World Journal of Advanced Engineering Technology and Sciences

eISSN: 2582-8266

Cross Ref DOI: 10.30574/wjaets

Journal homepage: https://wjaets.com/

(Research Article)

Check for updates

A study of the effect of coconut fiber on reinforced concrete beams subjected to combined bending and shear

Samina. M. Kazi, Ashok Ramkrishna Munde, Vijay Shivaji Shingade, Sonal Vaibhav Shelar and Vaibhav Vilas Shelar *

Department of Civil Engineering, Trinity College of Engineering and Research, Pune, India.

World Journal of Advanced Engineering Technology and Sciences, 2024, 13(01), 556–568

Publication history: Received on 12 August 2024; revised on 21 September 2024; accepted on 23 September 2024

Article DOI: https://doi.org/10.30574/wjaets.2024.13.1.0432

Abstract

This review paper examines the impact of coconut fiber reinforcement on the behavior of reinforced concrete beams subjected to combined bending and shear. Coconut fibers, also known as coir fibers, are a sustainable and cost-effective alternative to traditional steel reinforcement. The use of coconut fibers in concrete has shown promise in enhancing the ductility, energy absorption capacity, fracture resistance, and durability of concrete structures. The study highlights the mechanical properties and applications of coconut fiber reinforced concrete (CFRC) and investigates the effects of varying fiber content on concrete performance. Factors affecting the properties of fiber-reinforced concrete, such as the relative fiber matrix index, volume of fibers, aspect ratio of fibers, fiber orientation, workability, compaction, size of coarse aggregate, and mixing techniques, are also discussed. Understanding these factors is crucial for designing and constructing durable and sustainable concrete structures.

Keywords: Coconut Fiber; Reinforced Concrete Beams; Combined Bending and Shear; Fiber-Reinforced Concrete.

1. Introduction

One of the unfavorable attributes of brittle concrete is its inadequate durability and susceptibility to strain. As a result, reinforcement is required for its application as the most common building material. Traditionally, this reinforcement takes the form of continuous steel rods positioned in suitable locations within the concrete structure to withstand the required tensile and shear stresses. In contrast, fibers are typically short, discontinuous, and distributed in any direction across the concrete member to form fiber ferroconcrete (FRC), a composite building material. The predominant constituents of fibers found in cement-based composites are glass, steel, chemical compounds, and natural materials. Due to their propensity for closer spacing, fibers are able to inhibit splitting more efficiently than conventional reinforcing steel bars. It is imperative to emphasis that the fiber utilized for reinforcing concrete is not a substitute for conventional steel rods. Fibers and steel bars serve distinct functions in advanced concrete technology, and both materials have their place in various applications where continuous reinforcing steel bars and fibers are required. Coconut fibers, also known as coir fibers, are widely utilized as reinforcement in concrete. Due to its exceptional ductility in comparison to other natural fibers, coconut fiber exhibits promise as a potential reinforcement material for concrete. Due to its biodegradable nature, it will have minimal environmental impact. Additionally, this serves as a method of eliminating the fibers that are generated as byproducts in coir-based manufacturing facilities that produce high-strength materials. They are also inexpensive, readily available, and nonabrasive. CFs are initially employed to control and prevent plastic and curing shrinkage in concrete. Additional investigation and advancement have demonstrated that the incorporation of CFs into concrete substantially enhances its ductile behavior prior to ultimate failure, energy absorption capacity, resistance to fracture, and durability. This study investigates the mechanical properties and applications of coconut fiber reinforced concrete (CFRC) and examines the effects of CF addition to concrete. Fiber

*Corresponding author: Vaibhav. V. Shelar.

reinforced concrete is a mixture of cement, water, fine and coarse aggregates, and discontinuous coconut fibers. Coconut fiber reinforced concrete is a composite material composed of fibers added at random and distributed uniformly in small percentages ranging from 0.3% to 5% by volume in unreinforced concrete. The production process of CFRC products involves the incorporation of coconut fibers into the concrete mixture. Subsequently, the green concrete is poured into molds and cured using conventional methods.

Figure 1 Coconut Fiber Reinforced Concrete

1.1. Coconut fiber reinforced concrete

In this study Coconut Fiber was used, therefore it is necessary to study the behavior of the Coconut fiber. Coconut fiber was used in concrete. Coconut Fiber Reinforced Concrete is comprised of cements containing fine and course aggregates and Coconut Fiber. A super plasticizer is often used to enhance the mix workability. Coconut Fiber products are available in a variety of types and sizes. The underlying principle however on all CFRC designs is to provide discontinuous reinforcement and effective crack control. Coconut Fibers reinforce in three dimensions throughout the entire matrix. They restrain micro-cracking and act as tiny reinforcing bars.

