Supported by tetfund TERTIARY EDUCATION TRUST FUND

EARLY AGE STRENGTH PROPERTIES OF ANTHILL-SANDCRETE BLOCKS

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Received: September 03, 2017 **Accepted:** January 30, 2018

Abstract: This study assesses the early strength characteristics of sandcrete blocks made by replacing fine aggregate (sand) with anthill material. Normal mixing proportion of 1:6 (cement to sand) was used for the production of the control mix and other mixes by replacing the fine aggregate by weight of 10, 20, 30 and 40% using the absolute volume method. Six (6) inches (450 × 225 × 150 mm) blocks were produced from the mixes, cured by sprinkling water for 3, 7, and 14 days and tested for their respective compressive strengths at those ages. Result obtained indicate that the compressive strength of the blocks increases with increase in the anthill content which is here attributed to the increased binding effect of the anthill material in complementing the traditional function of cement in the mix. Results obtained also show that the optimum content of anthill in production of anthill-sandcrete blocks is 20%. This leads to mixes that are of good workability and resulting in blocks also of reduced honeycombs and cracks with compressive strength at 14 days age adequate for use in framed building project with reference to the Building Code: 2000 standards.

Keywords: Anthill, sancrete blocks, load bearing walls, compressive strength

Introduction

Sandcrete blocks are composite material that comprises of cement, sand, and water moulded into standard mould of various dimension and of different quality depending on composition of the constituent materials. They are used as walling units in building structures either as load bearing or non- load bearing elements as well as in foundations. Where it is used as load bearing they are designed to wholly support and transferring live and dead load from the overlaying structural element to the foundation footing of a building. Therefore, load bearing Sandcrete blocks acts as a support for the entire structure to spread the weight to the ground surface below in order to maintain equilibrium. Non load-bearing sandcrete blocks are generally of low compressive strength susceptible to failure when loaded or when subjected to serviceability concerns as in vibration activities.

Normal sandcrete blocks as described above are assessedafter continues curing at 28th day agewhere it is known to have attained adequate strength for building application. The recommended strength at this age for non-load bearing blocks are put at 1.75 and 2.0 N/mm^2 by the Nigerian National Buiding Code, British standard respectively(Building Code, 2006; BS 2028, 1970). The Nigerian Industry Standard however puts it at 2.5 to 3.45 N/mm^2. (NIS 87:2004, 2004)

In construction projects where time is of essence or where for some reasons it is intended that theproject be completed ahead of normal schedule date; allowing fresh block moulds for 28 days before used may be at conflict with the aforementioned objectives as the block strengths below the 28th day age are generally low for use.

In view of the above, this study, thus, seeks to explore means of improving on the early strength development and reduce cost of production of normal sandcrete blocks by using ant-hill materials in partial replacement of fine aggregate in the mix.

Anthill are piles of earth produce by the activities of ants especially earthworms and termites at the entrance of their dwellings as they transport large quantities of material from within the soil anddepositing them on the surface. Some of the termite moulds (anthill) are about 5 meter tall and 7 meters in diameter and are largely brownish grey in color, formed over a long period of time. Anthill materials are generally plastic when wet and become hard, brittle and non- plastic when dry.

Report (Adjei-Henne, 2009) indicates that the anthill soil have already found useful applications in production of ceramics, fuel saving bricks-when mixed with grass and sand and fuel saving stoves when mixed with ash. Anthills are also used as waterproof liner for ponds and dams.

Studies on the properties of solid and hollow laterite blocks often stabilized with cement have also been active in recent times (Aboshio *et al*., 2017; Agbede and Joel, 2008; Aguwa, 2010; 2009). From these studies the compressive strengths of the laterite-blocks are of wide range chiefly due to varied soil types used, content of the stabilizing agent,the compaction pressure and type/nature of compaction employed duringproduction.

Reportsalso show that the optimum cement content for stabilizing typical lateritic soils, which may also be adapted for the anthill-sandcrete blocks being studied, should range between 5 to 10 percent by weight of the laterite. The plasticity index of the laterite material should be in the range of 15 to 25 with preference for materials with plasticity index of less than 20 (Walker, 1995; Mesbah, 2004).

