Experimental Investigations on Bricks with the replacement of Coconut Fibre

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Abstract - *Space allotments for various kind of waste have been a major problem in all countries of the world. There are wastes like E-waste, Hazardous waste, Agricultural waste, Industrial waste, Municipal waste, Commercial waste, Chemical waste, etc. We are using the waste, Coconut fiber in this project for building material and to protect environment and natural resource like clay and sand. The basic waste used in this project is coconut fiber in addition with polymer as used to attain the strength of the brick. At first we have to shredded coconut fiber into the small pieces, mix them at the right proportion to make this brick, bricks are allowed to laid on the ground with the help of the mold, wet bricks are dried for seven days and the bricks are fired for another seven days after this process, the bricks have to be burnt for 15 to 20 days to attain the good strength. After these process bricks carried to the testing process as per Indian Standard codes 3495 part 1&2, 1077. The tests are Compression Test and Water Absorption Test, Output of this project has attain the strength 10% less than the Conventional Bricks, by this project we can reduce the usage of clay and sand considerably reduce the Environmental pollution and reduce the usage of resource.*

Key Words: **Agricultural Waste, E-Waste, Coconut fibre, Bricks, Environmental Pollution**

1. INTRODUCTION

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 mud bricks, 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. Brick made by shaping a plastic mass of clay and water, which is then hardened by drying and firing, are among the oldest and most enduring of mankind's building materials until comparatively recent times he clay was dug, the brick were made and the kilns set or drawn by manual labour with help from animal power.

About 100 years ago, the first effective machines for brick production appeared, and the trend towards mechanization of clay winning, making and handling operations has continued at an increasing pace to the present day. Brick is the simplest and most ancient of all buildings. Few other fabricated building units have enjoyed such widespread and continuous popularity. Properties offered by brick to the owner and builder.

This single material can be used to enclose a structure with a decorative, load-bearing wall, which is exceptionally durable and, if properly constructed in the first place, requires practically no maintenance. Because of the versatility of the raw material, which can readily be molded into a great range of shapes and sizes, and the flexibility that this gives to design and construction, building in brick has remained cost –effective. Secondary clay materials are compounds of alumina, silica with minor amounts of lime, magnesia, soda or potash.

Iron compounds, usually the oxides, hydroxides or carbonates, are nearly always present as impurities in brick clays, and they account for most of the wide range of colors found in the finished product.

1.1 Physical and Mechanical Properties

The physical and mechanical properties of coconut fibers are presented. The conditions specifically mentioned by the researchers are given at the end of table. Coconut fibers were investigated by many researchers for different purposes.

There is a huge difference in some properties, e.g. diameter of coconut fibers is approximately same and magnitudes of tensile strength are quite different, e.g. compare tensile strength of coconut fibers mentioned by

Ramakrishna et al. (2005a) and Toledo et al. (2005) in Table 1. Also, the range shown for a particular property is quite wide; e.g. Toledo et al. (2005) mentioned the density of coconut fiber as 0.67-10.0 g/cm3. These values seem to be unrealistic, real values may be the 0.67-1.00 g/cm3.

There are variations in properties of coconut fibers, and this makes it difficult for their frequent use as construction material. The purpose of compilation of data for the properties of fibers is to get a guideline, but after compilation, a huge variation is seen. There should be some standards for such variations, just like we have standards for sand and aggregates.

1.2 Chemical Properties

Coconut fibers contain cellulose, hemi-cellulose and lignin as major composition. These compositions affect the different properties of coconut fibers. The pre-treatment of fibers changes the composition and ultimately changes not only its properties but also the properties of composites. Some-times it improves the behavior of fibers but sometimes its effect is not favorable. The chemical composition of coconut fibers is presented in Table 2. Table 2.Chemical Composition of Coconut Fibers Sr. No.Fibre Hemi-cellulose (%) Cellulose (%) Lignin (%) Reference 1 Coir 31.1 a 33.2 a 20.5 a Ramakrishna, et al. (2005a) 15 - 28 b 35 - 60 b 20 - 48 b Agopyan, et al. (2005) 16.8 68.9 32.1 Asasutjarit, et al. 2007 - 43 45 Satyanarayana, et al. (1990) 0.15 – 0.25 36 - 43 41 - 45 Corradini, et al. (2006) a The compositions are % by weight of dry and powdered fiber sample b Chemical compositions are % by mass and author took other researchers data Ramakrishna and Sandararajan (2005b) investigated the variation in chemical composition and tensile strength of four natural fibers (coconut, sisal, jute and hibiscus cannabinus fibers), when subjected to alternate wetting and drying and continuous immersion for 60 days in three mediums (water, saturated lime and sodium hydroxide). Chemical composition of all fibers changed for tested conditions (continuous immersion was found to be critical), and fibers lost their strength. But coconut fibers were reported best for retaining a good percentage of its original tensile strength for all tested conditions. The effect of pre-treatment of coconut fibers is investigated by Asasutjarit, C., et al., 2007 for light weight boards.

