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Comparative Study on Conventional Concrete & Pineapple Leaf Fiber Reinforced Concrete

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Abstract— Different types of fibres are used in concrete for the improvement of its mechanical properties. Both the synthetic fibres and natural fibres could be used. The use of plant fibre in concrete holds a pre-dominant position in the concrete industry. For environmental protection purposes, the use of natural fibres rather than synthetic fibres is highly recommended. In this study, Pineapple Leaf Fibre (PALF) is used to improve the properties of conventional concrete. PALF is compatible natural fibre resource and constitutes a good chemical composition when compared to other natural fibres. The present work includes the experimental tests conducted to measure the strength of conventional concrete and concrete containing pineapple fibres at various dosages (0.2 to 1%) in 0.2% increments at 28 days curing. The experimental tests conducted are compressive strength, split tensile strength and flexural strength. The test results are compared and analysed. Water absorption and durability tests are also conducted.

Index Terms— concrete. Durability, mechanical properties,natural fibres, PALF, synthetic fibres,

1 INTRODUCTION

Concrete is the man made material widely used for construction purposes. Concrete made with Portland cement is comparatively strong in compression but weak in tension and tends to be brittle. In order to improve the tensile properties, fibers are added to the concrete, which is known as fiber added concrete. Researchers have used plant fibers as an alternative source of steel and/or artificial fibers to be used in composites (such as cement paste, mortar and/or concrete) for increasing its strength and ductility. Natural fibers have the advantages of low density, low cost, and biodegradability. When concrete cracks, the randomly oriented fibers start functioning, arrest crack formation and propagation, and thus improve strength and ductility.Pineapple leaf fiber is more compatible natural fiber resource and constitutes a good chemical composition and has better mechanical strength. Pineapple leaf fiber (PALF) is vital natural fiber, which have high specific strength, rigidity, flexural and torsional rigidity than other fibers. However, the main disadvantages of natural fibers in composites are the poor compatibility between fiber and matrix and the relative high moisture sorption. Therefore, chemical treatments are considered in modifying the fiber surface properties. The chemical treatment of fiber aimed at improving the adhesion between the fiber surface and the matrix may not only modify the fiber surface but also increase fiber strength. For homogeneous distribution of natural fiber into the cement matrix both the chemical composition as well as surface properties of natural fiber has to be modified by a dilute alkali treatment.

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2 MATERIALS USED AND METHODS

Material properties:
Cement: Ordinary Portland Cement (OPC) 53 grade conforming IS 8112:2013 was used. The cement used for experiments was obtained from a single consignment and of same grade and from same source.
Fine Aggregate: Locally available M sand passing through 4.75 mm IS sieve conforming to grading Zone II of IS 383:1970 and having a specific gravity of 2.67 was used.
Coarse Aggregate: The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75mm. Crushed aggregate available from local sources with maximum size of 20mm and conforming to IS 2386:1963 (PART I, II, and III) was used as coarse aggregate.
Water: Water used for mixing is to be fresh and free from any organic and harmful solution, which will lead to deterioration in the properties of the mortar.
Pineapple Leaf Fiber (PALF): Pineapple (Ananas Comosus) is the third most important tropical fruit in the world after banana and citrus. Fiber from the raw pineapple leaves is used and thus it could be easily accessible and cheap. Treatment with NaOH is done.

TABLE 1
Properties of PALF (provided by the online retailers)

Type	Tensile strength (MPa)	Young's modulus (GPa)	Density (g/cm^3)	length (cm)	Diameter (mm)
Natural	387-1486	29.8-81	1.3	12.5	0.6-1.1

Preparation and casting of specimens: The specimens were prepared by casting them in steel moulds with a size of 150x150x150 mm cubes, 150x300 mm cylinders and 500x100x100 mm beams. The interior of the steel mould was applied a liberal coat of lubricating oil to prevent concrete from adhering to the mould. The designed concrete mix was filled into the moulds in layers. Adequate compaction was carried out using table vibrator to avoid honey combing. After one day of casting, specimens were demoulded and immersed in water for curing.

Mix Proportions: The characteristic compressive strength of concrete used for the study was 25 MPa.

