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Epoxy Coated Bamboo As a Replacement for Steel in Structural Concrete Beams

Sharath B^[1], Dr S S Honnanagoudar^[2], Asha R^[3], Gagana N L^[4], Akash^[5], Nagesh Harpalle^[6]

^[1]Assistant Professor, Department of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, India

^[2]Professor, Department of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, India

^[3]U.G. Student, Department of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, India

^[4]U.G. Student, Department of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, India

^[5]U.G. Student, Department of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, India

^[6]U.G. Student, Department of Civil Engineering, Dr. Ambedkar Institute of Technology, Bengaluru, India

ABSTRACT: Steel is one of the conventional materials which is used for reinforcement in concrete. But depending upon cost and availability, hence it is required to replace the steel with some other suitable materials as reinforcement is now a major concern. To determine this, the tensile strength test is carried out on bamboo strips. Bamboo strips of length 20cm and 10cm with same cross sections are used in this test. Reinforcing steel used in reinforced concrete all over the world is very expensive that leads to the proposal of using bamboo as a reinforcement in concrete in terms of culms or strips. Many pieces of research are going on for the productivity and usage of bamboo as a reinforcement material. This review paper addresses the concept of bamboo-reinforced concrete and assesses the mechanical and structural performances of bamboo as an alternative to steel.

KEYWORDS: Bamboo, Epoxy, Reinforcement, Structural beam

I. INTRODUCTION

Bamboo has shown great future for creating of multiple materials and modules which are cost-effective and may be successfully utilized for structural and non-structural applications in construction. The generic name of bamboo is "*Bambusa vulgaris*". Bamboo can be grown in large quantity with low cost and this will be economical for construction purpose. Bamboo is a flexible material with its high strength, workability and durability. Bamboo has high lastingness property also as compression property. We have mainly focused on the comparison of steel reinforcement and shear reinforcement by taking into consideration the bamboo as structural material for reinforcement in beam. The objective of shear reinforcement by using as a structural member was to get a good as well as effective shear strength and flexural strength of bamboo in a beam. Bamboo has a high tensile strength as compared to steel bars. Bamboo is generally used as structural material but it is also used in construction of bridges, scaffolding and housing.

II. LITERATURE SURVEY

Several studies have been conducted to utilize bamboo as a reinforcement. Sajjad Qaiser [1] made the design of bamboo reinforced concrete beams which was done with the same reinforcement ratio but bamboo reinforced strips having different types of patterns on their surface. The strips of locally available bamboo have a potential to replace steel rebar in concrete. Properties of bamboo includes water absorption, tensile strength and bond strength. Similarly Muhtar [2] used the Adhesive coating which is to increase the durability and prevent water absorption of the bamboo and also the hose clamps are used to increase the bamboo reinforcement slip resistance. Xun Gao [3] concluded the mechanical properties, water absorption, and flame retardancy of polymeric and cementitious composites reinforced with long bamboo fiber and reviewed the cell wall structure of the bamboo fiber. Purushottam Kumar [4] reviewed the concept of bamboo reinforced concrete and assesses the mechanical and

structural performances of bamboo as an alternative to steel .He also concluded that the mechanical properties of bamboo are quite extraordinary.

III. METHODOLOGY

Using bamboo as a reinforcement material involves several steps and considerations. Here is a general methodology for using bamboo as a reinforcement:

Bamboo selection: Choose mature and straight bamboo culms (stems) that are free from damage, pests, and decay. Different species of bamboo may have varying properties, so select the appropriate species based on your specific requirements.

Harvesting and processing: Cut the selected bamboo culms at the base and remove the branches and leaves.

Splitting: Split the bamboo culms lengthwise into thin slats or strips using a knife or a specialized tool. This process exposes the bamboo's inner fibers and increases the surface area for better adhesion.

Treatment: To enhance the durability and resistance of bamboo, you can apply chemical treatments such as boron salts or preservatives. This step helps protect against biological degradation, fungal attack, and insect infestation.

Drying: Properly dry the bamboo strips to reduce moisture content and minimize the risk of decay. Ideally, the moisture content should be around 8-12% for construction purposes.

