

Experimental Investigation On The Mechanical Performance Of Concrete Reinforced With Sugarcane And Polypropylene Fibers

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ABSTRACT

This study begins by introducing the basic components of concrete and addressing environmental concerns associated with its production, particularly the depletion of natural aggregates. As potential solutions fiber-reinforced concrete (FRC) is explored for their ability to enhance sustainability. A comprehensive review of existing literature follows, covering natural fibers, their treatment methods and the potential benefits of combining these materials in concrete. The study then defines its objectives and scope, focusing on evaluating the effects of natural fibers on the compressive strength, workability, and density of concrete, while also assessing their role in promoting environmental sustainability.

Experimental investigation involves the mix design for M25 grade concrete, preliminary testing, and casting and testing of concrete cubes and beams, offering insights into the performance of fiber-reinforced concrete.

Keywords: Fiber Reinforcement Concrete, Workability of Concrete, Density of Concrete, M25 Grade Concrete, Eco-efficient Concrete.

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INTRODUCTION

Concrete is one of the most widely used construction materials due to its high compressive strength, versatility, and cost-effectiveness. However, it has tensile and flexural strength limitations, resulting in brittleness and vulnerability to cracking. This study explores the potential of fiber-reinforced concrete (FRC), incorporating sugarcane fibres and polypropylene (PP) fibers, to address these challenges by enhancing mechanical properties like crack resistance, toughness, and tensile strength.

Traditional fibers like steel and polypropylene have been commonly used in FRC, contributing to enhanced durability and resistance to dynamic loads. Yet, the environmental impact associated with these industrial fibers has spurred interest in more sustainable alternatives. This study examines corn straw—a renewable, low-cost agricultural byproduct—as an eco-friendly fiber, alongside PP, to improve concrete's performance while aligning with sustainable construction goals.

1.1. OBJECTIVE

- To evaluate the feasibility of incorporating sustainable fibres, such as sugarcane and polypropylene fibers, into concrete and to

investigate their effects mechanical properties such as compressive strength, flexural strength, and water absorption.

- To develop a cost-efficient fiber-reinforced concrete with adequate structural performance while reducing environmental impacts.
- To use the concept of machine learning in predicting the optimal fiber composition.

2.0 LITERATURE REVIEW

2.1 Overview of Fiber-Reinforced Concrete (FRC)

Fiber-reinforced concrete (FRC) has gained significant attention due to its ability to improve the mechanical performance and sustainability of conventional concrete. Studies indicate that the incorporation of natural and waste fibers enhances tensile strength, crack resistance, and durability, although workability may be adversely affected. Agricultural waste materials such as sugarcane bagasse ash (SBA) and corn stalk ash (CSA) further contribute to sustainability by reducing reliance on conventional cementitious materials. Hybrid fiber systems have shown promising results in optimizing strength and durability, with coir fiber demonstrating a notable increase in compressive strength by up to 42.19%. However, research gaps remain

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in understanding combined fiber effects, fiber–cement bonding mechanisms, and optimization techniques such as machine learning.

2.2 Natural Fiber Incorporation in Concrete

Babar Ali et al. (2022) investigated coir fiber-reinforced cementitious composites, focusing on bond behavior, absorption capacity, and workability. The study concluded that coir fibers enhance tensile toughness, ductility, and impact resistance. However, higher fiber content reduces workability and density due to fiber balling. The optimal fiber content was identified as 1–2% by weight of cement.

Maglad et al. (2023) reviewed the use of agricultural waste ash (AWA), particularly SBA and CSA, as partial cement replacements. Their findings highlighted improved sustainability and adequate mechanical performance. Experimental studies involving slump flow tests, compressive strength, and chemical composition analysis confirmed the feasibility of these materials in ultra-high-strength concrete applications.

Kiamahalleh et al. (2024) emphasized that natural fibers improve flexural strength and contribute to sustainable construction. Microstructural analyses, including SEM and nitrogen adsorption tests, revealed enhanced durability and reduced porosity in fiber-reinforced mixes.

Lin Chen et al. (2023) conducted a comprehensive review of 196 studies and reported that natural fibers significantly improve tensile strength and crack resistance. However, compressive strength may decrease slightly. The study also highlighted that most applications remain at the laboratory stage, with limited field implementation.

