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STRENGTH PERFORMANCE OF LATERITIC BRICKS REPLACED WITH VARIED PROPORTIONS OF CEMENT

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Abstract
The research investigated the strength performance of lateritic bricks produced with varied proportions of cement. Ordinary Portland cement (OPC), Lateritic sand and Water were batched by weight and cured for 7, 14, 21 and 28 days respectively. Lateritic brick was replaced by 10, 20, 30 and 40% OPC respectively; 150mm x 150mm x150mm sizes were used. The properties of lateritic sand were determined and the compressive strengths of cube specimens were investigated. Mean compressive strength values of cube specimens were recorded and analyzed. The result showed that cement has a significant effect on the strength of lateritic brick: 30% laterite replacement with cement for brick attained a compressive strength of 3.55N/MM^2; samples with 60% laterite/ 40% cement mix attained a higher compressive strength of 6.62 N/MM^2. Hence laterite-cement mix was recommended for brick production for both load and non-load-bearing walls.

Keywords: Brick, cement, compressive strength, laterite, replacement.

INTRODUCTION

Housing has been universally accepted as the most important human need after food. Housing in all ramifications is more important than mere shelter since it embraces all the social services and utilities that make a community livable Akinluyi et al. (2013). Housing is also the first and most important of all fundamental human rights because of the importance attached to the provision of housing units (Ebie, 2009). According to Oladapo (2006), the housing situation in Nigeria is characterized by some inadequacies, which are qualitative and quantitative. Various other studies also further revealed the problems of housing production in Nigeria. Chukwujekwu (2006) opines that these problems include but are not limited to escalating high cost of building materials.

The provision of affordable housing units with the required strength performance has been the focus of most researchers in recent times as there is an increasing rate of building collapse in Nigeria. The use of substandard materials in concrete block production as a building component has contributed to building failure. This research is part of the continuing effort to make provision for housing units that are affordable to the dwellers as it intends to investigate the strength performance level of lateritic brick produced with varying proportions of cement.

Lateritic soils according to Osadebe and Nwakonobi (2007) are widely used as construction materials in Nigeria and other under-developed and developing countries of the world. However, laterites have not been extensively used in constructing medium to large-size building structures, probably because of a lack of adequate data needed in the analysis and design of structures built of lateritic soils, hence the need for more research effort.

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LITERATURE REVIEW

A lot of definitions have been given to laterite depending on the professional inclination of the authors. Some are purely morphological, some are purely physical and some others are purely chemical (Olusola, 2005). Laterite is a pedogenic and highly weathered natural material formed by the concentration of hydrated oxides of iron and aluminium, further oxidized to or insoluble precipitate online particles, further concentration and dehydration and subsequent cementation forms hard concretionary modules or the coalescence of particles into a hard vesicular mass of honeycomb, structure where activities may contain the host soil. Given Robert (2007), laterite is a soil or rock found in the tropics that is very high in iron, it is not considered clay because it is usually absent of silica, and a mixture of fine grains of quartz with minute scales of hydrates of alumina laterite is a pedogenic and highly weathered natural material the concentration of hydrated oxides of iron and aluminium. According to Osunade (2002), the term laterite was used to describe ferruginous, vesicular, unratified and porous materials with yellow ochre caused by its high iron content.

In recent times researchers have shifted focus to alternative materials like laterite for sand in the production of walling units, (Joshua and Lawal, 2011). Asiedu and Agbenyago (2014) studied the suitability of laterite fines as a partial replacement for sand in the production of concrete brick and concluded that the use of laterite fines as partial replacement has a significant influence on the engineering properties of brick.

MATERIALS AND METHOD

In the course of this study related texts, journals, published books and web materials were first consulted; properties of the materials were determined then the strength performance of lateritic brick produced with varying proportions of cement was investigated whether it satisfies the minimum compressive strength and requirement of Nigeria Industrial Standard (NIS) for load bearing block of strength 3.50 N/mm2.

Materials: Laterite fines, the main constituent materials used for this research were obtained from a burrow pit at Owo, Ondo State in air-dried condition. Laterites and cement were mixed before adding water and mixing manually. A hand trowel was used to fill already mixed laterite-cement mixes into 150mm x 150mm x 150mm size mould. Batching by weight was adopted. The Compressive Strength Test Machine was used to determine the load at failure of each of the samples.

Experimental Method: The sample of laterites used was air dried before being taken into the laboratory for particle size distribution test. The sample of laterites for the sieve was weighed before sieving and also the empty sieves were weighed and recorded. Then the soil sample was poured into the sieve machine and was closed and the sieving machine was switched on and allowed to sieve the samples for 15 minutes with the timing being taken by a stopwatch. After which the retained soil on each of the sieves was recorded.

Percentage of soil retained = % Weight of soil retained /Total mass of soil
The water/cement ratio adopted for this research was 0.6; a Mix ratio of cement to laterite of 1:10 was adopted.

Mixing and Moulding: The lateritic soil and cement were properly bathed and mixed before the addition of water. Cube moulds of size 150mm x 150mm x 150mm were used for the specimen. Prepared mixes were placed in the mould using a

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hand trowel and compacted twenty-five times in three layers.

Curing and Crushing: The cubes were cured by sprinkling method for 7, 14, 21 and 28 days respectively before crushing. The samples were crushed and the failure load was recorded. Extra care was taken to ensure that cubes were perfectly positioned and aligned with the axis of the thrust of the compressive machine to guarantee uniform loading on the cubes.

RESULT AND DISCUSSION

The physical properties of Laterite carried out included particle size distribution of the soil sample used. It further investigated the failure load for each of the cube samples; the compressive strength of the lateritic cube produced with varying proportions of cement was determined for each replacement level. Data obtained from laboratory tests and experiments conducted are presented in tables and figures below.

