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The Suitability of Lateritic Soils for Block Making

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ABSTRACT: *The Nigerian Building and Road Research Institute (NBRRI) have used lateritic soils for block making for several years. The lateritic soil obtained from the Rivers state University of Science & Technology premises was used to produce soil - cement blocks and soil-lime blocks, with a view to comparing which of the two would be better for block making. The results show that it is the soil -cement blocks that satisfied the minimum 28 days compressive strength of 2N/mm^2 stipulated by NBRRI. It is concluded that the soil cement blocks are stronger and better for block making, since they are also cheaper.*

Key words: *Lateritic soil, soil-cement blocks, soil-lime blocks, Ordinary Port land cement, hydrated lime, compressive strength*

I. Introduction:

The distribution of lateritic soils in Nigeria together with their nature, formation, depth extent and classification has been studied by Faniran 1970, 1972, 1974 and 1978, Adekoya et al 1978. Lateritic soils have also been studied for agricultural purposes and for geotechnical purposes (Ola 1978, 1980a, 1980b, and Alao 1983). Not much attention has been paid to the use of lateritic soils for block making, inspite of its abundance in Nigeria except however, the work of Madedor (1992); Falola and Adeyeye (2007) and the work of Otoko (2014).

Stabilization is the process of improving the properties of soil by mixing additives with the soil (Bell 1993). The most commonly used additives are cement and lime (Otoko 2015a and 2015b). The cement requirement of most soils for stabilization range from 3 to 16%; while the lime requirement may however, be slightly higher.

In this study, the use of lateritic interlocking blocks for building construction, instead of the usual sandcrete blocks is reported, as the former do not require cement motar for block bonding. The properties of the lateritic soil-cement blocks are compared to the soil-lime blocks, as to find out which one is compliant with the NBRRI specification (NBRRI 2006).

Table 1 Lateritic Soil Classification Test Results

S/NO	Variables	Data
1	Depth of sampling (m)	1.0
2	Specific gravity	2.7
3	Bulk unit weight (kN/m^2)	17.8
4	Natural moisture content (%)	20.5
5	Liquid Limit (%)	29.8
6	Plastic Limit (%)	16.7
7	Plasticity Index	13.1
8	Liquidity Index (%)	0.29
9	Shrinkage Limit	11.3
10	Organic content (%)	3.4
11	pH	6.7

12	Grain size distribution (1) Clay size (%) (< 0.002mm) (2) Silt size (%) (> 0.002 < 0.075mm) (3) Sand size (%) (> 0.075mm)	 37 42 21

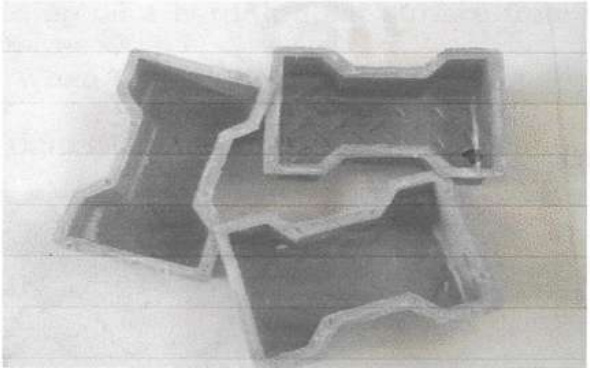

Fig. 1: Locally fabricated plastic moulds

Fig. 2: Interlocking blocks made from locally fabricated moulds

Experimental Procedures

The lateritic soil used for testing was obtained from the Rivers state university of Science and Technology premises, Rivers State, Nigeria . (See fig 3)

The lateritic soils passing sieve 6mm in accordance with (Oshodi 2004) were stabilized with lime and ordinary portland cement at 0%, 5%, 10%, 15%, 20% and 25% by weight, and used to produce interlocking soil-cement and soil-lime blocks. Strength and durability tests were carried out on the blocks after air drying and curing in accordance with the International labour organization manual (1987), NBRRI (2006) and National building code (2006).

Fig. 3: Map of Nigeria showing the location of Port Harcourt

The blocks were tested for abrasion resistance, water absorption and compressive strength. The abrasion resistance determines the durability of the blocks, and is determined by measuring the particles abraded after wire-brushing the pair of blocks 50times to and fro on all surfaces; whereas, the water absorption is determined after soaking the pair of blocks in water for 24 hours as follows :

$$W_{abs}\% = \frac{W_{soaked} - W_{dry}}{W_{soaked}} \times 100$$

where $W_{abs}\%$ = percentage water absorption
W_{dry} = weight of dry block before immersion in water
W_{soaked} = weight of soaked block

The load bearing capacity of the blocks were determined by their compressive strength, after 3,7,21 and 28 days curing. The blocks were removed from the curing tank two hours before the test, in order to ensure the dryness of the blocks, before weighing and testing. The crushing force was divided by the cross – sectional area of the block, to determine the compressive strength.

II. Results and Discussion

From Table 2, it is clear that the abrasion resistance of the blocks increases with increased cement and lime contents, from the control (0% cement and 0% lime content). This indicates that stabilization of the lateritic soil is required before using if for block making and to ensure the durability of the blocks. The cement stabilized blocks showed higher durability than the lime stabilized blocks.

