DETERMINATION OF THE STRENGTH OF TERMITE HILL SOIL STABLIZED WITH RICE HUSK AS A LOW COST MATERIAL FOR FARM STRUCTURE

BY

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CERTIFICATION

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DECLARATION

I hereby declare that this project is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certification at any university oo institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

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DEDICATION

This project is dedicated to the Almighty God for His loving-kindness, tender mercy and amazing grace towards me, and to my parent for givening me the opportunity to be educated.

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ABSTRACT

Termite hills are described as the structure built by termite using soil in the surrounding or within the earth. The mound has extremely hard walls constructed from bits of soil cemented with saliva and baked by the sun. This research work is to determine the compressive strength of termite hill soil stabilized with rice husk. The study investigated the compressive strength of 150 X 150mm cubes made from termite hill soil and rice husk in the different mix ratio of 50:50, 60 40, 70:30, 80:20, and was cured for 28 days crushing the cubes at 7days interval. Test result showed that the compressive strength of the cubes increases with age i.e. at 28 days and increases with decrease in percentage of rice husk. However the mix ratio of 50:50 has the least compressive strength of 0.4800MN/mm^2, while the mix ratio of 80:20 has the highest compressive strength of 0.9244MN/mm^2 compared to mix of 100% termite hill soil. Termite hill soil seems to be promising as a suitable, locally available housing material for farm structure.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

Overtime man has spent immeasurable amount of energy on the provision of housing, one of his basic needs. As extensive as these efforts are, the problem of inadequate housing delivery has persisted. Rising cost of living, high cost of building materials, have all contributed to the prohibitive cost of housing delivery.

The concept of adaptable habitation is a new area of building engineering that deals with the adaptability of local resources, technologies, skills and manpower in the provision of affordable houses specific to particular communities. It studies the primordial housing delivery characteristics of individual communities with a view to understanding the limitation in terms of technology, skill and resources. Improvements on exiting method, materials e.t.c to meet minimum standard of shelter, aesthetics and health are then introduced. By this concept, houses are delivered as affordable as possible while preserving the cultural traditional peculiarity of the communities.

Therefore, except there is a deliberate policy designed toward adopting the above concept with a view to bringing down the cost of houses vis-à-vis the cost of building materials as well as available delivery technology, the problem of inadequate housing will definitely persist.

1.1.2 Termite hill

Termite hills are described as the structure built by termites using soil from within the earth. The structures are used as shelter for the colony since termites are social insects. Termite hill of certain tropical species are huge mounds like structure often 6m in height. Their mounds have extremely hard walls constructed from bits of soil cemented with saliva and baked by the sun. Inside the walls are numerous chambers and galleries, interconnected by complex net work of passage, ventilation and drainage are provided and heat required for hatching the eggs is obtained from the fermentation of organic matters which is stored in the chambers serving as neoseries .Termite mounds build of cemented soil particles are characteristics features of many land scape in Africa, Latin America, Austria and Asia. Their mounds and network of underground passage and aboveground covered runways that typically spread 20 – 30m beyond the mounds are essentially termite 'cities'. Termite mounds may persist in the land scape for more than two decades. Termite may consist of organic and minerals compound which can also affect the physical properties of this soil.

1.1.3 Rice husk

Rice hull(or rice husk) are the hard protecting covering or coating for the seeds or grains of rice plant, to protect the seed during the growing season, the hull is made of hard material including opaline silica and lignin. The hull is mostly indigestible to humans. During milling process the hulls are removed from the grains to create white rice. Rice hulls are a class A insulating material because they are difficult to propagate mold or fungi.

Though in some areas, the husk are use for filling used pits, as fill on some local roads during raining season. Therefore it is wise to note that because of local use of rice husk for semi technical work, it raises some interest to carry out a research on the suitability of the husk as a fiber for building material, since very little is known about the behavior of this husk as a material for engineering structure.

1.2 Objective

- To determine the strength of termite hill soil stabilized with rice husk

1.3 Justification of project

Termite mounds build of cemented soil particles are characteristics features in many land scape in Nigeria and base on the enormous quantity of rice husk being wasted and also constituting health hazard, this project is to consider the local use of it as material for farm structure and also to bring down the cost of locally made blocks

1.4 Statement of the problem.

The amount of rice husk that is wasted is enamors and the presence of termite hill that characterize many land scape in Nigeria.Therefor this project was carried out to determine the use of termite hill soil and rice husk as building material

1.5 Scope of study.

This project is limited on the suitability of using a certain percentage of termite hill soil and rice husk mixed in varied proportion to produce blocks as local material for building. The chemical composition of rice husk is not part of the scope of the work.

