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A Study of The Hygroscopic Properties Of Hollow Sandcrete Blocks

Samuel Sunday Omopariola
Department of Works and Services, The Federal Polytechnic, Ilaro, Nigeria

***Abstract:* -** Housing refers to the space where the active members as well as youngsters in the society spend most of their time and as such should be suitable and provided with minimum facilities necessary for human health, body and spirit. It is pertinent to state that such buildings that provides housing facilities should be perceived as safe for habitation without the fear of collapse. Environmental degradation has been identified as a contributing factor to cases of building collapse. This study examines the hygroscopic properties of hollow sandcrete blocks which is a major component of building materials. Samples of 150mm and 225mm hollow sandcrete blocks were collected for laboratory tests and control experiment was also set up. Experimental results reveals that Total Water Absorption and moisture content of commercially produced blocks do not meet up with recommended value in literatures while the values obtained in the control experiment are okay. However the total volume porosity for all samples are okay.

***Keywords:* -** *Hygroscopic Properties, Total Water Absorption, Moisture Content, Total Volume Porosity, Control Experiment*

I. INTRODUCTION

Provision of shelter is identified as one of the major challenges and problems in the developing countries in this twenty first century. This is as a result of dependence on expensive imported advanced technology in building construction which absorbs large proportion of housing budget. It has been recommended that government should develop the rural areas and small supporting towns to curb rural-urban migration and also to develop indigenous natural and human resources to meet their needs by which houses can be built to meet local conditions.

Blocks unlike other walling materials other than bricks have their shape to be one of their intrinsic properties. They are usually cuboidal in shape and have been recognized for many centuries and are widely used in the construction industry especially buildings (residential and non-residential). There is the need to understand their properties for their efficient use because of their bearing on appropriate application. There is also the need to take necessary precautions to ensure satisfactory behaviour in service. 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 [1]. [2] all stated that durability may be regarded as a measure of the ability of a material to sustain its distinctive characteristics, and resistance to weathering under conditions of use for the duration of the service lifetime of the structure of which it forms part. [3] posited that the use of poor quality materials is one of the major causes of building collapse. 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.

According to [4] "the main failure of buildings is the damage caused by water and its interactions on the building and local environment. Whether it is rain runoff or moisture in the air, some consider about 75% of buildings failures are due to water. 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. In vapour form molecular transport, solution diffusion and convection are the methods of water ingress. 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 the UK. 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". [5] defined water content as the quantity of water contained in a material such as soil, rock, ceramics, fruit or wood. [6] highlighted four states of moisture content as:

Oven-dry (OD): when all moisture is removed from the aggregate by heating in an oven at 105^0 C to constant weight that is all pores are empty.

Air-dry (AD): when all moisture have been removed from surface, but internal pores are partially full.

Saturated- surface-dry (SSD): when all pores are filled with water, but no film of water on the surface.

Wet: when all pores are completely filled with water with a film on the surface.

It was further stated that of these four states, only OD and SSD states correspond to specific moisture contents, and either of these states can be used as reference states for calculating moisture contents [6] futher affirms that 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.

Absorption is defined as the taking of one thing into the area of another, it is the taking up or sucking up of liquids or gases, like the way roots absorb water (6). [7] Water absorption can be defined as the rate at which water is taken in to, and morphed into another object or phase. Water can be absorbed into the atmosphere, and change into another state, such as gas, or it can be absorbed into an object, like a sponge, 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. [6] also affirms that absorption capacity (AC) or absorption represents the maximum amount of water the aggregate can absorb. It is calculated from the difference in weight between the SSD and OD states, expressed as a percentage of the OD weight:

The effective absorption (EA) represents the amount of water required to bring an aggregate from the AD state to the SSD, expressed as a fraction of the SSD weight:

$$EA = (WSSD – WAD) / WSSD \times 100\%$$

The effective absorption is used to calculate the weight of water absorbed (Wabs) by the weight of aggregate (Wagg) in the mix:

$$Wabs = (EA)\, Wagg$$

[8] states 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. [9] further states 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.

