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AN ASSESSMENT OF THE COMPRESSIVE STRENGTH OF SOLID SANDCRETE BLOCKS -IN IDIROKO AREA OF NIGERIA

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ABSTRACT
Sandcrete block is a major component of building construction in Nigeria and in many other nations of the world. The durability of a building is to a great extent determined by the properties of the various components of the building in which sandcrete blocks is major. This paper examines the dry density and compressive strength 100mm and 125mm blocks. Visits were made to Idiroko area of Ogun State where solid blocks of smaller thickness (100mm and 125mm) is being used for building construction and the practice is fast gaining ground. Physical inspection of buildings constructed with these types of blocks was carried out and samples of both types of blocks were collected for laboratory tests. After analysis, the experimental results obtained from the laboratory tests reveals that the solid blocks of smaller thickness meet the required standard in terms of dry density and strength. From the study, values of the dry density, wet compressive strength and dry compressive strength of 100mm and 125mm used for building construction in Idiroko Area of Ogun State, Nigeria are hereby presented.

KEYWORDS: Sandcrete Blocks, Durability, Standard, Dry Density, Compressive Strength.

INTRODUCTION

One of the major challenges and problems identified in the developing countries in this twenty first century is provision of shelter. There is need to make housing affordable and accessible to the people so as to overcome this challenge. Lack of housing and its expensive nature has generated special attention by successive government of Nigeria which have formulated several policies to bring housing within the reach of the masses. The Nigerian government as part of its effort at overcoming housing problem initiated the building of low cost houses for labour and low income earners (low earning people) and established factories to produce localized building materials. The need for locally manufactured building materials has been emphasized in many countries of the world, and that there is imbalance between the expensive conventional building materials coupled with depletion of traditional building materials (Aguwal, 2009). He suggested that this situation can be addressed by paying attention to low-cost alternative building materials. Past and present governments in Nigeria had formulated various policies aimed at solving housing problems faced by the citizens of this country, none of which has yet yielded positive concrete results. There is no gain - saying in the fact that housing is beyond the reach of low-income earners as a result of build-up costs of houses. The reason for this is not far-fetched as the cost of building material such as cement, roofing sheets, sanitary fittings, planks; blocks etc. are sky rocketing day after day.

The astronomical increase in the cost of cement has untold effect on the cost of building blocks. Block on the other hand, is part of the structural components of a building and the cost is a significant part of the budget for putting up a building. Joshua and Lawal (2011) stated that the major factor affecting the construction industry in developing nations is the cost of building materials most of which have to be imported. All these notwithstanding, housing designs meant for the low income earners fail to give due consideration to the income level of this category of people in their conception as such designs often done to suit the taste of the rich putting the low income earners at bay. As a result, peasants and low-income earners have resorted to sourcing for cheaper means of providing materials for building construction at the prices that are affordable to them. According to landlords and estate developers interviewed at Idiroko area of Ogun State, the use of 100mm and 125mm solid sandcrete blocks for building construction is one of such means.

BACKGROUND TO THE STUDY

Montgomery (2002) defined sandcrete block as blocks made or moulded with sand, water and cements which serve as a binder. Oyetola and Abdullahi (2006) defined Sandcrete blocks as comprising of sand, water and binder, stating that cement as a binder, is the most expensive input in to the production of sandcrete blocks. They further affirmed that producers of sandcrete blocks produce blocks with low Ordinary Portland Cement (OPC) content so as to make it affordable to people and with much gain. They are of the opinion that the poverty level amongst West African counties and particularly Nigeria has made these low quality blocks widely acceptable among the populace so as to minimise the cost of construction works. Sandcrete blocks have been in use in many nations of the world including Nigeria for a long time (Oyekan and Kamiyo, 2008). "Hollow Sandcrete blocks containing a mixture of sand, cement and water are used extensively in many countries of the world especially in Africa. In many parts of Nigeria, sandcrete blocks forms one of the major cost component of the most common buildings" (Oyekan and Kamiyo, 2011). It possesses an intrinsic low compressive strength hence its susceptibility to seismic activity. According to Abdullahi (2005), past research conducted by other researchers has revealed dismal production result of commercial sandcrete blocks which exhibit compressive strength far below standardized strength for construction. Sandcrete blocks are classified as solid, hollow or cellular.

