A STUDY ON THE DURABILITY OF SOLID SANDCRETE BLOCKS

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Abstract

100mm and 125mm solid blocks are extensively used for building construction at Idiroko area of Ogun State in Nigeria and environ with no record of known available data. There is also no quality control of the standard of the structural properties of these type of blocks to justify its usage and the use is spreading fast. This research is therefore undertaken to present these data. The study involve laboratory tests on the physical, and structural properties of 100mm and 125mm thick solid blocks. The results obtained from the laboratory tests was evaluated, conclusion were drawn and recommendations made. After analysis, the experimental results obtained from the laboratory tests reveals that these type of blocks meet the required standard in terms of dry density, moisture content, water absorption, volume porosity and strength. Investigation has revealed that the use of poor quality materials is one of the major causes of building collapse which constitutes a major setback to sustainable development and human capacity building. This paper examines the conformity of the structural properties of these types of blocks to relevant codes and standards so as to stem the tide of building collapse as a result of the use of low quality blocks.

Keywords: building blocks, building construction, structural properties, physical inspection standard

INTRODUCTION

Past and present governments in Nigeria had formulated various policies aimed at solving housing problems faced by the citizens of this country, none of these policies has yet yielded positive concrete results. 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 (Omopariola, 2014). The astronomical increase in the cost of cement has untold effect on the cost of building blocks (Omopariola, 2014). This has resulted in peasants and low-income earners resorting to sourcing for cheaper means of providing materials for building construction at the prices that are affordable to them. The use of 100mm and 125mm solid blocks is one of such means. The researcher is aware of the use of these sizes of solid blocks (100mm and 125mm) for building construction at Idiroko area of Ogun State in Nigeria and environ and in some areas in the Eastern part of the country. It is also reportedly being used in the Republic of Benin. The researcher is not aware of the availability of the record of any known data. There is also no quality control of the standard of production to ensure that the structural properties of these type of blocks to justify its usage and the use is spreading fast. This research is therefore undertaken to present these data with a view to encourage or discourage its use. The research work is limited to the study of the structural properties of 100mm and 125mm solid sandcrete that is used for construction of buildings in Idiroko Area of Ogun State, Nigeria.

Investigation has revealed that the use of poor quality materials is one of the major causes of building collapse. The collapse of buildings is usually associated with multistorey buildings which generally goes along with attending colossal waste and human casualties. On the other hand, multistorey buildings are either built because of social status or commercial viability of a location as more people will jostle for space to provide shelter for themselves, their goods and services as well as exhibit their products or make contact with their customers or client. As a result, building springs up in urban areas like Lagos, Porthartcourt and Abuja in Nigeria, there will always be influx of people and buildings will keep springing up due to this there will be stiff competition for very few available spaces. Designers and building developers will have to settle for multi storey building due to increasing and unending economic value of these places. As the soil in some of these areas are sandy and loose soil that are not strong or compacted soils the requirement of building construction professionals will usually be high in these places. The use of durable materials such as solid sandcrete blocks will minimise if not eradicate building collapse. This will in turn result in sustainable development as funds that could have been used for clearing of debris and reconstruction of collapsed buildings will be channelled towards other projects that will enable the government achieve the millenium development goal of housing for all in the year 2020. As a result, sustainable development and human capacity building will be enhanced. This paper examines the conformity of the structural properties of these types of blocks to relevant codes and standards so as to stem the tide of building collapse as a result of the use of low quality blocks.

BACKGROUND STUDY

Durability is typically defined in the range of “poor” to “excellent” Houben and Guillaud, (1994). Franklin and Chandra (1972), stated that the word durability originates from the Latin word ‘durabilis’ which means ‘lasting’ and as such can be used in the context of most building material to mean resistance to weakening and disintegration. BS 7543: 1972, defines durability ‘as the ability of a building and its parts to perform its required function over a period of time and under the influence of disintegrating agents. While BSI CP3, 1950 defines
durability as ‘a measure, albeit in an inverse sense of the rate of deterioration of a material or component.’