CHAPTER TWO

2.0 LITRETURE REVIEW

Mijinyawa Y. *et al* (2007), reported that the use of clay in the construction of crop storage structure dates back to 1915 when round barn or silo was constructed with hallow clay tiles at the Slayton farm in Iowa, United state (Iowa FHPC, 2003). Different types Of clay constructed structures are in present use in various parts of the world. These include the native rhumbu, the laterite- impregnated grass structure and the dried earth granaries in Northern Nigeria while the puss bin is common in India. The major advantage of the native rhumbu is its ability to provide a cool environment for storage. This is attributed to the low thermal conductivity of about 1.15W/m K which is lower than that of concrete and metal silo (Osunde and Lasisi, 1998). Domestic grain storage especially those for use as seeds, is done in hermetic clay pots. The *kachia koth* is a crop storage structure manufactured from clay and popularly used in Asia. Other types include the Mexico store which is a closed clay in curved walls that is difficult for rats to gain access

2.1 Definition and properties of clay

Although a number of authors such as Copper (1991) and Morris (1997) have given different definition of, clay can be defined as a very fine- grained soil of less than 0.1mm in size and which is plastic when moist but hard when fired. The plastic nature under wet condition enables clay to be molded into any shape which is retained upon drying. Good clay should therefore exhibit this plastic property. The suitability of any clay for molding can be tested through molding about 200mm coil (about the size of a finger) on a slab. If the coil cracks in the outer edges, the clay is probably less plastic, if on the other hand, the clay does not in the outer edges, the clay has adequate plasticity and is a good material for moulding (Daniel, 1977). When used in construction, clay often undergoes some treatment which improves the properties. When used as bricks, clay is subjected to a tempreture of as much as 500°C or even higher. During this processes, the alumina content in the clay melts thus raising the burning tempreture to about 275 degree which is much higher than tempreture experienced in fine accident. This is why clay product posses excellent fine resistance properties compared to wood,(Hall and jackman; 1975; Lucas and Fuwape; 1984; Schaffer; 1988; Schaffer; 1992; FPL, 1974; Hendry *et al*, 1987). Parker (1998) reported that beside the improvement in fine resistance, the elevated tempreture also improve the resistance to moisture penetration. A pile of earth made by termite mound. It is made of clay whose plasticity has further been improved by the secretion from termite while being used in building the mound. It is therefore a better material than the ordinary clay in term of utilization for moulding (Odumodu, 1991). This type of clay has been reported to perform better than ordinary clay in dam construction ((Yahanna *et al*, 2003). The clay from termite mound is capable of maintaining a permanent shape after moulding. Termite mound clay is being considered for use in silo construction because of its plasticity and less prone to crack when compared with ordinary clay. Heat treated termite mound clay unite are resistance to wear, abrasion and penetration by liquid (Parker, 1988). Termite mound clay has low thermal conductive ity and expectedly should reduce solar heat flow into the enclosure and regulate temperature fluctuations within the storage environment

2.2 Clay Collection and Brick Making

In other to be able to obtain clay from the mound, the termites were evacuated through the application of chemical powder (pestox) into the broken mounds and the surroundings. The lumps of termite mound clay were then collected and deposited at a clean site. Size reduction of the clay lumps was achieved through pounding with pestle. The clay was then mixed with water in the ratio of two volume of termite mound to one volume of water. The wet clay was then poured into a 215 ×150 × 65 mm wooden mould placed in a manually operated molding machine and vibrated to ensure compaction and appropriate shape forming. The bricks were then removed and left for five days to dry naturally. They were thereafter burned in a mud-kiln with the use of firewood as the source of heat. The kiln temperature was about 500c monitored with a thermocouple.

. Ndaliman.B (2004). Noted that the activity of termite are, perhaps more important than the activities of earthworm in the areas of day formation. Termite transport large quantities of material from within the soil, depositing it on the surface. Some of the termite mould hills are about 5 meter tall and 7 meter in diameter. The earth movement activity of some termite result in greater than-normal content of days. It is because of the anticipated transformation of the original clay content that stimulate the research in this area. In an earlier paper (Akinbod. F. O. 1996), it was shown that the behaviors of termite hill material when subjected to this refractory test were in good comparison with firebrick obtained elsewhere. It was

then suggested that further improvement may be obtained when additive or other forms of rectification could be made.

Refractory materials include alumino-silicate silica, magnesite chrome, carbon and dolomite etc. These oxides are classified according to their chemical behavior. Over 80% of the total refractory materials are being consumed by the metallurgical industries for construction and maintenance of furnaces Kilns, Reactor Vessels and Boiler. The remaining 20% are being used in the non-metallurgical industries as cement, glass and hard ware (Aderibigbe A; Chuwuogo B. 1984). It was showed (Ndaliman B.2001) that termite hills can be used to produced insulating refractory when 25% of additives (Corn Husk, Saw Dust used) were used. However, low values of refractoriness (1,200 degree) were recorded for these cases. The application would require a compromise between insulating and operating temperature. In yet another investigation, which sought to increase the refractoriness, (Ndaliman B 2000) used 25% each of graphite powder and asbestos with termite hill materials. It was found that the refractoriness of 1,700degree and 1,600d were obtained in addition to improvements recorded in other properties

The materials for investigation are the termite hills and the additives (Graphite and Asbestos). The termite hill used was those spread around Oshodi area in Lagos. They were dug up from a field divided into three (3) parts. Five hills from each of each part were used; they were crushed, sized graded by sieving to remove leaves and other materials .The chemical analysis was then conducted.

