IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, May 2026
Impact Factor: 8.2

Experimental Investigation and Performance of Fibre Reinforced Concrete by using Palm Tree Fibre

Martin Bastian C[1] and Dr. R. Premsudha[2]
[1]PG student Department of Civil Engineering
[2]Professor, and Head Department of Civil Engineering
Akshaya College of Engineering and Technology, Autonomous, Coimbatore

Abstract: *Although the conventional concrete is the most globally used building material, however its detrimental structural characteristics such as brittle failure mechanism in tension need to be improved. Concrete, which is weak in tension, can be overcome by the inclusion of a sufficient volume of certain short and discrete fibers to some extent. As such, natural fibers are used in this project. Here, fiber obtained from leaf sheath of Palmyra Palm is used. The effects of the addition of optimum percentage of Palmyra Palm fiber on flexural behavior of Reinforced concrete beams have been investigated in this paper. In order to determine the optimum percentage of Palmyra Palm fiber, required number of cubes, cylinders and prisms of M30 grade concrete were casted with 0,1 and 2 percentages of Palmyra Palm fiber and have tested. Based on their results of mechanical properties, it was found that optimum fiber content is 1% by mass of cement. On other hand, poor resistance to moisture absorption makes the use of natural fibers less attractive. In order to improve this property, fibers were subjected to chemical treatments, namely, mercerization on various dosages of 2, 4, 6 and 8 percentages of sodium hydroxide for period of 6 hours. Based on tensile and elongation test results, it was found that 4% sodium hydroxide treated fibers were best suited. So, here compiled specimens were casted to study the mechanical properties of Conventional Concrete (CC), 1% Unmercerized Palmyra Palm Fiber Concrete (UPPFC) and 1% Mercerized Palmyra Palm Fiber Concrete (MPPFC). Further, three Conventional Reinforced Concrete Beam (CRCB), three 1% Unmercerized Palmyra Palm Fiber Reinforced Concrete Beam (UPPFRCB) and three 1% Mercerized Palmyra Palm Fiber Reinforced Concrete Beam (MPPFRCB) were casted. The experimental results show that UPPFRCB exhibits better flexural behaviour in comparison with and MPPFRCB and CRCB under three-point loading.*

Keywords: FRC, Palmyra Palmfibre, Fiber Reinforced Concrete

I. INTRODUCTION

The most used material in construction industry is in no doubt Concrete. Concrete is a mixture of cement, water, and aggregates, with or without admixtures. The cement and water will form a paste that hardens as a result of a chemical reaction between the cement and water. The paste acts as glue, binding the aggregates (sand and gravel or crushed stone) into a solid rock-like mass. The quality of the paste and the aggregates dictate the engineering properties of the construction material. During hydration and hardening, concrete will develop certain physical and chemical properties, among others, mechanical strength, low permeability and chemical and volume stability. Concrete has relatively high compressive strength, but significantly lower tensile strength.

Nevertheless, the construction industry continues to be the main consumer of energy in a world in which energy issues remain at the forefront of human conflict and global political/economic stability. Hence, the need for sustainable, energy efficient construction materials has oriented extensive research on alternative materials that can reduce the cost

ISSN: 2581-9429 Volume 6, Issue 2, May 2026 Impact Factor: 8.2

and environmental impact of construction processes. Two approaches have been explored: one includes the use of intrinsic modification (change in internal composition) to reduce the emissions associated with cement production, and the production of other construction materials. Examples of such approaches include the use of admixtures, limestone substitution and pozzolanic cements. The other approach includes the use of extrinsic modification (reinforcement with fibers) in the design of composites with attractive combinations of strength, stiffness, fracture toughness/ resistance-curve behavior and durability. The second approach will be the focus of this project. Within this context, the composites may be reinforced with synthetic polymers such as polypropylene, rayon, nylon, polyester, Kevlar and carbon fibers.