TABLE 2
MIX PROPORTIONS

Material	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (litres)
Weight (kg/m^3)	438.133	640.259	1236.362	197.16
Ratio	1	1.46	2.82	0.45

The pineapple fibres were added in various proportions of 0.2%, 0.4%, 0.6%, 0.8 and 1% (by the weight of raw materials used)

3. EXPERIMENTAL RESULTS AND DISCUSSIONS

3.1. Effect of Pineapple Fiber on the Compressive Strength of Concrete Cubes

A standard size of 150 x 150 x 150 mm concrete cubes was used for this study. The experimental investigation has been conducted on 18 concrete cubes. Three concrete cubes were tested for each test and the average of three concrete cubes were tested after 28 days curing without the pineapple fibre and the remaining 15 concrete cubes were tested after 28 days curing with the pineapple fiber at different proportions (0.2%, 0.4%, 0.6%, 0.8, and 1% with the weight of raw materials ie. fine aggregate, coarse aggregate and binder).

Fig.1 Compressive Strength on cube

Table 3 presents the compressive strength of concrete cubes.

TABLE 3
COMPRESSIVE STRENGTH OF CONCRETE CUBES

sl.no.	% of pineapple fiber	compressive strength (N/mm^2) after 28 days
1.	0	28.20
2.	0.2	32.70
3.	0.4	43.73
4.	0.6	38.20
5.	0.8	32.13
6.	1	27.70

Compressive strength of concrete is affected by addition of PALF. Addition of 0.2% of PALF causes about 13.47% increase in strength. Also in 0.4% addition of PALF there was an increase in strength up to 55.07% and in the case of 0.6% addition causes 35.46% increase in strength than the conventional concrete. Addition of 0.8% of PALF causes 13.94% increase in strength and addition of 1% of PALF causes 1.77% decrease in strength. The variation of compressive strength of conventional concrete and different percentage PALF added in concrete, at M25 mix and 28 days curing is represented graphically in figure 4.1. The abscissa of graph represents compressive strength of concrete cube (in N/mm^2) and ordinate represents percentage of PALF added.

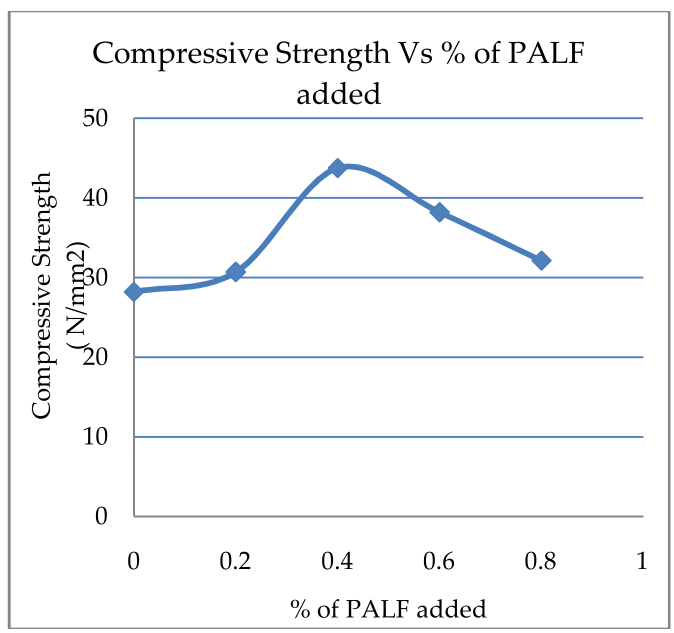

Fig.2 Compressive Strength vs. Percentage of PALF Added

Maximum compressive strength of 43.73 N/mm^2 was obtained at 28 days by adding 0.4% of PALF by total weight of raw materials.

Hence, we could get a high strength economical concrete by adding 0.4% of fine PALF. Minimum compressive strength of 27.70 N/mm^2 was obtained at 1% addition of PALF.

3.2. Effect of Pineapple Fiber on the Flexural Strength of Concrete Cubes

Standard size 100x100x500 mm of simple plain concrete beams was used for this study. The concrete prism was loaded at one-third span points. Experimental investigations have been conducted on 12 concrete beams. Two concrete beams were tested for each test. Out of 12 concrete beams, two reference concrete beams were tested after 28 days curing without the pineapple fiber and the remaining 10 concrete beams were tested after 28 days curing with pineapple fiber at different proportions (0.20%, 0.40%, 0.60%, 0.8% and 1% with the weight of raw materials).

