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FLEXURAL STRENGTH ENHANCEMENT IN BAMBOO REINFORCED CONCRETE MEMBERS

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ABSTRACT- This paper highlights the various failures occurring in bamboo reinforced concrete members. The study also highlights the methodology which can be implemented while using bamboo as reinforcement in structural beams. Ultimately the study is also extended for improving the flexural strength in bamboo reinforced concrete using artificially prepared CFRP wraps.

I. INTRODUCTION

Concrete is a building material which comprises of aggregates, sand, cement, and water. The concrete can be cast into various forms by pouring it into desired moulds which forms a hard substance on hardening. The concrete is usually weak in tension; hence the steel bars are used as reinforcement members in concrete beams. Steel provides sufficient flexural strength to the concrete members which are weak in tension. Steel manufacturing causes pollution as it exhaust the carbon-dioxide gas to the environment causing rise in global warming. Also Steel is not economical; hence in case of low cost housing certain remedies should be introduced to counter this problem.

Nature provides a a strong flexural material i.e. bamboo which can be used as a replacement for steel as it is eco friendly material as well as it is available easily. When used reinforcement it gives more strength to RCC flexural members.

CFRP: A carbon fiber reinforced polymer (CFRP) refers to a type of durable and strong material that is composed of linked chain carbon atoms in a matrix structure of polymer resin. The polymers are highly corrosion resistant.

CFRP is the carbon fiber reinforced polymer which possesses the strength and stiffness which is usually implemented for retrofitting of structures. CFRP wraps are used with resin like epoxy which binds the elements to be retrofitted.

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Fig No. 1.1 CFRP Wrapping Roll

II. LITERATURE REVIEW

Study on properties such as mechanical strength of bamboo was done by T.Gutu to establish if bamboo would play a complementary role as a construction material [6]. The research also stated the supply of wood as a main source of material for construction works in Zimbabwe. His study suggest that Bamboo can be used for constructional works

Further studies on the effects of compressive and flexure strength under bamboo reinforcement was done and tested successfully by Dr. Shakeel Ahmad, Altamash Raza [5]. The study was extended to comparing results in plain concrete. It was found that the strength of the specimens were considerably adequate. Then singly and doubly reinforced beam with bamboo have been cast and tested in flexure test. It was found that there was increase in the flexural strength and modulus of elasticity of bamboo

reinforced beam member. This indicates that strength of concrete cubes with bamboo fibers do not show much improvement up to initial 28 days but surprisingly later strength doubles in 50 days.

Suresh Barmavath, Kiran M V, and Khammam [7] studied concrete mix design for M40 grade concrete as per design requirement of IS 10262:2009. Bamboo reinforcement concrete beam were caste using Ordinary Portland Cement. The cast beams were singly and doubly reinforced. This concrete beams were fully replaced with bars of bamboo. The curing of these elements periods was 7 days, 21 days, 28 days. The specimens were compared under the Tensile Test on UTM. It was concluded that, bamboo being a grass type possess low strength while the dry bamboo possess high compressive strength. The load capacity of single bamboo RCC beam was tested with flexural load being applied for measuring the cracking deflection in Beam.

A review on Bamboo Reinforced Concrete was done by Dhanendra Kumar, Dr. S. Mandal[8]. They found that Bamboo, as with any natural material can efficiently replace the steel as reinforcement for low cost residential structure.

Nirav B. Siddhpuraa, Deep B. Shaha [9] tried to study usefulness of bamboo as construction material. The compressive strength of this concrete was found to be excellent as compared to tensile strength. Due to the high cost the steel was replaced with an alternative material (Bamboo) as reinforcement. In developing countries this case is found common. This study states the usefulness of Bamboo as a structural member in flexural element. Various surface coatings were applied on the bamboo and the reinforcement cage was prepared using the Bamboo stirrups. The flexure test was conducted on the beam elements. Modulus of Elasticity was detected. From this study the authors concluded that in tensile test Bamboo specimen failed at the mid height by splitting of the fibers .The failure of the tensile test specimen was ductile, Modulus of elasticity of the Bamboo was quiet lower than that of the steel.

