

Experimental Study on Bamboo as a Reinforcement in Concrete Using Building Structure

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Abstract - To reduce the cost of construction so that houses may be made affordable to common man of the society, in the present research work bamboo sticks had been provided as reinforcement in concrete beams in place of steel bars. Different shapes of cross section of bamboo stick such as circular, square and triangular were used as reinforcement. As the work was experimental in nature concrete beams reinforced with bamboo sticks as well steel bars were cast and tested under to concentrated load with the help of hydraulic jack. Steel reinforced concrete beam were tested to compare the result obtained for the bamboo reinforced concrete beam.

Key Words: Bamboo Reinforcement, Concrete Beam, Tensile Strength, Dial Gauge, Hydraulic Jack Deflection and Crack Pattern.

1. INTRODUCTION

Bamboo is replenish-able grass growing almost in all climatic conditions and the most preferred traditional building material in rural areas and villages through the centuries, throughout the world [Ghavami, 2005]. It has good tensile strength comparable to mild steel which places bamboo in row of eco-friendly reinforcing material [Subrahmanyam, 1984]. As per the report of United Nations Centre for Human Settlements, "more people live in houses made from bamboo than that of any other material" [A Camille, 1990] This thesis is aimed with specific attention given to low cost housing to fulfill certain objectives based on several years of laboratory and field investigation and experimentations. It is mainly intended to check the possibility of employing bamboo as reinforcing material for concrete's substitute to steel bars. Bamboo is being used as scaffolding, floorings, rafters, posts, poles and member of trusses in building construction. The study is also aimed to

find the low cost treatment for bamboo, which can be applied with the help of unskilled local labourers, so as to reduce the water absorption by the bamboo from fresh concrete without affecting its bond strength with surrounding concrete enhancing its applicability for low cost housing in rural area.

2. Need of Project

1. The purpose of this study has been to promote the use of bamboo, as alternative reinforcing material to concrete, by developing the analysis and design philosophy parallel to the conventional RCC, with special attention on Dendrocalamus Strictus variety of bamboo.
2. The broad goal of this project was to assess the possibility in providing affordable housing for low-income masses of the society, with appropriate technical backup.
3. For understanding of the properties and behavior of bamboo and bamboo reinforced concrete, several experiments have been conducted.
4. Valuable information has been obtained through the determination of physical and mechanical properties and
5. Testing of bamboo reinforced concrete flexural members. From the collected data and derived parameters, analysis and design procedure has been formulated for flexural members by working stress as well as Limit state method.

3. LITERATURE REVIEW

Sanjeev Gill¹, Dr Rajiv kumar²[1] HOD Department of Civil Engineering, JBIT, Dehradun (U.K)

Tensile strength of bamboo is good and can be used as reinforcement in R.C.C structure for low cost

Housing project. Bamboo reinforced concrete beam, the load carrying capacity increased about 3 times that of plain concrete beam having same dimensions.

H.Y Fang et al. [2] Department of Civil Engineering, Lehigh University, Bethlehem

Submitted thier paper which presents the basic factors for selecting bamboo, the mechanism of bamboo-water-concrete interaction, and the sulfur-sand treatment of the bamboo used for reinforcement in structural concrete.

Ghavami (1995) [3] Studied bonding and bending with bamboo in lightweight concrete. Most developing countries have several problems, and one of the main problems is housing .The housing problem has been related to lack of research in field of low cost housing projects. The values of the test of compression and shear are dependent on the type of bamboo .The tensile strength is higher than the compression strength.

Jin et. al. (2005) [4] Examined abrasive wear property of the cross section of bamboo stem. The abrasive material used for tests is the mixture of quartz sand, condition. The wear resistance of bamboo is increased with its vascular fibers content. The effects of the tensile strength and the impact strength of bamboo on its abrasive wear are also discussed.

Jung ,Y (2006) [5] In this research program, the feasibility of the use of bamboo as a reinforcement agent in concrete is evaluated through tensile and pull-out tests. The several tensile tests with two types of bamboo and the bond strength of bamboo reinforcing bars in concrete were studied. Also the compressive strength of test on concrete cylinders with 6 x 12 in (152 x303 mm) observed approximately 6000 psi (41.4 Mpa). The main purpose of those experiments, tensile and pullout tests with Solid and Moso bamboo, is to evaluate the possibility of using bamboo as reinforcement instead of steel and other materials as FRP.

