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# Comparative Studies of Steel, Bamboo and Glass Fiber as Reinforcing Bars in Concrete Tensile and Flexural Characteristics

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ABSTRACT

This study comparatively evaluated the flexural performance and deformation characteristics of concrete elements reinforced with bamboo (Bambusa vulgaris), Glass fiber and the twisted steel rebars. The yield strength (YS), ultimate tensile strength (UTS) and the elongation of 9 specimens of the three materials were determined using a universal testing machine. These beams of concrete strength 25 N/mm2 at age 7, 14 and 28 days were separately reinforced with bamboo, glass fiber and steel bars of same percentage, while the stirrups were essentially mild steel bars. It is Determined that out of three which material sample is suitable rebars for non-load bearing and lightweight RC flexural structures also bonding and load-carrying capacity.

**Keywords :** Deformation, concrete beam, reinforcement, Tensile strength, Fiber.

## I. INTRODUCTION

Reinforced concrete (RC) structures account for majority of the constructed facilities globally and their performance is greatly influenced by the properties of the reinforcing bars. The transfer of stress from concrete to steel is made possible through effective bond between concrete and the reinforcement. Previous studies on the chemical, physical and strength characteristics of steel reinforcing materials revealed the dangers of maximizing profit at the expense of quality, a situation that pose a major challenge to the structural

reliability and durability of buildings and civil infrastructure. Although extensive studies have been carried out on synthetic and natural non-ferrous reinforcing materials in the past decades, natural reinforcement still remains a dynamic field of further investigation.

## II. LITERATURE SURVEY

**Navin Chand, Mukul Shukla & Manoj Kumar Sharma** found that the Tensile strength of bamboo has been experimentally determined parallel and perpendicular to the fibre direction. Different properties are exhibited in two directions in bamboo due to the basic structural difference present in the two directions. Striking differences exist in the distribution of cells within one culm, both horizontally and vertically. Stress and strain values of bamboo under tensile loads are also determined by using the Finite Element Method (FEM) software ABAQUS and the failure load patterns have been generated and analyzed. Flexural strength and deflection in bamboo determined experimentally

matches closely with the FEM generated values. Numerous studies have been carried out on natural reinforcing materials such as wood **(Andonian *et al.*),** jute **(Manzur and Aziz),** bamboo **(Kankam *et al.*)**, raffia palm **(Kankam)** and palm stalk **(Kankam).** Attention is gradually been focused on the use of bamboo (*Bambusa vulgaris*), rattan (*Calamus deerratus*) and other natural fiber reinforcing materials as alternative reinforcements in concrete especially for low-cost housing for rural communities. In rural communities of Ghana, babadua is used in thatching and its stems are tied into framework of houses before daubing with mud (Schreckenbach and Abenkwa).

Although extensive literature abound on natural rebars in reinforced concrete structures, no clear comparative investigations had been done on steel, bamboo and glass fiber under similar geometric and loading conditions to determine the relative capacities and thereby establishing the limits to the applicability of the natural rebars. Hence, this study will present the experimental study to comparatively evaluate the flexural behaviour of concrete beams reinforced with steel, bamboo and Glass fiber. The physical and tensile strength properties of steel, bamboo and Glass fiber were first determined and the flexural capacities of concrete beams reinforced with the individual materials bars were evaluated. The limits of usage of bamboo and Glass fiber bars as reinforcement were established with respect to the steel RC beams.

The primary objective of this paper is to investigate the variation in stability of beams of different reinforcing materials, also
To determine the tensile properties of the three reinforcing material beams.

The elongation of which sample may or may not be ductile.

Methodology Considered:

- The physical and tensile strength properties of steel, bamboo and rattan were determined experimentally using a 600 kN capacity universal testing machine (UTM)
- Ordinary Portland cement was used. The aggregates which comprises river sand and crushed granite of 20 mm maximum nominal size was used.
- Mixed at a water-cement ratio of 0.45.
- Twelve 150 × 150 × 900 mm concrete beam specimens were produced and grouped into three.
- In rebar case 10Φ4 bars and stirrups were 10Φ8 mm steel bars spaced at 100 mm centre and the nominal cover was 25 mm.
- In Glass fiber case Glass fiber is used as much A.s.t is required and stirrups were 10Φ8 mm steel bars spaced at 100 mm centre and the nominal cover was 25 mm.
- In Bamboo fiber case Bamboo fiber is used as much A.s.t is required and stirrups were 10Φ8 mm steel bars spaced at 100 mm centre and the nominal cover was 25 mm.
- In case of mix sample of both 50% of each material is taken as per required Ast %.

**Test Preparation**

The tensile test is conducted on UTM. It is hydraulically operates a pump, oil in oil sump, load dial indicator and central buttons. The left has upper, middle and lower cross heads i.e; specimen grips (or jaws). Idle cross head can be moved up and down for adjustment. The pipes connecting the lift and right parts are oil pipes through which the pumped oil under pressure flows on left parts to more the cross-heads.

Fig:1 Preparation of beams

Fig:2 Testing machine U.T.M.

## III. Test Results

**Failure loads for beam**

| Beam | First crack load, Fc (KN) | Ultimate load failure, Fu (KN) | Fc/Fu | Flexural Strength (N/mm²) |
|---|---|---|---|---|
| R/f beam | 19 | 33 | 0.575758 | 12.1 |
| glass fiber beam | 12 | 18 | 0.666667 | 6.4 |
| bamboo beam | 7 | 7.5 | 0.933333 | 3.21 |
| Glass & Bamboo fiber mix | 9.8 | 12 | .732 | 5.45 |

Failure mode and crack characteristics

| Beam no. | mode of failure | type of crack at failure | experimental min. crack width |
|---|---|---|---|
| R/f beam | shear | Diagonal | 9.1 |
| glass fiber beam | flexural | Vertical | 6.4 |
| bamboo beam | shear | Vertical | 7.2 |
| Glass & Bamboo fiber mix | Shear | Diagonal | 6.10 |

**Conclusion and Discussion:**

As I have did experimental study on laboratory and prepared a comparative study, it can be concluded that R.C.C. beam is comparatively more stable in load resisting but in comparison we can also prefer glass fibre or Glass fiber and bamboo fiber mix one as depends on load resisting requirements, following are

the conclusions mentions below as per results find out in 7 day, 14 day and 28 days sample:

1) The tensile properties of the three reinforcing materials are normally distributed and their stress ratios satisfied the minimum requirement value of 1.08. The strength of Glass fiber and bamboo represented 45% and 17% of that of steel reinforcing bars respectively.

2) The elongation of bamboo did not meet the ductility requirements of 12%, glass fiber marginally satisfied this, but steel rebars fully met the requirements.

3) Bamboo and glass fibre can only be used for lightweight RC structures. The flexural stiffness of bamboo and glass fibre RC beams was about 13.5% and 33% respectively of the conventional steel bars RC beams.

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