

# EFFECT OF CLAY ON THE STRENGTH OF SANDCRETE BLOCKS

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## ABSTRACT

This research work is carried out to determine the effect of clay on the strength of sandcrete blocks when used as a partial replacement for conventional fine aggregate (sand), in hollow sandcrete blocks production, which is intended to develop more economic sandcrete blocks without compromising the integrity of the block. Hence, test were carried out to determine some index properties of clay which include moisture contents, sieve analysis, Waterberg's limit test and compressive strength test the block were produce replaced sand with clay in step of 10,15, 20, and 30, there compressive strength were determined .Eighteen (18) number of 225mm x 225mm x 450mm hollow sandcrete clay blocks were produced, cured for 28 days and crushed to determine their compressive strength, the strength varies between  $0.55\text{N/mm}^2$  to  $1.11\text{N/mm}^2$  and compared with BS standard 2028 of  $2.8\text{N/mm}^2$  for mix ratio 1 :3,and the Nigeria industrial standard NIS 74: 1976 which also state  $2.5\text{N/mm}^2$  for mix ratio 1:3 therefore it is not suitable for block mouldings, the result show a significant difference in strength as compared with the aforementioned standard it is therefore recommended that the introduction of clay in sandcrete blocks production is not suitable as it reduces its strength.

keywords: effect, clay, strength, sandcrete blocks

## 1.0 introduction

Naturally, clay is a material composed primarily of fine grained. Minerals which show plasticity through a variable range of water content, and which can be harden when dried or fired. Clay deposits are mostly composed of (phyllo-silicate minerals) which impact plasticity and harden when dried or fired and lose their strength if their original structure is disturbed, even though the water content remain unaltered, these are sensitive clay.

Clay minerals are typical formed over long period of time by the ground chemical weathering of rock usually silicate and low concentration of carbonic acid and other dilute solvents. These solvent usually acidic migrate through the weathering rock after leaching through upper weathered layer in addition to the weathering process some clay minerals are formed by hydrothermal activity. Clay deposit may be formed in place as residual deposit which is the smallest particle in the soil mass and is believed to be colonials think deposits which are usually formed as a result of secondary sedimentary deposition process after they have been eroded and transported from their original location of Clay deposits are usually associated with very low energy depositional environment such as large lake and marine deposits, clay are distinguished from other fine grained soil by various differences in compositions its present in a soil reflect the weathering and depository history of site. Silt which are fine grained soil which do not include clay mineral tends to have large particles sizes than clays. But there are some lap in particle size and other physical properties. Primary clay such as Hallosite, Honite also known as kaolin's are located at the site of formation, secondary clay deposited have been moved by erosion water from its primary location. E.g. vermiculite, charife, illite clay etc. (craig,2003).

Clay is a powerful cementing agent but the aggregate of mineral particle formed by it are very small and easily broken. It is an aggregate of mineral particles of microscopic and submicroscopic range, the soil may be organic, inorganic clay are generally more plastic than the organic clay whereas the organic clay are more compressible because of the present of finely divided organic matter. Clay is the smallest particles in the soil mass; they are the most important mineral constituents of soil. (craig,2003)

The following are the physical properties of clay

- Clay has very small particles
- It form aggregate or lumps
- It has small pores
- It has high water holding capacity
- Clay soil are the centre soil
- Clay swell when wet and form cake when dried.

Sandcrete blocks

On the other part sandcrete block are made from a mixture of durable and particle free sand cement and water on setting to be used as walling units. Sandcrete blocks have been in used in many nations of the world including Nigeria, playing a major role in the building industry the materials constituents their mix presence of admixtures and the manufacturing process are

important factor that determine the properties of sandcrete blocks. (Adeyeye A. O, 2011).

Sandcrete blocks are peculiar to Africa and Asia, and are used as infill in western Africa and Asia unit panel discovered to be important component of all structure since it is used to separate more regions (Obande, 1990).

Sandcrete blocks come in various sizes; commercial blocks are produced to meet the standard of sizes in accordance with B.C.6073 part 1 and 2 of 1981, the standard and most common size of sand crete blocks are 225mm x 225mm x 450mm, 150mm x 225mm x 450mm, 100mm x225mm x 450mm undergoes dimensional charges with change in temperature especially if accompanied by drying and wetting. Adequate curing of block is essential to ensure sufficient hydration of the cement.

The method of curing employed can significantly affect the properties of the block since it contains cement and sand strength which moisture is refined and mixed for the setting of the cement (Obande, 1990).

