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Investigation Of The Effect Of Compression And Firing On Clay Samples From Ekiti State South Western, Nigeria.

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Abstract

Using the Atterberg scale, liquid limit activity of clay is found to be between 0.75 and 1.25 which is acceptable for structural material in engineering, This has not been effective like lead in shielding ionizing radiation due to its brittleness. Clay samples used mainly for building construction and pot making in Ara Ijero, Ire, Orin and Isan of Ekiti State South Western Nigeria were investigated so as to know their effectiveness as radiation shielding material. The samples was grinded into powder, weighed and formed into paste before compressing it into bricks. Pressures of $875Nm^{-2}$, $1750Nm^{-2}$, $2625Nm^{-2}$, $3500Nm^{-2}$, and $4375Nm^{-2}$, was used in compression for thicknesses of 1.0cm, 1.5cm, 2.0cm, 2.5cm, 3.0cm and 3.5cm. It was then fired at a temperature of $1000^{o}C$ and then re-weighed.

The result obtained shows that has the pressure and thicknesses of compression increases for the same weight before firing, the corresponding weight decreases significantly after firing with clay from ire ekiti showing significant decrease in weight after firing than other clay.

Keywords : Atterberg scale, Ionizing radiation, compression, firing, shielding, weight, thickness and pressure.

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INTRODUCTION

From prehistoric times, clay has been indispensable in architectures, in industry and in agriculture. Thousands of years BCE the cuneiform script was written on clay tablets with a blunt reed called a stylus (Ehlers, et al 1982). Clay is used as a building material, it is used in the form of brick, either sun- dried or fired. Clays are also of great industrial importance e.g. in the manufacture of tile for wall and floor coverings, and of pipe for drainage and sewage. The less absorbent bentonites are used chiefly in the oil industry, e.g. as filtering and deodorizing agents in the refining of petroleum (Grim, 1986). Clay is also of high domestic importance, e.g. in the manufacture of cooking pots and other cooking utensils. Clay is a naturally occurring material, composed of primarily of fine grained minerals which show plasticity through a variable range of water content, and which can be hardened when dried or fired. Clay deposits are mostly composed of clay minerals (phyllosilicates minerals), minerals which impact plasticity may also be a part of clay (Guggenheim et al., 1995). Clay or concrete material has been discovered to be effective as shielding material for ionizing radiations.

Compressive strength is a mechanical property with two important reasons. Firstly a high compressive material is used to improve properties like flexure and abrasion (Bukar, 1992). Secondly compressive strength decreases with increasing porosity but can be influenced by clay composition and firing, (Bukar, 1992). Compressive testing is a method for assessing the ability of a material to withstand compressive loads. This test is commonly used as a simple measure of workability of material in service. Material behave differently in compression than they do in tension so it may be important to perform mechanical tests which simulate the condition the material will experience in actual use. Compression testing is typically carried out on the following material plastics, foams, rock, concretes and asphalt (Bukar, 1992).

Earthenware type of clay reaches maturing or vitrifying temperature between 1000^oC and 1180^oC. This is the point at which its maximum fired strength and compactness resulting from its progressive fusion during firing is reached.(lisa Besozzi, 2008). Below this temperature the body will be weak and conversely if a clay body is fired beyond its maturing temperature range then faults can occur such as warping, bloating, collapsing or eventual transformation to a molten state. .(lisa Besozzi, 2008).

MATERIALS AND METHOD

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3.1 Sample collection

Clay sample were collected from four major location in Ekiti State (i) Ara Ijero Ekiti (sample B) where the clay is used in pots making (ii) Ire Ekiti (sample B) where the clay is predominantly used for block making and consequently a fancy block factory was sited at the location, and (iii) Orin Ekiti (sample C) where we have red clay deposit mostly used for building construction. Isan Ekiti (sample D) where clay is used chiefly for pot making.

Samples were wrapped separately with a polythene bag to avoid contamination with other soil samples, this is to maintain the properties and identity of the sample at all stages of sample preparation.