The samples were prepared by using 200g as the basis of each mixture. Each of the graphite powder and asbestos were added in the percentage of 20,25,30,35, and 40 respectively. This makes up a total number of ten (10) samples for investigation. These mixtures were blended and molded with sufficient water. They were rammed into various test shapes with the use of a die and hydraulic press. The samples were then oven dried and fired to 1100c for further test.

The method used in analysis of chemical composition is X-ray method. Other refractory properties investigated are linear shrinkage, refractoriness, and thermal shock resistance permeability, and porosity, bulk density, specific gravity.

The properties listed above have standard test procedure. Generally, the standard test methods as contained in BS 1902: part 1A: 1966 (Chester J. H. 1983) was used in studying the refractory properties of the samples.

2.3 Chemical Bonding of Clay

Crispin Pemberto-Pigott, reported that while looking into the different means one might use to get a low expansion clay stove body he tripped over a possible explanation of why the low temperature 'clay' bricks made from termite mounds are so strong. Stove Components are usually fired at what ceramics people consider very low temperature: 800c is about the maximum. We call it terracotta and it is only barely a ceramic in the view of industrial advisors.

When he test fired termite mound material he got very strong bricks at 400c which is definitely not a ceramic bond at the molecular level. They are reddish and appear to be clay but it is now clear these bonds are chemically not ceramic. He chased the idea that potassium collected in the grass that is hovered up the ant (not really termites) from the ground around the mound is accumulated in the mix. This is a flux and lowers the melting temperature of the clay minerals. He chased the idea that adding lithium feldspar to the clay (to get the lithium content up) might produce low expansion clay tolerate of thermal shock. This works well, however the firing temperature are so high that it is not going to happen in a field kiln. Unless 1200c is reached, there is no going substantive change to the ceramic minerals resulting in a really low expansion product (meaning it still cracks when heated rapidly on one side).

Now it appears that adding phosphate to sand + clay and firing it at relatively low temperatures will give a chemical bond something akin to te termite mound result. There might also be a natural glaze in the material that is melting and glueing the particles together – not sure. The expansion rate of this type of material appears to have been explored little. Everyone in formal industry immediately goes for high temperature firing because it is easy in a real kiln. Given the constraint of a low firing temperature and a relatively low temperature in use (about 600°C), there is a lot of room for investigation of chemical bonding of clay and sand with the goal of finding (perhaps) not an ultra low thermal expansion (ULTE) clay but an expansion – tolerant chemical bond that is flexible enough to accommodate the stresses encountered lighting or running a stove.

The stresses are heightened by the interest in insulative ceramic components. Obviously if the stove design calls for a high temperature on one side of a brick and room temperature on the other , huge stress can arise in between as one side expand and the other does not. Similarly if a vertical pipe is used with the flames coming out the top, sideways under a pot, the top of the pipe gets hot and the bottom remains cool. The pipe tends to get conical and cracks because the heat is not distributed evenly, inside to outside, top to bottom. The standard answer of adding sawdust or other filler to create a little air pocket in a porus clay structure may not be done what is assumed in terms of resistance cracking. If the firing temperature not high enough to create 'real' ceramics, the bonding is chemical and cracking. In short, it is not a flexible or expansion tolerant ceramics. it is soil glued together.

Lastly, the possibility that components can be dry- molded (with very low water content) may be good way to increase the chemical bonding because there is no (or almost no) shrinkage with its consequent micro-cracking. If the bonding via low temperature firing is predominantly chemical, then the little cracks expected to 'heal' during firing remain open, interfering with the chemical bond, as the part is not heated to a high enough temperature to melt and flow the c lay minerals. Thus it may be very important to focus on maximizing chemical bonds (using calgonite, for example) while keeping the cracks away by pressing parts in a mould. Pot- spinning wet clay parts may be worst way to make a strong, low temperature stove component. If so it may explain why parts made in that way are so weak.

2.4 Uses of termite hill soil

Steve Patter a former employee of the Center for Appropriate had carried out some experiments of rammed antbed at Kentore many years ago. The experiments involved a trail of rammed antbed / earth bricks. A hole was dug until a clay layer was reached. Crushed anthill soil was mixed with the clay and water was added. A tractor was run back and forth over the mixture to grind and blend it. The mixture was put in moulds to see how hard it got. Steve noted that the material did not work as well as they had hoped, and that it may be necessary to add cement to the antbed soil when rammed antbed bricks are made.

