EXPERIMENTAL AND COMPARATIVE STUDY ON BRICK WITH REPLACEMENT OF CEMENT, BANANA FIBERS, PINEAPPLE LEAF FIBERS AND COCONUT FIBERS

V.Logeswaran
Assistant Professor
Dept. of Civil Engineering
Sri Venkateshwaraa College of Engineering & Technology
Pudhucherry, India.

V.Balaji
Assistant Professor
Dept. of Civil Engineering
Achariya College of Engineering & Technology
Pudhucherry, India.

V.Anbukarasi
Assistant Professor
Dept. of Civil Engineering
Sri Venkateshwaraa College of Engineering & Technology
Pudhucherry, India.

ABSTRACT
The purpose of this paper is to provide the natural materials to the brick manufacturer. The use of pineapple leaf fibres, coir fibres, banana fibres material for lightening the weight of bricks is well established. Most of the developing countries are very rich in agricultural and natural fibre. India alone produces more than 400 million tonnes of agricultural waste annually. It has got a very large percentage of the total world production of rice husk, jute, stalk, jutefibre, banana fibre and coirfibre. Experimental work on bricks carried out by many tests has been present on the natural fibres considering various parameters are studied. All these natural fibres have excellent physical and mechanical properties and can be utilized more effectively in the development of building materials for various building applications.
Keywords: Banana Fibre, Pineapple leaf fibre, Coir fibre, Bonding Strength, Compressive Strength.

1. INTRODUCTION

1.1 BRICK

A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Bricks are produced in numerous classes, types, materials, and sizes which vary with region and time period, and are produced in bulk quantities. Two basic categories of bricks are fired and non-fired bricks. Block is a similar term referring to a rectangular building unit composed of similar materials, but is usually larger than a brick. Lightweight bricks (also called lightweight blocks) are made from expanded clay aggregate. Fired bricks are one of the longest-lasting and strongest building materials, sometimes referred to as artificial stone, and have been used since circa 5000 BC. Air-dried bricks, also known as mudbricks, have a history older than fired bricks, and have an additional ingredient of a mechanical binder such as straw. Bricks are laid in courses and numerous patterns known as bonds, collectively known as brickwork, and may be laid in various kinds of mortar to hold the bricks together to make a durable structure.

Production of bricks increased massively with the onset of the Industrial Revolution and the rise in factory building in England. For reasons of speed and economy, bricks were increasingly preferred as building material to stone, even in areas where the stone was readily available. It was at this time in London that bright red brick was chosen for construction to make the buildings more visible in the heavy fog and to help prevent traffic accidents.

The transition from the traditional method of production known as hand-moulding to a mechanised form of mass-production slowly took place during the first half of the nineteenth century. Possibly the first successful brick-making machine was patented by Henry Clayton, employed at the Atlas Works in Middlesex, England, in 1855, and was capable of producing up to 25,000 bricks daily with minimal supervision. His mechanical apparatus soon achieved widespread attention after it was adopted for use by the South Eastern Railway Company for brick-making at their factory near Folkestone. The Bradley & Craven Ltd 'Stiff-Plastic Brick making Machine' was patented in 1853, apparently predating Clayton. Bradley & Craven went on to be a dominant manufacturer of brick making machinery. Predating both Clayton and Bradley & Craven Ltd. however was the brick making machine patented by Richard A. VerValen of Haverstraw, New York in 1852.

The demand for high office building construction at the turn of the 20th century led to a much greater use of cast and wrought iron, and later, steel and concrete. The use of brick for skyscraper construction severely limited the size of the building – the Monadnock Building, built in 1896 in Chicago, required exceptionally thick walls to maintain the structural integrity of its 17 storeys. Following pioneering work in the 1950s at the Swiss Federal Institute of Technology and the Building Research Establishment in Watford, UK, the use of improved masonry for the construction of tall structures up to 18 storeys high was made viable. However, the uses of brick has largely remained restricted to small to medium-sized buildings, as steel and concrete remain superior materials for high-rise construction. Raw bricks sun-drying before being fired. Fired bricks are burned in a kiln which makes them durable. Modern, fired, clay bricks are formed in one of three processes – soft mud, dry press, or extruded. Depending on the country, either the extruded or soft mud method is the most common, since they are the most economical.

Normally, bricks contain the following ingredients:

1. Silica (sand) – 50% to 60% by weight
2. Alumina (clay) – 20% to 30% by weight
3. Lime – 2 to 5% by weight
4. Iron oxide – $\leq$ 7% by weight
5. Magnesia – less than 1% by weight

Figure 1: Brick

Table 1: Standard Size of Bricks in Various Place of World

STANDARD	VALUE
Australia	230 × 110 × 76 mm
Denmark	228 × 108 × 54 mm
Germany	240 × 115 × 71 mm
India	228 × 107 × 69 mm
Romania	240 × 115 × 63 mm
Russia	250 × 120 × 65 mm
South Africa	222 × 106 × 73 mm
Sweden	250 × 120 × 62 mm
United Kingdom	215 × 102.5 × 65 mm
United States	194 × 92 × 57 mm

1.3 BACKGROUND

The use of natural fibres for textile materials began before recorded history. The oldest indication of fibre use is probably the discovery of flax and wool fabrics at excavation sites of the Swiss lake dwellers (7th and 6th centuries BCE). Several vegetable fibres were also used by prehistoric peoples. Hemp, presumably the oldest cultivated fibre plant, originated in Southeast Asia, then spread to China, where reports of cultivation date to 4500 BCE. The art of weaving and spinning linen was already well developed in Egypt by 3400 BCE, indicating that flax was cultivated sometime before that date. Reports of the spinning of cotton in India date back to 3000 BCE. The manufacture of silk and silk products originated in the highly developed Chinese culture; the invention and development of sericulture (cultivation of silkworms for raw-silk production) and of methods to spin silk date from 2640BC.

