinforcement beam
Size of Beam	100 x 100 x 500 mm
Grade of Concrete	M40
Types of Reinforcement bars	4 Bamboo Sticks
Percentage Reinforcement Provided	1.02 %
Reinforcement Provided	2 no. of 8 mm bars
Cover	25 mm

## V. RESULTS:

### Compressive strength test:

For 3D shape test two kinds of examples either blocks of 15cmX 15cm X 15cm. This cement is poured in the form and tempered appropriately so as not to have any voids. These examples are tried by pressure testing machine following 7 days, 14 days or 28 days restoring. The compressive strength testing of cubes was carried out on a universal testing machine of capacity 1000kN.

$$\text{Compressive strength of concrete} = \text{ultimate load} / \text{cross sectional area (N/mm}^2\text{)}$$

**Table 5.1:** Compressive strength of concrete for 7, 14 days & 28 days

DAYS	COMPRESSIVE STRENGTH
7	29.2 N/mm <sup>2</sup>
21	37.5 N/mm <sup>2</sup>
28	43.32 N/mm <sup>2</sup>

### Split tensile test:

Mould size of 150mm x 300 mm concrete cylinder was used as test specimen to determine the split tensile strength. We have casted the cylinder and gone through split tensile strength test in universal testing machine.

$$\sigma_{sp} = 2P/\pi DL \text{ (N/mm}^2\text{)}$$

**Table 5.2:** Split tensile test for 14 days & 28 days

DAYS	SPLIT TENSILE STRENGTH
14	2.89 N/mm <sup>2</sup>
28	3.29 N/mm <sup>2</sup>

**Split tensile test of bamboo:**

The properties investigated in the samples include only split-tensile strength, determined using a universal testing machine at a consistent loading and universal testing machine has a load of 40kN and the result of the Split tensile test of bamboo is 6.6 kN/m<sup>2</sup>. Elasticity of bamboo recorded to be 43064.28MPa in this study.



**Fig 5.1:** Tensile strength test of bamboo

**Flexural test:**

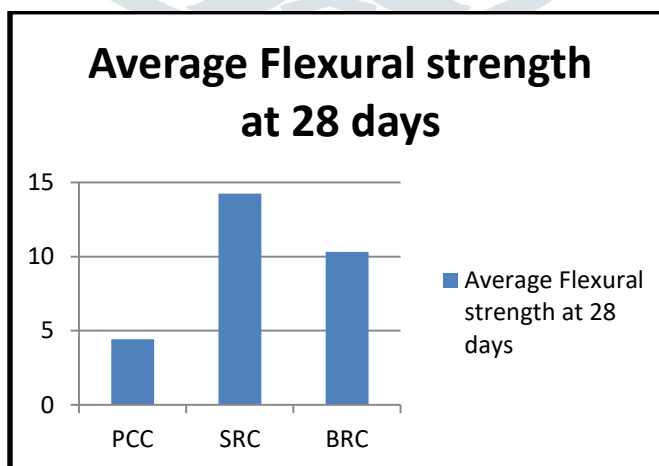
This test was acted as per IS: 516-1959 on 100 x 100 x 500 mm on 28 days resting under flexural testing machine. Flexural strength (N/mm<sup>2</sup>),

$$f = \frac{PL}{bd^2} \text{ and Bending moment, } M = \frac{PL}{6}$$

Where, P = maximum load L = Span of beam (500mm) b = Width of the beam, d = Depth of beam

**Table 5.3:** Flexure test results of PCC, BRC and SRC beams at 28 days

Beam Designation for beam of size 100 x 100 x 500 mm	Average Flexural strength at 28 days
PCC	4.42
SRC	14.25
BRC	10.32



**Fig 5.2:** Graph showing Average Flexural test at 28 days



**Fig 5.3:** Flexural strength of beam

## CONCLUSION:

Following ends can be drawn based on the task work done in research facility:

- 1) The compressive strength of M40 at 28 days is 43.32 N/mm<sup>2</sup>.
- 2) The split tensile test of M40 at 28 days is 3.29 N/mm<sup>2</sup>.
- 3) The flexural test of SRC beam is discovered higher as for every single other kind of beam. The flexural quality of PCC bar is discovered least. This is valid for both the extents of the beam.
- 4) At 28 days, the flexural quality of BRC and SRC beam found about 10.32 and 14.25 more noteworthy than that of PCC beam.
- 5) This investigation gives bamboo as a potential material to be utilized as fortification for low burden bearing structures.

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