COMPARATIVE STUDY OF THE DENSITY AND COMPRESSIVE STRENGTH OF HOLLOW SANDCRETE BLOCKS AND SOLID SANDCRETE BLOCKS OF SMALLER THICKNESS

S.S. Omopariola

Department of Works and Services, The Federal Polytechnic, Ilaro, Nigeria

E-mail: hfeforchrist@yahoo.com

ABSTRACT

Sandcrete blocks are a common walling material in Nigeria and many other countries in Africa. However, hollow sandcrete blocks are the most predominant types of blocks in use in most places. A visit to Idiroko area of Ogun State in Nigeria reveals that solid sandcrete block of smaller thickness is gaining attention and its use is spreading to other parts of the state. Investigation reveals that this type of block is widely used in the Republic of Benin and some areas in the Eastern part of Nigeria. The study compared the density and compressive strength of both hollow and solid sandcrete blocks of smaller thickness. Samples of both types of blocks were collected for testing; control experiment was also carried out by moulding these types of blocks in conformity with relevant codes and standards. The results indicated that the dry density of both types of blocks fall within the range of type A blocks for hollow blocks according to BS 2028 (1970) and the compressive strength of solid sandcrete blocks were considerably higher than that of hollow sandcrete blocks both for the commercial samples as well as the control experiment.

Keywords: Sandcrete blocks; Walling materials; Smaller thickness; Density; Compressive strength.

INTRODUCTION

Lack of housing and its expensive nature has generated special attention by successive government of Nigeria which has formulated several policies to bring housing within the reach of the masses.

The Nigerian government as part of its effort in overcoming housing problem has embarked on the building of low cost houses for labour and low income earners (low earning people) and establishment of factories that produces localized building materials. This however has not yielded positive result as there are reported cases of a single family of ten members living in just one rented room in Lagos, Nigeria, while many other people sleep in garages, under kiosks and bridges. This is as a result of their inability to have an apartment of their own and they cannot afford the exorbitant amount of renting a place of abode. 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 and this astronomical increase in the cost of cement has untold effect on the cost of building blocks (Omopariola 2014). Sandcrete blocks are classified as solid, hollow or cellular. Solid sandcrete blocks are blocks which are essentially void less except for grooves, finger holes or any other small cavities provided so as to improve its handing as well as reduce its weight. The volume of such voids should not exceed 25% of the gross volume of the block. Hollow sandcrete blocks consists of much more cavities which pass right through the block but the total volume of such cavities must not be greater than 50% of the gross volume of the block. Cellular sandcrete blocks are special types of hollow blocks in which case the cavities do not pass right through the block but is closed at one end. The total volume of the cavities like that of hollow blocks must not exceed 50% of the gross volume of the block Gage and Kirkbridge (1980).

BACKGROUND STUDY

According to Abdullahi (2005), the word “sandcrete” have no standard definition, what most workers have done was to define it to suit their own purpose. However, Montgomery (2002) defined sandcrete block as blocks made or moulded with sand, water and cements which serve as a binder. Raheem, Mohmoh and Soyingbe (2012) defined it as a walling unit produced from sand, cement, and water. Hodge (1971) said that sandcrete blocks are available for the construction of load and non load bearing structures. It possesses an intrinsic low compressive strength (Omopariola 2014).

Oyekan and Kamiyo, (2008) stated that sandcrete blocks have been in use in many nations of the world including Nigeria for a long time. "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 is the major cost component of most common buildings" (Oyekan and Kamiyo, 2011). Omopariola (2014) also stated that sandcrete blocks are major components of building construction in Nigeria and in many other nations of the world. 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. The Density of sandcrete block is a function of aggregate, density, size, grading and degree of compaction. Keralli, (2000) stated that the density of a block is a valuable indicator of its quality which can be expressed in a number of different ways, depending on the pre-existing moisture state of the block. He further stated that the different ways of measuring density include: Block dry density (BDD), block bulk density (BBD) and saturated block density (SBD) obtained when blocks are soaked in water for between 24 and 48 hours after being oven dried. BS 6073: Part 2, 1981 stated that it is the dry density that is commonly used in building specifications and as such it is the one discussed in this study.

