International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

# Experimental Study of Concrete Using Natural Coconut Fiber

Raj Ravilal Rudani[1], Omkar Sandip Ambekar [2], Darsh Girish Kacha[3], Om Nitin Chaudhari[4], Tejas Sandip Shinde[5], Mr. Satish .P. Deore[6], Mr. Raghav .D. Vadje[7]

[1-5]Students, [67]Lecturer

*Department of Civil Engineering Mahavir Polytechnic, Nashik*

---***---

**Abstract -** This study provides an experimental investigation of the performance of concrete reinforced using natural coconut fiber with a view to improving its mechanical strengths and sustainability factors. Coconut fiber, a by-product of agriculture, is cheap, eco-friendly, and has good tensile strength, which makes it a good concrete-reinforcing additive. The research examines the influence of adding different proportions of coconut fiber (0%, 1%, 1.5%, and 2%) on the workability, compressive strength, split tensile strength, and flexural strength of concrete. The concrete samples were cast and then tested after different curing times of 7, 14, and 28 days. The results show that incorporation of coconut fiber enhances tensile and flexural performance as a result of its bridging action of microcracks, but a moderate loss in compressive strength is noticed at higher fiber contents. The best fiber content was found to be 1%, which had the optimal combination of strength and workability. This research shows that coconut fiber is a very promising, environmentally friendly reinforcement material that can improve the performance of concrete while helping to utilize waste and promote environmental sustainability.

***Key Words*:** Cococnut fiber, Spilt tensile strength, Flexural strength.

## 1. INTRODUCTION

Concrete is the most popular construction material in the world because it is strong, durable, and versatile. But it is inherently weak in tension and brittle, which tends to cause cracking and structural failure under some conditions. To overcome this limitation, fibers are added to concrete to enhance its tensile and flexural strength. In recent times, natural fibers have come into focus as a sustainable option to synthetic fibers, owing to their low price, biodegradability, and abundance.

Coconut fiber, or coir, is a natural fiber obtained from the outer cover of the coconut. It is a waste product from agriculture, and it is found in large quantities in tropical regions. Coconut fiber possesses favorable mechanical properties, such as tensile strength, and its use in concrete will prevent crack extension, improve ductility, and enhance the general durability of the mix.

This research explores the use of coconut fiber as a renewable reinforcing material in concrete. The aim is to analyze the influence of varying fiber content on the mechanical strength of concrete, i.e., its compressive strength, split tensile strength, and flexural strength. In doing this, the study hopes to contribute to the advancement of sustainable and environmentally friendly construction techniques.

## 2. Coconut fiber in construction

Coconut fiber, also known as coir, is being increasingly researched as a green building material because of its inherent strength, durability, and environmental advantages. Coconut fiber, when added as a reinforcement to cement-based composites like concrete or mortar, has the potential to enhance mechanical properties such as tensile strength, impact resistance, and crack control. Its inherent hardness and high lignin content also make it more resistant to decomposition than other natural fibers. The abrasive, hairy surface of coconut fiber further aids in promoting a good bond with the cement matrix and improves the structural integrity of the composite. Its lightness also results in lower total structural load, while thermal insulation characteristics serve it well in energy-efficient building applications. With the addition of coconut fiber to construction products, not only is mechanical performance increased, but the recycling of agricultural waste is encouraged, which supports the aspirations for sustainable and green construction processes.

## 3. Literature review

Applying natural coconut fiber to concrete is a trendy concept in the construction sector, particularly for improving buildings' environment-friendliness and affordability. Coconut fiber or coir is obtained from the outer husk of coconuts. Coconut fiber is a durable, resilient, biodegradable, and inexpensive material available abundantly in tropical areas. Scientists have been exploring how this fiber can alter the characteristics and enhance the performance of concrete if incorporated into it. One of the principal advantages is that coconut fiber contributes to making concrete stronger in terms of pulling forces (tensile strength) and resisting cracking. It also increases the toughness and flexibility of the concrete, such that the material can sustain more stress and strain before failure.

Quite a number of studies have established that incorporating 1% to 2% of coconut fiber on a weight basis of the cement provides optimum results. Incorporating too much fiber will cause the concrete to be difficult to mix and compromise its compressive strength, which is the capacity to support heavy loads. In order to achieve improved bonding between the fiber and the concrete.Still, there are challenges in the use of coconut fiber, for example, ensuring that the fibers are uniformly distributed within the mix and that the concrete will remain strong in the long term.

Despite these limitations, coconut fiber concrete is an excellent opportunity, particularly in rural or developing regions where coconut waste is readily available. It minimizes environmental waste and reduces the cost of construction. As a whole, incorporating coconut fiber into concrete is a step towards more sustainable construction. With further research and experimentation, this form of fiber-reinforced concrete may be a standard green construction material.