With improved transportation and communication, highly localized skills and arts connected with textile manufacture spread to other countries and were adapted to local needs and capabilities. New fibre plants were also discovered and their use explored. In the 18th and 19th centuries, the Industrial Revolution encouraged the further invention of machines for use in processing various natural fibres, resulting in a tremendous upsurge in fibre production. The introduction of regenerated cellulosic fibres (fibres formed of cellulose material that has been dissolved, purified, and extruded), such as rayon, followed by the invention of completely synthetic fibres, such as nylon, challenged the monopoly of natural fibres for textile and industrial use. A variety of synthetic fibres having specific desirable properties began to penetrate and dominate markets previously monopolized by natural fibres. Recognition of the competitive threat from synthetic fibres resulted in intensive research directed toward the breeding of new and better strains of natural-fibre sources with higher yields, improved production and processing methods, and modification of fibre yarn or fabric properties. The considerable improvements achieved have permitted increased total production, although natural fibres actual share of the market has decreased with the influx of the cheaper, synthetic fibres requiring fewer man-hours for production.

In developing countries, there is a different approach to deal with organic waste. In fact, the word 'waste' is often an inappropriate term for organic matter, which is often put to good use. The economies of most developing countries dictates that materials and resources must be used to their full potential, and this has propagated a culture of reuse, repair and recycling. In many developing countries there exists a whole sector of recyclers, scavengers and collectors, whose business is to salvage ' waste' material and reclaim it for further use. In India, 1500 jam and juice industries exist and in Tamilnadu, 259 industries are involved in processing. One of the commonly used fruits is Pineapple. From each pineapple fruit, only 52 % is used for jam and juice production. Remaining 48 % consists of fruit peel and leaves forming the waste. These waste are rich in lignin and cellulose and thus from a very good raw material for allied fibres. Also, Waste disposal is a major problem in these industries because of very high lignin and cellulose content of the waste leaves which is difficult to be degraded, thus resulting in pollution and affecting the environment.

The available, traditional methods of fibre extraction involve the processes viz., retting, decortications, combing etc., which takes 5-7 days. During decortications, it is difficult to extract the fibres as they are sticky due to the presence of pith thus necessitating the use of chemicals which is not ecosafe. Thus, there is an urgent need for the development of eco-friendly, cost effective technology.

1.4. OBJECTIVE

Analyse and Study the properties of the materials to be used. To study the compressive strength of the brick by adding different percentage of cement & natural fibre. Analyse the cost of commercial brick using replacement of cement ,soil , natural fibre.

1.5. SCOPE

-To attain maximum strength
-Utilization of agricultural by product.
-To save the natural aggregate by using natural fibre.
-We can use light weight bricks for the construction purpose

1.6. NEED FOR STUDY

Nowadays, managing of agriculture waste has become a necessity for environment
-To promote the preservation and natural resources through a process of optimization of agricultural by products
-Building construction cost may reduce.
-Addition of cement with clay and natural fibres on manufacturing of bricks can be studied.

2. LITERATURE REVIEW

A.N. Kasim, M.Z. Selamat, et.al.,2017 - This study investigates the mechanical properties of high impact polypropylene composite reinforced with pineapple leaf fibre from the Josapine cultivar as a function of fibre loading. PLF was extracted by using a pineapple leaf fibre machine and then an alkaline treatment was conducted to enhance the properties. Samples of the composite were fabricated with 100 mm fibre length with five different fibre loadings of PLF (30, 40, 50, 60 and 70 wt%). The fabrication was made by a compression moulding technique with unidirectional fibre orientation. Related tests such as tensile, hardness and density tests were conducted to determine the effect of fibre loading. The experimental data showed that the composite with the 60 wt% fibre loading offered the highest value of tensile strength, which was about 309%, and the Young's modulus was about 540% compared to 0 wt% of PLF loading. Meanwhile, the hardness and density of the PLF/PP composites showed very similar values, with small increments from 30 wt% up to 70 wt% PLF loading compared to 0 wt% of PLF loading. The highest values are 65.38 Shore-D and 1.002 g/cm^3 respectively. The results also revealed that PLF from the Josapine cultivar with alkaline treatment greatly influences the mechanical properties of PLF/PP composite.

Md. ReazuddinRepon, K. Z. M. Abdul Motaleb, 2017, et.al.,. The objective of this study is to examine the tensile strength, elongation percentage, Young's modulus and water absorption percentage of jute and pineapple fabric reinforced polyester composite. Unsaturated polyester resin was used as matrix material. In this study, tensile and water absorption properties of jute and pineapple fabric reinforced polyester composites were investigated. The tensile strengths as well as Young's modulus of pineapple composite were exhibited better results than that of the jute fabric reinforced composites. Opposite scenario has observed for elongation percentage at break. The capacity of water absorption was noticed higher in jute fabric composite than pineapple. The jute and pineapple fabric reinforced composites has degradable behaviours and can be used as environmental friendly materials. Further investigation will be done to improve processing, to expand the application fields for jute and pineapple composites.

