

EXPERIMENTAL STUDY ON BAMBUSA BAMBOO AS A REINFORCED MATERIAL IN CONCRETE

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ABSTRACT

The bamboo is one of multi-use forest product and it is economically most important, it is called as the “Green Gold”. It has special place in the life of poor and in rural businesses. It is easily becoming available and affordable forest produce meeting with the basic needs related to timber of human being. Therefore it is also called as the “Timber of the Poor”. This study is based on the use and performance of bamboo reinforcements in construction of low cost structures. Traditionally steel is used as reinforcement in concrete structure. But because of cost and availability, replacement of steel with some other suitable materials as reinforcement is now a major concern. It is a fact that the construction industry is the main consumer of energy and materials in most countries. Though bamboo has been used as a construction material, especially in developing country, until today its use as reinforcement in concrete structure is very limited due to various uncertainties. Since bamboo is a natural, cheap and also readily available material, it can be a substitute of steel in reinforcing of concrete structure. This investigation was carried using a combination of experimental testing. I included flexural testing of bamboo reinforced beams.

Keyword: Bamboo reinforcement, low cost housing, renewable material strength, concrete beam, test on bamboo.

1.INTRODUCTION

Bamboo is a natural source of fiber and one of the fastest growing giant’s plants with great economic potential. Bamboo grows to its full size for about a year. Another two or three years are required for the plant to gain its high strength. Bamboo can be grown even on degraded land. Construction materials from bamboo should be treated in order to achieve longevity. The use of high energy materials, like cement or steel, is minimized. Therefore the adoption of bamboo for house construction helps preserve the environment. Bamboo is renewable resource. The growth of Bamboo is faster. Bamboo is the perennial grass which having various shapes and size according to construction requirement. In Chandrapur region Bambusa type bamboo are available. 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. 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. Bamboo has special place in the life of poor and in rural businesses. Bamboo is fastest growing renewable building material. The material is easily available & eco Friendly. Bamboo is available alternative for steel, Concrete and masonry. It can easily bend giving desired shape. India is home to almost 45 % of world’s bamboo forests. Bamboos are some of the fastest growing plants in the world. They are capable of growing 60 cm or more per day. However, the growth rate is dependent on local soil and climatic conditions. Bamboo are found in diverse climates, from cold mountains to hot tropical regions. In bamboo, the inter nodal regions of the stem are hollow and the vascular bundles in the cross section are scattered throughout the stem instead of in a cylindrical arrangement.. Bamboo gets fully mature within 4years consuming less energy to harvest and transport. For constructions of bridges and houses and for scaffolding bamboo has been used for thousands of years in Asia. Due to its superior properties like low weight to strength ratio, high tensile strength and factors like low cost, easy availability and environment friendly during service, bamboo has constantly attracted the attention of scientists and engineers for use as reinforcement in concrete in construction industries. Bamboo has several unique advantages like ability to

grow fast with a high yield and also it matures quickly. Additionally, bamboo can be grown abundantly and that too at a lower cost which makes it more economical. Bamboo is a traditional building material throughout the world's tropical and sub-tropical regions. Bamboo is a renewable and versatile resource, with high strength and low weight. That's why it is widely used in different forms of construction, particularly for housing in rural areas. It can also be used to make traps, cages, tools, weapons, bridges, rafts, towers, fences, water wheels, irrigation pipe, and thousands of other items.

2.LITERATURE REVIEW

1)Strength properties of bamboo and steel reinforced concrete containing manufactured sand and mineral admixtures.S. Karthika, P. Ram Mohan Rao, P.O. Awoyera-This study focused on the strength properties of bamboo and steel reinforced concrete containing manufactured sand and mineral admixtures. Bamboo is a ductile reinforcing material having some appreciable tensile strength, which makes it suitable as a substitute for steel. Due to its strongly bonded particles, bamboo can be an excellent material for members subjected to compression and bending. Although, their values are low relative to the reference concrete, but it can form a good material for some structural applications.

2)Flexural behavior of steel reinforced lightweight concrete slab with bamboo permanent formworks , Akmaluddina, Pathurahmana, Suparjoa, Zaedar Gazalba-This study has presented and discussed the experimental results of sandwich beams under flexural loading. The present of steel reinforcement in the bamboo slab proportionally increased the slab capacities. However, the increasing number of reinforcement ratio is found to decrease the slab ductility.

