ASSESSMENT OF THE PERFORMANCE OF TERMITE-MOUND POWDER (TMP) AS PARTIAL REPLACEMENT FOR CEMENT IN THE PRODUCTION OF LATERITIC BLOCKS

[1]*Aderibigbe, Yinka Wasiu* & [2]*Ataguba, Oguche Clement*
[1]Department of Building Technology, Federal Polytechnic Idah, Kogi State, Nigeria
[2]Department of Civil Engineering, Federal Polytechnic Idah, Kogi State, Nigeria

ABSTRACT

The world is facing the dilemma of housing shortages, as a result of its ever increasing population. Sustainability in construction industry will remain elusive without due consideration to the use of construction materials obtainable locally. For this reason, the use of alternative technologies in building construction is receiving attention. This investigation was conducted to explore the possibility of partial replacement of cement with Termite Mound Powder (TMP) in stabilizing lateritic soil bricks. Compressive strength test, optimum percentage replacement level of cement with TMP and water absorption test on lateritic soil-cement/TMP brick was conducted. Brick samples were produced at replacement levels of 0%, 10%, 20%, 30% and 40% of cement with TMP. The 0%, replacement,served as the control.All the brick samples were cured and tested at 7, 14, 21, and 28 days for compressive strength. The result revealed that the compressive strength achieved at the lowest percentage of 10% was 2.20N/mm^2 which is greater than the required minimum standard of 1.75N/mm^2 specified in Nigeria Industrial Standard (NIS). Coefficient of absorption of TMP brick generally increased with increase in the amount of replacement level. Bricks made at 10% replacement level with 10% rate of absorption in the mixes appeared to achieve the better performance, an indication of optimum compaction level. The idea and techniques of termite-mound lateritic bricks should be adopted since it can reduce total dependence on the usage of Portland cement in the production of stabilized lateritic soil bricks.

Keywords: *Termite mound, Replacement, Cement, Compressive strength, abrasion.*

1.0 INTRODUCTION

It is well known that the growth in the world's population is physically taxing the world of its renewable and non-renewable resources with associated environmental impacts. The UN Habitat (2008) reports that 5 million houses are needed annually to curb the current global housing backlog by 2050. The world is thus facing the dilemma of housing its ever growing population whilst preserving the environment for the needs of the future generation. Conventional construction methods use conventional construction materials such as; concrete, aluminium, steel and timber which have high energy impacts for the production of these materials and environmental impacts, generated in the construction process, including raw material use, waste generation, energy consumption and its associated air emissions.(Okeet al 2015)

In line with sustainable development and the urgent need to provide shelter for the world's growing population, there is need for alternative environmental-friendly building material technologies in construction that is capable of reducing demands on expensive conventional building material such as cement.

Cement is one of the most popular conventional material for most construction works, thus, any change in its price portends significant effect on the total cost of construction. In order to reduce over dependence on conventional building materials, especially cement and also addressing the problem of 7% CO_2 emission of atmosphere (Rashid et al. 2010), researches have been intensified on alternative materials that can be used to replace cement partially or wholly for construction purposes (Dashan and Kamang, 1991). The prominent material of construction in many African countries is the laterite, and often contain some reasonable amount of clay minerals that can affect it strength and stability, hence the need for its improvement.

The use of laterite bricks (soil-cement bricks) for housing purposes has been very popular, especially in the rural areas as well as in some urban centers (Abejide and Abubakar 2002). Consequently, research efforts are now being focused on lateritic soil cement bricks in order to improve its qualities for various construction purposes. Additive such as cement, lime, bitumen and pozzolans have been suitably tested for this purpose and encouraging results were obtained. Several other materials have also been identified to possess potentials of been used to improve the lateritic bricks. Prominent among such materials are rice husk ash, timber saw dust and termite mound powder.

According to Mijinyewa et al (2007), termites are obtained from termite mound, while mound is a file of earth made by termite, resembling a small hill. It is made of clay whose plasticity has further been improved by the secretion from the termite while being used in building the mound,it is therefore a better material than the ordinary clay in terms of utilization for moulding lateritic bricks and this type of clay perform better than ordinary clay in dam construction (Yohanna et al 2003). Mijinyewa et al (2007) asserted that clay from the termite mound is capable of maintaining a permanent shape after moulding because of its plasticity; and are less prone to crack when compared with ordinary clay.