Therefore, to overcome these problems, here as an initiative and innovative Palm Fibers were used as Natural Fibers added to concrete mix. On the other hand, the main drawbacks of all such natural fibers are their water sensitivity. All plant-derived cellulose fibers are hydrophilic in nature, mainly as a consequence of their chemical structure. Natural fibres have a good potential for chemical treatment due to presence of hydroxyl groups in lignin and cellulose. From various chemical pretreatment to overcome such drawbacks of water absorption, Mercerization, one of the most used chemical treatments was given to these fibers.

Hence, experimental investigation and strength study on fiber reinforced concrete using Palmyra Palm Fiber in M30 concrete is made in this project.

II. REVIEW OF LITERATURES

Among the various natural fibers such as, sisal fibers, bamboo fibers, coir fibers and jute fibers are of particular interest as these composites have high impact strength besides having moderate tensile and flexural properties compared to other lignocellulosic fibers. Also by considering the case of waste disposal, an attempt is made to study the possibilities of reusing the above natural fibres which not only has various applications but also helps to solve the problem of waste disposal atleast to a small extent (Tara Sen, H. N. Jagannatha Reddy).

This experimental investigation was carried out to study the properties of lightweight crushed brick concrete containing palm fiber of different volume fractions. An experimental programme was planned in which the tests such as density, compressive strength and flexural strength were conducted to investigate the properties of lightweight crushed brick concrete reinforced by palm fiber. The specimen incorporated different volume fractions of palm fiber, i.e., 0, 0.2, 0.4, 0.6, 0.8 and 1.0%. Test results showed that the use of this fiber slightly increases the density of lightweight concrete. The use of 0.8% of palm fiber increases the compressive strength and flexural strength by about 13.4 and 16.1% respectively. The results indicated that the use of palm fiber with lightweight crushed brick concrete enhances the mechanical properties of the concrete and the optimization of the palm fiber fractions is required to get the best performance (Mahyuddin Ramli and Eethar Thanoon Dawood).

Main purpose of using fibers in concrete is to eliminate or lower down the shrinkage cracks developed and improve the flexural and split tensile strength of concrete. It cannot be used as reinforcement but it can lower down the requirement of reinforcement. Wood-cellulose fiber has relatively good mechanical properties compared with many man-made fibers such as polypropylene, polyethylene, polyester and acrylic. Addition of Cellulose fibers in concrete containing Silica Fume also improves the properties of concrete. Due to addition of Silica Fume in concrete there is well dispersion of fibers in concrete which directly affects the mechanical properties of the concrete. Fiberin larger percentage cannot use due to the problem of balling in concrete (Pratik Patel, Dr. Indrajit N. Patel).

The concluded result is that Coconut-fiber addition in the concrete increases the many properties of the concrete such as torsion, toughness and notably tensile strength which is the main properties of the concrete. Sometimes, it is noted that the coconut fiber which is to be used in the concrete will be available priceless which will make the concrete economy. It is noted that if there is increase in the percent of coconut fiber in the concrete than 3% of cement there is decrease in the strength of the concrete. The use of coconut fiber as reinforcement in the concrete will decrease the application of steel nearby 2% which is affordable with respect to the simply steel reinforced concrete and also increase the strength of the concrete. But it is not possible to use this fiber in the concrete which is used to build the malls,

DOI: 10.48175/IJARSCT-34812

ISSN 2581-9429 IJARSCT

ISSN: 2581-9429

bungalows, commercial buildings etc. because it will not give the required strength but can de use to reinforce the non-structural components (Abhijeet.R.Agrawal, Sanket.S.Dhase, Kautuk.S.Agrawal).

Using coir fiber in civil construction reduces environmental pollution factors and may also bring several improvements in concrete characteristics. Coir fiber used in cement improves the resistance of concrete from sulphate attack. Compressive strength is also improved up to certain percentage. Addition of coirfiber also arrests the micro cracks present in the concrete (J.Sahaya Ruben, Dr.G.Baskar).