Materials and Method

Materials

The following materials were used in this study for the production of the anthill-sandcrete blocks:

a) Anthill soil material
b) Fine aggregate of natural source
c) Cement

Anthill soil material

The Anthill used wasobtained locally on a site along Bunu Sherif Musa Road in Bayero University, Kano staff quarters at varying depths up to a maximum of 1 m below the surface or to the formation level of the anthill. The required quantity of the material was obtained and taken to the Civil Engineering Laboratory where it was crushed, air dried and sieve based on standard procedure.

Fine aggregate

The river sand used for this study was obtained from River Challawa. It was noted to be clean, sharp and does notcontain particles like clay, loam, dirt, organic or chemical matter.

Cement

The cement used in this research work is Ordinary Portland Cement manufactured in Nigeria by Dangote Industries Ltd (Dangote3x cement, grade 42.5).

Water

The water usedin this study was obtained from Civil Engineering Laboratory reservoir; the water inside the reservoir is a tap water, meeting the standard of BS5328 (1997) for water requirement for mixing concrete.

Methods

Sieve analysis

Sieve analysis of both fine aggregate and the anthill material were carried out in accordance to with BS EN 933-1 (2012) and (BS 812 Part 1, 1975).The fine aggregate is sharp sand with a bulk density of 1899.50 kg/m^3 and moisture content of 2.50%. The results show that the fine aggregate falls within zone 1 based on (BS 882, 1992) grading limits while the anthill material are largely of very fine grain particles with about 99% passing the 75 µm sieve.

Mix proportion

The proportion of the materials were calculated using the absolute volume method for the control mix of 1:6 (cement: sand) and for other mixes with percentage replacements of sand at 0. 10, 20, 30, and 40% for the mixes considered for the sandcrete blocks measuring 450×150×225 mm and effective area of 41900 mm^2

Atterberg's limit test

This was conducted in accordance with (BS 1377, 1990). The Plasticity Index of the anthill material was obtained as 7.6 Hence classified based on the Unified Soil Classification System as a poorly graded silty-clay mixture

Compressive strength test

The compression strength test was carried out using the Avery Dennison Universal testing Machine (UTM) for anthill-sandcrete blocks at the ages of 3 days, 7 days, and 14 days of the early ages of the sandcrete blocks.

Results and Discussion

Compressive strength

Tables 1 to 3 show the compressive strength results and maximum loads for the various mixes indicated in Section 2 for ages three (3) to fourteen (14) of the cured sandcrete blocks

Table 1: Three days age sandcrete blocks compressive strength

Mix type	Age (days)	Compressive Strength (N/mm2)	Average Compressive Strength	Standard Deviation
Control, i.e. 0% Anthill	3	0.45 0.47 0.44	0.45	0.02
10% Anthill	3	0.53 0.52 0.5	0.53	0.02
20% Anthill	3	0.63 0.61 0.6	0.63	0.02
30% Anthill	3	0.66 0.68 0.63	0.66	0.03
40% Anthill	3	0.62 0.68 0.64	0.62	0.03

Results from Tables 1 to 5 and as depicted in Fig. 1 shows that the three days age strength of the anthill-sandcrete blocks increases with increase in the content of the anthill material up to 30% replacement of the sand beyond which no appreciable increase in strength was observed.

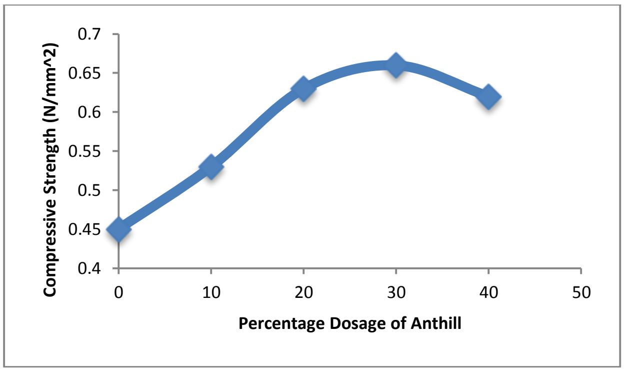

Fig. 1: Effect of anthill on the 3 days age compressive strength of sancrete blocks at varying percentage replacement of sand with the anthill