According to Ettu, Mbarjiogu and Arimanwa (2013) many researchers have investigated various aspects of sandcrete blocks as a constructional material. Banuso and Ejeh (2008), Abdullahi (2005) Afolayan, Arum and Daramola (2008) found out that tested samples of sandcrete blocks in Kaduna State, Minna and Ondo state of Nigeria respectively, exhibits compressive strengths far below that recommended in the British standard of 3.5N/mm2 and NIS standard of 2.5N/mm. Baiden and Tuuli (2004) confirmed that mix ratio, materials quality and mixing of constituent materials affect the quality of sandcrete blocks. Wenapere and Ephraim (2009) found out that the compressive strength of sancrete blocks increased with age of curing for all mixes tested at the water cement ratio of 0.5. Ettu, Mbarjiogu and Arimanwa (2013) also stated that the strength at ages 7, 14 and 21 days were 43%, 75% and 92% of the 28 days strength respectively. They further said that much of the focus of researchers in this field within the past decade has been to find ways of reducing the cost of cement used in sandcrete and soilcrete blocks production. In this regards, this paper is aimed at determining the structural properties of solid sandcrete blocks of smaller thickness being used for building construction at Idiroko area of Ogun State in Nigeria with a view to either discourage or encourage its use in construction of buildings. This research work is limited to the study of the dry density and wet and compressive strength of 100mm and 125mm solid sandcrete that is used for construction of buildings in Idiroko Area of Ogun State, Nigeria.

MATERIALS AND METHODS

Constituent materials used in the production of samples of sandcrete blocks tested in the laboratory are: Ordinary Portland Cement from West African Portland Cement Company, Ewekoro in Ogun State whose properties conform to BS 12 (1971), well graded sand with a continuous or dense gradation, of low plasticity index and free from clay, loam, dirt, soluble salts and organic or chemical matter which can have harmful effects on OPC both during hydration and even after hardening and fresh, colourless, odourless and tasteless portable water. The mix proportion being used by commercial block producers in all the sites visited varied from 1:10 to 1:12**.** No definite water - cement ratio was used in all the sites visited, water was being added randomly as deemed fit by the operators. Compression of the damp soil and stabiliser mix was done mechanically by the commercial block producers where block samples were collected. While curing of green blocks was done by spraying or sprinkling of water in the morning and in the evening for two days in an open place.

CONTROL EXPERIMENT

Control experiment was set up to obtain desirable result when production is done according to laid down procedures. To this end, the mix ratio used in the control experiment is 1:8, with water cement ratio of 0.5. Curing was done by spraying with water daily for seven days and also by covering the blocks with waterproof polythene sheet to prevent direct rays of sunlight. The secondary phase consisted of stacking the blocks side by side for a further 7, 14 and 21 days while the curing temperatures were maintained at (22-24^{0}C). The blocks were then removed for testing at the stipulated ages of 7, 14, 21 and 28 days.

LABORATORY TESTS

All experiments were conducted following standard procedures to ensure accuracy, repeatability and reproducibility. The bulk properties identified for the purpose assessing the properties likely to influence the durability of 100mm and 125mm sandcrete include: Block dry density (BDD); Wet compressive strength (WCS) and Dry Compressive strength (DCS). Therefore, block samples were tested for all the above stated properties which have direct bearing with the investigation of the effect on the durability of blocks. The grading test of the sand used was carried out in the laboratory following specified procedures, screening of the sand was done by pouring portions of it at a time unto a circular framed screen placed tightly over a laboratory soil storage bin and circular sieve aperture of 5mm was used to allow only fine gravels and sand to pass through. The dry density of the collected block samples was determined by carefully weighing the block samples with an accurate weighing balance when laboratory dry and the dimensions of the block samples were taken with an accurate steel tape. The dry density was then calculated using the formulae below:

$$ld = \frac{m}{v} kg/m^3 \quad (1)$$

Where ℓd = dry density, m= mass of dry block sample and V= volume of block sample. The density obtained in each case was expressed to the nearest kg/m^3 (BS 6073: Part 2, 1981) as presented in Tables 1 and 2 below. The wet compressive strength test was carried out based on the standard of BS 6073 Part 1, (1981). Each block sample was soaked for 24 hours in ordinary tap water. They were then removed and kept aside for 30 minutes to let the extra surface water to drip off, then capped with two 230 x 460 x 20mm thick steel plates. The capped samples were then carefully placed within the set marking pins of the compression-testing machine. The crushing load was continuously applied without shock to the sample at a rate of 15kN/min till failure, and in this way the maximum crushing load was obtained for each sample. The wet compressive strength was then calculated in each case from the ratio of the maximum load and the cross sectional area of the block in N/mm^2. Load was then obtained for each sample.