The natural fibres, abundantly available in nature and also generated as agricultural waste, can be used advantageously in improving certain physical properties of cement matrix and concrete, even though the durability of resultant mix is relatively poor. As compared to the fibres widely used in construction activities viz. steel, glass carbon synthetic etc., these are advantageous in the sense that they are renewable, non-abrasive, cheaper, comparatively more flexible etc. Also, the health and safety concerns during their handling, processing and mixing are less. Several natural fibres have been used in experimental studies and construction activities to investigate and improve upon the mechanical properties of cement and concrete matrices which are brittle in nature (Vikas Srivastava , P.K.Mehta)

III. EXPERIMENTAL INVESTIGATION AND ANSYS 15.0

Initially, basic tests were conducted for fine aggregate, coarse aggregate and cement to check their suitability for concrete making. Palmyra fibers are soaked in the 2%,4%,6%,8% sodium Hydroxide solution separately in tub, prepared by adding 20,40,60,80 grams of NaOH pellets in one liter of water for a period of 6 hours. Then the treated fibre are rinsed with huge quantity of water to remove the excess of NaOH sticking to the fibers and the fibre are drained and sun dried at ambient conditions till the moisture is removed from the fibre by natural means. These treated fibers are tested for tensile, elongation and water absorption tests.

FIG I. TREATMENT OF FIBERS

A. Experimental Investigation

Mix design is the process of selecting suitable ingredients of concrete and determining their relative proportion with the object of producing concrete of certain minimum strength and durability as economically as possible. The mix design of grade (M30) were determined and the mix is designed. As per IS 10262:2009. Trial mixes were made, tested and final mix proportion is arrived.

TABLE I. MIX PROPORTION

Concrete	Water	Cement	Fine Aggregate	Coarse Aggregate	Fiber
CC	0.428	1	1.177	2.321	0
MFR (1%)	0.428	1	1.170	2.218	0.0095
UMFR (1%)	0.428	1	1.171	2.219	0.0089

DOI: 10.48175/IJARSCT-34812

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, May 2026
Impact Factor: 8.2

Workability is the important quality of fresh concrete. Workability is defined as the ease with which apple give set material can be mixed into concrete and subsequently handled, transported, placed and compacted with minimum loss of homogeneity. The word workability or workable concrete signifies much wider and deeper meaning than terminology consistency often used loosely for workability. Consistency is the general term to indicate degree of mobility.

TABLE II. WORKABILTY TEST RSEULT

Concrete	Slump (mm)	Compaction Factor	Vee-Bee seconds.	Flow Percent
CC	100	0.94	5	69.33
MFR	80	0.92	8	53.33
UMFR	75	0.91	10	48.67

For obtaining flexure behavior of RC beams, beam of size 100×200×1500mm were casted in wooden moulds to maintain the dimension of the beam in the laboratory. The bottom flexural reinforcement consisted of two numbers of 12mm diameter bars providing a total cross section of 226.19mm2 and the top hanger bars consisted of two numbers of 10mm diameter bars providing a total cross section of 157.08mm2. Two legged vertical stirrups made of 8mm diameter rods were used at a spacing of 130 mm to provide adequate shear reinforcement. Here the beams were designed as under reinforced beam.

