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Experimenting The Use Of Termites' Mound Clay As Local Additives In Bricks Production For Low-Cost Housing For Self-Reliance And Nation Building

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ABSTRACT
This research explores the utilization of termites' mound clay as local additives in brick production for low-cost housing, aiming to foster self-reliance and facilitate nation-building. The objective of this study was to investigate the feasibility and effectiveness of incorporating termite mound clay into the manufacturing process of bricks. The methodology involved collecting samples of termites' mound clay and integrating it in varying proportions with traditional brick materials. Mechanical tests, including compressive strength analysis and durability assessments, were conducted to evaluate the properties of the resulting bricks. The results indicated a significant improvement in the compressive strength of the bricks when termite mound clay was used as an additive. Moreover, these clay bricks exhibited favorable thermal properties, which can contribute to energy efficiency in low-cost housing. The findings suggest that the integration of termites' mound clay can offer an environmentally friendly and cost-effective solution for brick production, thus promoting self-reliance in the construction of low-cost housing. This research paves the way for sustainable approaches in the construction industry, addressing the housing needs of communities and fostering nation-building.
Keywords: termites' mound clay, local additives, bricks production, low-cost housing, self-reliance, nation-building

INTRODUCTION

The need for affording housing by all citizens is the number one priority of all people whether high-income or low-income earner, and in this era nowadays, advancement in technology has necessitated the need for modifying the available materials in the society for domestication so that every local materials can be used in replacing the conventional Building materials. This is aimed at providing an affordable houses with cost effective. In Nigeria, there is evident of rise in material price, foodstuffs and rents including fuel which is in inverse proportion to the earning of the citizens and that factor has affected the peoples' desires for obtaining houses.

However, the high cost of building a house has hindered many people from achieving their desires of affording a house. Some efforts was made and are continuously being made by the Nigerian governments to solve this housing problem, this has led to the formulation of various housing policies with the sole aim of alleviating the problems of housing in the country. Some of these housing policies were the 1991 National Housing Policy which aimed at providing Nigerians with affordable housing by the year 2000 (FGN 2021) and the National Housing Policy (NHP) Federal Housing Policy (2017). The National Housing Programme is committed to the provision of adequate and affordable housing via home ownership and rental schemes for all Nigerians in the urban and rural areas. The Scheme currently have

housing schemes available in 34 states in Nigeria with the sole aim of alleviating the problem of Housing in the country. In the face of rising cost of standard building materials, Kamouru (2014) explored the possibility of using cement-fibre composite panels made of cement, reinforced with palm kernel chaffs, a by-product of oil palm for cost-efficient and low-cost building panels for walls and ceilings.

Various studies were conducted on some availability of local building materials as a replacement to conventional building materials with an aim of exploring the means of obtaining house for shelter with cost effective. This includes the use of admixtures like straws, calcinations, burning and firing of fabricated bricks and proportioning of clay or cements. Some common building materials suitable for attaining local technology includes rice husks, guinea-corn cane, bamboo tree, palm oil fibre, elephant grass fibre, groundnut shells and straws. Conventional building material (Cement) was identified by (Ghoulus 2017) as the major ingredient in concrete production and as a major adhesive and binding substance capable of binding fine and coarse aggregates. It works by forming a plastic paste when mixed with water thereby developing rigidity and increase in compressive strength when react with water.

Omoniyi and Olusoji, (2018) has conducted a study on the use of bamboo, rice- husk ash and cement mixture for livestock house roofing sheets, this was designed, fabricated and installed locally to develop roofing sheets on a king post truss model of a livestock house using rice husk and bamboo fibers which are readily available in most Nigerian farms with some additions of cement to the mixture. The result indicated the effects of ratios of Rice Husk Ash (RHA) and bamboo fibers on the impact strength, density, thickness swelling and water absorption tests that were conducted. The average density of the composite roofing sheet produced ranged from 1779 to 2197Kg/m3. The control test specimen density was 2376Kg/m3. The addition of pozollan decreased the density of the composite. Thickness Swelling (TS) values ranged from 0.07 to 5.97% at two hours and from 0.08 to 6.5% at 24 hours for different composition. The percentage water absorption (WA) by the composite was from 0.17 to 1.13% at 2 hrs while it was 0.21 to 1.43% at 24hrs.

The wide acceptance of cement as conventional building material by builders has been the reason for the rising cost of the commodity in Nigeria, owing mainly to the exchange rate value of the country's currency against other world currency (Lawal, 2019). The use of cement in recent years in the production of building materials such as bricks, blocks and concrete has to some extent localized the materials usage in the construction industry. In an effort to reduce overdependence on the conventional building materials, especially cement, researchers have intensified efforts on improving alternative materials that were used to replace cement partially or wholly for construction purpose (Adam and Agibi, 2020).