## 4. Methodology

The procedure includes gathering materials, making concrete mixes with different percentages of natural coconut fiber (0–2.5%), casting standard specimens, curing for 7, 14, and 28 days, and testing compressive, split tensile, and flexural strength. Results are compared to control mixes to evaluate fiber effect on concrete performance.

## 5. Material

This sections explores the properties of material used in this research. The materials were obtained from the local resources.

### 5.1 Cement

Ordinary Portland Cement (OPC) 43 grade is commonly applied for general building. It has moderate strength development and meets IS: 8112-2013, with quality, durability, and guaranteed performance in concrete.

### 5.2 Coarse aggregates and fine aggregates

Fine and coarse aggregates are critical constituents of concrete. Fine aggregates (such as sand) pack the voids and enhance workability, whereas coarse aggregates (such as gravel or crushed stone) contribute to strength and bulk. They together create a strong, hard matrix, which minimizes shrinkage and increases the structural strength of the concrete mix.

### 5.3 Coconut fiber

Coconut fiber, a biodegradable and renewable resource, is incorporated in concrete to add tensile strength and minimize cracking. It also serves as a secondary reinforcement that enhances bonding between the mix constituents. Its fiber structure assists in controlling shrinkage, enhancing durability, and providing impact resistance, making it an efficient green addition to concrete.

### 5.4 Water

According to IS 456:2000, water used for mixing and curing shall be clean and free from injuries amount of oils, acids, alkalis, salts, sugar and organic materials or any other substances that may detorious to concrete and steel. pH value of water used for mixing the concrete shall be less than 6.

## 6. Experimental Investigation

### 6.1 Proportioning

The proportioning of materials such as water in concrete mixes for assessing the material available suitability shall be the same in all respects to those that will be utilized in the work. In the event that the proportions of the concrete ingredients used in the sites are to be specified by volume, they will be determined from the proportional by weight utilized in the test cubes and the material unit weight.

### 6.2 Weighing

The weights of the cement, each aggregate size and the water for every batch shall be as ascertained by weight to 0.1 percent accuracy of the total weight of the batch.

### 6.3 Mixing of concrete

The mixing process for M20 grade concrete with OPC 43 grade cement and natural coconut fiber includes a number of systematic steps to achieve uniformity and performance. All the materials, such as cement, fine aggregate (sand), coarse aggregate (20 mm down size), clean water, and natural coconut fibers, are gathered and weighed precisely. The mix ratio of 1:1.5:3 (Cement: Sand: Coarse Aggregate) is maintained, with a water-cement ratio of approximately 0.50. Coconut fibers, taken started to separate the coconut fiber like a thread for easy to mix and remove there dust. Dry mixing is the first process, in which cement, sand, and coarse aggregate are mixed well till there is a uniform gray color.

Adding the prepared coconut fibers and mixing in order to distribute them evenly throughout the mix. Water is added slowly in two stages, approximately 70% initially and the remaining 30% subsequently, while mixing continuously for a minimum of 2 to 3 minutes to achieve a uniform and workable concrete mix. After mixing, a slump test is conducted to determine workability. The fresh concrete is then filled into molds and compacted suitably using a tamping rod or vibrating table to expel entrapped air. The surface is leveled off and covered to avoid premature loss of moisture. The specimens are de-molded and water-cured for 7, 14, and 28 days after 24 hours to achieve proper hydration and strength gain.

## 7. Results analysis :

### 7.1 Compression strength of concrete

- One of the most important and useful property of concrete.
- Compression strength test carried out on cubes for various mixes M1, M2, and M3.
- The compressive strength of cubes was tested on 7,14,and 28days.
- Formula for compressive strength of concrete :

=Load applied [P] /Cross sectional area[A] = $N/mm^2$

Compressive Strength test

### 7.2 Split tensile strength test

Split tensile strength of concrete is an indication of its resistance to tensile (pulling) forces, to which concrete is not strong. As concrete tends to crack under direct tension, this test gives an indirect method to measure its tensile strength, which is critical in knowing how concrete will act in structures such as pavements, beams, and slabs where tensile forces are encountered.

**Need:**

- Concrete has high compressive strength but low tensile strength.
- Direct tensile tests are challenging because they are affected by the problem of gripping and also of alignment.
- The split tensile test is a straightforward and dependable means to estimate tensile strength indirectly.