Coconut fiber are agricultural waste products obtained in the processing of coconut oil and are available in large quantities in the tropical regions of the world, most especially in Africa, Asia and America. Coconut fiber are not commonly used in the construction industry but are often dumped as agricultural wastes. However, with the quest for affordable housing system for both the rural and urban population in the developing countries, various schemes focusing on cutting down conventional building material costs have been put forward.

One of the suggestions in the forefront has been the sourcing, development and use of alternative, non-conventional local construction materials including the possibility of using some agricultural wastes and residues as partial or full replacement of conventional construction materials. In countries where abundant agricultural wastes are discharged, these wastes can be used as potential material or replacement material in construction industry. One such alternative is coconut fiber, produced in abundance has the potential to be used as substitute coarse aggregate in concrete.

The huge amount of coconut fiber waste that are produced in the factories. The current waste disposal practice of incineration within the industry is normally done in an uncontrolled manner and contributes significantly to atmospheric pollution. Thus, these residues are becoming expensive to dispose by satisfying the requirements of environmental regulations. In such a situation, efforts are going on to improve the use of these by-products' through the development of value-added products. One of the ways of disposing these wastes would be the utilization of coconut fiber into constructive building materials. Oil Palm Shell (OPS) are the hard endocarp that surrounds the palm kernel.

2. MATERIALS AND METHODOLOGY

Table 1 standard Size Of Bricks In Different Countries

Standard	Imperial	Metric
Australia	9 × 4⅓ × 3 in	230 × 110 × 76 mm
Denmark	9 × 4¼ × 2¼ in	228 × 108 × 54 mm
Germany	9 × 4¼ × 2¾ in	240 × 115 × 71 mm
India	9 × 4¼ × 2¾ in	228 × 107 × 69 mm
Romania	9 × 4¼ × 2½ in	240 × 115 × 63 mm
Russia	10 × 4¾ × 2½ in	250 × 120 × 65 mm
South Africa	8¾ × 4 × 3 in	222 × 106 × 73 mm
Sweden	10 × 4¾ × 2½ in	250 × 120 × 62 mm

Coconut fiber

Coconut fiber is a natural fiber extracted from the husk of coconut and used in products such as floor mats, door mats, brushes and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir are in upholstery padding, sacking and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, string, rope and fishing nets.

Clay

Clays are distinguished from other fine-grained soils by differences in size and mineralogy. Silts, which are fine-grained soils that do not include clay minerals, tend to have larger particle sizes than clays, but there is some overlap in both particle size and other physical properties, and there are many naturally occurring deposits which include silt sand also clay. The distinction between silt and clay varies by discipline. Engineers distinguish between silts and clays based on the plasticity properties of the soil, as measured by the soils Atterberg Limits. Clay as collected from the lallkui.

River sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand can also refer to a texture class of soil containing more than 85% sand-sized particles by mass. The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica usually in the form of quartz. The second most common type of sand is calcium carbonate, which has mostly created, over the past half billion years, by various forms of life, like coral and shellfish. Sand is nonrenewable resources over human timescales, and suitable for making concrete is in high depend.

