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INFLUENCE OF CEMENT GRADE ON STRENGTH PROPERTIES OF SANDCRETE BLOCKS

*** [1]Nuruddeen, M. M., [2]Ma'aruf, A., and [3]Murtala, S. A.**

[1 2 3] Department of Civil Engineering, Kano University of Science and Technology, Wudil Kano State, Nigeria

*Corresponding Author Email Address: mnuruddeeen@gmail.com Tel: +2348037881713

ABSTRACT

This paper presents the result of experimental investigation to determine the influence of cement grade on compressive strength of hollow sandcrete blocks. 27 numbers of 225 x 225 x 450mm hollow sandcrete blocks were produced with three types of cement (Type 1 (grade 42.5), Type 2 (grade 32.5) and Type 3 (grade 32.5)) and were tested for density, compressive strength and water absorption. From the test results, the density of sandcrete blocks is higher in grade 42.5 than in grade 32.5. Also, the water absorption is lower in blocks with cement grade 42.5. Furthermore, the compressive strength is higher in sandcrete blocks with cement grade 42.5. It is concluded that higher cement grade improves the performance of hollow sandcrete blocks. It is therefore recommended that cement grade 42.5 should be used for sandcrete blocks production.

Keywords*: Sandcrete blocks; Cement grade; density, compressive strength, water absorption*

INTRODUCTION

Hollow sandcrete block is a building material made from Portland cement and sand, and moderately compacted into shapes(Oyekan & Kamiyo, 2008; Tyagher, Utsev, & Adagba, 2011). While researchers like (Oyetola & Abdullahi, 2006) define sandcrete blocks as walling units made from course natural sand or crush stone dust mixed with binder and water pressed to shaped. Hollow Sandcrete block is a commonly used building material in Nigeria, whose significant as part of local building materials cannot be over emphasized in building and construction industry of the country (Abdullahi, 2005; Anosike & Oyebade, 2012). The incessant occurrences of building collapse in Nigeria and its attendant loss of lives and properties have become worrisome and of great concern. These failures have been attributed to various reasons, among which is a poor quality and sub-standard building material, notable among them sandcrete blocks (Hijab, Halilu, & Hadi, 2010; Oladeji & Awos; Omopariola, 2015).

Compressive strength of blocks is a measure of their resistance to load application when placed in the crushing machine and is indeed a very important feature (Boob, 2014). Various factors are found to affect the strength of hollow sandcrete blocks, these includes the: quality, grading and density of fine aggregates/sand, curing conditions, quality control, vibration time, amount of water used, cement-sand mix ratios, cavity volume, centre-web to end-web ratio and the cement type and grade (Adewole, Ayininula, Ajagbe, & Akinade, 2014). The Nigeria Industrial Standard (NIS-87, 2004) specified that the compressive strength shall be the average compressive strength of five blocks and shall not be less than 3.45N/mm^2 for load bearing walls and 2.5N/mm^2 for non-load bearing walls for machine vibrated blocks and shall not be less than 2.45N/mm^2 for load bearing walls and 1.8 N/mm^2 for non-load bearing walls for hand compacted blocks.

Cement is a major constituent of sandcrete blocks and is manufactured in different grades. The grade of cement refers to its compressive strength at 28 days. When tested, if the 28 days strength is less than 32.5N/mm^2, it is called 32.5 grade of cement. If the 28 days strength lies between 32.5 to 42.5N/mm^2, it is called 42.5 grade of cement. If the 28 days of strength lies between 42.5 to 52.5N/mm^2, it is called 52.5 grade of cement (Jackson & Dhir, 1996). Currently, In Nigeria, there are 32.5 and 42.5 grades of cements, with 32.5 grades being phased out gradually. Few published works ((Adewole et al., 2014; Umasabor & Alutu, 2015)) existed on the effect of cement grades on the compressive strength of hollow sandcrete blocks and they have varying results. (Adewole et al., 2014) concluded that the compressive strengths of hollow sandcrete blocks produced with Portland-limestone cement grade 42.5 are higher than the sandcrete blocks produced with cement grade 32.5. While, (Umasabor & Alutu, 2015) concluded that that cement grade does not translate to sandcrete strength.