**Calculation:**

Calculation of splitting tensile strength:

$$T = 2P/\pi.L.D$$

Split tensile strength

### 7.3 Flexural strength test

Flexural strength of concrete, or modulus of rupture, is a measure of its resistance to bending or flexural stress. It is relevant to structures such as pavements, beams, and slabs where concrete is under bending. Flexural strength provides information about the tensile behavior of concrete under flexural loading and is generally greater than split tensile strength.

**Need:**

- Ensures that the concrete mix is able to resist flexural stresses during service conditions.
- More realistic in bending-dominated structures compared to direct tension or split tensile tests.

**Calculation:**

Flexural Test = P.L/bd$^2$

## 8. Test results :

The observation of the various tests on fresh and hard coconut fiber was conducted tests as slump test, compressive test, split tensile test, flexural test on concrete.

### 8.1 Compressive strength of concrete

| Sr. No | M20+ Coconut fiber | 7days [N/mm$^2$] | 28days [N/mm$^2$] |
|---|---|---|---|
| 1. | 0% | 16.54 | 20.94 |
| 2. | 1.5% | 20.24 | 24.85 |
| 3. | 2% | 21.64 | 25.66 |
| 4. | 2.5% | 23.72 | 27.78 |

### 8.2 Split tensile test of concrete

| Sr. No | M20+ Coconut fiber | 7days [N/mm$^2$] | 28days [N/mm$^2$] |
|---|---|---|---|
| 1. | 0% | 1.5 | 1.40 |
| 2. | 1.5% | 1.10 | 1.87 |
| 3. | 2% | 1.17 | 2.42 |
| 4. | 2.5% | 1.32 | 2.54 |

### 8.3 Flexural strength of concrete

| Sr. No | M20+ Coconut fiber | 7days | 28days |
|---|---|---|---|
| 1. | 0% | 2.24 | 3.89 |
| 2. | 1.5% | 2.48 | 4.14 |
| 3. | 2% | 2.53 | 4.34 |
| 4. | 2.5% | 2.72 | 4.65 |

## 3. CONCLUSIONS

From the experimental study, the following results were obtained:

- In terms of compressive strength with the addition of a small quantity of coconut fiber improves the performances of concrete as anticipated and neutralizes deleterious shrinkage effects in concrete
- The findings indicate the short coconut fibers are better at improving the performance of concrete
- The thresold value of the fiber content that will be of benefit to the long term durability of the concrete in all conditions is 2%
- The properties may rise or fall with respect to fiber and its material. Due to this as a results CFRC can be stronger than the of plain concrete
- It is flexible material has been reported as most energy absorbent and ductile have broad application in earthquake prone regions as well as in marine structures.

## ACKNOWLEDGEMENT

We take this opportunity our deepest scene of gratitude and sincere thanks to those who have helped us in completing our research. We express our sincere thanks to our guide Mr. Raghav .D. Vadje and our HOD Mr. Satish .P. Deore. Department of Mahavir Polytechnic, as a they have guided us in achieving goal of our project by appropriate guidance.

## REFERENCES

1. Slate FO “Coconut fibers in concrete”, Engg J Singapore Vol.3[1] pp. 51-54,[1976]

2. Mukesh, T.S., Nandhini, M., Premkumar, T.S., & Paul Danny Kingsley, P. (2020). "Experimental Investigation of Concrete by Addition of Coconut Fiber and Partial Replacement of FA by Granite Powder." *International Journal of Advanced Science and Technology*, 29(04), 5150-.

3. "Experimental Study on Coir Fibre Mixed Concrete" by Achudhan et al. (2018): This research investigates the incorporation of coir (coconut) fibers into concrete mixes and evaluates the resulting mechanical properties.

4. "An Experimental Study on Fibre Reinforced Concrete by Using Coconut Coir" by K. Abdul Basith et al. (2022): This paper examines the effects of adding coconut coir fibers to concrete, focusing on improvements in strength and durability.

5. "Experimental Study on Coconut Fibre Reinforced Self Compaction Concrete" by Mohammad Meer et al. (2024): This research focuses on the integration of coconut fibers into self-compacting concrete and assesses its mechanical performance.

6. Hema, S. (2016). "Experimental Studies on Coconut Fibre and Banana Fibre Reinforced Concrete." *International Journal of Earth Sciences and Engineering*, 9(3), 529-533.

7. Jagdale, S.D., Deshmukh, M.G., Navale, A., Kazi, S., Gayali, O., Jadhav, S., & Dodtalle, N. (2022). "Experimental Study on Concrete with Partial Replacement of Cement by Lime and Coconut Fiber.

8. Ali, M., Liu, A., Sou, H., & Chouw, N. (2012). "Mechanical and Dynamic Properties of Coconut Fibre Reinforced Concrete." *Construction and Building Materials*, 30, 814-825.