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# EXPERIMENTAL INVESTIGATION OF M60 GRADE COCONUT FIBRE REINFORCED CONCRETE

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**ABSTRACT**:

Fibers have the property to enhance the toughness of concrete. The cost of construction has skyrocketed together with the deteriorative impact on setting. This resulted in the adoption of a more balanced approach with the environment as its nerve centre to create a better world to live in. This has led to the adoption of a fiber like Coconut for the strength sweetening in concrete. Coconut fiber is obtainable in abundance, which makes it quite viable as a reinforcement material in concrete. This Report presents a experimental discussion on the subject of coconut fiber reinforced concrete (CFRC).

This study aimed toward analyzing the variation in strength of coconut fiber concrete at variable fiber contents and to establish it with that of conventional concrete. The various strength aspects analyzed are the flexural and compressive strength of the coconut fiber concrete at variable percentages (1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5%, 5%) by the load of cement of fiber. This research is based on the use of coconut fibers in structural concrete to enhance the mechanical properties of concrete.

**Keywords**: CFRC (coconut fiber reinforced concrete), flexural strength, compressive strength, Coconut fiber, M60 grade of concrete

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## I. INTRODUCTION

### General

One of the undesirable characteristics of the concrete as a brittle material is its low lastingness, and strain capability. Therefore, it needs reinforcement so as to be used because the most generally construction material. Conventionally, this reinforcement is within the kind of continuous steel bars placed within the concrete structure within the acceptable positions to face up to the obligatory tensile and shear stresses. Fibers, on the opposite hand, are usually short, discontinuous, and every which way distributed throughout the concrete member to provide a composite construction material called fiber ferroconcrete (FRC). Fibers utilized in cement-based composites are primarily made from steel, glass, and chemical compound or derived from natural materials. Fibers can control cracking more effectively due to their tendency to be more closely spaced than conventional reinforcing steel bars. It ought to be highlighted that fiber used because the concrete reinforcement isn't a substitute for standard steel bars. Fibers and steel bars have totally different roles to play in advanced concrete technology, and there ar several applications during which each fibers and continuous reinforcing steel bars ought to be used. Coconut fibers (Coir fibers) are one of the most popular type of fibers used as concrete reinforcement.

### Types of fibers used in construction

Most commonly used types of fibers are:

1. Steel Fiber Reinforced Concrete
2. Plastic fibers: i. Polyester, ii. Poly propylene, iii. polyethylene
3. GFRC Glass Fiber Reinforced Concrete
4. Asbestos Fibers
5. Carbon Fibers
6. Organic Fibers: i. Bamboo Fiber, ii. Coconut Fiber

### Areas of Application of fibers

The areas in which the reinforced fiber concrete is generally used:

1. Plastering

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2. Pipes
3. Thin sheets
4. Shot Crete
5. Curtain walls
6. Precast elements
7. Tiles
8. CFRC Boards
9. Flat slabs
10. Highway and airport pavements
11. Canal lining, sewer lining
12. Stabilization
13. Factories
14. Aircraft hangers
15. Aprons and taxiways
16. Parking areas

**Coconut fibres:**

Natural reinforcing materials can be obtained at low cost and low levels of energy using local manpower and technology. Utilization of natural fibres as a form of concrete enhancement is of particular interest to less developed regions where conventional construction materials are not readily available or are too expensive. Coconut and sisal-fibre reinforced concrete have been used for making roof tiles, corrugated sheets, pipes, silos and tanks (Agopyan, 1988). Concrete made with Portland cement has certain characteristics: it is strong in compression but weak in tension and tends to be brittle.

