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Utilization of Biodegradable Waste in Manufacture of Eco Brick

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Abstract: *Cow dung is the undigested residue of plant matter which has passed through the guts of cow. It is rich in minerals like Potassium, Magnesium, Sodium, Manganese, and is comprised of organic matters. Cow dung can be used to manufacture bricks which are eco-friendly and much cheaper. The main objective of the journal is to analyze the utilization of the biodegradable waste in the manufacture of eco-bricks, compared to conventional brick. In this the advantages of soil, cow dung, areca fiber are considered as a potential towards the economy. The suitability of biodegradable waste, cow dung, is accessed along with clayey soil as a partial replacement for producing the eco-brick. The method of producing traditional bricks from the kiln is costly and causes pollution. Areca fiber is the low cost, light weight, fairly good mechanical properties, non-abrasive, non-biodegradability attributes swap for a regular fiber. The use of areca nut husk fiber has reinforcing material in the preparation of light weight composites provides utility value to areca nut husk fiber. Areca nut husk fiber is an agricultural waste, which does not contribute to the economy of areca nut plantation. The areca fiber acts as a reinforcing element in the specimen. Considering all the parameters it can be concluded that eco-bricks prepared with cow dung and areca fibers can be used as a sustainable construction material and it proved to be economical.*

Keywords: Cow Dung, Minerals, Eco-friendly, Areca Husk Fibers, Mechanical properties

I. INTRODUCTION

This has led to the development of Biodegradable Earth Bricks. The manufacturing of burnt clay bricks using waste materials can minimize the environmental overburden caused by waste deposition on open landfills and would also improve the brick performance at low production cost leading to more sustainable construction. Wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment Several attempts have been made to reduce the rising cost of bricks production in developing countries with very little success [1]. There is the need to seek alternatives to conventional brick and to seriously consider the utilization of industrial and agricultural by-products as feedstock for the brick industry to produce brick. The problem of disposal of these byproducts is minimized and the amount of harmful gases released into the atmosphere through burning processes is also greatly reduced.

Cow dung as a building material has been used for a long time, but many people still perceive that it is not a building material or a poor man's material. In this dissertation, it is shown that in the present and future cow dung is considered a stable material, and various buildings were built from small span to long span and from one floor to another [5].

Apart from economic considerations, the usefulness of a fibre for commercial purposes is determined by such properties as length, strength, pliability, elasticity, abrasion resistance, absorbency, and various surface properties. Most textile fibres are slender, flexible, and relatively strong. They are elastic in that they stretch when put under tension and then partially or completely return to their original length when the tension is removed [6].

1.1 Clay

Clay is regarded as one of the most abundant natural mineral materials on earth. Clay used for brick manufacturing has plasticity, which permits them to shaped and moulded when they are mixed with water. Clay should have sufficient air-

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dried and wet strength, in order to maintain the shape after forming. Clay types (surface clay, shale clay, fire clay) have similar chemical compositions but differ in their physical characteristics. The manufacturer minimizes these variations by mixing clays from locations and sources in the same pit. The brick from the same manufacturer may have slightly different properties in subsequent productions. Clay bricks have a set of properties which are important in governing the strength and durability of bricks. In the study, following properties were considered:

(a) Porosity: It is defined as the ratio between the volume of void spaces and the total volume of the specimen. Porosity influences chemical reactivity, mechanical strength, durability and the general quality of the brick. Normal clay bricks exhibit high porosity values, ranging from 15% to 40%.

(b) Apparent Density: It is the ratio between the dry brick weight and the volume of the clay brick. Higher the apparent density, denser the brick is and the better its mechanical and durability properties.

(c) Water Absorption: It determines the capacity of the fluid to be stored and to circulate within the brick. Brown and red bricks were found to have water absorption of 21% and 25% of weight respectively.

(d) Moisture Expansion: Due to wetting or drying, the expansion or shrinkage in clay bricks can be partially or totally reversible. Moisture expansion in clay bricks are influenced by the contents of argillaceous materials and lime modules.

(e) Compressive Strength: Mineral composition, texture, crack pattern and porosity level can provide an indication of compressive strength, by revealing the conditions of drying clay bricks have a compressive strength of 1.5MPa to 32MPa

Fig 1.1.1 Clay

1.2 Cowdung

Addition of cowdung to clay modifies the properties of clay which results in better brick qualities when compared to other organic waste additives. Cowdung improves the plasticity of clays and reduce green breakage and also act as internal fuel in firing bricks thereby reducing firing cracks. But excessive content of cowdung reduces strength and density. The best ratio for addition is 20% to 30% that gives the desired properties for a brick. Along with the improvement of plasticity, cowdung also act as a reinforcing agent which reduces concentrated cracks. The dung fibre ignite upon firing, thereby assisting in even firing of bricks and minimize the development of high temperature gradients. When fibers are burnt out, it leave cavities within the brick which reduce the unit weight and improve thermal characteristics When the bricks are laid in mortar bed, the cavities present on top and bottom surfaces of the bricks increases the bond.

