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EVALUATING THE FLEXURAL STRENGTH OF BAMBOO REINFORCED CONCRETE BEAMS

PRASHANT, DR. P S CHARPE

Research Scholar, Department of Civil Engineering, Kalinga University, Raipur, Chhattisgarh
Research Supervisor, Department of Civil Engineering, Kalinga University, Raipur, Chhattisgarh

ABSTRACT

The use of bamboo as a reinforcing material in concrete beams is a novel solution that aligns with sustainable building principles while also increasing the flexural strength of the beams. In this research, experiments have been conducted to determine whether or not bamboo reinforced concrete beams, which are simple, effective, and cost-effective for use in rural building, may be used. This comparative study of bamboo reinforced concrete beam with various frictional properties, such beam have been tested to failure bend test, flexural strength of 8 and 32 days has been taken into consideration for comparison purpose, should be taking the cube test 8 and 32 days compare the result, ordinary using material in construction, Hence it can be recommended that bamboo can act as a good potential reinforcement low cost housing and can replace steel conveniently thereby saving natural resources to considerable extent.

Keywords: Flexural strength, Construction, Bamboo, Concrete, Reinforced

I. INTRODUCTION

Reinforced concrete components' flexural strength is an important design and structural analysis parameter, and new developments have investigated novel materials and methods to improve this attribute. The use of bamboo fibers as a reinforcement in concrete beams is one potential approach. This innovative method seeks to enhance the overall performance and sustainability of concrete buildings by using the distinct mechanical qualities of bamboo. We explore the basic ideas of flexural strength, bamboo's properties as a building material, and the benefits of using reinforced beams made of bamboo and concrete in this in-depth analysis. Beams made of concrete, which undergo considerable bending moments, need a high flexural strength, often called bending strength, tensile strength, or just flex. Elements exposed to different sorts of loads must have this attribute to ensure their structural integrity and load-bearing capability. The principal method for increasing concrete's flexural strength in the past has been the use of steel reinforcing. Sustainable and environmentally friendly building methods are becoming more important, thus engineers and researchers are looking at other materials that might function as reinforcements. As a renewable resource with a high strength-to-weight ratio and low cultivation requirements, bamboo is showing great promise as a material to increase the flexural strength of concrete beams.

Because of its exceptional mechanical qualities, bamboo—a natural composite material—is well-suited for use in building. Fibres are aligned throughout its length, giving it a cylindrical form, a fibrous structure, and great strength. Reinforcing concrete using bamboo is a great idea because of its mechanical properties, which include pliability, compressive strength, and tensile strength. As an eco-friendly building material, bamboo is attractive due to its rapid growth, renewability, and sustainability. Investigating bamboo-reinforced concrete beams is a fresh and relevant strategy in light of the growing need for eco-friendly construction methods. Reinforced beams made of bamboo and concrete combine the best qualities of the two materials, creating a solution that is both strong and efficient. Bamboo adds flexibility and tensile strength, while concrete adds durability and compressive strength. This mutually beneficial partnership solves some of the problems with regular concrete, such its tendency to break when subjected to tensile stresses. Engineers may improve the composite material's overall performance, resulting to increased flexural strength and fracture resistance, by carefully integrating bamboo into the concrete matrix.

Countless experimental investigations have been carried out to evaluate the practicability and efficacy of concrete beams reinforced with bamboo. Beams are fabricated and tested under different stress circumstances to assess their flexural behavior in these experiments. Mechanical properties, failure mechanisms, and performance characteristics of bamboo-reinforced concrete beams may be better understood with the use of the experimental data produced by these investigations. To better comprehend and foretell how these composite structures would behave in various contexts, analytical models and simulation methods have been created. The flexural strength of beams reinforced with bamboo in concrete is affected by a number of important parameters. Among the most important factors are the concrete mix proportions, the curing circumstances, the kind and placement of the bamboo, and the bonding between the two materials. Researchers have investigated several ways to include bamboo into concrete beams, such as substituting it for conventional steel reinforcement or using it as an additional reinforcement in addition to steel. The flexural performance of bamboo beams is greatly affected by factors such as the spacing and orientation of the bamboo inside the beams. The experimental studies on concrete beams reinforced with bamboo have shown encouraging results, suggesting that these beams might achieve far higher flexural strengths than regular concrete beams. The fibrous bamboo fibers improve the composite material's ductility and fracture resistance by acting as a bridge for any cracks that may form in the concrete. Furthermore, in real-world applications, bamboo-reinforced concrete beams have shown to be resilient against climatic conditions including dampness and insect infestations, demonstrating their endurance.

