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Assessment of Some Clay South West and Aluminmium Dross as Roofing Tile Materials.

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Abstract- Clay has been widely used as a raw material in construction and in the building sector from the ancient period till date. It is a sustainable material and the technology of processing it can be found anywhere in the world. As a result of its sustainability, it can be used in many industries. One of the products derived from clay is roofing tiles. Some of the properties to be considered are thermal and durability of the materials, are necessarily to be taken into consideration, especially if the building needs to be situated in tropical region. Clay seems to be a good choice. This paper will therefore, assess the possibility of using clay from south west and aluminum dross as composite roofing tiles. Clay samples were collected from five (5) deposits in Igboora (Oyo), Ilaro, Itori, Ajegunle in (Ogun) and Ikorodu in (Lagos) states in south west of Nigeria. The clay samples were crushed, pulverized and sieved. Their chemical compositions analysis was carried out using Atomic Absorption Spectrometer (AAS); molds 135mm by 120mm by 15mm were made for the clay samples. Composites were made in the following proportions by a mix of clay samples with aluminum dross in a percentage ratio of 50:50 and another mixture of clay samples with aluminum dross and bentonite as a binder at a percentage ratio of 45:45:10. The physical properties such as water absorption and cold crushing strength were carried out. Also thermal conductivity was carried out on the sample. The result of chemical analysis showed that Igboora, Silica (47.9%) an alumina (36.7%), the rest were the traces or the other element. Ilaro samples were silica (43.5%) and alumina (34.2%) Itori samples, silica (49.8%) and alumina (30.7%). Ajegunle sample, silica (46%) and alumina (38.2%) and Ikorodu sample, silica (54.5%) and alumina (24.6%). These results were compared to the Grim-Shaw specifications which specified (25.45%) alumina and 40.6% silica compositions in requirements for clay soils ascertained that the samples were all clay soils, though the Ikorodu samples was lacking a little in its alumina content. The result of water absorption test of Igboora samples and its composite agree with the Indians roofing tiles' standard (IS 654:1992) while the other samples failed. The result for Ilaro composite 50:50 had the lowest thermal conductivity of 0.086w/m.kg for the crushing strength test, the Itori and Ilaro composite with bentonite acting as binder produced results of 1.07KN and 1.01KN which agrees with the Indian roofing standard. At this preliminary work, it can be suggested that in conclusion, Igboora and Ilaro clay and their composites seem to be promising for roofing tiles.

Keywords: Roofing Tiles, Clay, Aluminum Dross, Raw Materials, Thermal Properties.

1. Introduction

Clay is a viable mineral that exhibit high economic significance and usefulness that affects every sphere of life though it is a product of disintegration form chemical weathering of feldspathic and granite rocks [1]. It consists of fine particles of hydrous aluminum silicate which has a wide variety of physical characteristics such as plasticity, shrinkage under firing and under air-drying, fineness of grain, color after firing. Hardness cohesion and capacity of the surface to take decoration [2].
Furthermore, clay is a unique form of soil and it is of different forms. It is made up of different minerals. Clay minerals are made up of different components, among which are mineralogical, chemical composition, phase constitutions, and microstructural morphology of these materials make clay to be unique and suitable as industrial minerals whose application is dependent on its structure and chemical composition [3].
The major clay in Nigeria are three different deposits of Kaolinite, microcline, muscovite/iolite, plagioclase/ albite and quartz.

In their work [4], it was observed that the two major types of clay are the foundation of three basic types of clay bodies; earthenware, stoneware and porcelain whose maturing temperature ranges between 750°c and 1150°c, 1150°c and 1350°c as well as 1400°c and 1700°c respectively; these clays form the rudiments for other clay bodies. However, clay body formations which are varying from place to place have been documented by these authors [5]. Which also indicated the differences in the properties of the clay that are being used in industrial set up. The important properties of cay are plasticity, colour, clay strength, drging and firing shrinkages. The percentages of minerals oxides such as (Fe_2O_3, MgO, CaO, Na_2O and so on) in clay ultimately determine the areas of application of the clay such as bricks, floor tiles, paper and so on, while the quantity of alkali metal oxides (Na_2O, K_2O, CaO, etc) indicate their suitability for making ceramics products [6].
Also, one of the products from clay is roofing tiles. Roof tiles in houses have been an ancient tradition and the current use allows the maintenance of the architectural outlook in many countries. From the ancient time till present day, a wide variety of materials for roofing will afford better bargains in terms of finiancial costs, the kind of building to be erected, the availability of the material, environmental and climate factors [7]. Also thermal and durability properties of the materials are necessarily to be taken into consideration, especially if the building needs to be situated in tropical regions. Clay seems to make a good choice.
Due to its inherent properties, as a roofing material clay possesses the ability to absorb heat projected onto its surface and still leave the interior of its building structure cool. The roof receives the most solar radiation of any building component under normal circumstances [8].
Solar reflectance is the most important characteristic of a roof product in terms of yielding the highest energy savings during warmer months [9]. The higher the solar reflective value, the more efficient the product is in reflecting sunlight and heat away from the building and reducing roof temperature. This is particularly important in warm areas where peak load is a concern [10].
This paper will therefore, assess the possibility of using some clay from south west and aluminum dross as composite roofing tiles.
Aluminum dross is the by-product of the smelting process in the creation of aluminum from bauxite (an aluminum ore). It forms on the surface of the molten metal and is as a result of oxidation of the metal. Aluminum dross is a by-product which constitutes nuisance to the aluminum industries as slag to the steel industries. If the dross is found useful in roofing tile industry, it will help to keep the aluminum industries environment clean and economical.

