EFFECT OF EARTH MUD BRICKS STABILIZED WITH PALM TREE STRANDS ON COMPRESSIVE STRENGTH AND WATER ABSORPTION RATE

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Abstract
The study determined the effects of earth mud bricks stabilized with palm tree strands on compressive strength and water absorption rate. Determine the compressive strength of earth mud bricks with 0% control stabilization, determine the compressive strength of earth mud bricks with 10%, 15% and 20% palm tree stabilization, find out the water absorption rate of earth mud bricks with 0% control stabilization and find out the water absorption rate of earth mud bricks stabilized with palm tree strand. Four research questions guided the study. The study adopted true experimental research design. The Laboratory test was conducted in Building Department of the Federal University of Technology, Minna. A total of 54 earth mud bricks cubes were produced consisting 12 mud cubes for 0% control stabilization and 36 mud cubes for 10%, 15% and 20% stabilization for compressive strength and 6 mud cubes for water absorption rate. Materials used were palm tree strand, earth mud and water while the test conducted were compressive strength and water absorption rate. The findings of the study revealed that the compressive strength of earth mud brick stabilized with palm tree strand at 10% with 2.12 Nmm^2 is not in conformity, 15% with 2.53 Nmm^2 at 28 days is in conformity with Nigerian Industrial Standard (NIS) (2.5–3.45 Nmm^2, while 20% with 14.27 Nmm^2 is above the NIS value. The findings on the water absorption rate of earth mud brick stabilized with strands are 8.45%, 9.21% and 7.25% which is in conformity with NIS of 12% minimum standard. It was therefore recommended that building professionals should encourage the use of palm tree strand at 15% in conformity and 20% stabilization since it yielded high compressive strength for the production of stabilize earth mud bricks for building construction and government should organize training and sensitization on the percentage of palm tree strands required in the production of stabilize earth mud bricks of high compressive strength with good water absorption rate.

Key words: *Earth Mud Bricks, Palm Tree Strands, Compressive Strength, Water Absorption Rate.*

Introduction

Earth mud bricks are made by mixing earth with water, placing the mixture into moulds and drying the bricks in the open air, straw or other fibres that are strong in tension are often added to the mixture of earth and water to help reduce cracking. Earth mud bricks are bonded with the earth mortar to build walls, vaults and domes (Downton, 2013). Earth mud brick is

one of the most important material for construction industries. It was anciently produced by mixing the virgin resources, forming the bricks. Adeleke (2008), reported that earth mud bricks are mixture of earth and water which is cast in moulds and allowed to cure between 7-14 days or even more depending on weather conditions. Adams and Agib, (2001) however argued that in order to improve the durability of earth mud bricks one may need to stabilized it with additional palm tree derivatives.

Palm tree strand are produced by cutting the palm tree into logs, splitting the logs into softer tissues to dry, then further processed by removing the strands fibres from the tissues. According to Yalley and Seidu, (2018) the strands comes in various inches ranging from 12-16 inches long, the curly stems which are used in coiling, floral design, basket making, creative art work and native traditional arts. The strands are also flexible and easy to work with depending on the purpose to which is being used, when this is use as stabilizer of earth mud bricks, it may help to increase its strength and quality likewise with addition of other derivatives like palm tree powder and palm tree ash.

Earth mud stabilization is a method often used to improve earth mud strength and increase resilience to softening by water through bonding the earth mud particles together with stabilizing agents. Research has shown that it is possible to provide construction materials and methods that are appropriate for all environments and affordable for stabilizing mud bricks which are called stabilizers Otunyo & Chukwuigwe, (2018). Earth mud stabilization additives are used to improve and maintain earth mud moisture content, increase earth particles cohesion and serve as cementing and water proofing agent. The common earth mud stabilization techniques are becoming costly day by day due to the rise in cost of the stabilizing agents like cement and lime (Omar, 2017). Thus, the use of agricultural waste like rice husk ash, bamboo leaf ash, palm tree ash, powder, and strands and others will considerably improve the durability and compressive strength properties of the earth mud brick since no building unit can perform it function without these requirements most especially as an alternative.

