International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 4, May-June 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

An Experimental Study on Mechanical Characteristics of Treated Bamboo Reinforced Concrete Beams

Gowtham M, A. Alex Rajesh

KSR College of Engineering, Tiruchengode, Tamil Nadu, India

ABSTRACT

Recently, in the attention in response to global warming issues and sustainable society, the manufacturing using natural materials has become actively. Bamboo, low cost, fast growing, and broad distribution of growth, is expected to contribute significantly to earthquake-resistant construction and seismic retrofit technology in the developing countries. This paper investigates the mechanical properties of bamboo reinforced concrete beams. It compares these experimental results of bamboo reinforced concrete beams with the experimental ones of reinforced concrete beams and the mechanical property of the bamboo reinforced concrete beams is studied. From these experimental works, the possibility of effective using of 'Bamboo' is discussed.

How to cite this paper: Gowtham M | A. Alex Rajesh "An Experimental Study on Mechanical Characteristics of Treated Bamboo Reinforced Concrete Beams" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-4, June 2021, pp.501-504, URL: www.ijtsrd.com/papers/ijtsrd42316.pdf

IJTSRD42316

1. INTRODUCTION

In recent years, steel prices have soared. For developing countries, steel is difficult to obtain because of expensive prices, and for the construction industry, usage of steel is currently limited heavily. The production of steel has high consumption of fossil fuels. Meanwhile, for developing countries, it is important to make the development of buildings construction; low cost, no requirement of sophisticated technologies and reliable construction methods. Environmental destruction such as pollution of air and water has been occurring in some regions by rapid development and production of materials like iron, steel, glass, cement and aluminium that use limited mineral resources. On the other hand, plants and fibers are annually reproducible clean resources.

Bamboo is a unique group of gigantic grasses the culm of which originates in underground rhizomes. It grows naturally in many parts around the world country but some species are artificially planted. Bamboo forests are found across tropic and sub-tropic zones between latitudes of about 40° south, i.e. areas with mean annual temperatures of from 20°C to 30°C.

Bamboo suitable for water pipes grows at altitudes from 20 to 3,000meters. Among the many possibilities for such substitutions, bamboo, which is one of the fastest growing plants, has got a great economic potential. Bamboo has been used in constructions of bridges and houses for thousands of years in Asia. Bamboo takes less energy to harvest and transport. Therefore, bamboo has low manufacturing costs compared with steel; bamboo is widely expected to be possible even in countries and regions that have no advanced manufacturing technology and construction techniques.

2. MATERIALS AND MIX PROPORTION

Materials: Raw materials are required such as Cement, Sand, Coarse aggregate, Bamboo, Water, Epoxy resin.

A. Cement: The cement used for the present investigation was ordinary Portland cement of 43 grade.

Table 2.1: Properties of Cement

S. no.	Properties	Observed
1	Standard Consistency Test	32%
2	Fineness Test	6%
3	Specific Gravity	3.14
4	Initial setting time	29 min
5	Final setting time	600 min

B. Fine Aggregate

Sand is from Zone-II as per IS: 383-1970.

Table 2.2: Properties of Fine Aggregate

S. no.	Test for Fine Aggregate	Observed Values
1	Fineness Modulus	4.566
2	Specific Gravity	2.515
3	Water absorption (%)	2.4%

C. Coarse Aggregate

Crushed aggregate and rubber aggregate both are 20mm graded aggregate as per IS: 383-1970.

Table 2.3: Properties of Coarse Aggregate

S. no.	Test of Coarse Aggregate	Result (%)
1	Fineness Module	3.359
2	Specific Gravity	2.688

D. Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Ordinary portable water available in the laboratory is used.