Fig.3 Flexural Strength test on beams

Table 4 presents the flexural strength of concrete beams

TABLE 4
FLEXURAL STRENGTH OF CONCRETE BEAMS

sl. no.	% of pineapple fiber	flexural strength (Nmm^2) after 28 days
1.	0	4.25
2.	0.2	6.00
3.	0.4	6.75
4.	0.6	5.50
5.	0.8	5.25
6.	1	5.00

Flexural strength of concrete is also affected by addition of PALF. Addition of 0.2% of PALF causes about % 41.17% increase in strength.

Also in 0.4% addition of PALF there was an increase in strength up to 58.8% than the conventional concrete and in the case of 0.6% addition causes 29.41% increase in strength than the conventional concrete. Addition of 0.8% of PALF causes 23.53% increase in strength and addition of 1% of PALF causes 17.64% increase in strength.

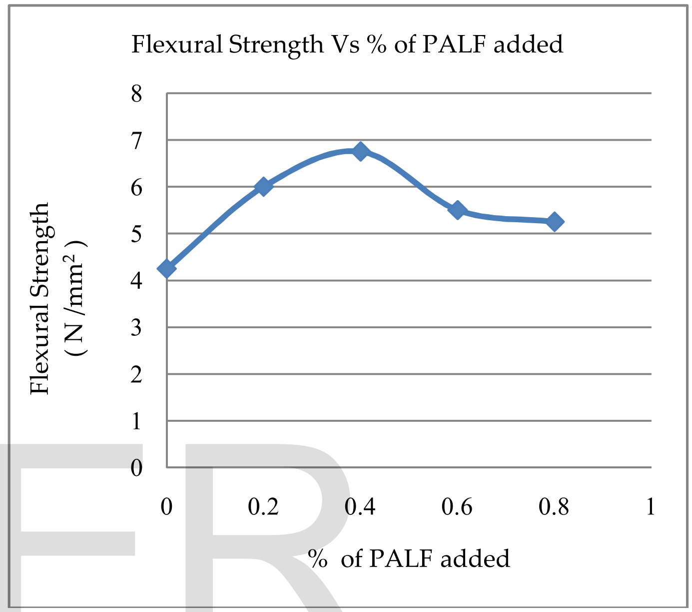

Fig.4 Flexural Strength vs. Percentage of PALF Added

Maximum Flexural strength of 6.75 N/mm^2 was obtained at 28 days by adding 0.4% of PALF by total weight of raw materials. Hence, we could get a high strength economical concrete by adding 0.4% of fine PALF. Minimum compressive strength of 5 N/mm^2 was obtained at 1% addition of PALF which is still greater than strength of conventional concrete.

3.3. Effect of Pineapple Fiber on the Split Tensile Strength of Concrete Cubes

Standard size 300x150 mm of simple plain concrete cylinders was used for this study. An experimental investigation has been conducted on 12 concrete cylinders. Two concrete cylinders were tested for each test. Out of 12 concrete cylinders, two reference concrete cylinders were tested after 28 days curing without the pineapple fiber and the remaining 10 concrete cylinders were tested after 28 days curing with pineapple fiber at different proportions (0.20%, 0.40%, 0.60%, 0.8% and 1% with the weight of raw materials).

Fig.5 Split Tensile Strength On Cylinders

Table 5 presents the flexural strength of concrete cylinders.

TABLE 5
SPLIT TENSILE STRENGTH OF CONCRETE CYLINDERS

sl.no.	% of pineapple fiber	split tensile strength (Nmm²) after 28 days
1.	0	3.20
2.	0.2	3.51
3.	0.4	3.65
4.	0.6	3.23
5.	0.8	2.42
6.	1	2.22

Split tensile strength of concrete is also affected by addition of PALF. Addition of 0.2% of PALF causes about 9.68% increase in strength. Also in 0.4% addition of PALF there was an increase in strength up to 14.06% than the conventional concrete and in the case of 0.6% addition causes 0.93% decrease in strength than the conventional concrete. Addition of 0.8% of PALF causes 24.70% decrease in strength and addition of 1% of PALF causes 30.60% decrease in strength.