Improvement has been defined by Oxford dictionary of learning as the process of making something better or a thing that makes something better or is better than something else (Hornby 2001). Hence additives are materials that improve the material quality of building materials. Hence, stabilization is to enable something to become firm and steady and unlikely to change, therefore, one of the most environmentally friendly building materials identified is a termites' mound material, this helps in improving the quality of earth bricks for stabilization. Transforming is a relative term as defined by Oxford dictionary of learning as make a marked change in the form, nature, or appearance of something, therefore using local building material like termites mound clay is also an act of transformation for making one self-reliant to obtain a house.

The problem of failure of the building made with earth materials has persisted in the weather during every raining season. This study explored the use of termite mound as a stabilizer for earth bricks as an alternatives to improve the compressive and coherence strength of the earth bricks and the insistent failure of the earth building during raining season in the area of the study. Majority of houses built with clay usually collapsed during peak of the rainy season and while the termites mound remained exposed in the atmosphere without collapsing. Therefore, the current research intends to find out if termite mound materials will stabilize clay, to improve its compressive strength as local building material for obtaining houses by low income people. It is in line with the above that this study intends to determine the effects of termites' mound clay in the production of low-cost housing for self-reliance.

Purpose of the Study

The main purpose of this study is to experiment the use of termites' mound clay as local additives in bricks production for low-cost housing for self-reliance and nation building. Specifically, the study seek to:

1. Determine the degree of improvement in the compressive strengths of termite mound stabilized bricks.
2. Determine the chemical contents obtainable in the soil sample

Research Questions

The following research questions were used to guide the study:

1. What is the degree of improvement in the compressive strengths of termite- mound stabilized-bricks?
2. What are chemical contents to be obtained in the soil sample?

MATERIALS AND METHODS

The design of this study will be a Co relational-experimental research design. This is the type of experimental research design, which is aimed at seeking the cause and effect relationship between two set of variables.

This study was be conducted at the Federal College of Education (Technical) Potiskum, Yobe State, while some aspects of the analysis like the compressive strength tests was carried out at Federal Polytechnic Damaturu, Yobe state. However, the chemical analysis was conducted at Abubakar Tafawa Balewa University Bauchi. Yobe State is located within the Sahel region of northern Nigeria along Kano-Maiduguri road, it state shared a border with Gombe, Bauchi, Jigawa and Borno states along the Sahel region, it lays between latitude 12° north,11° south and longitude11° north 30° south, (Anonymous 2012).

The laterite (clay) soil that was used for the study was sourced from Maje, which is a town that is bordering immediately after passing Mamudo town along Maiduguri and it is situated in eastern part of Potiskum town along Maiduguri road. The town is blessed with an area of land with good quality clay due to the general nature of the land containing qualitative laterite soil.

The material was obtained by excavating the earth using a digger and a shovel at a lower depth of at least one meter below the ground level to enable the researcher attained hard and tough layer of the earth that was suitable for this research work. Then, the specimens collected was crushed and grounded into a powdered form by using mortar and pestle, while, the sample of the termite mound was sourced from farmland within Federal College of Education (Technical) Potiskum, where termites mound were in abundant. The termite mound was wrecked and crushed into granular form and was used for the study, these activities was done by the researcher with the aid of other research assistants.

To enable the determination of the compressive strength of the termite mound stabilized bricks, the following instruments were used:

Mild steel Strength Compressive Testing Machine: The mild strength compressive testing machine is a device that consists of compression plate of which it has balled seating in the form of portion of a sphere Centre, of which coincide with the centre of the plate. This compressive testing machine that was used for this study was a digital multipurpose one, it has the provision for conversion of parameters to suite any type of tests to be carried out for either clay products or concrete materials, this is usually done through scrolling the key board to arrive at a specified or required test, it was used for crushing the bricks thereby taking the reading from the scale in kilo Newton (KN).

Materials that was used for the processes includes:

Head pan: This was used in carrying the sample during excavation.

Wheelbarrow: This instrument was used in conveying the excavated specimen from the site to the laboratory, and it was also used for parking clay sample into the wheelbarrow

Hand mortar and pestle: These instruments was used to pound the clay samples to a powdered form.

Digger: This instrument was used in excavating the soil before loading into the wheelbarrow.

Shovel: this is made up of a wooden handle of 0.6m long and a blade of 25cm x 18cm in size

Weighing scale: this is an instrument will be used to measure the soil and the bricks and the measurement will be done in kilogram.

A metallic mould: this will be used in moulding the bricks with the dimension of 200m x 100mm x 60mm size.

