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Suitability and Advantages of Using Laterite as a Soilcrete Block Material

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ABSTRACT

Laterite which is readily available and affordable in most parts of the West African countries can be used effectively in the production of blocks which is a major construction material. The suitability and advantages of using laterite have been highlighted. Soilcrete blocks were produced using 6% to 10% cement stabilization and a compressive strength of 2.15N/mm^2 with 10% cement content was obtained which is higher than the recommended value of 1.65N/mm^2 proposed by the Nigerian Building and Road Research Institute (NBRRI) for laterite blocks. Furthermore, this obtained value of compressive strength of soilcrete block can compete favourably with the recommended value of Nigerian Industrial Standard (NIS) for hand-compacted sandcrete blocks which is 2.0N/mm^2. The cost analysis gave percentage cost savings in using soilcrete block as 46.67%.

Keywords: Laterite, Soilcrete block, Compressive strength, Cost analysis

1. INTRODUCTION

With the ever increasing population in Nigeria, a West African country and the corresponding increase in demands and need for housing, which is one of the basic needs of man, there is an urgent need to focus attention on low-cost alternative building materials. Masonry unit, otherwise known as block is a major building construction material which can be made from a wide variety of materials ranging from binder, water, sand, laterite, coarse aggregate, clay to admixtures. The constituent materials determine the cost and the type of blocks which include soilcrete blocks, sandcrete blocks, clay bricks, concrete blocks, mud blocks, etc.

River sand is a major constituent used in the production of sandcrete block which is widely used in Nigeria. There is an increasing rise in the cost of river sand and this affects the production cost of blocks and consequently has made housing units unaffordable for middle class citizens of Nigeria. Also, in some parts of the country, like the northern Nigeria, there is scarcity, or even unavailability of river sand. This also affects block production in these areas but an alternative material like laterite is readily available and affordable in most parts of the country. This laterite soil can be harnessed for production of soilcrete blocks in areas where there is abundant laterite soil deposits.

Another problem is that sandcrete blocks which are widely used, are not considered the best for building in tropical countries because of their poor environmental and thermal insulating properties as a result of high degree of porosity. Cost of building is increased as a result of plastering of both the internal and external surfaces in order to improve the quality for domestic building [1].

The use of river sand in block production requires a reasonable quantity of binder to produce a solid mass. The most commonly used binder is cement which is also very expensive. All these make the use of sandcrete block expensive. However, it is economical to use laterite because very little cement is required in laterite block production [2-4].

Besides, sand is mainly gotten from dredging of river which makes them deeper and wider. This increases the tendencies of accidents occurring in our waterways thereby making them very much unsafe for those travelling by sea. Sand dredging process in the Niger-Delta and some parts of

eastern Nigeria is mainly done by the use of canoes. When these canoes are loaded with sand, it endangers the lives of the paddlers.

Consequently, this study presents the suitability and advantages of readily and affordable laterite as a soilcrete block material. So many advantages are associated with the use of laterite in block making. The use of soilcrete blocks will result in the construction of buildings with greater resistance to extreme weather conditions, fire, and bullet penetration (i.e. bullet proof). The curing process of laterite blocks is environmental friendly because they are usually covered with tarpaulin and water proof devices [2]. Soilcrete blocks can be used in the construction of structures in areas where termites, bacteria and fungi pose as hazards [5].

Several researchers have reported that laterite can be used in road and building construction [6-9].

2. MATERIALS AND METHODS

The materials used in the production of the blocks are cement, laterite, and water. Dangote cement brand of ordinary Portland cement with properties conforming to BS 12 was used [10]. The laterite was sourced from Ikeduru LGA, Imo State. The grading and properties of these fine aggregates conformed to BS 882 [11]. Potable water conforming to the specifications of EN 1008:2002 [12] was used.

Solid soilcrete blocks of size 450mm x 150mm x 225mm were produced using laterite and 6 – 10% cement content. The mix ratios are presented in Table 1. The blocks were demoulded immediately after manual compaction of newly mixed constituent materials in a mould. The blocks were cured for 28 days after 24 hours of demoulding using the environmental friendly method of covering with tarpaulin/water proof devices to prevent moisture loss. In accordance to British Standard specifications [12], the blocks were tested for compressive strength. Using the universal compression testing machine, blocks were crushed and the crushing load was recorded and used to compute the compressive strength of the blocks.

Table 1 Mix ratios for soilcrete block production

Mix ratios (w/c: cement: laterite)	Cement content (%)
0.8:1:8	10
1:1:12.5	8
1.28:1:16.67	6

3. RESULTS AND DISCUSSION

The test result of the compressive strength of the soilcrete blocks based on 28-day strength is presented in Table 2. The compressive strength was obtained from the following equation:

$$f_c = P/A \quad (1)$$

where f_c is the compressive strength

P is the crushing load

A is the cross-sectional area of the specimen

Three blocks were tested for each point and the average taken as the compressive strength of the point.

