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A Study of The Hygroscopic Properties Of Solid Sandcrete Blocks

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Abstract: **-** In many parts of Nigeria and indeed in Africa 150mm and 225mm hollow sandcrete blocks are generally used for building construction. However information has it that 100mm and 125 mm solid sandcrete blocks are in use in idiroko area of Ogun State Nigeria. Since environmental degradation has been identified as a contributing factor to cases of building collapse, this study aims at examining the hygroscopic properties of 100mm and 125mm solid sandcrete blocks with a view to determining the suitability of the use of these types of blocks for building construction without any fear of collapse of the building taking place. Visits were made to sites where these types of blocks are produced for physical inspection to assess their conformity with block production processes as stipulated in relevant codes and standards. Samples of Sandcrete blocks were collected from block manufacturers and tested for water absorption, volume porosity and moisture content. Control experiment was set up to obtain desirable result when production is done according to laid down procedures. In the course of the study, it was confirmed that the staff of contractors had no formal training in quality control of block production and that mix ratio, and mixing procedures of the constituent materials as well as curing method affected the quality of sandcrete blocks produced. It was also confirmed that the quality of blocks produced by commercial manufacturers does not conform to the required standard in BS 2028 of 1970.

Keywords: **-** Block, Building, Construction, Collapse, *Hygroscopic, Properties*

INTRODUCTION

Provision of shelter is one of the major challenges facing the developing countries of the world in this twenty first century. There are reported cases of a single family of six or more members living in just one rented room, while many other people sleep in garages, under kiosks and bridges as a result of their inability to have a building of their own and because they cannot afford the exorbitant amount of renting a place of abode. Buildings that provides housing facilities should be perceived as safe for habitation without the fear of collapse. But the desire to have a place of abode coupled with the rising cost of building materials especially cement has led many people to the use of poor quality materials in building construction. Commercial block producers have capitalised on this by reducing the quality of blocks produced for sale to unsuspecting housing developers. It is being insinuated that some commecial block producers produce as much as 45 numbers of 150 mm blocks from a bag of cement instead of the recommended 25. This is a contributing factor to the incidents of building collapse in some parts of the country which has reached a worrisome dimension.

Block is an important component of walling materials that have their shape to be one of their intrinsic properties. They are cuboidal in shape and have been widely used in the construction industry especially buildings (residential and non-residential) for many centuries. The need to understand their properties for their efficient use because of their bearing on appropriate application is therefore essential. There is also the need to take necessary precautions to ensure satisfactory behaviour of these walling material component in service. 150mm and 225mm hollow sandcrete blocks are the most commonly used blocks for building construction in Nigeria and many other countries in Africa. The use of 100mm and 125 mm solid sandcrete blocks is not so common and the properties of these type of blocks have not been widely researched into, hence the need for this study.

LITERATURE REVIEW

Fagbenle and Oluwunmi (2010) defined building failure as the inability of a building component of to perform what are normally expected or required of those components. They posited that when part or the whole of the structure has failed and suddenly gave way in a way that as a result of this failure, the building could not meet the purpose for which it is intended, the building has collapsed. They further stated that this can occur during the different stages of construction process and after and that building failure or collapse cuts across cultural and ethnic barriers. Olusola et al were of the view that building collapse may arise as a result of failure in building, as the failure get to an uncontrollable measure. Building collapse cuts across different categories of building as reported cases includes both private, corporate or public and it is also not limited to multistorey buildings. Amusan, (1991) reported that Barnawa flat disaster in 1977 was a three (3) storey building, a public secondary school which collapsed in March 1988 at Ibadan was a two (2) storey building, the collapse of a showroom for cars in Lagos in 1987 was a storey buildin while the collapsed primary school in Iloabuchi, Rivers State in July 1991 was a bungallow building.