E. Tests on Bamboo

Table 2.4: Properties of Bamboo

S. no.	Test of Bamboo	Result (%)
1	Specific gravity	0.575 to 0.655
2	Average weight	0.625kg/m
3	Modulus of rupture	610 to 1600kg/cm^2
4	Modulus of Elasticity	1.8 x10^{5}kg/cm^2

F. Epoxy resin

Table 2.5: Properties of Bamboo

S. no.	Test of Epoxy Resin	Result (%)
1	Aspect	Pale yellow liquid
2	Mix density	1.05Kg/litre
3	Mix Ratio	by weight 77:23
4	Pot life	50 Minutes at 25 °C
5	Compressive Strength	70 Mpa at 7 days
6	Tensile Strength	18 Mpa at 7 days
7	Shear Bond Strength	18 Mpa at 7 days
8	Flexural Strength	55 Mpa at 7 days
9	Shrinkage	Passes

G. Polyester Resin

Polyester resins have high thermal and heat stability, low shrinkage and good mechanical strength when combined with glass fiber to create composite structures. Polyester resins are the most economical resin systems used in engineering applications, but with limited use in high performance composites

H. Mix proportion

TABLE 2.6: Mix proportion

CEMENT	SAND	COARSE AGGREGATE
383kg	727kg	1173kg
1	1.87	3

3. RESULT

The Density test, Water absorption test, Moisture Content test, compression test and tensile test were tested for Conventional concrete.

A. Density Test

The density test was performed to find out the basic mass per volume or density of bamboo. The density of bamboo can be used as an appropriate parameter for classification of bamboo because unlike other physical and mechanical properties of bamboo, it depends only on the green volume and the oven dry mass.

Table 3.1: Density test result

Specimen No.	Oven dry mass (gm)	Volume of specimen (cm^3)	Mass density (gm/cm^3)
1	1.60	2.70	0.593
2	1.60	2.80	0.571
3	1.50	2.60	0.577
4	1.85	2.60	0.712
5	2.25	3.50	0.643

B. Water Absorption Test

Bamboo is a hygroscopic material, tending to absorb moisture from air and surroundings. The water absorption capacity of bamboo splints is more than 50% by weight; hence it absorbs and reduces a part of water added in the concrete mix for hydration reactions.

Table 3.2: Water absorption test result

Type	Water absorbed after 15 days	Water absorbed after 30 days
A-1	24.80	25.65
A-2	56.70	57.80
A-3	85.40	90.25
B-1	08.25	10.05
B-2	11.25	14.05
B-3	24.55	29.70

C. Moisture Content Test

Bamboo is a hygroscopic material which means moisture content changes with change in relative humidity and temperature of surroundings. Free and bound water exists in bamboo, however the amount of free water is small as compared to bound water hence bamboo starts to shrink as soon it losses moisture. Type-1: Zero internodes present , Type-2: One internodes present, Type-3: Two internodes present

Table 3.3: Initial moisture content test results

S. no.	Nodes	Thickness (cm)	Initial weight (gm)	Oven dry weigth (gm)	Moisture content %
1	0	0.6	20.00	17.35	13.25%
2	0	0.7	20.00	17.30	13.50%
3	0	0.6	16.20	14.15	12.65%
4	0	0.6	16.90	15.00	11.24%
5	1	0.5	50.00	41.95	16.10%

D. Compression Test

The compression test was carried out on hollow bamboo culms to determine the compressive strength of bamboo. The compressive strength of bamboo is of utter importance to calculate the maximum allowable stresses in bamboo, when bamboo is being used as compressive reinforcement in the upper fiber of a doubly reinforced concrete beam.

Table 3.4: Compression test results

Sample	Nodes	Thickness (mm)	Outer diameter (mm)	Ultimate compressive strength (Mpa)
A-1	0	6	47	57.97
A-2	0	8	43	84.58
A-3	0	10	44	74.20
B-1	1	5	47	72.00
B-2	1	8	43	90.72
B-3	1	9	44	88.52

E. Tensile Test

Tensile tests were conducted on specimens having nodes at the end. Nodes are weak and brittle in resistance to tensile force as referred. This test was performed on specimens with nodes at gauge position and its main purpose was to determine modulus of elasticity of the specified species Bamboo. It has been observed that mostly the failure occurred at mid height. The failure occurred looks like the splitting of the fibres.