3.2 Apparatus

The apparatus used includes clay soil samples, a metallic cylinders (of diameter 2.7cm), AC Hydraulics (compressor) of capacity , 16 tons, Mettler weighing device (Maximum weight =310g, Minimum weight = 0.5g, 0.01g, deionized water , oven (at 110^{o}C) Electrical furnace (at 1000^{o}C), and Meter rule.

3.3 Experimental procedure for compression and firing

This experiment was set up at the ceramics department of the federal institute of industrial research, oshodi lagos (FIIRO). Firstly deionized water was obtained and was used to mix the soil sample to form a paste. This was done in a dry container and was measured accordingly as shown in table 4.1. the measured soil samples were poured into the metallic cylinders ,one after the other, and were compressed by the Hydraulics to different thicknesses at different pressures. The compressed samples were allowed to air dry for a day before being transferred to the oven which is at 110^{o}C. The samples were allowed to oven dry for a day after which they were fired at 1000^{o}C in a blast furnace. These set of samples were reweighed

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after firing for the values of weight W_3 (g). The samples were also coded just after compression for easy identification. the samples were rearranged to thicknesses x= 0.01, 0.015, 0.02, 0.025, 0.030, 0.035 meters for the different pressures P=875 $x10^4$, 1750 $x10^4$, 2625 x 10^4, 3500 x 10^4, 4375 x $10^4 N/m^2$ respectively.

Plate 3.1: Samples compressed at different pressures for different thicknesses

RESULTS AND DISCUSSION

Table 4.1: Table of compression of sample A at different pressures and different thickness measured at weight W_1 (g) before firing, and weight W_2(g) after firing.

w_1(g)	X(m)	P(Nm^{-2})	w_2(g)
16.5	0.01	875	13.67

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16.5	0.01	1750	13.23
16.5	0.01	2625	13.33
16.5	0.01	3500	12.93
16.5	0.01	4375	12.63
22.6	0.015	875	17.58
22.6	0.015	1750	17.95
22.6	0.015	2625	17.57
22.6	0.015	3500	17.22
22.6	0.015	4375	25.65
31.5	0.02	875	25.63
31.5	0.02	1750	25.08
31.5	0.02	2625	25.08
31.5	0.02	3500	25.83
31.5	0.02	4375	25.37
38.6	0.025	875	33.24
38.6	0.025	1750	32.24
38.6	0.025	2625	32.15
38.6	0.025	3500	31.8
38.6	0.025	4375	31.2
42.9	0.03	875	36.76
42.9	0.03	1750	36.46
42.9	0.03	2625	35.66
42.9	0.03	3500	35.27
42.9	0.03	4375	35.66
51.6	0.035	875	35.23
51.6	0.035	1750	43.48
51.6	0.035	2625	41.52
51.6	0.035	3500	43.41
51.6	0.035	4375	43.6

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Table 4.2: Table of compression of sample B at different pressures and different thickness measured at weight W_1 (g) before firing, and weight W_2 (g) after firing.

W_1(g)	X(m)	P(Nm^{-2})	W_2(g)
16.5	0.01	875	13.28
16.5	0.01	1750	13.05
16.5	0.01	2625	12.53
16.5	0.01	3500	11.8
16.5	0.01	4375	11.76
22.4	0.015	875	17.9
22.4	0.015	1750	17.71
22.4	0.015	2625	16.63
22.4	0.015	3500	16.23
22.4	0.015	4375	16.21
31.5	0.02	875	25.43
31.5	0.02	1750	25.45
31.5	0.02	2625	25.67
31.5	0.02	3500	25.43
31.5	0.02	4375	25.61
38.2	0.025	875	25.04
38.2	0.025	1750	32.56
38.2	0.025	2625	31.81
38.2	0.025	3500	31.98
38.2	0.025	4375	30.76
42.6	0.03	875	35.64
42.6	0.03	1750	35.85
42.6	0.03	2625	36.46
42.6	0.03	3500	35.4
42.6	0.03	4375	34.22
52	0.035	875	44.04
52	0.035	1750	44.51
52	0.035	2625	44.82
52	0.035	3500	43.55
52	0.035	4375	44.21

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Table 4.3: Table of compression of sample C at different pressures and different thickness measured at weight W_1 (g) before firing, and weight W_2 (g) after firing.