The use of faulty materials, poor quality materials and material fatigue has been identified as the major causes of building failure (Adenuga, 2012; Omopariola, 2014; Ede, 2010). According to Adenuga, (2012) ten percent (10%) of building failures are attributable to product failure. He further stated that failure in building could be of two categories namely; cosmetics and structural failure, he described cosmetics failure as occuring when something is added or subtracted from the building thus affecting the structural outlook, while structural failure affects both the structural stability and outlook of building. It can thus be infered that the addition of water to building blocks

by way of absorption will definitely result in cosmetic failure of the building and consequently the collapse of the building.The effect of any collapse of a building can be so detrimental as to cause loss of live, properties and money.

According to Thermal-survey.co.uk, “the main failure of buildings is the damage caused by water and its interactions on the building and local environment. Ingress of water can occur in either vapour or liquid form but only leave the substrate as a vapour. When in liquid form, the water can not only enter by direct means such as rain or direct water contact but also by capillary action. Therefore it is important to understand the effects water has on the materials making up the building. Where most of the effects occur is at a microscopic level at the boundary of the water and the substrate. To a lesser extent there are effects at a macro level but these are associated with weather extremes and are less common in Nigeria. Some of the properties of sandcrete blocks that can affect the quality and hence the durability of sandcrete blocks are water content, water absorption and volume porosity which are considered in this study.

Generally building materials are hygroscopic in that they take up water and subsequently maintain a dynamic equilibrium of water content by absorbing water from the environment or desorb it. This behaviour leads to the expansion and contraction of the material which in turn leads to damage through cracking”. Wikipedia stated that water content is the quantity of water contained in a material such as soil, rock, ceramics, fruit or wood. In www.engr.psu.edu, the four states of moisture content were highlighted as: Oven-dry state (OD), Air-dry state (AD), Saturated- surface-dry state (SSD) and Wet state (WS). Out of these, the SSD state is the best choice as a reference state for the following reasons: It represents the "equilibrium moisture" state of the aggregate in concrete; that is, the aggregate will neither absorb water nor give up water to the paste; the moisture content of aggregates in the field is much closer to the SSD state than the OD state; the bulk

specific gravity (BSG) of aggregates is more accurately determined by the displacement method in the SSD condition and the moisture content can be calculated directly from measurements of (BSG) using the displacement method.

In www.ask.comit it was stated that water absorption can be defined as the rate at which water is taken into, and morphed into another object or phase. The amount of water absorbed by a composite material when immersed in water for a stipulated period of time or the ratio of the weight of water absorbed by a material, to the weight of the dry materials. Composite.about.com stated that all organic polymeric materials will absorb moisture to some extent resulting in swelling, dissolving, leaching, plasticizing and/or hydrolyzing, events which can result in discoloration, embrittlement, loss of mechanical and electrical properties, lower resistance to heat and weathering and stress cracking. www.intertek.com further stated that water absorption is used to determine the amount of water absorbed under specified conditions and that the factors affecting water absorption include: type of plastic, additives used, temperature and length of exposure.

Keralli (2001), stated that volume expansion occurs as a result of increase in the moisture content termed wetting expansion and that almost all bricks and blocks can absorb water by capillarity. The existence of pores of varying magnitudes in these materials confers marked capillarity in them. The total amount of water absorbed is a useful measure of bulk quality. The reason for this is that the total volume of voids (or pore space) in a block can be estimated by the amount of water it can absorb. This property is clearly distinct from the ease with which water can penetrate a block and permeate through it (Keralli, 2001). Knowledge of the value of the total water absorption (TWA) of a block is important because it can be used for, routine quality checks on blocks (surrogate test for quality), comparison purposes with set standards and values for other like materials, the classification of blocks according to required durability and structural use and

