International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 05 | May - 2021 ISSN: 2582-3930

Physical & Mechanical Properties of Mees Bamboo for replacement with Steel in Concrete Structure

Prof. Satish Pitake [1], Tushar Panpaliya [2], Priyvrat Meena [3], Akash Naikare [4], Ankush Nomulwar [5]

[1] Faculty at Civil Engineering at PCCOE&R, Savitribai Phule Pune University

[2, 3, 4, 5] Student of Civil Engineering at PCCOE&R, Savitribai Phule Pune University

---

Abstract - Bamboos in India show a great diversity in both their habitats and species. There is need of research work for investigating feasible properties of bamboo for construction purpose. Indian Bamboo is a fast-growing wood tree as compared it with other trees. It achieves its optimum strength within four years and full maturity in five years. It is a low-cost sustainable material which is locally available. Due to lack in understanding in properties of bamboo, its utilization is limited in the industry. This paper presents an investigation through various tests on bamboo to know its physical and mechanical properties. To know properties of the bamboo species which were locally available were Mees Bamboo (Dendrocalamus strictus (Roxb.)), Assam Bamboo (Bambusa balcooa), Manga Bamboo. This bamboo was locally available in Pune, India. Among this bamboo we selected Mees Bamboo and performed various test such as tensile test, water absorption test, compression/bending test. The test resulted that, if we treat bamboo and then use it, results for good physical properties and bamboo has very good mechanical properties.

Key Words: Mees Bamboo, Tensile strength

1. INTRODUCTION

Bamboo is a fast-growing giant grass as compared it with other trees. It achieves its optimum strength within four years and full maturity in five years. As fast-growing plant bamboo reach 15 to 30m of height within two to four months of its plantation. It is a low-cost sustainable material which is locally available. Due to lack in understanding in properties of bamboo, its utilization is limited in industry. Generally, steel is used to reinforce the concrete. Though steel has a high tensile strength to complement the low tensile strength of concrete, use of steel should be limited since it is costly and also it takes so much energy in its manufacturing process. Thus, a suitable substitute of this with a low cost, environmentally friendly and also a less energy consuming one, is a global concern; especially for developing country. Addressing all these problems, bamboo is one of the suitable replacements of reinforcing bar in concrete for low cost constructions. Bamboo is natural, cheap, widely available and most importantly strong in both tension and compression. The tensile strength of bamboo is relatively high, which makes bamboo an attractive substitute to steel in tensile loading applications.

There are 1500 identified species of bamboo found around the world. As every bamboo species has similar anatomy, which includes nodes, internodes and diaphragm.

To differ the species of bamboo its root is checked which includes sympodial, monopodial and amphodial. In India, there are a total of 148 species are found in which there are 29 genera (both wild and cultivated). The maximum concentration species is found in the deciduous and semi-evergreen regions of North-east and semi-evergreen regions of north-east and the tropical moist deciduous forests of north and south India. The annual production of bamboo in India is 4.6Million tones, about which 1.9Million tones is used by the pulp industry. In Maharashtra, 90% of bamboo is grown in Vidarbha area and in konkan region only manga species of bamboo is grown.

In this paper, tensile property of bamboo is observed and evaluation of the use of bamboo as reinforcing bar in concrete with replace of steel is done. The aim of this research is to investigate the mechanical and physical properties of different species of local bamboos. This research is a part of an experimental work which focuses on the possibility of utilizing bamboo as reinforcement for beam

2. OBJECTIVE OF STUDY

The aim of this paper is to determine the practicability of bamboo reinforcement for concrete beams. The mechanical properties and behavior of steel reinforced concrete have been studied and due to current increasing demand of steel and problem during its manufacturing there is need of research for sustainable material.

We selected bamboo as an alternative because it is ecofriendly and having similar properties of steel. Therefore, the aim of this work is to provide a preliminary contribution toward the collection of the mechanical and physical properties with behaviors of bamboo reinforced beams. Following tests selected for determining properties as per IS code.

- Density Determination
- Water Absorption
- Static Bending
- Tensile Strength
- Compression Strength

3. MATERIAL & METHOD

- **Bamboo**

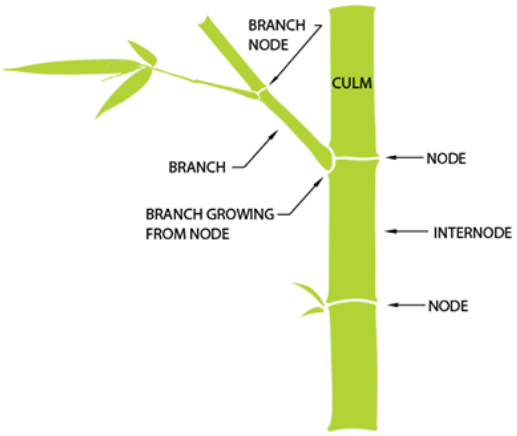

Fig -1: Bamboo Anatomy

Bamboo Culm –Culm means bamboo shoot which is hallow for some species and some species have solid culms. Stem have important job in this plant which is responsible for shape and size of plant and it support leaves, produce food. Various structures on stem like

- Node- where leaf and bud attach to stem and culm segment begins and end with joint.
- Internode-Distance between two nodes is known as internode which tells how much tree grew in one season.