The compressive strength of a block is perhaps one of its most important engineering properties. It was established from the literature that the durability of sandcrete blocks increases with increase in its strength (Stutz and Mukerji 1988; Houben & Guillaud, 1994). The compressive strength of sandcrete blocks is one of the most important technical properties, where the 28th days compressive strength value is usually representative of the final strength of concrete due to the fact that subsequent increase in strength after this age is considerably small. It is measured as the average crushing load/gross area. Wenapere and Ephraim (2009) stated that the compressive strength of sandcrete blocks increase with age of curing for all mixes tested at the water-cement ratio of 0.5.

MATERIALS AND METHODS

The materials used in moulding blocks consists of Ordinary Portland Cement (OPC) from West African Portland Cement Company, Ewekoro in Ogun State whose properties conform to BS 12 (1971); The sand used was well graded 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. Fresh, colourless, odourless and tasteless portable water was used during wet mixing. The sand used was graded in the laboratory following specified procedures by pouring portions of it at a time onto a circular framed screen placed tightly over a laboratory soil storage bin and using circular sieve aperture of 5mm to allow only fine gravels and sand to pass through. Standard procedures were followed in all experiments conducted to ensure accuracy, repeatability and reproducibility. The bulk properties tested in this study are block dry density (BDD); Wet compressive strength (WCS) and Dry Compressive strength (DCS). As a result, block samples were tested for all the above stated properties. Standard procedures. 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 equation (1) below:

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

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 Fig 1.

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 is applied continuously 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 using equation (2) below.

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

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 equation (2).

RESULTS AND DISCUSSION

The results of Block Dry Density BDD are presented in fig (1) below. The results of the Wet and Dry Compressive strength are presented in Figs 2 and 3 while the 7, 14, 21, and 28 days wet and dry compressive strength for each type of block are plotted in figs 4 and 5