Wang et al. (2024) analyzed natural fiber-reinforced foam concrete (NFRFC) and found that coir fibers increased compressive strength by 42.19%, while basalt fibers enhanced flexural performance. SEM and durability tests confirmed improved resistance to environmental cycles.

Nambiar et al. (2021) investigated high-performance concrete (HPC) incorporating jute fibers along with silica fume and fly ash. The results demonstrated improved strength and durability while reducing environmental impact.

Abdalla et al. (2022) reviewed natural fibers such as hemp, bamboo, and kenaf, highlighting improvements in tensile, compressive, and flexural strength. However, long-term durability remains insufficiently studied.

Ali et al. (2022) explored banana stem fiber (BSF) as reinforcement and reported enhanced mechanical properties and crack resistance compared to conventional concrete.

2.3 Agricultural Waste and Sustainable Materials

Cao et al. (2021) highlighted the role of green concrete in reducing CO₂ emissions through the use of waste materials such as tea waste. Their study incorporated advanced prediction models like ANFIS combined with metaheuristic algorithms to optimize concrete strength.

Zhou et al. (2022) emphasized the urgent need for energy-efficient construction materials due to increasing global energy consumption and environmental concerns. The use of agricultural waste fibers such as cotton stalks was identified as a sustainable alternative for building materials.

Kymlainen et al. (2021, 2022, 2024) explored bast fibers (flax, hemp) as sustainable materials for insulation, demonstrating competitive thermal performance compared to conventional materials, although further research is required to ensure consistent quality and performance.

2.4 Waste Fiber Incorporation in Concrete

Kareem et al. (2023) studied waste steel fibers (WSF) and waste tire rubber fibers (WTRF), demonstrating improved mechanical properties and sustainability. Response Surface Methodology (RSM) was used to optimize mix design.

Idrees et al. (2023) investigated waste carpet fibers and found improvements in tensile and flexural strength, along with enhanced durability against shrinkage and chloride penetration. However, workability and density were reduced.

Li et al. (2021) highlighted the environmental benefits of using scrap tire rubber in concrete as a sustainable waste management solution.

Bheel et al. (2024) explored millet husk ash and wheat straw ash, demonstrating improvements in compressive strength and durability, supporting their use in eco-friendly construction materials.

2.5 Hybrid Fiber Reinforcement in Concrete

Chen et al. (2023) and Zainal et al. (2020, 2024) examined hybrid fiber-reinforced rubberized mortar (RM), emphasizing the advantages of combining fibers to overcome limitations of single-fiber systems. Hybridization improved mechanical properties and addressed bonding issues associated with crumb rubber.

Gamage et al. (2022, 2024) reviewed the combined effects of natural and synthetic fibers, identifying shrinkage reduction and improved durability. The study also highlighted the need for systematic evaluation of hybrid fiber interactions.

Jingjing He et al. (2024) conducted an experimental study on corn straw and scrap steel fibers, reporting significant improvements in compressive (14.96%), tensile (42.90%), and flexural strength (16.30%). The optimal combination was identified as 0.8% corn straw and 0.6% steel fibers.

Yinh et al. (2021) explored fiber-reinforced polymers (FRP), particularly sisal-based FRP, and highlighted improvements in strength and ductility, although challenges such as debonding remain.

2.6 Research Gaps Identified

Despite extensive research, several gaps remain:

- Limited studies on combined effects of natural and synthetic fibers
- Lack of systematic optimization of hybrid fiber proportions
- Insufficient understanding of fiber–cement bonding mechanisms
- Limited application of machine learning and AI techniques for mix design optimization
- Need for deeper investigation into low-cost sustainable fibers such as corn straw and agricultural residues

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- Challenges in durability, shrinkage behavior, and long-term performance

setting, OPC 53 is chosen to ensure that masonry bricks have the necessary compressive strength.

2.7 Summary and Research Direction

The literature confirms that fiber reinforcement significantly enhances concrete performance, particularly in tensile strength, crack resistance, and durability. Natural and waste fibers contribute to sustainability, while hybrid fiber systems offer superior performance compared to single-fiber mixes. However, further research is required to optimize fiber combinations, improve bonding characteristics, and integrate advanced computational techniques for mix design. Future studies should focus on developing cost-effective, sustainable, and high-performance fiber-reinforced concrete through optimized hybridization and advanced analytical approaches.

