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Performance Characteristics Of Stabilized Clay Bricks Using Additives

O.S. Oladeji and A. F. Akinrinde
Department of Civil Engineering, Ladoke Akintola University of Technology, Ogbomoso Nigeria.

Abstract
The importance of shelter to human survival cannot be over-emphasized. In Nigeria, affordable housing policy has been a priority for successive governments though factors such as finance, legal restrictions and traditions have plagued the efforts with little success. In this work, performance characteristics of the effects of two chemical additives namely KS770 and soda ash on the properties of clay bricks were investigated. The methodology adopted includes field survey, soil sampling and laboratory tests. The results showed that the KS770 appears to increase the moisture content of clay thereby preventing early setting and hardening. Conversely, soda ash additive appears to increase the workability, and produces brick blocks with relatively higher compressive strength and lower corresponding density compared with the bricks without additive as well as those with the KS770 additive. The additive water ratio for achieving enhanced brick workability with soda ash is 1:27. Based on this work, it is recommended that encouraging the use of soda ash in the production of bricks, sensitization on the techniques of brick production as it relates to the use of fired bricks, as well as mass production of the soda ash additive will lessen the cost burden of construction and consequently increases sustainability in the housing industry in Nigeria.

I. Introduction

Shelter is one of the most basic of human needs. Unlike most African countries where socio-economic considerations, history and tradition have placed the responsibilities of construction of new houses on the citizenry, the governments of most developed countries have dedicated a large proportion of their budget to provision of housing in consonance to their population growth. In Nigeria, affordable housing policy has been a priority for successive governments, but with little evidence of success. Factors such as finance, legal restrictions and torturous land registration system, coupled with lack of continuity from various successive governments as well as the Land Use regulations, contributed to the abysmal under-performance of the housing sector in Nigeria. Akeju (2007) partially attributed the unsustainability in the national housing industry to the traditional belief that the government alone has the overall responsibility of providing houses, and argued that involvement of private developers and individual efforts, complimented by social housing system will mitigate against the national housing problems.

In Nigeria, Ordinary Portland cement is recognized as a major construction material and over dependence in its utilization has caused this commodity to become very expensive and unaffordable to the generality of the citizenry. A massive deficit of 14 – 16 million housing units exist in Nigeria (Policygnosis International, 2011). Therefore, finding locally available and suitable alternative building material is required to ensure sustainability in the housing industry, and this has been a focus for many researchers in many parts of the world (John *et. al*., 2005; Bignozzia, 2011; Akadiri *et. al.*, 2013)

The techniques of firing clay to produce bricks and tiles for building construction is more than 5000 years old (Yang *et. al.*, 2013) and their utilization are preferable especially in areas of harsh environment due to its resistance to cold and moist weather conditions (Osinubi *et al.*, 2007). In the United States, the compressive strength of bricks produced ranges between 7 and 105 N/mm² depending on the usage of the bricks. Modification of compressive strength of bricks produced from locally available lateritic soils, through additives in order to enhance their utilization in Nigerian construction industry is also desirable. Hence, the aim of this study is to investigate strength performance characteristics of clay bricks produced from locally available lateritic soils and admixture of chemical additives namely KS-770 and Soda Ash Liquid. KS-770 is chloride free water reducing and plasticizing brownish liquid designed as an aid in production of high quality sandcrete blocks because of its possessed capability to increase workability, eliminates vibration and aid its compaction. Furthermore, it improves water / cement ratio in sandcrete blocks, enhances early strength and thereby reduces breakages and waste. Also, Soda ash (sodium carbonate - Na_2CO_3) otherwise locally called 'Eyin aro' by Yoruba speaking part of Nigeria is a versatile product that can be produced inexpensively and occurs locally in crystallized form.

II. Materials and methods

The methodology adopted in this work includes field survey, soil sampling and laboratory tests. Soil sample was collected from the borrow pit at Moniya, Ibadan, Oyo state (Figure 1), with the aid of pick axes and shovel, due to availability and proximity to the soil laboratory where the tests were carried out. The clay soil materials were prepared and visible pebbles were removed to prevent cracking of the finished bricks. Manual finger crushing was carried out to dislodge lumped soil materials. The prepared clay materials were made to pass through the British Standard Number 24 sieve size in order to allow substantial amount of coarse material to be included in the soil material. The field tests carried out include sight, smell, touch, balls making, ribbons and threads, and sedimentation in a glass jar.