Table 2: Seven days age anthill-sandcrete blocks compressive strengths

Mix type	Age (days)	Compressive Strength (N/mm2)	Average Compressive Strength	Standard Deviation
Control, i.e. 0% Anthill	7	0.84 0.82 0.79	0.84	0.03
10% Anthill	7	1.01 1.04 0.97	1.01	0.04
20% Anthill	7	1.12 1.21 1.03	1.12	0.09
30% Anthill	7	1.22 1.2 1.21	1.22	0.01
40% Anthill	7	1.21 1.22 1.23	1.21	0.01

In contrast to the sharp increase in the compressive strength results obtained for the three days age blocks; the seven days age strength presented in Tables 6 to 7 and depicted in Fig. 2 has a gentle rise in strength with the maximum strength recorded at 30% replacement of sand with the anthill.

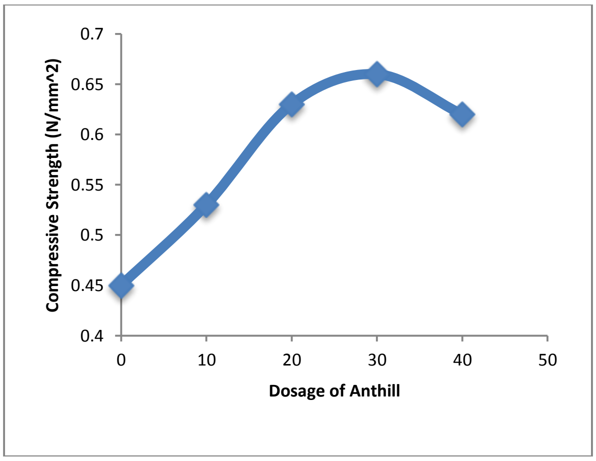

Fig. 2: Effect of anthill on the 7 days age compressive strength of sancrete blocks at varying percentage replacement of sand with the anthill

Table 3: Fourteen days age anthill-sandcrete blocks compressive strengths

Mix type	Age (days)	Compressive Strength (N/mm2)	Average Compressive Strength	Standard Deviation
Control, i.e. 0% Anthill	14	1.61 1.69 1.62	1.61	0.04
10% Anthill	14	1.68 1.74 1.71	1.68	0.03
20% Anthill	14	1.91 1.95 1.86	1.91	0.05
30% Anthill	14	2.05 1.75 1.98	2.05	0.16
40% Anthill	14	1.95 2.06 1.98	1.95	0.06

The fourteen days strength presented in Tables 10 to 15 and as also depicted in Fig. 3 also shows a sharp increase in the compressive strength with the varying percentages replacementof the find aggregate with the anthill. The increase here is more pronounced with sand replacement of up to 20% after which there was no appreciable increase in the compressive strengths of the blocks.

For all the results presented as summarily also presented in Figure 4; it can be seen that by replacing the fine aggregate-sand (which is cohesionless) with the anthill (which is cohesive) appreciable early age compressive strengths of the sandcrete blocks can be achieved. This is here attributed to the complementary role the anthill material plays in the mortar mix, in that the anthill as well as the cement act as binders in the mix thereby increasing the bond between the particles of the mix and hence the increase in the early strength properties of the blocks as reported.

Optimum anthill content however, was observed to be 20% in replacement of the fine aggregate. Anthill contents in excess the 20% results in mixes with poor workability leading to blocks with high honeycombs and cracks of varying widths. These effects were also observed to increase with increase of the anthill content beyond 20%.