Sizing and shaping: Cut the bamboo strips into appropriate lengths and shapes based on the intended application. This can be done using saws, chisels, or other cutting tools.

Epoxy coating on Bamboo: After cutting next step is to coat epoxy on Bamboo. Epoxy resins are typically formed by mixing two components i.e. a resin and a hardner .When these components are combined a chemical reaction occurs resulting in a cured and a solid material. The resin and a Hardner was mixed in a ratio 1:1 i.e. one part of resin and one part of hardner while mixing esure that there are no air bubbles.Then coat the epoxy over the bamboo surface.

Preparation of Reinforcement :The next step is to prepare the reinforcement of required dimensions. For the bamboo reinforcement we used steel stirrups because it is difficult to bend the bamboo as it tends to breaks. For steel reinforcement in Tension zone 2# of 12mm dia bars are used and in compression zone 2# of 10mm dia bars used and for stirrups 8mm dia bars are used at the spacing of 150mm c/c. Similarly for bamboo reinforcement in Tension zone 2# of 24mm dia strips are used and in compression zone 2# of 16mm dia strips are used and for stirrups 8mm dia steels stirrups at the spacing of 150mm c/c are used.

Casting: Once the reinforcement is prepared it is to be casted. We casted a beams for a mould dimension of 131×16 ×20.5 cm with a clear cover of 30mm and we demoulded it after 28 days.

Curing: Curing is a process which is done to increase the strength of the concrete. Curing has been done for 7 days,14 days and for 28 days to attain its respective strength.



Fig. 1. Epoxy coating



Fig. 2. Steel and Bamboo Reinforcement cage



Fig.3. (a) Casted Beam



Fig.3. (b) Casting of beam

Experimental results

The beams have been tested in Universal Testing Machine (UTM) available in Dr Ambedkar Institute of Technology having 60T load capacity, according to IS: 516- 2004 . All beams were subjected to a two-point pure bending test. Two-point load setup is followed in this investigation.. The mid-span deflection is recorded by a Linear Variable Displacement Transducer (LVDT). Providing 100 mm offset at the end supports in all the beams to maintain an effective span of 1100 mm in the load setup. Loads with an increment of 10 KN were applied under the two-point test setup was followed for all types of beams. Two concentrated loads were given which is transferred through an I-section (spreader beam) which is placed at the top surface of the beam. The given load is controlled and gradually increased until the beam gets fails. The mid-span deflection is recorded at every 10 KN load interval. The ultimate load, yield load, crack propagation was recorded for all type of beams.



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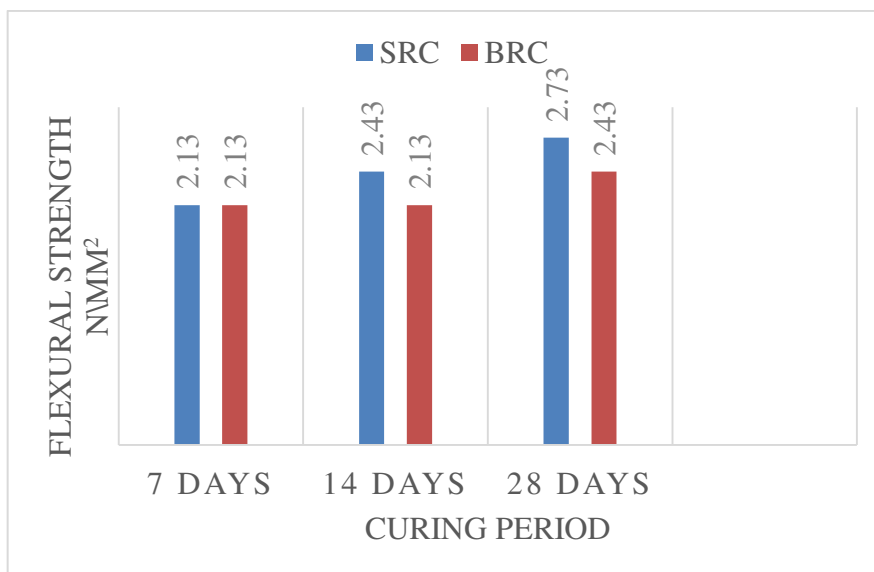
Table 1 Results of Conventional Concrete Beams.