Bruce Walker, direct of the Center of Appropriate Technology (CAT), has used rammed antbed to line water tanks in Arnhen land. Rammed antbed were used in the construction of house at Arrilhjere (Locally known as "Olives place"), built by staff of the Center for Appropriate Technology. The antbed floors were not useful and did not wear well. The skin started to peel off the surface and after some time, the antbed floor was replaced with concrete floor. Rammed antbed has been used for a footpath at Elliot, as well as being used for dust control at women center. Each day anthill soil was taken from a different area. This enabled the floor to be made in a number of different colors. Rammed antbed soil also been used for constructing driveways.

The University of Warwick UK has carried out experimental work on rammed c antbed tanks in Uganda. For a tank which was constructed at Mbarara they used an earth mixture consist of 80% anthill soil, 16% coarse murram and 4% cement (Murram is a type of hard soil containing small stones, found in east Africa and used for building roads.

Anthill soil has been used for plastering the exterior of "earthbag" houses, as a substitute for lime, sand and Portland cement. However it was found to be prone to cracking. It may be less likely to crack if it is mixed with sand.

Sun dried anthill bricks have been used for housing construction in Zimbabwe however, Peter Morgan, a latrine designer, noted that they are only durable if they are protected from the weather by an overhanging thatched roof. Bricks which have been fired are more weather resistance. A women conference center has been built in Turana, Kenya. East Africa from sundried anthill soil bricks and a cement alternative (ash mixed with cow dung). For the construction of pit latrine, anthill soil has been used as a substitute for cement in the construction of floors. However, if this is used as a cement substitute, it has been found that the surface needs to be renewed more frequently.

2.4.1 Termite Mound Clay in Stove Making

Mrs. Mawanga Jesca of cecac gave a report of what you will need to make a three plate mud stove are, wheel barrow of anthill , six wheel barrow of red soil, one basin of fine texture sand, water to mix, any grass, sweet potato leaves, dust, two banana stems, ash.Step one: mix thoroughly the anthill soil with the red soil, option to use anthill soil is based on the fact that when ants are building their anthills, they use soil from further down in the ground. This is thicker and compact, soil which contain material from termite mounds are reputed to be highly resistant to the effects of rain and water. For best result, use older anthill mounds than mounds which still have termites living in them. This is because the older termite mounds have higher clay content (30 – 80%) than newer mounds, clay is a naturally occurring material, composed primary of fine-grained materials, which show plasticity through a variable range of water content, and which can be hardened when dried or fired. It is also very impermeable when in contact with water

Option to use the new mounds should be used with caution, this is because you will be destroying the termite first either by poisoning or smoking and yet they have a right to leave. Termites are vital and are important part of arid and tropical ecosystem. Their role is to decompose plant materials and making them available to the soil so as to allow plants grow (they are as important as earth worms and fungi which are found in wetter environments). Life in tropical and are ecosystems depend on this nutrient cycling carried out by fungi. Termites are also an important part of food chain, providing a food source for ants, spider and lizards. Also the outer clay casing of termite mounds is believed to be more suitable for construction than the inner nest material.

According to Engineering and physical science research council, soil heavy in clay content is excavated for use in brick building. Clay is the cement which makes the bricks hard after baking. Often the soil found in termite mounds is preferred as the termite builds their mounds by bringing up clay rich soil from beneath the soil. The moist soil is mixed with dried straw and then put in a brick press. Old motor oil is used to grease the press and facilitate removing the brick from the press.

Once out of the press the raw bricks are set out in the sun to dry, allowing air to pass in between them in the drying process. After bricks are dry a brick oven is built, it is in this form that the bricks will be baked, the heat will change the composition of the clay in the bricks and they will become much harder. The space in between the bricks are then covered by mud to reduced the amount of heat that escapes the bricks oven, metal plates are place in front of the opening to contain the heat. Once the fire has cooled, the bricks are ready for use in home construction. In area where cement is expensive or hard to acquire a mortal mixture can be made with chalk locally from artisnamel quarries

2.4.2 Termite Mound Clay in Road Construction

Integrated Regional Information Network (IRIN), noted that Engineers are mimicking the technology of termite to build cheap, durable, environmentally friendly and desperately needed road infrastructure in Zambia a and, in the process, providing jobs at grassroots level. The almost indestructible nature of termite mounds and the realization that this technology could be adapted to build roads even more hard wearing than those made from asphalt came at cost of a broken limb. "The idea came from my best, best friend, a south Africa named Henry Halle, who, in his garden, tried to kick those [termite] hills away. On his third try he broke his leg," said Kim Anderson, a Danish national working in the Zambia capital, Lusaka. "After that he came to me and said, 'this is something! We need to replicate this technology for construction'"

Anderson, a regional manager for a Danish air service company, secured financing from the European Union and the Danish government for a road construction pilot project in South Africa, based on termite technology, and a recent initiative in Zambia. It is not the first time that termite technology has been used to build man-made structure: the Eastgate shopping centre in the Zimbabwe capital, Harare, was modeled on termite mounds, using the design for energy-saving ventilation. In Europe architectural firms are researching and copying mound technology in the design of high-rise buildings, in an attempt to replicate the termite ability to create climate control in their relatively mammoth structures.