OluyemiOjoDaramola, 2017, et.al., Investigations were carried out to study the effect of treated pineapple leaf fibre (PALF) on the mechanical properties and water absorption behaviour of reinforced polyester composites. PALF was extracted from pineapple plant using wet retting method. Chemical treatment was carried out on it to hinder water content and enhances good adhesion between fibre and matrix. Both the matrix and the fibre were compounded using hand lay-up method at room temperature. The samples were prepared for tensile test, flexural test, hardness test and water absorption test. It was observed that as the fibre content increases within the matrix, there is corresponding increase in the ultimate tensile strength and modulus of elasticity while there was decrease in the elongation at break. Flexural strength, flexural modulus and hardness properties of the developed composites increase linearly from 10 wt% to 30 wt% fibre loading and begin to decrease from 40 wt% fibre loading. The results of the water absorption test showed that the amount of water absorbed by the composite increased with increase in fibre loading.

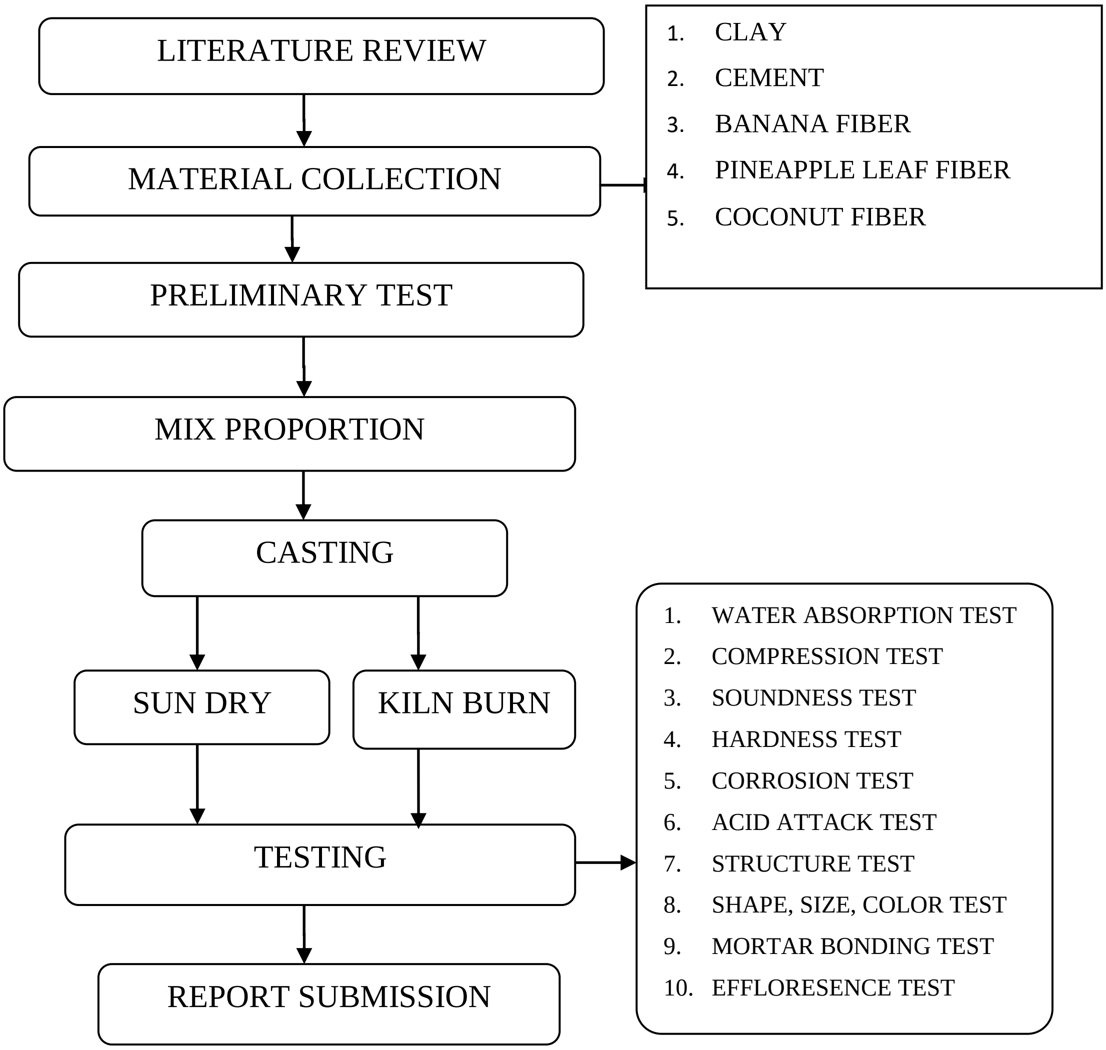
J.Poovizhi, E. T. Aarthi, 2015, et.al., This research is intended to provide detailed technical and economic information on the production of compressed cement stabilised soil bricks. These include information on suitable soil types, local stabilisers, stabilization techniques, production of compressed stabilized soil bricks and their economical value and potential. Critical review of related literatures show that soil types, proportions between soil and stabilizer and compaction pressure applied to the moist soil mix affects the quality of the compressed soil brick. Using the Ordinary Portland Cement manufactured as stabilizer and soil sample from Perundurai, three different series of tests were prepared based on literature recommendations. Tests were conducted on soil bricks performance like compressive strength and water absorption on which the durability of the blocks depend. The investigation has revealed that from the bricks produced at the varying cement contents from 12% in increments of 2% up to 16% at constant compressive pressure of 10MPa, all the blocks except bricks produced by 16% cement have 21st day wet compressive strength values well above most of the recommended minimum values for use in structural work. Further increasing cement content results in an increase in the compressive strength value and a decrease in the absorption capacity of the soil brick. Increment of the compaction pressure also improves the compressive strength of soil cement brick. Comparisons of the effects of local brick masonry and soil brick masonry showed that soil brick masonry has shown better stabilization effect based on the 21st day compressive strength of bricks.