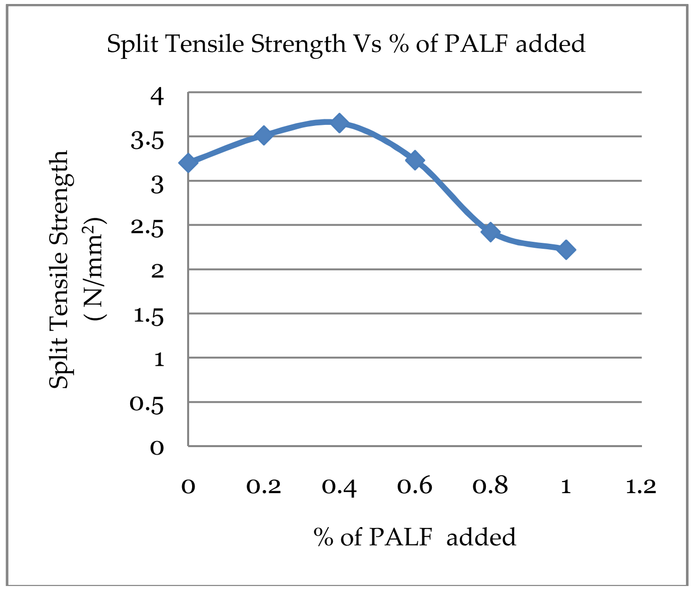

Fig.6 Split Tensile Strength vs. Percentage of PALF Added

Maximum Split tensile strength of 3.65 N/mm² was obtained at 28 days by adding 0.4% of PALF by total weight of raw materials. Hence, we could get a high strength economical concrete by adding 0.4% of PALF. Minimum split tensile strength of 2.22 N/mm² was obtained at 1% addition of PALF which is lower than strength of conventional concrete.

3.4. Effect of Pineapple Fiber on Water Absorption Rate

After 28 days of curing of concrete, weight of specimens was taken. From the dry weight and weight after 28 days curing following water absorption values are obtained.

TABLE 6
WATER ABSORPTION RATE VALUES

sl.no.	percentage of palf added (%)	water absorption rate (in %)
1.	0	1.36
2.	0.2	1.41
3.	0.4	1.5
4.	0.6	1.6
5.	0.8	1.6
6.	1	1.69

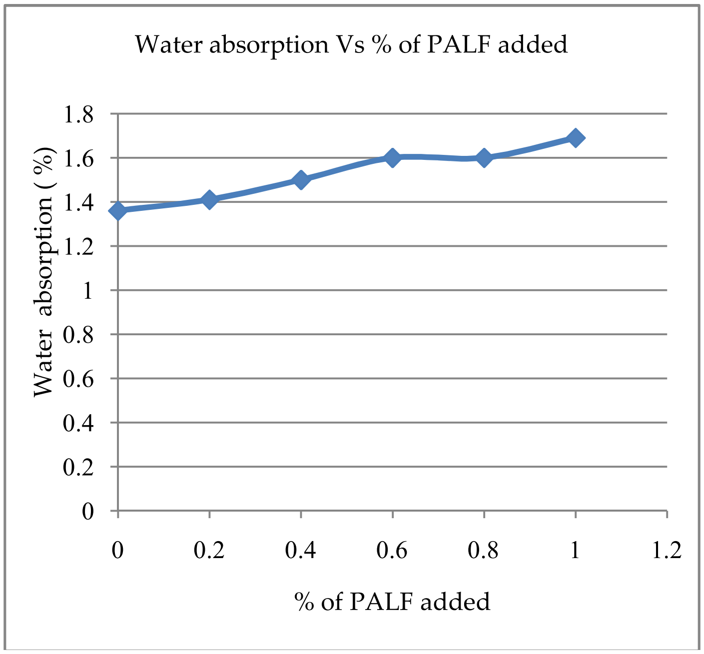

Fig.7 Water absorption Vs. Percentage of PALF Added

3.5. Durability Tests on Pineapple Leaf Fiber concrete cubes in Sea Water and Waste Water

Durability tests on hardened concrete are done in sea water and salt water. Compressive strength of conventional and PALF added concrete is found out for 30 days curing of concrete cubes in sea water and waste water.

