**CHAPTER ONE**

**1.0 Introduction**

This research work means to determine the different properties of sandcastle blocks moulded with locally excavated sand, in terms of compressive strength, durability and cost an economic importance, and that of River Sand.  And after, compare the two strengths of the concrete which will help in recommending the right and give the desired strength for the designed strength for a particular purpose.

Sand is the general name applied to comparatively finely divided, unconsolidated grains of rock, minerals, or slag. For this report only the naturally formed product will be considered. Although this report is concerned primarily with foundry sand, it is perhaps well to consider briefly other important uses of sand. Concrete, plaster and similar sands used in construction represent by far the largest consumption of sand, (Cisse and Laguerbe, 2000). Some molding sands for the non-ferrous metals contain not more than sixty or seventy percent of silica. Sands used for other purposes such as: the manufacture of glass, engine sand to prevent slipping of locomotive wheels, abrasive in grinding operations, filter sand at municipal water filtration plants, fire or furnace sand for lining the bottom of furnaces, as well as sand for other special uses will be discussed briefly as references to them occur in the text (Falade, 1997), .

Nair et al. (2006) opine that concrete’s effectiveness depends on its ingredients and consistency. You don’t want a mixture that shrinks or becomes brittle; nor do you want it to be runny. There will be four basic materials you need in your mix: Portland cement, sand, aggregate and water.

Adding water will form a paste that will bind the materials together until the mix hardens. The strength of the concrete is inversely proportional to the water/cement ratio. In other words, the more water you use to mix the concrete, the weaker the concrete mix. The less water you use to mix the concrete, the stronger the concrete mix. A mix with little water and more concrete mix will be dryer and less workable but stronger.

But of course the water makeup isn’t the only consideration. The sand and the aggregate help to reduce the cost and also limit the amount of shrinking that happens to the concrete as it cures. In order to produce a strong, resilient concrete mix, you need to get the ratio of aggregate to sand to cement right. Consider the following formulas as you mix your concrete. Abdullahi, (2006), Eze et al., (2005), Thwala et al., (2012).

(Oyekan, 2001) proposed that one standard recipe calls for one part of cement to two parts of sand to four parts of gravel. This results in a C20-rated concrete mix, which means the concrete will be of medium strength. Concrete is rated on a system that indicates the strength of the mix after it’s cured for approximately a month.

To make the [concrete stronger, add more cement or less sand.](http://www.shellyco.com/products/sand-and-gravel/) The closer you bring the ratio to an even one-to-one of sand to cement, the stronger the rating becomes. This principles works in the opposite direction as well.

If you want to get a little more technical, some concrete experts recommend going for 26 percent sand, 41 percent gravel, 11 percent cement and 16 percent water. The lacking 6 percent volume is air entrainment. Air entrainment is an admixture added to the mix during production to assist the mix in resisting the damaging effects of freeze-thaw cycles. This admixture is required in all concrete exposed to exterior elements. Overall this makes a good general purpose mix for foundations and other structures.

While Portland cement is the standard for concrete mixtures, the type of sand you use may vary. Unwashed beach sand creates a mixture that isn’t quite as strong as products made with sand that’s been cleaned. Clean sand tends to produce a more high-quality product.

You can achieve an accurate mixing ratio by using buckets or other measuring devices to get the right quantity of each ingredient for your mixture. Getting the right ratios throughout the process means getting consistent mix throughout your whole concrete project.

* 1. **Background of the study**

Anosike (2011), is of the opinion that concrete is a yellow-white building material made from a binder (Portland cement) sand in a ratio of circa 1:8, and water. Sometime other ingredients may be added to reduce the amount of Portland cement such as “pozzolanas and rice husk ash”. Concrete is similar but weaker than mortan for which the ratio is 1:5.

Concrete is usually used as hollow rectangular blocks similar to concrete masonry units, often 45cm (18”) wide, 15cm (5.9”) thick and 30cm (12”) with hollows that run from top to bottom and occupy around one third of the volume of the block.

**1.2  Strength and Usage**

The final compressive strength of Concrete can be as high as 40N/mm2. Concrete is suitable for load-bearing columns, and is mainly used for walling of a house

–      making a fence

–      Septic tank and soak away tanks

–      Building a generator’s house.

In Nigeria, measured strength of commercial available concrete blocks was found to be between 0.5 and 1N/mm2, which is well below the 3.5N/mm2 that is legally required. This development may be due to the need of the manufacturers to keep the price low, and since the main cost-factor is the Portland cement, they reduce that, which results in a block that starts behaving more like loose sand Oyekan and Kamiyo, (2008)

**1.3 Concrete block sizes**

They are many different types of blocks used in [modern](https://projectchampionz.com.ng/tag/modern/) building, they include:

* 9”  hollow blocks (450mmx225mmx225mm)
* 6” hollow blocks (450mmx150mmx225mm)
* 6” solid blocks (450mmx150mmx225mm)
* 5” solid blocks (450mmx125mmx225mm)
* 9” solid blocks (450mmx225mmx225mm)

**1.4 Constituent materials of concrete blocks**

These include cement, fine aggregate (sharp sand) and water.

**1.4.1 Cement**

This refers to any adhesive and the material used in connection with block and it is referred to as “hydraulic cement” because the setting and hardening depends on the preserve of water. The cement widely used in civil work is called “Ordinary Portland Cement”.

**1.4.2 Fine aggregate**

The two major types of sand used are white and coloured sand. The sand were not free from materials such as dust, silt, tree roots etc. The sources of sand include pits, rivers and sea.

**1.4.3 Water**

Any type of water available can be used to mould concrete blocks. This includes water from stream, rivers, boreholes etc.

**1.5 Statement of the problem**

Apart from bad mixing ratios, which happen even some concrete block producers add more yield of blocks, some other things can cause blocks to be in bad condition which can affect the quality of the concrete blocks produced.

**1.5.1 Re-bag cement**

Another thing to note with cement is that some cement sellers re-bag cement, removing some quantity of cement or put low quality cement product in a bag of a high quality and trust cement brand. The ratio you thought you are using to produce a given quality has been compromised and it will produce a low quality block that can easily break even before it is being used for the project.

**1.6 The aim of study**

The aim of this study is an attempt to compare the use of excavated sand and river sand in terms of strength in concrete block moulding.

**1.7 The** [**objective**](https://projectchampionz.com.ng/tag/objective/) **of the study**

The objectives of this study are as follows:

1. This project research will help us to understand the different strength of concrete blocks produced with locally excavated sand and River sand.
2. This will also help to know the properties of sand after laboratory test has been carried out.
3. This will help us in determining the moulding [methods](https://projectchampionz.com.ng/tag/methods/) and properties of concrete blocks. These properties are determined by the ratio of block constituents such as cement, water and sand

**1.8 Scope of the study**

The scope of this project work is limited to obtaining the comparison of locally excavated sand with River sand in terms of strength in concrete blocks

**1.9 Significance of the study**

The significance of study is listed below:

1. To help us understand the strength of concrete blocks produced with locally excavated sand and River sand in Ogbomoso.
2. To help us determine the properties of excavated sand after carrying out laboratory test.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 Blocks and bricks molding**

Hollow sandcrete blocks have been in use in many nations of the world including Nigeria, playing a major role in the building industry (Dashan and Kamang, 1999; Al-Khalaf and Yousif, 1984; Morenikeji et al., 2015). Sandcrete blocks and bricks are masonry units manufactured from a mixture of cement, sand and water. They are largely used as walling materials in construction of shelter and other infrastructures. Oyetola and Abdullahi (2006) argued that sandcrete has been in use throughout West Africa for over 5 decades as a popular building material for preparation of building blocks and bricks. They posit that it is predominantly used and suitable for load and non-load bearing walls, or for foundations. The material constituents, their mix, presence of admixtures and the manufacturing process are important factors that determine the properties of sandcrete blocks.