"Millions of insects inhabit a single mound. Located in nest buried approximately a meter beneath the ground, they face a formidable challenge to ventilate the colony and maintain both temperature and moisture constants, whilst protecting the colony from harsh environment outside, in which they would perish," said Rupert Soar, a mechanical engineer and researcher at loughborough university, England, in a recent report. Though termite are popular known as wood-devouring pest, 75 percent of the 3,000 known species are classified as soil-feeding, whose diet consist of organic material mixed with clay minerals. "Environmentally friendly roads differ from asphalt roads: we don't use diesel to build [the]," Anderson said. During a visit to South Africa in 1995, we took a look at those big hills made by those insects. We took a test of the solution they use to mix up the soil, and found we could apply it to clay to make a road.

Termite mounds have clay content about 20 percent than that of the adjacent soil, reflecting the insects' preference for smaller clay particles for construction, while being transported in the insects' mouth or their five gut compartments, the particles are saturated by alkaline and other chemicals, which add nutrient and contribute to the structures' robustness. Soil particles probably undergo modifications in the insect's gut because of the extremely alkaline PH, reaching values up to 12" said a study published in the Brazilian periodical, scientia Agricola. After duplicating the chemical properties of the 'cement' created by termite to harden their mound, which extent one meter into the earth but can rise over two meters above it, Anderson's team launching their first pilot project in South Africa. We found if you mix it with soil, wherever you are in Africa, you can make very good roads, like asphalt. In South Africa we tested it in an agricultural area where heavy trucks are running. Since 1996 to December 2006, we calculated there have been 11 million vehicles using the road, five million of them heavy trucks, and there has been no wear on the road down to the roadbed. It's very durable" Anderson told IRIN

2.5 Termite Mound as Model

It was noted that Engineers and architects have been studying termite mounds to learn how nature keeps its structures at even temperature. From these insights they designed the Eastgate complex, a nine storey building located in Zimbabwe. In Zimbabwe's hot climate the building is unusual in that it is naturally ventilated without a traditional heating and air-conditional system. Termite build and live in mounds that regulate humidity and maintain an internal temperature of 30°C despite external temperature dropping as low as 3°C at night and reaching over 38°C during the day. The mounds are relatively large at up to 4.8 meters high and 4.8 meter wide. Their walls are approximately 40 to 60 cm thick and are made of soil and saliva, which combine to produce hard, cement- like material. Termite require a consistently mid climate because they are producer of fungus (their primary food source), which is sensitive to temperature and humidity variation.

Climate control in termite mounds is achieved through the combined use of insulation, and the natural phenomena of hot air rises and the venturi effect. The Eastgate complex is likely the only building whose climate control is based on the cooling and heating principles identified in termite mounds architecture. The building controls the air flow to provide natural cooling instead of using energy intensive -- and greenhouse gas producing- air-condition. The natural ventilation system eliminated the traditional heating and air conditioning system which led to lower building and energy cost, using 10 percent less energy than building of a similar type. The building also cost US$3.5 million less to build and offers rent fees 20 percent lower than the average and on the hottest days provides indoor comfort at 3-4°C lower than outer temperature. Termite mounds also have other features that we can learn from. Termite mounds soil content makes them fire resistance, the soil contains clay, which consist of inorganic material (minerals and water) and thus is incombustible. Termite mounds contain twice the concentration of clay as does the surrounding soil surface. Some mounds contain chrysotile (more commonly known white asbestos), which also comes from the surrounding soil. Chrysotile is incombustible and thus improves fire resistance. Termite mounds materials are all sourced on- site and are all biodegradable.

2.6 Natural Fiber

Fibers are a class of hair-like materials that are contiuous filaments or are in discrete elongated pieces, similar to pieces of thread. They can be spun into filament, thread, or rope. They can be used as a component of composite materials. They can also be matted into sheets to make products such as paper or felt. Fibers are of two types: natural fiber and man made or synthetic fiber

2.6.1 Sources of Natural Fiber

Natural fibers include those from plant, animal and mineral sources. Natural fibers can be classified according to their origin.