2. Materials and Methods

a. Raw Materials

Representative samples of the five (5) deposits in Igboora in Oyo, Ilaro, Itori, Ajegunle in Ogun and Ikorodu in Lagos states, all in the south west of Nigeria. The clay samples were crused, pulverized and sieved. Their chemical compositions analysis were carried out using Atomic Absorption Spectrometer(AAS), moulds of 135mm by 120mm by15mm were made for the clay samples

Composites were made in the following proportions by a mix of clay samples with aluminum dross in percentage ratio of 50:50 and another mixture of clay samples with aluminum dross and bentonite as binder in a percentage ratio of 45:45:10. The physical properties such as water absorptions and cold crushing strength were carried out. Also thermal conductivity was carried out on the samples.

b. Cold Crushing Strength

The molded samples were fixed at 105°c for 24 hours and were tested for crushing strength using hydraulic strength machine. The crushing strength was then calculated using the relationships:

$$\text{Cold crushing strength} = \frac{load\ KN_2}{area\ (M)} \quad 1$$

c. Water Absorption Measurements

Water absorption measurements were carried out according to British standard EN 99: (1991). The fired molded samples were soaked in boiling water in a beaker and left to cool down to room temperature still soaked in water. Excess water was removed from the samples surface using a moistened cloth prior to weighing. The wet weight (W_w) was then measured. Samples were left drying in an oven at 110°C over night, and the dry weight was measured (W_d). Water absorption (W_a) was computed as:

$$Wa = \frac{Ww - Wd}{Wd} \quad 2$$

d. Thermal Conductivity Measurements

The name of the apparatus is KD2 Pro. Using KD2 pro to take measurements, appropriate sensor was chosen and attached to KD2 pro meter, and then the meter was turned on. The sensor was properly inserted into the clay molded sample. Each measurement displayed in-situ temperature of the sample, thermal conductivity and thermal resistivity respectively. After each measurement, the instrument was allowed to rest for 25 minutes before taking the next reading in order to allow equilibrium position to be established. This procedure was repeated for the remaining samples.

3. Results and Discussion

e. Compositional analysis of the clays

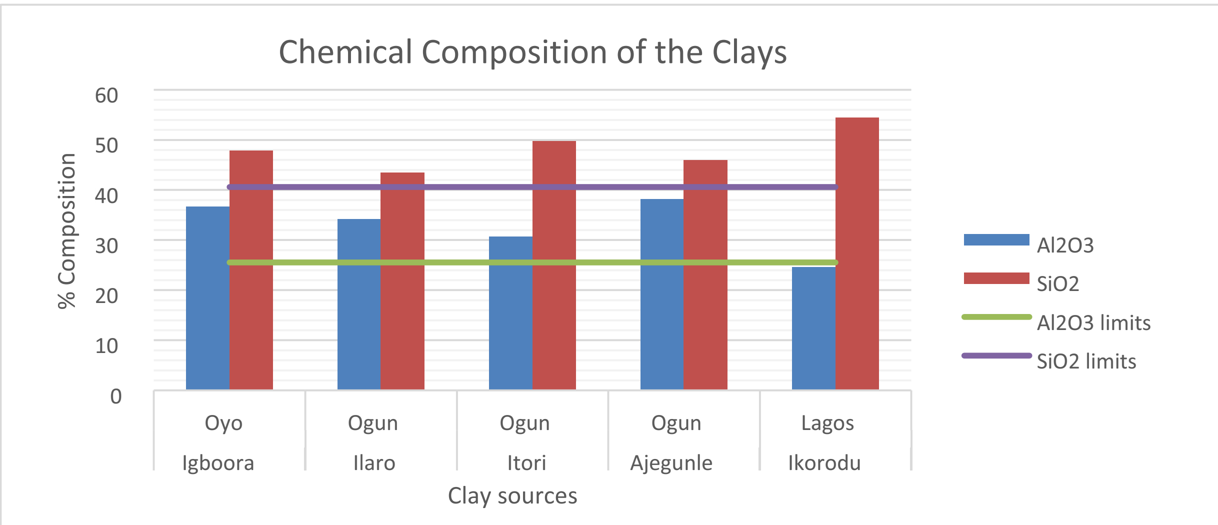

Figure 3.1: Chemical composition analysis of the clay from Southwest region of Nigeria.