In his own opinion, Kerali (2001) proposed that the definition and concept of durability should be based on three key parameters, namely: intended function of the material, the standardized conditions of its use and the time the material is required to fulfil its functions. He drew his proposed definition from the definition of Carroll, (1992) with due consideration for the intended function of sandcrete blocks as an internal and external walling unit stated that ‘the primary desirable characteristics of walling units are strength, dimensional stability and resistance to weathering. Webb, (1988) stated that these properties are governed to a large extent by the choice of constituent materials and by the quality of the manufacturing process used in their production. His definition of durability in this regard was the ‘ability of a block to sustain its distinctive characteristics under service conditions for the service lifetime of the structure. Omonopola, 2014 posited that 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.

MATERIALS AND METHODS
The materials used for the production of block samples tested in the laboratory are: Ordinary Portland Cement (OPC) from West African Portland Cement Company, Ewekoro in Ogun State. The properties of the (OPC) used are in conformity with the recommendations in BS 12 (1971). The sand used was well graded with a continuous or dense gradation. It is 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. Fresh, colourless, odourless and tasteless portable water was used. The mix proportion being used by commercial block producers in all the sites visited varied from 1:10 to 1:12 while the mix ratio used for the control experiment was 1:8. No definite water - cement ratio was used in all the sites visited as 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. The 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.

The bulk properties identified as likely to have direct bearing with the investigation of the durability of solid sandcrete blocks include: Block dry density (BDD); Total water absorption (TWA); Total volume fraction porosity (TVP); Moisture Content (MC); Wet compressive strength (WCS) and Dry Compressive strength (DCS). Hence, block samples were tested for all the above stated properties. Standard procedures were followed in accordance with BS 6073 Part 1: (1981) in all the experiments to ensure accuracy, repeatability and reproducibility. Three samples were tested in each category and the mean value used for subsequent analysis. The dry density was determined by 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:

$$\ell d \frac{m}{v} \text{ kg/m}^3 \tag{1}$$

Where $\ell d$ = dry density, $m$ = mass of dry block sample, $v$ = volume of block sample. The density obtained in each case was expressed to the nearest kg/m$^3$. The procedure for obtaining the moisture content involves the pre-soaking of the block samples for 24 hours, it was then removed and stacked for 30 minutes so as to allow the water to drain off. An accurate weighing balance was used to obtain the wet mass of the samples. It was thereafter oven dried for 48 hours and then weighed again (see figure 1b for test results).

The moisture content was determined by using the formulae

$$Mc=\frac{Ww-Wd}{Vs} \tag{2}$$

Where $Mc$ = Moisture content (Kg/m$^3$), $Ww$ = Mass of wet sample, $Wd$ = Mass of dry sample $Vs$ = Volume of block sample. Cold immersion method was used in determining the total water absorption of the block samples. Block samples were oven-dried for 48 hours after which they were weighed. The samples were then immersed in water for 24 hours after which they were weighed again. An accurate electronic weighing machine was used in this case, to an accuracy of 0.05g. The percentage water absorption by weight was calculated from the formula:

$$TWA=\frac{Ww-Wd}{Wd} \times 100 \% \tag{3}$$

Where TWA = percentage moisture absorption (%), $Ww$= mass of wetted sample (g), $Wd$= mass of dry sample (g). Mean values obtained from the calculations 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. The result is presented in figure 2a. The total volume fraction porosity (TVP) of the sandcrete blocks were 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 was expressed in weight percent. The value of the water absorption was then converted to volume basis porosity by using the following relationship:

$$n=\frac{(TWA) \times \ell q d}{100 \times \ell q w} \tag{4}$$

where $n$ = volume fraction porosity, $\ell d$= dry block density (kg/m$^3$), $\ell q$ = 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 figure 2b. The compressive strength test carried out was 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. The
samples were capped with two 230 x 460 x 20mm thick steel plates. The capped samples were 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 15 kN/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$^2$ as indicated in the formula below:

$$W_{CS} = \frac{ML}{As} \text{ kN/mm}^2$$  \hspace{1cm} (5)

