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Light Weight Laterite Bricks Stabilised with Cement and Sawdust for Multi-Storey Construction

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ABSTRACT

Stabilised brick has been identified for use in various areas of building construction as an environmentally sustainable, friendly and durable building material with excellent thermal properties that makes it suitable for construction in most regions with extreme climatic conditions. However, the use of stabilised bricks has not been fully incorporated into high rise building construction due to its overall weight which is one of the major considerations for multi-story buildings. This research on light weight bricks was carried out to ascertain its suitability for various applications in high rise building and engineering constructions. The production was done using different percentages of Ordinary Portland Cement (OPC) and Saw Dust (SD) to establish the percentage required for light weight construction while maintaining the optimum compressive strength required for performance in building construction comparable with that of a sandcrete block to confirm its suitability for use in multi- story construction projects. The experimental procedures used involved the use of Saw Dust obtained from the sawing process of wood at a saw mill, lateritic soil was collected from a borrow pit and ordinary Portland cement was obtained from an open market for producing the bricks. Various chemical and physical analyses were carried out on four samples of laterite soils and sawdust respectively. Liquid limits, plastic limits and water absorption of the soil samples were measured. The soils were then stabilized with cement and sawdust at 5, 10 and 15 % replacements. Bricks with size (300 x 150 x 150mm) were produced from the various mixes. After curing for 28 days, the brick samples were weighed to observe the varying degree of weight reduction with respect to the quantity of saw dust replacement. Compressive strength of the bricks was also examined to ensure that the strength of the bricks is within allowable limits for construction purposes. The reduction in weight and the corresponding compressive strength of the bricks were measured for conformity with ASTMS building codes and standards and were compared with that of a sandcrete block to establish its suitability for use in multi-story construction projects.]

Keywords: Stabilization, Lightweight, Multi-storey construction, Bricks.

1. INTRODUCTION

Due to the current economic breakdown coupled with the increasing global warming, there is the need to look inwards for local building materials that will be of good thermal property and high strength, cheap and affordable, aesthetically attractive and acceptable for all classes of building. Recent efforts have shown that blocks and bricks made from lateritic local soil can be improved upon to produce masonry units with strengths high enough to meet building standards. Akinmusura (1985) has shown that the inclusion of grids of wood or bamboo cores significantly improves the strength of walls built for appropriate use by rural dwellers.

Affordable low cost housing is one of the greatest needs of Africans in general and Nigerians in particular. Successive governments at different levels in Nigeria have focused largely and harnessed their resources towards the provision of low cost housing on a massive scale to meet the housing deficit in the country. To meet the housing needs of Nigerians, there have been calls from different stakeholders and leaders of thought on the need for the Nigerian government to focus on the development and use of locally produced construction materials in order to reduce the cost of building construction. In response to this, the Nigerian government has consistently been laying emphasis on the use of local building materials in order to reduce the demand and pressure on the imported materials. To meet the mandate on the massive provision of low-cost housing, there is the need to look inwards for local building materials that will be of high quality, durable, weather resistant, aesthetically pleasing and acceptable for all classes of building.

However, the limitation presented by the overall weight of bricks, the poor soil texture or quality, excessively low or high water absorption rate and so on have limited its use in buildings of more than one story. Various Researchers such as Oladunmoye O.M. And Olutoge F.O. (2017), Amu, O.O. et al. has been able to establish that water absorption rate of bricks can be reduced by stabilizing with pozolans like wood ash and other types of pozzolans that can increase the density of the bricks. This in a way will eventually increase its weight and makes its use to be futher limited for multistorey buildings. This research is aimed at establishing the percentage stabilisation at which the weight of bricks can be reduced for light weight construction without affecting its compressive strength and thermal properties by the addition of ordinary portland cement and sawdust to the soil mix.

Justification of the study

Due to the overall weight of existing bricks especially unfired bricks, its use has been limited to mostly bungalows and maximally one storey buildings and this has made it to be neglected as an option for multi-storey buildings. This study therefore seeks to establish the possibility of light weight stabilized bricks with higher compressive strength than most widely available ordinary bricks.

2. MATERIALS AND METHODOLOGY.

The materials required for the production of light weight compressed stabilised bricks are lateritic soil, stabiliser (cement and saw dust) and water. The stabiliser, saw dust was obtained from the saw mill as a waste product of wood processing. Cement was made available in powder form obtained from the open market. The soil may be wet or dry when it was obtained, and will probably not be homogeneous. In order to have uniform soil, it is often necessary to crush it so that it can pass through a 5 to 6mm mesh sieve. It is not only important to measure the optimum proportion of ingredients, but also to mix them thoroughly.

Mixing brings the stabiliser and soil into direct contact, thus improving the physical interactions as well as the chemical reaction and cementing action. It also reduces the risk of uneven production of low-quality bricks.

Procedures

Sieving: The oversized materials contained in the soil that are too large for use in brick production was removed by sieving using 5 to 6mm mesh sieve.