SL.NO	DAYS	ULTIMATE LOAD kN
1	7	70
2	14	80
3	28	90

Table 2 Results of Bamboo Reinforced Concrete Beams

SL.NO	DAYS	ULTIMATE LOAD kN
1	7	70
2	14	70
3	28	80

Graphical representation of results



Test setup



(a)



(b)



(c)



(d)

Table 3. Load at first crack

SL.NO	TYPE OF BEAM	LOAD AT FIRST CRACK kN
1	BRC 1	40
2	BRC 2	30
3	BRC 3	30
4	SRC 1	30
5	SRC 2	40
6	SRC 3	30

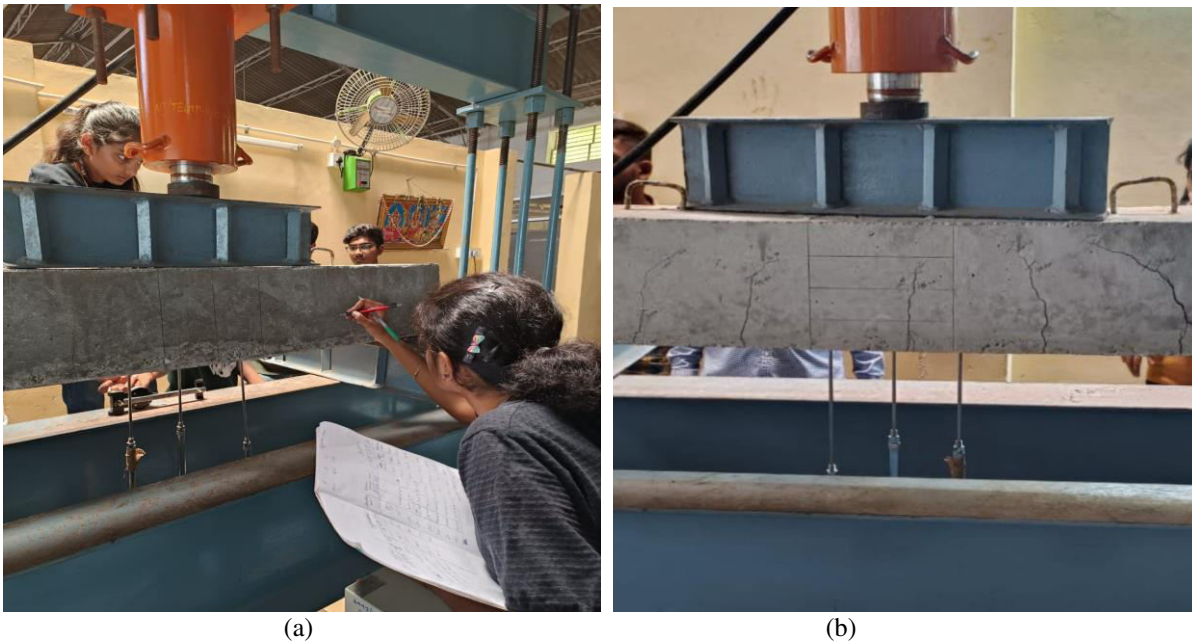


Fig. 4. (a) & (b) Crack Pattern

IV. CONCLUSION

All the concrete Beams were tested to the failure and behavior was observed. The ultimate load of both the beams were shown in the table 1 and table 2. The first crack load was shown in the table 3. From the graph it was observed that the bamboo reinforced concrete beam achieved 100% strength over conventional concrete beam for 7 days test. And for 14 days the strength was about 87% and for 28 days it was 89%. Hence, Bamboo with Epoxy coating Can be used as Replacement for Reinforcement of Steel in structural beams.

Future Scope

There is no innovation in using Bamboo as a construction material but can be used as reinforcement material due to its tensile properties. The durability can be increased by coating epoxy over its surface. Here we focused on using bamboo as a main reinforcement. Further studies can be made to use it also as stirrups.

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