Uma Shankar, ArunPrakash, 2015, et.al., Increasing concern about the globalwarming, primarily due to deforestation has led to the ban on use of clay brick by government in buildings construction. Subsequently, a large action plan for the development use of fly ash bricks substitute has resulted in creation of more awareness about the use of fly ash based building materials. In the past one decade or so the joint efforts by R & D organizations, private industries and funding agencies provided the much needed thrust for the actual transfer of technical know-how and product to the end users. Most of the developing countries are very rich in agricultural and natural fibre. Except a few exceptions, a large part of agricultural waste is being used as a fuel. India alone produces more than 400 million tonnes of agricultural waste annually. It has got a very large percentage of the total world production of rice husk, jute, stalk, jute fibre, banana fibre and coconut fibre. All these natural fibres have excellent physical and mechanical properties and can be utilized more effectively in the development of building materials (Inclusion in fly ash bricks) for various applications. Use of fly ash and Natural fibre help in prevention of environmental degradation and use of agriculture land utilised in clay brick production

Naveed Ali, Muhammad Ashraf, 2016, et.al., This paper aims to study the In-plane shear strength of unreinforced brick masonry. Under lateral loads i.e. earthquake, wind, floods etc., it is commonly the walls that tend to undergo shear failure in most of the cases. The failure corresponding to these lateral loads during earthquake can be purely shear if the mortar is weak. Mortar is playing an important role in resisting lateral loads by inducing friction in presence of vertical precompression. Due to the importance of mortar, various mortar ratios are tested to find the effect of mortar ratios on the shear resisting properties of unreinforced brick masonry. Similarly, the frictional component of shear strength depends on vertical stresses, therefore, four different precompression levels are also selected and used. Standard brick unit prevalent in Pakistan is considered, similar to units that can be found also in neighbouring countries like India, Iran and Bangladesh amongst others. The results showed that by using rich mortar helps in increasing the shear strength as compared to lean mortar. Four different mortar ratios are used which are common in construction of masonry structures. 12 samples each of 4 mortar ratios are tested. The shear strength parameters i.e. cohesion and coefficient of friction are monitored and observed and are related to the compressive strength of mortar as well as the mortar ratio. Empirical correlations are developed, which can be used for shear design of unreinforced masonry.

3. METHODOLOGY

3.1 FLOW CHART



3.2 Materials Used in this Study

Cement, Clay, Coconut fibre, Pineapple leaf fibre, Banana fibre

4. RESULTSAND DISCUSSION

4.1 PRELIMINARY TEST REPORT

TEST CONDUCTED	TEST VALUE
Standard consistency of cement	33%
Initial and final setting time of cement	30 mins& 375 mins
Specific gravity of cement	3.05
Fineness of cement	2.1 %
Specific gravity of clay	2.66
Water absorption of clay	15%

Liquid limit of clay	33
Plastic limit of clay	34

4.2 SOUNDNESS TEST

Name of brick	Coir fibre brick	Pineapple fibre brick	Banana fibre brick
Result	Good	Good	Good

4.3 HARDNESS TEST

Name of brick	Coir fibre brick	Pineapple fibre brick	Banana fibre brick
Result	Strong	Strong	Weak

4.4 ABRASION TEST

Name of brick	Coir fibre brick	Pineapple fibre brick	Banana fibre brick
Result	Good	Good	Good

4.5 CORROSION TEST

Name of brick	Coir fibre brick	Pineapple fibre brick	Banana fibre brick
Result	No change	No change	No change

4.6 ACID TEST

Name of brick	Coir fibre brick	Pineapple fibre brick	Banana fibre brick
Result	No change	No change	No change

4.7 STRUCTURE TEST

Name of brick	Coir fibre brick	Pineapple fibre brick	Banana fibre brick
Result	Even structure	Even structure	Even structure

4.8 EFFLORECENCE TEST

Name of brick	Coir fibre brick	Pineapple fibre brick	Banana fibre brick
Result	Nil	Nil	Nil