The laboratory tests carried out include sieve analysis, atterberg limits, compaction, slump, compressive strength and density tests. All the tests were carried out according to BS1377 (1990) specifications. The first additive used was KS-770, usually packaged in 5, 20, 25 and 50 liters plastic jars. The second additive used was Soda ash liquid, which was obtained as a by-product of the locally made black soap. Slump tests were carried out on the prepared clay samples using varying proportions of water to determine the optimum amount of water sufficient for brick production. Slump tests were subsequently repeated in duplicates using varying mixture of water and the additives.

Thereafter, clay bricks with and without additives were molded in duplicates and allowed to dry completely in the open air for seven days and each of the duplicate was subsequently taken to oven for firing at approximately 105°C for 24 hours, and then taken to the laboratory for compressive strength and density tests. The size of the bricks for the purpose of the tests used in this work was 200 x 225 x75 mm.

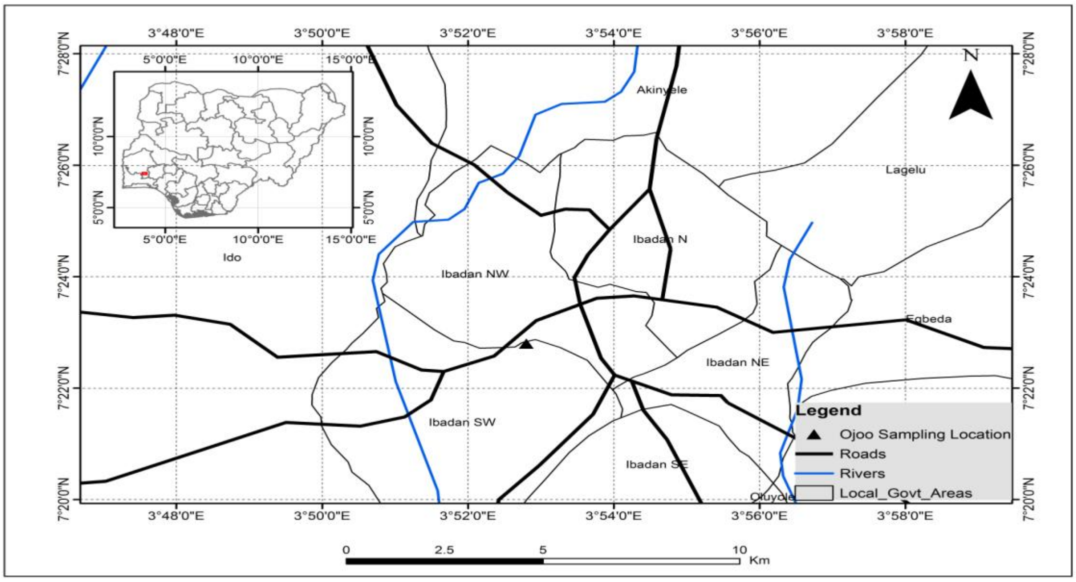

Figure 1: Location of clay sample collection

III. Results and discussion

The properties of the clay soil sample used in this work are presented in Figure 2, and the soil grading curve is presented in Figure 3. The field observations showed that the soil sample was consistently reddish in colour, lateritic in nature with substantial quantities of coarse materials. As a rough guideline, the minimum clay contents required for the production of bricks is assumed to be between 40% and 60 %, though experience and expert advice are required to determine the optimum clay content because high percentage can potentially lead to shrinkage and cracking. The grading curve (Figure 2) indicated that the soil sample used in this work met the required guideline where the percentage finer than clay particle size approximately amounts to 40 %. This clay content is considered essential because excessive proportions of clay without some coarse material can cause high shrinkage and cracking, which is unsuitable for producing durable bricks.

The results of the control slump tests (NA_1 and NA_2) which give a true slump of 10 mm, as well as that of the slump tests for KS 770 and Soda ash are shown in Figure 4. The slump test for bricks generally requires relatively smaller quantity of water compared to concrete mix, and provides approximate water volume for achieving good and workable bricks. None of the tests employing KS770 had true slump as there is excess moisture observed after each mixing. Conversely, slump tests employing soda ash showed a true slump with an additive-water ratio of 0.18:4.38 liters, and this ratio was used in the subsequent experiments.

