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EFFECT OF COWDUNG AND COIR IN STRENGTHENING OF CLAY BRICKS

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Abstract – *This study was conducted to investigate the effect of cowdung, coir and lime in strengthening of clay bricks for the construction of environment friendly buildings. There is a need to explore sustainable approaches to building construction with the increasing demand for low cost housing and the high cost of building materials. Bricks which are the core material in building construction are made from clay, which is processed either by sundried or burnt. Coir is a abundantly available natural fiber and is extracted from the husk of coconut fruit. In the work, coir is used to act as reinforcement in the ratios, 5% and 10%. Mixing cowdung to clay improves plasticity, reduces green breakage, and act as internal fuel in fire bricks thereby reducing firing cracks. The various ratios of cowdung used are, 5%, 10%, 15%, 20%, 25%. In good brick material a small quantity of brick not exceeding 5% is desirable. Lime prevents shrinkage of raw bricks.*

Key Words: Clay, Types of Clay, Properties of Clay Bricks, Fiber Extraction, Moulding, Drying, Compression Test, Water Absorption Test

1. INTRODUCTION

Bricks are the small rectangular blocks typically made of fired or sun-dried clay. These bricks are obtained by moulding clay in rectangular blocks of uniform size and then they are dried and burnt. At places where stones are not easily available and if plenty of clay is available, the stones can be replaced by the clay bricks. Being uniform in size, they can be well arranged, and also does not require any heavier lifting mechanisms are they are light weight. The art of laying bricks is simple that it can be carried out with unskilled labours also.

Clay bricks are the first man made artificial building material. They possess greater fire resistance than stone and concrete masonry. Clay bricks are a significant basic material of construction required in all spheres of constructional activities and it constitutes about 13% of the total cost of building materials. The use of clay bricks provides a comfortable physical living environment than the use of other materials.

The demand for clay bricks have been increasing year by year with increased urbanization, growing population, industrialization etc., in both the private and government sectors. A significant change have been taking place in the building habits that, there is a common tendency to shift from traditional housing types to RCC type houses which make use of bricks for construction. Thus the demand for bricks is registering a steady and significant growth over the years. This situation along with the demand for low cost housing and high cost of construction materials has lead to several investigations to develop light weight and cost effective bricks for constructional activities. The normal bricks are made from various type of clay such as, surface clays, shale clays and fire clays. In the study conducted, cowdung, coir and lime is used along with clay to manufacture clay bricks, which have the desirable light weight properties and which is also cost effective.

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-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 20.1% and 24.9% 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 about 1.5MPa to 32MPa.

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.

1.3. Coir

Coir is a green building material obtained from the husk of coconut fruit. Regarding to the advantageous properties, coconut 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 3% coconut fiber. The coir 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 coir, but it produces adequate clay bricks that comply with the standard for non-load bearing purposes. Incorporation of coir 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.

1.4. Lime

Lime is desirable in small quantities, not exceeding 5%, for 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%.

2. METHODOLOGY

The materials for the brick manufacturing were collected. Cowdung is dried and crushed into a fine state. Lime is also used after proper cleaning. Coir is brought as thin fibers. Clay is brought and used in the normal form. The methodology includes; preparation, mixing, moulding, drying, testing and the determination of results.

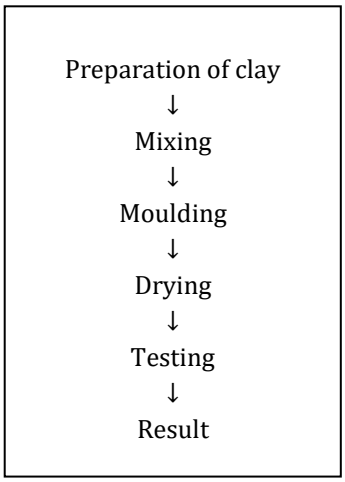

Fig-1: Methodology

2.1. Preparation of Clay

Pure clay is taken for the preparation of bricks. The clay in top layer of soil about 200mm depth is thrown away, as it may contain impurities. After the top layer is removed, the clay is dug out from the ground and is spread over the plain ground. The clay is cleaned of stones, vegetable matters and other wastes in visible form. The lumps of clay are broken down manually. The cleaned clay is then exposed to atmosphere for softening. A weathering period of 4 weeks is provided.

2.2. Mixing

In the work, only hand mixing is used to mix the ingredients together. Clay is mixed with cowdung and coir in different proportions. Lime is kept constant as 5%. Coir and lime are added as excess materials. The different proportions are as shown below;

Table-1: Mix Proportions for 5% and 10 % Coir

Sl. No:	SET 1	SET 2
1.	5% Coir	10% Coir
2.	5% Coir + 5% Cowdung	10% Coir + 5% Cowdung
3.	5% Coir +10% Cowdung	10% Coir+10% Cowdung
4.	5% Coir +15% Cowdung	10% Coir+20% Cowdung
5.	5% Coir +20% Cowdung	10% Coir+25% Cowdung
6.	5% Coir +25% Cowdung	10% Coir+30% Cowdung

2.3. Moulding

The prepared clay is moulded into brick shape. Wooden rectangular shaped moulds of size (200x100x100) mm were used for the purpose. The longer sides of moulds are projected out of the box in order to serve as handles. The mixture is filled in the mould in three layers and tamping is provided for each layers by using a wooden tamping rod. The top surface is leveled using a trowel. After setting, the mould is removed and the bricks are taken for drying purposes.