2.6.2 Vegetable Fibers

Vegetable fibers are generally comprised mainly of cellulose include cotton, jute, flax, ramine, sisal, and hemp. Cellulose fibers serve in the manufacture of paper and cloth. This fiber can be further categorized into the following:

- Seed fiber: Fibers collected from seeds cases e.g. Cotton and kapok.
- Leaf fiber: Fibers collected from leaves e.g . sisal and agave
- Bast fiber or skin fibers: Fibers collected from skin or bast surrounding the stem of their respective plant. These fibers have higher tensile strength than other fibers. Therefore, these fibers are used for durable yarn, fabric, packaging, and paper. Some examples are flax, jute, kenaf, industrial hemp, ramie, rattan, soybean fiber, and even vine fibers and banana fibers.
- Fruit fiber: Fibers are collected from the fruit of te plant, e.g. coconut (coir) fiber.

- Stalk fiber: Fibers are actually the stalks of the plant. E.g. straws of wheat, rice, barley, and other crops including bam boo and grass. Tree wood is also such a fiber.

The most use natural fibers are cotton, flax and hemp, although sisal, jute, kenaf, and coconut are also widely used.

2.6.3 Animal Fibers

Animal fibers generally comprise protein, example include silk, wool, angora, mohair and alpaca.

- Animal hair (wool or hair): Fibers or wool taken from animals or hairy mammals. e.g. sheep's wool, goat hair (cashmere, mohair). alpaca hair , horse hair etc.
- Silk fiber: Fiber collected from dried saliva of bugs or insect's during the preparation of cocoons. Examples include silk from silk worms.
- Avian fiber: Fibers from birds e.g. feathers and feather fiber.

2.6.4 Mineral Fibers

Mineral fibers are naturally occurring fiberor slightly modified fiber procured from minerals. These can be categorized into the following;

- Asbestos: the only naturally occurring minerals fiber. Variations are serpentine (chrysotile) and amphiboles (amosite, crocidolite, tremolite, actinolite, and anthophylite).
- Ceramic fibers: Glass fibers (glass wool and Quartz), aluminum oxide, silicon carbide, and boron carbide.
- Metal fiber: Aluminum fiber.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Materials

The material uses to carry out this project are as follows:

Termite hill soil, rice husk, water, weighing balance, weighing pan, mallet, polythen sheet(thick),mixing try, bucket, cup, mould (wood), crushing machine.

Properties of material

3.1.2 Termite hill soil

Termite hill soil was collected from Gurara, Minna-Bida road; they were filled in 50kg bags and transported to the school.

3.1.3 Rice Husk

Rice husk was collected from rice mill in Chanchaga, along Minna paiko road.

3.1.4 Water

The water used during the Experiment was collected from the tap in Civil Engineering laboratory of Bosso campus.

3.2 Natural Moisture Content

The natural moisture content of a soil sample is the amount of water contain in aknow mass of the soil at its natural state expressed as a percentage of the soil dry unit weight. It is necessary to determine the natural moisture content as this will help determine the amount to be added to the soil during mixing.

3.3 Methods

3.3.1 Production of Test cubes

The production of test cubes involves four different stages they are as follows:

i Batching

material were batched by weight, measurement were done manually using measuring pan and weighing balance, the weight of the empty pan was noted before weighing of samples.

ii Mixing

Mixing was done manually on a wide tray, the termite mould clay was poured on the tray, the rice husk was added to it and also water, they were then thoroughly mixed together.

iii Placing, Compaction and Molding

The mould was cleared with water (to allow for easy removal). Moulds made with wood were used, the freshly mixed termite mound clay was scoped into the mould; ie wooden mould of 150mm×150mm, length, breathe, and height respectively were used. After placing the termite mound clay, then compaction follows. Compaction is the process of driving out air bubble from the freshly termite mound clay. This process is achieved by hitting the side of the mould so as to dislodged the air and forces the clay into a closer configuration. . the was then struck off with the trowel to level it up with the top of the top of the mould and the surface was also smoothened with hand trowel.

iv Curing

The cubes were casted outside on a ply wood with a polyethen sheet on the ply wood for easy removal, the cubes were demolded immediately, the cubes were open dry, but were covered at evenings and opened in the mornings. Three (3) cubes were crushed for, 7 day, 14 day, 21 day and 28 day after noting their weight and date of crushing.

Compressive Strength Test

3.4 Compressive Strength Test

The compressive strength test was carried out using the hydraulic-press machine with a capacity of 200KN and electrically powered. The hydraulic- press machine has a lower and upper plates, the lower is stationary while the upper plate is moveable in order to compress the cube placed in between them.

The cube was centrally positioned to received maximum load before failure will occur, when the knob was turned from unload to load, the upper plate started moving down gradually towards the cube and once it was compress the terminal started recording the load sustain by the cube and cracking began. Immediately failure is reached the knob is turned to the unload position and the upper plate moves up to met original position, reading was noted from the screen.

