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UNDERSTANDING THE COMPRESSIVE STRENGTH OF COMMERCIALLY PRODUCED SANDCRETE BLOCKS USING THE GHANA BUILDING CODE

Andohful, K.F.[1], Mensah, C. E.[2], and Bamfo-Agyei, E.[3]
[1,2 &3]Department of Building Technology, School of Built and Natural Environment, Cape Coast Technical University, Ghana.
[1]andohful123@gmail.com
[3]emmanuel.bamfo-agyei@cctu.edu.gh

ABSTRACT

Purpose: Sandcrete blocks are one of the most widely utilized building materials in the industry. It is thought that the load-bearing walls of the sandcrete blocks utilized as walling units were not strong enough to handle the applied load because of their poor quality. The study aims to determine the compressive strength of sandcrete blocks produced in Cape Coast Metropolis. The objectives are to identify the factors influencing the compressive strength of the sandcrete blocks and to determine the compressive strengths of sandcrete blocks produced all over Cape Coast Metropolis.
Design/Methodology/ Approach: This study employed an experimental research design. Solid 36 sandcrete blocks with dimensions of 450x225x125mm were tested for strength in the Cape Coast North Constituency. The 9 sandcrete block companies in operation in the research area were chosen via purposeful sampling. A silt test was also performed on a sample soil to measure the amount of silt and clay in fine particles. To evaluate whether the weight of sandcrete blocks influenced the compressive strengths of the sandcrete blocks, data were analyzed descriptively using tables and the Pearson Correlation Coefficient.
Findings: The average compressive strength at 28 days was 1.943N/ mm^2 revealed that sandcrete blocks fell short of the Ghana Standard Authority's requirement of 2.8 N/ mm^2.The studies also demonstrated that silt concentration on the material used to make sandcrete blocks has a detrimental impact on the compressive strength of the sandcrete blocks. The compressive strength of the sandcrete blocks was shown to be influenced by the weight and density of the blocks.
Research Limitation/Implication: The study focuses on the parameters that influence the blocks' compressive strength. The study focused mostly on the Cape Coast North Constituency.
Practical Implication: The knowledge advanced in this study will inform block manufacturers on ways to achieve the standard strength of sandcrete blocks.
Social Implication: The knowledge gained from this study will assist the Ghana Standard Authority in strengthening its supervisory role in ensuring that manufacturers meet the required standards in the production of sandcrete blocks. This will also lessen the number of building collapses in Ghana.
Originality/ Value: The findings aid in the building of housing infrastructure in Ghana by identifying the elements that influence the compressive strength of sandcrete blocks.
Keywords: *Block factories. construction industry. compressive strength. sandcrete blocks. silt*

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INTRODUCTION

Sandcrete blocks are the most commonly used in building and civil engineering projects for a variety of purposes, including the construction of walls both load-bearing and non-load-bearing walls, dividing up space, and providing shelter for the safety of people and property (Ewa & Ukpata 2013).

In recent years, the strength of sandcrete blocks produced and used as walling units in Ghana's construction sector has been a source of concern (Coffie, Adzivor, & Afetorgbor, 2019). Because of the poor quality of sandcrete blocks used as walling units, it is claimed that the load-bearing walls were not strong enough to handle the applied load. This study aims to investigate the compressive strength of sandcrete blocks produced for building construction in the Cape Coast North Constituency.

Literature Review

Sancret blocks are available as hollow and solid concrete blocks, and solid lightweight blocks, autoclave aerated concrete blocks, concrete stone masonry blocks, sandcrete blocks and soil-based blocks (Ghana Building Code, 2018). This study focused on solid sandcrete blocks.

Sandcrete blocks are defined by Oyekan & Kamiyo (2011) as a mixture of sand, cement, and water that is moulded into various shapes and sizes. Sandcrete blocks are a cement, sand, and water composite material that can be used for both load-bearing and non-load bearing walling units (Anosike & Oyebade, 2012). Sandcrete blocks of 450mm x 150mm x 225mm for load-bearing walls and sandcrete blocks 450mm x 125mm x 225mm for non-load bearing walls are the most common sizes in Ghana. Sandcrete blocks are available in both solid and hollow rectangular shapes (Anosike & Oyebade, 2012). The hollow blocks have a void that runs from top to bottom and takes up about a third of the total volume.

A solid Sandcrete block, on the other hand, does not contain any voids. The water-cement ratio and the degree of compaction are thought to affect the strength of sandcrete blocks. Sandcrete block manufacturers are typically small and operate on a local level. Despite the cost savings of sandcrete blocks, improper use of these blocks causes micro-cracks in the walls after construction, resulting in the building collapse, which has become a serious problem in Ghana's construction industry.

