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Bricks by Cow Dung using Lime and Clay

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ABSTRACT: This study was conducted to investigate the effect of cow dung, clay 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, Lime prevents shrinkage of raw bricks.

A local earth was stabilized chemically by Cow dung. A better compressive strength at the dry state and after 10 minutes of immersion in water was obtained with cow dung stabilization at content of 15 to 30% by weight of earth. Bricks stabilized with 15 to 30% Cow dung contents by weight of earth have a dry and wet compressive strength of 6.64 and 2.27MPa respectively. There is an increase of about 25% in the dry compressive strength of bricks stabilized with 30% cow dung content over that of the plain earth brick without stabilizer The 30% cow dung content resulted in lower migration of water into the brick (i e. lower permeability). Also the abrasive resistance increased with increase in the cow dung content up to 30%. The highly decreased in compressive strength after 10 minutes of immersion in water, even with optimum Cow dung content, indicated that appropriate building design that would prevent stabilized earth bricks from coming into direct contact with rainwater is important. The study recommends that appropriate construction specification is necessary to prevent cow dung stabilized earth bricks from coming into any prolonged direct contact with rainwater.

I. INTRODUCTION

With the increasing demand for low cost housing and high cost of building material, there is a need to explore sustainable approaches to the needs of the building industry. Bricks as the core material in building construction can be produced by clay which is processed either through sundried or burned. The latter however is expensive and technically exhausting whereas sundried bricks can be produced by the layman. In order to ensure the durability and optimal strength output with sundried clay bricks, fibrous materials is believed to enhance such characteristics. This study intends to explore how cow dung can be used to enhance the quality of clay bricks that can be used for low cost building construction in various communities around Nagpur.

Clay bricks have been used since 4300BC and are still widely used today (Krakowiak et al., 2011). Next to concrete and steel, masonry is the most used construction material on Earth. Clay has the property of forming a coherent sticky mass when mixed with water, being readily mouldable when wet but if dried retains its shape (Okolode, et al, 2012). The brick making technology is driven by using the soil onsite or near to site, and then a certain amount of fibre is mixed into the soil, depending on the characteristics of the soil, and then stabilized by compaction, so as to improve the engineering properties of the produced bricks. (Makunza, 2006)

This research is driven by the objective of making extensive use of raw earth, containing a natural component of clay, as the main building material, aided by a fibrous material, which in this case is cow dung. This is to develop technologies that are energy saving, eco-friendly and sustainable (Okolode et al., 2012). The scope of this report presents the fundamental investigation and procedures for the manufacture of the clay brick of which the constituents are clay, cow dung, sand, silt and water. The principal processes and procedures for forming the bricks are researched, tested, analyzed and discussed, and appropriate conclusions and recommendations are drawn

Earth is one of many alternative materials that can be used in place of residential stick building. A number of binders have been used to stabilize earth, for construction. Such binders are aimed to improving water proofing or wear resistance properties of vulnerable earth based construction. Such binders include cements, lime, tars and bitumen's, sodium silicate, casein, oils and fats, molasses, and certain locally specific plant-based materials such as gum Arabic, other specific resins and the sap, latexes and juices from specific trees and other (Corum, 2005). Blast furnace slag and pulverized fuel ash are the two waste materials which are being used to the greatest extent in construction. These materials can make a particular contribution in conserving energy in the manufacture of cementitious materials and of lightweight aggregates. A study on the reuse of paper de-inking sludge, undertaken in Spain, showed that, it has the potential as raw material for producing a binding material with pozzolanic properties (Asavaspisit and Chotklang, 2004; García , Vigil de la Villa, Vegas, Frías and Sánchez de Rojas, 2008). A research conducted by García, et. al.,(2008) showed that calcination paper sludge has higher pozzalnic characteristics as compared to other industrial pozzolanic by-products, such as fly ashes normally used in cements. Another research results on paper sludge as pozzolanic addition in cement manufacturing, indicated that a significant gain of compressive strengths (approximately 10%) was achieved; when 10% calcined paper sludge was blended with ordinary Portland cement (Moisés Frías Iñigo Vegas, Raquel Vigil de la Villa and Rosario García Giménez, 2012). In recent years, the use of solid waste derived from agricultural products as pozzolans in the manufacture of blended mortars and concrete has been the focus of researchers in the construction materials sector. The addition of ashes from combustion of agricultural solid waste to concrete is at present, a frequent practice because of the pozzolanic activity of the ashes toward lime. One of the most interesting materials is the ash obtained from the combustion of sugar cane solid wastes (Yalley and Bentle, 2009; Martins, et. al., 2012).

