Bamboo Reinforced Concrete Beam (Green Construction)

Prof. Leena Kishor More[1], Mr. Vishal Katkar[2], Mr. Atharva Raut[3], Mr. Swaraj Bhilare[4], Mr. Aditya Bhalchakra[5]

[1,2,3,4,5]*Department of Civil Engineering*

[1,2,3,4,5]*JSPM's Rajarshi Shahu College of Engineering Polytechnic, Tathawade Pune 411033*

***Abstract*—Bamboo Reinforced Concrete (BRC) is an eco-friendly construction technique that replaces conventional steel reinforcement with bamboo — a renewable, lightweight, and cost-effective natural material. This project explores the feasibility of bamboo as reinforcement in concrete beams, emphasizing sustainability, material preparation, and performance comparison with RCC beams. Experimental testing showed that treated bamboo beams possess satisfactory load-carrying capacity, ductility, and cost benefits, making them a viable option for low-cost and rural housing.**

***Index Terms*—Bamboo, Reinforced Concrete, Sustainable Construction, Eco-friendly Materials, Low-cost Housing.**

I. INTRODUCTION

The growing demand for sustainable and eco-friendly infrastructure has encouraged engineers and researchers to explore renewable natural materials as alternatives to conventional construction resources. Bamboo has emerged as a promising candidate because of its rapid growth rate, low cost, and impressive mechanical properties. With tensile strength comparable to mild steel and a high strength-to-weight ratio, bamboo can effectively resist tensile forces in structural elements such as concrete beams. Additionally, it is widely available in rural and developing regions, reducing transportation costs and supporting local economies. However, since bamboo is an organic material, it is susceptible to moisture absorption, swelling, shrinkage, and biological degradation. To enhance its durability and structural performance, proper treatment methods—such as chemical preservation, surface coating, and seasoning—are necessary to reduce water absorption, prevent insect attack, and improve bonding between bamboo and concrete. When adequately treated and designed, bamboo reinforcement can significantly lower the carbon footprint of construction while maintaining structural integrity. This project highlights the feasibility of using bamboo as a green, sustainable alternative to steel reinforcement in concrete beams, contributing to environmentally responsible and cost-effective construction practices.

II. OBJECTIVES

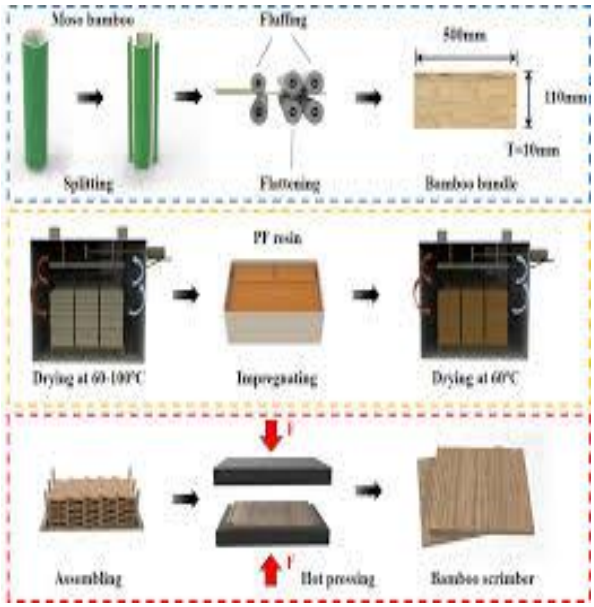
1. To compare bamboo-reinforced beams with conventional RCC beams. (Research papers site visit)
2. To study the feasibility of bamboo as a reinforcing material in concrete beams. (Personal interview)
3. To promote sustainable and cost-effective construction techniques. (Poor people petty shops)

III. LITERATURE REVIEW

- Ghavami, K. Demonstrated that bamboo can effectively replace steel reinforcement in low-load structures when properly treated.
- Amada, S. Highlighted bamboo's anisotropic structure and tensile strength properties.
- IS 456:2000 (BIS Code) — Specifies design and testing procedures for plain and reinforced concrete beams.
- Agarwal, A. Studied the flexural behavior of bamboo-reinforced concrete beams and reported that treated bamboo bars improved load capacity and crack resistance compared to untreated bamboo.
- Terai, M. Evaluated bond characteristics between bamboo and concrete, concluding that surface treatment and mechanical anchorage significantly enhance bonding strength in BRC beams.

- Sharma, B. Investigated the mechanical performance and durability of bamboo as reinforcement, emphasizing proper seasoning and coating methods to increase strength and service life in structural applications.

IV. METHODOLOGY



4.1 Material Selection and Treatment

- Bamboo species: *Dendrocalamus strictus* (approx. 3 years old).
- Cut and seasoned for 15–20 days.
- Surface coated with bitumen and epoxy resin to improve bonding.
- Ends wrapped with wire to prevent splitting.

4.2 Beam Casting

- Beam size: 1000 mm × 100 mm × 150 mm
- Concrete: M25 mix (1:1:2 ratio).
- Reinforcement: 3 longitudinal bamboo strips (12 mm equivalent).
- Curing period: 28 days.

4.3 Testing Procedure

- Performed on a universal testing machine (UTM) under two-point loading.

- Observed parameters: load, deflection, crack formation, and failure pattern.

V. PROJECT IMAGES

VI. TABLES (WITH CLEAR LINES)

Table 1: Material Properties

Material	Property	Value
Cement	Grade	OPC 43
Fine Aggregate	Zone	II
Coarse Aggregate	Maximum Size	20 mm
Bamboo	Tensile Strength (typ.)	M25
Concrete	Grade	M25

Table 2: Test Results

Beam Type	Ultimate Load (kN)	Max Deflection (mm)	Failure Mode
Conventional RCC	35.0	4.2	Flexural crack at mid-span
Bamboo Reinforced	28.0	5.8	Gradual flexural cracking

Table 3: Cost Comparison

Item	Steel Reinforced	Bamboo Reinforced
Reinforcement material	High cost	Low cost
Overall beam cost	100% (baseline)	~60–70%

VII. RESULTS AND DISCUSSION

- Bamboo-reinforced beams sustained about 80% of the load of RCC beams.
- The deflection was higher, showing good ductility and gradual failure.
- Proper surface treatment enhanced bond strength and reduced water absorption.
- Cost savings were approximately 35–40% compared to steel-reinforced beams.
- This supports bamboo as an excellent material for green construction.

VIII. CONCLUSION

1. Bamboo can be effectively used as reinforcement in concrete beams when properly treated.
2. It provides adequate strength and ductility for small-scale and low-cost construction.
3. The technique is eco-friendly, economical, and sustainable.
4. It's recommended for rural housing, temporary structures, and environmentally conscious projects.
5. Further research can focus on hybrid bamboo-steel reinforcement and long-term durability.

REFERENCES

[1] Ghavami, K. — "Bamboo as Reinforcement in Concrete."
[2] Amada, S. — "Study on Strength Properties of Bamboo."
[3] IS 456:2000 — *Plain and Reinforced Concrete (BIS Code).*
[4] Prof. Leena K. More — *Project Guide Notes, JSPM's RSCOE Polytechnic (2025).*
[5] Project Report & Images — *Bamboo Reinforced Concrete Beam*