TABLE 6
COMPRESSIVE STRENGTH OF CUBES AFTER 30 DAYS OF CURING IN SEA WATER AND WASTE WATER

Sl.no	Percentage of PALF added (%)	Compressive strength in sea water (N/mm²)	Compressive strength in waste water (N/mm²)
1	0	28.1	27.4
2	0.2	30	20.4
3	0.4	39.2	19.8
4	0.6	37.6	18.2
5	0.8	31.8	13.4
6	1	25.2	13.4

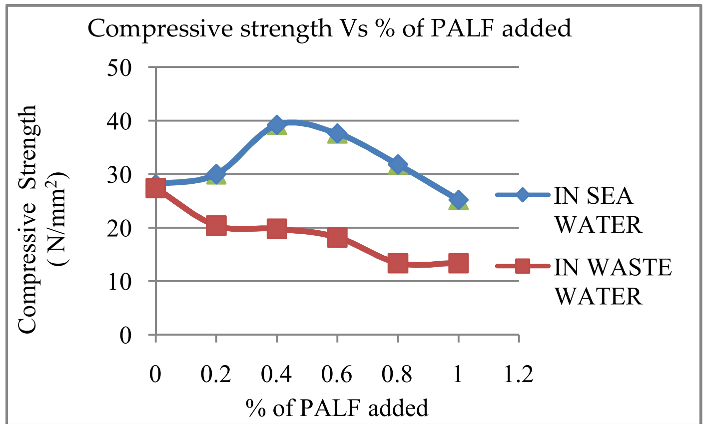

Fig 4.5 Compressive Strength vs. Percentage of PALF Added

The sea water contained high alkalinity and high chloride content, the compressive strength is reduced compared to strength of cubes after 28 days curing in normal water. But the strength of PALF added concrete is still higher than plane concrete. As for cubes cured in waste water due to high acidity and sulphate content strength is decreasing with increase of PALF content.

4 CONCLUSION

From the results of experimental investigations conducted:

- PALF added in concrete increases the properties of conventional concrete.
- The optimum fiber content is 0.4%
- Addition of 0.4% by weight of raw materials, increased the compressive strength, split tensile strength and flexural strength.
- By the addition of 0.4% of PALF 55.07% increase in compressive strength, 58.80% increase in flexural strength and14.06% increase in split tensile strength.
- Water absorption of PALF reinforced concrete is slightly greater than the plain concrete, but it is within the range
- After durability tests it is found that compressive strength of PALF added concrete is decreasing compared to the concrete after 28 days curing in normal water.
- PALF added concrete is comparatively durable in sea water.

Pineapple leaf fiber is a natural fiber and it is also an eco-friendly material. Fiber from the raw pineapple leaves is used and thus it could be easily accessible and cheap. By the addition of PALF in the M25 grade concrete, the strength obtained is similar to that of M40 grade plain concrete. So the reduction of raw materials are possible, and thereby the reduction in cost.

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REFERENCES

[1] Anmar Abdulwahid Sarray, (2013), "The Deterioration of Concrete in Wastewater Treatment Plants", IJJET

[2] A.Majid, (2012) Natural fibres as construction materials, *Journal of Civil Engineering and Construction Technology*, Vol. 3(3), pp. 80-89.

[3] C.Andressa *et.al,(2011)* Mechanical behavior of natural fiber composites, Sciencedirect, *journal of cement & concrete composite,*Vol. 10, pp. 2022-2027.

[4] Dr. Nagabhushana et.al (2017) "EFFECT OF SALT WATER ON COMPRESSIVE STRENGTH OF CONCRETE", *IRJET*,Volume: 04, Issue: 05

[5] E. Mello, et.al., (2014), "Improving Concrete Properties with Fiber addition", *IJCIEE,* Volume 8, No. 3 pp. 249-254.

[6] Kshitija Nadgouda, (2015), "Coconut Fiber Reinforced concrete", *IJMAPE,* Volume 3, Issue 1

[7] Linto Mathew, (2017), "Mechanical Properties of Pineapple Fiber Reinforced Concrete Subjected to High Temperature", *GRD Journals,* Volume 2, Issue 5.

[8] M Asim, et.al, (2017), "effect of Alkali treatments on physical and mechanical strength of Pineapple leaf fibers", *ICAMME,* Volume 01

[9] Phaninda Varma et.al, (2015),"Estimation of mechanical properties on pineapple or jute natural fiber composites", IJMER, Volume 5, Issue 9

[10] Riya johnson, Amritha E. k. ,(2018), "Experimental Study on Pineapple Leaf Fiber Reinforced RCC Beams", *IJERGS,* Volume 6 Issue 3

[11] R. Roselin, DR. M. S. Ravikumar, (2018), "Experimental Investigation on Pineapple fiber Reinforced Cement Concrete", *IJCIET,* Volume 9, Issue 6, pp. 1479–1484

[12] www.fiberlife.com, March 2019

[13] www.exporterindia.com, sept. 2018

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