II. LITERATURE REVIEW

V.S.R. Pavan Kumar.Rayaprolu, P. Polu Raju, they carried out on the topic about Incorporation of Cow Dung Ash to Mortar and Concrete This paper presents result on study of cow dung ash (CDA) as supplementary cementing material in mortar and concrete. This paper mainly highlights the significance and necessity of consumption of these waste materials for the manufacturing of sustainable concrete for construction of green buildings in future**.**

T. Omoniyi, S. Duna, A. Mohammed. They studied on the topic Compressive Strength Characteristic of Cow dung ash blended cement Concrete. This work reports on an investigation into the use of cow dung ash (CDA) as Supplementary Cementitious Material (SCMs) in concrete. Cement was replaced with cow dung ash (CDA) up to 30% at 5% interval. Setting times (initial and Final) and slump test were carried out on the fresh cement/CDA blended paste and concrete respectively.

Peter Paa-Kofi Yalley, he studied and research on the topic based on Strength and Durability Properties of Cow Dung Stabilized Earth Brick. This research, reports on the investigation into the strength and the durability properties of earth brick stabilized with Cow dung. A local earth was stabilized chemically by Cow dung. A better compressive strength at the dry state and after 10 minutes of immersion in water was obtained with cow dung stabilization at content of 20% by weight of earth. Bricks stabilized with 20% Cow dung contents by weight of earth has a dry and wet compressive strength of 6.64 and 2.27MPa respectively.

Mr. Mohammed Majzoub, he studied on the topic utilization of cow-dung in brick making. This paper review about Some agricultural residues and animal wastes are useful in brick making. Examples are: saw dust, groundnut shell, "garad" seed, charcoal fines, bagasse and cow-dung. Cow dung, when added to brick clays modifies properties of those clays and results in better brick qualities compared to other organic waste additives. Addition of cow-dung to clays improves plasticity, reduces green breakage and acts as internal fuel in firing bricks thus reducing firing cracks.

P. Thej Kumar, R. Harshini Reddy and DVS Bhagavanulu, They conveys about project on the topic ―A study on the replacement of cement in concrete by using cow dung ash‖. Cement was partially replaced with four percentages (5%, 10%, 15%, and 16%) of cow dung ash by weight. Consistency limits and chemical composition of ordinary Portland cement (OPC), cow dung ash and OPC mixed with cow dung ash were determined. The compressive strengths of the mortar and concrete specimens were determined at 7, 14 and 28 days respectively. Test results indicated that the consistency limits increased up to an optimum content and decreased further with the increase in the % of CDA in cement. The compressive strength is increased when the cement is replaced by 5% of CDA and decreased with the increase in the cow dung ash content. This study observed that During hydration, the Calcium Hydroxide (CH) produced reacts with the silica from CDA over time to form the more stable Calcium Silicate Hydrates(C-S-H) which can be responsible for the appreciable strength gain. It has been reported by several researchers that incorporation of pozzolanic materials into cement reduces the CH formation (which promotes micro cracking) and enhances formation of C-S-H, which promotes later strength gain.

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Sruthy B, Anisha G Krishnan, Gibi Miriyam Mathew, Sruthi G Raj, They conveys about ―An experimental investigation on strength of concrete made with cow dung ash and glass fibre‖.Cow dung is used as fuel for the domestic purpose, which generates solid waste as ash. This paper presents the result on the study for the use of Cow Dung Ash (CDA) as partial replacement of cement in production of concrete. This replacement was designed to study the effects of adding Cow Dung Ash (CDA) in various percentages by weight (6%, 8%, 10%, 12% and 14%) of cement. To strengthen the CDA concrete and making it more durable 0.5% glass fiber is being added, as it is an economically strong material, have excellent flexural strength, crack resistance and can also be used as an alternate material for concrete construction. The M25 mix design for the proposed concrete mix is calculated. Results showed that up to 8% replacement of cement by cow dung ash there was an increase in compressive strength. They finally resulted that The replacement of cement with cow dung ash 6% and 8% leads to increase in compressive strength whereas the percentage replacement of 10% leads to decrease in compressive strength.

Aiyedun;D.M. Raheem; F.T. Owoeye and B.U. Anyanwu They studied on the topic Production and characterization of clay – cow dung insulating fire – bricks. The use of clay is of high economic potential in Abeokuta, South West Nigeria, to metallurgical, chemical and allied, ceramic and glass industries. This research work was carried out to investigate the suitability of using clay – cow dung to produce insulating firebrick and to determine the optimal ratio of the constituent. The results showed that all the brick samples had good insulating characteristics, suggesting that cow dung can be used as additive in production of insulating fire- bricks.