Arpit Sethia¹, Vijay Baradiya²(2014) [6] This work provides bamboo as a potential reinforcement in concrete. From stress-strain curves of bamboo, it can be seen that bamboo possesses low modulus of elasticity compared to steel. So, it cannot prevent cracking of concrete under ultimate load. But from the flexural test of bamboo reinforced beam, it has been seen that using bamboo as reinforcement in concrete can increase the load carrying capacity of beam having the same dimensions. For bamboo reinforced concrete beam, the load carrying capacity increased about 3 times that of plain concrete beam having same dimensions. The maximum deflection of bamboo reinforced concrete beam is about 1.5 that of plain concrete. This report concludes that it is possible to use bamboo as reinforcing for masonry structure. Though the tensile strength is about 1/3rd that of steel, this is sufficient for masonry structure and provides a more economical and environment- friendly alternative that is accessible to every section of the society.

4. METHODOLOGY

Experimental Investigation

Properties of Materials Used 53 grade Ordinary Portland cement of normal consistency 27%, initial setting time 28 min., final setting time 560 min. and compressive strength at 28 days as 40 MPa was used throughout the test. Locally available Badarpur sand was used as fine aggregate having specific gravity and fineness modulus as 2.60 and 2.65 respectively. Crushed stone of nominal size 10 mm was used as coarse aggregate having specific gravity and fineness modulus as 2.68 and 3.58 respectively. M20 grade concrete was used for casting of Beams. Bamboo sticks were tested under UTM and yield strength as well as modulus of elasticity was found to be 132 and 52000 MPa respective

Testing

The tensile tests were conducted for several samples of both bamboo and bamboo twig specimens. Their failure pattern, ultimate and yield strength will be discussed in the following section. Tension tests were performed for specimens with different conditions of gripping. Proper gripping is an important factor for tensile test. Bamboo is relatively soft materials than the materials used for gripping purpose in

UTM. At the time of tension tests, early failure was observed at the gripping end, possibly due to high stress developed from lateral compression. Moreover, the surface of the bamboo specimen is very slippery and therefore the samples in some case experienced slip at the time of tension test. To solve these gripping problem GI wires (2mm diameter) were wringed spirally at both ends of the specimen. The application of GI spiral around the ends of bamboo specimen.



Testing of Beams

All the beams were tested under two concentrated load each applied at two point of the beam with the help of hydraulic jack Loads were gradually increased and corresponding deflections were recorded at three different locations viz. under the two loads and at the centre of the beam with the help of two dial gauges. In each case beam was tested up to failure.



Bond strength of bamboo in M20 grade concrete

The swelling and bond between bamboo reinforcement and concrete was major hurdle in employing bamboo as reinforcement in cement matrices. As mentioned in earlier chapter 22 different techniques were tried to overcome this problem. Of course, the low cost and easy applicability with local labourers was also the basic intension behind the study. Among the treatments bamboo splits coated with thin layer of a bitumen-kerosene mix applied with brush with zeolite powder sprinkled in wet condition. The special type bituminous mix named Black Japan-kerosene mix prevented the water absorption and the zeolite powder roughened the surface ensuring bond between bamboo reinforcement and concrete thus solved both the problems to aconsiderable extent, economically.

This investigation was aimed for low cost housing, so the minimal grade of concrete prescribed by IS 456: 2000, i.e. M20 was used. The reinforcement used in the form of bamboo splints with Black Japan+ kerosene mix applied on the surface of splints and fine zeolite powder sprinkled on it. The average bond strength for the specimen with the nodal portion inside the concrete was observed as 1.19 N/mm²

5. RESULT

On the basis of test results obtained by testing of twelve beams it was observed that among the bamboo reinforced beams load at first crack and ultimate load and corresponding deflection was higher in the case of beam with square bamboo reinforcement. Flexural and shear strength was also higher for square section. In most of the cases beam failed under flexure but in some cases combined flexural and shear failure too place.

TABLE NO 1: FLEXURAL AND SHEAR STRENGTH

SR NO	BEAM DESIGNATION	FLEXURAL STRENGTH (MPa)	SHEAR STRENGTH (MPa)
1	BBT	4.65	0.93
2	BBC	6.48	1.31
3	BBS	7.64	1.50
4	BSC	15.46	2.92

BBT: Bamboo reinforced beam with triangular cross section,

BBC: Bamboo reinforced beam with circular cross section .

BBS: Bamboo reinforced beam with square cross section,

BSC: Steel reinforced beam with circular cross section .

6. CONCLUSION

1. From test result it was found that tensile strength of bamboo is approximately one half that of mild steel and modulus of elasticity is approximately one third that of mild steel.

2. The load carrying capacity of the bamboo reinforced beam using square cross-section was higher than bamboo reinforced beams with triangular and circular cross sections. From test result it was found that load at first crack and ultimate load in bamboo reinforced beam with square cross section was 53% less than that of mild steel concrete beam.

3 Flexural and shear strength was higher in bamboo reinforced beam with square cross section as compared to triangular and circular bamboo sections. These were about 50% less than steel reinforced concrete beam.

7. REFERENCES

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