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REPLACEMENT OF STEEL REINFORCEMENT BY BAMBOO REINFORCEMENT IN CONCRETE BEAM

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Abstract

The present paper deals with cost-wise comparison of steel reinforcement with bamboo reinforcement. The utilization of bamboo reinforcement as replacement of steel reinforcement is gaining immense importance today, mainly on account of the improvement in the economical aspect combined with ecological benefits.
To study the effect of replacement of steel reinforcement by bamboo reinforcement, designs have been conducted providing beam of 750 mm length and 160mm×160mm. In this paper the designs are done on the basis on Flexural strength . Based on this study of cost and strength provided results have been discussed in the paper. To determine this, the tensile strength test and bending strength test is carried out on bamboo strips and steel specimen. Bamboo strips of length 275mm with 3/4 inch cross sections are used in this test and steel length 275 mm with 12 mm diameter are used in this test.
Also flexural strength test of bamboo reinforced beam is done to characterize the performance of bamboo as reinforcement. Doubly bamboo reinforced beams of 750 mm length having 160 mm width and depth is tested and is compared with bamboo concrete beam and steel reinforced beam. bamboo is a natural, cheap and also readily available material, it can be a substitute of steel in reinforcing of concrete structure. Authors have tested & evaluated physical and mechanical properties like compressive strength, tensile strength, Flexural test, Bonding strength, water absorption, density etc. of the selected bamboo species in material testing laboratory. Purpose of the experiments on bamboo strips is for validation and justification of these results confirm the application of bamboo as reinforcement element.
Concrete mix for M-20 grade concrete has been found as per design requirement of the IS code 10262-2009. The bamboo sticks were seasoned for about 2 to 3 weeks and then they were used as reinforcement. The flexural test results showed that steel reinforced concrete beam had the highest flexural strength compared to others.

KEYWORDS: *Bamboos, steel, Node & end Split, Renewable natural resource, Water absorption & waterproofing agent Bamboo, flexural strength, , SRC beam, BRC beam, etc.*

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1. INTRODUCTION

India is a country with rich resources of bamboo, In the world India is the second largest country with rich bamboo resource. Bamboo grows naturally in thousands of hectares of forest land, also grown in private plantations and in homesteads. There are 130 types of different species in India, which spreads across the states. The commercially significant species are given below. 1. Bambusa balcooa 2. Bambusa bambos 3. Bambusa nutans 4. Bambusa pallida 5. Bambusa polymorpha 6. Bambusa tulda 7. Bambusa vulgaris 8. Dendrocalamus brandisii 9. Dendrocalamus giganteus 10. Dendrocalamus hamiltonii

• In recent year, steel prices are increasing day by day. The production of steel have high consumption of fossil fuel.

• Through research and test it has found that some species of bamboo have ultimate tensile strength appear to mild steel at yield point also bamboo is versatile material because its strength to weight ratio , easy workability and ability.

• So, it can be use in concrete at low load bearing structure bamboo is a gaint grass not a tree construction industry is one of the most polluting industries of the world.

• Production of 1 ton of steel emits > 2 ton of CO_2 in the atmosphere

• Production of 1 ton of bamboo consumes > 1 ton of CO_2 of the consumption

In recent times, the high cost and shortage of reinforcing steel in many parts of the world has lead to increasing interest in the possible use of alternative locally available materials for the reinforcement of concrete. In this project work, use of bamboo which is fast growing and ecologically friendly material for structural applications especially in a developing country like India is being considered as quite appropriate. Bamboo is an important non-wood forest resource which is found mainly in forest as well as non-forest areas of tropical regions of Asia. Bamboo reinforced concrete construction follows same design, mix proportions and construction techniques as used for steel reinforced. Just steel reinforcement is replaced with bamboo reinforcement. The steel as a reinforcing material is a demand that is increasing day by day in most of the developing countries. There is situations when the production is not found enough to face the demand for steel. Hence it is essential to have an alternative that is worth compared to steel. Bamboo is found in abundant, they are resilient and hence these can face the demand as a reinforcing material and become an ideal replacement for steel. The tensile strength property which is the main requirement of a reinforcing material is seen appreciable for bamboo, compared with other materials including steel. The structure of bamboo from its origin gives this property.

The material used as reinforcement in concrete should show all the essential properties to make the element structurally active under load. In the case of steel, steel to the desired proportion and test for the basic strength values as a quality check. Similarly, the process must be done for bamboo too. Bamboo is found in nature, they have in different species. Each species differs in their characteristics, texture, thickness and strength. Hence it is essential to know which species is best for reinforcing and which is not Balcoa bambusa bamboo species generally used for reinforcement.