Table 3.5: Tensile test result

Load (kN)	Elongation (mm)	Strain	Stress (N/mm²)
0	0	0	0
10	0.10	0.0008	47.300
12	0.20	0.0015	56.870
14	0.50	0.0038	66.351
16	0.50	0.0038	75.829
18	1.00	0.0075	85.308
20	2.00	0.0150	94.787

4. Beam Test

In Doubly Reinforced Beam the crack developed in flexure. Two cracks were generated in the beam. The cracks developed at a very slow rate. The cracks formed triangular shaped. During the failure the Bamboo in the bottom was failed by a node failure. The upper Bamboo also failed at node. The failure type node split failure. The beam failed at load of 12.5 kN Lack of gripping between the Bamboo and the concrete was observed.

Table 4.1: Conventional beam deflections

S. no.	Load (kN)	Deflection (mm)
1	0	0
2	5	0.010
3	9	0.020
4	10	0.03
5	10	0.04

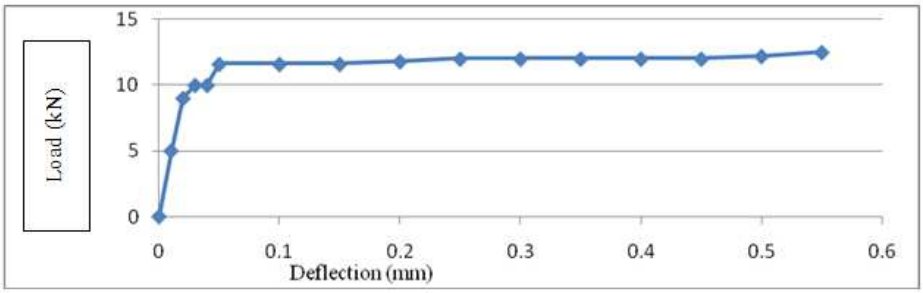

Figure 4.2: Conventional beam Load vs Deflection

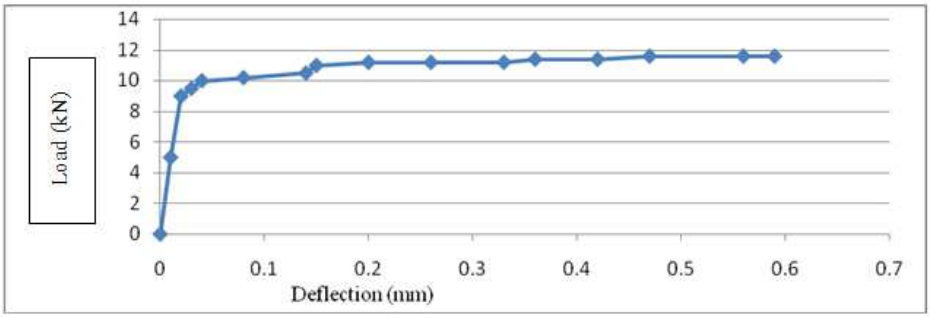

Figure 4.3: Bamboo reinforced beam Load vs Deflection

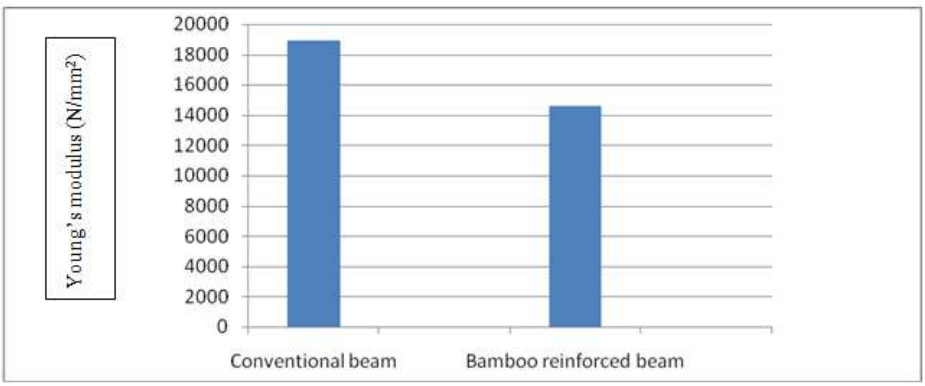

Figure 4.4: Comparison of young's modulus

5. CONCLSION

This experimental work shows the various results

- The analysis is carried out for the conventional concrete cubes, cylinders, prisms.
- The preliminary tests of bamboo and concrete materials were completed.
- Conventional and bamboo reinforced concrete beams were casted and tested.
- The compressive strength of bamboo with node is found greater than without node.
- The shear strength of the reinforced bamboo sections is comparatively lower than that of the completely steel reinforced beams.
- Bamboo reinforced beam can be used as a structural member for low cost housing and recommended for single storey building.
- Replacement of steel with bamboo in a larger amount will make the structure lighter as the percentage of bamboo reinforcement that has to be given increases and the density of bamboo reinforced concrete beam decreases.

As this is a lighter structure it will be less vulnerable to earthquake loads. Replacement of steel by bamboo makes the structure most economical and making easy to lower-income families to build their houses.

6. REFERANCES

[1] KhosrowGhawami, "Bamboo as Reinforcement in Structural Concrete Elements Bamboo", Cement and concrete composites, Vol. 27, pp. 637-649, 2005.