1.2. Factors affecting properties of fiber reinforced concrete

There are few factors which are responsible for the properties of fiber reinforced concrete, which are as follows:

1.3. Relative fiber matrix index

The modulus of snap of matrix should be abundant not up to that of fiber for economic stress transfer. Low modulus of fiber like nylons and polypropene area unit, therefore, unlikely to grant strength improvement, however the assistance within the absorption of huge energy and thus, impart bigger degree of toughness and resistance to impart. High modulus fibers such as steel, glass and carbon impart strength and stiffness to the composite.

1.3.1. Volume of fibers

The strength of the composite for the most part depends on the amount of fibers utilized in it. It can be seen that the increase in the volume of fibers, increase approximately linearly, the tensile strength and toughness of the composite. Higher percentage of fiber is likely to cause segregation and harshness of concrete and mortar.

1.3.2. Aspect ratio of fiber

One of the most important factor which guides the properties and behavior of the composite is the aspect ratio of the fiber. It has been observed that up to aspect ratio of 75, increase on the aspect ratio increases the ultimate concrete linearly. In various research it is also found that beyond 75, relative strength and toughness is reduced.

1.3.3. Orientation of fiber

Shape and orientation of fiber is very important as it is found as raw and processed. To see the effect of randomness mortar specimens reinforced with 0.5% volume of fibers were tested. In one set specimens, fibers were aligned in the direction of the load, in another in the direction perpendicular to that of the load, and in the third randomly distributed.

1.4. Workability and Compaction of concrete

Incorporation of Coconut fiber decreases the workability considerably. This situation adversely affects the consolidation of fresh mix. Sometimes prolonged external vibration fails to compact the concrete. The fiber volume at which this situation is reached depends on the length and diameter of the fiber. The workability and compaction standard of the mix is improved through increased water/ cement ratio or by the use of some kind of water reducing admixtures.

1.4.1. Size of coarse aggregate

Maximum size of the coarse combination ought to be restricted to 20mm, to avoid considerable reduction in strength of the composite. Fibers also in effect, act as aggregate. Although they need an easy pure mathematics, their influence on the properties of fresh concrete is complex. The orientation and distribution of the fibers and consequently the properties of the composite governed by the inter-particle friction between fibers and between fibers and aggregates.

1.4.2. Mixing

Mixing of fiber reinforced concrete needs careful conditions to avoid balling of fibers, segregation and in general the difficulty of mixing the materials uniformly. It is important that the fibers are dispersed uniformly throughout the mix; this can be done by the addition of the fibers before the water is added. When combining during a laboratory mixer, introducing the fibers through a wire mesh basket will help even distribution of fibers. For field use, some other suitable methods should be adopted.

1.5. Objective of the Review

- To investigate the mechanical properties of coconut fiber reinforced concrete (CFRC) beams under combined bending and shear loading conditions.
- To analyze the behavior of CFRC beams with varying percentages of coconut fiber content subjected to combined bending and shear.
- To evaluate the effectiveness of coconut fiber reinforcement in improving the ductility and crack resistance of reinforced concrete beams under combined bending and shear forces.

2. Literature review

1. Suhad M. Abd et.al (2023) In recent years, textile reinforcement has been widely researched and used in reinforced concrete beams, slabs, and thin plates. However, the design for bending is completely different from that of the shear case. The use of textile carbon yarns in place of or in addition to traditional steel stirrups to reinforce the shear has been investigated. Eight beams with dimensions of 200 mm × 300 mm × 1500 mm were used in this investigation. These beams were tested in shear under four load points. Two specimens were used with and without steel stirrups as reference specimens, while the other six beams used textile carbon yarns instead of steel stirrups. The variables of this study were the length of overlap, which was 30%, 60%, and 100%, the spacing was 90 mm and 130 mm, while inclination was 45 ∘ and 90 ∘ , and bonding with or without steel fibers. The results showed that using 100% overlap length, 90 mm spacing, a 45 ∘ angle, and adding steel fibers increased the shear capacity, increased the deflection, and made the cracking behavior better.

2. Thongbam Manimatum Devi et.al (2022) describes the experimental function on the usage of banana fiber and Ground Granulated Blast Furnace Slag (GGBS) to make better strength and applications of concrete. Banana fibers are extensively obtain able even as agricultural scrap from Banana cultivation. They have key characteristics like low density, light weight, cheap, high tensile strength, water and fire resistant. They are eco-friendly, inexpensive (zero cost)with chemicals free. The adding of banana fibers considerably improved many attributes of the concrete such as compressive strength, tensile strength and flexural strength. It also increased the potential to with stand rupturing and collapsing of concrete. In this study, banana fibers of four different percentage (0%, 2.5%, 5%, and 7.5%) having length of 40mm and constant percentage of GGBS (2.5%) were used. The banana fiber reinforced GGBS concrete were tested for compressive strength, tensile strength at different ages.