The research work is aimed at exploring the possibilities of substituting some quantity of cement with termite-mound in powdered form in the production of lateritic soil-cement brick, with view to obtaining strong and durable building material at relatively cheaper price while the objective of this research work can be stated as:

i. To determine the effect of percentage replacement of laterite with termite-mound powder on the compressive strength at lateritic soil-cement bricks.
ii. To assess the water absorption of termite-mound powder laterite mould bricks.
iii. To determine the abrasion properties of termite mound powder lateritic mould bricks.

Using termite mound powder as partial replacement of cement in the production of lateritic soil-cement bricks in construction would help in reducing the demand on the sources of primary materials.

2.0 METHOD AND MATERIALS

This research work involved laboratory experiment work meant to determine the effect of percentage replacement of cement with termite mound powder on the compressive strength, water absorption and abrasion characteristics of bricks. 190 x 90 x 90mm bricks were made with varying percentages replacement of cement with ground termite mound powder at 0%, 10%, 20%, 30% and 40% level within various curing period of 7, 14, 21, and 28 days. 1:16 mix was used in producing the TMP laterite bricks. The mix of the samples was done manually and was cured. Curing was by sprinkling of water on the mould sample on daily basis.

2.1 Materials:

The materials used for this research work includes: Termite-mound powder, Ordinary Portland Cement (OPC), fine aggregate (sand) and water. The soil (laterite) used for the research was obtained from River Niger mining site at Idah. The cement used was Dangote Portland Cement obtained from the open market and conform to the requirement of BS 12 (1991) on Ordinary Portland Cement. The termite mound sample was ground to powder.

2.2 Laboratory Analyses of Samples

Laboratory analyses of the various samples were carried out to ensure that the selected samples used for the research work comply with established standards. The tests conducted includes; Particle Size distribution test (Sieve Analysis)conducted to assess particle sizes of the aggregate (laterite) in accordance with BS 1377 (2016), Compressive Strength Test and rate of moisture absorption test in accordance with BS EN Eurocode 2 (2014) and NIS 87 (2004).

The brick specimens used were made in the size 190 x 90 x 90mm. The manual method of mixing was adopted for mixing of the constituents of the bricks. The mix ratio used was 1:16 cement - laterite. The required quantity of cement/termite mound was measured and with thelaterite soil. The quantity was measured and added as required (percentage replacement) and water was added to the soil. The mixture was thoroughly mixed until uniform colour was obtained. Water was carefully measured and poured into the mixture in stages for adequate mixing. The mixture was then shoveled into the mould.

4.0 RESULTS AND DISCUSSION

4.1 Sieve Analysis

The percentage passing (finer) and the cumulative percentage of Soil retained were calculated using the expression below:

$$Percentage\ laterite\ retained\ on\ any\ sieve = \frac{weight\ of\ soil\ retained\ (g)}{Total\ soil\ weight\ (g)} \times 100$$

$$Percentage\ passing\ any\ sieve = 100 - Cummulative\ percentage\ of\ soil\ retained$$

The results of the sieve analysis are presented as shown Fig.1.