``CHAPTER FOUR

4.0 RESULT AND DISCUSSION

The performance characteristics of termite mound clay stabilized bricks are in relation to conventional requirement with a view to determine their strength compliance and suitability

Table 4.1.The natural moisture content result

Can No	F1	B5
Wt of can (g)	9.8	24.0
Wt of can + wet soil (g)	29.6	56.0
Wet of can + dry soil (g)	27.0	53.0

Table 4.2 Compressive strength at 7 day

Termite Mound clay+ rice husk	Date of Casting	Date of Testing	Test Day (Age)	Normal Size (mm)	Average Weight (Kg)	Average Crushing Load (KN)	Average Comp Strength MN/mm^2
50:50	4-9-08	11-9-08	7	150	5.15	1.10	0.0489
50:50	"	"	"	150	5.20	1.50	0.0667
50:50	"	"	"	150	5.19	1.30	0.0578
60:40	4-9-08	11-9-08	7	150	5.30	3.00	0.1333
60:40	"	"	"	150	5.28	2.90	0.1289
60:40	"	"	"	150	5.35	3.20	0.1422
70:30	5-9-08	12-9-08	7	150	5.40	12.00	0.5333
70:30	"	"	"	150	5.43	12.20	0.5422
70:30	"	"	"	150	5.48	12.80	0.5556
80:20	5-9-08	12-9-08	7	150	5.60	16.50	0.7333
80:20	"	"	"	150	5.54	16.90	0.7511
80.20	"	"	"	150	5.50	16.20	0.7200
100	5-9-08	12-9-08	7	150	5.83	18.00	0.800
100	"	"	"	150	5.93	18.51	0.8223
100	"	"	"	150	5.95	18.60	0.8266

Table 4.3 Compressive strength at 14 day

Termite Mound clay + rice husk	Date of Casting	Date of Testing	Test Day (Age)	Normal Size (mm)	Average Weight (Kg)	Average Crushing Load (KN)	Average Comp Strength MN/mm²
50:50	4-9-08	18-9-08	14	150	4.72	10.00	0.4444
50:50	"	"	"	150	4.68	9.50	0.4222
50:50	"	"	"	150	4.70	9.80	0.4356
60:40	4-9-08	18-9-08	14	150	4.90	8.20	0.2178
60:40	"	"	"	150	4.95	8.50	0.3778
60:40	"	"	"	150	5.00	8.90	0.3956
70:30	5-9-08	19-9-08	14	150	5.30	13.20	0.5867
70:30	"	"	"	150	5.40	13.50	0.6000
70:30	"	"	"	150	5.46	13.90	0.6178
80:20	5-9-08	19-9-08	14	150	5.43	18.00	0.8000
80:20	"	"	"	150	5.44	17.90	0.7956
80:20	"	"	"	150	5.48	17.50	0.7778
100	5-9-08	19-9-08	14	150	5.30	19.00	0.8445
100	"	"	"	150	5.00	18.90	0.8400
100	"	"	"	150	4.90	18.30	0.8133

Table 4.4 Compressive strength at 21 day

Termite Mound clay + rice husk	Date of Casting	Date of Testing	Test Day (Age)	Normal Size (mm)	Average Weight (Kg)	Average Crushing Load (KN)	Average Comp Strength MN/mm^2
50:50	4-9-08	25-9-08	21	150	4.00	9.80	0.4356
50:50	,,	,,	21	150	4.50	10.20	0.4533
50:50	,,	,,	21	150	4.55	10.40	0.4622
60:40	4-9-08	25-9-08	21	150	4.80	9.10	0.4044
60:40	,,	,,	21	150	4.70	8.98	0.3956
60:40	,,	,,	21	150	4.50	8.30	0.3689
70:30	5-9-08	26-9-08	21	150	5.29	14.60	0.6622
70:30	,,	,,	21	150	5.25	14.50	0.6445
70:30	,,	,,	21	150	5.32	15.00	0.6667
80:20	5-9-08	26-9-08	21	150	5.00	18.50	0.8222
80:20	,,	,,	21	150	5.20	19.50	0.8667
80:20	,,	,,	21	150	5.19	19.20	0.8533
100	5-8-08	26-9-08	21	150	5.50	19.30	0.8578
100	,,	,,	21	150	5.52	19.40	0.8622
100	,,	,,	21	150	5.60	20.00	0.8888