3.0 METHODOLOGY

3.1.1. Concrete Mix Design:

A standard mix using Ordinary Portland Cement, fine and coarse aggregates, and water is prepared, with fiber-free control samples for comparison.

3.1.2. Fiber Preparation:

Sugarcane is collected, washed, and treated with NaOH to improve bonding; PP fibers, sourced commercially, are used in lengths of 10–20 mm for optimal crack-bridging effects.

3.1.3. Fiber Dosage and Mixing:

Concrete is mixed with sugarcane and PP fibers at different dosages by volume in various combinations, using a mechanical mixer to ensure even fiber distribution. A slump test assesses workability for consistency.

3.1.4. Specimen Casting and Curing:

Samples, including 150x150x150 mm cubes for compressive strength and 100 x 100 x 500 mm beams for flexural testing, are cast and cured for 7&28 days under controlled conditions.

150x150x150 mm cubes will be prepared to evaluate

3.1.5. Compressive Strength:

compressive strength. Tested on 28-day cured cubes to evaluate load-bearing capacity.

3.1.6. Flexural Strength:

100x100x500 mm beams will be cast for flexural strength testing. Assessed through three-point bending tests on beam specimens, evaluating crack formation and resistance under bend.

3.1.7. Curing:

All specimens will undergo curing for 28 days in a controlled environment with constant temperature and humidity to ensure complete hydration and optimal strength development.

4.0 MATERIAL PROPERTIES

4.1. STUDY OF MATERIALS

4.1.1. CEMENT

Ordinary Portland Cement (OPC) 53 grade and recycled fine aggregates (RFA) from construction and demolition (C&D) waste, this study aims to create an environmentally friendly mortar mix. Because of its high strength and rapid



Figure 4.1: Cement

4.1.2 AGGREGATES

The materials used are natural coarse aggregate of size 20 to 30 mm and fine aggregate of size 75 micron to 4.75 mm from the local market.

The equipment used was tamping rod for compaction, weighing balance for accurate measurement, mixing tray for mixing concrete components, curing system and compression testing machine.



Figure 4.2: Fine aggregate and coarse aggregate

4.1.3. SUGARCANE FIBRES

Sugarcane Fibers will be sourced, cleaned, and treated with an alkali solution (e.g., NaOH) to enhance fiber-matrix bonding and increase fiber surface roughness. The fibers will then be cut into uniform lengths, typically ranging from 20 mm to 40 mm, to ensure consistency in the mix.



Figure 4.3: Sugarcane Fibers

4.1.4. POLYPROPYLENE FIBRES

Commercially available polypropylene (PP) fibers, known for their high tensile strength and resistance to chemical degradation, will be used. The fibers will be 12–20 mm in length to optimize crack-bridging performance.



Figure 4.4: Polypropylene Fibers

4.2. TEST ON MATERIALS

PRELIMINARY TESTS ON MATERIALS:

Concrete Mix Design: A standard concrete mix will be formulated using Ordinary Portland Cement (OPC), fine aggregates (sand), coarse aggregates (gravel), and water. A control mix (without fibers) will also be prepared for comparative analysis.

4.2.1. WATER ABSORPTION TEST (IS 2386 Part 3: 1963)

- The water absorption of fine and coarse aggregates was determined by soaking the aggregates in water for 24 hours, then surface drying them and measuring the change in weight.
- This test is essential to adjust the water-cement ratio to maintain the desired workability and strength of concrete.



Figure 4.5: Wire Basket

4.2.2. SIEVE ANALYSIS OF FINE AGGREGATE (IS 383:2016 & IS 2386 Part 1:1963)

- A sieve analysis was conducted on M-sand to determine its particle size distribution and classification as well-graded, poorly graded, or gap-graded.
- The sand was passed through IS standard sieves (4.75 mm to 150 μ m) and the retained percentage was calculated.
- Proper gradation ensures better packing of aggregates, reducing voids and improving the overall strength of concrete.