Table 1: Particles sizes distribution result for lateritic soil

Sieve Size (mm)	Weight of Empty Sieve	Weight of Sieve Soil Retained	Weight of Soil Retained	% of Soil Retained	Cumulative % of Soil Retain
3.350	488.0	572.0	84	8.4	8.4
2.360	473.0	539.0	69	6.9	15.3
1.700	464.0	532.0	59	5.9	21.2
1.180	442.0	500.0	58	5.8	27.0
0.850	423.0	466.0	42	4.2	31.2
0.425	391.0	464.0	66	6.6	37.8
0.212	353.0	423.0	46	4.6	42.4
0.150	358.0	378.0	20	2.0	44.4
0.075	354.0	356.0	2	0.2	44.6
0.063	351.0	364.0	13	1.3	45.9

Table 2: Compressive Strength of laterite Cube with cement after 7 days of curing

% Replacement	No of Samples	Failure Load (KN)	Mean Compressive Strength N/MM
100%L (Control)	1	0	
	2	0	0
	3	0	
90%L to 10%C	1	20	
	2	30	1.19
	3	30	
80% to 20%	1	35	
	2	40	1.40
	3	40	
70% to 30%	1	55	
	2	50	2.37
	3	55	
60%L to 40%C	1	90	
	2	90	4.00
	3	90	

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Table 3: Compressive Strength of laterite Cube with cement after 14 days of curing

% Replacement	No of Samples	Failure Load (KN)	Mean Compressive Strength N/MM
	1	10	
100%L (Control)	2	15	0.59
	3	15	
	1	25	
90%L to 10%C	2	25	1.19
	3	30	
	1	35	
80%L to 20%C	2	40	1.70
	3	40	
	1	60	
70%L to 30%C	2	60	2.25
	3	50	
	1	110	
60%L to 40%C	2	110	4.74
	3	100	

Table 4: Compressive Strength of laterite Cube with cement after 21 days of curing

% Replacement	No of Samples	Failure Load (KN)	Mean Compressive Strength N/MM
100%L (Control)	1	20	
	2	20	0.89
	3	20	
90%L to 10%C	1	30	
	2	25	1.25
	3	30	
80% to 20%	1	40	
	2	45	1.92
	3	45	
70% to 30%	1	80	
	2	80	3.55
	3	80	
60%L to 40%C	1	120	
	2	120	5.33
	3	120	

Table 5: Compressive Strength of laterite Cube with cement after 28 days of curing

% Replacement	No of Samples	Failure Load (KN)	Mean Compressive Strength N/MM
100%L (Control)	1	20	0.89
	2	20	
	3	20	
90%L to 10%C	1	40	1.70
	2	40	
	3	35	

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% Replacement	No of Samples	Failure Load (KN)	Mean Compressive Strength N/MM
80% to 20%	1	50	2.22
	2	50	
	3	50	
70% to 30%	1	85	3.63
	2	80	
	3	80	
60%L to 40%C	1	150	6.62
	2	150	
	3	147	

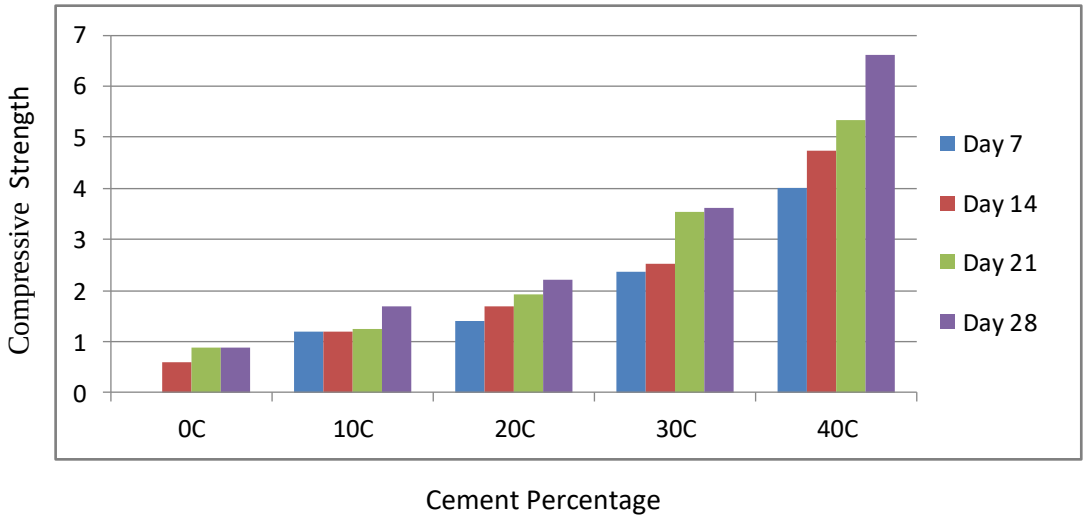


Figure 5: Compressive Strength of laterite Cube with cement after 7, 14, 21, and 28 days

CONCLUSION AND RECOMMENDATION

Based on the research carried out using varied proportions of ordinary Portland cement for lateritic brick production it was concluded that cement content in the mix increases the compressive strength of lateritic bricks: cement has a significant and positive effect on the compressive strength of lateritic brick. Hence the following were recommendations:

To achieve optimum strength of lateritic brick 40% cement content was recommended.

Lateritic brick with 30% - 40% cement content is suitable for non-load-bearing walls.

Curing of lateritic bricks should be done for a minimum of 21 days to achieve optimum strength.

The Government should establish a strict policy for proper monitoring of locally produced walling units to comply with standards as stipulated by SON.

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