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An Experimental Investigation on Cement Brick Using Coconut Fiber and Partial Replacement of Cement by Saw Dust

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Abstract: ***Normally cement bricks are widely used for making temporary and permanent civil structures. The aim of this study is to find out the utilization of Saw Dust Ash as a construction material in civil engineering works as a partial replacement of cement. The mix ratio of cement and sand is 1: 5 and water cement ratio of 0.6. Whereas the Coconut fiber is at constant percentage of 0.4% of the volume to be casted. Three range of curing period of 7 days, 14 days and 28 days are considered in the present study of Cement brick with replacement of cement by 0%, 10%, 20% and 30% using Saw Dust Ash (SDA) and Coconut fiber as additive. Mixes with different percentages of SDA are casted. It has been decided to make three different types of conventional specimens with partial replacement of cement with SDA on a percentage of 10%, 20% and 30% in cement brick. Brick mould size 190 x 90 x 90 (mm).***

Keywords: Saw dust ash, M Sand, Cement, Coconut Fiber

1. Introduction

1.1 General

Saw dust ash is the residue produced from incineration of wood and its products for power generation or other uses. Cement is an energy extensive industrial commodity and leads to emission of a vast amount of greenhouse gases, forcing to look for an alternative, such as sustainable building practice. Natural fibers are eco - friendly, cost - effective, lightweight, renewable, have better thermal properties and corrosion resistance capabilities. The addition of natural fibers in concrete will be a sustainable step to enhance their mechanical properties as well as encouraging green construction. Coconut fibers are cheap among all the natural fibers and are abundantly available in several developing countries. This paper presents an overview of the work and studies on incorporation of saw dust ash as partial replacement of cement in concrete and addition of Coconut fiber to the concrete.

1.2 Saw Dust Ash

Saw dust ash is generated as a by - product of combustion in wood fired power plants and wood burning factories. Since wood is a potential source of energy and environmentally friendly material, there will be increased usage of wood in energy production in the future. As a result the quantity of ash generated will also increased and concurrently raising the issues of disposal. Incorporation of wood ash as a partial replacement of cement material in blended cement and concrete will be beneficial from both the environmental and economic point of views. This will give a solution to the waste management problem while minimizing the consumption of energy in manufacture of cement.

Figure 1.1: Saw Dust Ash

1.3 Manufactured Sand

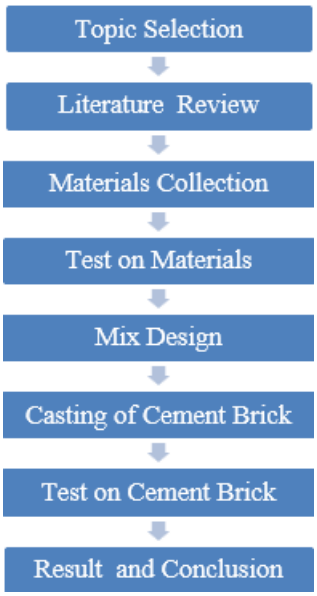
Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Then another reason for use of M - Sand is its availability and transportation cost. Since manufactured sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far - off river sand bed.

Figure 1.2: M - Sand

1.4 Objectives and Scope of Project

- To utilize the saw dust ash into a useful one.
- To reduce the cost of cement by partial replacement with saw dust ash.
- To improve the compression & tensile strength of cement with the addition of Coconut fiber.
- To utilize the waste natural Coconut fiber.
- To improve crack resistant by Coconut fiber.

1.5 Methodology



2. Literature Review

2.1 General

We are going to see about the journals related to saw dust ash and jute fibre of various author in this chapter.