Quantity/ Proportioning of materials needed: The needed quantity of each stabilizer was determined and varied between 5% to 15% by volume. Similarly, the optimum water content (OMC) for each percentage replacement was determined experimentally. The moisture level varies widely with the nature of the soil and the type of stabilizer used. The volume of each material used in the brick making process was measured at the same physical state for subsequent batches of bricks. The volume of soil or stabilizer was measured in dry conditions. After establishing the exact proportion required of each material, a measuring device for each material was developed. Water was measured with a measuring cylinder to ascertain the actual amount of water needed for each mix type and for uniform mix.

Mixing: In order to produce good quality brick, it is very important that mixing be as thorough as possible. Dry materials was mixed first until they are of uniform colour, water is measured before addition to the first batch to know the exact quantity required per mix. Mixing continued until a homogeneous mix is obtained, it was performed manually on a hard surface with shovels.

Brick moulding: moulding was done with mould size (300 x 150 x 150mm) and was used to manufacture bricks of uniform size and density, special precautions was taken to fill the mould with the same amount of mix for each compaction by using a measuring device. To facilitate development of the pressed blocks and to ensure good neat surfaces it is advisable to moisten the internal faces of the machine mould with a mould releasing agent (oil) which can be applied with either a rag, brush or spray. Figure 3.1 shows the stabilised bricks produced after curing and is ready for further tests such as compressive strength test, water absorption test, thermal properties and durability tests. Figure 3.2 (a) and (b) shows the samples of bricks with varying percentage of stabilisation and their behaviour under load during compressive strength test.

Figure 3.1: Produced bricks after curing

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Curing of bricks: As it is a basic requirement for all cementitious materials to achieve maximum strength, compressed stabilized bricks need a period of damp curing, where they were kept moist for the moisture of the soil mix to be retained within the body of the brick for a few days to prevent dry shrinkage. Various methods are used to ensure proper curing. Such methods include the use of plastic bags, grass, leaves, etc. to prevent moisture from escaping. A minimum of 28 days is recommended to cure bricks.

3. TESTING

Average Weight Of Bricks

The average weight of the brick samples of size 150mm x 150mmx 150mm were measured after demoulding and subsequently at an interval of 7days till final curing when the bricks had reached its maximum drying. The percentage change in weight for the different samples was recorded noting the one with maximum weight loss. There was a significant decrease in weight up to 20% after 28th days in samples with 10%, and 15% sawdust replacement. The bricks were further tested for compressive strength.

Compressive strength test

There is the need to ascertain the compressive strength of the bricks in order to ensure its ability to withstand various forms of imposed load despite its reduction in weight due to addition of saw dust. Hydraulic machine with maximum capacity of 3000KN, types SWP 300 EM1, Masch Nr. 6329 was used for crushing. Average maximum compressive force for the 4 brick samples for each grade was determined and recorded for computation of compressive strength which was conducted in accordance to British Standard (BS 1881, 1983).

Water Absorption Result for Saw Dust Stabilised Brick (MIX 4 and 5)

Table 1: Water absorption test for cement and sawdust stabilized laterite

Sample (%)		28 Days	56 Days	90 Days
Control (0%)		**30.81**	**30.01**	**25.11**
Sample with 5% cement with saw dust variation MIX 5A	**5C**	**28.88**	**24.11**	**22.03**
	5C5SD	28.71	25.62	25.01
	5C10SD	29.51	28.31	28.21
	5C15SD	28.58	28.10	25.01
Sample with 10% cement with saw dust variation MIX 5B	**10C**	**29.02**	**23.02**	**20.05**
	10C5SD	25.08	24.98	24.61
	10C10SD	23.92	23.90	22.85
	10C15SD	24.85	24.55	24.45
Sample with 15% cement with saw dust variation MIX 5C	**15C**	**22.69**	**21.41**	**21.30**
	15C5SD	20.81	20.61	20.41
	15C10SD	15.76	15.66	15.01
	15C15SD	16.51	16.41	15.58

Figure 3.2 (a): Compressive strength tests

Figure 3.2 (b): Compressive strength tests

4. RESULTS

The optimum value for water absorption of Saw Dust stabilization was obtained at 15% Cement and 10% saw Dust replacement. Optimum compressive strength of 3.42 N/mm^2 was achieved at 15% stabilization of Cement and Saw Dust which falls within the recommended range of 2.5 to 3.5 N/mm^2 for stabilized brick. The average weight of this saw dust stabilized brick has up to 20% reduction in weight when compared with the conventional stabilized brick thereby making it comparable with that of a sandcrete block and thus confirms its suitability for use in multi-story construction projects.

5. SUMMARY AND CONCLUSION.

This study was able to establish the percentage stabilisation of laterite for production of compressed stabilised bricks (with length, width and height less than or equal to 300mm, 150mm and 150mm respectively) for light weight construction of load bearing and non-load bearing walls and other civil engineering applications especially in multi-story buildings. The method of production involves the stabilisation of lateritic soil with cement and then using saw dust (a form of waste product management) to reduce the overall weight of the bricks by 20% after drying. These production processes includes mixing of lateritic soil with the cement and saw dust, moulding, demoulding, curing and testing methods and all in accordance with the ASTM standards. Thus the bricks can be used for general and specialised construction in high rise buildings comparatively with concrete blocks as load bearing and non-load bearing wall due to its greatly reduced weight while its strength is even of greater value.

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