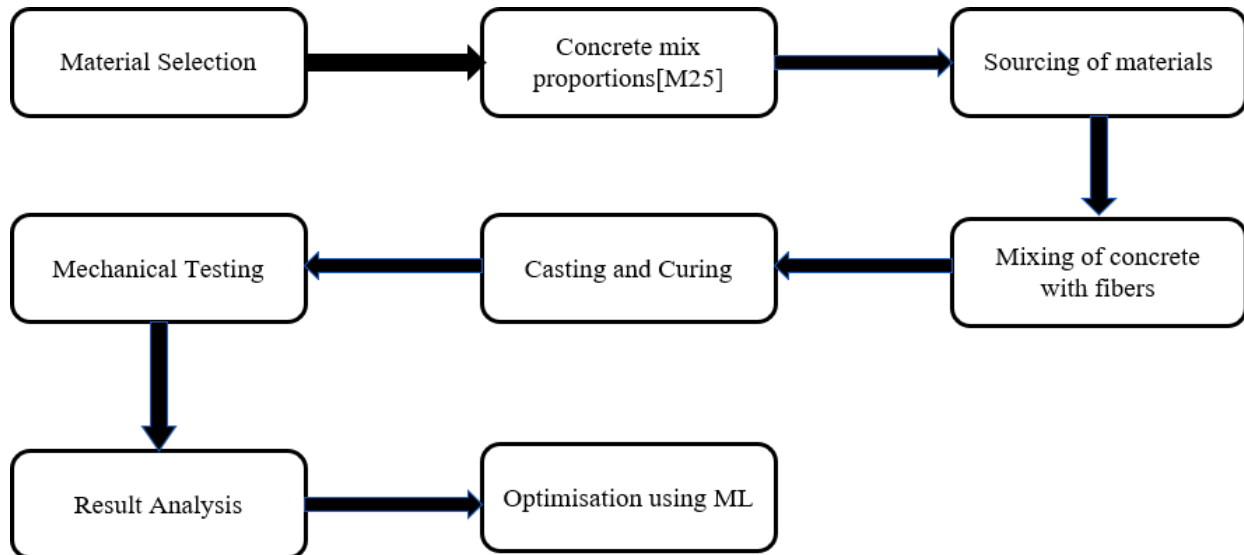
Figure 4.6: Sieve Set

4.2.3. AGGREGATE IMPACT TEST (IS 2386 Part 4:1963)

- The aggregate impact value (AIV) was determined to assess the toughness of the coarse aggregate and its ability to resist impact loads.
- The test was performed by subjecting the aggregates to repeated impact loading in a standard Impact Testing Machine and calculating the percentage of crushed material.
- As per IS standards, AIV less than 30% indicates good-quality aggregate suitable for structural concrete applications.
- These tests ensured that the selected materials met the standard specifications for strength, durability, and workability in fiber-reinforced M25 concrete.



Figure 4.7: Impact testing machine



- Sugarcane Fibers (C): 0.5% to 2.5% of cement weight

5.0 CASTING OF CUBES

5.1. CASTING OF CUBES USING SUGARCANE FIBRE AND POLYPROPYLENE FIBRE

5.1.1. MIX PROPORTION FOR M25 GRADE SPECIMENS WITH SUGARCANE AND POLYPROPYLENE FIBERS

Fiber Dosage:

Various fiber dosages will be explored, ranging from 0.5% to 1.5% by volume of the concrete. Combinations of sugarcane and polypropylene fibers will be used in different proportions (e.g., 0.5% sugarcane + 5% polypropylene, 1% sugarcane + 5% polypropylene, etc.) to assess their synergistic effects.

Mixing Process:

The concrete will be mixed in a mechanical mixer to ensure uniform distribution of fibers throughout the matrix. The fibers will be added gradually to prevent clumping, which could compromise the consistency of the mix. Mix Design Calculation for M25 Concrete Reinforced with sugarcane and Polypropylene Fibers. The mix design for M25 grade concrete was carried out with a fixed water-cement ratio (W/C) of 0.5. The concrete mix was reinforced with sugarcane fibers ranging from 0.5% to 2.5% and Polypropylene fibers (P) ranging from 5% to 20% by weight of cement. Final Mix Proportion (by weight):

The mix was proportioned as: Cement: Fine Aggregate: Coarse Aggregate = 1: 1.96: 3 Material Quantities (per m³ of concrete):

- Cement = 383 kg
- Water = 191.5 kg
- Fine Aggregate (FA) = 718.43 kg
- Coarse Aggregate (CA) = 1133.95 kg
- Addition of Fibers:
 - Polypropylene Fibers (P): 5% to 20% of cement weight



Figure 5.1: casting of cube

6.0 EXPERIMENTAL INVESTIGATION

6.1. TESTS ON MORTAR BRICKS WITH SUGARCANE AND POLYPROPYLENE FIBERS

6.1.1. COMPRESSIVE STRENGTH TEST (IS 516: 1959 & IS 456:2000)

The compressive strength test determines the ability of concrete to withstand axial loads and is a key indicator of its structural performance.