3. Zainorizuan Mohd Jaini et.al (2016) introduce the pelletized coconut fiber aggregate to reduce the consumption of cement but able to enhance the compressive strength. In the experimental study, forty-five (45) cube samples of foamed concrete with density 1600kg/m3 were prepared with different volume fractions of pelletized coconut fiber aggregate. All cube samples were tested using the compression test to obtain compressive strength. The results showed that the compressive strength of foamed concrete containing 5%, 10%, 15% and 20% of pelletized coconut fiber aggregate are 9.6MPa, 11.4MPa, 14.6MPa and 13.4MPa respectively. It is in fact higher than the controlled foamed concrete that only achieves 9MPa. It is found that the pelletized coconut fiber aggregate indicates a good potential to enhance the compressive strength of foamed concrete.

4. Majid Ali et.al (2011) presents the versatility of coconut fibers and its applications in different branches of engineering, particularly in civil engineering as a construction material. Coconut fiber is one of the natural fibers abundantly available in tropical regions, and is extracted from the husk of coconut fruit. Not only the physical, chemical and mechanical properties of coconut fibers are shown; but also properties of composites (cement pastes, mortar and/or concrete etc), in which coconut fibers are used as reinforcement, are discussed. The research carried out and the conclusions drawn by different researchers in last few decades are also briefly presented. Figures showing the relationship between different properties are shown in this paper. Coconut fibers reinforced composites have been used as cheap and durable non-structural elements. The aim of this review is to spread awareness of coconut fibers as a construction material in civil engineering.

5. Shivendra Awasthi et.al (2022) Coconut fiber is extracted from the outer shell of a Coconut. The common name, scientific name and plant family of coconut fiber is Coir, Cocosnucifera and Arecaceae (Palm), respectively. There are two types of coconut fibers, brown fiber extracted from matured coconuts and white fibers extracted from immature coconuts. Brown fibers are thick, strong and have high abrasion resistance. White fibers are smoother and finer, but also weaker. Coconut fibers are commercial available in three forms, namely bristle (long fibers), mattress (relatively short) and decorticated (mixed fibers). These different types' of fibers have different uses depending upon the requirement. In engineering, brown fibers are mostly used.

6. Jiaxin Chen et.al (2018) focuses on the flexural performance of flax fiber reinforced polymer (FFRP) tubes confined coconut fiber reinforced concrete (CFRC) composites. In total, six 520 mm long cylindrical specimens with a mechanical bond between CFRC and FFRP tube were constructed. Two configurations were considered: 1). CFRC core confined by a single outer FFRP tube; 2). CFRC filled double FFRP tubes, and the inner tube was placed along the centre line of the cylinder beam. In the third point bending test, the maximum load, flexural deformation and outer tube strains in the longitudinal and hoop directions were measured. It was found that the double tube specimens possessed excellent flexural characteristics, in comparison to the single tube specimens.

7. Anthony Liu et.al (2012) Coconut fibers have the highest toughness amongst natural fibers. They have potential to be used as reinforcement in low-cost concrete structures, especially in tropical earthquake regions. For this purpose, the mechanical and dynamic properties of coconut fiber reinforced concrete (CFRC) members need to be well understood. In this work, in addition to mechanical properties, damping ratio and fundamental frequency of simply supported CFRC beams are determined experimentally. A comparison between the static and dynamic moduli is conducted. The influence of 1%, 2%, 3% and 5% fiber contents by mass of cement and fiber lengths of 2.5, 5 and 7.5 cm is investigated. To evaluate the effect of coconut fibers in improving the properties of concrete, the properties of plain concrete are used as a reference. Damping of CFRC beams increases while their fundamental frequency decreases with structural damage. CFRC with higher fiber content has a higher damping but lower dynamic and static modulus of elasticity. It is found that CFRC with a fiber length of 5 cm and a fiber content of 5% has the best properties.

8. C.Arvind Kumar et.al (2015) it is combined torsion and bending which is of real practical interest. In this work combined bending and torsion has been considered for the fiber reinforced concrete beams by taking the different percentage of fiber volume. The glass fibers are used for the investigation. This would seem to justify large number of investigations dealing with pure torsion of concrete members. In present research, an attempt is made to study the following aspects: Behavior of reinforced concrete beam under. 1) Combined bending and torsion, (a)Without glass fibers (b)With glass fibers 2)The effect of increase of fiber percentage on torsional resistance of beam. 3) To develop torque. Vs. twist relation of the beams. The experimental program consists of casting 4 reinforced concrete beams of size 150mm X150 mm and length 2m. Two of them were cast without fibers to make a comparative study with the remaining 3 beams; one beam is cast with 0.5% fiber by weight, one beam 1.0% fiber by weight in the rest one beam 1.5% fiber by weight added. The longitudinal reinforcement, spacing of shear stirrups is kept constant.