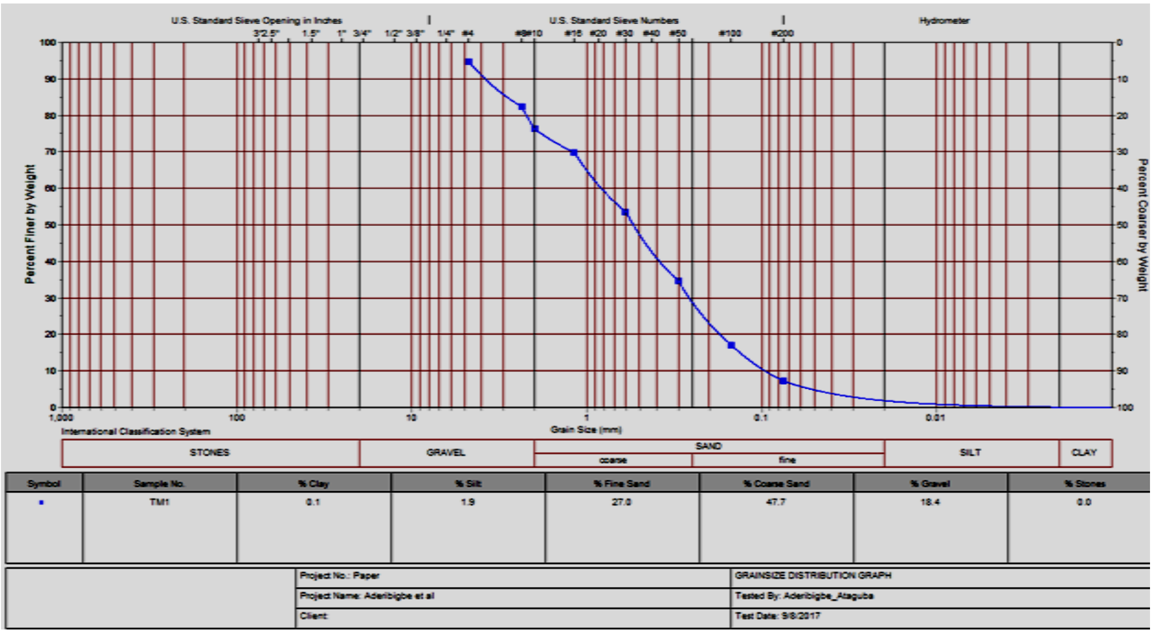

Fig. 1: Particle Size Distribution Test Result Graph

The result of particle size distribution carried out on the laterite was in accordance with BS: 812:1990 as presented in Fig.1. The result shows that about 75% of the laterite particle falls within the sandy region. The laterite can be classified as coarse sand. Thus the laterite possesses a balanced particle distribution which meets design requirements.

4.2 Compressive Strength Test

The compressive strength test was carried out on three replicates for each of the percentage replacement; Corresponding to the curing period of 7, 14, 21 and 28 days. The formula used for the determination of the compressive strength in N/mm^2 is

$$Compressive\ Strength = \frac{Failure\ load}{Area}$$

The result of the compressive strength obtained within the curing period of 7, 14, 21 and 28 day for all the percentage replacement is presented in Fig. 2. The areas where determined from the relation:

$$Area = \frac{Volume\ of\ brick}{Height\ of\ brick} = \frac{153900\ mm^3}{90\ mm}$$

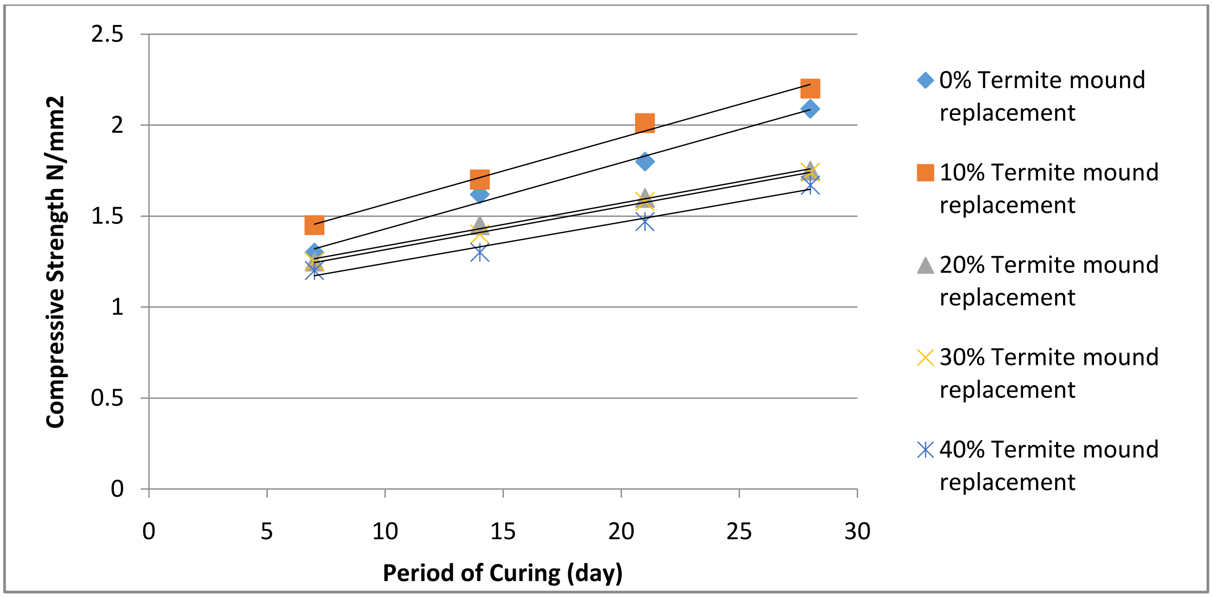

Fig. 2 Compressive strength of TMP stabilized bricks.