Procedure:

Specimen Preparation:

Concrete was properly mixed and compacted to avoid segregation and voids.

The specimens were cured for 7 and 28 days to achieve strength development.

Pre-Test Preparation:

The specimen was removed from the curing tank, and excess moisture was wiped off. The bearing surface of the Compression Testing Machine (CTM) was cleaned.

Testing:

The specimen was positioned centrally on the CTM base plate.

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Load was applied gradually and continuously at a uniform rate until the specimen failed.
The maximum load at failure was recorded.

Observations:

The compressive strength results were compared with IS 456:2000 requirements to verify compliance with the design mix.



Figure 6.1: Concrete Testing Machine

6.1.2. FLEXURAL STRENGTH TEST (IS 516:1959 & IS 456:2000)

The flexural strength test, also known as the modulus of rupture test, measures the ability of concrete to resist bending or tensile stress.

Procedure:

Specimen Preparation:

- Concrete was filled into molds in layers of equal thickness and compacted using a tamping rod.
- The specimens are cured for 7 and 28 days in water maintained at $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$.
- Pre-Test Preparation:
- The rollers of the testing machine were cleaned to ensure even load distribution.
- Any loose material was removed from the specimen surface.
- Testing:
- The specimen was positioned centrally on the supporting rollers along its longitudinal axis.
- A gradual and continuous load was applied through two symmetrical rollers until the specimen failed.
- The maximum load applied before failure was recorded
- Observations:
- The flexural strength results were analyzed to determine the mix's ability to withstand tensile stress, ensuring its suitability for structural applications.
-

6.1.3. WATER ABSORPTION TEST (IS 2386 Part 3:1963)

Objective:

To determine the water absorption capacity of concrete, which indicates its porosity and permeability characteristics.

Apparatus Required:

- Weighing balance (accuracy $\pm 0.1\text{g}$)
- Oven (capable of maintaining $100^{\circ}\text{C} - 110^{\circ}\text{C}$)
- Water container
- Towel or cloth for surface drying

Procedure:

Drying the Sample:

- Place the concrete specimen in an oven at a temperature of $100^{\circ}\text{C} - 110^{\circ}\text{C}$ for 24 hours.
- Remove the sample and allow it to cool in a dry environment.
- Weigh the dry specimen and record it as W_1 (dry weight).
- Water Absorption:
- Immerse the dried sample completely in water at room temperature for 24 hours.
- After 24 hours, take the sample out, wipe the surface gently with a cloth to remove excess water, and weigh it.
- Record this weight as W_2 (wet weight).

Calculation:

- The percentage of water absorption is calculated using the formula:

$$\text{Water Absorption (\%)} = [(W_1 - W_2) * 100] / W_2$$

- A lower water absorption value indicates better concrete quality and lower permeability.

6.1.4. WATER ABSORPTION TEST

The Water Absorption Test is conducted to determine the porosity and permeability of concrete by measuring the amount of water absorbed by a concrete sample. This test helps assess the durability and resistance of concrete to moisture-related damage.

As per IS 2185 (Part 1): 2005 (for concrete blocks), the test procedure involves drying, immersing, and weighing the sample at different stages.

Preparation of Specimen

- Select a concrete specimen that has been properly cured for 28 days.
- Wipe off any loose dust or particles from the surface.

Drying the Specimen

- Place the specimen inside a drying oven at $100^{\circ}\text{C} - 110^{\circ}\text{C}$.
- Keep it inside the oven for 24 hours until it reaches a constant weight.
- After drying, remove the sample and cool it to room temperature in a dry atmosphere.
- Weigh the completely dry specimen (W_1 in grams).

Immersion in Water

- Completely immerse the specimen in clean water at room temperature ($27 \pm 2^{\circ}\text{C}$).