9. Libo Yan et.al (2015) investigated the flexural behavior of plain concrete (PC) and coir fiber reinforced concrete (CFRC) beams externally strengthened by flax fabric reinforced epoxy polymer (FFRP) composites. PC and CFRC beams without and with FFRP (i.e. 2, 4 and 6 layers) reinforcement were tested under three- and four-point bending. The microstructures of coir fiber, coir/cement matrix, flax/epoxy matrix, and FFRP/ concrete interfaces were analyzed using scanning electronic microscope (SEM). Test results indicated that the peak load, flexural strength, deflection and fracture energy of both PC and CFRC specimens enhanced proportional to an increase of FFRP layers. Coir further increased load, strength and energy of the specimens remarkably. It was also found that the thickness and coir influenced the failure modes while the test method influenced the load and energy of the specimens remarkably. SEM studies showed effective bond at coir/cement, flax/epoxy and FFRP/concrete interfaces.

10. Wai Hoe Kwan et.al (2014) explore the effects of simulated aggressive environments on flexural strength and impact resistance of FRC and to identify the relationship between the two parameters. Three types of fibers, namely, coconut fiber, Bar chip fiber (BF), and alkali resistant glass fiber, were used in this study. The fiber dosage ranged from 0.6% to 2.4% of the binder volume. All mixes have constant water/binder ratio of 0.37 and their compressive strengths were all exceeding 60 MPa. The specimens were prepared and exposed to three different aggressive exposure environments, namely, tropical climate, cyclic air and seawater conditions, and seawater environment for up to 180 days. Results indicate that flexural strength and impact resistance of FRC have a direct relationship with fiber content. Nonetheless, change in fiber type is more significant than increasing fiber dosage in enhancing flexural strength but alteration in both matters would significantly impact the impact resistance. Tensile strength of an individual BF (640 MPa) is much higher than the flexural strength of the BFRC composite.

11.Zhenghao Tang et.al (2014) The results of an experimental study to evaluate the residual compressive and shear strengths of novel coconut-fiber-reinforced-concrete (CFRC) interlocking blocks are discussed in this paper. This work is part of a research project in which the development of mortar-free interlocking structures is intended for cheap and easy-to-built earthquake-resistant housing. Recently, mortar free walls made of these blocks were tested under a series of harmonic and earthquake loadings. Only few blocks at the wall bottom were damaged, the other blocks (with no visual damage) had gone under numerous uplifts which might have affected the block strengths. In parallel, the blocks without any use over a period of time in tropical environment are also considered as coconut fibers are natural materials whose strengths might have decayed.

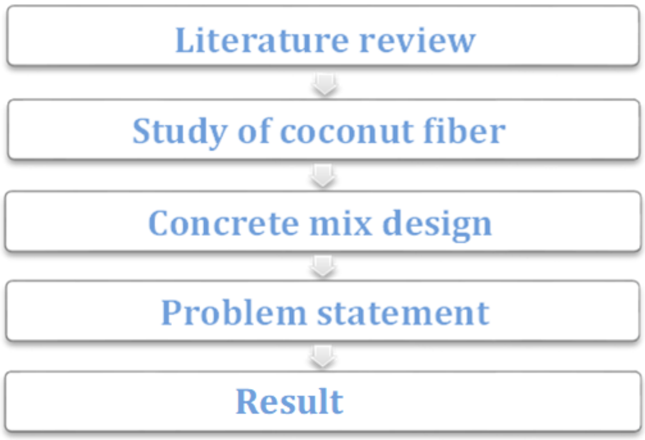
12. Amaziah Walter Otunyo et.al (2017) the effect of coconut fiber content on the mechanical properties and fracture behavior of reinforced concrete was studied. The mix design used for the plain concrete and the coconut fiber reinforced concrete was based on 1:2:4 for cement: sand and coarse aggregate. Water/cement ratio used was 0.6. The coconut fiber was added as reinforcement principally to check the propagation of cracks. The composites developed by adding 6%, 8%, 10% and 12% coconut fiber (by weight), mixing and curing. Plain concrete was cats, cured, and used as control. Composites were cured for 7, 14 and 28 days. It was observed that the composite with 6% of coconut fiber demonstrated the highest compressive, flexural and split tensile strengths when compared to the control.

2.1. Research gap

The existing literature on the use of natural fibers in concrete, particularly coconut fiber, extensively covers their mechanical properties, application methods, and effects on concrete performance. However, a research gap exists in the holistic understanding of the long-term durability and sustainability aspects of coconut fiber-reinforced concrete (CFRC) structures in real-world conditions. Most studies focus on short-term mechanical properties and immediate performance enhancements, neglecting the effects of aging, environmental exposure, and service life prediction. Additionally, there is limited research on the optimization of coconut fiber content and its interaction with other additives, such as mineral admixtures or chemical modifiers, to achieve superior long-term performance. Investigating these aspects could provide valuable insights into the practical application of CFRC in sustainable construction practices, ensuring its viability as a green alternative in the construction industry.

3. Methodology

The methodology involves selecting appropriate proportions of Portland cement, Aggregate, Water, Superplasticizer, and Retarders for concrete mix. Coconut fiber is incorporated into reinforced concrete beams to analyze its effect under combined bending and shear conditions.