3. RESULT AND DISCUSSIONS

1. WATER ABSORPTION TEST ON BRICKS

Absorption test is conducted on brick to find out the amount of moisture content absorbed by brick under extreme conditions. In this test, sample dry bricks are taken and weighed. After weighing these bricks are placed in water with full immersing for a period of 24 hours. Then weigh the wet brick and note down its value. The difference between dry and wet brick weights will give the amount of water absorption. For a good quality brick the amount of water absorption should not exceed 20% of weight of dry brick. To determine the percentage of water absorption of bricks. A sensitive balance capable of weighing within 0.1% of the mass of the specimen and ventilated oven Three numbers of whole bricks from samples collected for testing should be taken. Dry the specimen in a ventilated oven at a temperature of 105 °C to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight specimen too warm to touch shall not be used for this purpose. Immerse completely dried specimen in clean water at a temperature of 27+2°C for 24 hours. Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water .Water absorption, % by mass, after 24 hours immersion in cold water in given by the formula,

NOTE: For a good quality brick the amount of water absorption should not exceed 20% of weight of dry brick. The less water absorbed by brick the greater its quality

Table 2. Water Absorption of bricks

S.NO	WEIGHT BEFORE ABSORPTION OF WATER(W1)g	WEIGHT AFTER ABSORPTION OF WATER(W2)g	% OF ABSORPTION OF WATER
NORMAL BRICK	2856 g	3171 g	9.82 %
5% BRICK	2806 g	3149 g	12.22 %
10% BRICK	2793 g	3135 g	12.24 %
15% BRICK	2824 g	3161 g	11.94 %

2. COMPRESSIVE STRENGTH OF BRICK (IS: 3495- PART 1-1992)

Unevenness observed in the bed faces of bricks is removed to provide two smooth and parallel faces by grinding. It is immersed in water at room temperature for 24 hr.

Table 3. Compressive Strength of Brick.

SPECIMEN	S.NO	C/S AREA mm2	LOAD kN	COMPRESSIVE STRENGTH N/mm2
CONVENTIONAL BRICKS	SAMPLE 1	100*70	110	15.71
	SAMPLE 2	100*70	100	14.28
	SAMPLE 3	100*70	115	16.42
BRICKS WITH 5% OF CF	SAMPLE 1	100*70	120	17.14
	SAMPLE 2	100*72	115	15.97
	SAMPLE 3	100*72	120	17.14
BRICKS WITH 10% OF CF	SAMPLE 1	100*70	110	15.71
	SAMPLE 2	100*75	120	16.00
	SAMPLE 3	100*70	125	17.85
BRICKS WITH 15% OF CF	SAMPLE 1	100*71	90	12.67
	SAMPLE 2	100*72	70	9.53
	SAMPLE 3	100*74	85	11.52

The specimen is then removed and any surplus moisture is drained out at room temperature. The frog and all voids in the bed face is filled with cement mortar (1 cement, clean coarse sand of grade 3 mm and down). It is stored under the damp jute bags for 24 h followed by immersion in clean water for 3 days. The specimen is placed with flat faces horizontal, and mortar filled face facing upwards between two 3 ply plywood sheets each of 3 mm thickness and carefully centered between plates of testing machine. Load is applied axially at a uniform rate of 14 N/mm2 per minute till failure occurs. The maximum load at failure is noted down. The load at failure is considered the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

Principal of operation: operation of the machines is by hydraulic transmission of load from the test specimen to separately housed load indicator. The hydraulic system is ideal since it replaces transmission of load through levers and knife edges, which are prone to wear and damage due to shock on rupture of test pieces. Load is applied by a hydro-statically lubricated ram.

Main cylinder pressure is transmitted to the cylinder of the pendulum dynamo-meter system housed in the control panel. The cylinder of the dynamo-meter is also of self-lubricating design. The piston of the dynamo-meter is constantly rotated to eliminate friction. The load transmitted to the cylinder of the dynamo-meter is transferred through a lever system to a pendulum. Displacement of the pendulum actuates the rack and pinion mechanism which operates the load indicator pointer and the autographic recorder. Application file compression testing machine is designed for test materials under compression bending, transverse and shear loads. Hardness test on metals can also be conducted.

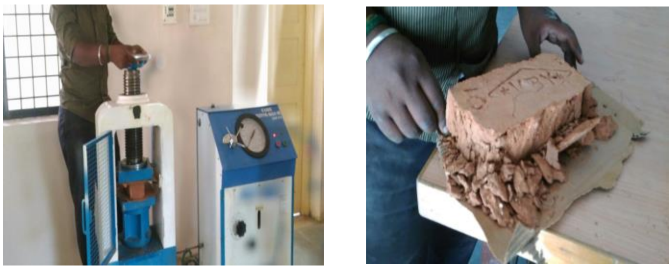


Fig 1. Compressive strength specimen

COMPRESSIVE STRENGTH TEST: (FOR BURNT BRICKS)

The burnt bricks made of different proportions of river sand, coconut fiber and clay compositions were tested for compressive strength.