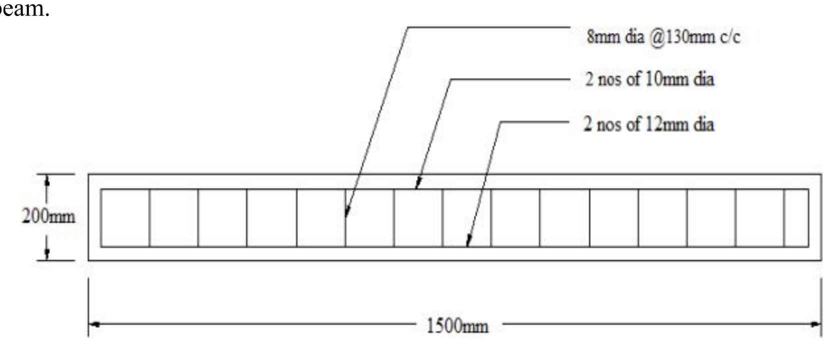

FIG II. LONGITUDINAL REINFORCEMENT OF BEAM

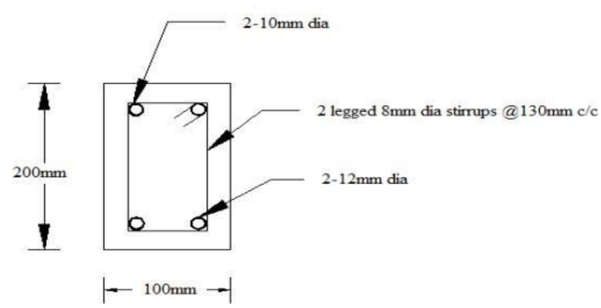

FIG III. REINFORCEMENT DETAILS FOR BEAM CROSS SECTION

B. Test Setup

A total of nine beams were cast. Out, three was Conventional Reinforced Concrete Beam, three was 1% Mercerized Palmyra Palm Fiber Reinforced Beam and the other three was 1% Unmercerized Palmyra Palm Fiber Reinforced Beam. Each beam specimen ware tested on a effective span of 1200mm under a simply supported condition. The beam was loaded by two concentrated load by means of an I section to provide a load on pure bending region in the central portion of the beam. Loading was applied by means of 40 tonne hydraulic jack. Load is given at 2.45kN interval. Dial gauge of sensitivity 0.01mm were used to measure the deflection of beams at the mid span. The strain gauge was used to determine the strains at the top most concrete fiber of beam and strain at centroid of tension steel at bottom of the beam at mid span section with sensitivity of 0.002mm. The crack patterns were also recorded at every load increment. All the beams were tested up to failure.

Sample	Initial crack load kN	Ultimate load kN	Deflection Centre mm	Flexural Strength N/mm^2	Avg. Ult. Load kN	Avg. Defl. Centre mm	Average Flexural Strength N/mm^2
CRCB							
1	14.71	53.95	7.53	16.18	56.41	7.8	16.92
2	19.62	58.86	8.08	17.66			
3	17.17	56.41	7.79	16.92			
MPPFRCB							
1	26.98	66.22	7.63	19.87	63.77	7.34	19.13
2	22.07	61.31	7.47	18.39			
3	24.52	63.77	6.92	19.13			
UPPFRCB							
1	34.33	68.67	6.12	20.60	71.94	6.11	21.58
2	31.88	76.03	6.24	22.81			
3	39.24	71.12	5.98	21.34			

IV. RESULTS

The deflection at the centre of the specimen is noted with 0.01mm sensitive dial gauge. The deflection in centre to applied load graph is drawn for different types of specimen.

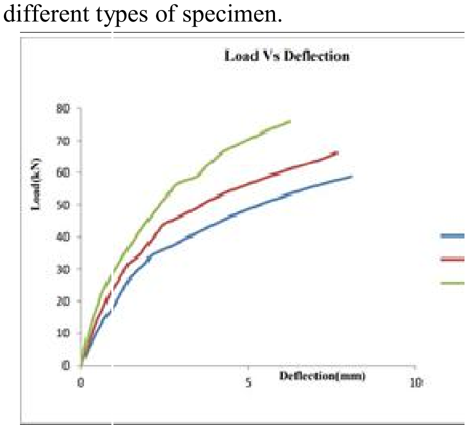

FIG IV. LOAD VS DEFLECTION CURVE OF REINFORCED CONCRETE BEAM

It is observed from the test result

1). Deflection decreases with increase % of fibre. 2). Deflection of 1% UPPFRCB was lesser than deflection of CRCB as shown above. The strains were measured at the top and bottom most fibers of the beam at mid span section and they are graphically represented below. It is observed from the test result

1). Strain decreases with increasing % of fibre. 2). Strain of 1%UPPFRCB is lesser than CRCB.

