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Study on Bamboo as Reinforcement in Concrete Structures

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Abstract -*It is a fact that the construction industry is the main consumer of energy and materials in most countries. The motivation for such replacement is typically cost—bamboo is readily available in many tropical and sub-tropical locations, whereas steel reinforcement is relatively more expensive—and more recently, the drive to find more sustainable alternatives in the construction industry.*

The use of bamboo which is fast growing and ecologically friendly material for structural applications is being considered as quite appropriate. The tensile strength of bamboo is quite high and can reach up to 125 MPa. This makes bamboo a pretty alternative to steel in tensile loading applications. Based on this study of cost vs strength provided results have been discussed in the paper.

Key Words: *Bamboo, Flexural Strength, Economical, Estimation Cost, etc.*

1.INTRODUCTION

The timber demand is increasing at a rapid rate but the timber supply is decreasing. It is been found through research that bamboo can suitably replace timber and other materials in construction and reinforcement material. Bamboo is natural, cheap, widely available and most importantly strong in both tension and compression. The tensile strength of bamboo is relatively high and can attain 357 MPa. The use of steel should be limited since it is very costly and most energy consuming, so overcome this all-problem bamboo is one of the suitable replacements of reinforcing bar in concrete for low-cost constructions.

1.1 Bamboo as Construction Material

Throughout study it has been found that species of bamboo have ultimate tensile strength same as mild steel at yield point. The ultimate tensile strength of bamboo it varies from 120KPa to 250KPa. The compressive strength of bamboo is greater than the compressive strength of concrete and the tensile strength of bamboo is close to steel. Bamboo can be bended without breaking. (e.g. [1]).

1.2 Strength Properties of Bamboo

The Compressive strength of bamboo is 19.76 KN/m2 at bottom and then slightly increasing29.36KN/m2, for untreated bamboo sample and the compressive strength of bamboo is 36.63KN/m2, for treated bamboo sample. bamboo is stronger than steel in the tensile strength. Steel has a tensile strength of 23,000 pounds per square inch. But bamboo tensile strength 28,000 pounds.

2. Methodology

2.1 Selection and Preparation of Bamboo

2.1.1. Sizing Bamboo

The split culms should be fourth-third inch. Select the longest large diameter culms.

2.1.2. Seasoning of Bamboos

Use only **bamboo** looking a pronounced brown colour. Bamboo will be three years old. Do not use whole culms of green, unseasoned **bamboo**. Avoid **bamboo** cut in early summer. But regular support should be provided at culms.

2.1.3. Bending of Bamboo

Bamboo can be bend in wet or dry condition by applying loading. (Making C shaped stirrup for supporting)

2.1.4. Waterproof Coatings

The overcome swelling problem when contact with concrete provided the brush coat or dip coat of asphalt emulsion and other type coating is tar, paint etc.

2.2 Construction Processes

2.2.1 Mix Proportion

The Mix Design of bamboo concrete is same as steel reinforcement concrete. The concrete should be low workability and early strength cement for gain early strength due to swelling problem.

2.2.2. Placement

The whole diameter of bamboo should be same adopted. Bamboo should not be placed near the 1- 1.5 inches face of concrete portion. The clear spacing between bamboo rod should not be less than the ½ inches and spacing of stirrup should not be more than the 6 inches.

e.g.fig.2

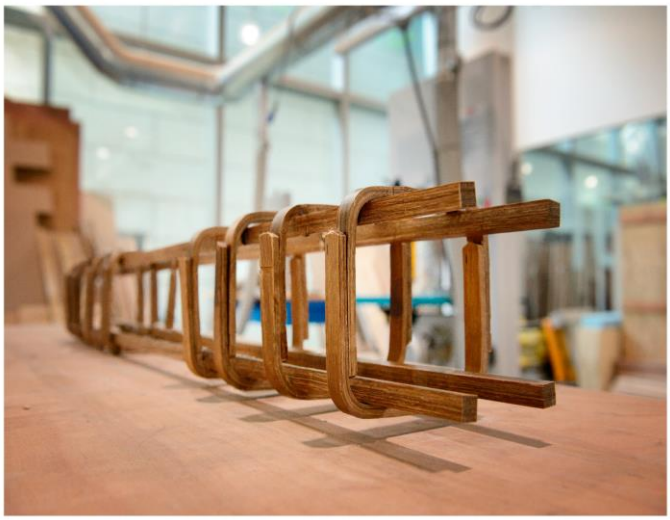


Fig -2: Frame of Bamboo Column

3. Design Principles

The Design properties of bamboo concrete structure is similar to the steel concrete structure.

Table -1: Mechanical Properties of Bamboo

Mechanical Property	Symbol	Value	Unit
Ultimate compressive strength		36.60	MPa
Allowable compressive strength	σ	$56*10^3$	MPa
Ultimate tensile strength		295	MPa
Allowable tensile strength	σ	170.64-104.82	MPa
Allowable Bond stress	μ	$27.58*10^3$	MPa
Elasticity Modulus	E	$2*10^6$	MPa