2.2 Literature Study

- **Zakaria *et al* (2016)** compressive, flexural, and tensile strength are found to enhance significantly for volume content of 0.1 and 0.25 % and the fiber cut length of 10 and 15 mm. it can be stated that the maximum increment is observed for tensile strength which is 35 % with reference to the plain concrete.
- **Arul Surya *et al* (2006)** anatomized the effect on coconut coir to the normal fly ash bricks. It has shown a huge enrichment in compressive strength. The use of coconut coir in the brick up to 10% has shown good results, further addition of coconut coir is not still investigated. This says that the brick with coconut coir will have a gradational increase in its strength
- **Kiruthika, Niresh. B *et al* (2002**) conducted a study on the compressive strength of cover ash bricks using coir fibre is 1.6% advance than the ordinary complexion bricks, so these bricks can be effectively used for all construction purposes.
- **Rama Krishna et. al (2005),** This study invested on the variation of chemical composition and tensile strength for all four natural fibers, i. e, sisal, jute, coconut, hibiscus, cannabinus fiber was continuous immersion for 60days in water and subjected to alternate wetting and drying, continuous immersion was found to be critical due to loss of tensile strength. Among all the fibers, coconut fiber gives the best result for retaining a good percentage of tensile strength in all tests conditions. He carried an experimental on impact resistance of slabs. For all four different fiber content of 0.5%, 1.0%, 1.5% and 2.5%. By the weight of cement and their different length of 20, 30, 40mm. A fiber context of 2% and length of 40mm of coconut fiber which gives the best result by absorbing 2.5 and 3.5 J impact energy.
- **Pranav S. Dhakulkar *et al* (2018)** Compressive strength of saw dust ash concrete is found to be optimum at 15% (26.16 N/mm^2). Tensile strength of saw dust ash concrete is found to be optimum at 15% (1.89 N/mm^2). Flexural strength is also found to be optimum at percentage of 15% (13 N/mm^2).
- **S. Chowdhury *et al* (2015)** Wood Ash at replacement percentage up to 10% of the weight of binder can be successfully used as additive in place of cement to produce structure grade concrete. water absorption increased with increasing wood ash percentage.
- **Lisbeth M. Ottosen, *et al* (2016)** The mortar porosity increased linearly with decreasing w/c ratio. Using Wood Ash as partly cement replacement at low percentages (<10%) seems promising. The result showed that the compressive strength was strongly dependent on the w/c ratio There seemed to be a dependence on the compressive strength by the amount of ash in the mortar.

2.3 Summary

The review of literature has been discussed in this chapter.

3. Experimental Programme

3.1 Genral

The aim of this study is to find out the utilization of Saw Dust Ash as a construction material in civil engineering works as a partial replacement of cement. The mix ratio of cement and sand is 1: 5 and water cement ratio of 0.6. Where are the Coconut fiber is at constant percentage of 0.4% of the volume to be casted. Three range of curing period of 7 days, 14 days and 28 days are consider in the present study of Cement brick with replacement of cement by 0%, 10%, 20% and 30% using Saw Dust Ash (SDA) and Coconut fiber as additive.

3.2 Material Used

3.2.1 Cement

Cement is one of the binding materials. Cement is a finely milled mineral powder, usually grey in colour. The Cement used should confirm to IS specifications. There are several types of cement are available commercially in the market of which Portland Pozzolana Cement is the most known and available everywhere. PPC was used for this study. The properties of cement were obtained from various tests according to IS: 12269 - 2013 and IS: 4031 (PART 2) 1988. Physical properties of cement presented in table 3.1.

Figure 3.1: Cement

3.2.2 Saw dust ash

Saw dust ash is generated as a by - product of combustion in wood fired power plants and wood burning factories. Since wood is a potential source of energy and environmentally friendly material, there will be increased usage of wood in energy production in the future. As a result the quantity of ash generated will also increased and concurrently raising the issues of disposal. Incorporation of wood ash as a partial replacement of cement material in blended cement and concrete will be beneficial from both the environmental and economic point of views. This will give a solution to the waste management problem while minimizing the consumption of energy in manufacture of cement.

Figure 3.2: Saw Dust Ash

Table 3.2: Physical Properties of Saw dust ash

Replacement %	10%	20%	30%
PPC	0.432	0.384	0.336
Saw Dust Ash	0.048	0.096	0.144
Water/binder ratio	32%	34%	36%

3.2.3. Fine Aggregate

Fine aggregate is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles but is distinct from clays which contain organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains. Usually commercial sand is obtained from river beds or from sand dunes originally formed by the action of winds. Much of the earth's surface is sandy, and these sands are silica, usually quartz and other siliceous materials. In recent days the demand for River Sand is increasing due to its lesser availability. Good quality sand may have to be transported from long distance adds the cost of construction. So that it becomes inevitable to use alternative materials for fine aggregates which include recycled aggregates, manufactured sand and using water material also like Crumb Rubber. Compared to River sand, the cost of the manufactured sand is less with gives more Strength

3.2.3.1. M - Sand

Manufactured Sand (M - Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard Granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material and to make M - Sand more eco - friendly than river sand. The other advantage of using M - Sand is, it can be dust free, the sizes of m - sand can be controlled easily so that it meets the required grading for the given construction. The size of manufactured sand (M - Sand) is less than 4.75mm. Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. M - Sand is sold by the unit load or metric ton. The weight varies from 1450 to 1650 kg/m^3, depending on the composition and size of grain. Compared to River sand, the cost of the manufactured sand is less with gives more Strength. The M - Sand available in nearby Quarry and Manufacture site like Madurai, virudhunagar, Thirunelveli, etc. The fine aggregate was passing through 4.75 mm sieve and had a specific gravity of 2.65. Those particles passing the 9.5 mm (3/8 in.) sieve, almost entirely passing the 4.75 mm (No.4) sieve, and predominantly retained on the 75 µm (No.200) sieve are called fine aggregate. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape.