Fig 1.2.1.1 Sieved cowdung

Areca Fibers

Areca fiber is a green material obtained from the husk of Areca nut. Regarding to the advantageous properties, areca fiber is a highly potential waste to be incorporated into unfired clay bricks because it can reduce air pollution from open burning activities and most of the desired. properties complied with the addition of 2-2.5% areca fiber. The areca fibers added act as low cost pore formers to make light weight clay bricks. Though some of the properties are decreased by the addition of areca fiber, but it produces adequate clay bricks that comply with the standard. Incorporation of areca fibers provides a cost effective method to produce light weight bricks and also provides the provision for its disposal thereby reducing the impact towards the environment.

Fig 1.3.1.1 Areca fiber preparation

1.4 Lime

Lime is desirable in small quantities, not exceeding 5%, far good brick materials. It is present in finely powdered state in order to prevent flaking of bricks. Lime can well prevent the shrinkage of clay bricks. The lumps of lime are converted into quick lime after burning and the quick lime later slakes and expands in the presence of moisture. Such an action causes splitting of brick into several pieces. So lime is always carefully added in a low percentage by not exceeding the limited value of 5%

Fig 1.4.1.1 Lime

II. METHODOLOGY

For fabricating concrete earth bricks, the soil cow dung and areca fibers were collected first. Clayey soil is comprised of very fine mineral particles and not much organic material. The soil is then sieved through IS 4.75mm sieved and required amount of cow dung and areca fibers are mixed with the retained sieve. By adding cow dung as a partial replacement of the soil the overall soil content can be minimized since the soil availability is low. Here for manufacturing the brick cow dung is collected from a farm land and dried until all the moisture is removed.

Preparation of clay
↓
Mixing
↓
Moulding
↓
Drying
↓
Testing
↓
Result

Fig 2.1 Methodology

Later it is sieved through 4.75 micron sieve. Lime is also added as required to make the mixture well prepared and for better bond.Tests were conducted on the materials to determine their properties. For the preparation of bricks Soil samples are taken in its natural state.

Dried husk of matured areca nut was collected from the plantation. Dried husk was soaked for 24 h in fresh water to loosen the fibers. Later, the water soaked areca nut husk was cleaned with freshwater to remove the soil partials attached to the fibers. Consequently, the areca nut husk was soaked in 6% by volume NaOH alkali solution for 24 h at room temperature of 26 ± 2C to perform the chemical retting process. The alkali-treated husk was washed with distilled water to remove the chemical traces on surface of the fibers. The washed areca nut husk was sun dried for 2 days to reduce the absorbed moisture content from the areca nut fiber. Fibers were extracted from the sun dried areca nut husk and stored in airtight covers to avoid the moisture absorption the soil is then sieved through IS 4.75mm sieved and required amount of cow dung and areca fibers are mixed with the retained sieve. Water is then added. Amount of water added with the mixture was equal to the OMC. The blend is mixed until it is plastic enough to mould.

2.1 Properties of soil

Moisture content of the soil	51.68%
Liquid limit of the soil	29.33%
Plastic limit of the soil	32.033%
Specific gravity	2.19 gm/cc

2.2 Properties of cow dung

Specific gravity of cowdung	2.63
Bulk density $\frac{m^2}{Kg}$	1520
pH	9.5
Loss on Ignition %	4.6
Fineness modulus	2.62
Blains fineness $\frac{m^2}{Kg}$	370-338

III. RESULT AND DISCUSSION

3.1 Compression Test

Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression with the help of compression testing machine. The compressive strength of the brick is the most important property of the bricks because brick is mostly subjected to compression and hardly to tension. The compressive strength of brick is essential for confirming that any particular brick will be able to withstand the certain load or not.

3.1.1 Procedure

Place the specimen with flat faces horizontal and mortar filled face facing upwards between plates of the testing machine. Apply load axially at a uniform rate of 14 N/mm^2 (140 kg/cm^2) per minute till failure occurs and note maximum load at failure. The load at failure is maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

Compression testing machine, the compression plate of which shall have ball seating in the form of portion of a sphere Centre of which coincides with the centre of the plate. Load increased till failure takes place.

The compressive strength can be determined by the following equation.