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f. Water Absorption Test

In the water absorption test, only the Igboora, Ajegunle and Ilaro clay samples and its composite produce the results which are in Figure 3.2.

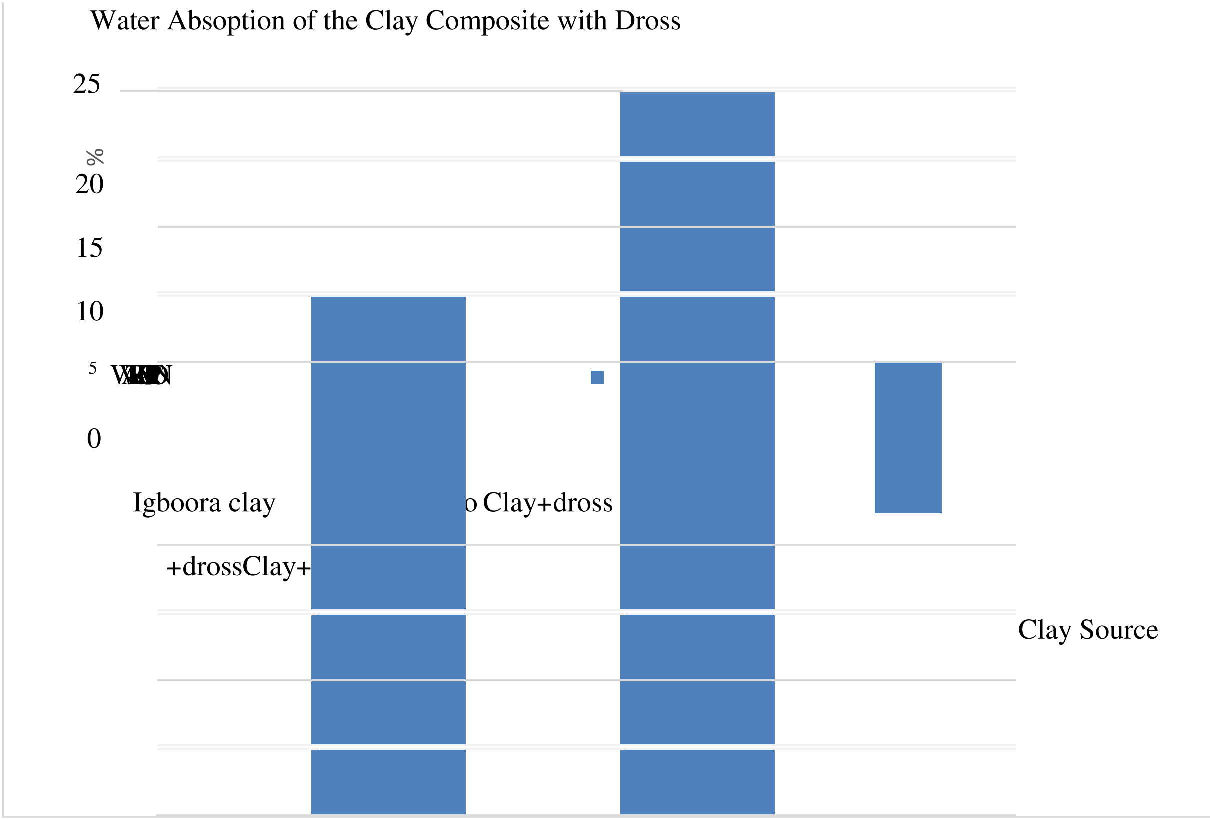

Figure 3.2: Water Absorption Results.