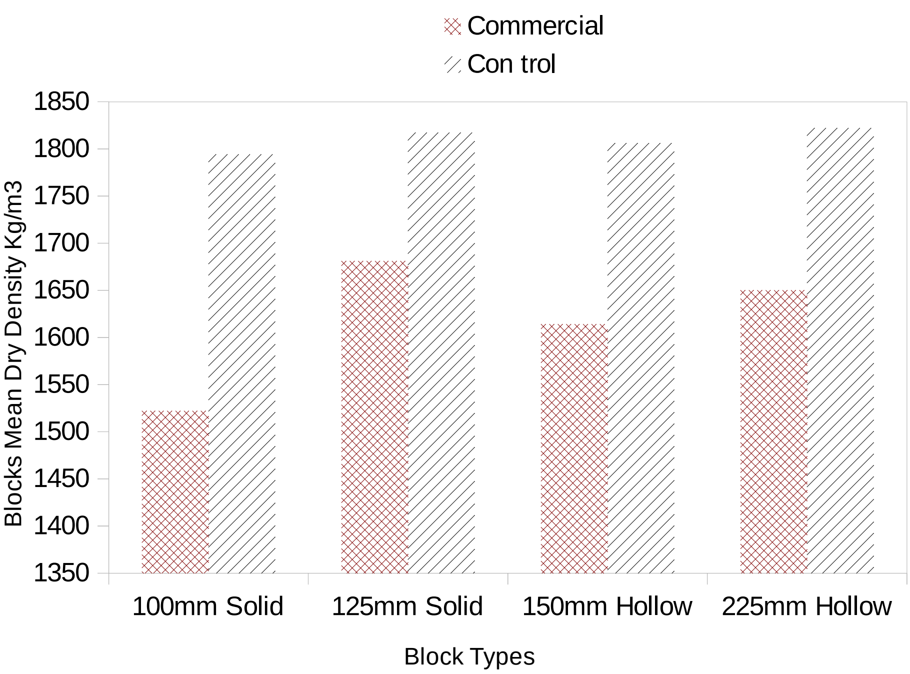

Figure 1. **Bar Chart of Dry Density of Blocks at 28 Days**

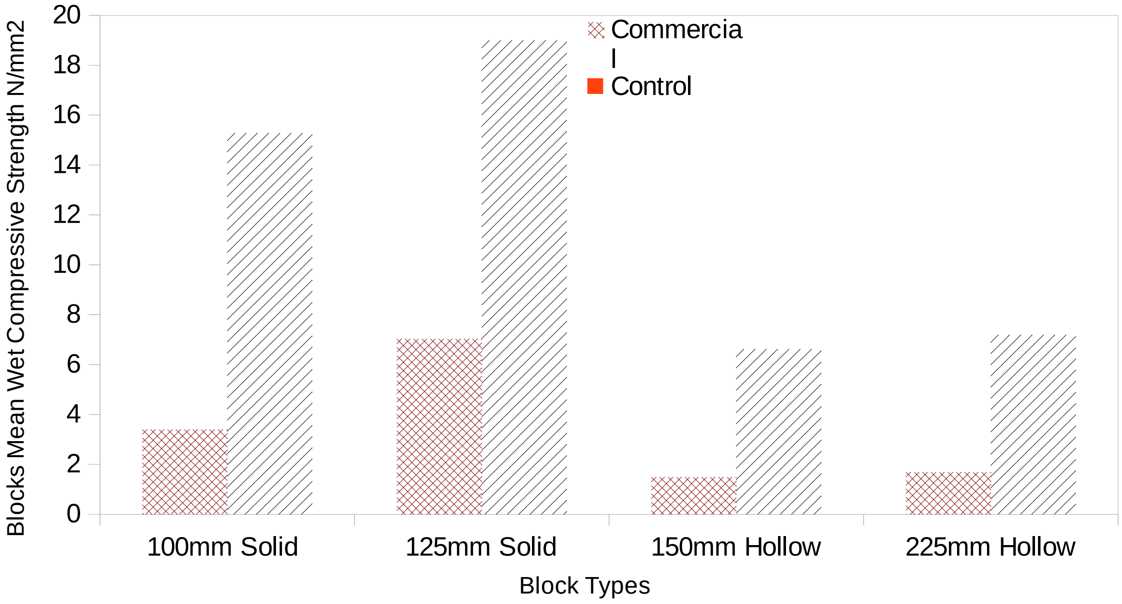

Figure 2. Bar Chart of Mean Wet Compressive Strength of Blocks at 28 Days

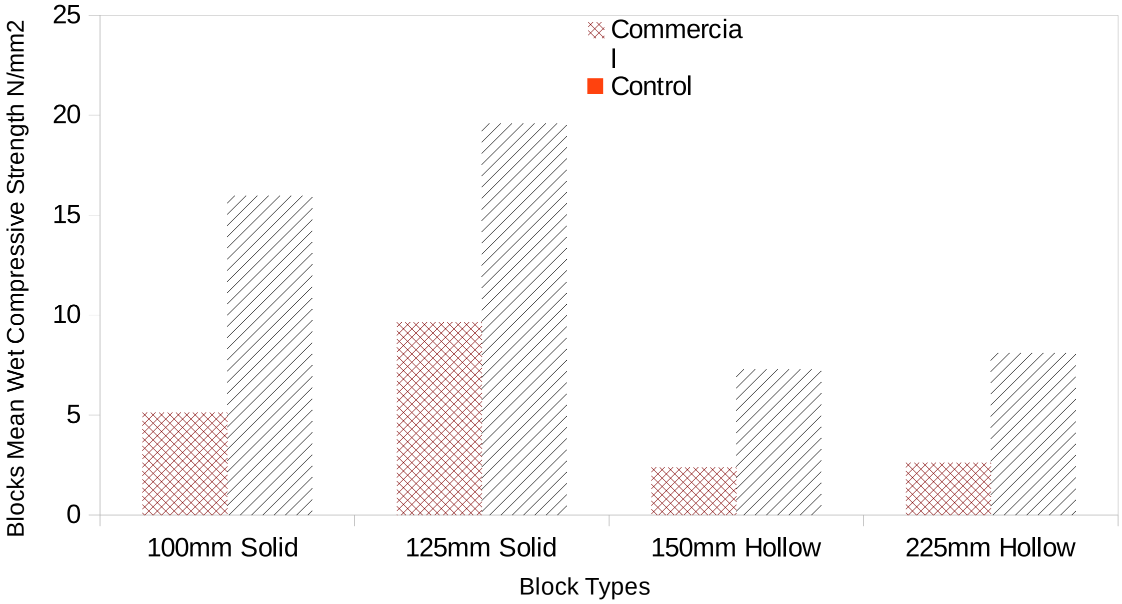

Figure 3. Bar Chart of Mean Dry Compressive Strength of Blocks at 28 Days

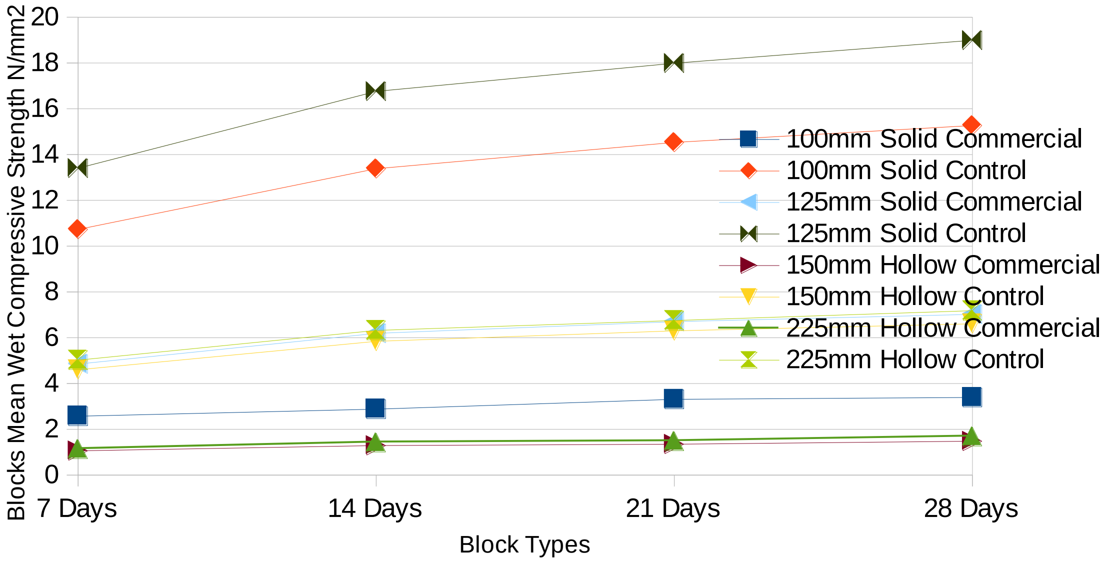

Figure 4: Wet Compressive Strength for All samples

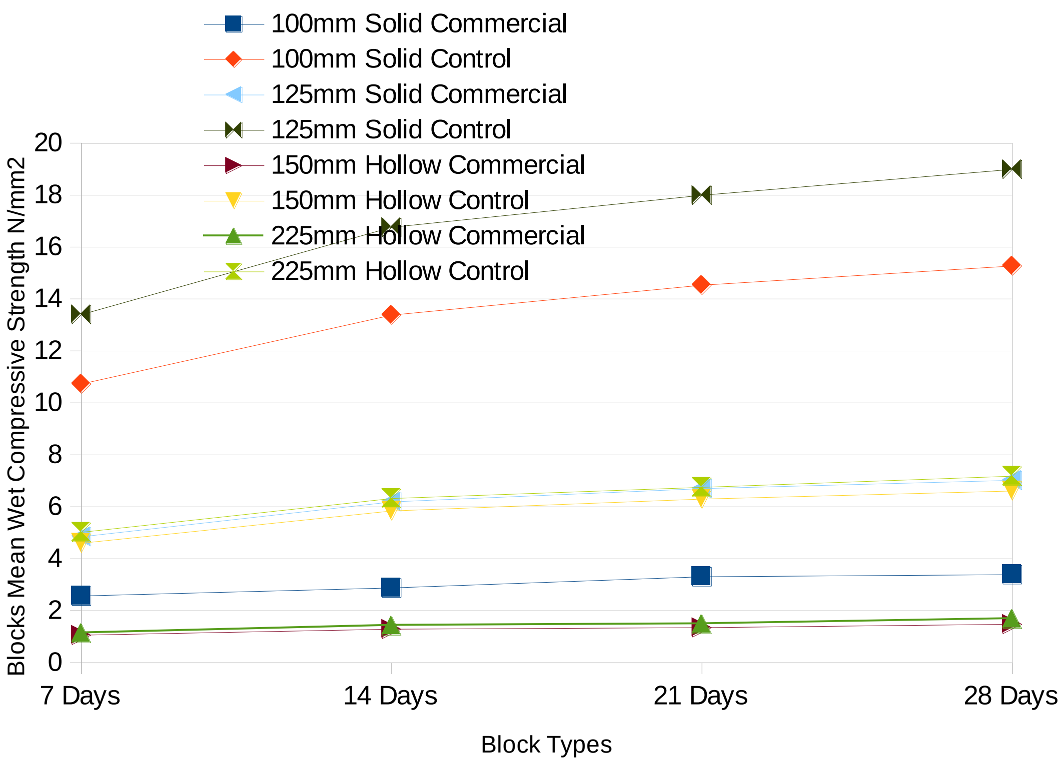

Figure 5: Dry Compressive Strength for All samples

Experimental results on BDD reveal that for the commercial samples, 100mm solid have the least value of 1552 kg/m^3, while 150mm hollow blocks is 1614kg/m^3, 225mm hollow blocks has 1650kg/m^3 while 125mm solid block have the highest value of 1681kg/m^3. For the prepared sample, 100mm solid block has the least value of 1794kg/m^3, while the value for 125mm solid blocks is 1800kg/m^3, 150mm hollow blocks has 1806kg/m^3 while 225mm hollow block has the highest value of 1822kg/m^3.(see Fig 1). The marked increase in the mass and subsequently the density witnessed in the control experiment could have been due to any or all of: the degree of compaction used the density of the constituent materials and the size and grading of the soil particles. The degree of compaction used can grossly affect the pore filling effects of the blocks, increased homogeneity of constituent materials, improved bonding of the constituent materials and reduced voids in the blocks. 