To round up our theoretical knowledge of the mechanics of bamboo-reinforced concrete beams, we have analytical models and simulation investigations. At the microstructural level, these models account for bond strength, slip, stress distribution, and other aspects of the interaction between bamboo and concrete. Engineers may make better judgments when designing and building buildings using bamboo-reinforced concrete beams when experimental and analytical methods are combined to evaluate their flexural behavior. Beyond theoretical models and laboratory tests, the actual applications of bamboo-reinforced

concrete beams are vast. To take use of bamboo's advantages, engineers and architects are thinking about using these creative ideas in real building projects more and more. The worldwide movement toward greener construction methods is congruent with the use of bamboo as a reinforcing material. Adding bamboo to concrete buildings improves performance, helps local economies grow, and reduces environmental impact in areas where bamboo is prevalent. In order to promote broad acceptance and implementation, researchers are continuously working to resolve the obstacles that hinder the use of bamboo-reinforced concrete beams. The lack of consensus on how to test and design using bamboo-reinforced concrete is a major obstacle. Standards across the industry are necessary to guarantee the security, dependability, and uniformity of bamboo-reinforced concrete beams in various uses, as this method is still novel and unorthodox.

II. REVIEW OF LITERATURE

Bali, Ika & Wijaya, Erianto (2021) As new innovations in civil engineering materials seek for environmentally friendly and economically viable alternatives to traditional reinforced concrete, bamboo reinforced concrete is being considered. This research uses flexural tests to look at the maximum load, displacement, and failure pattern of bamboo reinforced concrete beams, as well as their flexural behavior. Beams of reinforced concrete with one percent longitudinal steel reinforcement and beams of bamboo reinforced concrete with one, two, or three percent longitudinal bamboo reinforcements make up the suggested examples. In terms of maximum load, displacement, and failure pattern, the reinforced concrete beam with 3% longitudinal bamboo reinforcement is most similar to the reinforced concrete beam with 1% longitudinal steel reinforcement, according to the comparison between the two types of reinforcements. The results showed that bamboo is a decent material to use in place of longitudinal steel reinforcement in RCC beams.

Qaiser, Sajjad et al., (2020) Concrete has limited usage because of its poor tensile strength. That is why it needs reinforcement, and steel is the best material for the job. Finding more cost-effective and readily accessible reinforcing alternatives to concrete is a pressing topic in the present energy crisis situation. The primary goal of this study is to examine the feasibility of using bamboo as a reinforcement in concrete beams, since the fabrication of steel rebar consumes a great deal of energy. This investigation revealed that locally sourced bamboo strips might be used as a substitute for steel rebar in concrete. This investigation employed a battery of experiments on bamboo to determine its qualities; those findings informed the construction of bamboo reinforced beams. Absorption of water, tensile strength, and bond strength were some of these characteristics. With these characteristics in hand, the design of bamboo reinforced concrete beams could begin. The reinforcement ratio remained constant, but the surface patterns of the bamboo reinforced strips were varied. Using standard steel rebar as the primary reinforcement, an alternative beam design was also developed for the same loading circumstances. The beams that were cast were subjected to tests that measured their ultimate loads, crack loads, failure patterns, and the degree to which the locally sourced bamboo material exhibited the same level of resistance to the loads as the beams that were reinforcing with steel rebar. Different attributes were compared and discussed in terms of

loading failure kinds using graphs and comparison charts for load deflection. We analyzed the bond stress comparisons, the amount of strength gain in bamboo reinforced beams, and whether or not they are suitable to be used as rebar elements in concrete beams.