S.NO	CLAY (%)	RIVER SAND (%)	COCONUT FIBER (%)	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm2)
1	50	50	0	108	15.47
2	50	45	5	118	16.75
3	50	40	10	118	16.52
4	50	35	15	82	11.24

The result showing the compressive strength of partial replacement of clay, river sand and coconut fiber by mixture of solid waste bricks. Slightly higher to that of the clay brick. The other proportions of coconut fiber, river sand and clay bricks also show similar results to that of clay brick.

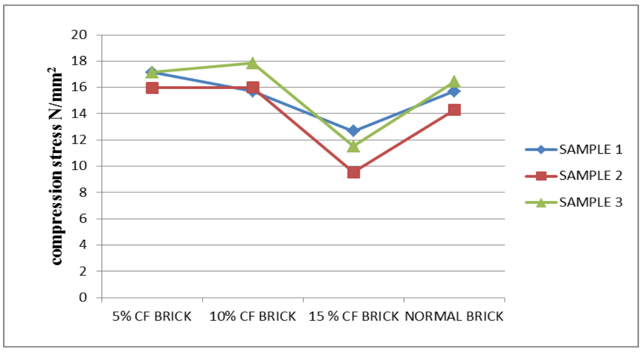


Chart 1 Compressive strength of brick

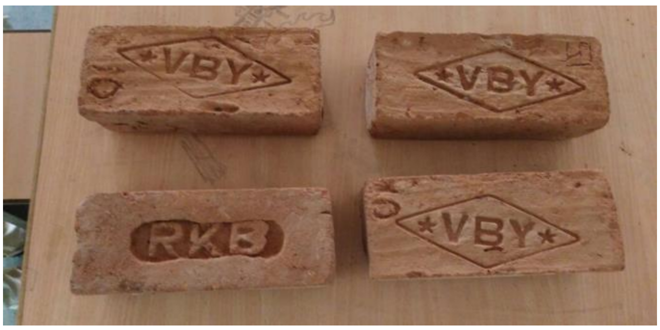
3. WATER ABSORPTION TEST:

The burnt bricks were tested for water absorption. Water absorption rate has been used as an indication for porosity of the brick

S.NO	CLAY	RIVER SAND	COCONUT FIBER	WATER ABSORPTION VALUE IN %
1	50%	50%	0%	9.87%
2	50%	45%	5%	12.22 %
3	50%	40%	10%	12.24 %
4	50%	35%	15%	11.94 %

4. EFFLORESCENCE TEST ON BRICKS

A good quality brick should not contain any soluble salts in it. If soluble salts are there, then it will cause efflorescence on brick surfaces. To know the presence of soluble salts in a brick, placed it in a water bath for 24 hours and dry it in shade. After drying, observe the brick surface thoroughly. If there is any white or grey color deposits, then it contains soluble salts and not useful for construction. The presence of alkalies in bricks is harmful and they form grey or white layer on brick surface by absorbing the moisture. This test is conducted to find out the presence of alkalies in bricks.



SUMMARY

The major raw materials used to manufacture of bricks are clay, river sand and coconut fiber. We collected river sand and clay from mepur. Then we collected coconut fiber from ayanavaram. Then we conduct the basic physical analysis (specific gravity, liquid limit, plastic limit, standard proctor compaction test, permeability test and consolidation test) for clay, river sand and coconut fiber. Then compare physical properties of river sand and coconut fiber with base material clay.

Firstly, we replace the clay by the mixture of river sand& solid waste (coconut fiber) to manufacture the different proportion of brick and conduct basic test on bricks (compressive strength test and water absorption test). Test procedure as per IS 3495 (part 1 and part 2).

We decided to partially replace the solid waste by clay with different proportion of bricks. Then we got good results in compressive strength and water absorption test.

SCOPE FOR FURTHER STUDY

Partial replacement of the bricks with coconut fiber and river sand in addition with clay it is a performance study, by this project the usage of the clay can be reduced and it lead to the safety of the environment. For the further study of the project using bricks others can use, take our project as a reference for their project for building materials, by re-placement for sand, re-placement for cement in the concrete mix etc.