The compressive strength of building plays an important role in the durability, stability and average strength of a building. Igwe, (2015) stated that compressive force of bricks is a vital data for ascertaining the characteristics of the output produced. Compressive strength refers to the ability of the bricks to withstand load or stress placed on them before they break (Ikechukwu, 2010). Johnson, (2014) further argued that Compressive strength is the capacity of a material or structure to withstand load tending to reduce size, as opposed to which withstand loads tending to elongate or resist failure. The addition of palm tree strands will help in improving the durability, compressive strength and water absorption rate.

Water absorption rate is the quantity of water contained in a material such as earth mud, clay and wood. It is the amount of water present in a moist sample, it can be expressed on wet or dry basis. Water absorption rate is determined by measuring the decrease in mass of saturated brick and surface dry sample. A weighing balance and a water tank will be used in the water absorption test (Makinde, 2007). The water absorption rate determines the physical properties of mud bricks when produced to meet the required standard (Samuel, 2015). Water absorption test on earth mud bricks are conducted to determine properties of mud bricks such as durability, hardness, sound insulation and behavior of bricks in weathering. This can be achieved through determining the effect of the produced earth mud brick stabilized with palm tree derivatives. This study is set to assess the effect of earth mud bricks

stabilized with palm tree strands on compressive strength and water absorption rate by 0% control, 10%, 15% and 20% as an alternative building materials.

The vast availability of earth mud with palm tree strands in a large quantity within the regions around the world, and minimizing energy use for transportation (during importing and exporting) and generally intermediate-technology solutions for production of earth mud brick, they do not require sophisticated machinery or specialized expertise to construct, and can be constructed quickly when compared to conventional building unit of sandcrete block. These factors not only make alternative construction technologies attractive for developing countries in general, but also make them particularly well suited to solve economical, social and environmental related problems. In support of the above, Kareem *et al,* (2016) pointed out that ever increasing cost of conventional building material is a matter of serious concern that calls for the investigation of alternative building materials. Thus, determination of the effect of earth mud bricks stabilized with palm tree strand on compressive strength and water absorption rate is the need for this study.

Purpose of the Study

1. Determine the compressive strength of earth mud bricks with 0% control stabilization.
2. Determine the compressive strength of earth mud bricks with 10%, 15% and 20% palm tree stabilization.
3. Find out the water absorption rate of earth mud bricks with 0% control stabilization
4. Find out the water absorption rate of earth mud bricks stabilized with palm tree strand.

Research Questions

1. What is the compressive strength of earth mud bricks with 0% control stabilization?
2. What is the compressive strength of earth mud bricks with 10%, 15% and 20% palm tree stabilization?
3. What is the water absorption rate of earth mud bricks with 0% control stabilization?
4. What is the water absorption rate of earth mud bricks stabilized with palm tree strands?

Materials and Method

The study adopted true experimental research design. The study was conducted in Building Department Laboratory of the Federal University of Technology, Minna. A total of 54 earth mud bricks cubes were produced consisting 12 mud cubes for 0% control and 36 mud cubes for 10%, 15% and 20% palm tree stabilization for compressive strength and 3 earth mud bricks cubes for water absorption rate of 0% control and 3 earth mud cubes for strands stabilization sample test. Materials used were earth mud, palm tree strand and water while the test conducted were compressive strength and water absorption rate.

Experimental Procedure

Procedure for testing Compressive Strength of Earth Mud Bricks (Cubes)

A total number of 54 earth mud brick were produced with palm tree strands stabilization, 36 mud brick cubes for 10%,15% and 20% strands stabilization, 12 earth mud bricks cubes for 0% control compressive strength and 3 earth mud bricks cubes for water absorption rate of 0% control and 3 mud cube for strands stabilization.

1. Earth mud bricks Cubes were soaked in water for 24 hours after curing for 7, 14, 21 and 28 days respectively.
2. Earth mud bricks Cubes were weighed and recorded.
3. Three earth mud brick cubes for each percentage stabilization was taken to the crushing machine for crushing, each for 7, 14, 21 and 28 days cured.

4. The machine was set in action and operated to carryout compressive strength test of cubes.
5. The force or reading on the machine was noted and recorded. Compressive strength $= \frac{load\ failure}{cross\ sectional\ area\ of\ value}$
6. The load failure value of each of the three mud cubes crushed was taken and used to calculate the compressive strength for each percentage stabilization of palm tree derivatives (powder, ash and strands).