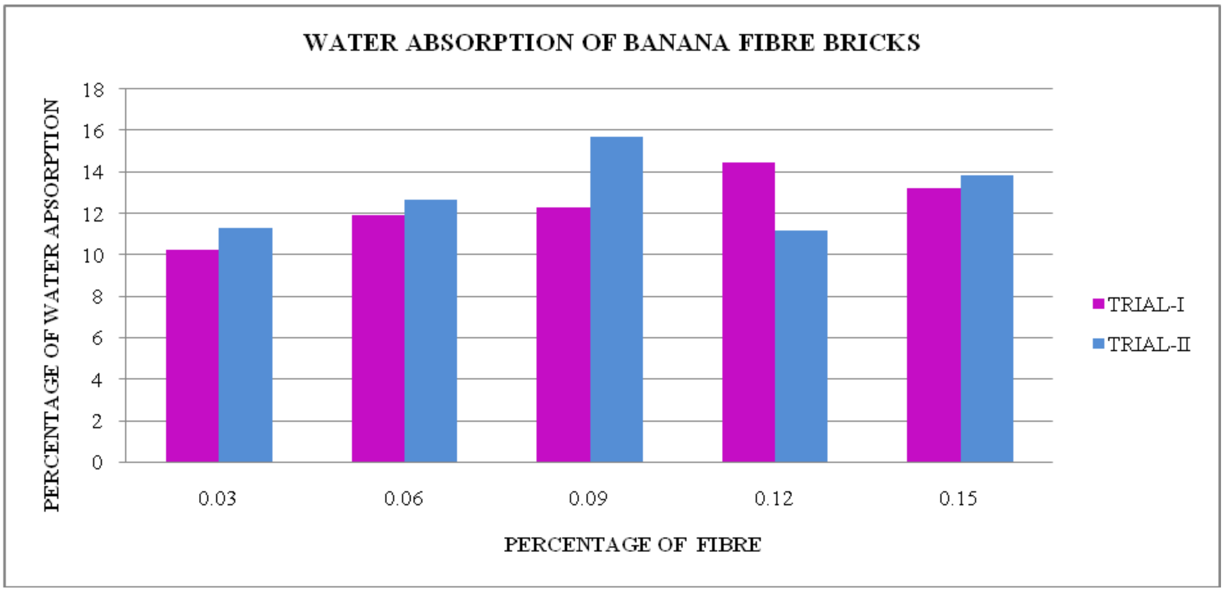
4.9 MORTAR BONDING TEST

Table 4.4: Mortar Bonding Test

Sl.No	Types of Fibres	Compressive strength for mortar bonding
1	5	2.21
2	25	2.13

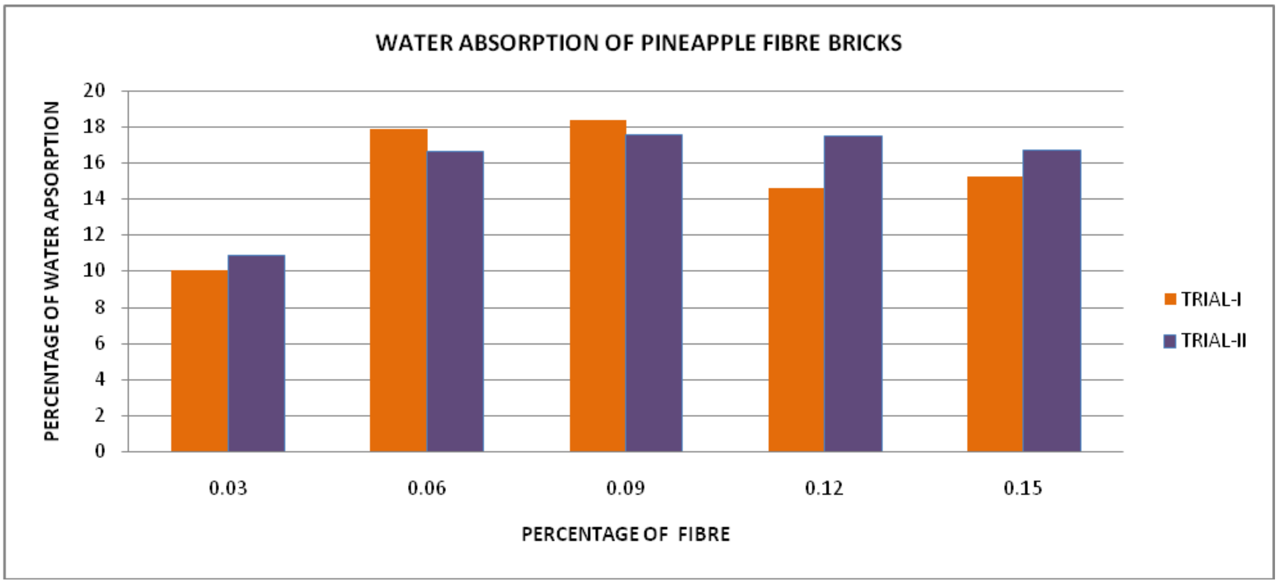
4.10 WATER ABSORPTION OF BANANA FIBRE BRICKS