III. METHODOLOGY OF PROPOSED SURVEY

Data Collection
Composition required for making brick
1. Cow dung = 0 to 30 %
2. Lime = 5%
3. Clay or Grass = 75%
4. Cow urine or water **=** as per requirement

Proportion of material can be increase or decrease

Methods

2.2 Test methods A few small-sized bricks without stabilizer were produced as a preliminary test to assess the optimum compression pressure that might be required to produce a brick of maximum strength. The optimum moisture content of earth in its natural state (not dried in oven) and also the mass of earth required to produce a batch of 15 bricks were also required. A BREPAK earth brick press (see Figure 1) that could deliver pressures of up to 35 MPa, was used Civil Engineering the laboratory, for the bricks production block mould pressure pump handle handle extension block mould cover base barometer

Figure 1 Brick moulding equipment

Preliminary tests such as dry density and moisture content of the earth in the natural state were first conducted on the earth bricks without stabilization and with 15%, 20%, 25%, and 30% cow dung stabilization to ascertain the optimum water content for each batch. Afterwards investigation was conducted on bricks with 0%, 15%, 20%, 25%, and 30% of cow dung by weight of earth material and its effect on the dry density, compressive strengths, abrasive resistance and water absorption coefficients at the optimum moistures contents were analyzed after 28- days of air curing. Five batches of 15 bricks per batch were produced for the study. In all a total of 75 bricks were used in the studied.

Preparation of Clay

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.

Mixing

In the work, only hand mixing is used to mix the ingredients together. Clay is mixed with cow dung and lime in different proportions. Lime is kept constant as 5%. dung and lime are added as excess materials.

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.

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

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

IV. OBSERVATION

Density test

The objective of this test was to determine how the moisture content influences the density of the bricks and the effect of cow dung on density of the bricks. Three bricks from each batch were selected after four weeks of curing. These bricks were gently wiped with non-absorbent cloth in order to remove any dust or loose matter stuck to them. Each dimension of these bricks in the middle of each face was measured and the average calculated (see Figure 2). Their volumes were then calculated. These bricks were then oven-dried at a temperature of 105°C until constant masses of the bricks were obtained (BS1880, Code of for earth, 1990). The mass of the bricks were considered to be constant when the difference between two weighing at 24 hour intervals was less than 0.1% of the initial masses. On removal from the oven the bricks were left open to ambient air to cool (typically for two hours). After cooling, the bricks were weighed and then the densities were calculated and the average was then taken from each batch.

1. Put a brick ¡n the ventilated oven and dry it at a temperature of 105° — 115° C

Till it achieves appreciable constant mass.

2. Then cool ¡tin room temperature and record its mass as M.

3. After that, measure the dimension of the brick and calculate its volume.

Calculation:

The bulk density of brick is calculated by the following formula:

Bulk Density = Mass (M) / Volume (V)

$$\text{Length, } L = \frac{L_1 + L_2}{2} \qquad \text{Height, } h = \frac{h_1 + h_2}{2} \qquad \text{Width, } w = \frac{w_1 + w_2}{2}$$

Dry Compressive strength test

Three bricks which had no surface cracks visible to the naked eye were selected from each batch of moulded bricks. The bricks were oven-dried to a temperature of 40°C until constant masses were obtained (BS1880, Code of for earth, 1990). The bricks were then removed from the oven and left to cool in open air, and gently wiped of any dust or loose dirt stuck to them. The bricks were then tested for their dry compressive strength using a compression test machine.

1. Place the specimen with flat face s horizontal and mortar filled face facing upwards between plates of the testing machine.
2. 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.
3. 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.

Calculation Compressive Strength of Bricks = Maximum Load at Failure (N)/Average area of bed face (mm^2)

Wet Compressive strength

Buildings are often exposed to the effect of water, particularly as a result of capillarity and of spraying from rain water. The mechanical strength of wet bricks is found to be weaker than those of dry bricks. The main purpose of this test was to find the minimum strength of the bricks and also to improve on the strength of the wet bricks if they were found to be unsatisfactory. Again three bricks were selected from each batch and oven-dried at 40°C until constant masses were obtained. The bricks were then air cooled. The bricks were dusted and then fully immersed in water of temperature of about 20°C in the laboratory for 10 minutes. The bricks were then remove from water and dried with a tissue. The bricks were then tested for their compressive strength using compression test machine.