In Nigeria, 95% of walling materials in buildings are made of sandcrete blocks. Anwar et al. (2000) put forward that Sandcrete walls have adequate strength and stability, provide good resistance to weather and ground moisture, durable and easy to maintain. They also provide reasonable fire, heat, airborne and impact sound resistance. As material for walls, its strength is less than that of fired clay bricks, but sandcrete is considerably cheaper. Chandrasekhar et al. (2003) argued that Sandcrete is the main building material used for the construction of walls of most post-independent buildings in Nigeria. In many parts of Nigeria, Sandcrete hollow blocks are the major cost component of the most common buildings. The blocks are usually manufactured with the use of a vibrating machine (Falade, 1997; Cisse and Laguerbe, 2000).

A new technology developed in South Africa but now used in several parts of Africa known as hydraform technology is also used in manufacturing sandcrete blocks in Nigeria (Oyekan, 2001). Hydraform block, usually solid, is a type of sandcrete block that could be stacked together to form a wall without cement. HYDRA comes from Hydraulic indicating the hydraulic action in manufacturing blocks, while FORM comes from the formation of interlocking blocks. The main benefit of using Hydraform ‗Interlocking‘ Block for a walling unit is that the interlocking blocks are dry stacked meaning no mortar is required in 70% of the structure. Nair et al. (2006) opine that the Hydraform interlocking blocks lock front and back, top and bottom eliminating the need for mortar joints in the super structures.

Interlocking refers to the male and female ridges on the top and bottom as well as front and back of the Hydraform blocks. Ganesan et al. (2008) added that these ridges lock into one another to lock the blocks into place. Hydraform blocks lock on 4 sides, front and back; top and bottom which ensure each block is locked into place. The foundation is laid in mortar as normal; blocks from the first course up can be dry-stacked. The top 3-4 courses below the roof structure must be bedded in mortar (ring beam). This secures the wall ensuring each block is perfectly locked and in place. Original Hydraform Machines are only manufactured in South Africa (Abdullahi, 2006; Eze et al., 2005; Thwala et al., 2012).

Oyetola and Abdullahi (2006) shed light on the utilization of rice husk and rice husk ash as a partial replacement material or stabilizing agent in building works. Studies carried out to investigate some characteristics of aha husk ash/ordinary Portland cement concrete. Test results indicate that the compressive strength for all the mixes containing AHA increases with age up to the 14-day hydration period but decreases to the 28-day hydration period while the conventional concrete increases steadily up to 28-day hydration period. Further studies was carried out on rice husk as a stabilizing agent in clay bricks. In that study, clay bricks were produced with 0%, 1%, 2%, 3%, 4%, 5%, and 10% rice husk. Some of the bricks were burnt in an electric furnace to a temperature of 1005°C for about 3-4 hours. Compressive strength and absorption tests were carried out. It was concluded that the addition of husk reduces the compressive strength of the bricks and the husk clay bricks becomes lighter as the percentage of husk clay increases.

Oyekan and Kamiyo (2011) opine that 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 block is the major cost component of the most common buildings. The high and increasing cost of constituent materials of sandcrete blocks has contributed to the non-realization of adequate housing for both urban and rural dwellers. Hence, availability of alternatives to these materials for construction is very desirable in both short and long terms as a stimulant for socio-economic development. In particular, materials that can complement cement in the short run, and especially if cheaper, will be of great interest. Oyekan (2001) argued that over the past decade, the presence of mineral admixtures in construction materials has been observed to impart significant improvement on the strength, durability and workability of cementitious products. The author added that in the areas prone to flood, hydrothermal properties of the buildings construction materials are of importance. Also, energy requirements for residential and commercial buildings are known to be influenced by building design and by the materials used.

Nair et al. (2006) posit that in both temperate and tropical regions, thermal properties of building materials are of significant importance to the determination of the heating or cooling load within the building and hence the capacity of the mechanical equipment required in handling the load. This is necessary to provide a given level of thermal comfort within the building and over the annual climatic cycle. Substitution of any of these admixtures is aimed at enhancing at least one of the properties of the block. However, Yogenda et al. (1988) suggested that rice husk is a residue produced in significant quantity on a global basis. While it is utilized as fuel in some regions, it is regarded as a waste in others thereby causing pollution; due to problem with disposal. Hence, it is beneficial to adopt in an environmentally friendly manner, will be a great solution to what would otherwise be a pollutant. When burnt under controlled conditions, the rice husk ash (RHA) is highly pozzolanic and very suitable for use in lime-pozzolana mixes and for Portland cement replacement. Effect of RHA blended cement on the strength and permeability properties of concrete has been investigated by Ganesan et al. (2008). On sandcrete block, Cisse and Laquerbe (2000) observed that the mechanical resistance of sandcrete blocks obtained when unground ash resulted to increase in performance over the classic mortar blocks. Their studies on Senegalese RHA also revealed that the use of unground RHA enabled production of lightweight sandcrete block with insulating properties at a reduced cost. Okpala (1993) partially substituted cement with RHA in the percentage range of 30–60% at intervals of 10% while considering the effect on some properties of the block.

The experiment showed that a sandcrete mix of 1:6 (cement/sand ratio) required up to 40% cement replacement and a mix of 1:8 ratio required up to 30%, are adequate for sandcrete block production in Nigeria. Hence, as a result of the high cost of procuring the rice husk required for producing large number of blocks needed for an average-size building, and in the light of the reducing agricultural activities in Nigeria, replacing cement with such high volume of RHA could be economically counterproductive for local sandcrete block manufacturers thereby defeating the main purpose of the substitution which is to reduce the unit cost of the block.

**2.2 Quality of sandcrete blocks and bricks**

Quality is defined as ―fitness for purpose‖ or compliance with specification (Anosike, 2011, Taylor, 2002). They authors argued further that it is the overall characteristics needed by a product or service to satisfy stipulated and implied needs. ISO 8402-1986 standard defines as "the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs". In addition, the manufacturing business dictionary, defined quality as a measure of excellence or a state of being free from defects, deficiencies, and significant variations, brought about by the strict and consistent adherence to measurable and verifiable standards to achieve uniformity of output that satisfies specific customer or user requirements. Ogunsanmi et al. (2011) identified quality as one of the three key elements for developing risk classification model for design and build projects. This therefore follows that quality is a significant factor that cannot be undermined in the construction of projects. Nunnally (2007) argued that quality management and quality assurance on the other hand have been adopted to include all aspects of producing and accepting a construction project which meets all required quality standards. He further asserts that quality management includes such activities as specification development, process control, product acceptance, laboratory and technician certification, training and communication. The author concluded that quality control, which is a part of the quality management process, is primarily concerned with the process control function.

The Standard Organization of Nigeria (SON) established through Act 56 in 1971 is the sole statutory body that is vested with the responsibility of standardizing and regulating the quality of all products in Nigeria including sandcrete blocks.

The Nigerian Industrial Standard (NIS) for sandcrete block is a standard reference document developed by the SON which prescribes the minimum requirement and uses of sandcrete blocks.

Abdullahi (2005) reported that sandcrete blocks are widely used in Nigeria, and other countries like Ghana, as walling units. The blocks are composed of cement, sand, and water, molded into a variety of shapes and sizes (Kumar et al., 2012). The quality of blocks, however, is inconsistent due to the different production methods employed and the properties of the constituent materials used. Blocks are those building units used in the construction of wall and partitions. They are of sizes and weights that can be easily handled by bricklayers, with the facing surface layer than that of a brick but conveniently dimensioned. Hodge (2007) opine that sandcrete blocks are available for the construction of load bearing and non-load bearing structures. He argued that load bearing blocks must conform to building regulations which stipulate the amount of solid mineral contained in section—i.e., the total width of block. Sandcrete blocks are also used in the task of transforming the actual load from the overlaying structural element to the foundation. However, the load bearing wall are referred to those walls acting as supports for the whole structure to transmit the weight to the ground surface underneath it for stability (NIS 87: 2000; Duncan et al., 2012).