SL. NO	% OF FIBRES (%)	DRY WEIGHT (Kg)	WET WEIGHT (Kg)	TRIAL 1 (%)	DRY WEIGHT (Kg)	WET WEIGHT (Kg)	TRIAL 2 (%)	AVERAGE (%)
B1	3	2.690	2.965	10.22	2.692	2.997	11.32	10.77
B2	6	2.720	3.045	11.94	2.724	3.069	12.66	12.3
B3	9	2.685	3.015	12.29	2.690	3.115	15.7	13.99
B4	12	2.665	3.050	14.44	2.667	2.965	11.17	12.80
B2	15	2.645	2.995	13.23	2.643	3.009	13.84	13.53



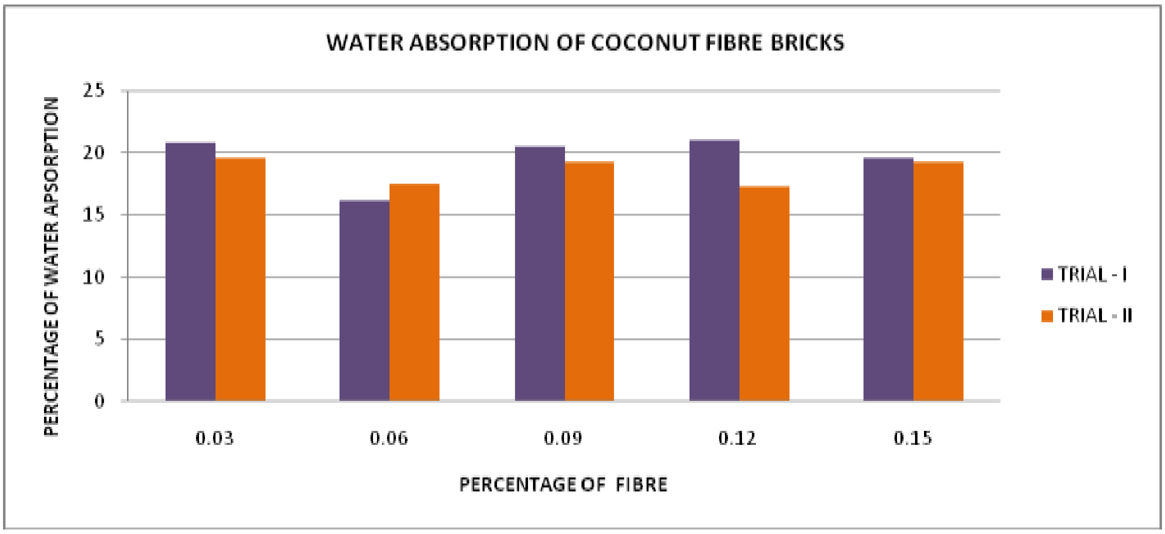
4.11 WATER ABSORPTION OF PINEAPPLE FIBRE BRICKS

SL. NO	% OF FIBRES (%)	DRY WEIGHT (Kg)	WET WEIGHT (Kg)	TOTAL 1 (%)	DRY WEIGHT (Kg)	WET WEIGHT (Kg)	TOTAL 2 (%)	AVERAGE (%)
P1	3	2.690	2.96	10.03	2.688	2.980	10.86	10.44
P2	6	2.655	3.130	17.89	2.651	3.092	16.63	17.26
P3	9	2.640	3.125	18.37	2.646	3.112	17.61	17.99
P4	12	2.615	2.996	14.56	2.625	3.085	17.52	16.04
P5	15	2.510	2.892	15.21	2.506	2.925	16.71	15.96