The main ingredients are as follows

- Cement.
- Fine aggregates (i.e. sand).
- Course aggregate.
- Super plasticizer
- Steel bars
- coconut fiber

Material Properties:

3.1. Cement

Ordinary Portland cement, 53 grade shall be manufactured by intimately mixing together Calcareous and argillaceous and/or other silica, alumina or iron oxide bearing materials, burning them at a clinkering temperature and grinding the resultant clinker so as to produce a cement capable of complying with this standard. Cement used and tested in laboratory and its results are as follows; Brand Name**:** Ultra tech Cement 53 Grade O.P.C.

3.2. Fine Aggregate (Sand)

Fine Aggregate plays an important role in concrete as it help in practical packing in high strength concrete. It bound together with cementing material. The strength of concrete depends on the bond between the cement and the aggregate. Hence for making concrete the naturally available strong aggregate with particular size and shape are required for making normal concrete.

3.3. Coarse Aggregate

Coarse aggregate plays an important role in case of high strength concrete, because as the grade of concrete increases the mix of concrete becomes more cohesive and the fine aggregate play an important role of only particle packing. After collecting samples the properties of good aggregate that found in local area of 20 mm size aggregate confirming to IS 383-1970 are taken.

3.4. Admixture

As the grade of concrete increases water cement ratio decreases hence for proper mixing of cement with other ingredients the water per cubic meter decreases. Hence for increasing workability of a concrete a super plasticizer **"MASTERGLENIUM"** of a poly-carboxylic ether base by FOSROC Chemicals is used in his experimental work. Confirm to IS 9103-1993.

3.5. Water

Water plays an important role in concrete as the addition of water in cement paste the hydration reaction start. The water used in the concrete should be portable. When water mix with cement paste forms and cement paste bound the other ingredients of concrete. The C-S-H gel binds the other ingredients of concrete.

3.6. Mix design

Concrete mix design M25 Data Required for Concrete Mix Design

(i) Concrete Mix Design Stipulation:

(a) Characteristic compressive strength required in the field at 28 days grade designation — M 25 (b) Nominal maximum size of aggregate — 20 mm

Shape of CA — Angular

Degree of workability required at site — 5075 mm (slump)

Degree of quality control available at site — As per IS: 456

Type of exposure the structure will be subjected to (as defined in IS: 456) — Mild

Type of cement: PSC conforming IS: 455

Method of concrete placing: pump able concrete

(ii) Test data of material (to be determined in the laboratory)

Specific gravity of cement — 3.15

Specific gravity of FA — 2.64

Specific gravity of CA — 2.84

(d) Aggregate are assumed to be in saturated surface dry condition.

(e) Fine aggregates confirm to Zone II of IS – 383

➢Procedure for Concrete Mix Design of M25 Grade Concrete

Step 1 — Determination of Target Strength

Himsworth constant for 5% risk factor is 1.65. In this case standard deviation is taken from IS: 456 against M 20 is 4.0. $\mathbf{t_{arget} = f_{ck} + 1.65 \times S}$

= 25 + 1.65 x 4.0 = 31.6 N/mm^2 Where,

S = standard deviation in N/mm^2 = 4 (as per table -1 of IS 10262- 2009)

Step 2 — Selection of water / cement ratio:-

From Table 5 of IS 456, (page no 20)

Maximum water-cement ratio for Mild exposure condition = 0.55

Based on experience, adopt water-cement ratio as 0.5.

0.5<0.55, hence OK.

Step 3 — Selection of Water Content

From Table 2 of IS 10262- 2009,

Maximum water content = 186 Kg (for Nominal maximum size of aggregate — 20 mm)

Table 1 Table for Correction in water content

Parameters	Values as per Standard reference condition	Values as per Present Problem	Departure	Correction in Water Content
Slump	25-50 mm	50-75	25	(+3/25) x 25 = +3
Shape of Aggregate	Angular	Angular	Nil	–
			Total	3

Estimated water content = 186+ (3/100) x 186 = 191.6 kg /m^3

Step 4 — Selection of Cement Content

Water-cement ratio = 0.5

Corrected water content = 191.6 kg /m^3

Cement content = (From Table 5 of IS 456),

Minimum cement Content for mild exposure condition = 300 kg/m^3

383.2 kg/m^3> 300 kg/m^3, hence, OK.

This value is to be checked for durability requirement from IS: 456.

In the present example against mild exposure and for the case of reinforced concrete the minimum cement content is 300 kg/m^3 which is less than 383.2 kg/m^3. Hence cement content adopted = 383.2 kg/m^3. As per clause 8.2.4.2 of IS: 456

Maximum cement content = 450 kg/m^3.

Step 5: Estimation of Coarse Aggregate proportion:- From Table 3 of IS 10262- 2009,

For Nominal maximum size of aggregate = 20 mm,

Zone of fine aggregate = Zone II

And For w/c = 0.5

Volume of coarse aggregate per unit volume of total aggregate = 0.62

4. Results and discussions

In this research utilizing Finite Element Method (FEM) in ANSYS, this study investigates the impact of incorporating coconut fiber on reinforced concrete beams subjected to combined bending and shear. Key results include shear stress, total deformation, normal stress, maximum deformation, maximum principal stress, and their implications, discussed in detail for understanding the fiber's influence on beam behavior.