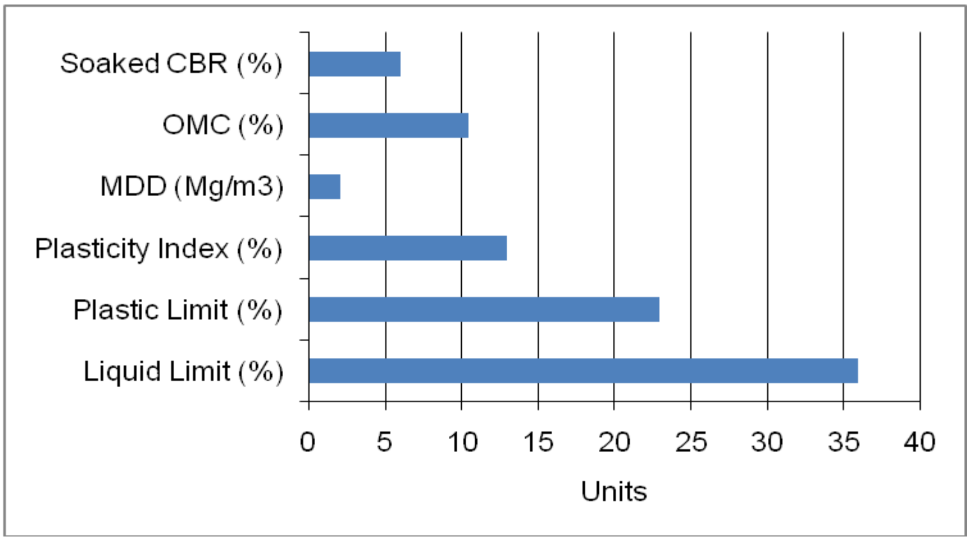

Figure 2: Some physical properties of the soil sample

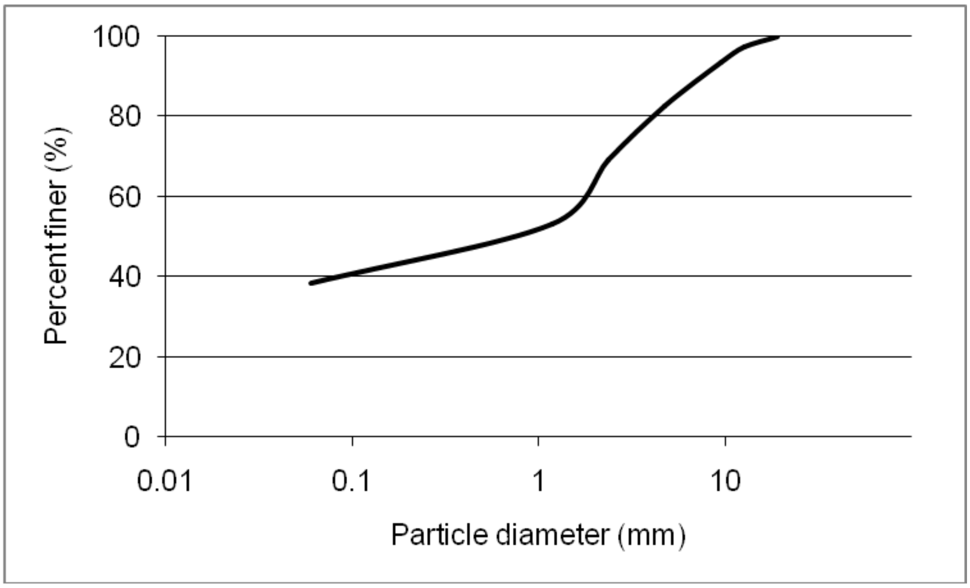

Figure 3: Grading curve for the soil sample

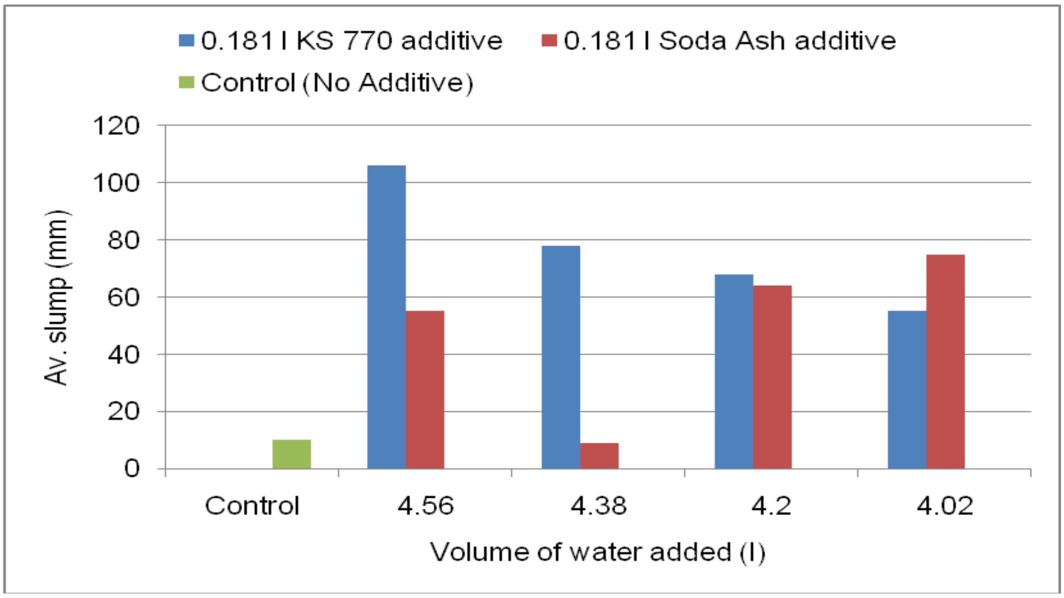

Figure 4: Slump tests

The results of the variation in the density as well as the compressive strength of the brick samples due to the gradual increase in the volume of water used in the production of both the fired and unfired bricks are shown in Figure 5. It could be deduced from Figure 5 that the density of the unfired sample is generally higher than the corresponding fired samples, and both density values, as well as the compressive strength for the unfired brick sample decrease with increasing volume of water. Conversely, the compressive strength of the fired clay brick sample increases proportionally to the increase in the volume of water used, with the increase more apparent with the use of soda ash compared to KS 770 additive.