## II. LITERATURE REVIEW

### LITERATURE REVIEW

Coconut fibre is out there in abundance at the test site, which makes it quite viable as a reinforcement material in concrete. Further, it acts as a replacement source of income for the coconut producer who gets the advantages of the new demand generated by the development industry. In addition to the present, it's an efficient method for the disposal of coir mattress waste which can reduce the demand for extra waste disposal infrastructure and reduce the load on existing landfills and incinerators. The problem of high rate of water absorption of the fibre might be reduced by coating the fibres with oil. This has led to enhance the strength of concrete by the adoption of a natural fibre like Coconut Moreover the fibers have being natural in origin. The construction industry is revolutionizing in two major ways. One way is that the development of construction techniques, like using automated tools in construction. The other is that the advancement in high-performance construction materials, like the introduction of high strength concrete. In recent years, research and development of fibres and matrix materials and fabrication process related to construction industry have grown rapidly. Their advantages over other construction materials are their high lastingness to weight ratio, ability to be moulded into various shapes and potential resistance to environmental conditions, leading to potentially low maintenance cost. These properties make FRCB composite a good alternative for innovative construction. Their application in construction includes both upgrading existing structures and building new ones, which may apply to varied sorts of structure, for instance offshore platforms, buildings and bridges **(Thou, 2005)**

**Izad Amir Bin Abdul Karim et al (2012)** made a study on the coconut fibers. They stated that coconut fibers have in chemical composition although lignin content is higher and cellulose content is lower. The use of coconut waste from the dispose of coconut fibers could be a useful material in the formation of an admixture for housing construction. Therefore, in-depth study will be made to ensure the appropriate use coconut waste such as coconut fibers by conducting some experiment so as to obtain good result.

**Yalley, P. P. and Kwan et al (2008)** The Addition of coconut fibers improves the properties of concrete, notable torsion, toughness and tensile strength. The ability to resist cracking and spalling were also enhanced. However, they concluded that the addition of fibers adversely affects the compressive strength due to difficulties in compaction which consequently led to increase of voids.

**Aim of the study**

The aim of this study was to identify the improvement in strength characteristics of concrete with the addition of oil coated coconut fiber. In this study, coconut fiber is added to concrete and plain cement concrete is used as reference to study its effects on compressive strength property. Fiber is coated with oil so as to decrease the water absorption. Some of the advantages being observed
are low-cost, low-density, reasonable specific strength, good thermal insulation, reduced wear and ability to be recycled with minimal impact on environment. Thus in addition to the enhancement in the physical properties in concrete, it turns out to be a sustainable waste management technique.

**Ojective of the study**

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The present study deals with the Addition of coconut fiber for M 60 grade of concrete.

i) To study the effect of adding different percentages 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5% & 5% by the load of cement of fiber in concrete block preparation.
ii) To determine the workability of freshly prepared concrete by Slump test.
iii) To determine the compressive strength of cubes at 7, 14, 28 days curing
iv) To determine the flexural strength of beams at 28 days curing.

## III. EXPERIMENTAL PROGRAMME

**Materials Used:**

The materials used in this investigation are

- OPC (43 Grade)
- Sand
- Coarse aggregate
- Water
- Coir fiber

**Materials Testing**

**Aggregates Sieve analysis**

Sieve analysis is a test used to assess the particle size distribution of a particular material. The size distribution is often of critical importance to the way the material performs in use. This test was done to determine the fineness modulus of cement, fine aggregate, and coarse aggregate. It was done as per IS: 4031-1989 for cement and IS: 2386- 1963 for aggregates.

**Fig 3.1: Sieves for Fine aggregates**

**Fig 3.2: Sieves for Coarse aggregates**

**Specific Gravity Test**

Specific gravity tests were performed on cement, fine aggregate and coarse aggregate. Specific gravity is defined as the ratio of the weight of material to the weight of equal volume of kerosene/water displaced by it. The experiment was performed on cement as per IS: 4031-1989 and aggregates as per IS:2386-1963. Density bottle method was used for performing the

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experiment on cement. Pycnometer method was used for performing the experiment on fine aggregate and coir fibers. Wire mesh bucket was used to determine the specific gravity of course aggregate.