The pictorial representation of the variation of compressive strength with respect to the cement content is shown in Fig. 1

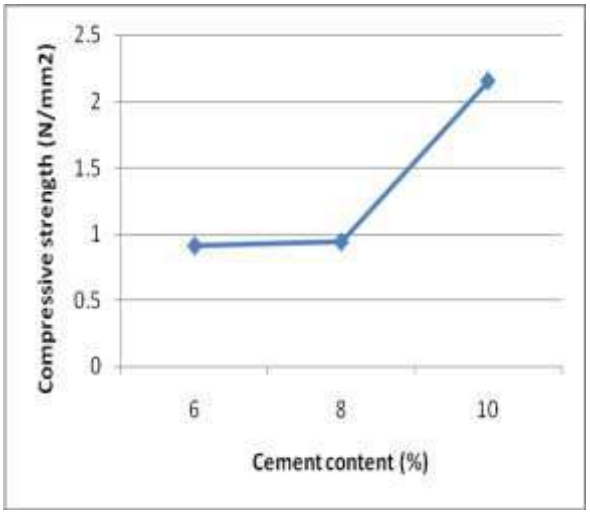

Fig. 1: Graph of strength against cement content

The maximum compressive strength obtained with 10% cement content is 2.15N/mm^2. The blocks with 6% and 8% cement content have lower values of compressive strength. Generally, from the test results and graph of Fig. 1, it can be observed that the compressive strength of the soilcrete blocks increased with increase in cement content.

Table 2: Compressive strength test results of soilcrete blocks

Exp. No.	Replicate	Mass (kg)	Density, ρ (kg/m^3)	Average Density, ρ (kg/m^3)	Failure Load (KN)	X-sectional Area (mm^2)	Compressive Strength, f_c (N/mm^2)	Average Compressive Strength, f_c (N/mm^2)
1.	A	23.6	1553.91		145		2.148	
	B	23.2	1527.57	1533.89	140	67500	2.074	2.15
	C	23.1	1520.99		150		2.222	
2.	A	22.0	1448.56		70		1.037	
	B	22.5	1481.48	1461.73	69	"	1.022	0.94
	C	22.1	1455.14		56		0.830	
3.	A	21.7	1428.81		60		0.889	
	B	21.7	1428.81	1426.61	75	"	1.111	0.91
	C	21.6	1422.22		50		0.741	

3.1 Cost Analysis

The average quantities of materials used (cement, laterite and water) per block were calculated and used in determining the cost per block as at the time of this research. It is worthy of note here that laterite can be used in areas where it is locally abundant. Hence, the cost of laterite is zero Nigerian Naira (NGN). The unit cost of the soilcrete block is as follows:

(i)	Cement: 1.4kg@ NGN36 per kg	NGN50.40
(ii)	Laterite: 23.58kg @ NGN0	NGN0
(iii)	Water: 1.8kg@ NGN2 per kg	NGN3.60
(iv)	Labour:	NGN10
Total cost per block:		**NGN64.00**

The average current market price of block within Owerri metropolis is NGN120. However, these blocks are generally substandard. A difference of NGN56.00 is obtained for soilcrete block. This difference can be referred to as the cost savings. The percentage cost savings in using soilcrete block is 46.67%.

4. CONCLUSION

1. Soilcrete blocks have been successfully produced with laterite using between 6% to 10% cement stabilization.

2. The highest value of compressive strength of soilcrete block obtained with 10% cement content is 2.15N/mm^2. The Nigerian Building and Road Research Institute (NBRRI) proposed a compressive strength of 1.65N/mm^2 for laterite blocks [14]. The

obtained strength value of blocks produced in this work is higher than the recommended value. Furthermore, this obtained value of compressive strength of soilcrete block can compete favourably with recommended value of Nigerian Industrial Standard (NIS) for hand-compacted sandcrete blocks [15]. NIS recommends that the lowest crushing strength of individual load bearing blocks shall not be less than 2.5N/mm^2 for machine compacted and 2.0N/mm^2 for hand compacted sandcrete blocks.

3. The compressive strength of the soilcrete block increased with increase in cement content.

4. The percentage cost savings in using soilcrete block is 46.67%.

5. Other advantages of using laterite as a soilcrete block material apart from lower cost include: availability; suitability in tropical regions because of its thermal insulating properties and greater resistance to extreme weather conditions; fire and bullet resistance; environmental friendliness of the curing method; and its suitability in the construction of structures in areas where termites, bacteria and fungi pose as hazards.

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