Compressive strength, $f_{CK} = Load/\text{area}$

Observation and calculation**:**

Area of specimen = 19× 9 × 9 = 153.9

Range of load selected = 500K

Table 3.1.1.1 Observation for compressive strength test

Percentage Cow Dung	Percentage Areca Fiber	Failure Load (KN)	Compressive Strength (N/mm^2)
5	0.5	20	1.29
	1	28	1.81
	1.5	30	1.94
	2	62	4.02
	2.5	88	5.7
10	0.5	30	1.71
	1	38	2.16
	1.5	40	2.27
	2	72	4.1
	2.5	98	5.5
15	0.5	142	8.1
	1	151	8.6
	1.5	161	9.1
	2	177	10.1
	2.5	153	8.7
20	0.5	120	7.7
	1	115	7.47
	1.5	100	6.49
	2	95	6.17
	2.5	90	5.84
25	0.5	88	5.71
	1	80	5.19
	1.5	78	5.06
	2	75	4.87
	2.5	70	4.54

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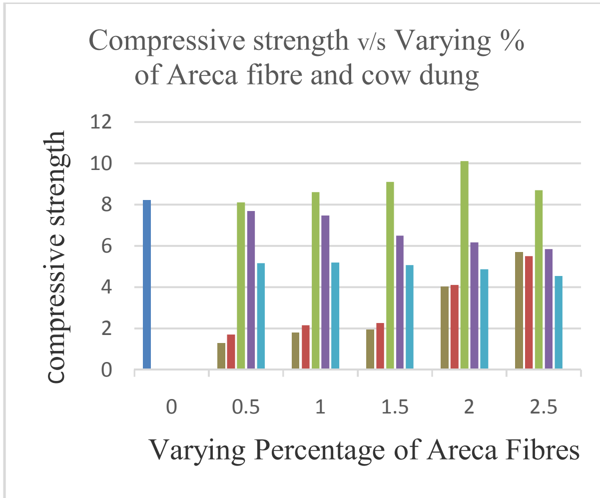

Figure Compressive strength v/s Varying % of Areca fibre and cow dung

- Compressive strength of standard brick (0 % cow dung and 0 % fibre)
- Compressive strength of Eco brick having 5 % cow dung and 0.5 % fibre
- Compressive strength of Eco brick having 10 % cow dung and 1 % fibre
- Compressive strength of Eco brick having 15 % cow dung and 1.5 % fibre
- Compressive strength of Eco brick having 20 % cow dung and 2 % fibre
- Compressive strength of Eco brick having 25 % cow dung and 2.5 % fibre

3.2 Water Absorption Test

Water absorption test is conducted to determine the durability properties of the bricks and the properties include degree of burning, quality and behaviour of the bricks in weathering. Normally, a brick with water absorption of less than 7% offers better resistance to damage by freezing. Since water is absorbed by pores, the degree of compactness can also be obtained through water absorption test. For un-burnt clay the value should not exceed 35%. In the study, the dry specimen is kept in a ventilated oven at a temperature of 105° C to 115° C, till it attained substantially constant mass. Then the specimen is cooled to room temperature and its weight $\boldsymbol{M_1}$ is obtained. Later on, the completely dries specimen is immersed in clean water for 24 hours. After 24 hours the specimen is taken out and all traces of water is wiped out with damp cloth and the specimen is weighed then $\boldsymbol{M_2}$

From the different proportioned samples the bricks that gives highest compressive strength were taken for the water absorption test.

Water Absorption in % = $\frac{M_1-M_2}{M_1}$x100

Fig 3.2.1.1 water absorption test

Table 3.2.1.1 Water absorption test

Sl No:	Ratio	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (%)
1	5% Cowdung+2.5 % areca fiber	2.1	2.96	41
2	10% Cowdung+2.5 % areca fiber	2.3	2.9	26.1
3	(15% Cowdung)+(2 % areca fiber)	2.34	2.88	23.1
4	20% Cowdung+0.5 % areca fiber	2.5	3.08	20.7
5	25% Cowdung+0.5 % areca fiber	2.8	3.4	21.4

IV. CONCLUSION

Addition of cow-dung to clays improves plasticity, Cow-dung when added to brick clays modifies properties and better brick qualities compared to other organic waste additives. The use of waste materials in the brick production also helped in the management of wastes in the locality considered. Areca fibers are hard and show similarity to coir fibers in cellular structure. The use of areca fiber will give more efficient strength with increasing fiber weight ratio. Fibers may also improve the resulting in a greater tensile strength, flexural strength and impact strength. Thus for the manufacturing of successful eco brick having partially replaced soil with 15% cow dung and 2% areca fibres shows 10.1N/mm^2 the strength of standard brick is 8.241 N/mm^2.It is observed that beyond 15% cow dung and 2% areca fibers the compressive strength tends to decrease rapidly. Thus it can be concluded that the manufactured bricks acquired sufficient strength and became more economical and the weight of cow dung brick is less than the normal brick, so it reduces the dead load of building, also being environmental friendly.

The water absorption capacity of a normal standard un-burnt clay bricks range from 12% to 35%. The range of water absorption ranges from 20.7% to 41%. Among the sample the brick which has the highest compressive strength of 10.1 N/mm^2 has a water absorption capacity of 20.7% which is in the range of un-burnt clay brick.

The weight of normal caly brick is 3 kg to 4 kg compared to this the weight of the brick manufactured using Cowdung and areca fiber is between1.8 kg to 3.2 kg which is less than normal un-burnt clay bricks

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