[10] 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 [11]. 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 [12 and 13]. Blocks with lower water absorption capacity are not likely be durable. Total Volume Porosity is an important factor that contributes to water absoption capacity of blocks. 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.) [14]. 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 [2]. However, the general link between porosity and quality has been widely reported in concrete literature [11]. 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. The capillary porosity which is often the most predominant is believed to be a function of the water-cement ratio and the [3]. 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.

II. MATERIALS AND METHODS

The constituent materials for the production of sandcrete blocks consists of Ordinary Portland Cement (OPC) from West African Portland Cement Company, Ewekoro in Ogun State whose properties conform to [15], 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 ratio being used by commercial block producers in all the sites visited varied from 1:10 to 1:12**.** There was no definite water **-** cement ratio used in all the sites visited as water was being added randomly as deemed fit by the operators. Mechanical method of compression of he damp soil and stabiliser mix was used 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. Block samples were collected from commercial block producers for the purpose of carrying out laboratory tests. Laboratory based experiments were carried out and attempts were made to ensure that the results obtained satisfied three basic conditions: accuracy, reliability and reproducibility.

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. Extra care was taken at all stages of the block production process: soil preparation, mixing, compression, and curing of the samples. Specimen design and preparation describes the procedures adopted and the precautions taken to produce the required number of block specimens for the various tests planned. The description is based on the four main stages of sandcrete block production: soil preparation, mixing, moulding and curing.

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.

III. RESULTS AND DISCUSSION

The results of Moisture content, Total water absorption and Total volume porosity for both the commercial samples and the control experiment are presented in figures 1 and 2 below.

The moisture content values show a considerable range of variation for the commercial samples. The values obtained are also considerably lower than the recommended values in literature. 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. Another reason can be as a result of poor curing process being employed by the commercial block producers. The resulting consequence is the higher value of water absorption which is an indication of poor quality block. For the control experiment, the obtained values are higher. The corresponding values obtained for water absorption in the control experiment is considerably low, an indication of a better quality block than those obtained for the commercial samples. **[**16] states that TWA values above 12% as high while values below 7% are regarded as being low. The values for all commercial samples are 12.33 and 12.99 for 225mm hollow blocks and 150mm hollow blocks respectively. Both values are slightly higher than 12% and as such can be regarded as high. However, for the control experiment the results obtained are 5.61 and 5.66 respectively are lower than 7 hence can be regarded as low. There are marked significant differences in the values of the commercial samples and that of the control experiment. 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. For the commercial samples, 225mm hollow blocks have 20.34% while 150mm hollow blocks have 20.30% but for the control experiment the values are 10.21% and 10.28% respectively. 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 (Jackson and Dhir, 1996). All the blocks examined during this research can therefore be considered to be of low porosity.

IV. CONCLUSION AND RECOMMENDATION

From the results obtained in the laboratory tests, the following conclusion can be drawn:

The moisture content values show a considerable range of variation for the commercial samples unlike the control experiment which has fairly consistent values. The values of the moisture content obtained in the commercial samples are considerably lower than that of the control experiment. 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. 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.

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.