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- Keep it submerged for 24 hours.
- Remove the specimen from water and wipe off any excess surface water using a damp cloth.

Weighing the Wet Specimen

- Immediately weigh the saturated surface-dry specimen (W_2 in grams).
- This weight includes the water absorbed by the specimen.
- Acceptance Criteria (IS 2185: 2005 & IS 456: 2000)
- For concrete blocks (IS 2185: 2005), the maximum allowable water absorption:
 - Normal-weight blocks: <10% by mass.
 - Light-weight blocks: <15% by mass.
- As per IS 456: 2000, lower water absorption indicates better durability and resistance to permeability.

6.1.5. REBOUND HAMMER TEST (IS 13311 Part 2:1992)

Objective:

To estimate the in-situ compressive strength of concrete by measuring the surface hardness using a rebound hammer.

Apparatus Required:

- Schmidt Rebound Hammer
- A clean and smooth concrete surface

Procedure:

Surface Preparation:

- Ensure the concrete surface is clean, dry, and free from loose particles.
- Avoid testing on rough, uneven, or wet surfaces.

Performing the Test:

- Hold the rebound hammer perpendicular to the concrete surface.
- Press it firmly until the hammer impacts the surface and a rebound value is displayed.
- Take at least 10 readings at different points, ensuring they are at least 20 mm apart.
- Discard the highest and lowest values to minimize errors.

Result Interpretation:

- Find the average rebound number from the valid readings.
- Use the rebound number chart provided in the IS code to estimate the compressive strength of concrete.
- The strength varies based on the angle of impact and age of concrete

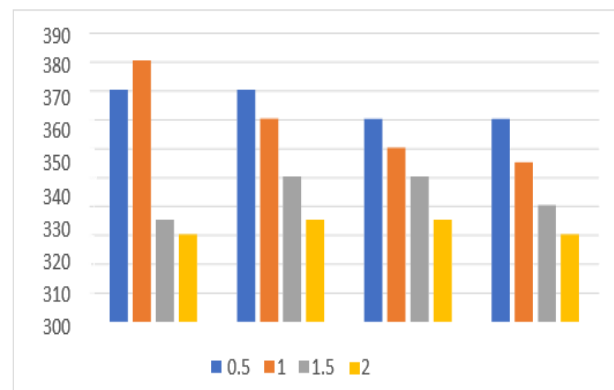
7.0 RESULT AND DISCUSSION

7.1.1. COMPRESSIVE STRENGTH TEST RESULTS

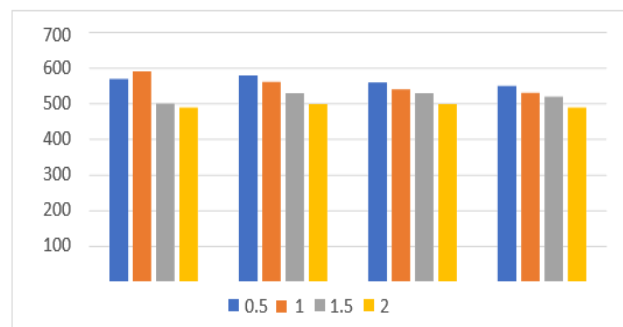
- The compressive strength test was conducted as per IS 516:1959.
- The results indicate that the mix with 1% polypropylene and 5% sugarcane fibers exhibited the highest compressive strength at 27.22 N/mm².
- The strength tends to decrease as fiber content increases beyond an optimal point (above 1.5% polypropylene), likely due to fiber clustering affecting compaction.
- The mix with 2% polypropylene shows the lowest compressive strength, implying excessive fiber addition may negatively impact concrete strength



Figure 7.1: Testing of Concrete cubes



7-Day Compressive Strength Results (N/mm²)



28-Day Compressive Strength Results (N/mm²)

Graph 7.1: Compressive strength test results

7.1.2. FLEXURAL STRNGTH TEST RESULTS

- The flexural strength test was conducted as per IS 516:1959.

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- The results show that at 7 days, the flexural strength for the 5% polypropylene and 1% corn straw mix was 2.24 N/mm², and at 28 days, it increased to 3.40 N/mm².
- The increase in strength over time indicates effective hydration and fiber interaction in concrete.