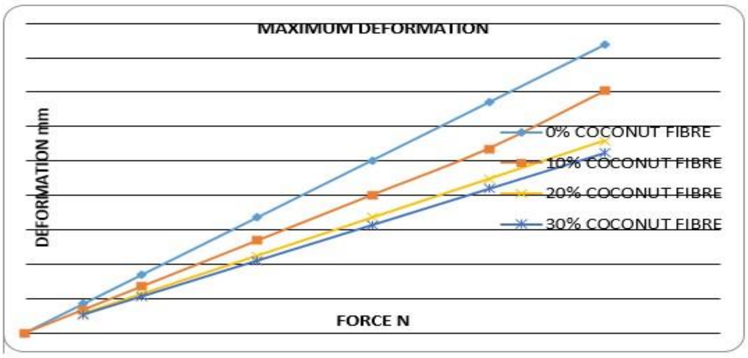


Figure 2 Maximum Deformation

In this Figure the max. Deformation is 1.7 in 0 % Coconut Fiber.

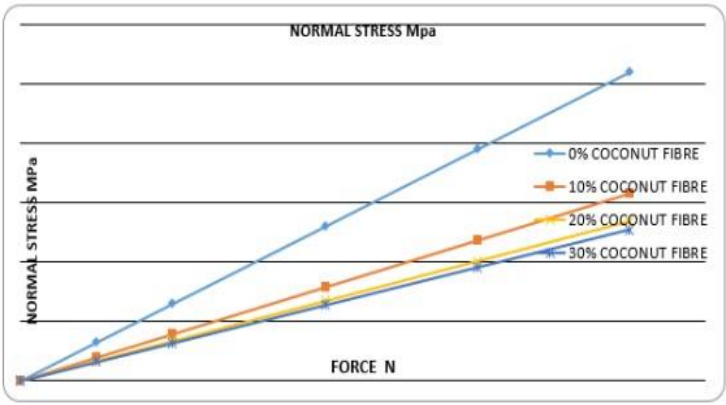


Figure 3 Normal Stress

In this Figure the max. Normal stress is 27 in 0 % Coconut Fiber.

Figure 4 Shear Stress

In this Figure the max. Shear stress is 29 in 0% and 10 % Coconut Fiber.

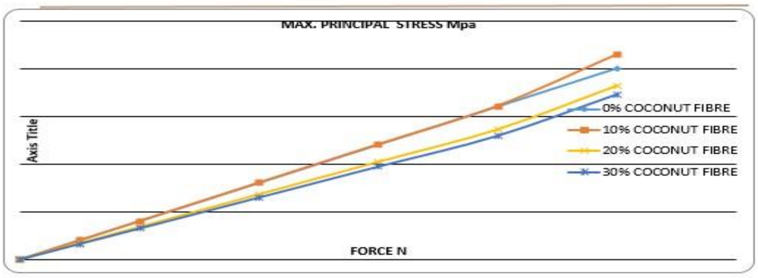


Figure 5 Max. Principal Stress

In this Figure the max. Principal stress is 22 in 0% and 10 % Coconut Fiber.

Figure 6 Maximum Deformation

In this Figure the max. Deformation stress is 1.9 in 0 % Coconut Fiber.

5. Problem statement and Modelling

5.1. Problem statement

In this chapter A RCC beam of size 700X150X100 mm is analyzed,4 bars of 12 mm diameter is used as per discussed in methodology 2 point loading at L/3 distance is applied as an incremental load in ANSYS software and following models are proposed the coconut fiber replaced against weight of cement, for M25 concrete (for 1m^3)2.47 kg for 10%, ,5.23 kg for 20% and 7.85 kg for 30% coconut fiber is used.

Table 2 Problem statement

MODEL NO.1	WITHOUT COCONUT FIBER
MODEL NO.2	WITH 10% COCONUT FIBER
MODEL NO.3	WITH 20% COCONUT FIBER
MODEL NO.4	WITH 30% COCONUT FIBER