The highest compressive strength of 2.33 N/mm^2 was obtained for the fired brick sample with 4.92 litres of water and 0.18 liters of soda ash additive. The corresponding density is 0.95 g/cm^3, and the additive water ratio for achieving this enhanced brick workability is approximately 1:27. The relationship between the density and the compressive strength for both the fired and unfired brick samples is presented in Figure 6. The density of the unfired bricks was observed to be relatively higher, and with reduced compressive strength, and this may adversely affect its usage for construction. Conversely, the density of the fired sample was found to be lesser, and with accompanied greater compressive strength.

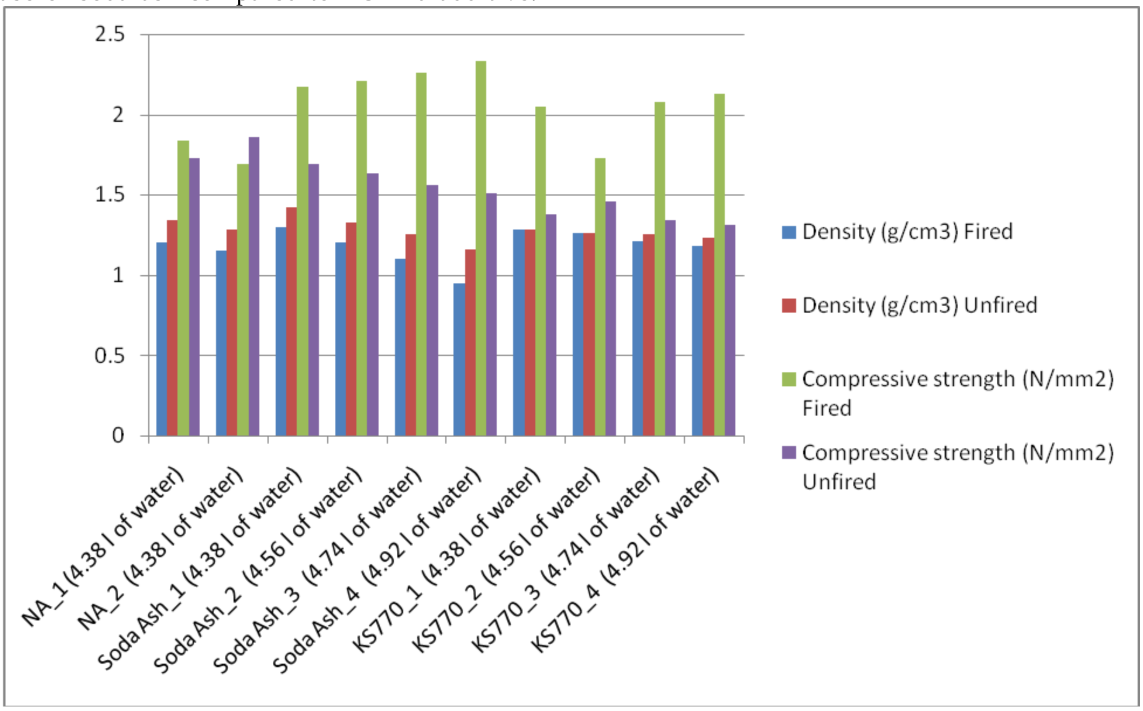

Figure 5: Effects of water content on the density and compressive strength of bricks

