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AN EVALUATION OF DURABILITY OF HOLLOW BLOCKS IN IDIROKO AREA OF NIGERIA

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ABSTRACT
The durability of a building is to a great extent determined by the properties of the various components of the building of which sandcrete block is major. Previous research has revealed dismal results of the compressive strength of commercial blocks in some other parts of the country. This paper examines the engineering properties of 150mm and 225mm hollow sandcrete blocks being used for building construction in Idiroko area of Ogun state. Idiroko area of Ogun State was visited for the physical inspection of block production sites to assess their conformity with block production processes. Laboratory tests were carried out and the analysis of the results obtained shows that the tested samples meet with the required standard in terms of dry density, total water absorption and total volume porosity while the moisture content and compressive strength fall below the recommended values in literature and codes of practice. The study thus provide necessary information on the strength properties of hollow sandcrete blocks used in Idiroko Area of Ogun State as to its conformity with relevant codes and standards.

KEYWORDS: Evaluation, Durability, Sandcrete Blocks, Engineering Properties, Production Processes,

INTRODUCTION

Lack of housing and its expensive nature has generated special attention by the Nigerian Government. 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. Part of the effort of the government for overcoming this problem is the building of low cost houses for labour and low income earners (low earning people) and establishment of factories that produces localized building materials which has not yet yielded positive concrete results. 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. There are several reported cases of building collapse in some parts of Nigeria. Investigation reveals that use of poor quality materials is one of the major causes of these collapses. The aim of this paper is to examine whether some other structural properties of 150 and 225mm hollow sandcrete blocks being used for building construction at Idiroko area of Ogun State in Nigeria conforms to the recommended values in literatures, codes and standards. This will help stem the tide, since sandcrete blocks is a major component material in building construction.

BACKGROUND TO THE STUDY

Sandcrete block is a major component material in the construction of buildings in Nigeria and many other countries in Africa. It possesses an intrinsic low compressive strength hence its susceptibility to seismic activity. It 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. The astronomical increase in the cost of cement has untold effect on the cost of building blocks. This has led to many commercial block producers to compromise the standard of production in an attempt to maximize profit. Abdullahi (2005), also stated that 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. Ettu, Mbajiorgu and Arimanwa (2013) stated that many researchers have investigated various aspects of this important construction materials, citing the works of Afolayan, Arum and Daramola (2008) on the compressive strength of commercial hollow sandcrete block and the findings of Wenapere and Ephraim that the compressive strength of sandcrete blocks increase with age of curing for all mixes tested at the water-cement ratio of 0.5. Also cited are the works of Agbede and Obam (2008) on the investigation of the strength properties of OPC- RHA blended sandcrete blocks as well as the research by Oyekan and Kamiyo (2011) on the Effects of Rice Husk Ash on some Engineering properties of Sandcrete Blocks and Concrete.

The research work is limited to the study of some structural properties of 150mm and 225mm hollow sandcrete blocks being used in the construction of building in Idiroko area of Ogun State, Nigeria.

MATERIALS AND METHODS

Block production sites were visited in order to ascertain whether commercial block producers conform to laid down procedures in the relevant codes. In all the sites visited, the materials used in moulding blocks consists of 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 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 onto 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. In this way all medium to coarse gravel present in the supplied sand was eliminated. The mix proportion being used by commercial block producers in all the sites visited is varies between 1: 10 – 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.

TESTING OF SPECIMEN

The bulk properties identified as likely to influence durability of SCB include: Block dry density (BDD); Total water absorption (TWA); Total volume porosity (TVP); Moisture Content (MC); 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. All experiments were conducted following standard procedures to ensure accuracy, repeatability and reproducibility (BS 1881 Part 3:1970, Part 115:1983, Part 116:1983, BS 5628: Part 3:1985, BS 6073 Part 1:1981).The determination of the dry density was done 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:

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

Where ℓd = dry density, m= mass of dry block sample, V= volume of block sample. The samples Three samples were tested in each category and the mean value used for subsequent analysis. The density obtained in each case was expressed to the nearest kg/m^3 (BS 6073: Part 2, 1981) as presented in Table 1. Cold immersion method was used in determining the total water absorption of the block samples. This involves oven-drying the block samples for 48 hours followed by cold-immersion in water. Blocks samples were weighed when laboratory dry, immersed in water for 24 hours, removed and weighed again. An accurate electronic weighing machine was used in this case, to an accuracy of 0.05g. The percentage moisture absorption by weight was calculated from the formula:

$$Mc = \frac{Ww - Wd}{Wd}\% \quad (2)$$

Where Mc = percentage moisture absorption (%), Ww= mass of wetted sample (g), Wd= mass of dry sample (g)