3. CONCLUSIONS

During different industrial, mining, agricultural and domestic activities, huge quantity of solid wastes are being generated as by-products, which pose major environmental problems as well as occupy a large area of lands for their storage/disposal. There is a tremendous scope for setting up secondary industries for recycling and using such huge quantity of solid wastes as minerals or resources in the production of construction materials. Environment-friendly, energy-efficient, and cost-effective alternative materials produced from solid wastes will show a good market potential to fulfill people's needs in rural and urban areas.

An incorporation of industrial wastes or sub-products in bricks is becoming a common practice. Quarry processing industry generates a large amount of wastes, which pollute and damage the environment. Therefore this work aims to Characterize and evaluate the possibilities of using the coconut fiber, generated by the process industries, as alternative raw materials in the production of bricks. The waste can be reused as a fully replacement of clay with respect to the physical characteristics. Fully solid waste bricks yield to degrade mechanical, in terms of compressive strength, and physical, in terms of water absorption, properties. According to IS specifications the water absorption values must lower than 20%. The fully solid waste brick shows the negative effect. There is a positive effect of river sand & coconut fiber partially on clay brick samples that reach its optimum at 50% clay, 35% river sand and 15% coconut fiber by weight can be incorporated into raw clay materials of brick chambers, without degrading their mechanical properties. Finally, coconut fiber as an alternative raw material in brick production will induce a relief on waste disposal concerns. Further, the incorporation of coconut fiber in brick production leads to a new method of wastes disposal and found to be an environmental eco-friendly recycling process in brick industries and also preserve the 50% clay material.

REFERENCES

[1] Appukutty P. , Murugesan R. 'Substitution Of Quarry Dust To Sand For Mortar In Brick Masonry Works' International Journal on Design and Manufacturing Technologies, Vol.3, No.1, January 2009.

[2] Ashish Kumar Parashar*, RinkuParashar 'Comparative Study of Compressive Strength of Bricks Made With Various Materials to Clay Bricks' International Journal of Scientific and Research Publications, Volume 2, Issue 7, July 2012 1 ISSN 2250-3153.

[3] Balasubramaniam .S, R.Vasantha Kumar 'Waste Into Wealth' TMS (The Minerals, Metals and Material society)on 2008

[4] Devi .M 1 and K. Kannan 2 'Inhibitory Effect of Triethanolamine in Quarry Dust Concrete' Coromandal Journal of Science, Vol. 1, No. 1, December 2012. Pp.10-16

[5] Djwantoro Hardjito1 and Sin Wing Why2 On the Use of Quarry Dust and 'Bottom Ash as Controlled Low Strength Materials (CLSM)'

[6] Dumitru .I, T.Zdrilic and G.Smorchevsky, Boral Construction Materials, Sydney, Australia 'The Use Of Manufactured Quarry Fines In Concrete' at the Institute of Quarrying Conferences in Australia in 1997 & 1998.

[7] Ilangovana .R1, N. Mahendrana1 and K. Nagamanib2 'Strength and Durability Properties of Concrete Containing Quarry Coconut fiber as Fine Aggregate' 'ARPN Journal of Engineering and Applied Sciences' ISSN 1819-6608 vol. 3, no. 5, October 2008.

[8] Ismail .S, and Z. Yaacob' Properties of Bricks Produced With Recycled Fine Aggregate' World Academy of Science, Engineering and Technology 43 2010

[9] Jayawardena1&d.m.s. Dissanayake2 Use of quarry dust instead of river sand for future constructions in Sri Lanka IAEG2006 Paper number 38

[10] Kartini, K., NorulErnida, Z. A., Noor Fazilla, B., Ahmad Farhan, H. 'Development of Lightweight Sand-Cement Bricks using Quarry Dust, Rice Husk and Kenaf Powder for Sustainability' International Journal of Civil & Environmental Engineering IJCEE-IJENS Vol:12 No:06

[11] Kothai .L, R. Malathy 'Strength Studies on Self Compacting Concrete with Manufactured Sand as Partial Replacement of Natural Sand' European Journal of Scientific Research ISSN 1450-216X Vol. 89 No 3 October, 2012, pp.490-496

[12] Safiuddin .M.D1*, Mohd Zamin Jumaat2, M. A. Salam2, M. S. Islam3 and R. Hashim2 'Utilization of solid wastes in construction materials' International Journal of the Physical Sciences Vol. 5(13), pp. 1952-1963, 18 October, 2010 ISSN 1992 - 1950 ©2010 Academic Journal.

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