The B.S 6073 of 1981 does not stipulate compressive strength classes but give strength classes for all blocks types and that average strength of 10 blocks should not less than  $2.5N/mm^2$  sandcrete block are weaker in compressive strength. Complete sandcrete block wall are very competitively price when compared to other construction materials, sandcrete block wall provide excellent resistance to damage without added cost of protection devices.

The Alam(2002) Prescribes minimum 'compressive strength of  $2.5N/mm^2$  at the 28days for sandcrete blocks. The federal ministry of works and housing specified minimum compressive strength of  $1.8N/mm^2$  after 7days curing as the minimum requirement.

To determine the particles size of distribution of available soil sample used.

To determine the strength of sandcrete blocks when partially replaced with clay.

## RESEARCH METHODOLOGY

In accordance to the specifications and standards provided by the British standard (B.S), German specification and Nigeria specification, the laboratory work were carried out to determine the physical and engineering characteristics of sandcrete blocks when some percentage of clay is being introduced.

The various tests include:

- I. Plastic limit test
- ii. Liquid limit test
- iii. Silt content test
- iv. Moisture content test
- v. Effect of different percentages of clay on the compressive strength of sandcrete block.

Soil is refer to the loose materials composed of weathering rock and other materials partly decayed organic matter that cover large part of the land surface, the earth soil contain three particle sizes namely sand, silt and clay each is expressed as the experience, robbing moist soil between the figure to discover the texture class. Coarse sand found gruffly, fine sand found silky, silt give a smooth and non-sticky feel add clay stick to the finger; this is one of the fast method of asscssing texture especially useful to the soil surveyor in the field (Alarn, 2002)

Sand particle are between the size 0.02mm diameter under an optica! microscopic smaller silt

are between the size of 0.02mm to 0.2mm diameter and higher power of an electronic microscope will reveal the presence of clay particles less than 0.002mm diameter (Alam singh, 2002).

## **SAND**

Sand is naturally occurring granular materials composed of finely divided rock and mineral particles. The composition of sand is highly variable depending on the local rock sources and but the most common constituent of sand is silica (silicon dioxide). Sand particles range in size from 0.0625mm to 2mm. An individual particles in the range is termed a sand grain, the next is gravel with particle size ranging from 2mm to 64mm the next smaller size class is silt particles smaller than 0.00625mm down to 0.004mm diameter, but particles diameter as small as 0.02mm were considered sand under the Albert Atterberg standard in use during the early 20<sup>th</sup> century (Wikipedia free encyclopedia, 2011).

The most common constituent of sand is silica usually in the form of quartz which because of its chemical inertness and considerable hardness is the most common mineral resistant to weathering, the composition of sand is highly variable depending on the local rock sources condition, the bright white sand found in tropical and subtropical coastal setting are eroded limestone and may contain coral and shell fragments in addition to other organic matter the gypsum sand dunes of white sand are sandstone with considerable feldspar contents derived from the weathering and erosion of granitic rock outcrop.

Some sand contains magnetite chlorite glauconitic or gypsum. Which are dark in colour as sand derived from volcanic basalts. Sand deposits in some area contain garnets and other resistant minerals including small gemstone (Alam singh, 2002)

## **HISTORICAL AND MODERN USES OF CLAY**

Clay layers in a construction site. Dry clay is normally much more stable than sand with regard to excavation. Clay exhibits plasticity when mixed with water in certain proportion when dry clay become firm when fired in a kiln, permanent physical and chemical change occur. These reaction among other change, cause the clay to be converted into a ceramic materials. Because of these properties, clay is used for making pottery item both utilitarian and decorative. Different types of clay, when used with different minerals and firing condition are used to produce earthenware, stoneware and porcelain. Pre historic humans discovered the useful properties of clay. And one of the earliest artifacts ever uncover is a drinking vessel made of sun-dried clay. Depending on the content of the soil, clay can appear in various colour, from a dull gray to a deep orange-red. Clay tablet were used as the first know writing medium inscribed with cuneiform script through the use of a blunt reed called a stylus. Clays sintered in fire were the first of ceramic. Brick cooking pots, art objects dishware and even musical instruments such as the ocarina can all be shaped from clay before being fired. Clay is also used in many industrial processes, such as paper making, cement production, and chemical filtering; clay is also often used in the manufacture of pipes for smoking tobacco. Until the late 20<sup>th</sup> century betonies clay was widely used as a mold binder in the manufacture of sand casting. Clay being relatively impermeable to water is also used where natural seal are needed such as in the core of dams or as

barrier in landfills against toxic seepage (lining the landfill. (Wikipedia free encyclopedia, 2011)

### **CLAY AS A BUILDING MATERIAL**

Clay is one of the oldest building materials on earth, among ancient naturally occurring geologic materials such as stone and organic materials like wood. Between one-half and two-thirds of the world population in traditional societies as well as developed countries still live or work in a building made with clay as an essential part of its load-bearing structure. Also a primary ingredient in many natural building techniques clay is used to create adobe, cob cord wood and rammed earth structure and building element such as wattle and daub, clay render case clay floor and clay paint free encyclopedia, 2011).