Figure 3.3: M - Sand

3.2.4. Coconut fibers

Coconut fibers are of silky texture. These are biodegradable and eco - friendly. The common structural properties of the Coconut fibers are very high tensile strength and low extensibility. In the present study Coconut fibers cut up to a length of 20 mm and dia 90 µm are used. The content of Coconut fibers is determined with respect to the weight of cement.

Figure 3.4: Coconut fiber

3.2.5. Water

Water is important ingredient of brick as it is used for manufacturing of brick. Since it helps to bind all the raw materials for giving proper mix. Water used for making brick should be free from impurities. Water used for mixing and

curing was fresh potable water conforming to IS: 3025 - 1964 part 22, part 23 and IS: 456 - 2000.

3.3 Casting of Test Specimen

3.3.1 Brick Mould

The mould size of 190mm x 90mm x 90mm and it was making from wood material. A brick mould properly cleaned next a layer of oil coated the inside mould. The required raw materials like cement, saw dust ash, M - Sand and Coconut fiber have to be mixed as per the ratio in hand mixer.

Figure 3.5: Casting Mould

Figure 3.6: Casting of specimen

These mixed materials are handling to the brick mould through the manual placed. After processing, as per required size of bricks were casted and the mould is removed within five minutes. Then one day dry process to taken for curing purpose. At early stages, bricks were cured by normal water curing in used for immersion method.

3.4 Curing

Curing plays an important role on strength development and durability of concrete. Curing takes place immediately after concrete placing and finishing, and involves maintenance of desired moisture and temperature conditions, both at depth and near the surface, for extended periods of time. Properly cured concrete has an adequate amount of moisture for continued hydration and development of strength, volume stability, resistance to freezing and thawing, and abrasion and scaling resistance. It is important to follow right curing practice because Curing helps to increase the strength of the brick wall. Durability of the concrete improves with curing highly recommended to avoid cracks and attain good strength and hard surface in plaster.

3.4.1 Purpose of Curing

- Curing increases the strength of the concrete with time.
- It improves the durability of the concrete.
- It makes concrete water tight by minimizing the cracks developed by shrinkage during drying.

3.4.2 Time to Start and Duration of Curing

Curing should be started after completion of final setting of cement brick. Usually cement brick takes 9Hrs to finally set itself. Though the duration of curing depends upon the mix proportion and type of cement used in the brick. The curing of cement brick for 7 days, 14 days and 28 days from date of casting of mould.

3.4.3 Method of Curing

There are several methods of curing depending upon the nature of work and climatic conditions. The most common methods of curing are listed below.

- Ponding method
- Wet covering method
- Sprinkling method
- Immersion method

Immersion method is mainly used in the laboratory for curing concrete test specimen

Figure 3.7: Curing

4. Compressive Test on Specimen

- To determination of compressive strength of the prepared samples was carried out as per standard using IS 3495 - 1992 (PART 1).
- The following table 4.1 to 4.5 shows the compressive strength of various samples of testing.
- The specimen was tested after 7, 14 and 28days of curing.

Figure 4.1: Compressive Strength Test

Compressive Strength = (Maximum Load x1000 N/Area of brick) in N/mm^2

4.1 Water Absorption Test:

The test specimens shall be completely immersed in water at room temperature for 24 hours. The specimens shall then be weighed, while completely submerged in water. They shall be removed from the water and allowed to drain for one minute and immediately weighed.