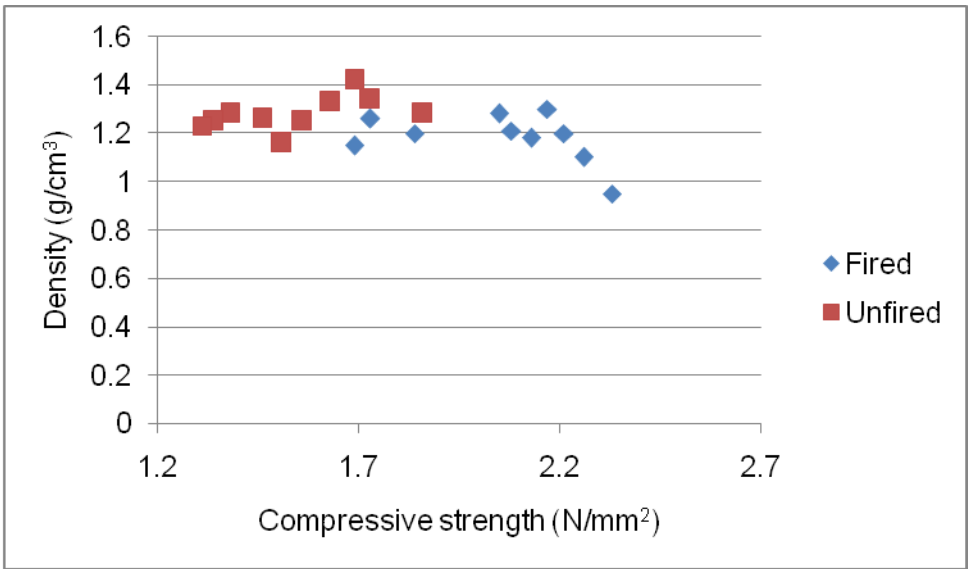

Figure 6: Relationship between the density and the compressive strength

IV. Conclusions

In this work, investigations on the performance characteristics of the effects of chemical additives on the properties of clay bricks were carried out. It was observed that the two chemical additives namely KS770 and Soda Ash investigated do not alter the aesthetic view of the resultant brick products. The KS770 appears to increase the moisture content of clay thereby preventing early setting and hardening. Conversely, soda ash additive appears to increase the workability, and produces brick blocks with relatively higher compressive strength and lower corresponding density especially when its fired, compared with the bricks without additive as well as those with the KS770 additive. The additive water ratio for achieving optimum enhanced brick workability is 1:27. In view of the above, it is hoped that encouraging the use of soda ash in the production of bricks, sensitization on the techniques of brick production as it relates to the use of fired bricks, as well as mass production of the soda ash additive will indirectly lessen the cost burden of construction and consequently increases sustainability in the housing industry in Nigeria.

References

[1] Akadiri, P.O., Olomolaiye, P.O., and Chinyio, E.A., 2013. Multi-criteria evaluation model for the selection of sustainable materials for building projects . Automation in Construction 30; 113–125

[2] Akeju, A.A., 2007. Challenges to Providing Affordable Housing in Nigeria. Paper presented at the 2nd Emerging Urban Africa International Conference on Housing Finance in Nigeria, Abuja

[3] Bignozzia, M.C., 2011. Sustainable cements for green buildings construction. Procedia Engineering 21; 915 – 921.

[4] BS 1377, 1990. Methods of test for Soils for Civil Engineering Purposes. British Standards Institutions. 2 Park Street, London. W1A 2BS.

[5] John, G., Clements-Croome, D., Jeronimidis, G., 2005. Sustainable building solutions: a review of lessons from the natural world. Building and Environment 40; 319–328.

[6] Osinubi, K. J., Eberemu, A.O. and aliu, O.S.. 2007. Stabilization of laterite with cement and bagasse ash admixture. Proc. of the first Inter. Conf. on Environ. Res., echn. And Policy. “ERTEP 2007” under the auspices of International Society of Environmental Geotechnology, Accra, Ghana, 16 – 19 July, Category B: Mining and Environment.

[7] Policygnosis International, 2011. A feasibility study on the establishment of a secondary mortgage institution in Nigeria. Final Report submitted to The Company for Habitat and Housing in Africa. 322 Secretariat Way, Glenwood, MD 21738, USA. 76p

[8] Yang, Y., Yu, S.Y., Zhu, Y. and Shao, J., 2013. The Making of Fired Clay Bricks in China Some 5000 Years Ago. Archaeometry. doi: 10.1111/arcm.12014