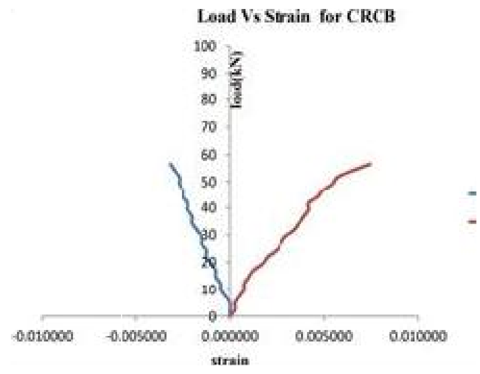

FIG V. LOAD VS STRAIN FOR CRCB

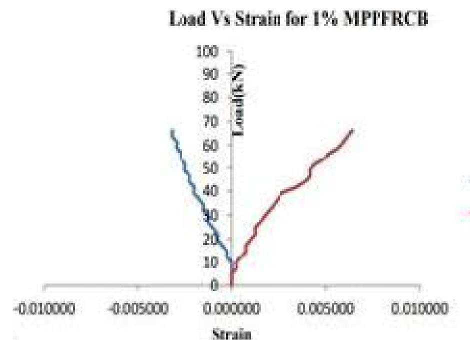

FIG VI. LOAD VS STRAIN FOR 1% MPPFRCB

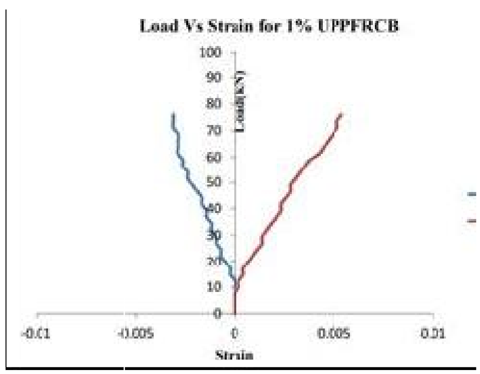

FIG VII. LOAD VS STRAIN FOR 1% UPPFRCB

A. Moment Vs Curvature

From the typical observation made, on the beams the ultimate load and moment as obtained from experiments. The curvature at any load was obtained by dividing the arithmetic sum of compressive strain and tensile strain in the constant bending moment zone by the distance between the lines of measurement of strains. From these curves, it was clearly seen that curvature increased as the load increased in all the beams.

It is observed from the test result

• Moment increases with addition of fibre increase.
• Curvature decrease with addition of fibre increase
• 1% UPPFRCB is capable of carrying higher moment compared to CFRCB
• Curvature decreases in 1% UPPFRCB compared to CFRCB.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, May 2026
Impact Factor: 8.2

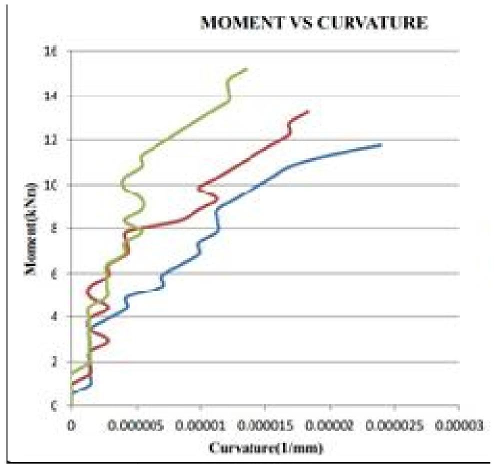

FIG VIII. MOMENT VS CURVATURE CURVE OF REINFORCED CONCRETE BEAM

B. SEM Analysis

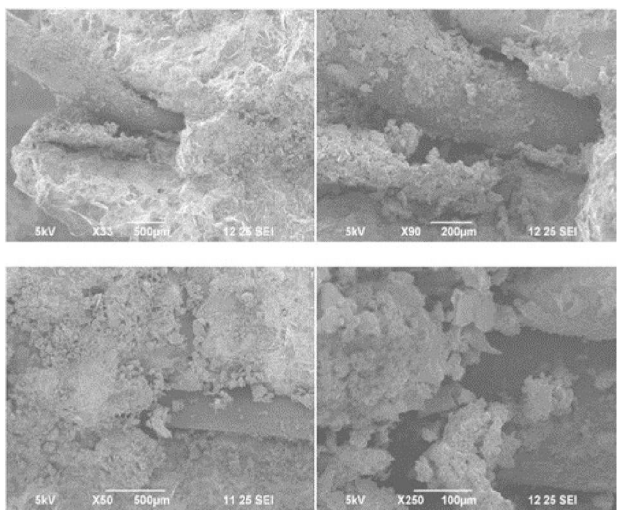

FIG IX. FIBER IN CONCRETE BY SEM ANALYSIS

C. Future Scope

• Palmyra Palm Fiber is a new find to concrete, and hence it can be studied further by blending it with other natural and synthetic fibers forming hybrid fibers.