Therefore, the aim of this research is to ascertain the influence of cement grade on the compressive strength of hollow sandcrete blocks.

MATERIALS AND METHODS

MATERIALS

Cement

Three types of Portland-limestone cements were used in conducting this research. They were Dangote cement of grades 42.5 and 32.5 (hereafter called "Type 1" and "Type 2") and Bua cement grade 32.5 (hereafter called "Type 3"). They all complied with CEM II of (NIS-44., 2003) Part 1.

Fine Aggregate

River sand was used as fine aggregate, it is clean, sharp and free from clay, loam, dirt and any other deleterious materials. The fine aggregate is dried so that water cement ratio would not be affected. The sieve analysis was conducted on the aggregate.

Water

The water used for the research was free from salt and other deleterious materials.

METHODS

Hollow Sandcrete Block Production

Sandcrete hollow blocks of sizes 225 x 225 x 450mm were produced using the three grades of cements and the materials described in 2.1. The mix ratio used was 1:6 (one part of binder to six part of sand). The sandcrete blocks were mechanically produced using block moulding machines. Nine (9) numbers of blocks were produced for each grade of cement, a total number of 27 blocks were cast. The sandcrete blocks were air-cured for 24 hours and thereafter watered in the morning and evening for 7, 14 and 28 days.

Compressive Strength Test

The compressive strength of the block samples was determined in accordance with (NIS-87, 2004). The weights of the block samples were taken before the compressive strength test was conducted. Five sample blocks made from the three different grades of cements were crushed each at 7, 14 and 28 days.

Water Absorption Test

The water absorption test was conducted on the block samples in accordance with (NIS-87, 2004) at 28 days.

RESULT DISCUSSION

Particle size distribution of fine aggregate

The result of particle size distribution of fine aggregate is presented in Figure 1.

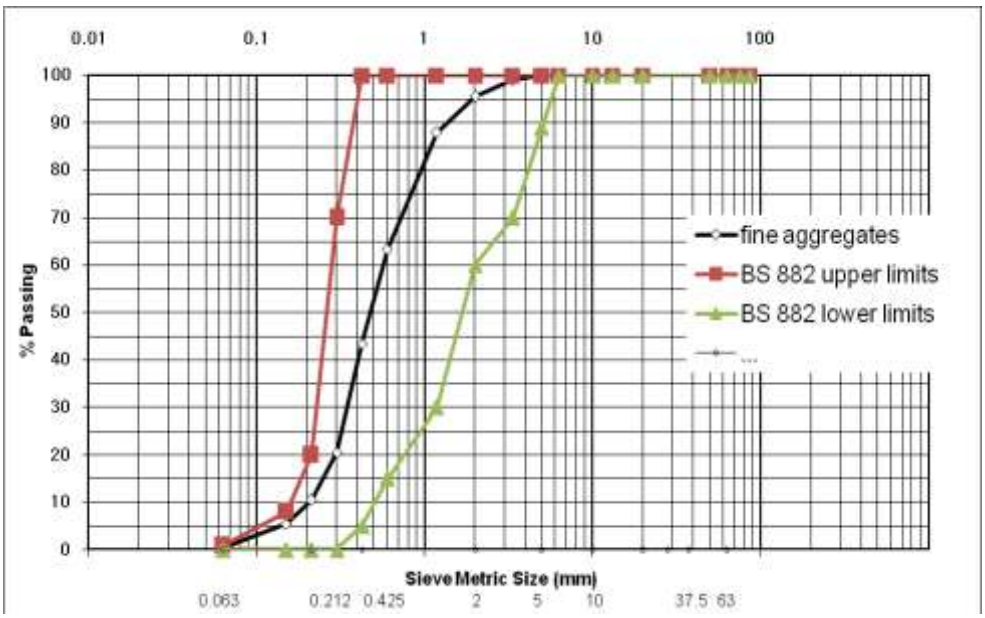

Fig. 1: Particle size distribution of fine aggregate

From Figure 1, the fine aggregate falls into zone 2 of the BS 882 (BS882, 1983). Hence the fine aggregate is suitable for making sandcrete blocks.

Hollow sandcrete blocks density.

Figure 2 shows the result of density test for sandcrete blocks having different cement grades.