$$WCs = \frac{Ml}{As} kN/mm^2 \quad (2)$$

Where WCS = Wet compressive strength N/mm^2, Ml = Maximum load and As = Cross sectional area. For the wet compressive strength test block samples were pre-soaked for 24 hours while for the dry compressive strength block samples were crushed when laboratory dry without the 24 hour pre-soaking process. The value was obtained using the same formula. The results are presented in Tables 3 - 6 while the 7, 14, 21, and 28 days strength for each type were plotted in figures 1 – 4.

RESULTS AND DISCUSSION

In Tables 1 and 2 below are the results of the blocks dry density for both the commercial samples and the control experiment, while the result of the wet compressive strength for both the commercial samples and the control experiment are presented in Tables 3 & 4 and the dry compressive strength for both the commercial samples and the control experiment are presented in Tables 5&6

Table 1: Dry density of blocks (commercial samples)

			125mm			100mm		
S/N	Item	Units	**1**	**2**	**3**	**1**	**2**	**3**
1	Gross volume	$X10^{-3} m^3$	10.30	10.30	10.30	8.20	8.20	8.20
2	Oven dry mass	G	17480	17155	17315	13050	12583	12550
3	Blocks' dry density	Kg/m^3	1697	1681	1665	1536	1530	**1591**
4	Mean BDD	Kg/m^3	**1681**			**1552**		

Table 2: Dry density of blocks (Control Experiment)

			125mm			100mm		
S/N	Item	Units	**1**	**2**	**3**	**1**	**2**	**3**
1	Gross volume	$X10^{-3} m^3$	10.30	10.30	10.30	8.20	8.20	8.20
2	Oven dry mass	G	19250	19324	19206	15734	15682	15725
3	Blocks' dry density	Kg/m^3	1816	1823	1812	1796	1790	1795
4	Mean BDD	Kg/m^3	1817			1794		

Table 3: Wet compressive Strength (Commercial Samples)

			125mm			100mm		
S/N	Item	Units	1	2	3	1	2	3
1	Maximum loading	KN	348.26	362.26	367.88	156.96	137.34	132.43
2	Cross sectional area	mm^2	51250	51250	51250	42000	42000	42000
3	Wet compressive strength	N/mm^2	6.79	7.08	7.18	3.74	3.27	3.15
4	Mean WCS	N/mm^2	7.02			3.39		

Table 4: Wet compressive Strength (Control Experiment)

			125mm			100mm		
S/N	Item	Units	1	2	3	1	2	3
1	Maximum loading	KN	961.38	961.38	961.38	647.46	652.37	647.46
2	Cross sectional area	mm^2	50625	50625	50625	42525	42525	42525
3	Wet compressive strength	N/mm^2	18.99	18.99	18.99	15.23	15.34	15.23
4	Mean WCS	N/mm^2	18.99			15.27		

Table 5: Dry compressive Strength (commercial samples)

			125mm			100mm		
S/N	Item	Units	1	2	3	1	2	3
1	Maximum loading	KN	519.93	510.12	451.13	173.92	235.44	235.44
2	Cross sectional area	mm^2	51250	51250	51250	42000	42000	42000
3	Wet compressive strength	N/mm^2	10.14	9.95	8.80	4.14	5.61	5.61
4	Mean WCS	N/mm^2	9.63			5.12		

Table 6: Dry compressive Strength (Control Experiment)

			125mm		100mm			
S/N	Item	Units	1	2	3	1	2	3
1	Maximum loading	KN	990.81	985.91	995.72	676.89	667.08	667.08
2	Cross sectional area	mm^2	50625	50625	50625	42525	42525	42525
3	Wet compressive strength	N/mm^2	19.57	19.47	19.67	16.12	15.88	15.88
4	Mean WCS	N/mm^2	19.57			15.96		