The nodes in bamboo culms were an important factor in the uniform distribution of mechanical properties. The locally available spices of bamboo in Pune are Mees bamboo (Bambusa Vulgaris), Assam bamboo (Bambusa Balcooa) & Manga Bamboo (Qxytenanthera Ritcheyi). From the species available, we choose Mees bamboo and conducted some test (as per IS-6874:2008) on the species of bamboo.

Physical Test:

It includes two tests, which are:

1) Density Determination:

The test specimens for determining basic mass per volume taken from freshly felled culms at different positions of the culm (base, middle and top) about 25 mm in length and 25 mm in width with full wall thickness. In this test a sample of calculated dimension was taken from bamboo and its volume and its weight was measured. Density of bamboo species was determined as per procedure mentioned in IS code.

2) Water Absorption Test:

During our research from previous research papers we found that bamboo absorbs water. To stop bamboo from absorbing water we used oil paint as an agent. In this test 8 samples of different size and different bamboo strips were taken. Out of which 4 samples were untreated and 4 samples were treated with oil paint to stop bamboo from absorbing water. The weight of this sample was recorded and then samples were placed in water tank for 24 hours and weight of this sample was recorded again. The test specimen was weighed with an accuracy of 0.01 g. Percentage water content in treated and untreated samples was calculated.

Fig -2: Treated and Untreated bamboo for water absorption test

Mechanical Test:

It includes three test. These tests were conducted on UTM (Universal testing Machine), which are:

1) Static Bending test:

A beam of suitable length to support the test specimen was kept at right angle to the platform of the Universal testing machine. The test specimen was placed on supports with saddles and a wooden beam was placed over the specimen using saddles in such a way that load is applied through the loading head of the testing machine. The test specimen was then allowed to find its own position; the specimen, saddles, load and supports was aligned visually in one vertical plane. The loading of the test specimen was carried out uniformly at constant speed. The loading head of testing machine was moved at the rate of 0.5 mm/s. Deflection at the middle of the span was recorded at the points of sudden changes in deflection, at the time of failure and at maximum level. Crack development and the form of failure were noted.

Fig -3: Bamboo Strip Bending Test

Fig -4: Hollow Cylindrical Bending Test

2) Tensile Strength Test:

This test was conducted on UTM. The grips were pressing the test specimen perpendicular to the fibers and in radial direction. The load was applied continuously and the movable head of the testing machine shall travel at a constant rate of 0.01 mm/s. The maximum load was recorded.

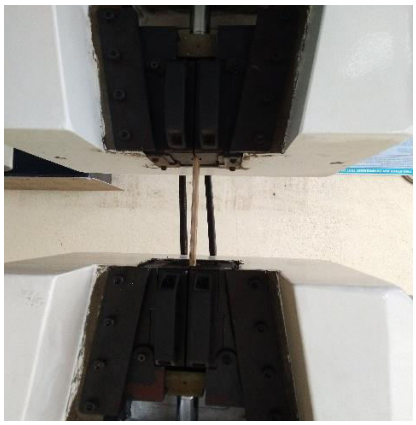

Fig -5: Bamboo Strip Tensile Test

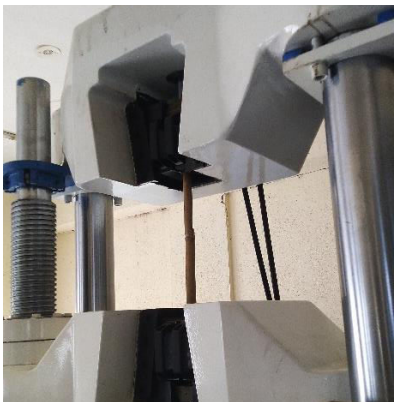

Fig -6: Bamboo Cylindrical Strip Tensile Test

3) Compression Strength Test:

This test was conducted on Digital compression testing machine until crushing and the crushing loads were recorded. The length of bamboo we took to perform test was 50 mm. The inner and outer diameters at top and bottom portion of the samples were measured. The average diameter was considered for calculating crushing strength.

4. RESULT & DISCUSSION

4.1 Physical Properties Test Result: -

Density of Bamboo= $752.4\ {}^{kg}/_{m^3} = 0.7524\ {}^{g}/_{cc}$

Water Absorption Test Result and Observation: -

The water content of each test specimen calculated as the loss in mass, expressed as a percentage of the oven dry mass.

Formula: -

$$w\% = \left(\frac{Wf - Wi}{Wi}\right) * 100$$

Wi = Initial weight of specimen

Wf = Final weight of specimen

w% = percentage water content absorbed in 24 hrs.

