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Use of Bamboo as a Construction Material

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ABSTRACT: Bamboo has a long and well-established tradition as a building material throughout the world's tropical and sub-tropical regions. It is widely used for many forms of construction, in particular for housing in rural areas. Bamboo is a renewable and versatile resource, characterized by high strength and low weight, and is easily worked using simple tools. It is widely recognized as one of the most important non-timber forest resources due to the high socio-economic benefits from bamboo-based products. It is estimated that there are 1200 species growing in about 14.5 million hectares area. Most of them grow in Asia, Africa and Latin America. Bamboo is a renewable and versatile resource, characterized by high strength and low weight, and is easily worked using simple tools. It is widely recognized as one of the most important non-timber forest resources due to the high socio-economic benefits from bamboo-based products. Bamboo is the world's fastest growing woody plant.

KEYWORDS: Bamboo Reinforcement, Tensile Strength, Water Absorption, Shape of Bamboo, Durability.

I. INTRODUCTION

Bamboo is a versatile, strong, renewable and environment friendly material. It is exceedingly strong for its weight and can be used both structurally and as a finish material. Bamboo is recognized as one of the most important non timber forest resources because of the high socio-economic benefits from bamboo-based products. Bamboo can be combined into useful products and elements such as flooring, partition walls, trusses, domes, etc.

Bamboo is a woody grass. It is the fastest-growing woody plant in the world. Some species of bamboo grow so fast you can almost see them grow. Bamboos are the absolute quickest developing plants on the planet. They are equipped for becoming 60 cm or more every day. Be that as it may, the development rate is reliant on neighbourhoods' soil and climatic conditions. Bamboo is found in various atmospheres, from cold mountains to hot tropical areas. They happen crosswise over East Asia, through to Northern Australia, and west to India and the Himalayas.

As reinforced concrete is common building material, it is important to make the development of building construction, low-cost material. For developing country steel is difficult to obtain because of expensive prices and for low-cost housing and temporary structure. Many researches around the world are began to explore the use of low-cost and low-energy substitute construction material as reinforcing material. Among the many possibilities for such substitution, bamboo. Bamboo which is one of the materials fastest growing plants, and it is great economical potential. It grows naturally in many parts around the world and easily available. Bamboo takes less energy to harvest and transport. Therefore, bamboo has low manufacturing costs compared with steel. Bamboo has a good tensile strength and light weight. Bamboo has a good water absorption capacity it may reduce the mechanical properties and causes the structural failure. There is need to control the water abortion of bamboo. There is need to use proper seasoning method to reduce the water absorption.

Bamboo is able to resist more tension than compression. The fire resistance is very good because of the high content of silicate acid. Bamboo durability heavily depends on the preservation treatment method. This preservation method includes smoking, heating, drying, coating and another method is chemical treatment. From the early times, bamboo is used as a construction material. The bamboo is used in both technical as well as non-technical ways. Our ancestors used Bamboo in the construction of the houses. The Bamboo was used as the struts, post, roof etc., in the construction of the houses. Nowadays concrete are used as the basic material for the construction works. The concrete is good in compression but weak in the tensile strength. So steel is used as reinforcement in the concrete to achieve the tensile strength. Problems encountered with the commonly used construction material like steel are high in cost, corrosion etc. Due to the advantages characteristics of Bamboo, in the last few years, studies have been made on the use of bamboo as

structural material and reinforcement in concrete. The main obstacle for the application of Bamboo as a reinforcement is the lack of sufficient information about its interaction with concrete, strength and durability.

II. LITERATURE REVIEW

Ali Awaludina, Viki Andriania, et. al. connection in bamboo construction is regarded as the weakest part and have hindered the optimal utilization of excellent bamboo engineering properties were studied in this work. This paper discussed development of various methods of bamboo jointing, including the authors' proposal where fiber Reinforced Plastic in the form of sheets is used to improve the structural performance of bolted bamboo joints. The test result showed a significant increase of join slip modulus and lateral load capacity of the bolted bamboo connections due to wrapping effects when they are reinforced with FRP sheets, especially the overlap joints.

Atul Agarwal, Bhardwaj Nanda, Damodar Maity, et.al. In this study, the feasibility of usage of bamboo of as reinforcement in concrete has been evaluated through a series of experiment investigation on of various beams and column. The bamboos were chemically treated. The test performed on specimens were tensile test on bamboo specimen, pull out test of concrete slabs embedded in concrete, axial load and transverse load test on BRC columns and 2 point load on BRC beams. It is observed from pull out test that the bonding strength of the treated bamboo concrete composite is highest for Sikadur 32 Gel among the other adhesive composed.

Sanjeev Gill, Dr. Rajiv Kumar, bamboo can use as reinforcement. Bamboo is cheap substitute for steel because bamboo grows much faster and is renewable source after 5-6 years. Water absorption in bamboo is directly affect the strength of bamboo. Tensile strength of bamboo is good so it can be use as a reinforcement. The behavior of bamboo as a reinforcement is same as plain steel bar.

I. K. Khan, it is found that the tensile strength of bamboo is approximately one half of the mild steel. The tensile strength of bamboo is 132 N/mm².

Pratish Kumar Singh, Aashish Jodhani, Abhay Pratap Singh, it is been found that bamboo in the vertical position is more durable than in horizontal. Bending of bamboo can be permanently bent if heat, either dry or applied the pressure. The type of coating will depend on the seasoning material is used. A brush coat or dip coat of emulsion is useful for treatment of bamboo. Bamboo reinforced concrete beam design is similar to steel reinforcing design.