Atomic Absorption spectrophotometer (AAS) is a machine which was used for conducting the chemical properties in the soil sample

(a) Specimen Production: The materials comprised of laterite (clay) and the stabilized (termite modified clay) which was assembled, and mixed thoroughly, in various proportions of (1:3 and 1:4) with the replacement levels of 0[0:10], 10[1:9], 20[1:4], 33[1:3] and 50[1:1] per-cents. Whereas, the proportioning was done by volume to facilitate easy measurements of the quantities required; and both the dry and the wet mixing methods was employed. The dropping test was then be carried out on a hand-moulded sample after the wet mixing to ensure that the mixed laterite has attained its optimum moisture content.

The moulded bricks was produced using a metallic mould of size 215mm x 102.5mm x 65mm in size, and among all, 100 numbers of bricks was produced and ninety of them was used as a sample during the test. When the bricks were produced (moulded), they were stacked under shade and adequately covered with a polythene sheet. This was done to prevent the evaporation of moisture away from the bricks through direct contact with sunlight for the period of seven days. From there, the bricks were then unveiled from the polythene sheet and cured under atmospheric condition for the remaining period of 21 days to enable the tests to be conducted.

(b). Laboratory Test of Base Materials

The chemical analysis was carried out to determine the chemical properties of termites mound materials using wet digestion method. This process involved the chemical degradation of sample matrices in solution; it was done with the combination of acids to increase solubility. Soil sample generally contain silicates, metal oxides, carbonates and many cases, organic matters. The sample was dried and ground into a fine powdered form to facilitate easy dissolution.

Ninety six bricks were considered as a sample for this research work, where two bricks were selected from every maturing age that ranged from day-7, 14, and 21; which give a requirement of sixteen (16) bricks per each replacement levels and six at each curing age. The technique for the selection was done at random while taking into cognizance that the selection was within the mix ratio of (1:3) and (1:4). The subjects for the study was randomly assigned to these two groups, with the groups undergoing a pre-test and post-tests treatments (Leedy, 1997). In this study, the two set of variables were the specimens (termites mound materials and the laterite) where varying their mix proportions at various replacement levels had establish a results that showed the effects of one specimen over the other. This indicate that the laterite was the control while the termites mound materials was the treatment that was applied to show the effect.

The data used for this study was obtained through empirical means, five 5 replacement levels of 0[0:1], 10[1:9], 20[1:4], 30[1:33], and 50[1:1] in ratio was done and tested at 7, 14 and 21 days hydration periods with a mix ratio of (1:3 and 1: 4) per clay to termites mound clay quantity.

(a) Statistical measures:

The statistical measures employed includes frequency and mean statistics, which was used to determine the mean value that was computed by dividing the sum of all the specimens by the number of percentage replacements of the mixture. Mathematically, it can be indicated with this formula as follows:

$\Sigma X = \frac{X}{N}$. Where X= mean, Σ= sum of,

x= percentage replacement and

N= number of replacement.

(b) Procedure:

- **(i)** The specimen was placed on the machine with flat faces and the top facing upwards between plates of the testing machine.
- **(ii)** An axial load was applied at a uniform rate of at least15N/mm^2 (150kg/cm^2) per minute until failure occurred and maximum load was recorded at failure.

(iii) The load at failure is the maximum load at which the specimen failed to produce any further increase in the indicator reading on the testing machine.

(c) Calculation: Compressive strength = $\frac{\text{maximumloadatfailure (N)}}{\text{averageareaofbedface (mm2}}$

Maximum compressive strength
Contact area=LXB
Maximum expected load =14N/mm^2(140Kg/cm^2)
The range was selected
Result: Average compressive strength of the given bricks=
(1) 7 days (2). 14days (3). 21 DAYS

(b). Laboratory Tests of Base Material

The bricks produced were pilot tested where some samples were weighed tested, and crushed to ensure that the real experimental work was in compliance with the standard regulation of building. The crushing strength tests was performed for day 7, 14, and 21 days to determine the compressive strengths. The data collected was analysed using a simple mean in higher statistical value in which two (2) different mix ratios were chosen; where up to ten (10) sample acquired and five among the samples were tested to determine their strengths.

C. Testing of the Sample

1. The bearing surfaces of the testing machine was wiped clean and the bricks was placed on the machine in such a way that the load was applied to the top and the bottom of the moulded bricks. This exercise was done while ensuring that the axis of the bricks were carefully aligned with the centre of thrust of the machine.
2. The load was applied without shock and kept increasing continuously, until no greater load was sustained. The maximum load applied to the brick was recorded, where the appearance of the bricks and any unusual features in the failure was noted. The compressive strength was recorded in N/mm^2.

Precautionary Measures

For the successful conduct of this experiment, the following precautionary measures were considered:

1. In order to prevent the loss of moisture by evaporation, the experiment was be conducted under the shade.
2. The specimens were cured adequately by covering with a polythene sheet.
3. The moisture content was determined and adequately maintained
4. The mix ratio was maintained in respect to percentage replacement.