Water absorption test (IS-3495 part-3)

Water absorption of brick depend on their porosity which is due to void of various size present in brick Almost all brick absorb water by capillary action But porosity and water absorption does not give proper indication as to whether brick work can keep away the rain water and protect the interior from dampness travelling from outside Permeability measure the travel of moisture through a brick. Percentage of water absorption give indication of compactness which is obtain from burning (1) 24 Hour Immersion Cold water Test Dry bricks are kept in oven (105-115 C) till attains constant mass. After cooling the bricks to room temp. Weight recorded as w_1 Now bricks are immersed in water at a temperature of 27+2 C for 24 hour Bricks are then taken out of water and wiped with a damp cloth and weight as w_2 after 3 min

Water absorption in % = W_2-W_1/W_1 X 100

Average water absorption shall not be more than 20% by weight up to class 125 and 15% by weight for higher class

Five- Hours Boiling Water Test

Weight of the oven dried bricks (W1) is recorded as above. Then the specimen is immersed in the Water and boiled for five hours, followed by cooling down to 27° 2°C by natural loss of heat within 16-19 hours. Then bricks is taken out of water and wiped with a damp cloth and the weight is recorded as W_3

Water absorption in % = W_3-W_1/W_1 x 100

Comparison between red brick, cow dung brick and fly ash brick

Properties	**Red Bricks/Clay Bricks**	**Cow dung brick (30%)**	**Fly Ash Bricks**	**Remarks**
Density	1600-1900 kg/m^3	1800-1850 kg/m^3	1700-1850 kg/m^3	Higher load bearing
Compressive strength	30-35 kg/cm^2	45-50 kg/cm^2	90-100 kg/cm^2	Higher load bearing
Absorption	15-25%	12%	10-14%	Less dampness
Dimensional stability	Very low tolerance	Low tolerance	High tolerance	Saving in mortar up to 25%
Wastage during transit	Up to 10%	Up to 8%	Less than 2%	Saving in cost up to 8%
Plastering	Thickness vary on the both sides of wall	Not much vary	Even on both sides	Saving in plaster up to 15%.
Cost	Less cost	Very low cost	High cost	20% cost reduce
Weight	2.92 kg	2.82 kg	2.84 kg	Slightly less

Table 1: comparison between bricks

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Note
1 Mpa = 10.1972 kg/cm2
1 kg/cm2 = 0.0980665 Mpa

V. RESULT & DISCUSSION

By conduction of this study & analysis of data following result has been made based on experimental investigation and research.

The effects of moisture on Dry Density Table 2 shows the results of the preliminary test. It could be seen that there were different optimum moisture contents for earth bricks with cow dung as stabilizer compared to those without any stabilizer. The optimum water content for the earth bricks without stabilization and for bricks with 15% cow dung content was 10% by weight of earth. The corresponding maximum densities were 1748 kg/m3 and 1841 kg/m3 respectively. The optimum moisture content for earth brick stabilized with 20%, 25% and 30% of cow dung at 28-day curing age was found to be 11% and had maximum densities of 1847 kg/m3 , 1861 kg/m3 and 1910 kg/m3 respectively. Although 1% addition of water seemed only a small amount (about 450g), it was possible that 1% additional water added permitted more complete hydration of the cow dung. The 1% addition of water gave water to cow dung ratio of 0.2, 0.25 and 0.33 for earth bricks with cow dung content of 30%, 25%, and 20% respectively. The minimum water/cement ratio for adequate hydration is between 0.22 and 0.5 The 1% excess water gave water/cow dung ratio values between 0.2 and 0.33 for bricks with cow dung stabilizer, which thus fall within the range of water requirement for adequate hydration for stabilized Lateritic Earth.

The batches are labeled such that Xi represents batch X with % of water content by weight of earth.

Specimen	Dry density kg/m^3	Weight (kg)
A10	1748	2.69
A11	1739	2.67
A12	1713	2.63
B10	1841	2.83
B11	1797	2.76
B12	1766	2.71
C10	1797	2.76
C11	1847	2.84
C12	1807	2.78
D10	1817	2.79
D11	1861	2.86
D12	1758	2.70
E10	1813	2.79
E11	1910	2.93
E12	1837	2.82

Table 2: **dry density of sample**

Furthermore, batches with 0%, 15%, 20%, 25% and 30% of cow dung content were assigned letters A, B, C, D and E respectively

Weight calculated by density multiply by volume
Volume of brick = 0.190 X 0.090 X 0.090 mm = 0.001539 M^3
Weight = Density X density

Table 3 Mechanical characteristics and strength of Cow dung Stabilized Earth Brick (CSEB)

Specimens	Dry density (kg/m3)	Dry compressive strength (MPa)	Wet compressive strength (Mpa)	Water absorption coefficient, Cb (%)
A	1748	4.56	0.00	16.80
B15	1797	4.70	0.85	19.90
B20	1910	5.77	2.76	10.40
B25	1861	5.14	2.25	11.00
B30	1847	4.62	1.94	12.00

NB. The batch with 0%, of cow dung content is assigned letters A and those with certain level of cow dung content are labeled such that Bi represents batch B with i% of cow dung content by weight of earth.