Procedure for Testing Water Absorption Rate

i. Earth mud bricks cubes of 100mm x 100mm x100mm were weighed and recorded.
ii. Three earth mud bricks cubes of each percentage were soaked in water for twenty-four (24) hours.
iii. The weight of wet earth mud bricks cubes were taken and recorded after removal from water.

Weight of wet bricks (cubes) $=M_2$
Weight of dry bricks (cubes) $= M_1$
Therefore, water absorption rate formular is:
Absorbance rate $\frac{M_2-M_1}{M_1} \times 100$

$$\frac{wet\ weight - dry\ weight}{dry\ weight} \times 100$$

Research Question One

What is the compressive strength of earth mud bricks with 0% control stabilization?

Table 1: Compressive Strength of Earth Mud Bricks with 0% Stabilization

The laboratory test results in table.1: of compressive strength of earth mud bricks with 0% control stabilization of 3 earth mud cubes

S/NO.	0% Control	Age of curing (days)	Mould size	Water/earth mud ratio	Curing type	Weight of mud bricks after curing (g)	Average weight of mud bricks (g)	Failure load (N)	Compressive strength (N/mm^2)	Average compressive strength(N/mm^2)
1	0	7	100 x 100	0.15	Open air	870		18.3	1.83	
2	0	7	100 x 100	0.15	Open air	900	916	18.6	1.86	1.84
3	0	7	100 x 100	0.15	Open air	980		18.5	1.85	
4	0	14	100 x 100	0.15	Open air	1080		17.5	1.75	
5	0	14	100 x 100	0.15	Open air	1180	1153	17.8	1.78	1.77
6	0	14	100 x 100	0.15	Open air	1200		18.0	1.80	
7	0	21	100 x 100	0.15	Open air	1300		17.4	1.74	
8	0	21	100 x 100	0.15	Open air	1350	1366	17.6	1.76	1.79
9	0	21	100 x 100	0.15	Open air	1450		18.7	1.87	
10	0	28	100 x 100	0.15	Open air	1600		18.7	1.87	
11	0	28	100 x 100	0.15	Open air	1580	1633	18.9	1.89	1.90
12	0	28	100 x 100	0.15	Open air	1720		19.5	1.95	

crushed at 7days showed 1.83 N/mm^2, 1.86 N/mm^2, 1.85 N/mm^2, while at 14 days revealed 1.75 N/mm^2,1.78 N/mm^2, 1.80 N/mm^2 and 21 days showed 1.74 N/mm^2, 1.76 N/mm^2, 1.87 N/mm^2 and at 28 days revealed 1.87 N mm^2, 1.89 N/mm^2 and 1.95 N/mm^2 which were all below the Nigerian Industrial Standard NIS87: 2007 (2.5-3.45N/mm^2) at 28 days. The compressive strength of earth mud bricks with 0% control at 7days is 1.84N/mm^2, at 14days shows 1.77N/mm^2, at 21days is 1.79N/mm^2 and 1.90N/mm^2 at 28days which were all below the NIS87 specified standard. From the results analyzed it showed that as the curing days increases the compressive strength of bricks decreased.

Research Question two

What is the Compressive Strength of Earth Mud Bricks with Palm Tree Strands at 10%, 15% and 20% stabilization?

Table 2: Compressive Strength of Earth Mud Bricks with 10% Palm Tree Strands stabilization.

S/No.	% Stabilization	Age of curing (days)	Mould size	Water/earth mud ratio	Curing type	Weight of mud bricks after curing (g)	Average weight of mud bricks (g)	Failure load (N)	Compressive strength (N/mm^2)	Average compressive strength(N/mm^2)
1	10	7	100 x 100	0.15	Open air	1593		16.8	1.68	
2	10	7	100 x 100	0.15	Open air	1680	1624	19.3	1.93	1.76
3	10	7	100 x 100	0.15	Open air	1600		16.9	1.69	
4	10	14	100 x 100	0.15	Open air	1720		17.8	1.78	
5	10	14	100 x 100	0.15	Open air	1700	1712	18.4	1.84	1.83
6	10	14	100 x 100	0.15	Open air	1717		18.9	1.89	
7	10	21	100 x 100	0.15	Open air	1840		16.8	1.68	
8	10	21	100 x 100	0.15	Open air	1819	1828	17.9	1.79	1.77
9	10	21	100 x 100	0.15	Open air	1825		18.5	1.85	
10	10	28	100 x 100	0.15	Open air	2050		20.5	2.05	
11	10	28	100 x 100	0.15	Open air	2130	2116	21.3	2.13	2.12
12	10	28	100 x 100	0.15	Open air	2170		21.7	2.17	