3) Omkar Gaikwad, Dipak Patil, Mayuri Rathod, Suraj Saw, Vijay Wairagade-From this study of a Bamboo, anyone can conclude that bamboo as a natural material which is eco-friendly and economic material. Though it has low stiffness and strength compared to steel, it can be used as reinforcement in limited storeys. And bamboo must be treated before using as reinforcement in concrete.

4)Comparison in characteristics of Bamboo and steel reinforcement, Durga G, R.G.Dhilip Kumar, B. Jyothi Panduranga Prasad, C B Ujwal-Bamboo, on using as reinforcement in concrete deflects more due to low density; but it attains flexural strength almost equivalent to Steel reinforced concrete. Hence it can be used in member taking fewer loads such as roof slabs of parking area, public toilets, watchman cabins and sunshades. It also helps in cost effectiveness and reduces environmental effects that are cost by steel production. Using Bamboo we can reduce the cost of the construction by 25%. Bamboo concrete composite structural members can provide tailored solutions to the eco-housing initiatives at cheaper costs.

5)The Use of Bamboo as Reinforcement in Concrete: Department of Geography and Environmental Management University. (1878),Abdullah Moh'd Abdullah Khatib-This research shows that the bond of bamboo to concrete Corrugating bamboo significantly improves the bamboo bond with the concrete through mechanical interlock. The bond strength of corrugated bamboo can be estimated under low embedment lengths (100 mm) based on the shear strength of bamboo and the shear-friction of concrete. The slip corresponding 80% of the maximum bond is equal to 1.11 mm. The bond achieved using waterproofed corrugated bamboo splints is comparable to the bond achieved using splints treated with expensive epoxy treatments. The stiffness of the reinforcement affects the bond at long embedment length (over 100 mm) and needs to be taken into account when estimating the average bond.

6)A Review Paper on use of Bamboo as Reinforcement in Cement Concrete: Yashdeep, Deepak Kumar, Sitender, Department Of Civil Engineering, Ganga Institute Of Technology And Management, Kablana, Jhajjar, Haryana, INDIA-From this research author conclude that Plain Cement Concrete Beam failed suddenly without any prior notice. Hence, it is to be said that it has shown brittle failure. Tension test performed on Bamboo strip revealed elastic behavior .Both singly and doubly Reinforced Beam has shown elastic behavior while performing flexural tests on them . Doubly Reinforced Beam has performed more elastically than Singly Reinforced Beam while performing flexural tests. Load carrying capacity in Doubly Reinforced Beam increased by 29.31 % as compared to Singly Reinforced Beam.

3. ADVANTAGES OF BAMBOO

- Bamboo is easy to cut, repair, handle, reposition and maintain without the need for sophisticated tools and equipment.
- Bamboo is suitable for all types of structures and constructions due to its physical characteristics.
- Bamboo is non-polluting and does not have crusts or parts that can be considered waste. Instead of adding to the problems of polluting landfills like conventional building waste, any part of the bamboo that is not used is recycled back into the earth as fertilizer or can be processed as bamboo charcoal.
- Its circular form and hollow sections make bamboo a light building material, which is easy to handle, transport and store. Therefore, building with bamboo saves time.
- Bamboo can be utilized for permanent and for temporary constructions.
- In each of its nodes, bamboo has a dividing or transverse wall that maintains strength and allows bending thus preventing rupturing when bent. Because of this characteristics bamboo construction offers superior construction earthquake resistance.
- The composition of fibres in the walls of the cut lengthwise or cross cut in pieces of any length using simple manual tools like the machete.
- The natural surface of the bamboo is smooth, clean, with an attractive colour which does not require painting, scraping or polishing.
- Besides being used as a structural element, bamboo can also serve other functions such as flooring, wall panelling, water pipes, drainage and furniture.
- Another advantage of building with bamboo is that it can be used in combination with other type of materials like reinforcing materials for foundation.

4. DISADVANTAGES OF BAMBOO

- Bamboo tends to shrink therefore special laundering may be required.
- Designing and constructing with bamboo requires a special skill set that the average contractor may not possess.
- The number of benefits of bamboo outweighs its disadvantages.

5. RESEARCH METHODOLOGY

The proposed methodology of the project is as follows

- **Study of properties of steel and bamboo-**

I. Tensile stress and unit weight

the common tensile stress in steel reinforcement is 160 MPa

and in bamboo is 370 MPa

II. Density of steel is 7850 kg/m³ and of bamboo is about 500-700 kg/m³.

III. Bamboo will be cheaper because of the price of bamboo per weight will be less than half that of steel.

IV. The durability of bamboo depends strongly on the preservative treatment methods in accordance with basic requirement.