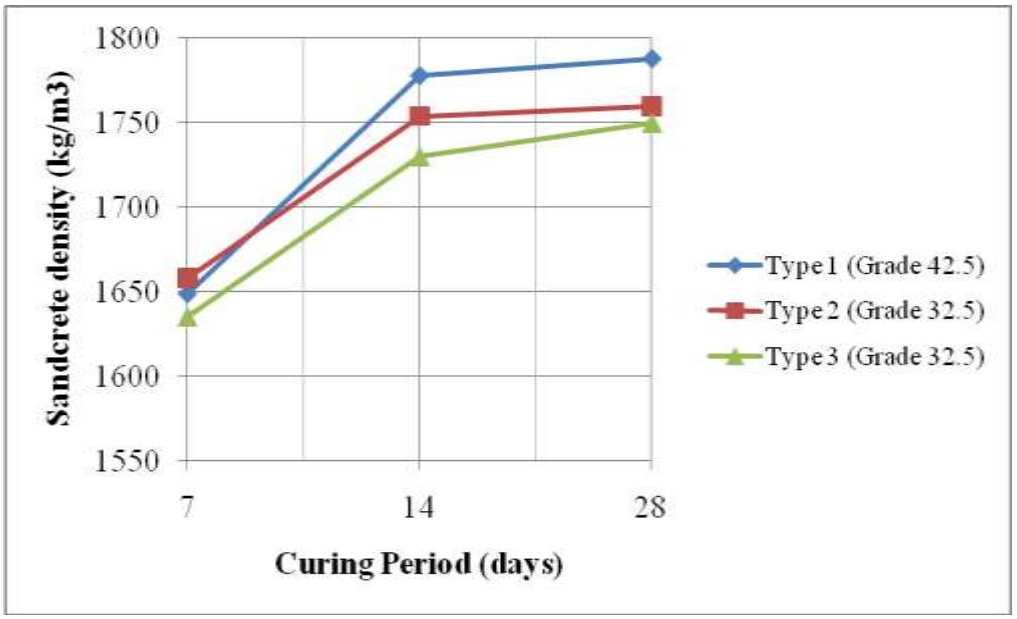

Fig. 2: Effect of cement grades on sandcrete density.

From Figure 2, the density of the blocks increases with an increase in the cement grades and the curing period (i.e. the higher the cement grade the higher the density and vice-versa). This implies that cement grade 42.5 produced denser sandcrete block than cement grade 32.5.

Water Absorption

Water absorption is the measure of the amount of water that block absorbed in a specified period of 24 hours in cold water. This test was conducted in accordance with NIS 87:2004. The result of the test is presented in Figure 3. The amounts of water absorbed by the blocks are within the limit specified by the code (absorbed water shall not exceed 12% of the dry mass). Type 1 (grade 42.5) has lower water absorption than both the Type 2 (grade 32.5) and Type 3 (grade 32.5). Determination of water absorption is of importance in knowing how the block will perform under moist or wet condition. The result therefore shows that sandcrete made with Type 1 (grade 42.5) performed better.