The laboratory test results in table.2: of compressive strength of earth mud bricks with 10% palm tree strands stabilization of 3 cubes crushed at 7days revealed 1.68N/mm^2, 1.93N/mm^2, 1.69N/mm^2, at 14days, 1.78N/mm^2, 1.84N/mm^2, 1.89N/mm^2 at 21days, 1.68N/mm^2, 1.79N/mm^2, 1.85N/mm^2 and at 28days 2.05N/mm^2, 2.13N/mm^2 and 2.17N/mm^2 which were all below the Nigerian Industrial Standard NIS87: 2007 of 2.5-3.45N/mm^2 at 28 days. The analysis further revealed that the average Compressive strength of earth mud bricks with 10% palm tree strands stabilization at 7days showed 1.76N/mm^2, at 14days shows, 1.83N/mm^2, 21days is 1.77N/mm^2 and 28days 2.12N/mm^2 which were below the minimum stipulated value by NIS87.

Table 3: Compressive Strength of Earth Mud Bricks with 15% Palm Tree Strands stabilization.

S/No.	% Stabilization	Age of curing (days)	Mould size	Water/earth mud ratio	Curing type	Weight of mud bricks after curing (g)	Average weight of mud bricks (g)	Failure load (N)	Compressive strength (N/mm^2)	Average compressive strength(N/mm^2)
1	15	7	100 x 100	0.15	Open air	1760		17.0	1.70	
2	15	7	100 x 100	0.15	Open air	1820	1790	18.2	1.82	1.80
3	15	7	100 x 100	0.15	Open air	1790		18.9	1.89	
4	15	14	100 x 100	0.15	Open air	1930		19.2	1.92	
5	15	14	100 x 100	0.15	Open air	1848	1882	18.4	1.84	1.91
6	15	14	100 x 100	0.15	Open air	1870		19.7	1.97	
7	15	21	100 x 100	0.15	Open air	2060		20.8	2.08	
8	15	21	100 x 100	0.15	Open air	2181	2153	21.8	2.18	2.15
9	15	21	100 x 100	0.15	Open air	2220		22.2	2.22	
10	15	28	100 x 100	0.15	Open air	2400		24.0	2.40	
11	15	28	100 x 100	0.15	Open air	2400	2443	24.1	2.41	2.44
12	15	28	100 x 100	0.15	Open air	2530		25.3	2,53	

The laboratory test results in table 3: of compressive strength of earth mud bricks with 15% palm tree strands stabilization of 3 cubes crushed at 7days revealed 1.70N/mm^2, 1.82N/mm^2, 1.89N/mm^2 at 7days, 1.92N/mm^2, 1.84N/mm^2, 1.97N/mm^2 at 14days, 2.08N/mm^2, 2.18N/mm^2, 2.22N/mm^2 at 21days and 2.40N/mm^2, 2.41N/mm^2 at 28 days are not in conformity with Nigerian Industrial Standard NIS87 but at 28days the strength increases to 2.53N/mm2, the analysis shows that the result is in conformity with Nigerian Industrial Standard NIS87: 2007 of 2.5-3.45N/mm2 at 28days minimum compressive strength of earth mud bricks. The analysis further showed that the result for 28days is in conformity with Nigerian Industrial Standard NIS87 as the curing days increases the compressive strength of bricks increases.

Table 4: Compressive Strength of Earth Mud Bricks with 20% Palm Tree Strands stabilization.

S/No.	% Stabilization	Age of curing (days)	Mould size	Water/earth mud ratio	Curing type	Weight of mud bricks after curing (g)	Average weight of mud bricks (g)	Failure load (N)	Compressive strength (N/mm^2)	Average compressive strength(N/mm^2)
1	20	7	100 x 100	0.15	Open air	1744		172.4	17.24	
2	20	7	100 x 100	0.15	Open air	1671	1718	186.5	18.65	17.20
3	20	7	100 x 100	0.15	Open air	1740		157.2	15.72	
4	20	14	100 x 100	0.15	Open air	1612		146.3	14.63	
5	20	14	100 x 100	0.15	Open air	1641	1646	129.1	12.91	14.35
6	20	14	100 x 100	0.15	Open air	1486		155.2	15.52	
7	20	21	100 x 100	0.15	Open air	1624		123.5	12.35	
8	20	21	100 x 100	0.15	Open air	1603	1623	146.0	14.40	13.49
9	20	21	100 x 100	0.15	Open air	1642		137.4	13.74	
10	20	28	100 x 100	0.15	Open air	1612		146.0	14.60	
11	20	28	100 x 100	0.15	Open air	1641	1646	129.1	12.91	14.27
12	20	28	100 x 100	0.15	Open air	1686		153.2	15.32	