Table 4.5 Compressive strength at 28 day

Termite Mound clay + rice husk	Date of Casting	Date of Testing	Test Day (Age)	Normal Size (mm)	Average Weight (Kg)	Average Crushing Load (KN)	Average Comp Strength MN/mm^2
50:50	4-9-08	2-10-08	28	150	4.00	11.10	0.4933
50:50	,,	,,	28	150	3.90	10.8	0.4800
50:50	,,	,,	28	150	3.80	10.50	0.4667
60:40	4-9-08	2-10-08	28	150	4.30	10.50	0.4667
60:40	,,	,,	28	150	4.28	9.80	0.4356
60:40	,,	,,	28	150	4.10	9.30	0.4133
70:30	5-9-08	3-10-08	28	150	5.10	16.20	0.7200
70:30	,,	,,	28	150	5.00	16.00	0.711
70:30	,,	,,	28	150	4.90	15.80	0.7022
80:20	5-9-08	3-10-08	28	150	4.80	20.80	0.9244
80:20	,,	,,	28	150	4.80	21.10	0.9378
80:20	,,	,,	28	150	4.55	20.50	0.9111
100	5-8-08	3-10-08	28	150	5.30	22.00	0.9728
100	,,	,,	28	150	5.30	22.20	0.9868
100	,,	,,	28	150	5.42	25.00	1.1111

Table 4.6 Result of compressive strength test

Termite mound clay + Rice husk Ratio	7 day (MN/mm^2)	14 day (MN/mm^2	21day (MN/mm^2	28 day (MN/mm^2
100	0.8163	0.8326	0.8696	1.0235
50:50	0.0578	0.4341	0.4504	0.4800
60:40	0.1348	0.3304	0.3896	0.4386
70:30	0.6681	0.6015	0.6578	0.7111
80:20	0.7348	0.7911	0.8474	0.9244

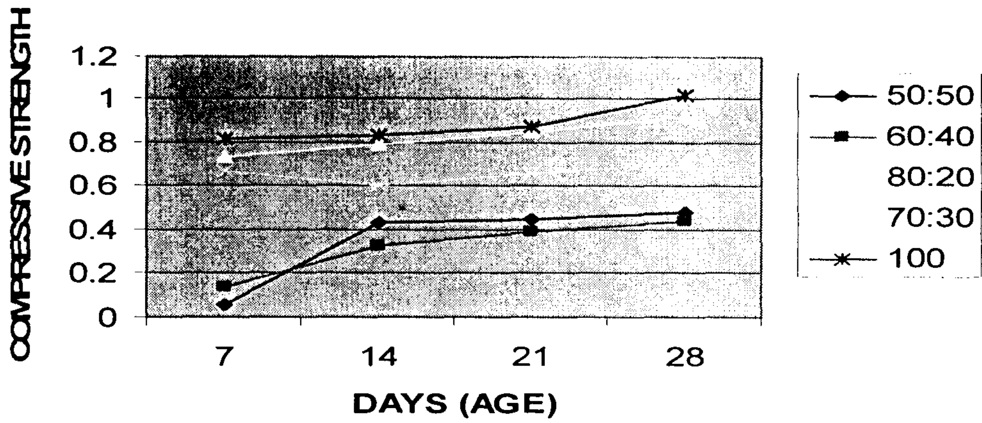

Fig 4.1 Graph of Compressive Strength Against Age.

4.1 Discussion of Result

The strength of brick is very important when it comes to structure or building, therefore in view of this, the research study was carried out to see that this important property (strength) is enhanced in termite mound clay +rice husk.

Looking at table 4.2 the result obtained after crushing for 7 days shows that the mix ratio of 50:50 has the least value of compressive strength, while the mix ratio of 80:20 has the highest value of compressive strength, looking at table 4.3 the result obtained after crushing for 14 days shows that the mix ratio of 60:40 with the least value of compressive strength while the mix ratio of 80:20 has the highest compressive strength. Table 4.4 the result obtained followed the same pattern with table 4.3. However looking at the compressive strength after crushing at the 28 day the result obtained indicate that the mix ratio of 50:50 and 60:40 were very close also the mix ratio of 80:20 and 100% were equally close, while the of the mix ratio of 70:30 was entirely different.

From fig 4.1 the graph shows that the 50:50 and 60:40 mix ratio followed a similar pattern, equally the 80:20 mix ratio and the 100% termite mound clay followed tha same or similar pattern the graph of 70:30 mix ratio followed a different path. Termitr hill seem to be promising as a suitable, locally available housing material for farm structure.

CHAPTER FIVE

5.0 CONCLUSION AND RECONMENDATION

5.1 Conclusion

The result obtained from the compressive strength test at all proportion of mixing shows that the compressive strength of the cubes increases with age and decreases with increase in percentage of rice husk.

5.2 Reconmendation

1. The result and finding should be send to research institute so that they can carry out the same experiment and than compare the result and finding so as to arrive at a logical conclusion.

2 A comparative evaluation of the brick performance with those of other materials of locally made bricks should also be undertaken.

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APPENDIX

Average Crushing Load (KN)

Average weigth (Kg)

Normal size (mm)

Average Compressive Strength $MN/mm^2 = KN \times 1000/mm^2$