Observation Table:

Table -1: Water Absorption Test Table

Sr. No.	Specimen & Size (in mm)	Wi (g)	Wf (g)	w%
1)	Untreated Sample-1 (100*35*7.5)	20.9	30.67	19.92
2)	Treated Sample-1(100*35*7.5)	21.98	26.36	46.74
3)	Untreated Sample-2 (50*28*10)	7.42	8.98	21.13
4)	Treated Sample-2 (50*28*10)	7.94	11.32	42.64
5)	Untreated Sample-3 (100*26*9)	16.45	19.98	21.46
6)	Treated Sample-3 (100*26*9)	17.55	24.84	41.64

7)	Untreated Sample-4 (100*27*10)	17.68	21.31	20.56
8)	Treated Sample-4 (100*27*10)	18.72	26.68	42.54

Average water content for untreated samples after 24hrs is 43.36%. Average water content for Treated samples after 24hrs is 20.76%. Water content decrease by 52.12% after treating bamboo with oil paint.

4.2 Mechanical Properties

I) Static Bending test: In this test deflection in the bamboo strip and hollow bamboo were measured. The maximum deflection allowed in UTM machine and in bamboo was recorded as 100 mm. But the bamboo strip didn't break. Therefore, the load at which bamboo would break in 2 parts was not determined in single point loading test.

II) Tensile Test Result:

Table -2: Tensile Test Table

Specimen	Cross sectional area (mm^2)	Tensile load (kN)	Tensile strength (N/mm^2)
Hollow Cylindrical Bamboo Strip	94.25	11.46	121.59
Bamboo strip	100	12.48	124.8

III) Compression Test Result

Table -3: Compression Test Table

Sr No	Length (mm)	Diameter (mm)		Area (mm^2)	Crushing load(kN)	Crushing Strength (N/mm^2)
		inner	outer			
1)	50	20	38.5	849.99	64	75.29
2)	45	21	38	787.75	62	78.7

5. CONCLUSIONS

The study in this paper indicates that bamboo has a promising potential to be used as a construction material. In the study, we performed some physical test and Mechanical tests which include compression, tensile, bending test were conducted to test two bamboo samples from selected species. Ability and capability of Mees bamboo which was locally available was determined. Mees bamboo (Dendrocalamus strictus) exhibited a good performance in tensile strength test and compression strength test. The water absorption capacity of bamboo was reduced by moisture resistant material i.e., oil paint. It reduced the water absorption by 52.12%. Thus, the experimental results discovered that bamboo has a good performance in strength properties.

ACKNOWLEDGMENTS

It gives us a delight for completing our final year Civil engineering project "Performance evaluation of bamboo reinforced concrete beam". This Project gave us an insight of the Bamboo properties and behavior. This project would not have been possible without our teachers and guide Prof. Satish Pitake. We would also like to thank our Head of Civil Department Dr. Sameer Sawarkar and Prof. Sudarshan Bobade for their encourage words and support in completion of our project. Special thanks to the Principal of Pimpri Chinchwad College of Engineering and Research. Dr. Harish Tiwari for his valuable suggestions and feedbacks. Lastly we like to appreciate my group members who worked together as a team and their contribution for completion of this work.

REFERENCES

- International Journal of Science, Environment and Technology, Vol. 3, No 3, 2014, 836 – 840.
- Steinfeld, C. 2001. "A Bamboo Future," Environmental Design and Construction.
- ASTM. 2006. Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, ASTM C136, Annual Book of American Society for Testing Materials Standards, Vol. C 04.02.
- Wu Yao, Zongjin Li Flexural behavior of bamboo–fiber-reinforced mortar laminates, Cement and Concrete Research 33 (2003) 15–19
- Wan Tarmeze Wan Ariffin Numerical Analysis of Bamboo and Laminated Bamboo Strip Lumber.
- B. Sharma, A. Gatoo, M. Bock, H. Mulligan, and M. Ramage, "Engineered bamboo: state of the art," Proc. ICE - Constr. Mater., no. April, 1–11, (2014).
- M. R. Wakchaure and S. Y. Kute, "Effect of moisture content on physical and mechanical properties of bamboo," Asian J. Civ. Eng. (Building Housing), 13, no. 6, 753–763, (2012).
- Kabir, M.F., Bhattacarjee, D.K. & Sattar, M.A. Physical and mechanical properties of four bamboo species. Bangladesh Journal of Forest Science, 20, pp 31-36, (1991).
- ISO/TR. 22157-1, "Bamboo - Determination of physical and mechanical properties -Part 1: Requirement," 2004, 1–8, (2004).
- ISO/TR 22157-2, "Bamboo - Determination of physical and mechanical properties -Part 2: Laboratory Manual," 2004, 28, (2004).
- T. Gutu, "A Study on the Mechanical Strength Properties of Bamboo to Enhance Its Diversification on Its Utilization," no. 5, 314–319, (2013).