1.1 WHY BAMBOO REINFORCEMENT

Through research it has been found that some species of bamboo have ultimate tensile strength same as that of mild steel at yield point. Experimentally it has been found that the ultimate tensile strength of some species of bamboo to that of mild steel and it varies from 140 N/mm2 – 280 N/mm2 bamboo is versatile material because of its high strength-to-weight ratio, easy workability and availability. The strength of bamboo is greater than most of the timber products. Bamboo can prevent pollution.

2. OBJECTIVE

1. Understanding the stress-strain relationship of bamboo split.
2. To compare flexure strength of RCC and BRC.
3. To investigate the bond with concrete.
4. To analysis of cost ratio or BRC or RCC.
5. The goal of this research is to determine the feasibility or bamboo reinforcement for concrete beam.

3. FUTURE SCOPE

Bamboo is a versatile material because of its high strength to weight ratio, easy workability and availability. The analysis of the replacement of steel with bamboo as reinforcement shows that reinforcement with bamboo is quite cheaper than that of steel reinforcement. The positive attributes of bamboo are listed, supporting its environment friendly naturel. But there are some negative attribute of bamboo were also given, focusing on its tendency to absorb water. Of those, the bonding between the bamboo and concrete is considered the biggest problem due to absorption of water and smooth wall of the bamboo culm. Also there is a need for the development of a simple design code for the application of bamboo as a construction material. Several researches are on going to overcome these problems. Many new techniques are being developed which may make bamboo the best constructional material in future. It has wide scope in low cost constructions. The goal of the bamboo reinforced concrete project is to design and build a wall that uses bamboo as a structural alternative to steel rebar in order to replicate the shear strength and load bearing capabilities that traditional rebar provides for concrete walls, while minimizing cost.

Cement: Portland Slag Cement conforming to IS: 455-1989 was used in the entire experimental study. The detail of physical properties of cement is presented below in tabular form.

4. APPLICATION

The application technology of bamboo reinforced concrete element in building structure, such as bamboo reinforced concrete beam, bamboo reinforced concrete column, bamboo reinforced concrete slab, bamboo reinforced concrete footing, bamboo reinforced concrete wall compound.

5. ADVANTAGES & DISADVANTAGES BAMBOO

5.1 ADVANTAGES OF BAMBOO

- It is Light, strong and versatile.
- It is Environment friendly.
- Easily Accessible to the poor.
- Self renewing resource of nature.
- Speedily growing
- Highly productive.
- Low Cost Material

5.2 DISADVANTAGES OF BAMBOO

- It requires preservation.
- Shaped by nature
- Durability- bamboo is subjected insects; for this reason, untreated viewed as temporary with an than 5 years.

•Jointing-although many jointing structural efficiency is low.
• Lack of design guidance and codes.
• Prone to catch fire very fast culms during wind, and is seen

6. SELECTION AND PREPARATION OF BAMBOO SELECTION

The following factors should be considered in the selection of bamboo culms (whole plants) for use as reinforcement in concrete structures:
• Use only bamboo showing a pronounced brown colour. This will insure that the plant is at least three years old.
• Select the longest large diameter culms available.
• Do not use whole culms of green, unseasoned bamboo.
• Avoid bamboo cut in spring or early summer. These culms are generally weaker due to increased fibre moisture content.

6.1 PREPARATION

• **Sizing**- Splints are generally more desirable than whole culms as reinforcement. Larger culms should be split into splints approximately 3/4 inch wide. Whole culms less than 3/4 inch in diameter can be used without splitting. Splitting the bamboo can he done by separating the base with a sharp knife and then pulling a dulled blade through the stem. The dull blade will force the stem to split open; this is more desirable than cutting the bamboo since splitting will result in continuous fibres and a nearly straight section
• **Seasoning**- When possible, the bamboo should be cut and allowed to dry and season for three to four weeks before using. The culms must be supported at regular spacing"s to reduce warping.
• **Waterproof Coatings**- When seasoned bamboo, either split or whole is used as reinforcement; it should receive a waterproof coating to reduce swelling when in contact with concrete. Without some type of coating, bamboo will swell before the concrete has developed sufficient strength to prevent cracking and the member may be damaged, especially if more than 4 percent bamboo is used.

Fig.1 (Speciman of Bamboo)

Fig.2 (Synethetic Resin)

6.2 CONSTRUCTION PRINCIPLES

In general, techniques used in conventional reinforced concrete construction need not he changed when bamboo is to be used for reinforcement.'