5.2. ANSYS MODELLING

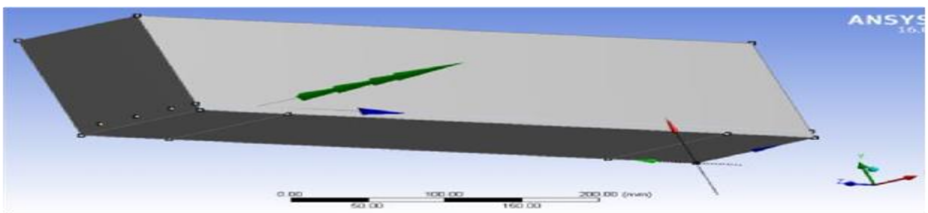


Figure 7 RCC model in workbench

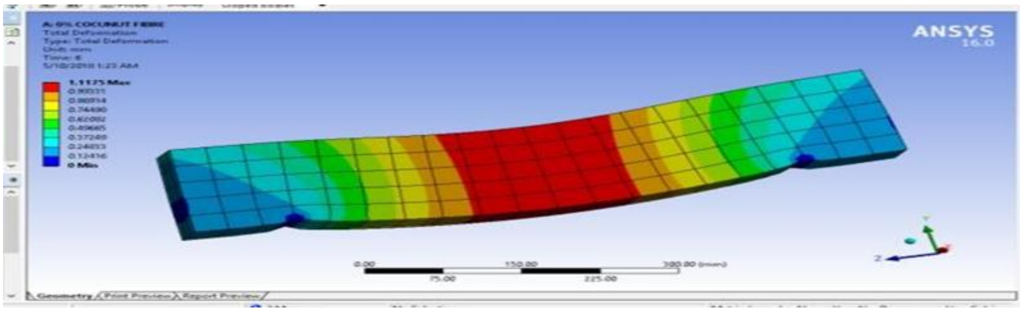


Figure 8 Coconut fiber mesh

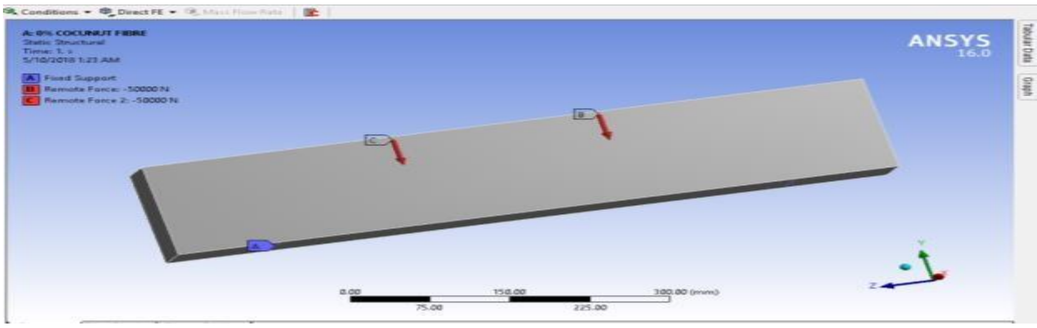


Figure 9 Point loading in ansys

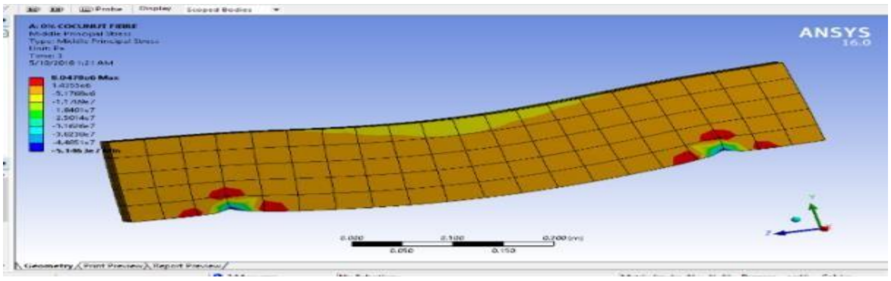


Figure 10 Middle Principal Stress

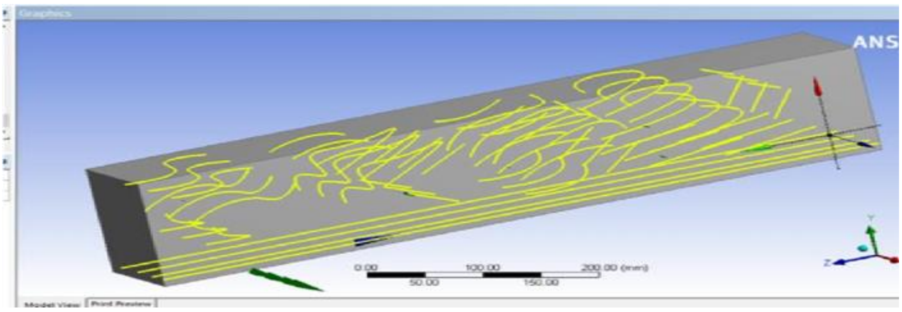


Figure 11 Max. Deformation

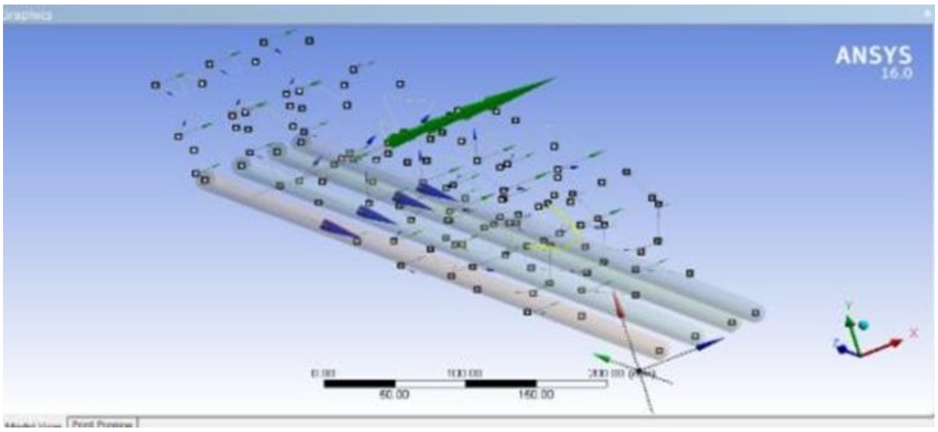


Figure 12 Longitudinal Reinforcement

6. Conclusion

In conclusion, the study investigated the effect of coconut fiber reinforcement on the behavior of reinforced concrete beams subjected to combined bending and shear forces. The mechanical properties of coconut fiber reinforced concrete (CFRC) beams were studied, and the behavior of CFRC beams with varying percentages of coconut fiber content was analyzed. The study found that the addition of coconut fibers improved the ductility and crack resistance of the reinforced concrete beams. CFRC beams showed enhanced resistance to cracking and higher load-carrying capacity compared to plain concrete beams. The findings suggest that coconut fiber reinforcement can be a sustainable and cost-effective solution for improving the performance of concrete structures. Further research is needed to optimize the use of coconut fibers in concrete and to explore its full potential in construction applications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed,

References

[1] Abd, S. M., Mhaimeed, I. S., Tayeh, B. A., Najm, H. M., &Qaidi, S. (2023). Investigation of the use of textile carbon yarns as sustainable shear reinforcement in concrete beams. Case Studies in Construction Materials, 18, e01765. https://doi.org/10.1016/j.cscm.2022.e01765

[2] Ali, M., Liu, A., Sou, H., & Chouw, N. (2012). Mechanical and dynamic properties of coconut fiber reinforced concrete. Construction and Building Materials, 30, 814–825. https://doi.org/10.1016/j.conbuildmat.2011.1 2.068

[3] Awasthi, S., Prof, A., & Verma, A. (2022). A Review on Coconut Fiber and Marble Waste.1–5.