• The durability of Palmyra Palm fiber can be studied. In various exposure conditions.

• Investigation can be made on Palmyra Palm fiber by using it with Recycled Aggregates, M-sand, Silica Fumes, Ground Granulated Blast furnace Slag.

V. CONCLUSION

The optimum fiber content for Palmyra Palm Fiber was 1% by the weight of cement.

• Due to the crack resistance and brittle resistance of fiber, the strength of concrete tends to increase.

• From the test results, it was found that as the volume of fiber increases, the strength parameters of concrete is also increased.

• The optimum fiber content for Palmyra Palm Fiber was 1% by the weight of cement

• The Compressive Strength, Split Tensile Strength and Flexural strength of 1% Unmercerized Palmyra Palm fiber Concrete occurs to be maximum on comparison with 1% Mercerized Palmyra Plam Fiber concrete and conventional Concrete.The ultimate strength is found to be more when Palmyra Palm fiber with 1% by the weight of cement was used for making beam.

• It was observed that the 1% Unmercerized fibre reinforced concrete beams possess maximum flexural strength of 21.58MPa at increased percentage of 27.54 on comparison with Conventional Reinforced concrete beams, while 1% Mercerized fibre reinforced concrete beams possess flexural strength of 19.13MPa.

• On comparison with CRCB, 1%UPPFRCB possesses high moment carrying capacity and energy absorption capacity.

• On Average, maximum central deflection for CRCB is 7.8mm at 56.41 kN, for the 1%MPPFRCB is 7.34mm at 63.77 kN, for 1%UPPFRCB is 6.11mm at 71.94kN.

.

REFERENCES

[1] A.R, Santhakumar (2012) ‘Concrete Technology’,10th Edition, Oxford Universty Press.

[2] Mahyuddin Ramli And Eethar Thanoon Dawood (2010), ‘Effects of Palm Fiber on the Mechanical Properties of Lightweight Concrete Crushed Brick’,2010 Science Publications.

[3] Pratik Patel, Dr. Indrajit N. Patel (2013), ‘A Literature Review on Use of Cellulose Fibres And Supplementary Material Silica Fume in Concrete’ Volume: 2, Issue : 5, May (2013) .

[4] IS 383 – 1970, ‘Specification For Coarse And Fine Aggregates From Natural Sources For Concrete’.

[5] IS 456 -2000 ‘Plain and Reinforced Concrete Code Of Practice’.

[6] IS 1489(Part I)-1991, ‘Portland Pozzolana Cement-Specification (Fly Ash Based)’.

[7] IS 2386 (Part I) – 1963, ‘Methods of Test for Aggregates for Concrete’.

[8] IS 2386 (Part III) – 1963, ‘Methods of Test for Aggregates for Concrete’.

[9] IS10262 – 1982, ‘Recommended Guidelines For Concrete Mix Design’.

[10] Shetty, M.S (2003) ‘Concrete Technology – Theory and Practice’, 5th Edition, S.Chand & Company Ltd.

[11] Saandeepani Vajje, Dr.N.R.Krishna Murthy-‘Study On Addition Of The Natural Fibers into Concrete’ IJSTR, Vol 2(2013).

[12] Tara Sen, H. N. Jagannatha Reddy (2011), ‘Application of Sisal, Bamboo, Coir and Jute Natural Composites in Structural Upgradation’,IJIMT, Vol.2, No.3, June (2011).

[13] Z. Ahmad, H.M. Saman and P.M. Tahir (2010), ‘Oil Palm Trunk Fiber as A Bio-Waste Resource For Concrete Reinforcement’,IJMME, Vol.5 (2010).