**Sieve analysis:**

**a) Coarse aggregate**

The coarse aggregate produced from quarry was sieved through all the sieves (i.e., 80mm, 40mm, 20mm, 10mm and 4.75mm). The material retained on each sieve was filled in bags and stacked separately. To obtain 20mm well-graded aggregate, coarse aggregate retained on each sieve is mixed in appropriate proportions which are shown below.

i) The fineness modulus for coarse aggregate(20mm) 7.07
ii) The fineness modulus for coarse aggregate(12.5mm) 7.75

**Table 3.3: Proportions of different size fractions to obtain 20mm aggr**

| Sieve sizes (mm) | Weight retained (gm) | % weight retained | Cumulative % weight retained | % passing |
|---|---|---|---|---|
| 80 | 0 | 0 | 0 | 100 |
| 40 | 0 | 0 | 0 | 100 |
| 20 | 490 | 9.8 | 9.8 | 90.2 |
| 10 | 4411 | 88.22 | 98.02 | 1.98 |
| 4.75 | 99 | 1.98 | 100 | 0 |

**Table 3.4: Proportions of different size fractions to obtain 12.5mm ag**

| Sieve sizes (mm) | Weight retained (gm) | % weight retained | Cumulative % weight retained | % passi |
|---|---|---|---|---|
| **16** | 0 | 0 | 0 | 100 |
| **12.5** | 875 | 17.5 | 17.5 | 82.5 |
| **9.5** | 2080 | 41.6 | 59.1 | 40.9 |
| **4.75** | 1980 | 39.6 | 98.7 | 1.3 |
| **2.36** | 65 | 1.3 | 100 | 0 |

**Methodology**

- Before adding the coconut fiber to the concrete, it washed with normal water to remove the dust particles. Then the fiber is treated with 5% of Oil to create boundary layer on the surface to decrease the water absorption. The fiber was dipped for 24hours and then dried under sunlight for 24hours.
- Weight the all materials as per requirements for M60 grade concrete and additionally add coconut fiber with various percentage by the load of cement of fiber.

**Fig.3.12: Oil immersion of coconut fiber**

**Mix Design**

Grade of concrete used-M60

Max W/C ratio-0.45

Concrete mix design is the process of finding right proportions of the cement, sand and aggregates for concrete to achieve target strength in structures.

So, concrete Mix =Cement: Sand: Aggregates.

The concrete mix design involves various steps, calculations and laboratory testing to find right mix proportions. This process is usually adopted for structures which requires higher grades of concrete such as M60 and above and large construction projects where quantity of concrete consumption is huge. Benefits of concrete mix design is that provides the right proportions of the materials, thus making the concrete construction economical in achieving required strength of structural members. As, the quantity of concrete required for large constructions are huge, economy in quantity of materials such as cement makes the project construction economical.

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### Coconut fiber reinforced concrete

Coconut fiber reinforced concrete production is done using the same equipment as that of conventional cement concrete. The detailed process is as given below

## IV. RESULTS AND DISCUSSIONS

### Fresh properties of concrete

Slump Test is conducted for various concrete mix containing coconut fibre. The study on slump test helps us to know the amount of water required to obtain a concrete mix with good workability. The slump value for concrete with 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5% and 5% coconut fibre. The test results given in below table 4.1.

**Table 4.1: Slump cone test**

| Cocounut fiber(%) | Slump (mm) |
|---|---|
| Control mix | 120 |
| 1 | 110 |
| 1.5 | 105 |
| 2 | 98 |
| 2.5 | 93 |
| 3 | 85 |
| 3.5 | 82 |
| 4 | 78 |
| 4.5 | 72 |
| 5 | 70 |

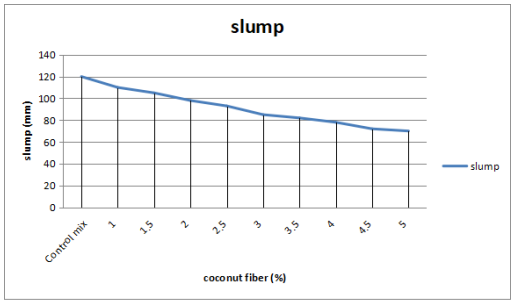


Fig 4.1: Slump test

The control mix has a slump value of 120 mm. It isobserved that concrete with increasing percentages of coconut fibre has decreasing slump value. Thus, lesser the amount of coconut fibre better will the workability.