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 BS6073 Part 2, 1981. It is also pertinent to state that the densities of all blocks tested (both hollow and solid, commercial samples as well as the prepared samples falls within the range of type A blocks for hollow blocks (BS 2028, 1970). There is not much difference in the values obtained in the prepared samples whereas there is a higher level of variation in the commercial samples. This could be as a result of the fact that due process was not followed in the production of commercial samples and there was no quality control.

COMPRESSIVE STRENGTH OF BLOCKS

The values of the mean Wet Compressive Strength (WCS) in hollow blocks for the commercial samples is 1.48N/mm^2 for 150mm hollow blocks and 1.68N/mm^2 for 225mm hollow blocks while the values for the prepared samples are 6.61mm^2 for 150mm hollow blocks and 7.18N/mm^2 for 225mm hollow blocks. The equivalent values of their dry compressive strengths are 2.37N/mm^2 and 2.61N/mm^2 for 150mm and 225mm hollow blocks respectively for the commercial samples and

7.27N/mm^2 and 8.09N/mm^2 for 150mm and 225mm hollow blocks respectively for the prepared samples. A similar trend emerged with results obtained for solid blocks. The mean WCS in these blocks are 3.39N/mm^2 for 100mm solid blocks and 7.02 N/mm^2 for 125mm solid blocks for the commercial samples and 15.27 N/mm^2 for 100mm solid blocks and 18.99 N/mm^2 for 125mm solid blocks for the prepared samples, while the corresponding dry strength are 5.12N/mm^2 and 9.63N/mm^2 for 100mm and 125mm solid blocks respectively for the commercial samples and 15.96N/mm^2 and 19.57N/mm^2 for 100mm and 125mm solid blocks respectively for the prepared samples. The results for solid blocks compare well with values reported