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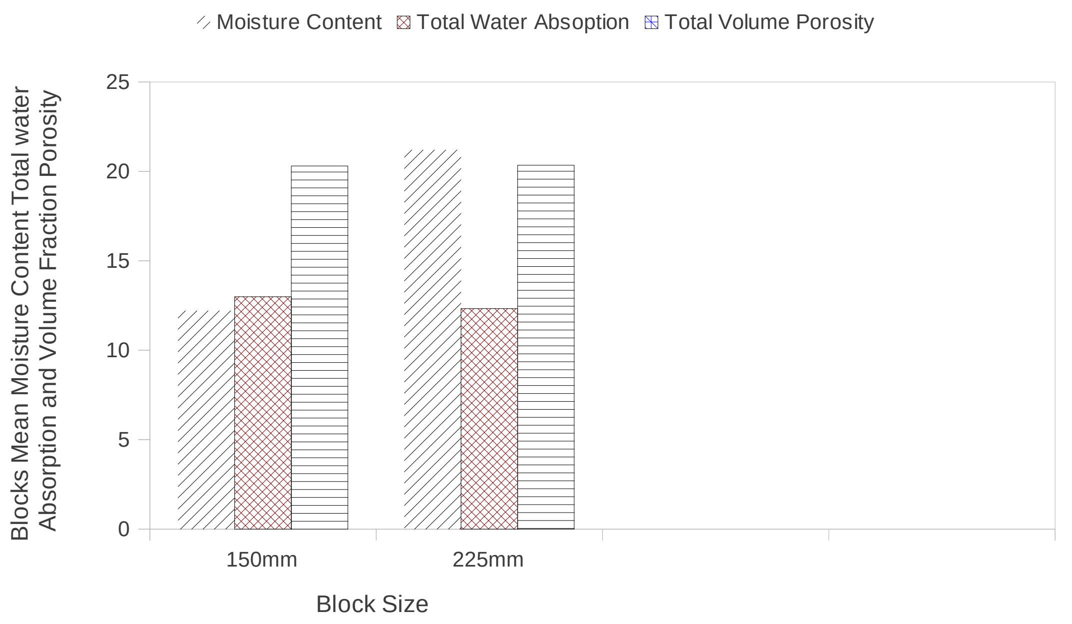

Figure 1 Bar chart of Blocks Mean Moisture Content, Total Water Absorption and Volume fraction porosity for the Commercial Samples

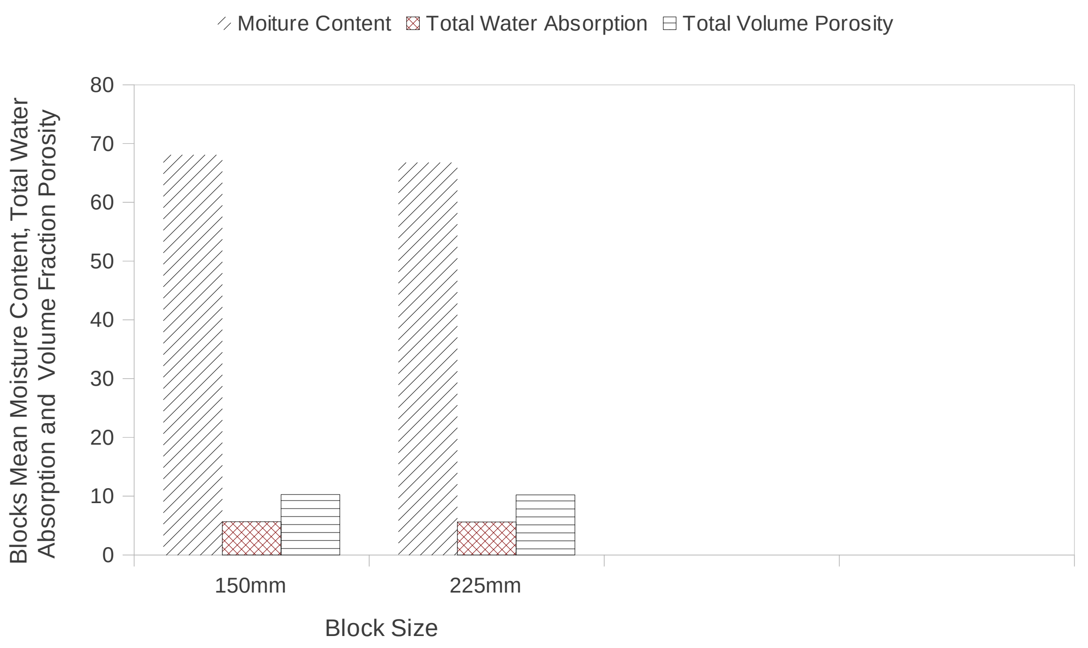

Figure 2 Bar chart of Blocks Mean Moisture Content, Total Water Absorption and Total Volume porosity for the Control Experiment