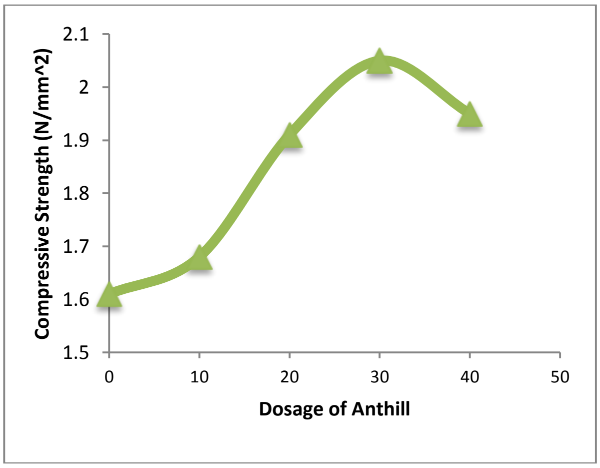

Fig. 3: Effect of anthill on the 14 days age compressive strength of sancrete blocks at varying percentage replacement of sand with the anthill

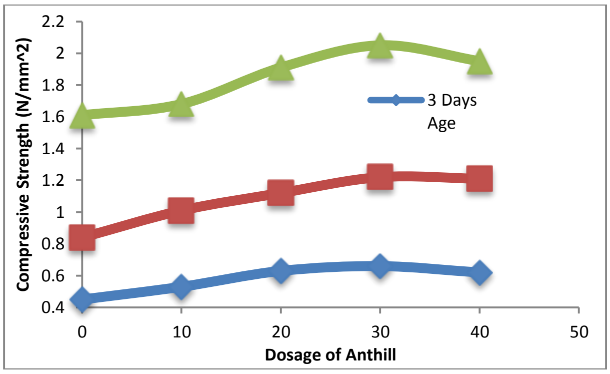

Fig. 4: Effect of anthill on the 3, 7 and 14 days age compressive strength of sancrete blocks at varying percentage replacement of sand with the anthill

Conclusion

In this study, early age compressive strength properties at 3, 7 and 14 days of a 1:6 (cement:sand) ratio control mix as well as those with varying percentage replacements of the fine aggregate with anthill were assessed. Results from the study indicate that:

a. Anthill material used in this study is a poorly graded clayed-silt of high plasticity;
b. Workability of anthill-sandcrete blocks mixes reduces with increase in anthill content beyond 20% thereby leading to formation of honeycombs and cracks in the blocks
c. The early compressive strengths of anthill-sandcrete blocks increases with increase in the anthill content;
d. The strength increase when compared with the control indicate 18% increase in strength at 3 days age, 20% at 7 days and 25% at 14 days age with 40% anthill content;
e. Optimum content of anthill in partial replacement of fine aggregate in a 1:5 (cement: fine aggregate) homogeneous mix is 20%. This has average compressive strengths of 0.54, 1.00 and 1.91 N/mm^2 at ages 3, 7 and 14 days respectively. The 14 days age strength met/surpasses the minimum set by the Building Code for use for a non-load bearing wall.

References

Aboshio A, Zayyad IB, Naim G & Uche OAU 2016. Assessment of the strength properties of cement stabilized solid laterite blocks. Proceedings of NIMACON 2016 Conference, Zaria, pp. 604 – 607.

Adjei-Henne G 2009. Anthill as a resource for ceramics. A Ph.D Thesis Submitted to the scholl of graduate studies, Kwame Nkrumah University of Science and Technology, Ghana.

Agbede IO & Joel M 2008. Use of cement-sand admixture in laterite brick production in low cost housing. Leonardo Electron. *J. Pract. Tecnol.*, 163–174.

Aguwa JI 2009. Study of compressive strength of laterite-cement mixes as a building material. *AU J. of Techn.*, 114–120.

BS 812 Part 1 1975. Method for determining particle size. British Standard Institution, London.

BS 882 1992. Specification for aggregates from natural sources for concrete. British Standard Institution, 2 Part Street London.

BS EN 933-1: 2012. Tests for geometrical properties of aggregates. Determination of particle size distribution. Sieving method. British Standard Institution, 2 Part Street, London

BS 1377 1990. Methods of testing soils for civil engineering purposes. British Standard Institution, 2 Part Street London.

BS 2028 1970. Precast Concrete Blocks. Her Majesty Stationery Office.British Standard Institution, 2 Part Street, London, England.

BS 5328-2: 1997. Concrete.Methods for specifying concrete mixes.British Standard Institution, 2 Part Street, London.

Building Code 2006. Nigerian National Building Code. Federal Republic of Nigeria.

NIS 87:2004, NIS 2004. Standard for Sandcrete Blocks. *Standards Organisation of Nigeria*.