### Harden properties of concrete

### Cubes Compressive strength

Compressive strength tests were conducted on standard cubes of dimension 15cm x 15cm x 15cm specimens each for plain concrete and coconut fiber reinforced concrete were cast at varying percentages of fiber (1%, 1.5%, 2% 2.5%, 3%, 3.5%, 4%, 4.5% 5%). For each combination of coconut fiber addition in concrete, nine specimens were tested.

**Table 4.2:Cubes Compressive strength (N/mm²)**

| Cocounut fiber(%) | 7days | 14days | 28days |
|---|---|---|---|
| Control mix | 41 | 56.1 | 62.1 |
| 1 | 43 | 58.2 | 64.8 |
| 1.5 | 46 | 59.5 | 65.8 |
| 2 | 44 | 57 | 63.5 |
| 2.5 | 40 | 52 | 61.72 |
| 3 | 35 | 49.2 | 58.2 |
| 3.5 | 31 | 45.64 | 54 |
| 4 | 28 | 42.34 | 51.8 |
| 4.5 | 25.3 | 36.2 | 48.45 |
| 5 | 20 | 32.84 | 45 |

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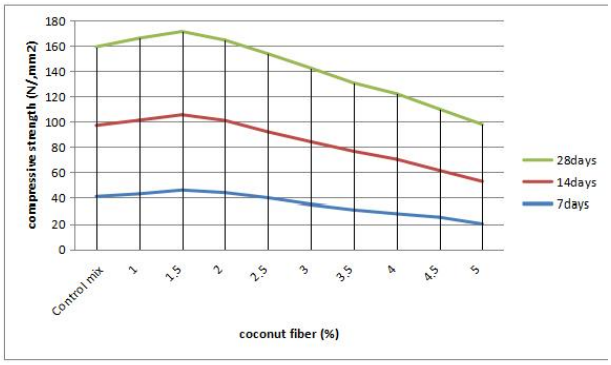


Fig 4.2:Cubes Compressive strength

Fig 4.3:compressive strength test specimen

The compressive strength of various concrete mix containing coconut fibres 1%, 1.5% & 2% got more compressive strength compare to control mix.

## V. CONCLUSION

Coconut fibre is out there in abundance at the test site,which makes it quite viable as a reinforcement material in concrete. Further, it acts as a source of income for the coconut producer who gets the benefits of the new demand generated by the construction industry. In addition to this, it is an efficient method for the disposal of coir mattress waste which will reduce the demand for additional waste disposal infrastructure and decrease the load on existing landfills and incinerators. Coconut fibres being natural in origin, is ecologically sustainable and can bring down the global carbon footprint quite effectively. Based on the experimental investigation carried out, the following conclusion was drawn:

- ✓ Workability of the concrete is reduced when compare with the normal concrete.
- ✓ For 1% to 2% of the coconut fibres addition to the concrete gives the higher compressive strength then control mix.
- ✓ From the 3% of fibre reinforced concrete the fibres are not uniformly distributed in the mix and balling forms.
- ✓ The bond between the matrixes is very higher than the normal concrete.
- ✓ Density of the coconut fibre concrete is less (i.e light weight concrete).
- ✓ Compressive strength for 3% of the fibre reinforced is decreased than the normal concrete.
- ✓ Evaporation losses are less, cracks are less after application of the compressive load (i.e. microcracks are reduced).
- ✓ Addition of the 1.5% of coconut fibres is recommended for the concrete constructions.

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