[2] Masakazu Terai and Koichi Minami, "Fracture Behavior and Mechanical Properties of Bamboo Reinforced Concrete", Procedia Engineering, Vol. 10, pp. 2967-2972, 2011.

[3] Adom –Asamoah Mark and AfrifaOwusu Russell, "Comparative study of Bamboo reincforced concrete beams using different stirrup materials for rural construction", International Journal of Civil and Structural Engineering, Vol. 2, 2011.

[4] Jigar K. Sevalia and Nirav B. Siddhpura,"Study on Bamboo as reinforcement in cement concrete", International journal of research and application, Vol. 3, 2013.

[5] Fang, H. Y. & Fey, S. M., "Mechanism of Bamboo-Water-Concrete Interaction", Proceedings of the International Conference on Materials of Construction for Developing Countries Bangkok, pp. 37-48, 2011.

[6] Youngsi Jung, "Investigation of Bamboo as Reinforcement in Concrete" The University of Texas, Arlington August, 2006.

[7] Janssen, J. A.Mechanical Properties of Bamboo (Forestry Sciences), Kluwer Academic Publishers, Vol. 37, pp. 148, 1991.

[8] Jung, Y. Investigation into Bamboo as Reinforcement in Concrete. Master's Thesis. The University of Texas at Arlington. Available: http://gradworks.umi.com//14/35/1435983.html,2006.

[9] Kumar, S. & Prasad, M. M. Performance of Bamboo Reinforced Flexural Member, proceedings of International Symposium Dedicated to Prof. Surenda Shah, University of Dundee, Scotland, United Kingdom, pp. 339 -348, 2003.

[10] Khare, L. Performance Evaluation of Bamboo Reinforced Concrete Beam. Masters' Thesis. The University of Texas at Arlington. [Online] Available: dspace.uta.edu/handle/10106/210/umi-uta-1098.pdf, 2005

[11] Lo, Cuo, Leung, "The Effect of Fiber Density on Strength Capacity of Bamboo", Materials Letter, Vol. 58, pp 2595-2598, 2004.

[12] Mardjono, Bamboo Knowledge Based Building Design Decision Support System, 1998.

[13] Masani, "Studies on Bamboo Concrete Composite Construction", 1998.

[14] Steinfeld, C, "A Bamboo Future", Environmental Design and Construction, pp. 41, Available: http://www.edcmag.com/CDA/, 2009

[15] U.S. Naval Civil Engineering Laboratory, "Bamboo Reinforced Concrete Construction",www.romanconcrete.com/docs/bamboo1966, pp. 19-21, 2000.

[16] IS 10262: 2009, "Concrete Mix Proportioning", Bureau of Indian Standards, New Delhi, 2009.

[17] IS 456:2000, Plain and Reinforced concrete – code practice, bureau of Indian standards, New delhi, 2000.