Mariarosa Raimondo et al (2009) considered the capillarity phenomenon and the suction capacity of brick depends on their micro-structural characteristics, amount, size and shape of pores. Besides some exceptions, the linear relationships between the capillary coefficient Ks and these micro-structural variables substantially confirm the role played by open porosity in increasing the absorption capacities of clay bricks. The capillary coefficient Ks, together with the micro-structural variables and phase composition, finally underwent a statistical procedure that confirmed the influence of porosity, as well as coarser pore dimension (in terms of both radius and percentage of pores greater than 3ƒÊm) in increasing the liquid adsorbing rate with the highest statistical significance.

In addition, the sintering pattern of products, leading to a different amorphous/crystalline phases ratio, proved to be relevant on the definition of the most suitable microstructure: the higher porosity, promoted by the complete CaCO3 decomposition and the smaller pore size, connected with the low sintering degree of clay bricks.

Giulia Baronio and Luigia Bindat (1997) demonstrated that a good degree of hydraulicity of the mortar obtained in ancient mortars were durable for centuries. Modern bricks are seldom pozzolanic, not only because they are fired at high temperature, but also because they can be made of materials which do not contain or have a low content of clays. When the basic material is clay, then a thermal treatment can give pozzolanicity properties in which the temperature and duration of the treatment must be chosen very carefully. The clays were fired for 15 to 30 minutes at two different temperatures at 6500C and 7500C. After treatment, the two clays were subjected to diffractometric analysis and pozzolanicity test. In order to improve the brick characteristics (pozzolanic reaction can take place at brick/joint interface) or simulate the production of pozzolanic materials from common clays useful in the preparation of hydraulic mortars.

Jose Luis Vivancos et al (2009) discussed that the energy consumption of a specific building depends mainly on the building type, climatologic conditions, building construction, occupancy behaviour, installations for heating, cooling, production of domestic hot water and lighting. Heat flux evolution on different types of clay and concrete bricks was studied using a guarded hot-plate. Michele et al (2004) outlined the thermal conductivity of clay and physical or micro-structural parameters which affect their thermal behaviour most significantly. A comparison of the correlation between the thermal conductivity data collected from the literature and those obtained in the present work with the bulk density highlighted that the dependence of thermal conductivity on bulk density, quoted by several authors was not always very obvious and was not able to describe accurately the thermal behaviour of clay bricks.

Through a statistical treatment of data, some trends regarding the relationships among the thermal conductivity and the main mineralogical and micro-structural variables of bricks were revealed. The simple linear binary correlations and the multivariate analyses (factor analysis and multiple linear regression analysis) highlighted the role played by some mineralogical components, in particular Ca-rich silicates (wollastonite and melilite), quartz and amorphous in depressing the insulating properties of clay bricks. On the other hand, among the microstructural parameters, the role of open porosity in improving the thermal performances of bricks was found to be predominant.

Gangadhara Rao et al (1998) made an effort to evaluate the thermal resistivity of class F fly ash using a laboratory thermal needle/probe. The effect of density of compaction and the moisture content on the thermal response of the fly ash were studied. Fly ash was used in conjunction with aggregates to design a proper backfill material. Soil as such was not a good conductor of heat when compared to the metals (normal conductors). Soil thermal resistivity was a measure of the resistance offered by the soil to the passage of heat. Thermal stability was normally related to the ability of moist soil to maintain a relatively constant thermal resistivity when subjected to an imposed temperature difference.

Thermal instability occurs when a soil was unable to sustain a rate of heat transfer; to overcome this; the native soil was replaced by materials (backfills) with better thermal properties. When water was added to the ash, it formed a thin film around the fly ash particles that eased the conduction of heat (i.e) increasing its conductivity and reducing its resistivity. This attributed to the fact that the thermal resistivity of air (equal to 4000‹C-cm/ W) was higher than that of the water (equal to 165‹C-cm/W). The addition of water to the fly ash resulted in decrease in the air voids (and hence the density increases) and as such the thermal resistivity of the fly ash in the near vicinity of its optimum moisture content attained almost a constant value that is the minimum value of thermal resistivity the fly ash can exhibit. At this situation the resultant resistivity of the fly ash, known as \critical moisture content,. was more dependent upon the resistivity of the pore water. There was a rapid increase in the thermal resistivity of the soil, with a small reduction in moisture content as less than the critical moisture content. This critical moisture content depends on the particle size distribution and the density of compaction.

From the resistivity-moisture content variations, another important observation was that as compaction density increased, critical moisture content decreased. The critical moisture content values for fly ash were obtained in the range of 28.32%. Henry Liu et al (2009) developed the brick made of pure fly ash and the manufacture of the brick did not involve high temperature heating in kiln, in contrast to manufacturing clay bricks. Consequently, using of greenest brick not only eliminated waste disposal of fly ash and saved landfill space, it also saved much energy and eliminated all the air pollution and global warming problems caused by burning fossil fuel in kilns to manufacture clay bricks. Fly ash bricks made from fly ash do not emit mercury into air. On the contrary, they absorbed mercury from air, making the ambient air cleaner. Fly ash brick did not emit radon gas, but only at about 50% of that emitted from concrete. Thus, it was considered safe to use concrete or concrete products in buildings and it should be even safer to use fly ash bricks. Leaching of pollutants from fly ash bricks caused by rain was negligible. In addition, long-term observation of the compacted fly ash bricks revealed that the long-term growth of strength of fly ash bricks was due to carbonation caused by absorption of CO2 from the atmosphere which brings relief to global warming.

Sandcrete blocks possess an intrinsic low compressive strength making then susceptible to seismic activity. Previous research has shown dismal results in the production of sandcrete blocks, which have exhibited compressive strength far below the standard requirement for the construction of houses (Oyekan and Kamiyo, 2008). Sandcrete blocks have been used for a long time throughout Nigeria (NIS 87:2000). The importance of the blocks as part of local building materials in the building and construction industry cannot be overemphasized. Bricks are alternatives to sandcrete blocks.

However, the clay suitable for making high strength bricks is not available everywhere in Nigeria and the clay bricks produced and presently used in construction are not uniform in quality. Anosike and Oyebade (2012) put forward that the rapid changes in the use of bricks to block in Nigeria have encouraged the investigations into the use of sandcrete blocks to be more elaborate. It was also realised that in some places in Ondo and Ekiti States in Nigeria were occupied by rivers, which make it easier to obtain river sand rather than clay for making blocks. Also, in Minna communities, sand is easily obtained from borrow pits and riverbeds situated in the environment which enhance the use of sand for block making. The word sandcrete‘ has no standard definition; what most workers have done was to define it in a way to suit their own purpose. The word for it in some local dialect means brick earth and the name ‗sandcrete‘ is merely a translation of the use to which these blocks are put. Sandcrete blocks are often too crude to reveal the nature and origin of sandcrete exhibiting the same physical properties. Though sandcrete varies widely, one feature remains constant: the same amount of combined silica in proportion to the alumina present, and it is in this respect that sandcrete differ from clay (Baiden and Tuuli 2004).

**2.3 Standardization and regulation of quality**

In Nigeria, the fulcrum of Standardization and Regulation of quality for all products is vested in the Standards Organization of Nigeria (SON). Established by Act No. 56 of 1971 and with three amendments in 1976, 1984 and 1990, SON as a corporate body have the sole responsibility for National Policy on Standards, Standards Specification, Quality Control and Metrology, Manufactured Industrial and imported products and services. The Act No. 20 of 1976 which amended the previous one conferred on the Honorable Minister of Industry the power to declare Mandatory Industrial Standards in Respect of products or processes recommended by the Nigerian Standards Council (UNESCO 2008).