The compressive strength of the bricks increases as the curing periods increases, but decreases as the percentage replacement of TMP increases. The optimal percentage replacement level was 10% where it tested to 2.2 N/mm² at 28days, which is greater than the required minimum standard of 1.75N/mm^2 specified in Nigeria Industrial Standard (NIS).

4.3 Water absorption:

The water absorption test graph illustrated in Fig. 2 reveals that the water absorption of TMP brick generally increased with increase in the amount of replacement level. Bricks made at 10% replacement level with 10% rate of absorption in the mixes appeared to achieve the better performance, an indication of optimum compaction level

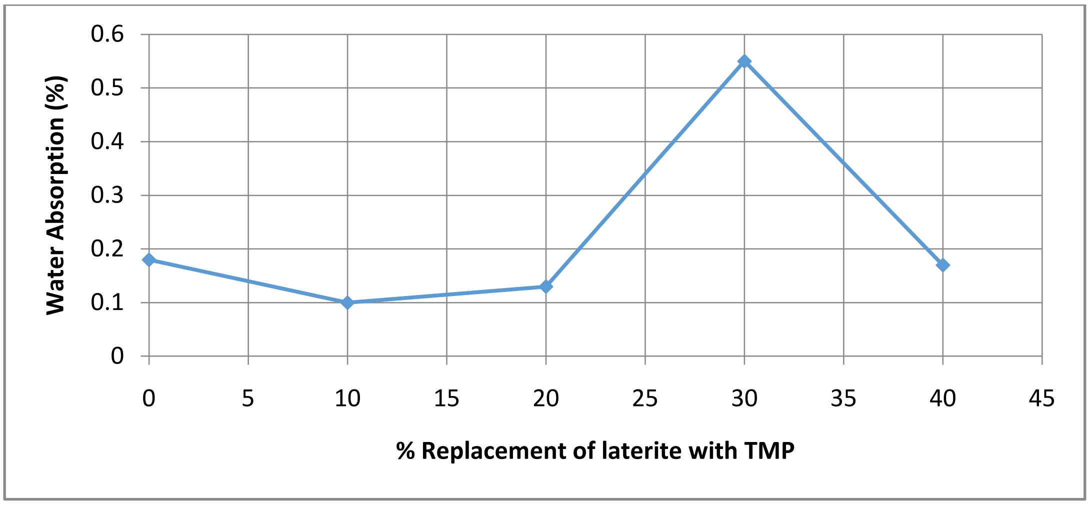

Figure 3 Water Absorption of TMP stabilized bricks

4.4 Abrasion

The result of abrasion test shown in Fig. 4 indicates that weight has a bearing on the percentage replacement; that is as the percentage replacement of TMP increases, abrasion increases at the initial stage. Termite mound powder stabilized brick become more prone to abrasion beyond 10% replacement level. This implies that the surfaces of bricks with high replacement is prone to deterioriation unless it is protected by plastering with cement mortar.

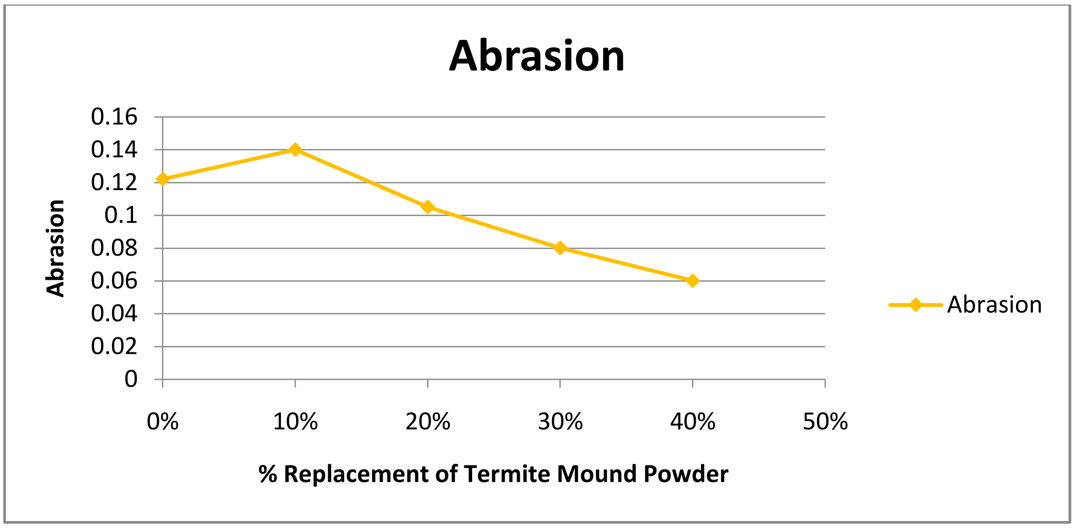

Fig. 4: Result of Abrasion Test

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the research findings it can be concluded that termite mound powder (TMP) can be used as partial replacement of cement in stabilization of lateritic soils for the production of lateritic soil-cement bricks.