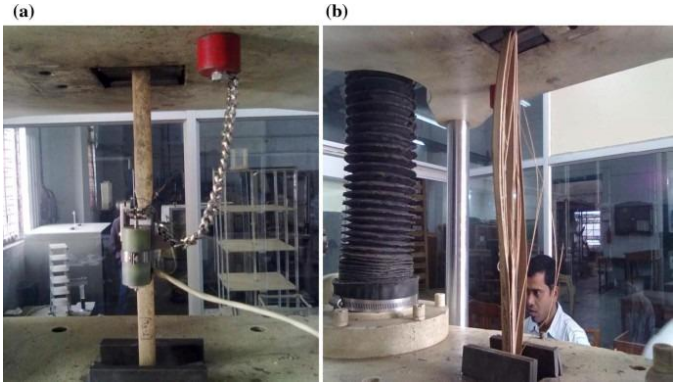
3.1 Ultimate Compressive Strength Test

The 10 cm length of bamboo taken throughout whole length with varying diameter. e.g. [fig-3]

Fig -3 Compressive Strength Test

3.2 Ultimate Tensile Strength Test

The taken sample for tensile strength similar of compressive strength and take some precaution for good result of test. (Contained at one knot in sample and avoid the any imperfection) e.g. [fig-4]



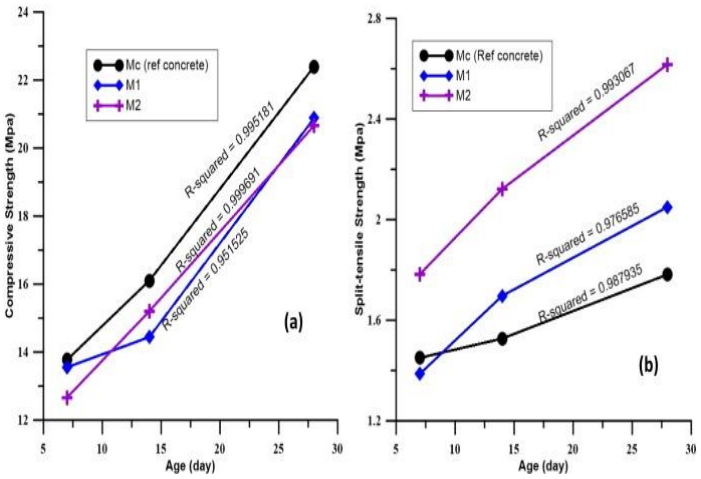


Chart -1: Compressive and Tensile Strength

3.3Design of Bamboo Reinforced

- Calculation of constants. –

For the given set of stresses, determine KC, JC and RC.

Kc= M σcbc/M σcbc+~st

Jc= 1-(Kc/3)

Rc= 0.5*L*Kc* Jc

• Calculation of bending moment. Assume suitable values of overall depth and breadth of beam, and determine the effective span. Calculate self-weight and total U.D.L. and maximum bending moment.

• Design of the section. Calculate the effective depth of the beam by the expression:

d= [(M)/ (RC*b)] 0.5

• Reinforcement. Calculate the area by the formula.

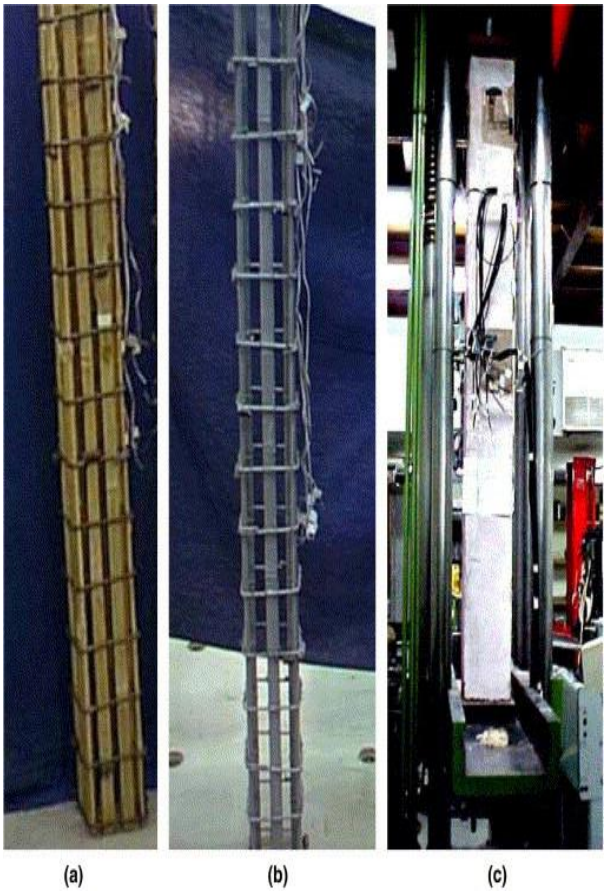
Ast= [(M)/ (σst*Jc*d)]

where ~st =permissible tensile stress in steel.

• Shear Reinforcement. Calculate the maximum shear force in the beam.

• Check for Development length at the end.

Ld<= (M1/V) +L0.



(a) (b) (c)

4. Result

The analysis of bamboo sample: -

Sample	Load (KN)	Max. Deflection(mm)
Bamboo1	30.45	0.85
Bamboo2	42.74	0.68
Bamboo3	22.58	0.56
Bamboo4	10.25	0.23

Sample	Stress (N/mm2)	Moment (KN-mm)
Bamboo1	50.26	$6*10^6$
Bamboo2	60.32	$8.1*10^6$
Bamboo3	32.45	$2.7*10^6$
Bamboo4	10.26	$1.2*10^6$

4. CONCLUSIONS AND FUTURE SCOPE

4.1 CONCLUSION

This is a good idea for low-cost economical budget building structure. In this structure both distribution bar and main bars had taken bamboo reinforced. In this study, this technique should be taken for single story building. The bamboo reinforcement technique is cheaper than steel reinforcement technique.

4.2 FUTURE SCOPE

It is widely future scope low-cost construction.

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