Dry Compressive strength

The compressive strength at the dry state is given in Table 3 and as depict in Figure 6. It could be seen that bricks with 20% of cow dung content had the highest dry compressive strength of 5.77MPa which was an increase of about 67% over un-stabilized earth brick but beyond that, there were decrease in dry compressive strength to 5.14 and 4.62MPa for bricks stabilized with 25% and 30% cow dung content respectively. This then implies that the optimum cow dung content for compressive strength is 20% by weight of earth. This might be attributed to the fact that the hydration products of the cow dung up to 20% was just enough to filled in the pores of the matrix and enhanced the rigidity of its structure by forming a large number of rigid bonds connecting earth particles.

Wet Compressive strength

The compressive strength after immersion in water for 10 minute at the age of 28 days is given in Figure 6. The immersion in water for 10 minutes reduced the compressive strength by an average of 67% for cow dung stabilized samples compared to the compressive strength in their dry state. Furthermore, complete disintegration of un-stabilized specimens was observed in a few minutes after immersion in water. Again bricks with 20% cow dung content as stabilizer had the highest wet compressive strength of 2.76 MPa. Specimens with cow dung content above 20% did not give any significant improvement of strength of the wet samples. The lower strength of the wet samples could be prevented by treating the surface with cow dung render, with polymers or cow dung– lime renders, especially when the construction is to be exposed to water.

Water absorption by capillary

Cow dung stabilization reduced substantially the water absorptivity from 16.8% for 0% cow dung content to 14.2%, 10.4%, 11 and 11.36%, when cow dung contents were 15%, 20%, 25% and 30% respectively (Figure 8). The 20% cow dung content thus resulted in lower migration of water into the brick (i e. lower permeability). This could be explained that the presence of cow dung up to 20% eventually led to higher hydrated cow dung and higher mortar content. The higher mortar content makes the brick with some amount of cow dung less porous and more impermeable than the earth matrix, probably by infilling the voids and displacing some of the earth with far less permeable cow dung hydration products, thereby reducing paths for water ingression. Again increasing cow dung content above 20% did not much improve the impermeability of the bricks.

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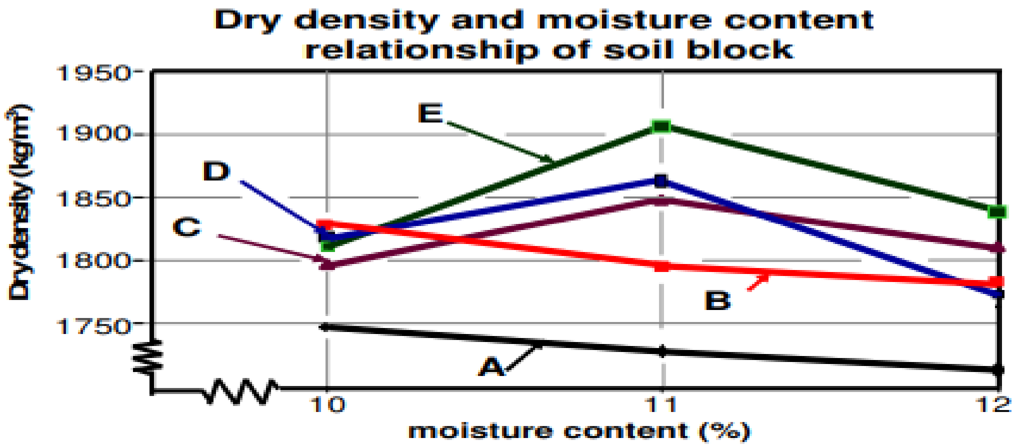
VI. CONCLUSION AND FUTURE WORK

By conduction of this study following conclusion has been made based on experimental investigation and research.



Optimum Moisture content and try density of earth brick

Cow dung brick can be considered as a sustainable building material. These bricks are eco-friendly, and lighter in weight. The brick obtained by partial replacement of clay with Cow dung. It maintain low temperature both inside & outside of building as compared to other brick, its resist control pollution inside the building and it will be save the electric power. Cow dung brick are cheaper, light weight and have good strength and cost effective over traditional brick so it is good eco friendly substitute over traditional brick for general building work.

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