

Study Of Bamboo Fiber as A Strength Enhancer in Concrete

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Abstract—Concrete is one of the most widely used construction materials due to its high compressive strength, durability, and ease of availability. However, conventional concrete suffers from prone to cracking. The use of natural fibres in concrete has emerged as an effective solution to improve its performance while promoting sustainable construction practices. Bamboo Fiber is a renewable, biodegradable, and environmentally friendly material with excellent tensile properties.

This study investigates the effect of bamboo Fiber on the compressive strength of M20 grade concrete. Bamboo Fiber was added at proportions of 0%, 0.25%, 0.50%, 0.75%, and 1.00% by weight of cement. Concrete cubes of size 150 mm × 150 mm × 150 mm were cast and tested after 7 and 28 days of curing. The results revealed that the addition of bamboo Fiber improved compressive strength up to an optimum content of 0.25%. The maximum compressive strengths obtained were 18.38 MPa at 7 days and 26.98 MPa at 28 days. Higher Fiber contents resulted in reduced strength due to poor workability and Fiber clustering. The study concludes that bamboo Fiber can be effectively utilized as a sustainable reinforcement material in concrete.

Index Terms—Bamboo Fiber, Sustainable Concrete, Fiber Reinforced Concrete, Compressive Strength, M20 Concrete, Natural Fibres.

I. INTRODUCTION

Concrete is the most commonly used construction material in the world. It is extensively utilized in residential buildings, commercial structures, bridges, roads, dams, and various infrastructure projects. Although concrete exhibits high compressive strength,

its tensile strength is relatively low, making it susceptible to cracking and brittle failure.

To overcome these limitations, different types of fibres are incorporated into concrete. Fiber reinforcement improves toughness, crack resistance, ductility, and energy absorption capacity. In recent years, natural fibres have gained significant attention due to their environmental benefits and low cost.

Bamboo is one of the fastest-growing natural resources and possesses excellent tensile strength. Bamboo fibres can be extracted easily and used as reinforcement in concrete. The use of bamboo Fiber reduces environmental impact while enhancing the engineering properties of concrete. Therefore, this study focuses on evaluating the effect of bamboo Fiber on the compressive strength of M20 grade concrete.

1.2. Objectives Of the Study

The main objectives of this study are:

1. To investigate the effect of bamboo Fiber on the compressive strength of concrete.
2. To determine the optimum bamboo Fiber content for M20 concrete.
3. To evaluate the behaviour of bamboo Fiber reinforced concrete at 7 and 28 days.
4. To compare the performance of conventional concrete and bamboo Fiber reinforced concrete.

1.3 Problem Statement

Conventional concrete suffers from the following problems:

- Brittle behavior
- Shrinkage cracking

- Environmental impact due to steel and cement usage

II. MATERIALS USED

The materials used in the present study are:

❖ Cement

Ordinary Portland Cement (OPC) conforming to relevant Indian Standards was used.

❖ Fine Aggregate

Natural river sand free from impurities was used as fine aggregate.

❖ Coarse Aggregate

Crushed stone aggregate of suitable grading was used.

❖ Water

Potable water suitable for drinking was used for mixing and curing.

❖ Bamboo Fibre

Natural bamboo fibres were used as reinforcing material.

❑ Test conducted on materials

Material	Test Conducted
Cement	Standard consistency, setting time
Fine Aggregate	Sieve analysis, fineness modulus
Coarse Aggregate	Specific gravity, water absorption

III. METHODOLOGY

The methodology adopted in this study consists of the following steps:

- 1) Collection Of Materials.
- 2) Preparation Of Bamboo Fibres.

3.1 Bamboo Fiber Specification

Parameter	Value
Fiber Length	30 mm
Fiber Thickness	1 mm
Fiber Type	Natural Bamboo Fiber
Condition	Clean and Dry
Mixing Percentage	0% – 1% by weight of cement

❑ for 1.5 kg Cement (Per Cube) and Total for 3 Cubes

❑ Formula Used

$$\text{Fiber Quantity} = \text{Fiber \%} / 100 \times \text{Weight of Cement}$$

Fiber Percentage	Calculation for 1 Cube	Fiber Required for 1 Cube	Total Fiber Required for 3 Cubes
0.25%	$(0.25/100) \times 1.5$	3.75 g	11.25 g
0.50%	$(0.50/100) \times 1.5$	7.50 g	22.50 g
0.75%	$(0.75/100) \times 1.5$	11.25g	33.75 g
1.0%	$(1.00/100) \times 1.5$	15.00 g	45.00g

3) Concrete Mix Preparation

3.3.1 Concrete Mix Design

❑ Given Data

1. Grade of Concrete = M20
2. Mix Ratio = 1 : 1.5 : 3
3. Water Cement Ratio = 0.52
4. Size of Cube = 150 mm × 150 mm × 150 mm
5. Fiber Percentages: 0%, 0.25%, 0.50%, 0.75%, 1.00%

3.3.2 Material Calculation

$$\text{Material Quantity} = \text{Total Ratio} / \text{Mix Proportion} \times \text{Dry Volume}$$

Material	calculation	Qty. for 1 cube	Qty. for 3 cube
Cement	$(1/5.5) \times 0.00571 \times 1440$	1.5 kg	4.5 Kg
Fine aggregate	$(1.5/5.5) \times 0.00571 \times 1600$	2.5 kg	7.5 Kg
Coarse aggregate	$(3/5.5) \times 0.00571 \times 1500$	4.7 kg	14.1 Kg
water	0.52×1.5	0.78 L	2.34 L

- 4) Casting Of Cubes
- 5) Curing Of Specimens
- 6) Compression Testing
- 7) Analysis Of Results



Concrete cubes of size 150 mm × 150 mm × 150 mm were cast for each Fiber percentage. The specimens were demoulded after 24 hours and cured in water for 7 and 28 days.