Table 2. Abrasive/water Absorption test results.

Stabilizer Content	Abraded away (%)		Water Absorbed (%)	
	Cement	Lime	Cement	Lime
0	1.24	1.54	-	-
5	0.58	1.01	6.9	10.8
10	0.49	0.90	6.0	9.7
15	0.40	0.82	5.2	7.5
20	0.21	0.55	3.5	6.1
25	0.13	0.38	2.8	4.2

Unlike in the abrasion test, Table 2 shows a decrease in water absorption with increase in the cement and lime content. However the 0% (untreated) blocks dissolved in water and gave no results. Although the water absorbed by the lime blocks were higher than that of cement, all blocks satisfied the maximum water absorption of 12% specified by the Nigerian Industrial Standard (2004).

Fig. 4 shows that the cement stabilized compressive strength is directly proportional to the cement content; while Fig. 5 shows that the lime stabilized compressive strength is directly proportional to the lime content up to 10% lime content. Thereafter, the lime stabilized compressive strength is inversely proportional to the lime content. The compressive strength of the control (0% cement) is directly proportional to the curing age in both Fig. 4 and 5. However, the 5% cement stabilization at 7 and 28 days did not meet the dry compressive strength of 1.60N/mm^2 and 2.0N/mm^2 recommended by the national building code (2006). Instead, the 10% stabilization stabilized the minimum requirement by the code, and is therefore recommended for use.

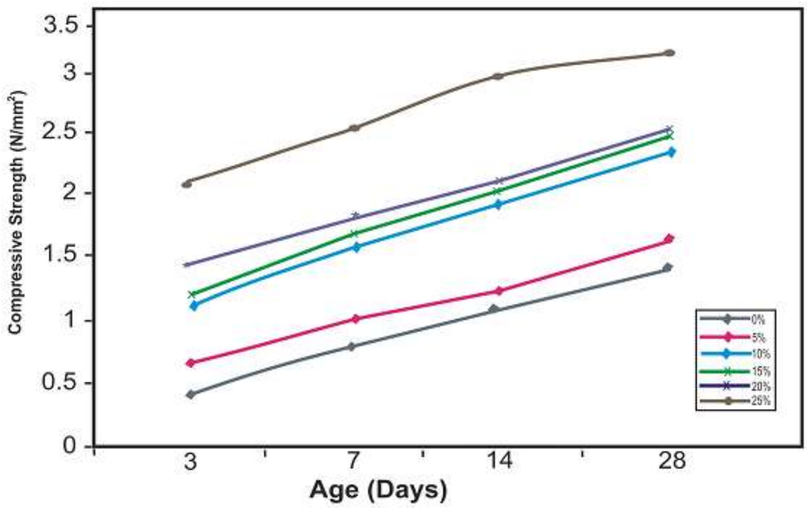

Fig. 4: Compressive strength of interlocking blocks stabilized with cement

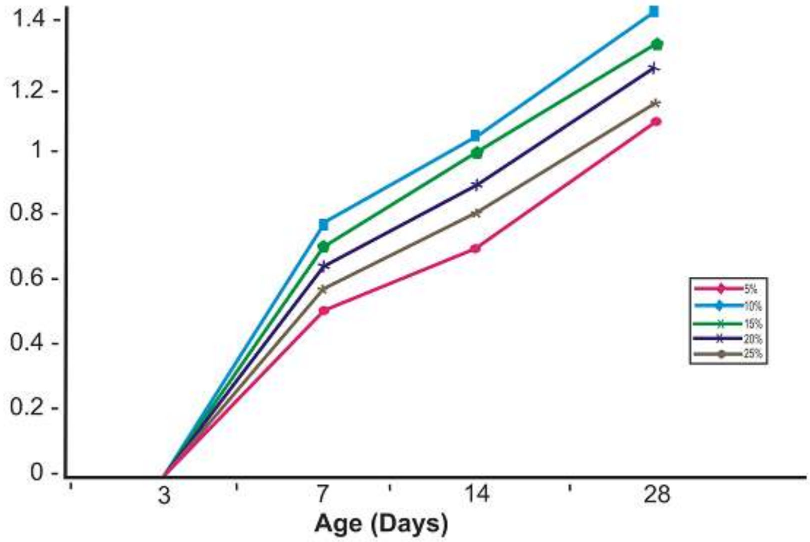

Fig. 5: Compressive strength of interlocking blocks stabilized with lime

On the other hand, lime stabilization did not follow the same pattern as cement stabilization. Although the compressive strength of lime stabilized blocks was directly proportional to curing age as in cement stabilized blocks, none of the blocks met the minimum requirements as in cement stabilized. Infact, the cubes were too weak to be crushed for compressive strength at 3 days. Also, the compressive strength was inversely proportional to lime content, beyond 10% lime content. Thus, indicating that lime stabilization is not suitable for the low clay content laterite interlocking blocks; as it would rather be suitable for high clay content soils (Bell 1993).

III. Conclusion

1. Interlocking blocks of soil-cement are of better quality than blocks of soil-lime in terms of water absorption, durability and compressive strength. 10% cement requirement is suggested as to meet up code requirement (NBRRI 2006).
2. Considering the unit cost of lime per bag, cement interlocking blocks are considered cheaper than lime blocks.

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