The TWA was calculated by taking the amount of water absorbed by a dried sample that had been immersed in water for a specified period of time (24 hours). Mean values obtained were taken as the total water absorption (TWA) of the sample. The result was expressed as a percentage of the original dry mass of the specimen to the nearest 0.01% of the dry mass. Details of all individual measurements recorded are presented in Table 2. The total volume fraction porosity (TVP) in a SCB was determined by direct measurement of the weight gain on saturation with water of an initially dry block after evacuation to remove air from the pore network. The water absorption is expressed in weight percent. The value of the water absorption was then converted to volume basis porosity by using the following relationship:

$$n = \frac{(TWA) x \varrho d}{100 x \varrho w} \quad (3)$$

where n = volume fraction porosity, ℓd= dry block density (kg/m^3), ℓq = density of water kg/m^3), TWA = Total water absorption (%). The result of the calculated total volume fraction porosity of collected samples is shown in Table 3. The procedure involves the pre-soaking of the block samples for 24 hours after which it is removed and stacked for 30 minutes to allow the water to drain off. The wet mass was obtained by weighing it in an accurate weighing balance. It was thereafter oven dried for 48 hours after which it was weighed again see Table 4 for test results.

The moisture content was determined by using the formulae.

$$Mc = \frac{Ww - Wd}{Vs} = \frac{Mw}{Vs} \qquad (4)$$

Where Mc = Moisture content (Kg/m^3), Ww = Mass of wet sample, Wd = Mass of dry sample Mw = Mass of water, Vs = Volume of block sample. The compressive strength test done is a standard test based on 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.

$$WCs = \frac{Ml}{As} kN/mm^2 \qquad (5)$$

Where WCS = Wet compressive strength N/mm^2, Ml = Maximum load, 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 5 and 6 while the 7, 14, 21, and 28 days strength for each type is plotted in Figure 1.

RESULTS AND DISCUSSION

The results obtained from the various tests carried out are presented below. In Table 1 is the Dry Density of the blocks, Table 2 presents the result of the Total Water Absorption, while Table 3 contains the result of The Total Volume porosity. Table 4 has the result of the Moisture Content while Tables 5 and 6 contains the results of the Wet Compressive Strength and the Dry Compressive Strength respectively. Figure 1 is the chart for the 7, 14, 21 and 28 days wet compressive strength and the dry compressive strength respectively.

Table 1: Dry density of blocks

	225mm					150mm		
S/N	Item	Units	1	2	3	1	2	3
1	Gross volume	X10^{-3} m^3	12.40	12.40	12.40	9.43	9.43	9.43
2	Oven dry mass	G	20587	20540	20255	15082	15163	15420
3	Blocks' dry density	Kg/m^3	1660	1656	1633	1599	1608	1635
4	Mean BDD	Kg/m^3	1650			1614		

Table 2: Total water absorption

			225mm			150mm		
S/N	Item	Units	1	2	3	1	2	3
1	Pre-test dry mass	G	20252	20587	20540	15082	15163	14800
2	Post-test wet mass	G	22640	23191	23189	17000	17072	16820
3	Total water absorption	%	11.80	12.63	12.56	12.73	12.59	13.64
4	Mean TWA	%	12.33			12.99		

Table 3: Total volume porosity

			225mm			150mm		
S/N	Item	Units	1	2	3	1	2	3
1	Total water absorption	%	11.80	12.63	12.56	12.73	12.59	13.64
2	Block dry density	Kg/m^3	1660	1656	1633	1599	1608	1635
3	100 x density of water	X 10^{5}Kg/m^3	1.0	1.0	1.0	1.0	1.0	1.0
4	Volume fraction porosity	%	19.59	20.92	20.51	20.36	20.24	22.30
5	Mean TVP	%	20.34			20.30		

Table 4: Moisture content

			225mm			150mm		
S/N	Item	Units	1	2	3	1	2	3
1	Laboratory dry mass	g	20255	20100	20214	15082	15163	15218
2	Oven dry mass	g	20016	19772	19992	14887	15116	15030
3	Volume	X 10^{-3} m^3	12.4	12.4	12.4	9.43	9.43	9.43
4	Moisture content	Kg/m^3	19.27	26.45	17.90	20.68	4.98	10.13
5	Mean Moist. Content	Kg/m^3	21.20			12.21		