Figure 7.2: Casting of beams



Figure 7.3: Testing of Beam

7-Day Flexural Strength Results (N/mm²)

Polypropylene/ Sugarcane Fiber	Beam Dimension (mm)	Flexural strength (N/mm ²)
5% Polypropylene, 1% Sugarcane Fiber	150*100*100	2.24

28-Day Flexural Strength Results (N/mm²)

Polypropylene/ Sugarcane Fiber	Beam Dimension (mm)	Flexural strength (N/mm ²)
5% Polypropylene, 1% Sugarcane Fiber	500*100*100	3.40

Table 7.1: Flexural strength results

7.1.3. WATER ABSORPTION TEST

- Higher fiber content generally increases water absorption due to the porous nature of fibers.

- The highest absorption was noted for 1.5% and 2% fiber content, indicating increased permeability at higher fiber dosages.
- 28-day cured samples exhibited lower water absorption than 7-day samples, suggesting improved concrete density with extended curing.
- The lowest absorption was observed for 20% fiber content at 28 days, possibly due to densification at higher fiber percentages.

28-Day Water Absorption Results (%)

Polypropylene/ Sugarcane Fiber	0.5	1	1.5	2
5	5.11	5.31	5.48	3.8
10	4.32	3.87	5.21	4.11
15	5.72	4.36	5.84	5.22
20	3.65	3.58	6.21	6.28

Table 7.2: Water absorption test results

7.1.4. REBOUND HAMMER TEST

- The highest rebound number was recorded for 1% polypropylene and Sugarcane Fiber content, indicating improved surface hardness.
- Lower rebound numbers for higher fiber dosages (1.5% and 2%) suggest a reduction in surface hardness, possibly due to increased fiber-induced porosity.
- Concrete with 5% fiber exhibited moderate rebound values, implying balanced mechanical performance.
- The results indicate that an optimal fiber dosage exists beyond which concrete surface hardness starts decreasing.

PP/ Sugarcane Fiber	0.5	1	1.5	2
Fiber				

5	20	28	21	18
10	21	25	22	17
15	19	24	17	16
20	18	23	15	15

Table 7.3: Rebound hammer test results

9.0 CONCLUSION

This project explores the use of natural fibers, such as corn straw and polypropylene fibers, as a partial replacement for in concrete, aiming to evaluate the mechanical properties, including compressive strength, and flexural strength. The study involves a comparative performance analysis between fiber-reinforced and conventional concrete, and machine learning optimization to identify the best fiber composition for enhanced mechanical properties. The findings indicate that Sugarcane and polypropylene fibers can improve mechanical performance while serving as an alternative to synthetic fibers.

- The study assessed the impact of polypropylene and Sugarcane fibers on concrete performance.
- Maximum compressive strength (27.22 MPa) was achieved with 1% polypropylene and 5% corn straw.
- Compressive strength declined when fiber content exceeded 1.5%, due to poor compaction and fiber clustering.
- The mix of 2% polypropylene showed the lowest compressive strength.
- Flexural strength improved from 2.24 MPa (7 days) to 3.40 MPa (28 days), indicating good fiber bonding and hydration.
- Higher fiber dosages increased water absorption due to the porous nature of fibers.
- 28-day cured samples showed reduced water absorption, suggesting denser concrete.
- Rebound hammer results revealed better surface hardness with moderate fiber content.
- Excessive fiber amounts reduced surface hardness by increasing porosity.
- A linear regression model was developed to predict compressive strength based on fiber content.
- The model showed strength decreases with increased fiber dosage, supporting experimental findings.
- Model accuracy ($R^2 = 0.3372$) suggests room for improvement using more advanced techniques.

The incorporation of polypropylene and Sugarcane fibers can enhance certain properties of concrete when used in

optimal amounts. However, excessive fiber content reduces strength and durability due to poor compaction and increased porosity. Thus, careful dosage optimization is crucial for achieving balanced mechanical performance and durability in fiber-reinforced concrete.

Scope of Future Works

Future work includes assessing the long-term durability of concrete reinforced with corn straw and polypropylene fibers under various environmental conditions such as moisture, temperature fluctuations, and chemical exposure. Additionally, advanced AI models, including deep learning and genetic algorithms, can be utilized for improved prediction and optimization of fiber compositions. Further research can also explore the impact of other agricultural waste fibers, such as rice husk, coconut fibers, and wheat straw, on concrete performance.

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