Where $W_{CS}$ = 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 formulae. The results are presented in figures 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 in the course of the study are presented below. Figure 1a presents the dry density of the blocks for both the commercial samples and the control experiment, figure 1b has the result of the moisture content for both the commercial samples and the control experiment. In figure 2a is the result of the total water absorption for both the commercial samples and the control experiment, while figure 2b contains the result of the total volume porosity for both the commercial samples and the control experiment. Also figures 3a & 3b contains the results of the wet compressive strength and the dry compressive strength respectively for both the commercial samples and the control experiment. Finally, figures 4 & 5 are the 7, 14, 21 & 28 days wet and dry compressive strength for both the commercial samples and the control experiment.
The value of BDD for the commercial samples are 1552 kg/m$^3$ for 100mm solid blocks and 1681 kg/m$^3$ for 125mm solid block. For the control experiment 100mm solid block has the least value of 1794 kg/m$^3$ and 125mm solid blocks has the value of 1800 kg/m$^3$. The marked increase in the mass and subsequently the density witnessed in the control experiment could have been due to any or all of these factors: the degree of compaction, the density of the constituent materials and the size and grading of the soil particles. The values obtained experimentally for the various types of blocks in this study fall within the range of recommended value for concrete blocks as stated in BS 6073 Part 2, 1981. It is also pertinent to state that the densities of all blocks tested for both the commercial samples as well as the control experiment falls within the range of type A blocks (BS 2028, 1970). The moisture content of the commercial samples show a considerable range of variation and the values obtained are also considerably lower than the recommended values in literature. 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. For the control experiment, the obtained values are higher and within the recommended value of 80 kg/m$^3$ Keralli (2001). The corresponding values obtained for water absorption is considerably low, an indication of a better quality block than those obtained for the commercial samples. The results of the TWA values compare well with current recommended maximum values for sandcrete blocks. The recommended maximum is 15%
The total volume fraction porosity values are lower in commercial samples than that of the control experiment as shown in Figure 2b. 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 (Keralli, 2001). The values of the mean Wet Compressive Strength (WCS) obtained for 100mm solid blocks is 3.39N/mm² and 7.02 N/mm² for 125mm solid blocks in the commercial samples. For the control experiment it is 15.27 N/mm² for 100mm solid blocks and 18.99 N/mm² for 125mm solid blocks. The dry compressive strength is 5.12N/mm² for 100mm solid blocks and 9.63N/mm² for 125mm solid blocks for the commercial samples. The values obtained for the control experiment are 15.96N/mm² and 19.57N/mm² respectively. It has been recommended that the ratio of the mean dry and wet compressive strength in sandcrete blocks should not be greater than 2 (Houben et al, 1996). In the commercial samples, the ratio obtained for 100mm solid blocks is 1.51 while that of 125mm solid blocks is 1.37. The ratio for the control experiment are 1.05 and 1.03 respectively. All the values are below the recommended value of 2. The result of the compressive strength test indicates higher values for the control experiment than the commercial samples. This is because commercial block production has low quality control measure and do not conform to laid down procedures in relevant codes and standards. However, the control experiment was carried out in accordance with laid down procedures in relevant codes and standards.

CONCLUSION

From the experimental results the following conclusions were drawn: Commercial block producers are ignorant of the existence of any relevant code or specifications relating to block production and properties. As a result of this, standard process of production and quality control are not ensured. Consequently, low quality blocks are produced and sold. The dry densities of all samples tested fall within the category of type “A” blocks according to the specification of BS 2038, 1970. The values also compare well with other similar materials. The moisture content of the commercial samples show a considerable range of variation, the values obtained are also considerably low. For the control experiment, the obtained values are higher and within the recommended value of 80kg/m³ (Keralli, 2001). The water absorption capacity of the commercial samples is higher than the control experiment, although all the samples are within the specified range and compares favourably well with recommended values for other like materials. The total volume fraction porosity ratio is considerably lower in the control experiment than in the commercial samples. However all the samples are within the specified range and compares favourably well with recommended values for other like materials. While the wet compressive strength of 100mm solid block for the commercial samples fall below the recommended values for type “A” blocks for the equivalent value of the recommended densities in BS 2028, 1970, the dry strength is slightly higher. The values of both the wet and dry strength for 125mm solid block in the commercial samples are considerably higher than the recommended values in BS 2028, 1970. Notwithstanding, all the values obtained in the control experiment are well above the recommended values in BS2028, 1970.

The recommendation of Omopariola, (2014) that the Nigerian Building Code of practice should be evolved and made available to all stakeholders in the construction industry and that the Nigerian Building Standard Enforcement Agency (NBSEA) should be set up and empowered like the NAFDAC to ensure conformity of all stakeholders in the construction industry to specified standard of labour, materials and workmanship is hereby reiterated. It was further recommended that compulsory and regular organised workshop and training on quality control practices in block production processes should be arranged for all stakeholders in the construction industry. All these will enhance sustainable development and human capacity building.

REFERENCES