The Act No. 32 of 1984 changed the name of the agency to Standards Organization of Nigeria (SON) from Nigeria Standards Organization (NSO). This was aimed at eliminating conflicting identity with the then Nigerian Security Organization. Finally, the Act No. 18 of 1990 conferred on SON partial autonomy from the Ministry of industry. This amendment gave far-reaching transformation to the Organization succession and a common seal, and may sue or be sued in its corporate name. The statutory functions of Standards Organization of Nigeria by section 3, subsections (1) of 1971 Act No. 56 are as follows:

(a) To organize test and do everything necessary to ensure compliance with standards designated and approved by the Council.

(b) To undertake investigations as necessary into the quality of facilities, materials and products in Nigeria, and establish a quality assurance system including certification of factories, products and laboratories.

(c) To ensure reference standards for calibration and verification of measures and measuring instrument.

(d) To compile an inventory of products requiring standardization.

(e) To compile Nigeria Industrial Standards.

(f) To foster interest in the recommendation and maintenance of acceptable standards by industry and the general public.

(g) To develop method for testing of materials, supplies and equipment including items purchased for use of departments Government of the Federation or State and Private establishment.

(h) Register and regulate standard marks and specification.

(i) To undertake preparation and distribution of standard samples.

(j) To establish and maintain such number of Laboratories or other institutions as may be necessary for the performance of its functions under this Act.

(k)To compile and publish general scientific or other data.

**2.4 Standard requirements**

The Federal Building Code (First edition, 2006) stipulates that the application of all materials and components used in the construction of buildings must be such that will achieve aesthetics, durability, functionality, character and affordability (Afolayan et al., 2008; Anosike, 2011). Locally available building materials should be integrated for their additional advantages of availability, identity, job creation and affordability. The National Building Code stipulates as follows:

**Sandcrete Blocks**: shall mean a composite material made up of cement, sharp sand and water.

i. Blocks shall be molded for sandcrete using metal (wood) molds of:

450mm x 225mm x 150mm

450mm x 225mm x 225mm

450mm x 225mm x 100mm

ii. They are usually joined by mortar which is a rich mix of sandcrete.

**Aggregate:** This include both coarse and fine, from natural sources, blast furnace slag, crushed clay and furnace clinker.

**Sand**: shall be of approved clean, sharp, fresh water or pit sand, free from clay, loam, dirt, organic or saline water of any description and shall mainly pass 4.70mm test sieve. If lagoon sand is used this must be properly washed to the approval of the supervisor.

**Mix proportion**: Mix used for blocks shall not be richer than 1 part by volume of cement to 6 parts of fine aggregate (sand) except that the proportion of cement to mix-aggregate may be reduced to 1:4 ½ (Where the thickness of the web of the block is one 25mm or less).

**Strength requirements**: Sandcrete blocks shall possess resistance to crushing as stated below and the 28day compressive strength for a load bearing wall of two or three story building shall not be less than:- average strength of 6 blocks, lowest strength of individual block 2.00 N/mm2 (300psi), 1.75N/mm2 (250psi).

**Molding**: The 28 day compressive strength of a sandcrete block for load bearing wall of two or three story buildings shall not be less than the values given above and shall comply with the existing NIS specification for sandcrete blocks.

**Compaction**: Two methods to be applied depending on the availability of materials (tools) are;

1. By approval (standard) machine compaction.

2. My metal mold (hand) compaction.

**Production/Processing**: The sandcrete block shall be cast using an appropriate machine with cement/sand ratio of 1:6 measured by volume. Where hand mixing is carried out, the materials shall be mixed until an even color and consistency throughout is attained. The measure shall be further mixed and water added through a fire hose in such sufficient quantity as to secure adhesion. It shall then be well rammed into molds and smoothed off with a steel face tool (Okoli et al., 2008).

**Curing**: After removal from machine, the blocks shall be left on pallets under cover in separate rolls, one block high, with a space between each block for at least 24 hours and kept wet by weathering through a fire watering hose (Anosike, 2011). The blocks may then be removed from the pallets and the blocks may be stacked during which time the blocks shall be kept wet. The blocks may be stacked not more than 5 blocks high under cover at least seven (7) days before use after the previous period.

**Physical requirement**: Special sizes and shapes of blocks and bricks 11.25mm (i.e. 4..) thick or less shall be solid with grove and tongued joints. Blocks of greater thickness, than 11.25mm (i.e. 4..) thick shall be hollow of used above damp proof course. Hollow blocks shall be more than 50mm thick. Hollow blocks shall be used only where vertical steel reinforcement is to be fixed (Eze et al., 2005).

**2.5 Standard enforcement**

Oyekan and Kamiyo (2008) argued that the Federal Building Code stipulates that for the control of building works in Nigeria, there shall be established in all Federal, State and Local Government Urban Development Agencies, a Code Enforcement Division/Unit in their Development Control Departments to carry out the following functions:

1. Enforce the provisions of the Code through the appropriate registered professionals.

2. Implement the provisions of the Code to secure the intent thereof.

3. Request, so far as is required in the discharge of official duties, receive the assistance, and cooperation of other officers in all Government Ministries, Departments, Parastatals, Police and other Law Enforcement Agency.

**2.6 Standard production methods**

Nunnally (2007) suggested that sandcrete blocks, usually hollow, are manufactured with the use of a vibrating machine for large scale production and hand mold for small scale production. Baiden and Tuuli (2004) added that the type of hollow sandcrete blocks commonly produced and used for construction of buildings in Nigeria are made of a standard mix proportion of 1:6 cement-sand ratio; that is, one part by volume of cement to six parts by volume of coarse sand. The sizes of blocks produced are 225 x 225 x 450mm and 150 x 225 x 450mm with one-third of their volume void, and the solid core blocks of size 100 x 225 x 450mm used mainly as non-load bearing partition walls. In the manufacture of the blocks, hand mixing is generally employed and the materials are turned over a number of times until an even color and consistency are attained (Goncalues and Bergmann (2007).

Water is usually added through a fire hose and it is further turned over to secure adhesion. It is then rammed into the machine moulds, compacted and smoothed off with a steel face tool. After removal from the machine molds, the blocks are left on pallets under cover in separate rows, one block high and with a space between 2 blocks for the curing period. They are kept wet during this period by watering daily. After curing, the blocks are stacked and stored ready for transportation to project sites for use. Hydraform blocks are composed of soil and mixed with 8-10% cement. In producing hydraform blocks, laterite soil or "Murrum" is preferred. Generally you can use soil with 5-35% clay and silt content. It is advisable never to use black cotton soil as it contains highly reactive clay and the blocks will crack when they dry. Uzoamaka (1977) opine that black cotton soil also contains high amounts of organic material not suitable for block production.

Dashan and Kamang (1999) posit that the Hydraform 220mm block is mostly dry-stacked (except for foundations, ring beam and lintels) and is suitable for any walls in the structure. The Hydraform 140mm block is a semi dry-stacked block. Slurry is made from fine sand and cement and poured into the cavities of the 140mm blocks. This locks the structure together creating a firm wall. The most common application would be internal. The Hydraform 220mm block is mostly dry-stacked (except for foundations, ring beam and lintels) and is suitable for any walls in the structure. The 140mm block functions similar to the 220mm block as a dry-stacked block but can save you up to 15% in material costs. The disadvantage would be the cornering, which must be plastered to achieve the required load strength (BSI 1992; Nair et al., 2006; ASTM 2004).