Anurag Nayak, Arehant S Bajaj, Abhishek Jain, Apoorv Khandelwal, Hirdesh Tiwari, bamboo can replace the timber and other material in construction work. When seasoned bamboo is used as reinforcing material it should receive a waterproofing coating to reduce swelling when in contact with concrete. Without some type of coating bamboo will swell before the concrete has developed sufficient strength. Bamboo reinforcement technique is cheaper than steel reinforcement.

Dr. Ashok Kumar Gupta, Dr. Rajiv Ganguly, Ankit Singh Mehra, the density of bamboo is very low which makes it very light material. Water absorption capacity is increase as increase in node. Tensile stress increase as increases in number node.

Atul Agarwal, Bhardwaj Nanda, Damodar Maity, adhesive has excellent resistance to water, oil and many other solvents. It observes that bonding strength at the interface of the bamboo concrete composite is higher for adhesive.

Chandra Sabnani, Madhuwanti. Latkar, Utpal Sharma, use only bamboo showing a pronounced brown colour. This will ensure that plant is at least three-year-old to get good strength. In any case, only a thin coating should be applied. A thick coating will lubricant the surface and weaken the bond with the concrete [12].

Ajinkya Kaware, Prof. U. R. Awari, Prof. M. R. Wakchaure, bamboo weak at node, maximum failure occurs at node of the bamboo. Bamboo is weak in bond stress hence it should be treated with epoxy coating to get bond stress. Bamboo is weak in shear so it cannot used as a shear reinforcement. Tensile strength of bamboo is good so it can be used as a reinforcement in R.C.C structure for low-cost housing. The behaviour of bamboo is same as the steel bar. Moisture of content of bamboo is varies according to topography.

III. OBJECTIVE OF WORK

This study aims to assess the potential of bamboo as a sustainable material for building construction.

To achieve this aim, the objectives of the study are as follows:

- i. To study the properties of bamboo as a building material.
- ii. To examine the sustainability of bamboo as a building material.
- iii. To study the challenges of bamboo as a material for building construction.
- iv. To propose recommendations that will enhance the use of bamboo as a building material for construction.

IV. SCOPE OF WORK

1. The lightweight of bamboo makes them easy to install and it can bear heavy loads too.
2. This is why the scaffolding used in construction can also be made out of bamboo.
3. Electricity and air conditioning can be easily incorporated into bamboo structures.
4. Because of its lightweight, bamboo can also be transported easily.

V. MATERIALS USED

Cement, water and Aggregates

Concrete is prepared by mixing various constituents like cement, aggregates, water etc. which are economically available. Ordinary Portland cement of 43 grade conforming to IS 8112 was used throughout the work. The fine aggregate used in this investigation was clean river sand, whose maximum size is 4.75 mm, conforming to grading zone II. Machine crushed blue granite stone angular in shape was used as coarse aggregate.

VI. METHODOLOGY

Experimental Programme

The aim of the experiment was to assess the feasibility of the Bamboo as reinforcement in the cement concrete flexural element that is beam. The concrete mix design was proposed using Indian Standard for control concrete. The grade was M35.

Specimen Preparation

To investigate the feasibility of using bamboo as a reinforcing material in reinforced-concrete members, flexural Strength were carried out on reinforced-concrete beams in which all rebars, including the main rebar and the stirrups, were replaced with bamboo. In this present study nine beams each of size 750x150x150 mm were cast to study the flexural strength, out of which 3 beams used as a Plain concrete beam. Doubly reinforced concrete was casted. Reinforcement is provided on both sides of the beam with a nominal cover of 30mm. Steel stirrups is used in both steel and bamboo reinforced beams. Bamboo selected for reinforcement had an average diameter of 12mm. Three steel reinforced beams and three bamboo reinforced beams were casted. Plain concrete beam nominated as PCB, Bamboo reinforced concrete beam nominated as BRCB and Reinforced Concrete Beam noted as RCB.

Effect Of Bamboo on Flexural Strength

As per design obtained in accordance to code IS-10262, mix proportion of various materials (viz. Cement, Sand, Aggregate and Water) is calculated for M-235 grade of concrete. The cubes were tested in the laboratory in accordance to code IS 1343-1980. The results of compressive strength of cubes for 7 days and 28 days were 47.6 and 57.8 N/mm². The tensile strength of bamboo was 14.6 N/mm². Nine beams were cast. The flexural strength was calculated as per IS 516-1959, The flexural strength of bamboo reinforced beam is 28% higher than plain concrete beam and 55% lower than the Reinforced concrete beam which is shown in fig. 8. The deflection at centre of bamboo reinforced beam is 50% higher than reinforced concrete beam and 60% lower than the plain concrete beam as shown in fig 9. The ultimate load carrying capacity of bamboo reinforced beam is 29 % higher than reinforced concrete beam and 55%. Higher than the plain concrete beam. The failure pattern of the beam.

VII. CONCLUSION

Bamboo can use as a reinforcement in R.C.C. structure as a low-cost housing or temporary structure. Bamboo can attain the tensile strength up to 370 N/mm². It is lies between 120 N/mm² to 370 N/mm². Bamboo has a good water absorption capacity, which reduce the mechanical properties of bamboo. Water content of bamboo is between 50%-60% by weight. To reduce the water absorption capacity of proper seasoning treatment should be required. Seasoning



of bamboo is good for bituminous paint, epoxy, and coal tar. Bamboo has low bond stress with concrete. There need to apply epoxy to bond with concrete. Epoxy should apply in a thin coat using brush, a thick apply lubricant the bamboo and reduce the bond stress. The behaviour of bamboo is same as steel bar, it can be used as reinforcement. Bamboo reinforcement design is same as R.C.C. steel beam. The density of is low so bamboo is light in weight.

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