### **SANDCRETE BLOCKS**

Sandcrete blocks are made up of materials such as coarse natural or crushed rock dust mixed with cement and water which is filled into a mould of required shape and compact. Sand is made up of particles which are coarse, medium and fine grained having particle size of between 0.6mm to 0.2mm. In view of this fact, this building product contains only sand as aggregate and of no stone it can also be called fine grained concrete, the trend at present is to lay emphasis on grading of sandcrete block that is sieve analysis specific gravity test and bulk density without much regard for the mode of formation or geological condition. A pallet is put into the mould box of the machine and the box is filled with a mixture of cement and sand, then the lid of the machine is used to compact the material to the required size, sandcrete blocks have to be made upon a pallet, as they are too soft to be carried when freshly made, put one pallet into the mould box according to the required size. Half fill mould box with the ready mixed sandcrete, compact the mould corner with a piece of wood then fill the mould box completely and again compact the corner then fill the flush top edge. Open the lid wide and pull the handle to push the block out, remove both pallet and block at the same time and set them in place for hardening and curing (Obande M.O 1990).

The strength characteristic of sandcrete influenced by variety of factors whose effect is not naturally occurring deposit which include silts and also clay. The distinction between silt and clay varies by discipline. Geologists and soil scientists usually consider the separation to occur (clay being finer than silts). Sandcrete blocks are made from a mixture of durable and particle free sand on setting to be used as walling units, sandcrete blocks are peculiar to Africa and Asia (Obanda, 1990) standard blocks are used as infill in West Africa and Asia until panel discovered to be an important component of all structure since it is used to separate more regions. Sandcrete blocks come in varieties of size. Commercial blocks are produced to meet the sandcrete size in accordance with B.S. 6073 part 1 and 2 of 1981. The standard and most common size of sandcrete blocks are 150mm x 225mm x 450mm, 225mm x 225mm x 450mm and 100mm x 225mm x 450mm, every walling material undergoes dimension changes with changes in temperature especially if accompanied by drying and wetting (Obanda, 1990)

Adequate curing of block is essential to ensure sufficient hydration of the cement. The method of curing employed can significantly affect the properties of the block since it

contain cement and sand strength can only be gained if blocks are subjected to condition in which moisture is refined and mixed for the setting of the cement (Obande, 1990).

The B.S. 6073 of (1981) does not stipulated compressive strength classes but give strength classes for all blocks types and that average strength of 10 locks should not less than  $2.5\text{N/mm}^2$ , sandcrete block are weaker in compressive strength. completed sandcrete blocks wall are very competitively price when compared to other construction materials, sandcrete bocks wall provide excellent to damage without added cost of protection devices.

The Alam(2002) prescribes minimum compressive strength of  $2.5\text{N/mm}^2$  at the 25days for sandcrete blocks. The Federal ministry of works and housing specified minimum compressive strength of  $1.8\text{N/mm}^2$  after 7days curing as the minimum requirement.

### TESTS ON THE STRENGTH OF SANDCRETE

In this experiment block were produced using mix ratio of (1:3) cement to sand and partial replacement of sand with clay content in percentages of 10, 15, 20, 25, 30, respectively, using block. moulding machine which vibrate and compact the block. Ten percent (10) of sand was calculate and deduced from four part of sand, the deduced value sand added to the sand portion as clay. Therefore each mix percentage was calculated and used to produce three block until the predetermined percentage is complete, water is also weighed and gradually applied to the mixture as the mixing process was going on it reach a homogenous and composite mix, the mix sample was then put into the sandcrete block mould in layers, each layer been thoroughly compacted to remove void until it is complete full the mixture compacted vibrate for 25second and pellet removed for the machine and carried to the curing site.

After 24hours of moulding the blocks curing operation was employed with clean water the same process was used for other blocks containing varying proportion of clay while curing operation.