Hydraform walls creates a smooth finish that can be left as a face brick finish for outside walls and plastered on internal walls. Hydraform recommends that outside face brick walls are treated with a water repellent to protect the outer surface. Paint can be applied directly to the smooth wall or to the plastered Hydraform wall. There are approximately 37 blocks in one square meter of wall. "Green" (fresh) Hydraform blocks are stacked and covered with black plastic to avoid moisture loss. The blocks are then watered daily to create a greenhouse effect, allowing the cement to harden and the blocks to strengthen. Hydraform recommends 250micron black plastic for curing. Cure your Hydraform blocks for a minimum of 7 days and allow the block to dry for another 7 days before building. This will ensure strong good quality blocks. Hydraform recommends that blocks are cured under black plastic for a minimum of 7 days. Allow the blocks to dry for a further 7 days before building. Blocks will achieve maximum strength after 28 days. Hydraform recommends a minimum of 8% cement which once properly cured should yield a Min 7MPa block. This means 12 parts soil to 1 part (UNESCO 2008).

**2.7 Origin of sand**

The grains and pebbles of which sand and gravel are composed have been derived from the mechanical disintegration and chemical decomposition of rocks M. S. Littlefield (1996). Later concentration of· the particles by water or wind produces the deposits as we know them today. The weathering processes which are constantly at work upon the rocks are of two types, mechanical and chemical. The difference between core and molding sands is essentially the absence of bonding material in the core sands, and the presence of clay and colloidal matter in the bonded or molding sands which gives them the desired property of having strength or cohesiveness so that no artificial bonding agent is necessary in preparing molds for metal castings.

In addition to these forms of unconsolidated sand deposits,there is a large group of consolidated deposits, classed as sandstone and quartz or silica rock, which are crushed and provide a very satisfactory clean sand for use in preparing cores and other artificial sand mixtures for foundry use J. A. Bownocker **(**2003) .

**2.7.1 River or stream deposits**

J. A. Bownocker, Muskingum County (2003) reported that Fluvial deposition tends to sort the sediment into size grades, and for this reason offers greater promise in the production of commercial material. If a rapid stream carrying sediment generally decreases in velocity downstream the gravel and then coarse sand are dropped first, followed progressively by finer material, until in almost still water silt and mud or clay are deposited. But the completeness of the sorting or separation of the different sizes of materials at any one point depends upon the rate of decrease of velocity. J. P. Moral Cardona (2007),  It is clear that uniform fineness in a deposit must be dependent upon constant conditions of deposition over a considerable time, as were maintained for considerable periods in those streams which flowed rapidly from the terminals of the glaciers and carried with them some of the material deposited by the ice sheet, as it melted. Simultaneous deposition of sand and clay without fine sand and silt is an impossibility. M. Achab, (2017). Analyzed that there is a remote possibility that alternate layers of sand and of clay might be deposited in such a proportion that the resulting section could yield a satisfactory molding sand composed of sand and clay without large amounts of fine sand and silt. For this reason, the actual formation of a bonded sand containing sand particles and clay without large quantities of fine sand and silt is usually dependent upon secondary changes occurring in the sand after deposition.

**2.7.2 Deposits in glacial outwash***:*

[D. H. Krinsley](https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=KRINSLEY%2C+D+H) and [F. W. McDoy](https://onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=McCOY%2C+F+W) (1997), reported that during the period that the Great Ice-sheet retreated northward across Michigan extensive plains of gravel and sandy material were deposited by the many streams which issued from the melting ice front. Some of these deposits are spread out like large aprons or fans. Others form relatively narrow belts marking the channels of former streams, as in the case of deltas. This type of deposit is characterized by the flat nature of its topography. The outwash trends roughly southward from the terminal moraines. J. S. Armstrong-Altrin and S. M. Hussain (2006)

In many places the deposits of outwash streams were fairly well sorted and the sharp sand is of a fairly uniform size. However, the possibility of depositing clay with this sand to form naturally bonded sand is so small that we seldom find any naturally bonded sand in glacial outwash aprons.

If any bonded sand is in these deposits it is very probable that it has been developed by secondary changes after the deposition of the sand. *Weathering*, the process of producing secondary changes, seems to take place best on the large flat areas and is aided to some extent by the covering of vegetation which furnishes organic acids which help in the solution and decomposition of the sand particles forming clay and colloidal matter which supplies the bond in the sand.

The sand of the Albany district is composed entirely of quartz or chert grains which are very insoluble under ordinary weathering conditions. The grains are coated with a strong type of clay which does not extend below the zone of weathering or the level of ground water where sharp sand or gravel is encountered. Clay bond in these deposits has been formed by the weathering of the soluble minerals out of the sand particles. Other examples of this type of deposit are found in extensive outwash flats south of Burlington, Wisconsin, and in similar outwash plains in southwestern Michigan.

**2.7.3Deposits along abandoned drainage lines.**

Occasionally the streams flowing from the ice deposited much sand and gravel in the valleys through which they were flowing. Such streams often clogged the valley with sediment to such an extent that the stream was frequently forced to find another course. Abandoned drainage lines leave filled valleys with no permanent or persistent streams flowing through them.

In numerous places the deposits of old glacial streams are sufficiently well sorted to yield satisfactory foundry material. In such deposits the sands are usually found under flat top terraces where a relatively thin deposit may be sufficiently well bonded to serve as satisfactory molding sand.

**2.7.4 Deposits along present lines of drainage**

In areas of deposits by the old glacial streams, a smaller stream frequently persists after the retreat of the glacier. These later, present streams cut through the old deposits leaving the sand as terraces above the bed of the stream.

The last deposition on the top of these terraces is frequently bonded molding sands, as in the Zanesville, Ohio, district, where the currents and the material supplied by the streams were favorable for depositing essentially the proper mixture of sand and clay to form a molding sand. Below the molding sand cover there is usually a much greater thickness of sharp sand and gravel. The "Red Flint" blast sand produced at Eau Claire, Wisconsin, comes from such a terrace which was made by the Chippewa River cutting through the sand previously deposited by the old glacial river.

Lacustrine or Lake Deposits Glacial Lakes according toMuskingum County(2003). Locally the old glacial streams or rivers flowing from the terminal of the glacier were dammed by a large deposit of material dropped by the streams or by the edge of the glacier forming a temporary dam across the valley in which the stream was flowing. The sediment, varying from the coarse sand to fine clay, carried by the streams running into these lakes spread over the lake bottom. The coarser material was deposited near the shore where wave action worked it over into sandy beaches or beach deposits and the finer material was carried further out into deeper and more quiet water. Many such deposits are found in Michigan along the old beaches and lake bottoms of the glacial lakes.

David W. Traynor, Jr. (2003) reports an analysis of the clay contents of the in the old lake bed at varying distances from the old beach ridge formed by the glacial lake Jean Nicolet in the Berlin District of Wisconsin. On the beach the sand had a clay content of 0.74 percent, two-tenths of a mile from the beach ridge the sand showed a clay content of 4 56 percent; the molding sand in the second foot below the surface and about one hundred feet further away from the beach ridge than the last sample showed a clay content of 30.66 percent; and a sample taken a quarter of a mile from the beach ridge showed 47.42 percent of clay.

In these lake deposits it is reasonable to expect that the natural bonding material was deposited simultaneously with the sand grains using the term "simultaneous disposition” in a geological sense.

Because lake deposits may have been formed in this way and contain sand of the proper size grade deposited with clay bond as molding sands, in which the development of the bond is not necessarily dependent upon weathering, we may expect to find molding sand or naturally bonded sand in lake deposits independent of the penetration of weathering, or other secondary changes in the deposit.( American Foundrymen's Association. Vol. 33, p, 707).

**2.8Secondary changes in sand deposits**

It has been shown by Moore, David (1999) that it is improbable, except in rare cases, for sand and clay to be deposited simultaneously in the same place without the inclusion of very fine sand or silt. As many natural bonded molding sands are a mixture of sand and clay without fine sand and silt, obviously processes additional to those already considered must have operated on such deposits.