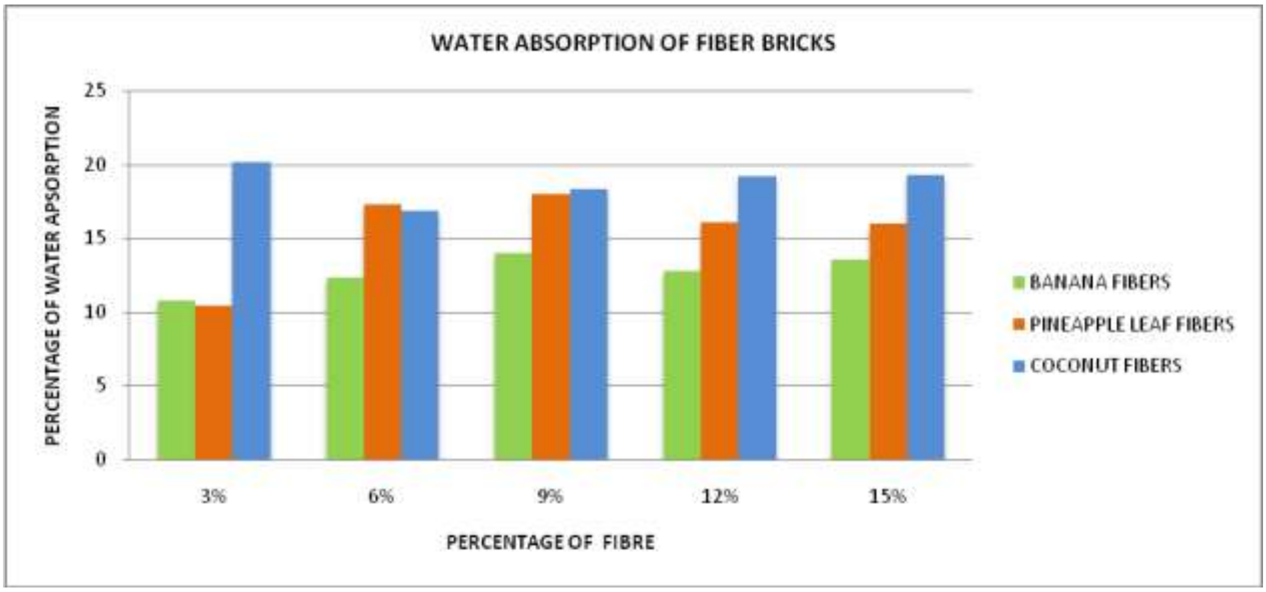
4.12 WATER ABSORPTION OF COCONUT FIBREFIBRE BRICKS

SL NO	% OF FIBRES (%)	DRY WEIGHT(Kg)	WET WEIGHT(Kg)	TRIAL 1(%)	DRY WEIGHT(Kg)	WET WEIGHT(Kg)	TRIAL 2(%)	AVERAGE(%)
C1	3	2.745	3.317	20.8	2.758	3.297	19.5	20.15
C2	6	2.775	3.225	16.2	2.780	3.269	17.5	16.85
C3	9	2.775	3.345	20.5	2.779	3.315	19.2	18.35
C4	12	2.650	3.120	21.0	2.662	3.125	17.3	19.15
C5	15	2.640	3.205	19.55	2.639	3.209	19.2	19.37



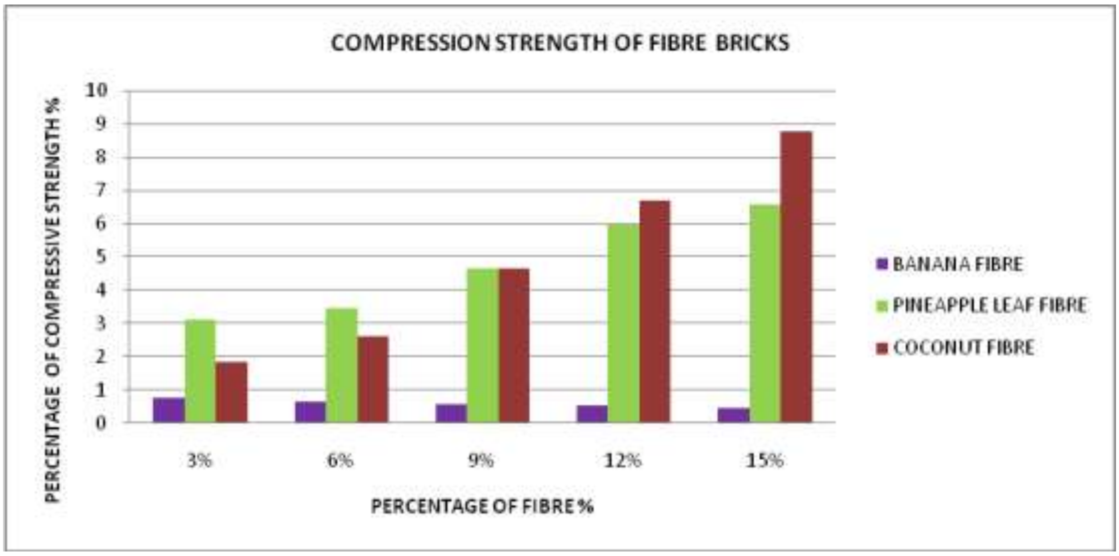
4.13 WATER ABSORPTION OF FIBER BRICKS

SI .No	FIBERS (%)	WATER ABSORPTION OF BANANA FIBER (%)	WATER ABSORPTION OF PINEAPPLE LEAF FIBER (%)	WATER ABSORPTION OF COCONUT FIBER (%)
1	3%	10.77	10.44	20.15
2	6%	12.3	17.26	16.85
3	9%	13.99	17.99	18.35
4	12%	12.80	16.04	19.15
5	15%	13.53	15.96	19.25