The following inferences were drawn:

1. Compressive strength of the bricks increases as the curing periods increases, but decreases as the percentage replacement of TMP increases.
2. The optimal percentage replacement level was 10% where tested to 2.2 N/mm² at 28days which is greater than the required minimum standard of 1.75N/mm^2 specified in Nigeria Industrial Standard (NIS).
3. The compressive strength of the bricks increases as the curing periods increases.
4. Coefficient of absorption of TMP brick generally increased with increase in the amount of replacement level. Bricks made at 10% replacement level with 10% rate of absorption in the mixes appeared to achieve the better performance, an indication of optimum compaction level
5. The minimum value of water absorption was obtained at 10% replacement.
6. The weight has a bearing on the percentage replacement i.e.; as the percentage replacement of TMP increases, abrasion increases at the initial stage.
7. Termite mound powder stabilized brick become more prone to abrasion beyond 10% replacement level. This implies that the surfaces of bricks with high replacement are prone to deterioration unless it is protected by plastering with cement mortar.

5.2 Recommendations

The following recommendations have been put forward from the research work:

1. The idea and techniques of termite mound lateritic bricks should be adopted since it can reduce total dependence on the usage of Portland cement in the production of stabilized lateritic soil bricks.
2. For partial replacement of termite mound with laterite and cement in moulding bricks, manual compaction should be used to give desired and predetermined number blows, so as to obtain higher compressive strength.
3. It is worthy to say at this point that this research work is open to further study basically in the areas of study of durability of TMP as partial replacement of cement in bricks and the chemical properties of TMP when used for lateritic bricks:

REFERENCES

Abejide O.S and AbubakarI. (2002) Soil Blocks Admixed with Bitumen and OPC for Building Construction. Proceeding of Millennium Conference 'Building in the 21st Century' Department of Building, AhmaduBelloUniversity, Zaria: 84-94.

Aluko, O.G, Oke, O.L. andAwolusi, T.F (2015) A study on the short term compressive strength of the compressed stabilized earth block with waste glass powder as partial replacement for cement.*International Journal of Scientific &Technology Research*Volume 4, Issue 12,

BS 12 (1996)Specification for Portland cement British Standard Institute **(BSI)** London.

BS 812 (1990) *Testing aggregates. Methods for determination of aggregate crushing value (ACV)*British Standard Institute (BSI) London.

BS 1377 (2016) *Methods of test for soils for civil engineering purposes. General requirements and sample preparation.*British Standard Institute (BSI) London.

BS EN A1 (2014) *Design of concrete structures. General rules and rules for buildings.*Eurocode 2.British Standard Institute (BSI) London.

Dashan I.I. and Kamang E.E. (1999) *Characteristics of AHA/OPC Concrete: A preliminary Assessment.* Nigerian Journal of Construction Technology Sciences, University of Jos, Nigeria. 2: 1: 22-29.

Mijinyewa, Y., Lucas, E.B. and Adegunioye, F.O. (2007) Termite Mound Clay as Material for Grain Silo Construction.*Agricultural Engineering International*: The CIGRE Journal ManuscriptBC 07 002. Vol. IX.

NIS 87 (2004). Nigerian Industrial Standard for sandcrete blocks. Nigerian Industrial Standard approved by The Standards Organization of Nigeria (SON)

Rashid M.D.A., Molla B.K.A. and Ahmed C.T.U. (2010) *Long term effect of rice husk ash on strength of mortar.*World Academy of Science, Engineering and Technology, 67.

UN Habitat (2008), *Global Housing Demand at Critical Levels,* web article, Accessed Online 2017/07/20. www.unhabitat.org/contents.asp?cid=5809&catid=576&typed=6&sub Mended=0

Yohanna J.K., Fulani U., Azagaku E.D. and Anda A.D. (2003) *Prospect of using anthill Materials in earth dam*. Proceedings of the Nigerian Institution of Agricultural Engineering Vol. 25: 135-142