Masakazu Terai & Koichi Minami Fukuyama [10] has been studied to understanding the mechanical behavior of bamboo reinforced concrete member and clarifying the differences of structural properties from steel reinforced concrete and bamboo reinforced concrete. Their study was in this field determines the mechanical properties of bamboo reinforced concrete structure. They compared both the experimental results of bamboo reinforced concrete members, and the mechanical property of the bamboo reinforced concrete members. From these experimental works, it was concluded that the possibility of effective using of 'Bamboo' is discussed. This paper presents the feasibility of using bamboo and non-steel as the reinforcing material in concrete members. In order to determine the behavior and the mechanical properties of Bamboo Reinforced Concrete members

Kavitha S, Felix Kala [2] carried out study on understanding the mechanical behavior of bamboo fiber reinforced concrete member. From this experimental, the possibility of using of 'Bamboo' was studied. Similarly results were obtained for different aspect ratios, where results showed an aspect ratio (40). An increase in fiber weight fraction provided a increase in ductility up to the optimum content (1.0%) with corresponding aspect ratio of 40. The study states that addition of Bamboo fiber to concrete leads to improvement of concrete strength, toughness, torsion and the tensile stress.

The results of investigation conducted to calculate the performance of foamed aerated concrete beams with bamboo as an tensile reinforcement was done by Efe Ikponmwosa1, Funso Falade[4]. The flexural parameters which were assessed are load-deflection behavior, failure mode, and flexural moments. The density and compressive strength were also determined. The use of bamboo as tensile reinforcement in pairs and bundles, as it will improve the flexural performance of foamed aerated concrete beams.

Dr. M B Verma [1] carried experimental studies on concrete beam reinforced with bamboo stirrups. Bamboo stirrups were coated with resin and fine particles of sand were attached to bamboo stirrups, these beams were tested under four points flexural test. It was observed that the bamboo strip reinforced concrete beam settled gradually and showed ductile failure.

Study on finding the flexural strength of natural fiber reinforced polymer composite was done by Sanjay Tiwari, Dr. Vinay Pratap Singh[3]. Short fiber having length 5-7 mm of hemp and bamboo were selected as reinforcing element with Epoxy Resin LY 554/6 and Hardener HY951. From this they concluded that the sample of bamboo fiber with epoxy resin showed improvement in flexural strength i.e. 83.22 Mpa. This improvement is about 5% more compared to flexural strength of epoxy resin sample.

III. CONSTRUCTION PRINCIPLES AND CONCLUSIONS

a) Concrete Mix Proportions

The conventional mix designs can be used as that of the steel reinforced concrete. Slump in the concrete should be lesser allowing workability. Excess water may lead to swelling of the bamboo. High early-strength cement can be used to reduce the cracks caused by swelling of bamboo.

b) Placement of Bamboo

Bamboo reinforcement should not be placed less than 1-1/2 inches from the face of the concrete surface. When using whole culms, the top and bottom of the stems should be alternated in every row and the nodes or collars, should be staggered. This insures a fairly uniform cross section of the bamboo throughout the length of the member, and the wedging effect obtained at the nodes will materially increase the bond between concrete and bamboo.

The clear spacing between bamboo rods or splints should not be less than the maximum size aggregate plus 1/4 inch. Reinforcement should be evenly spaced and lashed together on short sticks placed at right angles to the main reinforcement. When more than one layer is required, the layers should also be tied together. Ties should preferably be made with wire in important members. For secondary members, ties can be made with vegetation strips.

Bamboo must be securely tied down before placing the concrete. It should be fixed at regular intervals of 3 to 4 feet to prevent it from floating up in the concrete during

placement and vibration. In flexural members continuous, one-half to two-thirds of the bottom longitudinal reinforcement should be bent up near the supports. This is especially recommended in members continuous over several supports. Additional diagonal tension reinforcement in the form of stirrups must be used near the supports. The vertical stirrups can be made from wire or packing case straps when available; they can also be improvised from split sections of bamboo bent into U-shape, and tied securely to both bottom longitudinal reinforcement and bent-up reinforcement. Spacing of the stirrups should not exceed 6 inches.

c) **Anchorage and Splicing of Reinforcements**

Dowels in the footings for column and wall reinforcement should be imbedded in the concrete to such a depth that the bond between bamboo and concrete will resist the allowable tensile force in the dowel. This imbedded depth is approximately 10 times the diameter of whole culms or 25 times the thickness of 3/4 inch wide splints. In many cases the footings will not be this deep; therefore, the dowels will have to be bent into an L-shape. These dowels should be either hooked around the footing reinforcement or tied securely to the reinforcement to insure complete anchorage. The dowels should extend above the footings and be cut so that not more than 30 percent of the splices will occur at the same height. All such splices should be overlapped at least 25 inches and be well tied.

Splicing reinforcement in any member should be overlapped at least 25 inches. Splices should never occur in highly stressed areas and in no case should more than 30 percent of the reinforcement be spliced in any one location. To increase the flexural strength of bamboo reinforced concrete, the bamboo embedded can be wrapped with CFRP at various important locations which can help in increasing the strength of the BRC.

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