g. Cold Crushing Strength Result

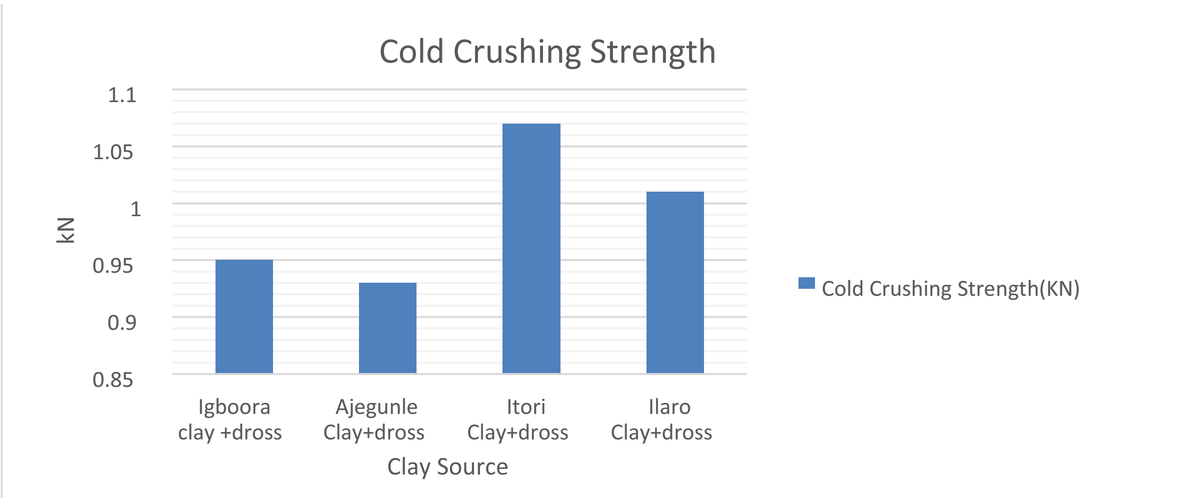

Figure 3.3 Cold Crushing Strength Result

3.4. Thermal Conductivity (W/M.K) Result.

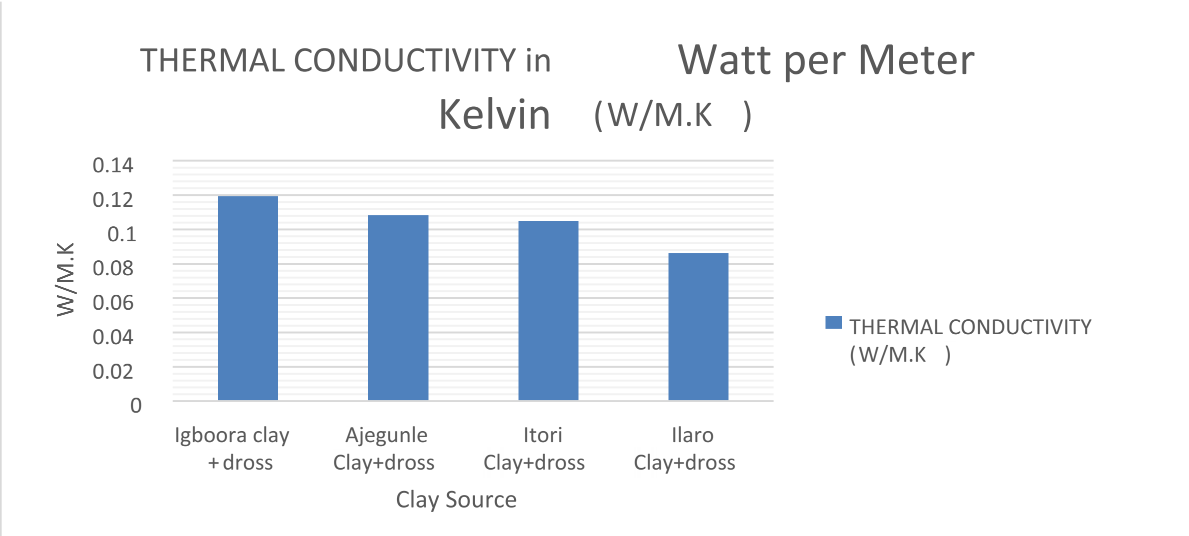

Figure 3.4 Thermal Conductivity Result.

4. Discussion and Conclusion

The results of the chemical analysis were compared to the Grim Shaw specification which specified 25.45% aluminum and 40.6% silica composition requirement for clay soils ascertained that the samples were all clays soils (although the Ikorodu samples was lacking a little in its alumina content). It failed other tests carried out on its samples. The results of water absorption test of Igboora samples and its composite agree with the Indian roofing tiles standard (IS 654:1992) [11] while the other samples failed. The Ilaro composites sample had the lowest thermal conductivity, which was unable to fit to Indian and Australia International standard [12] of roof tiles.
However, for the crushing strength test, the Itori and Ilaro composite with bentonite acting as binder produced the results which agree with the Indian roofing standard [11]. The work so far is encouraging.

5. Conclusion

At this preliminary work, it can be suggested that in conclusion, Igboora and Ilaro clay and their composites seem to be promising for roofing tiles. Further works is still ongoing to ascertain the possibility in using them on roofing tiles.

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