Most of the sand deposits were produced by mechanical disruption or by glacial action. Chemical decomposition and disruption of the sand particles may proceed after this sand has been deposited, as the soluble matter in the rock and mineral particles has not been removed by weathering or chemical action Lancaster, Lynne (2005).

According to Nick Gromicko & Kenton Shepard (2013), continual leaching of the sand deposits by rain water and by ground water, particularly when they contain some absorbed carbon dioxide from the atmosphere, removes the soluble part of the sand grains, causing a disruption of the grain. The insoluble residue formed by chemical action is left in the interstices between the grains as a deposit of clay. The insoluble particles of sand and mineral matter are left behind as sand grains. Solution of soluble matter under these conditions in a practically neutral solution favor the formation of colloidal solutions and colloidal particles which are readily absorbed on the surfaces of the sand grain and on the surface of the clay. In this way a deposit of well sorted sand originally without bond, under favorable conditions of weathering may become a well bonded usable molding sand, said Courland Robert (2011)

Molding sand formed in this way is generally the most valuable sand, as the action of the ground water removes practically all of the lime from the limestone, the alkali from the feldspar, and to a large extent the excess of iron that may be present, leaving the sand behind as essentially silica sand particles and a residue of clay, or aluminum silicate, between the grains M.D. Gidigasu,(2005).

Neville (1995) opined that the action of weathering begins at the top of a deposit and causes a formation of clay in the upper layers. This heavy layer, as it is called by a producer of molding sands, may be a single thick horizontally continuous layer or it may be a series of thin horizontal layers from an inch or less to over a foot thick separated by somewhat thinner layers of sharp, clean sand. Upon casual inspection it might be supposed that these more or less horizontal layers of high clay content were due to stratification in the deposition of the sand. But this is not the case. In many deposits, such as wind-blown or dune sands which are uniformly sorted from top to bottom, the clayey bands are found bearing no relation to the depositional stratification. In other deposits several stratified layers of different fineness may be included in a single clayey band. In general these deposits exhibit four distinct layers as follows:

(i) At the top a loam or reduced clay supporting vegetation.

(ii) Below this a layer of medium fine sand containing some clay running into

(iii) Sands of high clay content which are separated by a sharp sand usually coarser than found above the clay band, and

(iv) Below the clay band the sharp core sand continues as a uniform deposit practically free from bond.

Although these distinct layers are not always in evidence, owing to the fact that the Michigan deposits are still so young as not to have shown clearly the result of the weathering, in general, these four different layers are present or in the process of formation. In the deposits of uniform fineness the clayey bands run parallel to the top of the sand deposits and in their initial stages begin within a foot of the surface.

Generally clay bands are more pronounced in the higher deposits above the level of ground water, and seem to be found only in those deposits covered by a surface of soil or some form of vegetation said Henry G. Russel (2013).

**2.8.1 Mechanical Action**

[Simon Ings](https://en.wikipedia.org/wiki/Simon_Ings) (2014), explains that when water is being introduced into rocks through pores or joints, upon freezing exerts an expansive force of *150* pounds to the square inch. Such pressure breaks off large area of rock which in time are broken up into smaller pieces and finally crumble into sand. In arid regions, wide daily extremes of temperature set up strains in minerals having unequal rates of expansion, causing both the minerals themselves and the rocks which they form to disintegrate into sand. Even in ordinary climates the unequal expansion of rock minerals is an important factor in sand production, though *not* so striking as in desert regions. Pebbles and rock fragments, carried by -streams whose velocities in flood periods are often capable of moving boulders exceeding a foot in diameter, exert a constant abrasive action on the stream bed- and upon each other' producing much sand as they roll down-stream.

The gouging action of rock fragments held by glacial ice as it passes over the surface is one of the most effective means of rock disintegration in high latitudes and in lofty mountain areas.· The extensive gravel and sand deposits of our northern states are largely of glacial origin. The materials were first produced by the grinding action of the ice and later heaped into deposits as it advanced, or concentrated by water flowing from ·the ice as it melted. The expansion of tree roots and the action of burrowing animals also aids in breaking up the rock into fragments (Smith, 1984; Chandrasekhar et al., 2003; Yogenda et al., 1988; Anwar et al., 2000; Paya et al., 2000; Nair et al., 2006; Goncalves and Bergmann, 2007; Rodriguez et al., 2008).

In all rock disintegration the softer and less resistant rocks or minerals composing the rocks, such as calcite, hornblende, and similar minerals, are more rapidly broken up and ground into silt or clay.

The harder minerals such as quartz and feldspar, break up much more slowly, although the removal of the softer minerals loosens up the harder ones and permits rain and small streams to carry them down the slope into larger streams where the finer particles are quickly away, therefore, may rightly expect to form some opinion of the character of parent rocks from the sand that has been produced from them. Granite will form a sand composed of quartz, feldspar, mica, and hornblende. As the sand is carried further from the parent rock, the mica and hornblende and finally the feldspar will be broken up into clay, so that the resulting material will be largely composed of quartz (Okpala, 1993; Oyekan, (2001); Rodriguez et al., (2008); Umaru et al., ( 2012).

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Sand containing large amounts of the feldspars, such as that making up much of the Altamaha formation in South Georgia, was probably rapidly transported by large, swift streams over .comparatively short distances, else the feldspars would have not occurred in it. Sandstone and arkose upon disintegrating will leave quartzose and- feldspathic sand. Limestone and marble may rarely produce a calcareous sand, but their decay is more usually effected by solution without the production of sand. Shales and slates will, of course break up into silt and clay from which they were formed (Neville, 2000).

**2.8.2 Chemical action**

Decomposition proceeds usually through the solvent action of dilute reagents carried in surface and underground waters, or in atmospheric moisture. Rain, in passing through the atmosphere, acquires sufficient amounts of carbonic acid to render it capable of dissolving practically every type of rock in minute quantities D. Samson, A.U. Etimran (2002).

The feldspars and hornblende in a granite will be decomposed into clay and iron oxide leaving the quartz, which is only slightly affected by solvents, to accumulate as sand in more basic rocks, Or those containing less quartz or silica, B. Baiden and M. Tuuli (2004), the effect of solution is greater, and the resultant quartz,- or ultimate sand, much less.

Schist’s, gneisses and slates, so common throughout the Piedmont area of Georgia, are decomposed much as are unaltered igneous rocks, except that the process is more rapid since the foliations permit a more thorough impregnation by the dissolving solutions. The Toportion of quartz, however, in the resulting sand is usually considerably less than in sand from fresh igneous rocks.

**2.9 Classification of sand**

Although commercial sands are frequently divided into bank and stream sands, a further and- more detailed classification is necessary and desirable. Sand may be classified, according to its origin, chemical and mineralogical content, grain size and use D. Samson, A.U. Etimran and S.P. Ejeh,.(2002)

**2.9.1 Classification by grain size**

Just as the term sand refers to grains having certain arbitrary upper and lower size limits, just so may sand itself be classified according to the size of its grains. Such a classification· is especially

desirable for sands used for concrete, mortar and filter purposes.

**Considers three sizes**:

Fine sand \_\_\_\_\_\_\_ 0.5 mm. or 0.02 inch in diameter

Medium sand \_\_\_ 2 .0 mm. or 0.08 inch in diameter

Coarse sand \_\_\_\_\_ 5.0 mm. or 0.20 inch in diameter

In this report when coarse, medium, or fine sands are mentioned.

**2.10 Cleanness of sand**

Ritter, Michael E. (2006), The cleanness is of a sand is measured by its impurities, what be impurities in some sand may be necessary for the usefulness of other types, or impurities harmless in certain sands may entirely disqualify others. Iron in quantities as small as 0.05 per cent eliminates sand for use in high grade optical glass, in fact most sands with more than 1 per cent of iron are unfit for use in any kind of glass manufacture. For abrasive work, in which only the hardest sand grains are desirable, all grains softer than quartz are considered impurities.