The laboratory test result in table 4: for compressive strength of earth mud with 20% palm tree strands stabilization of 3 cubes crushed at 7days had 17.24N/mm^2, 18.65N/mm^2, and 15.72N/mm^2, at 7days, 14.63N/mm^2, 12.91N/mm^2, 15.52N/mm^2 at 14days, 12.35N/mm^2, 14.40N/mm^2, 13.74N/mm^2 at 21days and 14.60N/mm^2, 12.91N/mm^2 and 15.32N/mm^2 at 28days are higher than the Nigerian Industrial Standards NIS87: 2007 minimum compressive strength of bricks of 2.5-3.45N/mm^2 at 28 days. The result analyzed shows clearly that as curing days increases and the percentage stabilization increases, the compressive strength of the bricks increased and the strength is higher than the minimum value stipulated by NIS87.

Research Question Three

What is the water absorption rate of earth mud bricks with 0% control stabilization?

Table 5: Water absorption rate of mud bricks with 0% control stabilization

Dry weight of mud (g) bricks W1	Average dry weight of mud bricks (g) W1	Wet weight of mud bricks (g) W2	Average wet weight of mud bricks (g) W2	Absorbance rate %	Average absorbance rate %
1.077		1.189		10.39	
1.150	1.094	1.371	1.322	19.21	20.87
1.057		1.406		33.01	

The test analysis in table 5 above, shows that 3 earth mud bricks cubes soaked in water 24hrs for water absorption had the following absorption rate 10.39%, falls within the Nigerian Industrial Standard NIS87: 2007 of 12% minimum specified water absorption rate while 19.21% and 33.01% are in conformity with the Nigerian Industrial Standard NIS87: 2007 with high water absorption rate.

Research Question four

What is the water absorption rate of earth mud bricks stabilized with palm tree strands?

Table 6: Water Absorption Rate of Earth Mud Bricks Stabilized with Palm Tree Strands

Dry weight of mud (g) bricks W1	Average dry weight of mud bricks (g) W1	Wet weight of mud bricks (g) W2	Average wet weight of mud bricks (g) W2	Absorbance rate %	Average absorbance rate %
1.585		1.719		8.45	
1.573	4.77	1.718	5.166	9.21	8.30
1.612		1.729		7.25	

The laboratory test results table 6, shows that 3 earth mud bricks cubes soaked in water 24hrs for water absorption had the following absorbance rate 8.45%, 9.21% and 7.25% falls within the Nigerian Industrial Standard NIS87: 2007 of 12% specified maximum water absorption rate for bricks. The analysis shows clearly that the water absorption rate of strands stabilization falls within the minimum stipulated value by NIS87:2007.

Discussion

The results in table 1 relating research question one revealed that the compressive strength of the three earth mud bricks crushed for control had values of 1.83N/mm^2, 1.86N/mm2 and 1.85N/mm^2 at 7days and 1.87N/mm^2, 1.89N/mm^2 and 1.95N/mm^{2}at 28days with average compressive strength of 1.84N/mm^2 at 7days, 1.77N/mm^2 at 14days, 1.79N/mm^2, at 21days and 1.90N/mm^2 at 28days which is lower than the minimum specified compressive strength for earth mud bricks by NIS87.This findings is in line with the view of Johnson, (2014) who argued that a good earth mud brick has a strength of around 1.6 to 1.9 mpa which indicate that the mud bricks are of good quality for use. Supporting this findings Ikechukwu (2010) also reported that the maximum compressive strength for earth mud bricks ranges from 1.6 to 1.9 mpa, the author further emphasized that compressive strength of building materials can be identify through laboratory compressive strength tests to measure the amount of compressive load a material can bear before fracturing.