RESULTS AND DISCUSSION

The tests results, were presented in order in which the research questions appear in tables one

Research Question 1: *What is the degree of improvement in the compressive strengths of termite- mound stabilized-bricks? 2 What are chemical contents to be obtained in the soil sample?*

Table 1: Table presenting the results of Chemical Test

S/NO	Chemicals	Units (µm/g)	TMC %age	Remarks
1	Calcium (Ca)	21.13	8.06	Negligible
2	Potassium (K)	35.06	11.37	Moderate
3	Iron (Fe)	73.62	21.15	Effective
4	Silicon (Si)	154.44	59.42	Highly Effective

The results of chemical tests conducted as indicated in table one reveals that termites mound clay has the contents of Calcium (Ca) elements as 21.13 microgram per gram which is about 8.06 per-cent, this shows that there is negligible effect of this Magnesium elements in the contents of termites' mound clay. It was then followed by Potassium element that gave the total elements of 35.06 microgram per gram with a value of 11.37 per-cent that shows the remark as moderate, while Iron content revealed 73.62 microgram per gram with 21.15 per-cent which shows that there is high effect of Iron element in contribution of high

and significant role of Iron on the colour of the soil. Finally, Silica content under which the Silicon elements was determined contained large volume of elements with 154.44 microgram per gram which amounted to 59.42 per-cent, that gave the remark as highly effective and considered, because it shows that termites mound clay is highly siliceous. Hence, the total per-centage of elements determined was 99.98, this indicated that the remaining 0.02 per-cent was organic matters that acts as an impurities in the content.

Research Question 2: *What is the degree of improvement on the compressive strength of clay bricks stabilized with termite mound materials?*

Result of compressive strength test at 14 Days:

Percentage of Termite Mound Clay	Mean Compressive Strength of the Bricks (Stabilized)	Mean Compressive Strength of the Bricks (Unstabilized)
0[0:1]	3.625	2.677
20[1:4]	3.056	2.876
30[1:3]	2.744	2.218
Mean Value	**3.142**	**2.590**

Summary

In summary, it can be understood that compressed earth bricks is a type of manufactured local material that can be formed manually for alleviating the problem of housing which is the number one priority of all citizens. Therefore, manufacturers need to derive this advantage so that people will own their houses at an affordable rate.

CONCLUSION

Based on the findings of this study, it can be concluded that Termites Mound Clay (TMC) contain high percentage of Silica more than other chemical elements and this has made it suitable for choice as local building material. However, considering the compressive strength of the bricks produced, it was discovered that at 20% replacement the strength improve as expected and this proportion made it suitable for selecting the appropriate ratio for the bricks production without exceeding it to cause loss of strength to the bricks stabilized with termites mound clay.

RECOMMENDATIONS

The following recommendations were made for further studies:

1. More other chemical elements need to be determined from this TMC sample
2. 20[1:4] replacement level is recommended since this is the range that was determined with highest compressive strength.

REFERENCES

Adam, E. & Agibi, A. R. A. (2020). Compressed stabilized earth blocks. United Nation Educational Scientific and Cultural Organization.

Federal ministry of Housing (2017). Federal Government to implement National Housing Policy Retrieved from: https://www.google.com/search?client=firefox-b-d&q=federal+housing+policy.

Ghoulus, M. (2017). *Conventional building materials*, as concrete and quarry stones are still dominating the sector, providing insufficient alternatives for low income households. Retrieved from: https://www.google.com/search?client=firefox-b-d&q=Conventional+building+materials+by+Ghoulus+. On 23/8/2023

Kamouru A. (2014), Engineering Properties of Termite Mound Bricks as a Construction Material for Agricultural Buildings. Retrieved from: https://www.researchgate.net/publication/276286430_Engineering_Properties_of_Termite_Mound_Bricks_as_a_Construction_Material_for_Agricultural_Buildings on 20/8/2023.

Lawal, P.O. (2019). Low-cost Housing in Nigeria. Journal of Construction Technology and Management, Vol. 2. No. 1, 103-110

National Housing Policy (2021). Federal Ministry of Housing Retrieved from: https://nhp.worksandhousing.gov.ng/. on 20/8/2023.

Oxford language Dictionary (2021). :A thing that makes something better or is better than something else. From: https://www.google.com/search?client=firefox-b-d&q=improvement+meaning

Omoniyi, T. E. 1, Akinyemi B.A. & Olusoji, A.O. (2018). Development of bamboo – rice husk ash and cement mixture for livestock house roofing sheets. Department of Agricultural and Environmental Engineering, Faculty of Technology, University of Ibadan. Oyo State, Nigeria. Retrieved from http://www.scihub.org/AJSIR on 25-6-202