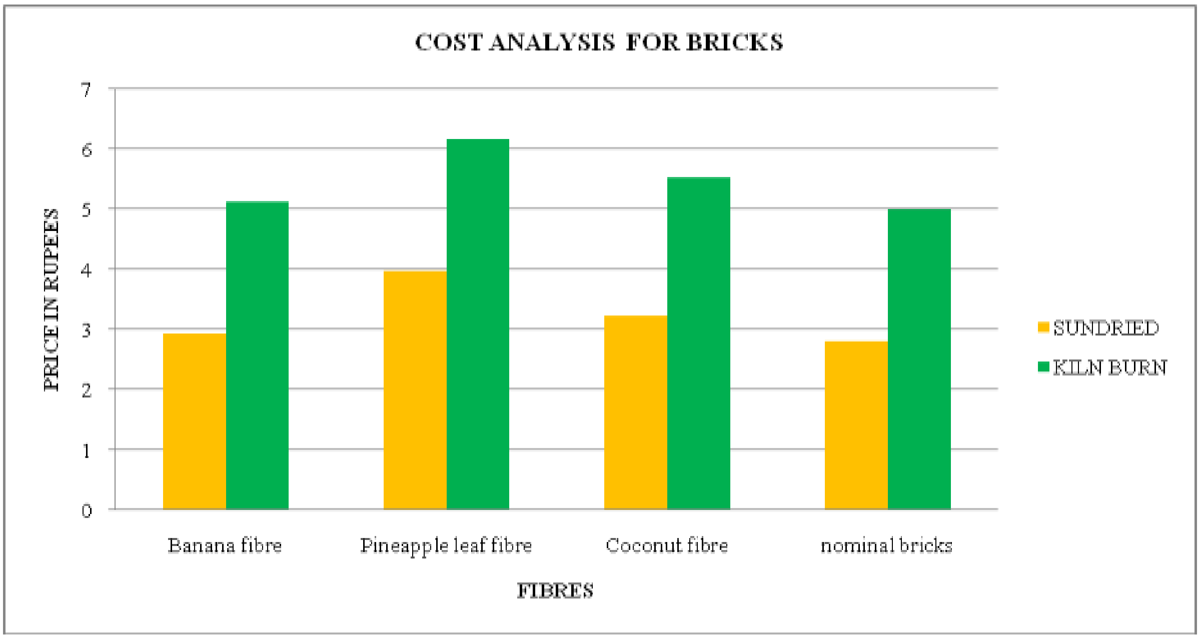
4.14 COMPRESSIVE STRENGTH OF FIBRE BRICKS

SI .NO	FIBRES (%)	COMPRESSION STRENGTH OF BANANA FIBRE (N/MM^2)	COMPRESSION STRENGTH OF PINEAPPLE LEAF FIBRE(N/MM^2)	COMPRESSION STRENGTH OF COCONUT FIBRE (N/MM^2)
1	3%	0.78	3.1	1.86
2	6%	0.65	3.46	2.6
3	9%	0.59	4.65	4.65
4	12%	0.55	5.95	6.69
5	15%	0.46	6.59	8.78



4.15 COST ANALYSIS FOR BRICKS

SL.NO	CLAY	FIBRE	CEMENT	LABOUR COST Rs.	KILN BURN COST Rs.	COST FOR SUNDRIED Rs.	COST FOR KILN BURN Rs.
BANANA FIBRE BRICKS							
B1	87%	3%	10 %	0.5	2.2	2.93	5.13
Rs.	0.589	0.246	1.6				
PINEAPPLE LEAF FIBRE BRICKS							
P5	75 %	15 %	10 %	0.5	2.2	3.98	6.18
Rs.	0.507	1.382	1.6				
COCONUT FIBRE BRICKS							
C5	75%	15 %	10 %	0.5	2.2	3.23	5.53
Rs.	0.507	0.728	1.6				



4.16. COMPARATIVE COST OF BRICKS

SL. NO	DESCRIPTION	COST (Rs)
1	Conventional brick	5
2	Fly ash brick	10

3	Hollow block – 150 x 200 x 31.25 mm	32
4	Hollow block – 100 x 200 x 31.25 mm	22
5	Zigzag pavement block – 60 mm thickness using hydraulic mould	9
6	Zigzag pavement block – 60 mm thickness using rubber mould	15
7	Zigzag pavement block – 80 mm thickness using hydraulic mould	11
8	Zigzag pavement block – 80 mm thickness using rubber mould	20
9	Round pavement block – 60 mm thickness	15

CONCLUSION

After all the effort and present experimental work the following observation are made by replacement pineapple leaf fibre, coconut fibre and banana fibre in clay bricks with different percentage and conclude that

1. Use of cement and Natural fibre help in prevention of environmental degradation and use of agriculture land in brick production.

2. The preparation process of the fibres is not simple and needs to be updated to include mechanical processing for large quantities production.

3. Bond strength and compressive strength increases as the mortar becomes richer.
4. As the compressive strength of the brick increases, the water absorption of the brick decreases. In this experimental work maximum compressive strength after 28 days is 6.59 N/mm^2, where minimum water absorption is 15.96% after 28 days in pineapple leaf fibre Brick.
5. As the compressive strength of the brick increases, the water absorption of the brick decreases. In this experimental work maximum compressive strength after 28 days is 8.78 N/mm^2, where minimum water absorption is 19.25% after 28 days in coconut fibre Brick.
6. As the compressive strength of the brick increases, In this experimental work maximum compressive strength after 28 days is 0.78 N/mm^2, where minimum water absorption is 13.53% after 28 days in banana fibre Brick.
7. Water Absorption Capacity of these Bricks are relatively lower when compared to the Clay Bricks.
8. The fibre reinforced soil bricks were found to have a high water absorption rate, which was due to the fibres pores effect on the bricks. This implies high fibre content in the soil bricks may absorb more water in rainy season which could affect some engineering properties of the bricks.
9. The addition of fibres to the soil clay contributed to a reduction in density of the bricks, which could be attributed to the low density of the fibre.
10. The bricks are used for the partition wall on the residential and institutional building.
11. The amount of water for the soil-cement mixture needs to be carefully controlled. There needs to be sufficient moisture for the cement to fully hydrate but no excess of

water which would reduce the final density, increase porosity and reduce final strength.

12. Using kiln burnt process the fibre brick loss its compressive strength and tensile strength of fibre.
13. The binding properties of clay, cement are increased by adding sand (more than clay), in the ratio of clay and sand (1:2).
14. To reduce the man power and mixing of fibre during casting of bricks by adding less than 10%.
15. The fibre bricks are prestressed, that bricks are used on the pavement roads.

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