7. EXPERIMENTAL SETUP, INVESTIGATION AND MIX DESIGN

Test on Bamboo Reinforcedment

Fig.3 (Bending test on bamboo)

Fig.4 (Tensile test on bamboo)

Cement: Portland Slag Cement conforming to IS: 455-1989 was used in the entire experimental study. The detail of physical properties of cement is presented below in tabular form.

Table I Physical Properties of cement

properties	Results	Standard limits (IS:455)
Consistency	34%	-
Soundness	Expansion 3.5 mm	<10mm
Initial setting time (min)	90 minutes	>30 min
Final setting time	285 minutes	<600 min
Specific gravity	3.11	3.14
Fineness	4.0% Retain on 90 micron sieve	<10%
Compressive strength 1. 3days 2. 7days 3. 28 days	N/mm^2 20.00 31.00 38.0	N/mm^2 >16 >22 >33

According to table I, the test results are within permissible limits.

Aggregate: The test results conducted on fine and coarse aggregate for this Research work are given in table II and III respectively.

Table II Tests of Fine Aggregate

Sr. No.	Test	Fine Aggregate
1	Zone	III
2	Moisture content	0.20%
3	Specific gravity	2.55
4	Bulk density	1.62 gm/cc
5	Fineness Modulus	2.21
6	Water Absorption	1.37%

Table III Tests of Coarse Aggregate

Sr. No.	Test	Coarse Aggregate
1	Bulk density	1.87 gm/cc
2	Moisture content	0 %
3	Water absorption	0.2 %
4	Specific gravity	3.0
5	Fineness modulus	7.92
6	Crushing value	23.43 %
7	Impact value	16.0 %
8	Elongation index	9.30%
9	Flakiness index	8.5 %

Concrete mix design: M 20 grade of concrete has been decided for present work as per IS 10262:2009.

The mix proportions are given in Table IV

Table IV Quantity of Materials for M 20 Concrete

Water	Cement	fine	coarse
		aggregate	aggregate
201.21 kg/m3	425.73 kg/m3	592.32 kg/m3	1306.82 kg/m3
0.47	1	1.39	3.07

8 FLEXURAL STRENGTH

Flexural strength tests were performed on bamboo reinforced concrete beams (BRC), and steel reinforced concrete beams (SRC) for both the sizes (160 x 160 x 750 mm and 160 x 160 x 750 mm). During the experimental test, load carrying capacity of the beam and the type of failure were observed. The maximum failure loads were recorded. At the same time, deflection of beams under load were recorded.

Fig.5 (Bamboo Reinforced Beam)

Fig.6 (Steel Reinforced Beam)

8.1 Flexural strength for 7 days

Sr.no.	Beam	Bamboo beam (N/mm^2)	Steel beam (N/mm^2)
1	Flexure strength specimen 1	6.15	8.29
2	Flexure strength specimen 2	7.53	9.59
	Avg	6.84	8.84

8.2 Flexural strength for 28 days

Sr.no.	Beam	Bamboo beam (N/mm^2)	Steel beam (N/mm^2)
1	Flexure strength specimen 1	9.78	15.26
2	Flexure strength specimen 2	10.16	16.99
	Avg	9.97	16.12

Design of bamboo reinforced concrete BRC beam and steel reinforced concrete SRC beam

Type of beam	BRC beam	SRC beam
Size of beam	160*160*750	160*160*750
Grade of concrete	M20	M20
Type of reinforced	bar treated bamboo sticks	under reinforcement
Percentage reinforced provided	1.20%	1.20%
Reinforcement provided	4 bamboo sticks @ 3/4 inch	4 NOS. 12mm
Cover	25mm	25 mm

9 RESULT

The following are Result for average flexure test

SR. NO.	Beam characteristics	BRC (KN)	RCC (KN)
1	Cracking load for 7 days	37.37	48.61
2	Cracking load for 28 days	54.48	88.085
3	Deflection for 7 days	7.38	8.82
4	Deflection for 28 days	7.42	6.75

Analysis of estimation of both steel and bamboo reinforcement

Item	Steel (4 sample)	Bamboo (4 sample)
Beam	1770 Rs/-	1260 Rs/-

Comparison between cost of steel and bamboo reinforcement concludes with the result that structure reinforced with bamboo as a reinforced found cheaper than that of with steel reinforcement.

10 CONCLUSION

Bamboo shows reasonable tensile strength, which suggests that it can be used as reinforcement in RCC structure for low cost housing projects. The flexural strength of SRC beam is found higher with respect to all other types of beam. The flexural strength of BRC beam is found least. This is true for both the sizes of the beams. At the same load, the deflection of BRC beam is higher with respect to SRC beams. While at the same load, the deflection of SRC beam is found least. This study gives bamboo as a potential material to be used as reinforcement for low load bearing structures.

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