IV. RESULTS AND DISCUSSION

Table 1: Compressive Strength Results at 7 Days

Fiber%	Average Load (kN)	Average Weight (kg)	Strength (MPa)
0.00	326.0	8.687	14.49
0.25	413.7	8.809	18.38
0.50	362.93	8.525	14.30
0.75	354.3	8.733	15.75
1.00	234.4	8.404	10.42

Discussion

The addition of bamboo Fiber improved the compressive strength up to 0.25%. The maximum strength of 18.38 MPa was obtained at 0.25% Fiber content. This represents approximately 26.85% improvement over conventional concrete.

Table 2: Compressive Strength Results at 28 Days

Fiber%	Average Load (kN)	Average Weight (kg)	Strength (MPa)
0.00	563.7	8.687	25.67
0.25	573.7	8.781	26.98
0.50	566.8	8.467	25.29
0.75	368.1	8.730	16.35
1.00	436.6	8.397	19.45

Discussion

The highest compressive strength at 28 days was observed for 0.25% bamboo Fiber content. The increase in strength is attributed to the crack-bridging mechanism provided by bamboo fibres. Excessive

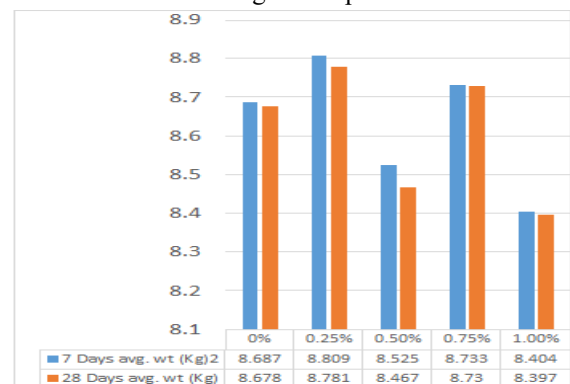
Fiber addition reduced workability and created weak zones within the concrete matrix.

Table: Summary of Compression Test Results

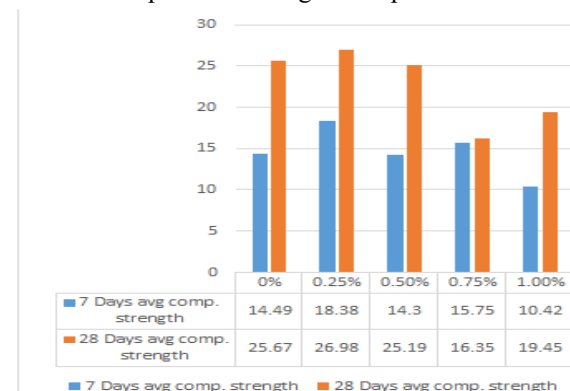
Fiber Content (%)	Average Load at 7 Days (kN)	Strength at 7 Days (MPa)	Average Load at 28 Days (kN)	Strength at 28 Days (MPa)	Performance
0.00	326.0	14.49	563.7	25.67	Control Mix
0.25	413.7	18.38	573.7	26.98	Best Performance
0.50	362.93	14.30	566.8	25.29	Moderate
0.75	354.3	15.75	368.1	16.35	Reduced Strength
1.00	234.4	10.42	436.6	19.45	Lowest Performance

V. GRAPHICAL REPRESENTATION ANALYSIS

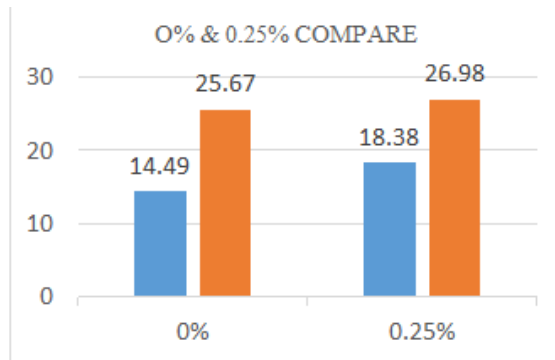
5.1 Weight Comparison



5.2 Compressive Strength Comparison Chart



5.3 Comparison Between Normal Concrete & 0.25% Bamboo Fiber Added Concrete



Key Finding: The optimum bamboo Fiber content was 0.25% by weight of cement, providing the highest compressive strength at both 7 and 28 days.

VI. CONCLUSION

Based on the experimental investigation, the following conclusions were drawn:

1. Bamboo Fiber can be successfully incorporated into concrete.
2. The optimum bamboo Fiber content was found to be 0.25%.
3. Maximum 7-day compressive strength obtained was 18.38 MPa.
4. Maximum 28-day compressive strength obtained was 26.98 MPa.
5. Bamboo Fiber improved crack resistance and ductility.
6. Higher Fiber contents reduced strength due to poor workability and Fiber clustering.
7. Bamboo Fiber reinforced concrete provides a sustainable and eco-friendly alternative to conventional concrete.

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