**2.11. Uses of sand**

Probably the most widely used method of sand classification is by their uses. For building purposes we have *concrete* sand and gravel, *brick* sand, *plaster* sand, and *paving* sand. *Glass* sand is one of exceptional freedom from iron. *Foundry* sands consist of a variety of types such as *molding* sand, *core* sand, or *brass* sand, depending on the kind of metal to be cast and the size and quality of the casting. Other uses require the designation of *filter* sand, *locomotive* sand, *abrasive* sand, and *fire* sand. We also have gravels for *ballast, roofing, road* building, and for use in tube mills. As this report is intended to emphasize the economic features of sand and gravel, the classification by uses will be followed Coja Isabelle and Renard, Maurice (2002).

**2.12 Concrete aggregate**

Ogunsanmi, O. E., Salako, O. A.,and Ajayi, M. O. (2011), with the advent of concrete roads, and the ever-increasing use of concrete for practically all building purposes, a consideration of the fine aggregate, or sand, and the coarse aggregate, which may be gravel, broken stone, slag, cinders, or broken bricks, becomes necessary if economical and durable results are to be obtained. Until within the last ten years very little attention had been given to the matter of determining what constituted good concrete aggregate. Tests were restricted to a casual inspection and rarely, if ever, was the sand or gravel made in concrete briquettes and subjected to tension and compression tests. At present the Federal government and some of the State governments, as well as the Portland Cement Association are making elaborate tests on sands and gravels not only to determine those tests of most practical value, but to actually determine which of a number of equally available aggregates will prove most economical and lasting Okoli, O. G., Owoyale, O. S.,and Yusuf, M. I. (2008).

**CHAPTER THREE**

**3.0 Research methodology**

Three types of investigations, namely field, literature review and interviews were carried out in this work. About 15 block production factories within Nigeria were visited. The survey was made in order to find out the block firms’ mode of production, mix ratios, infrastructure requirement and other relevant information pertaining to block production in Nigeria. Several literatures relevant to the subject matter where reviewed. This includes laws and regulations guiding the production of sandcrete blocks and bricks in Nigeria. Data collection for compilation and use were from secondary sources which include books, journals, library, the internet and relevant previous research works. Sandcrete block entrepreneurs, their technical staffs, relevant government officials, professionals and some other stake holders involved in one way or the other in the block production industry in Nigeria were interviewed to get relevant information relating to block production enterprise in Nigeria.

Sandcrete blocks are the most prominent of the concrete masonry units in the building industry today especially in the construction of residential, industrial and commercial buildings (Ejeh, 1982). Sandcrete blocks are the most widely used walling unit in Nigeria, accounting for 90% of houses (Ewa and Ukpata 2013). They could be used as external walls (i.e. 460 mm thick blocks) or as partition walls (the 150 mm thick blocks.). The later (150 mm) is usually non-load bearing.

They are made from a cement/sand mix usually 1 part of cement to 6 or 8 parts of sand (1:6 or 1:8) with a water/cement ratio of between 50 and 75% (B.S. 3921: 1969).

Historically, most concrete masonry units are manufactured on the local level and industry standards are not always adhered to (Ewa and Ukpata 2013, Aiyewalehinmi and Tanimola 2013, Mahmoud *et al* 2010, Abdullahi 2005). Variations in shape, size and surface texture are common features. There is no complete standardization of sizes in the industry for sandcrete blocks and sizes must be checked in each locality.

Cement stabilized laterite and cement stabilized sand (Sandcrete) increases in strength with cement content and that at high cement content, the granules of sandcrete blocks behave elastically (Adepegba, 1975). It was also observed that the most economic range of the use of cement stabilized sand lies between 0-10 percent cement content by weight (Ejeh 1982).

B.S. 2028 (1968) gives specification for precast concrete blocks which describes solid, hollow and cellular blocks: See Table 1.

**Table 1: Specification for precast concrete blocks.**

**Type Void percent of total volume**

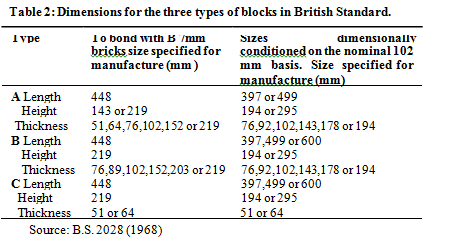
Solid Up to 25%

Hollow; large holes or cavities pass through the block. >25% < 50%

Cellular: Large holes or cavities with one bed, face closed (usually laid uppermost). > 25% <50%

It further stated that the total width of cavities measured at right angles to the face of the blocks as laid in a wall must not exceed 65 percent of the block thickness. Table 2 gives the dimensions for the three types of blocks described in the British Standard.

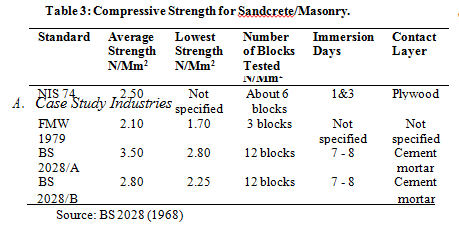
**Table 2: Dimensions for the three types of blocks in British Standard.**

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**The standard (BS 2028) describes type**

A blocks as dense (having a density of not less than 1500 kg/m3) and include the strongest blocks the use of which is permitted in all positions. Types B and C blocks are lightweight concretes having densities less than 1500 kg/m3 made with lightweight aggregate or aerated cement with or without fine aggregate, high pressure steam autoclaved.

The minimum level of performance of blocks and bricks which deals with solid blocks, cellular blocks and with a variety of aggregates including lightweight blocks and blocks made with autoclaved aerated concrete (NIS, 2004). This code also deals with solid bricks, hollow bricks and cellular bricks. It states that the minimum requirement for blocks (which are more than 75 mm thick) and for bricks are based on a sample of ten units for which the average crushing strength must be not less than 0.9Q + 0.62S, where Q = 2.8 N/mm2 as a minimum for concrete blocks and S is the standard deviation for the ten units.



Compressive strength for sandcrete /masonry is presented in table 3 above. The Compressive strength often referred to for sandcrete /masonry is based on the gross area of the unit, that is, the total area including any core spaces. The primary factors influencing the compressive strength of cement are type and gradation of aggregate, degree of compaction, amount of water used, and moisture content and temperature of the units at test period.

**3.1** **Materials and method**

The localities were so chosen because of accessibility and for the fact that they are the major block producing industries in the area. It is worth noting that the labels A,B,C,D and E of the industries do not necessarily have anything to do with the quality of the block concerned but are just mere labels for identifying the locality of the block samples.

**Industry A** is located along Stadium road Ogbomoso North Local Government . The producer claims that he produces about forty (40) blocks (225 mm thick) per each bag of cement instead of using a mix of 1 part cement to 4 parts The blocks are produced by means of an automatic block making machine which compact and vibrate the mix in a steel moulds. A very dry mixture of cement, aggregate and water is used and the moulds are removed immediately after compaction. This machine produces four 460 mm x 225 mm blocks simultaneously. The machine has a production capacity of about one thousand five hundred (1,500) per day. The source of water in the industry is a tap located at the corner. The industry has staff strength of about ten (10) men. Fifty blocks were bought from the industry. The method of curing is by spraying the blocks with water in the morning and evening for minimum of three (3) days to maximum of seven (7) days.

**Industry B** block industry is located Along Aroje of Ogbomoso North Local Government. Here the producer said to have been producing between thirty five (35) to thirty nine (39) blocks (225 mm thick) per bag of cement. The method of curing is by spraying the blocks with water in the morning and evening for minimum of three (3) days to maximum of seven (7) days

**Industry C**, block industry located at isale general area of Ogbomoso North Local Government the cement used is also of Dangote and the manager did not reveal his mix ratio. The method of curing is by spraying the blocks with water in the morning and evening for minimum of three (3) days to maximum of seven (7) days.