- **Selection and preparation of bamboo-**

I. Use only bamboo showing brown color.

II. Select the bamboo having longest length and large diameter.

III. Never use green, untreated, unseasoned bamboo.

IV. Bamboo should be cut and allowed to sundry to reduce moisture content for four weeks before using.

V. **Copper Chrome Boron (CCB)** test was conducted on bamboo for preservation.

CCB Treatment of Bamboo has been adopted to prevent bamboo from insect attack. It helps to increase life of bamboo. In this test concentration of acid ratio is 1.5:3:4 as Boric Acid, Copper Sulphate, Sodium Dichromate.



fig. Bamboo during the process of preparation

• **Concrete mix proportion-**

Grade of Concrete	M-25
Type of cement	OPC -53
Fine aggregate	Zone-1
Gravity of fine aggregate	2.60

- **Casting of Beam with steel reinforcement and with bamboo Reinforcement.**
- **Comparing strength of beams.**

6. EXPERIMENTAL PROCEDURE

Locally available species Bambusa was collected and made into splints of 16mm & 20mm respectively. These are then treated with Copper Chrome Boron treatment and after that they are then surface dried for 24 to 48 hours. Then cutting and preparation of bamboo splints both in plain and tor formed. Two types of bamboo splints are considered – plain and tor. These tor splints are then coated with bitumen and sand is sprinkled over them for developing a rough surface to increase the bond strength. Then Caging of the bamboo reinforced beams is prepared providing steel as the stirrup material.

1. **Tensile Test on bamboo splints-** Tensile Test on bamboo splints. Tensile tests were conducted for the bamboo splints of 16mm and 20mm diameter bars. Due to the problem of slippage the ends of the splints were wrapped in G.I wire, and then they were tested for tension in UTM. As bamboo splints are not perfectly round, instead of providing the traditional jaws used for HYSD bars flat jaws has been provided in the UTM to get proper grip
2. **Flexure Test on beam-** Flexure test were performed on (15 x 15x 70) cm beams and results were tabulated for 7, 28 and 45 days respectively. The beams used for testing were reinforced with 16mm, 20mm bamboo splints both plain and tor. Two different cases – splints without shear links and with shear links were considered. It shows the four points bent test performed on a flexure testing machine of 100 KN capacities. The midpoint deflection was measured with the help of a deflection dial gauge fitted to an undisturbed horizontal datum bar.
3. **Moisture Content Test-** Moisture content of bamboo varies from species to species due to cultivation area, climatic conditions etc. The test for Bambusa was conducted on treated specimens seasoned for three months. Green weight of bamboo pieces and their oven dried masses were used for evaluating the moisture content in bamboo specimen.
4. **Casting of cube-** Casting of three specimen of 15 cm × 15 cm × 15 cm concrete cube and test will be held after 7 days & 28 days.

Sr. No.	Age (Days)	Weight of Cube (gm)	Volume of Cube (cc)	Density of Cube (gm/cc)	Load at Failure (KN)	Strength (MPa)	Average Strength (MPa)
1	7	8776	3375	2.600	474	21.07	
2	7	8754	3375	2.594	488	21.69	
3	7	8792	3375	2.605	415	18.44	

RESULTS AND DISCUSSIONS

From above test it has been evaluated that the tensile strength of bamboo splints were found to be near about equal of mild steel .The corresponding elongations were found to be in the range of 5-6% . The more the number of reinforcement the better is the flexural strength even an increase in diameter and addition of shear links also results in better flexural performance. Both plain and tor splints were tested for flexure. The tor bars performed well due to better bond strength with a maximum improvement of flexural strength in 28 days

CONCLUSION

From the given paper we conclude the advanced bamboo reinforcement technique instead of steel reinforcement and following conclusion were obtained-Using bamboo we can reduce the cost of construction .Steel get corroded after some ages. So the partial replacement of bamboo can reduce the cost of concrete .It helps in reducing the pollution in environment. Tensile strength of bamboo is good and can be used as reinforcement in R.C.C structure for low cost housing project. It is clear from results that this bamboo reinforcement technique is absolutely cheaper than steel reinforcement technique especially for single story structure. A better flexural performance has been noticed with increased in number reinforcement, diameter. Bamboo also provide us strength which actually depend on species of bamboo, area of cultivation and cross sectional area. Therefore it can be concluded that the method presented in this report has structural applications better than the conventional ones and can be used for all the aspects of Civil Engineering on an advantageous note i.e. economy, safety, and eco-friendly construction.

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