approximation of the voids content of a block

Generally, the less water a block absorbs and retains the better is its performance likely to be. Reducing the TWA capacity of a block has often been considered as one of the ways of improving its quality. The deleterious effects of moisture on block properties were block that readily absorbs water is likely to be vulnerable to repeated swelling and shrinkage as moisture and temperature variations take place. Repeated swelling and shrinkage is likely to progressively lead to the weakening of a block fabric (either directly or indirectly). A block that contains absorbed water is often weaker with a less hard surface than when it is dry. The presence of absorbed water can also lead to the creation of conditions suitable for the resumption and acceleration of otherwise dormant chemical activity (BS 7543, 1992). Blocks with lower water absorption capacity are not likely be durable. Keralli, (2001) stated that Total Volume Porosity is an important factor that contributes to water absoption capacity of blocks and that the term porosity refers to the total amount of voids and pore structure within a block fabric (sand pores, gel pores, capillarity pores, entrapped air, entrained air, etc.). He further said that the concept of porosity has neither been well researched nor reported in sandcrete blocks literature, yet most bulk properties including strength and water absorption are believed to be a function of the total porosity of cement-based materials. However, the general link between porosity and quality has been widely reported in concrete literature. We can thus expect that similar findings will be obtained in SCBs. The shape, size and volume of pores within a block can determine its bulk performance. (Omopariola 2014b) posited that the capillary porosity which is often the most predominant is believed to be a function of the water-cement ratio and the degree of hydration

achieved. He further stated tha the value of the degree of hydration achieved can only increase as long as moisture is available to ensure the completion of hydration. Proper moist curing can therefore be a vital factor in influencing the volume fraction porosity of a block.

I.MATERIALS AND METHODS

Constituent materials used for the production of sandcrete blocks are Ordinary Portland Cement (OPC) from West African Portland Cement Company, Ewekoro in Ogun State whose properties conform to BS 12, (1978), 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. Commercial block production sites were visited in order to ascertain their confomity to laid down processes of production as stipulated in relevant codes and standards. Block samples were also collected from commercial block producers for the purpose of carrying out laboratory tests. In order to obtain desirable result when production is done according to laid down procedures control experiment was set up . The description of the specimen design and preparation was based on the four main stages of sandcrete block production which consists of soil preparation, mixing, moulding and curing. The procedures adopted and the precautions taken to produce the required number of block specimens for the various tests planned was also highlighted. The mix ratio used in the control experiment was 1:8, while the water cement ratio was 0.5. The primary phase of 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. While 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. Attempts were made to ensure that the results obtained satisfied three basic conditions: accuracy, reliability and reproducibility for all the laboratory based experiments that were carried out.

The hygroscopic properties identified as likely to influence durability of sandcrete blocks

include: Total water absorption (TWA), Total volume porosity (TVP) and Moisture Content (MC). Each of these properties were investigated in this study.

II. RESULTS AND DISCUSSION

From the visit to Commercial block production site, it was observed that in all the sites visited, the mix ratio being used varies from 1:10 to 1:12. There are no definite water - cement ratio used for block production as water was being added randomly as deemed fit by the operators. They also use the mechanical method of compression for mixing the damp soil and the stabiliser. 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. Figures 1 and 2 below shows the results of Moisture content, Total water absorption and Total volume porosity for both the commercial samples and the control experiment.