[4] Chen, J., &Chouw, N. (2018). Flexural behavior of flax FRP double tube confined coconut fiber reinforced concrete beams with interlocking interface. Composite Structures, 192,217–224. https://doi.org/10.1016/j.compstruct.2018.02.050

[5] Devi, T. M., Shijagurumayum, C., & Thokchom, S. (2022). An Experimental Study on Banana Fiber Reinforced GGBS Concrete. SAMRIDDHI : A Journal of Physical Sciences, Engineering and Technology, 14(01 SPL), 52–57. https://doi.org/10.18090/samriddhi.v14spli01.10

[6] Kumar, C. A. (2015). Behavior of Fiber Reinforce Concrete Beam in Combined Bending and Torsion. International Journal of Research in Engineering and Technology,04(07), 45455.

[7] https://doi.org/10.15623/ijret.2015.0407071

[8] Kwan, W. H., Ramli, M., & Cheah, C. B. (2014). Flexural strength and impact resistance study of fiber reinforced concrete in simulated aggressive environment. Construction and Building Materials, 63, 62–71. https://doi.org/10.1016/j.conbuildmat.2014.0 4.004

[9] Mohd Jaini, Z., Mokhatar, S. N., Mohd Yusof, A. S., Zulkiply, S., & Rahman, M. H. A. (2016). Effect of pelletized coconut fiber on the compressive strength of foamed concrete. MATEC Web of Conferences, 47, 1–7. https://doi.org/10.1051/matecconf/20164701013

[10] Sampaio, A. Z., & Santos, J. P. (2010). Journal of Civil Engineering and Construction Technology. Journal of Civil Engineering and Construction Technology, 2(6), 125–137.

[11] Tang, Z., Ali, M., &Chouw, N. (2014). Residual compressive and shear strengths of novel coconut-fiber-reinforced-concrete interlocking blocks. Construction and Building Materials, 66(September 2014), 533–540. https://doi.org/10.1016/j.conbuildmat.2014.0 5.094

[12] Walter Otunyo, A., & Dan Nyechieo, N. (2017). Mechanical Properties and Fracture Behavior of Coconut Fiber Reinforced Concrete (CFRC). American Journal of Civil Engineering and Architecture, 5(5), 208–216. https://doi.org/10.12691/ajcea-5-5-5

[13] Yan, L., Su, S., &Chouw, N. (2015). Microstructure, flexural properties and durability of coir fiber reinforced concrete beams externally strengthened with flax FRP composites. Composites Part B: Engineering, 80, 343–354. https://doi.org/10.1016/j.compositesb.2015.6.011