**Table 5: Strength for sandcrete block**

Production	Percentag of clay	Date of mouldin	Date of crushing	Weight of block (kg)	Load (KN)	Strength of block (Nzmrrr')	Average strenath(Nmm 2)
1 :3	0	10/03/2015	17/03/2015	19.00kg	95KN	$2.11\text{N/mm}^2$	
1 :3	0	10/03/2015	17/03/2015	19.1 Okg	95KN	$2.11\text{N/mm}^2$	$2.11\text{N/mm}^2$
1:3	0	10/03/2015	17/03/2015	19.10ka	95KN	$2.11\text{N/mm}^2$	
1 :3	10	10/03/2015	17/03/2015	18.90kg	40KN	$0.88\text{N/mm}^2$	
1 :3	10	10/03/2015	17/03/2015	19.00kg	40KN	$0.88\text{N/mm}^2$	$0.88\text{N/mm}^2$
1:3	10	10/03/2015	17/03/2015	19.00kg	40KN	$0.88\text{N/mm}^2$	
1:3	15	10/03/2015	17/03/2015	18.20kg	40KN	$0.88\text{N/mm}^2$	
1 :3	15	10/03/2015	17/03/2015	18.25kg	40KN	$0.88\text{N/mm}^2$	$0.84\text{N/mm}^2$
1 :3	15	10/03/2015	17/03/2015	17.65kg	35KN	$0.77\text{N/mm}^2$	
1:3	20	10/03/2015	17/03/2015	17.54kg	40KN	$0.88\text{N/mm}^2$	

1:3	20	10/03/2015	17/03/2015	17.26kg	35KN	0.80N/mm <sup>2</sup>	0.82N/mm <sup>2</sup>
1:3	20	10/03/2015	17/03/2015	17.60kg	35KN	0.77N/mm <sup>2</sup>	
1:3	25	10/03/2015	17/03/2015	17.60kg	30KN	0.66N/mm <sup>2</sup>	
1:3	25	10/03/2015	17/03/2015	17.60kg	30KN	0.66N/mm <sup>2</sup>	0.66N/mm <sup>2</sup>
1:3	25	10/03/2015	17/03/2015	17.55kg	30KN	0.66N/mm <sup>2</sup>	
1:3	30	10/03/2015	17/03/2015	16.75kg	25KN	0.35N/mm <sup>2</sup>	
1:3	30	10/03/2015	17/03/2015	16.90kg	25KN	0.58N/mm <sup>2</sup>	0.58N/mm <sup>2</sup>
1:3	30	10/03/2015	17/03/2015	16.90kg	30KN	0.66N/mm <sup>2</sup>	

Source experimental table 2015

Table 2 Liquid limit

Number of Trials	1	2	3	4	5
Number of blows	50	41	32	25	15
Mass of wet soil+ container(g)	34.2	27.4	27.5	27.1	32.8
Mass of dry+ container(g)	31.1	23.2	22.5	21.5	25.0
Mass of container(g)	10.0	10.0	10.0	10.0	10.0
Mass of moisture(g)	3.1	4.2	5.0	5.6	7.8
Mass of dry soil(g)	21.1	13.2	12.5	11.5	15.0
Mass of content(%)	14.69	31.82	40.0	48.7	50.0

Source experimental table 2015.

### Discussion

The liquid limit at which the soil will flow under its own weight is determined from the graph tabulated which is 50%.

### CONCLUSION

Sieve analysis is the size distribution of soil sample. The cumulative percentage passing

600µm of the soil used is 20% which fall within B.S 882 grading curve, hence sand used is medium fire sand.

Liquid limit is the minimum moisture content of which the soil will flow under its own weight, fine grained soil are sub-divided into soil of low medium and high plasticity that is;

- Low plasticity (L) LL.35
- Intermediate plasticity (I) L.L.35% - 50%N
- High plasticity (H) L.L.> 50%
- Silt :- Low plasticity
- Clay :- Medium plasticity
- Organic: - High plasticity.

From the liquid limit test table result of the last row is 50% hence comparing it with the above values the soil is said to be medium plastic which indicate that it is clay.

### **RECOMMENDATION**

From the above specification and result of practical conducted it has been discovered that present of clay in the sand used in producing sandcrete block either in little or large quantity will reduce the strength and performance requirement of block.

Hence, conventional fine aggregate (sand) containing clay will compromise the integrity of sandcrete blocks therefore it should be rejected for production of block, also clay particles should be carefully removed from sand before use.



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