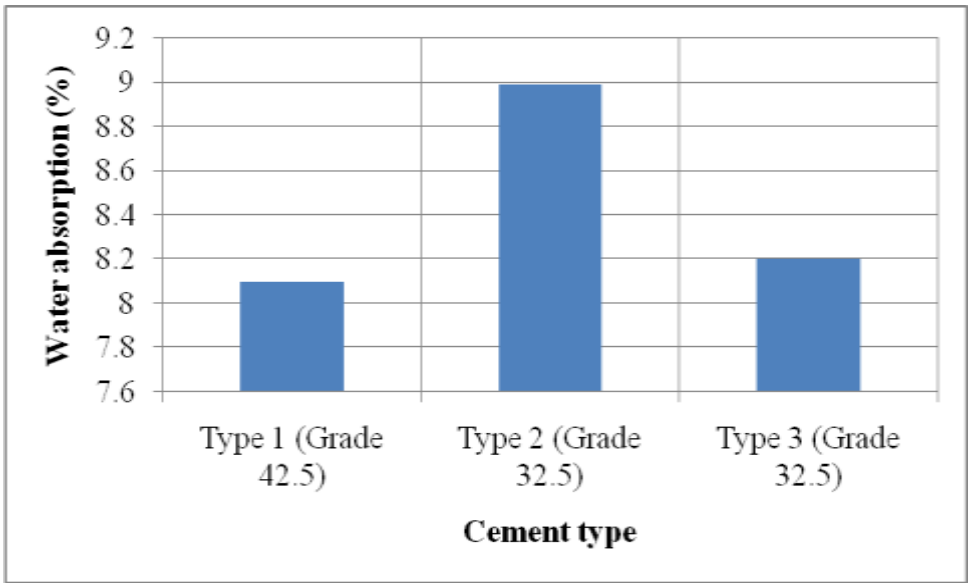

Fig. 3: Sandcrete water absorption at 28 days for different cement grades

Compressive Strength

The summary of compressive strength test result on sandcrete blocks with different cement grades after 7, 14 and 28 days of curing is presented in Figure 4. According to NIS 87:2004, the average minimum compressive strength of load bearing hollow blocks for machine compaction is 2.5N/mm^2. In view of this, all the samples have conformed to the standard.

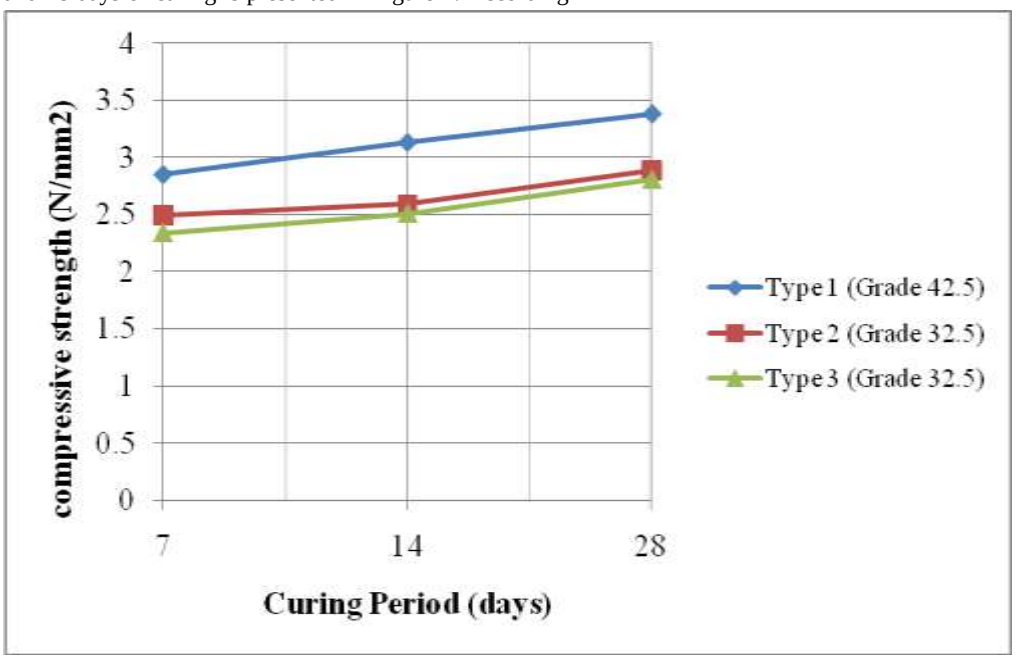

Fig. 4: Effect of cement grade on sandcrete compressive strength

The Type 1 (grade 42.5) cement exhibits higher compressive strengths than that of Type 2 (grade 32.5) and Type 3 (grade 32.5) at all ages. This is in agreement with earlier work by (Adewole et al., 2014). From the result, the sandcrete block compressive strength of grade 42.5 (Type 1) is higher than that of grade 32.5 (Type 2 and Type 3) by 18% (average) at 7 days, 23% at 14 days and 19% at 28 days. This implies that even though all the cements are suitable for making sandcrete blocks, grade 42.5 perform better.

CONCLUSIONS

From the experimental study, it can be concluded that use of higher cement grade improves sandcrete blocks

compressive strength, increase its density and reduce its water absorption capacity. It is concluded that higher cement grade improves the performance of hollow sandcrete blocks. With incessant building collapse in Nigeria, the use of higher cement grade will help in reducing the incidences and is highly recommended.

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