**Industry D**, The type of cement used is also Elephant type of ordinary Portland cement. The producer said to have been producing between 40 blocks (225 mm thick) per bag of cement. The method of curing is by spraying the blocks with water in the morning and evening for minimum of three (3) days to maximum of seven (7) days.

**Industry E**, The cement used by the producer is also the Lafarge brand of the ordinary Portland cement. The producer said to have been producing between 40 blocks (225 mm thick) per bag of cement. The method of curing is by spraying the blocks with water in the morning and evening for minimum of three (3) days to maximum of seven (7) days.

**3.3Data collection and preparation**

A total of two hundred and fifty (250) block samples (225 mm thick) were collected from five local government areas, that is 50 block samples from each area. The block samples were subjected to various tests in the structural laboratory of the department of Civil Engineering, Ladoke Akintola University of Technology, Ogbomoso. The tests carried out include dry development strength test, wet development test, wet compressive test, shrinkage, sieve analysis and moisture content. Each specimen was immersed in water at a temperature of 20+/- 2◦C for at least 16 hours and allowed to drain for about 30 minutes under damp sacking or similar material before capping with mortar in accordance with BS 2028 (1968). All the data gathered treated using the following tools.

**Percentage**

The percentage score was computed by the number of responses divided by the total number of the subjects and the quotient multiplied by one hundred (Wilkinson et. al., 1994). This method was helpful in interpreting subjects and subgroups having unequal sizes as in the cases of the sample characteristics of the respondents (Victoria, & Litman, 2000).

The formula is % = (f/N) × 100

where : f = frequency of responses

N = number of cases/responses

Weighted mean

The mean of the answers was determined to provide the average option. It was computed using the following formula (Rowe et. al., 1995):

Х = Σ (wx)/N

where : Σ = symbol for summation

X = mean

w = weighted of each item

x = item value

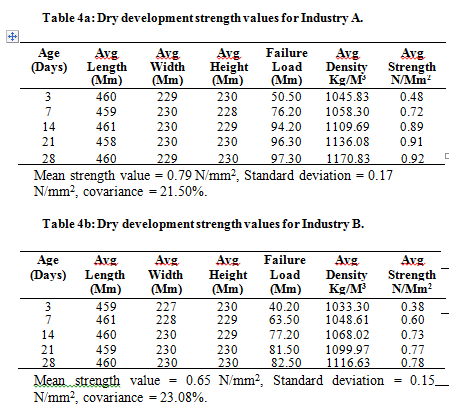
This formula was used to measure the acceptability and satisfaction of homeowners. The criteria that served as a basis for interpretation of the result was adapted from the concept of boundary made as shown in the table below

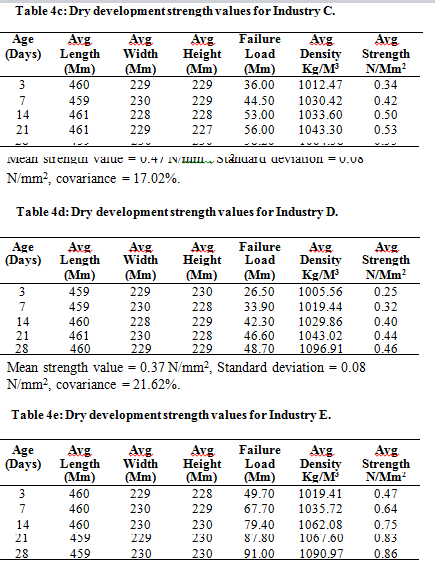
**Homeowner’s satisfaction**

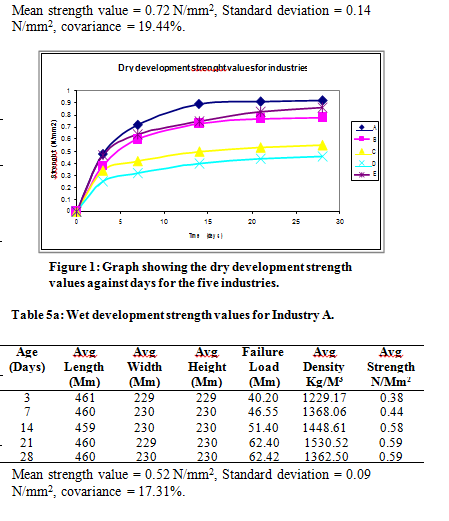
|  |  |  |
| --- | --- | --- |
| Mean | Weight | Satisfaction |
| 4.51-5.00 | 5 | Highly Satisfied |
| 3.51-4.00 | 4 | Very Satisfied |
| 2.51-3.50 | 3 | Satisfied |
| 1.51-2.50 | 2 | Fairly Satisfied |

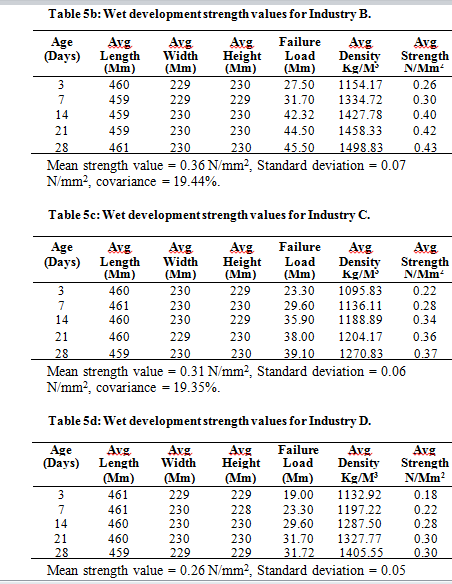
**3.4 Evaluation procedure**

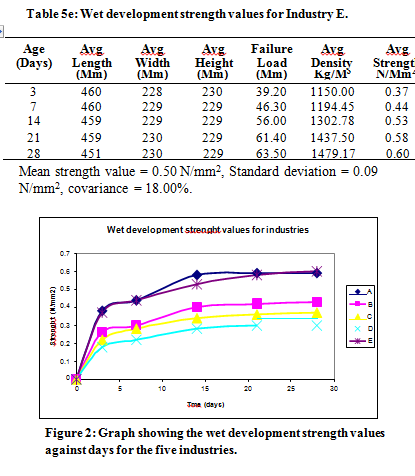
Since tests for compressive strength are widely accepted as the most convenient means of quality control and this quality is largely dependent upon the type and properties of the constituent materials used, results for the compressive tests for the five locations are as shown in Table 4a. The Age (days) refers to the number of days with reference to the time of production











**3.5 Discussion**

From the information obtained above, we can clearly see that none of the producers complies with the allowable mix ratio standardized for sandcrete blocks. And it can also be seen that none of them follows the appropriate method of curing by immersing the blocks in curing tank for the design period but instead they spray the blocks with the water twice a day. And they start selling out the blocks from the third day of curing instead of minimum of one weak.

Considering the methods and procedure of the tests conducted and as can be seen from the graphs, it is important to make the following observations and conclusion on the nature and quality of the Sandcrete blocks produced in Ogbomoso, Oyo States of Nigeria.

The strength of Sandcrete blocks produced in the industry A at 28 days is higher than that of other industries (B, C, D, E) in the dry development stages. However, this is much lower than the minimum value of 2.5 N/mm2 specified by the Nigerian Industrial Standard.

The wet development strength has a maximum value of 0.59 N/mm2 for the industry as compared with the minimum value of 2.50 N/mm2.The overall average dry development strength value is 0.58 N/mm2and that of the wet development strength is 0.39 N/mm2 (i.e. about 67% of the dry development strength value). The quality of the sandcrete blocks depend mainly on the quality of the constituent materials viz: cement, sand and water/cement ratio respectively. All the sand particles used by industries A, B, C, D and E fall within zone 1 of the grading curve of BS 882.

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