Muhtar, Muhtar et al., (2019) Due to its mechanical attribute of high tensile strength, bamboo may be used in basic concrete construction. At the same time, the bamboo's slick surface prevented the fractures in the BRC from spreading, leading to yield slip failure between the concrete and the bamboo bar. The BRC beam's load tests show a quite low load capability. By providing a waterproof coating, sand, and hose clamp installation, this research hopes to enhance the capacity and behavior of BRC beam bending. With a variety of reinforcements, up to 26 pieces were used to make the 75x150x1100 mm beam test specimen. The bamboo reinforcement is fastened using a hose clamp that changes in size at intervals of 0, 15, 20, and 25 cm. The tests were conducted using a basic beam subjected to two-point loading. Bending behavior of BRC beams differs from that of SRC beams, according to the test findings.

Abubakar, Ahmad & Oladimeji, Toheeb (2017) The purpose of this study is to examine the flexural strength of concrete beams reinforced with bamboo, namely 25 mm and 32 mm entire culms implanted in concrete cuboids, as compared to plain concrete, steel reinforced, and unreinforced concrete, as tested up to failure under flexure. Specimens were cast in a rectangle mold measuring 750 mm x 150 mm x 150 mm and then cured in water for seven, fourteen, and twenty-eight days. After seven days of curing with water absorption rates of 0.21, 1.77, 1.12, and 0.22, the flexural strengths of 10mm diameter steel, 25mm diameter bamboo, 9.20N/mm, and 1.13N/mm of plain concrete, respectively, are determined. After fourteen days of curing with water absorption rates of 1.08, 1.49, 2.41, and 1.13, the flexural strengths of 10mm diameter steel, 25mm diameter bamboo, 32mm diameter bamboo, and plain concrete are 14.19N/mm, 9.44N/mm, 10.73N/mm, and 1.77N/mm, respectively. The flexural strengths of 10mm diameter steel (19.17N/mm), 25mm diameter bamboo (9.21N/mm), 32mm diameter bamboo (10.34N/mm), and plain concrete (2.51N/mm) are determined via a twenty-eight-day curing time with water absorption rates of 0.94, 1.59%, 2.45%, and 1.25, respectively. Because the two bamboo specimens used in this research had a f1exural strength that was much higher than that of a plain concrete beam but lower than that of a steel-reinforced component after curing, bamboo may be utilized as a concrete reinforcement.

B., Raheem et al., (2015) Commonly used building materials, such as steel, might be problematic due to their high cost, corrosion, and other issues. Countless researchers and engineers are on the lookout for locally produced materials to substitute traditional steel reinforcement in reinforced concrete in an effort to circumvent these issues without lowering the material's tensile strength. One of the best materials to use instead of reinforcing bar in concrete is bamboo. In this research, we looked at how well bamboo worked as a concrete reinforcement. Both newly mixed and fully cured reinforced concrete were subjected to the tests. A value of 6 mm was recorded for the slump. A 28-day compressive strength of 25.26 N/mm2 is considered good by BS code 8110. Each kind of reinforcement—steel, bamboo, and mass—was examined with three beam specimens in the flexural test. The beam specimen

reinforced with bamboo had a deflection width of 6mm at a failure load of 102kN, while the control specimen without reinforcement had a deflection width of 15mm at a failure load of 95kN, whereas the steel reinforced beam experienced a maximum deflection of 4mm at a failure load of 162kN. According to the findings, the most robust beam material for supporting loads was steel reinforced concrete. In contrast to ordinary concrete beams, bamboo reinforced beams have a greater strength, making them suitable for usage in light load bearing reinforced concrete.