Calculate the absorption is

$$\text{Absorption, percent} = \frac{A-B \times 100}{C}$$

Figure 4.2: Water Absorption Weight gauge

4.3 Efflorescence Test on Specimen

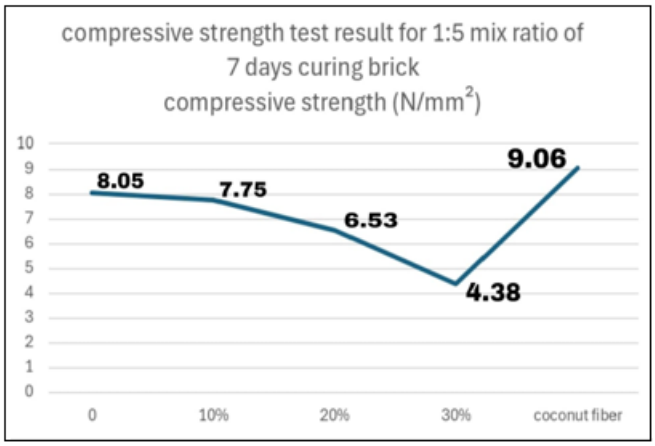
- First take a brick specimen and submerge it in water for 24 hours.
- After 24 hours, drain the brick and allow them to dry.
- Keenly observe the brick surface.

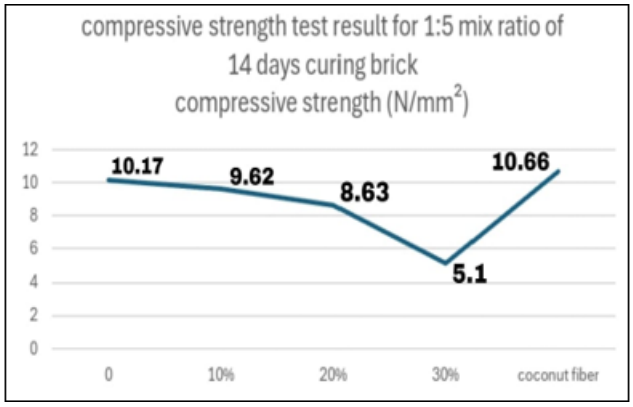
Figure 4.3: Efflorescence test

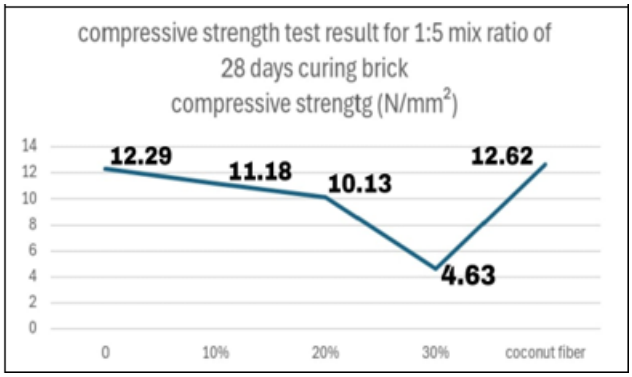
Hardness Test on Specimen

- At first, choose a brick randomly from the stack.
- Using a nail or finger make a mark on its surface.
- If there is no scratch, then it is a good quality brick.