Table 5: Wet compressive Strength

					225mm	150mm		
S/N	Item	Units	1	2	3	1	2	3
1	Maximum loading	KN	166.77	186.39	156.96	93.20	98.10	107.91
2	Cross sectional area	mm^2	101250	101250	101250	67500	67500	67500
3	Wet compressive strength	N/mm^2	1.65	1.84	1.55	1.38	1.45	1.60
4	Mean WCS	N/mm^2	1.68			1.48		

Table 6: Dry compressive Strength

			225mm			150mm		
S/N	Item	Units	1	2	3	1	2	3
1	Maximum loading	KN	294.30	255.06	245.25	137.34	186.39	156.96
2	Cross sectional area	mm^2	10120	101250	101250	67500	67500	67500
3	Wet compressive strength	N/mm^2	2.90	2.52	2.42	2.03	2.76	2.33
4	Mean WCS	N/mm^2	2.61			2.37		

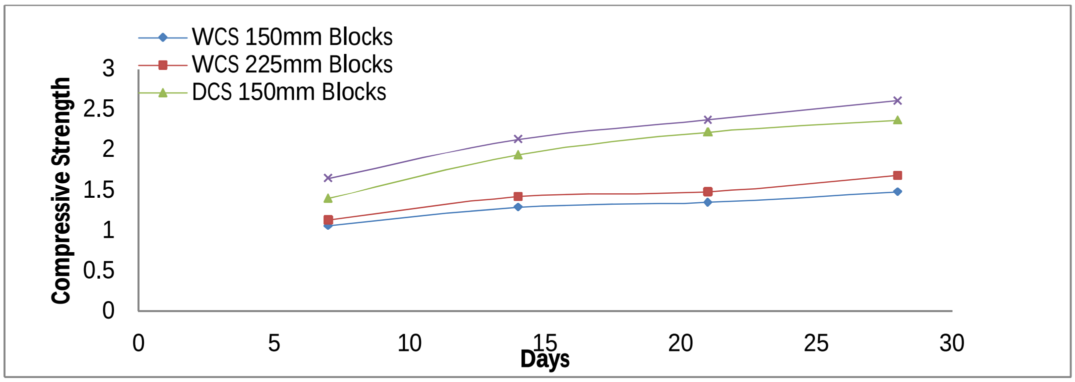

Figure 1: Wet and Dry Compressive Strength for all samples for 7, 14, 21 & 28 Days.

DISCUSSION

From Table 1 above, the BDD of collected samples of 150mm and 225mm hollow blocks are1614kg/m^3 and 1650kg/m^3 respectively. Both values fall within the stipulated values of density for type A blocks according to BS 2028 (1970). Table 2 presents the values of TWA for both150mm and 225mm which compare well with current recommended maximum values for sandcrete blocks. The recommended maximum is 15% (Keralli 2001). The values obtained favourably compares with those of like materials (clay bricks 0 to 30%; concrete blocks 4 to 25%; calcium silicate bricks 6 to 16% (Keralli, 2001). According to BS 5628 Part 1, TWA values below 7% are regarded as being low, while those above 12% as high. Since the values for all collected samples is slightly higher than 12% it can be regarded as high. The above results also confirm that sandcrete blocks have the potential to absorb appreciable amounts of water and possibly retain it too. The values for both categories of blocks however compare well with those of like materials. Materials with TVP above 30% are considered to be of high porosity (Keralli, 2001). All the blocks examined during this research can therefore be considered to be of low porosity. The values of the moisture content of all samples are considerably lower than the recommended values of 80kg/m^3 (Keralli, 2001). While the moisture content of 150mm hollow blocks is 12.21 kg/mm^3, that of 225mm blocks is 21.20kg/mm^3. There are also considerable variation in the test result of all the samples. This is perhaps due to the fact that there was no specified water cement ratio and the fact that poor curing process was followed. It can thus be adduced to be responsible for the higher value of water absorption which is an indication of poor quality block.

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Mean Wet Compressive Strength and Mean Dry Compressive Strength respectively for both sizes.

CONCLUSION

From the inferences of the result of the tests carried out, concluded that the BDD values of both 150mm and 225 mm solid blocks fall within the stipulated values for type A blocks according to BS 2028 (1970). The results of the TWA values compare well with current recommended maximum values for sandcrete blocks. The recommended maximum is 15% Keralli (2001). But the TVP values for both categories of blocks is less than 30% and can therefore be considered to be of low porosity. While the values of the moisture content of all samples are considerably lower than the recommended values of $80kg/m^3$ (Keralli, 2001).), The values of the mean Wet Compressive Strength (WCS) and the mean dry compressive strength of all samples are lower than than the recommended values in BS 2028 (1970).

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