Result on research question two showed that palm tree strands had lower compressive strength than the minimum standard specified by NIS87: 2007 with 10% stabilization given 1.68N/mm^2, 1.93N/mm^2 1.69N/mm^2, at 7days, 1.78N/mm^2, 1.84N/mm^2 1.89N/mm^2, at 14days, 1.68N//mm^2, 1.79N/mm^2, 1.85N/mm^2, at 21days, and 2.05N/mm^2, 2.13N/mm^2, 2.17N/mm^2, at 28days and 15% stabilization has 1.70N/mm^2, 1.82N/mm^2, 1.89N/mm^2, at 7days, 1.92N/mm^2, 1.84N/mm^2, 1.97N/mm^2, at 14days, 2.08N/mm^2, 2.18N/mm^2, 2.22N/mm at 21days, and 2.40N/mm^2, 2.41N/mm^2, but 2.53N/mm^2, at 28days is within the minimum value specified by NIS87: 2007 with average compressive strength of 1.76N/mm^2, 1.83N/mm^2,1.77N/mm^2 and 2.12N/mm^2, for 10% stabilization while 1.80N/mm^2,1.91N/mm,1.15N/mm^2 and 2.44N/mm^2 for 15% and the strength increased for 20% due to increase in percentage stabilization with high compressive strength of 17.20N/mm^2,14.35N/mm^2,13.49N/mm^2 and 14.27 N/mm^2 which are not in conformity with the specified value by NIS87. Compressive strength of bricks varied from 4.3 to 6.9 mpa with an average of 5.7 mpa (2-6 mpa for earth mud bricks (Muntosh, 2014) Also in support of that findings with Zhiri (2019) stated that compressive strength of 10% RHA replacement was 16.6 N/mm^2, close to control with 18.5N/mm^2 and strength of 10% RHA replacement gives compressive strength close to standard specified compressive strength of concrete from the findings of this study PTD strands prove to have properties that improve the quality and standard of earth mud bricks.

The result on water absorption test of 10% control was 10.39% ,19.21% and 33.10%. the water absorption rate of 10.39% falls within the conformity range of 12% while the rest are not in conformity. The water absorption rate of earth mud bricks stabilized with palm tree strands falls within the minimum specified standard for water absorption rate of 12% absorption rate by NIS87: 2007 with 8.45%, 9.2% and 7.25% and average water absorption rate of 8.30% within the specified value for minimum water absorption rate compare to the control with average of 21.45% which is not in conformity. In line with Nigerian Industrial Standard NIS87: 2007 the specified minimum water absorption of bricks conformity is 12%.

Conclusion

It was concluded that palm tree strands can be used for stabilization of earth mud bricks with strands at 15% cured for 28days within conformity with 2.53N/mm^2 and 20% cured for 28days with 15.32N/mm^2, because it yielded high comprehensive strength above the specified minimum value for earth mud bricks by NIS87: 2007 which are stronger and good to stand the test of time. This could bring about the reduction of construction cost and which is readily available construction materials for shelter.

It was concluded that palm tree strands can be introduced in the production of stabilized earth mud bricks as local natural materials to reduce cost of construction and enable the low-class individual to have access for shelter themselves at lower cost with ease and motivate unemployed youths to venture into producing stabilized earth mud bricks for commercial purpose and bring about societal development. It was also concluded that the water absorption rate of 10.39%, 8.45%, 9.21% and 7.25% earth mud bricks falls within the specified value of conformity class of 12% for earth mud bricks by NIS87: 2007.Therefore is considered good in quality and strong for construction purposes,

Recommendations

1. Building professionals should encourage the use of palm tree strand at 15% within conformity and 20% since it yielded high compressive strength for the production of stabilize earth mud bricks for building construction
2. Workshops and seminars should be organized periodically to enlighten producers of earth mud bricks on the importance of adhering to standards and engineers should always test for compressive strength and water absorption rate of earth mud bricks before allowing for usage.
3. Government should provide avenue for awareness campaign through social media and television on the use of earth mud bricks stabilized with palm tree derivatives for low cost construction and production of stabilized earth mud bricks to enhance development and empower individuals.
4. Building construction industries should emphasize on the importance of using natural alternative building material such as stabilized earth mud bricks and compliance with specified standard by Nigerian Industrial Standard Organization for the producers.

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