in concrete research where the ratio between mean wet and dry compressive strength ranges between 1.03 and 1.14. The results for hollow blocks similarly compare well with results obtained by earlier researchers. The values for the Wet Compressive strength for both 150mm and 225mm for the commercial samples agrees with the findings of sandcrete blocks produced by LAUTECH Block Industry which is 1.59 and 1.68 respectively (Raheem, Mohmoh and Soyingbe, 2012). Also the values of the dry compressive strength falls within the range of 1.59 and 4.25 for 225mm and 1.48 to 3.35 for 150mm blocks as obtained by (Raheem, Mohmoh and Soyingbe, 2012). It has also recently been recommended that the ratio of the mean dry and wet compressive strength in sandcrete blocks should not be greater than 2 (Keralli, 2000). The experimental results obtained here for both hollow and solid blocks of smaller thickness fall well within this limit of 1.03 and 1.14. However, the ratio in the commercial samples range between 1.37 and 1.55 and is much higher than in corresponding values obtained in the prepared samples. The marked increase in strength witnessed in improved blocks as opposed to traditional blocks can be linked to an increase in the degree of bonding within the constituent materials of the block. The result of the compressive strength indicates higher values for solid block of smaller thickness than those of the hollow blocks both for the commercial samples and the sample of the control experiment. The wet compressive strength for the traditional hollow blocks is far below the recommended value for the grade of their densities.