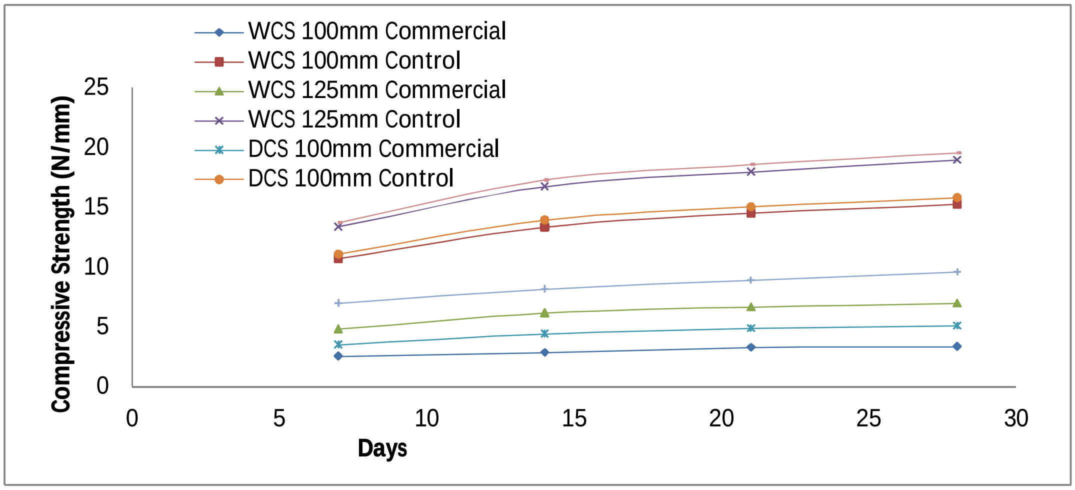

Figure 1: Dry & Wet Compressive Strength for 7, 14, 21 and 28 Days for All samples

DISCUSSION

From Table 1 above, the BDD of collected samples of 100mm and 125mm solid blocks are 1552kg/m^3 and 1681kg/m^3 respectively for the commercial samples while that of the control experiment are 1794kg/m^3 and 1817kg/m^3 respectively. All the values fall within the stipulated values of density for type A blocks according to BS 2038 (1970). This is implies that the densities of all the blocks meet the required standard of the relevant code.

The values of the mean Wet Compressive Strength (WCS) in 100mm solid blocks for the tested samples ranged between 3.39N/mm^2 and 15.27N/mm^2 for the commercial samples and control experiment respectively. The corresponding values for 125mm solid blocks are 7.02N/mm^2 18.99N/mm$^{2.}$ For the commercial samples and control experiment respectively. The equivalent values of their dry compressive strengths ranged between 5.12N/mm^2 and 15.96N/mm^2 for 100mm solid blocks for the commercial samples and control experiment respectively, while for 125mm solid blocks the values are 9.63N/mm^2 for the commercial samples and 19.57N/mm^2. The ratio of the mean dry and wet compressive strength in tested samples is 1.51 and 1.37 for 100mm and 125mm solid sandcrete blocks respectively for the commercial samples while the ratio is 1.04 and 1.03 for the control experiment. These values are within the range of recommended values in literature that the ratio of the mean dry and wet compressive strength SCBs should not be greater than 2 (Keralli, 2001). However, the variation in the values for the commercial samples could be attributed to the inadequate curing process of the commercial samples.

CONCLUSION

From the inferences of the result of the tests carried out, concluded that the BDD values of both 100mm and 125 mm solid blocks fall within the stipulated values for type A blocks according to BS 2028 (1968). The values of the mean Wet Compressive Strength (WCS) and the mean dry compressive strength of all samples in the control experiment are higher than that recommended values in BS 2028 (1968) and NIS:87 2000. However, the value of the wet compressive strength of the 100mm solid blocks in the commercial sample is lower than that recommended values in BS 2028 (1968) but higher than the recommended value in the NIS:87 2000. The values of the dry Compressive Strength of the 125mm solid blocks and the wet Compressive Strength of the 100mm solid blocks are higher than that recommended values in BS 2028 (1968) and NIS:87 2000. The result of the findings are that the values of wet compressive strength and dry compressive of the control experiment are higher than the recommended values of relevant codes and standards BS 2028 (1970 and NIS:87 2000). It therefore follows that both types of blocks are suitable for use in building constructions if moulded in accordance with laid down procedures. It is therefore recommended that 100mm and 125mm solid sandcrete blocks are suitable for use in place of the traditional 150mm and 225mm hollow sandcrete blocks.

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