Rahman, M. et al., (2011) Concrete has long made use of steel for its reinforcing needs. However, because to issues with accessibility and affordability, the adoption of alternative reinforcing materials to steel is now a key focus. Despite bamboo's long history of building usage, particularly in underdeveloped nations, the material's potential as a reinforcement in concrete remains largely untapped owing to a number of concerns. You may use bamboo instead of steel to reinforce concrete since it is a natural, inexpensive, and easily accessible resource. This research will assess the suitability of bamboo for use as a concrete reinforcement. This is determined by testing the tensile strength of three- and five-noded bamboo. This test makes use of bamboo sticks with different cross sections, each measuring 1 meter. To further understand how well bamboo works as reinforcement, flexural strength tests of bamboo-reinforced beams are also conducted. In this test, normal concrete beams are compared against bamboo reinforced beams of the same dimensions (750 mm length, 150 mm width, and 150 mm depth).

III. MATERIALS AND METHODS

Portland pozzolana cement: Ultratech PPC Cement, a favorite among engineers, was used.

Sand (fine aggregate): The majority of the sand that goes through an IS sieve with a size of 4.75 mm is called fine sand or fine aggregate. The Manjra River Sand, which is accessible locally, was screened using a 4.75 mm IS sieve.

Coarse Aggregate: Coarse aggregate is defined as material that passes through an IS sieve with a size greater than 4.75 mm. Coarse aggregate includes things like khadi and gitti, which are crushed stone or metal. Our coarse aggregate was angular in shape and ranged in size from 12.5 mm to 15 mm.

Reinforcement Steel: Stirrups were 6 mm in diameter and Fy-500 grade steel was used.

Bamboo: Using 6mm dai stirrups, we split the dry bamboo into several pieces with straight sticks that were 14mm in diameter. Reinforced bamboo sticks measure 125 mm in length.

Concrete: The concrete utilized for the experiment was of the M30 grade.

In order to compare the results, the flexural strength of the beams after 8 and 32 days of testing has been considered, but the cube test results after 8 and 32 days should also be included.

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IV. RESULTS AND DISCUSSION

Flexural strength

Flexural strength is determined by casting a 150 mm x 150 mm x 700 mm beam.

Age of concrete (days)	Average flexural strength(N/mm2)		
	Conventional concrete	Conventional reinforced concrete	Bamboo reinforced concrete
8	3.82	7.89	7.76
32	6.95	17.07	16.83

At 8 days of age, traditional reinforced concrete has a flexural strength of 7.89N/mm2, whereas bamboo reinforced concrete has a flexural value of 7.76N/mm2. At the 32-day mark, the flexural strength of traditional reinforced concrete is 17.07 N/mm2, whereas that of bamboo reinforced concrete is 16.83 N/mm2.

Rebound hammer test

- **Vertical rebound hammer test:** The 32-day rebound hammer test on the beam

Days of concrete	Average compressive strength(N/mm2)		
	Conventional concrete	Conventional reinforced concrete	Bamboo reinforced concrete
32	27.35	31	31

The compressive strength of bamboo reinforced concrete is 31N/mm2, which is the same as that of conventional reinforced concrete, according to a vertical rebound hammer test performed on a beam. The test was performed after 28 days and the results showed that both types of reinforced concrete had the same strength.

- **Horizontal rebound hammer test**

Days of concrete	Average compressive strength(N/mm2)		
	Conventional concrete	Conventional reinforced concrete	Bamboo reinforced concrete
32	31	32	32

Beams tested with a horizontal rebound hammer showed compressive strengths of 32N/mm2 for traditional reinforced concrete and 32N/mm2 for bamboo reinforced concrete at 32 days

of age. When compared to regular reinforced concrete, bamboo reinforced concrete has the same compressive strength..

V. CONCLUSION

Concrete beams reinforced with bamboo have already found use in many real-world building projects, proving the solution's viability and importance. Utilizing bamboo as a reinforcing material is in perfect harmony with the building industry's growing focus on sustainability and environmentally conscious methods. In addition to its practical advantages, using bamboo in concrete constructions might boost economic growth in areas with an abundance of the material, all while helping with environmental preservation initiatives.

The difficulties and continuing research efforts in this area, however, must be recognized. One major obstacle that has to be overcome before bamboo-reinforced concrete buildings may gain broad adoption is the lack of standardization in testing procedures and design requirements. The uniformity, dependability, and safety of bamboo-reinforced concrete beams in various applications may be guaranteed by establishing industry-wide standards.

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