REFERENCES:

Abdullahi M. (2005). Compressive Strength of Sandcrete Blocks in Bosso and Shiroro Areas of Minna, Nigeria. AU Journal of Technology, volume 9 no 2 pp 126 – 132

British Standards Institution. (1970), Precast Concrete Blocks. BS 2028, 1364: BSI, London, England.

British Standards Institution. (1978) Specification for Portland cement (Ordinary and Rapid Hardening). BS 12:1978. BSI, London, England

British Standards Institution. (1981). Precast concrete masonry units. Part 1. Specifications for precast concrete masonry units. BS 6073: Part 1: 1981. BSI. London, England.

British Standards Institution. (1981). Precast concrete masonry units. Part 2. Method for specifying pre-cast concrete masonry units. BS 6073: Part 2: 1981. BSI. London, England.

Gage, M. And Kirkbridge, T. (1980). Design in Block work. The Architectural Press, London.

Houben, H. and Guillaud, H. (1994). Earth Construction: A comprehensive Guide. CRATerre-EAG. Intermediate Technology Publications. London, England.

Keralli, A.G., (2001), Durability of Compressed and Stabilised Building Blocks, a Pd Thesis, University of Warwick

Montgomery, D.E. (2002). Dynamically – Compacted Cement Stabilised Soil Blocks for Low – Cost Housing. A PhD Thesis in Engineering University of Warwick

Omopariola S.S. An Appraisal of the Quality Control Practices in Sandcrete Blocks Production in Yewa South Area of Ogun State, Nigeria American Journal of Engineering Research (AJER) Volume 02, Issue 05 pp 55 - 60

Omopariola, S.S. An assessment of the compressive strength of solid sandcrete blocks in Idiroko area of Nigeria. Research Journal in Engineering and applied Science, 3(1):38-42

Omopariola S.S. An Assessment of the Compressive Strength of Solid Sandcrete Blocks -in Idiroko Area of Nigeria Research Journal in Engineering and applied Science, 3(1):50-54

Oyekan G.L. And Kamiyo O.M. (2008) Effect of Nigeria rice husk ash on some Engineering properties of sandcrete blocks and concrete, Research Journal of Applied Science Volume 3(5) pp (345 – 351)

Oyekan, G.L. and Kamiyo, O.M. (2011). A study on the Engineering properties of sandcrete blocks produced with rice husk ash blended with cement, Journal of Engineering and Technology Research Volume 3(3) pp 88 – 98

Raheem, A. A., Momoh, A. K. and Soyingbe, A.A. (2012) Comparative Analysis of Sandcrete Hollow Blocks And Laterite Interlocking Blocks as walling Elements, International Journal of Sustainable Construction Engineering & Technology Volume 3 (2) pp79 -88Hodge, J. C. (1971), “Brick work” 3rd edition, England, Edward Arnold

Stutz, R. Mukerji, K. (1988). Appropriate Building Materials: A Catalogue of Potential Solutions.

Revised & Enlarged Edition. Swiss Centre for Appropriate Technology. St Gallen, Switzerland.

Wenapere, D. and Ephraim, M. E. (2009) Physico-mechanical behaviour of sandcrete block masonry units Journal of Building Appraisal (4,) 301 - 309.