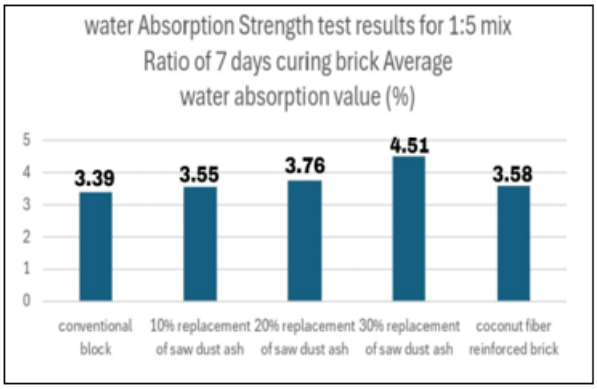
Compressive Strength Test Result

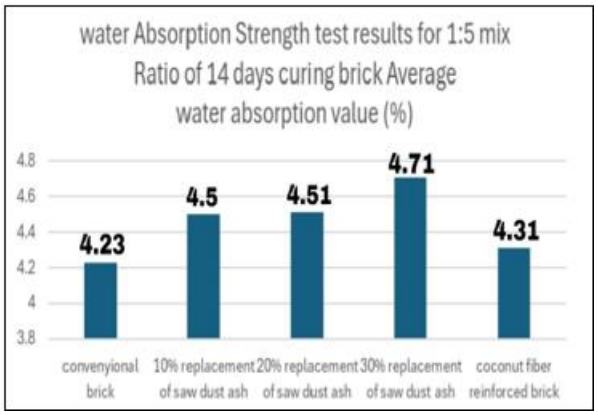


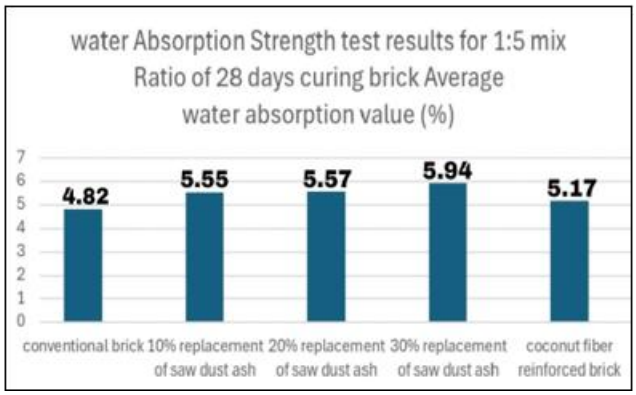




Water Absorption Strength Test Result







Efflorescence Test Result

Specimen	Brick Surface Condition	Degree of Efflorescence
Conventional brick	No white substance	Zero efflorescence
10% replacement of saw dust ash	Slight	Slight efflorescence
20% replacement of saw dust ash	Medium	Medium efflorescence
30% replacement of saw dust ash	Medium	Medium efflorescence
Coconut fiber reinforced brick	Slight to medium	Slight to Medium efflorescence

Hardness Test Result

Specimen	Brick Surface	Hardness by Scratches
conventional brick	Resistance	Scratch resistance
10% Replacement of saw dust ash	Moderate resistance	Partially scratch resistance
20% Replacement of saw dust ash	Moderate resistance	Partially scratch resistance
30% Replacement of saw dust ash	Moderate resistance	Partially scratch resistance
Coconut fiber reinforced brick	Resistance	Scratch resistance

5. Conclusion

- Saw dust ash has the potential to partially replace cement in the cement brick manufacturing industry.
- Due to the addition of Coconut fibers, there is an increase in the compressive strength of the cement brick when compared to conventional brick.
- This could be attributed to the results, which reflected that the optimum proportion that can replace cement was 20% resulting in concrete bricks with high compressive strength of 11.18 N/mm^2.
- There was a slight increase in compressive strength of all the saw dust ash blended concrete bricks with an increase in the curing period.
- Due to the addition of Coconut fibers, there is an increase in the Water Absorption of the cement brick when compared to conventional brick.
- This could be attributed to the results, which reflected that the optimum proportion that can replace cement was 20%
- The compressive strength increase with the increase in curing period water absorption of 28 day's was found ideal to strengthen the brick
- The efflorescence resistance of coconut fiber reinforced brick has a good result of slight to medium efflorescence on the surface of brick
- The Hardness resistance of coconut fiber reinforced brick has a scratch resistance on the surface of brick

References

[1] Mohammed Zakaria, Mashud Ahmed, Mohammed Mozammel Hoque and Shafiqul Islam, “Scope of using Coconut fiber for the reinforcement of concrete material” December 2016 DOI: 10.1186/40689 - 016 - 0022 - 5
[2] Arul Surya (2006): Evaluation of the effect of waste polysterene on performance of asphalt binder”, ARPN Journal of science and technology[at]2011 - 2012
[3] Kiruthik, Niresh, B (2002) “Constructing structures using eco - bricks”, International Journal of Recent Trends in International Journal of Recent Trends in Engineering & Research, Vol.2 (4), pp.159 - 164.
[4] Rama Krishna, Sandarajan (2005), Investigated the variation in chemical composition and tensile strength of four different fibers (coconut sisal, coconut, hibiscus cannabinus fibers).
[5] Pranav S. Dhakulkar, Prof. Sagar D. Malkhede, “Partial Replacement of Cement by Wood - Ash” International Journal of Advance Engineering and Research Development Volume 5, Issue 04, April - 2018.
[6] Swaptik Chowdhury, Mihir Mishra, Om Suganya, “The Incorporation of Wood Waste Ash As A Partial Cement Replacement Material for Making Structural Grade Concrete: An Overview”, Ain Shams Engineering Journal (2015) 6, 429437.
[7] Lisbeth M. Ottosen, EsbenOtergaard Hansen, Pernille E. Jensen, Gunvor M. Kirkelund& Per Golterman, “Wood Ash Used as Partly Sand And/Or Cement Replacement in Mortar” WIT Conferences, Vol.11 No.5 (2016) 781–791.