2.4. Drying

After moulding the bricks were taken for drying. It is done to avoid the formation cracks. The bricks are laid in stacks in way so as to allow sufficient circulation of air between them. The bricks are kept under sunshade for a period of 3 days for drying. Drying provides rigidity and also avoids the formation of cracks.

2.5. Testing

After drying, the bricks were taken for testing. Compressive strength and water absorption are two major physical properties of bricks and they also indicate the bricks ability to resist cracking of face. So, compression test and water absorption test are conducted and results were analyzed.

2.5.1. Compressive Test

Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression. The test is carried out with the help of Compression Testing Machine. It is important to know the compressive strength because; bricks are generally used for the construction of load bearing masonry walls, columns and footings.

Unevenness observed on the bed faces are removed in order to provide smooth and parallel faces. The specimen is placed in the testing machine with the flat face horizontal and the mortar filled face facing upwards, between plywood sheets of 3mm thickness and was carefully centered between the plates of the testing machine. Then after the placement of the specimen on proper position, load is applied axially at a uniform rate of 14N/mm^2 per minute till failure occurs. The maximum load at failure is noted. The load at failure is considered as the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

$$\text{Compressive strength} = \frac{\text{Maximum load at failure in N}}{\text{Avg. area of bed face in mm}^2}$$

2.5.2. 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 behavior 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 105^0 C to 115^0 C , till it attained substantially constant mass. Then the specimen is cooled to room temperature and its weight 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 (M_2).

$$\text{Water absorption in \%} = \frac{(M_1 - M_2)}{M_1} \times 100$$

2.6. Results

Values were obtained from compression test and water absorption test for different proportions of coir and cowdung used and it is tabulated.

Table-2: Compression test result for 5% coir addition

Sl. No:	Ratio	Weig-ht (Kg)	Compressi-on Value (KN)	Compressi-on Strength (N/mm^2)
1.	5% Coir	2	226.4	11.32
2.	5%Coir+5%Cow dung	2.01	285. 4	14.25
3.	5%Coir+10%Co-wdung	2.27	319.4	15.97
4.	5%Coir+15%Co-wdung	2.28	426.2	21.31
5.	5%Coir+20%Co-wdung	3.1	478.5	23.925
6.	5%Coir+25%Co-wdung	3.58	512.6	25.63

Table-3: Compression test result for 10% coir addition

Sl. No:	Ratio	Weig-ht (Kg)	Compres-sion Value (KN)	Compres-sion Strength (N/mm^2)
1.	10% Coir	2.56	230.6	11.53
2.	10%Coir+5%Cow dung	2.35	295	14.75
3.	10%Coir+10%Co-wdung	1.99	328	16.4
4.	10%Coir+15%Co-wdung	1.8	350	17.5
5.	10%Coir+20%Co-wdung	2.39	385	19.25
6.	10%Coir+25%Co-wdung	2.3	404.2	20.21

NB: The compressive strength increases with increase in the addition of the cowdung, keeping constant percentages of coir and lime. The highest compressive strength is obtained

when 5% coir is added with 25% cowdung and the value is 25.63N/mm^2. The least compressive value is obtained with the addition of 5% coir and the value is 11.32N/mm^2.

Table-4: Water absorption obtained for 5% coir

Sl. No:	Ratio	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (%)
1.	5% Coir	2	2.92	46
2.	5%Coir+5%Cowdung	2.01	2.84	41.29
3.	5%Coir+10% Cowdung	2.27	2.920	28.63
4.	5%Coir+15% Cowdung	2.28	2.89	26.75
5.	5%Coir+20% Cowdung	3.1	3.78	21.94
6.	5%Coir+25% Cowdung	3.58	4.47	24.86

Table-5: Water absorption obtained for 10% coir

Sl.No	Ratio	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (%)
1.	10%Coir	2.56	2.87	12.1
2.	10%Coir+5% Cowdung	2.35	3.01	28.08
3.	10%Coir+10 %Cowdung	1.99	2.67	34.17
4.	10%Coir+15 %Cowdung	1.8	2.52	40
5.	10%Coir+20 %Cowdung	2.39	3.11	30.13
6.	10%Coir+25 %Cowdung	2.3	3.08	33.9

NB: The water absorption is found to increase first and then deceases. The highest value of water absorption is 46%, which is obtained with 5% addition of coir and the least percentage value obtained is 12.1% for the addition of 10% coir.

3. CONCLUSIONS

From the study conducted, following conclusions were made:

- The compressive strength of the clay brick increases with the addition of cowdung, coir and lime.
- The maximum strength obtained is 25.63 N/mm^2 for the 5% coir and 25% cowdung ratio. As per IS 1077:1992, it is of the class 25. The normal strength of the un-burnt clay bricks are 7.9 N/mm^2 which is much less than the strength obtained from the ratio 5% coir and 25% cowdung.
- The normal water absorption capacity of un-burnt clay bricks range from 12% to 35%. The range of water absorption obtained from the work varies from 12.15% to 46%. The brick which has the highest compressive strength of 25.63 N/mm^2 has a water absorption capacity of 20.86% which is in the range of the normal un-burnt clay brick.
- The weight of normal un-burnt clay brick is 3KG to 4Kg. Compared to this, the weight of brick obtained by the addition of cowdung, coir and lime to clay ranges from 1.8Kg to 3.58Kg, which is less than the weight of normal un-burnt clay brick.

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