W_1(g)	X(m)	P(Nm^{-2})	W_2(g)
16.5	0.01	875	13.43
16.5	0.01	1750	13.93
16.5	0.01	2625	12.53
16.5	0.01	3500	12.56
16.5	0.01	4375	12.54
22.5	0.015	875	18.53
22.5	0.015	1750	18.42
22.5	0.015	2625	18.47
22.5	0.015	3500	17
22.5	0.015	4375	17.23
31.5	0.02	875	25.35
31.5	0.02	1750	25.67
31.5	0.02	2625	25.34
31.5	0.02	3500	26.55
31.5	0.02	4375	25.34
38.3	0.025	875	32.67
38.3	0.025	1750	32.48
38.3	0.025	2625	32.6
38.3	0.025	3500	31.83
38.3	0.025	4375	31.2
42.3	0.03	875	34.68
42.3	0.03	1750	35.89
42.3	0.03	2625	36.27
42.3	0.03	3500	34.95
42.3	0.03	4375	33.8
51.5	0.035	875	42.77
51.5	0.035	1750	42.47
51.5	0.035	2625	41.83
51.5	0.035	3500	41.23
51.5	0.035	4375	41.94

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Table 4.4: Table of compression of sample D at different pressures and different thickness measured at weight W_1 (g) before firing, and weight W_2 (g) after firing.

W_1(g)	X(m)	P(Nm^{-2})	W_2(g)
16.5	0.01	875	12.43
16.5	0.01	1750	12.13
16.5	0.01	2625	11.01
16.5	0.01	3500	11
16.5	0.01	4375	10.85
22.5	0.015	875	18.41
22.5	0.015	1750	17.08
22.5	0.015	2625	16.62
22.5	0.015	3500	15.43
22.5	0.015	4375	15.51
31.3	0.02	875	23.51
31.3	0.02	1750	23.8
31.3	0.02	2625	23.06
31.3	0.02	3500	23.32
31.3	0.02	4375	23.3
38.5	0.025	875	31.33
38.5	0.025	1750	30.24
38.5	0.025	2625	30.54
38.5	0.025	3500	29.24
38.5	0.025	4375	29.32
45	0.03	875	38.89
45	0.03	1750	38.67
45	0.03	2625	38.62
45	0.03	3500	38.23
45	0.03	4375	37.95
51.8	0.035	875	44.01
51.8	0.035	1750	43.78
51.8	0.035	2625	43.46
51.8	0.035	3500	43.77
51.8	0.035	4375	43.55

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The result so far obtained indicate that the various clays collected from the four locations responds differently to measurement and compression as it was observed, the compression results for sample A, B, C, D, with the pressure applied shows little differences in value from the measurement of its weight as recorded in tables 4.1 to table 4.4 for each samples. Table 4.2 shows that sample B has the highest value in weight as the thickness increases and the rate of compression increases down the table. This can be said to be the due to the geological chemical composition of the clay soil. The result obtained also indicates that the material is of high compressibility (Smith, 1990). This is observed when increases in value of pressures is applied to the same thickness of material thus increasing the density of the material. The result obtained after firing the clean at 1000^{o}C shows the lustreness and plasticity of the clay (Guggenheim et al 1995).

CONCLUSION

With higher pressure application down the table there is significant increase in the weight after firing this indicate that the material is of high compressible strength according to atterberg principle. This material indicate it will be of immense contribution to building construction in Engineering and an indication that the material when further analysed will be a good material for the shielding of Ionizing radiation due to its ability to withstand greater heat without loss of weight of the material which can be attributed to its relative molecular mass and the physical and chemical composition of the clay substance. (Guggenheim et al., 1995).

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Further work is suggested to ascertain the chemical composition and the molecular mass of the sample to and possibly complement the material by doping it with other material for better performance.

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