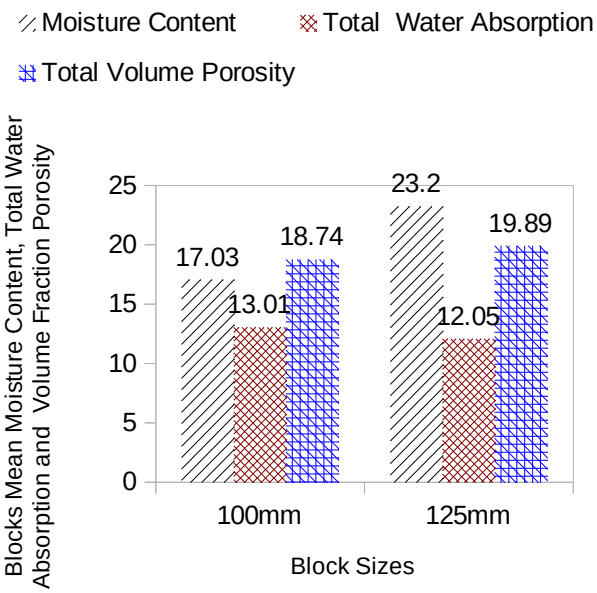

Figure 1 Bar chart of Block'sProperties for Coomercial Samples

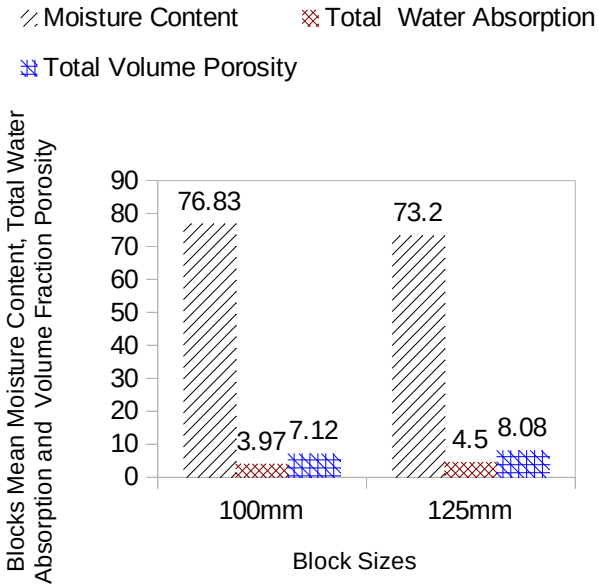

Figure 1 Bar chart of Block's Properties for Control Experiment

The moisture content values obtained for the commercial samples are considerably lower than the recommended values of 80kg/m3 while that of the control experiment is withing the recmmended value Omopariola (2014b). The reason for this can be due to the fact that water was being added to the dry mix at random without any specified water – cement ratio by the commercial block producers. Another reason can be as a result of poor curing process being employed by the commercial block producers. This resulted in higher value of water absorption which is an indication of poor quality block in the commercial samples and a corresponding lower values obtained the control experiment, an indication of a better quality block. BS 5628 Part 3, (1985) states that TWA values above 12% as high while values below 7% are regarded as being low. The values for all commercial samples classified as high while that of the cotrol experiment is low. This can be as a result of lack of adherence to specified procedure by the commercial block producers as there was no specified water/ cement ratio and also the curing process was not properly carried out. The above results also confirm that sandcrete blocks have the potential to absorb appreciable amounts of water and possibly retain it too. The total volume porosity values are higher in commercial samples than in the control experiment as shown in Figures 1 and 2. The values for both categories of blocks however compare well with those of like materials. All the blocks examined during this research can therefore be considered to be of low porosity according to (Keralli 2001) which stated that TVP above 30% are considered to be of high porosity.

III. CONCLUSION AND RECOMMENDATION

From the visit to commercial block production sites and the results obtained in the laboratory tests, the following conclusion can be drawn:

The mix ratio,water - cement ratioand curing process being used by commercial block producers does not conform to laid down procedures. The values of the moisture content obtained in

the commercial samples are considerably lower than that of the control experiment as well the recommended value in literature. Consequently, the total water absorption is higher in the commercial samples than in the control experiment. The results also confirm that sandcrete blocks have the potential to absorb appreciable amounts of water and possibly retain it too. The total volume porosity values are higher in commercial samples than in the control experiment. All the blocks examined during this research can therefore be considered to be of low porosity.

It is therefore recommended that commercial block producers be mandated to follow all necessary procedures in the relevant codes and standards in the production of sandcrete blocks. They must also be enlightened on the need to apply the required water-cement ratio and carry out adequate curing regime in the course of their production processes. The Nigerian Building Code of practice should be made available to all stakeholders in the construction industry. 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. 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.

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