In addition, when compared to other building materials, they are more resistant to rust, insect and pest attack, crumbling, and are nonhazardous (Odeyemi, Otunola, Adeyemi, Oyeniyan & Olawuyi, 2015). Sandcrete blocks are used in the construction of nearly 90% of buildings in West Africa, making them an important building material (Baiden &Tuuli, 2004; Anosike & Oyebade, 2012). Some sandcrete blocks may have a density as low as 1.12N/mm^2, making them vulnerable to seismic activity (Bamfo-Agyei, 2011). When tested after 28 days of curing in any medium, each block's strength is measured in N/ mm^2 (Yunusa, 2011). In many parts of Ghana, sandcrete blocks are made without regard to any international or national standards (Anosike & Oyebade, 2012).

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Properties of Sandcrete Block

The type and proportion of constituent materials, the manufacturing process, the mode and duration of curing used, as well as the shape and size of the block itself, all influence the properties of sandcrete blocks to varying degrees (Oyelami, & Van Rooy, 2016). Cement and sand/fine aggregates are combined under controlled moisture and density conditions to produce a material with distinct physical and engineering properties (Yaragal, Gowda, & Rajasekaran,2019). Even though the properties of sandcrete blocks produced have improved since the addition of cost-effective additives, there appears to be a lack of interest among researchers in incorporating mathematical models to optimise the constituents of sandcrete blocks to achieve optimal results in their properties (Ikeagwuani, Nwonu, Ugwu, & Agu, 2020).

Constituents of Sandcrete Blocks

The materials used for the sandcrete blocks are cement, sand and water. These materials are described in the following sessions:

Cement

Cement is a building material that is used in bonding stones, bricks, and sand together (Jayawardane, Ukwatta, Weerakoon, & Pathirana, 2012). Cement is a construction binder that binds materials together by setting, hardening, and clinging to them. Cement is rarely used on its own; rather, it is used to connect aggregates. Cement and fine aggregate are used to make masonry mortar, while sand and gravel are used to make concrete. Lime compounds are the primary components of cement. Hydration occurs when water is added to cement, and a large amount of heat is released. Cement was required to provide acceptable quality to meet various standards (Ewa, & Ukpata, 2013). Cement is made by combining a specific proportion of lime, silica, alumina, and iron oxide in a high-temperature reaction (Tregambi, Solimene, Montagnaro, Salatino, Marroccoli, Ibris, & Telesca, 2018). It's a fine-grained material with adhesive and cohesive properties. Cement is the most important and expensive component of the block, as it is required to provide the acceptable quality demanded by various standards (Ewa, & Ukpata, 2013).

It is a finely ground material with adhesive and cohesive properties, and it is the only scientifically controlled constituent of Sandcrete blocks (Ajagbe, Ganiyu, & Adeniji, 2013). Ordinary Portland cement is the most common type of cement used to make sandcrete blocks in Ghana today (Umar, 2016).

Fine Aggregates (Sand)

Fine aggregate is the technical term for sand. Sand, gravel, crushed rock, expanded shale, or expanded clay is all-natural or manufactured aggregates, according to Article 7.22.3 of the Ghana Building Code (2018). The quality of sand has a significant impact on the quality of sandcrete blocks, as it accounts for 75–90% of the total weight of the sandcrete blocks (Anosike & Oyebade, 2012). Aggregates, which can be natural or man-made, make up about 75% of the volume of concrete (Rashid, Yazdanbakhsh, & Rehman, 2019). The workability and thus the strength of a block can be affected by the grading, shape, porosity, and surface texture of fine aggregate (Khan,

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& Sarker, 2020). River sand and sand from quarries should be used. Sea sand should be thoroughly washed to remove the salt, which contains sulphate, which attacks ordinary portland cement.

Natural river sand is commonly used as fine aggregates in traditional cement mortar for sandcrete blocks in Ghana (Mensah, Ameyaw, Abaitey, & Yeboah, 2021). Aggregate is screened to remove any unwanted materials that could compromise the block's strength. For sand, the test includes a silt test and an organic impurities test. Very clean river sand and excellent sand is one of the sand sources. Mineral salts are found in a quarry sandpit. Sea sand contains salt and may cause efflorescence; crushed stone is good quality sand, but it is costly; and, finally, The quality of floor track sand varies by location and environment, but it typically contains silt, organic, and vegetable matter.

Water

Water is needed to mix cement and sand, wash aggregates, and cure blocks after they have been manufactured. Water is needed to mix cement and sand, wash aggregates, and cure blocks after they have been manufactured. According to Anosike & Oyebade (2012), the amount of water used in mixing determines the strength and workability of sandcrete. It plays an active role in the chemical reaction between cement and sand, assisting in the formation of strength and cement gel. (Adeniji, Ganiyu, & Ajagbe, 2013). The water used in the manufacture and curing of concrete or sandcrete must be free of suspended particles, inorganic salts, acids and alkalis, oil contamination, and algae (Anosike & Oyebade, 2012). Water that is suitable for mixing can also be used for curing. The standard for making blocks is water that is fit for drinking. Impurities such as suspended solids, organic matter, and dissolved salts should be absent from this water. Portable water from an approved public or community system was used in this study (Ghana Building Code, 2018).

Determining the standard Compressive Strength of Sandcrete Blocks

Compressive Strength

The constituents of wall materials play an important role in supporting the load applied from either the subsequent slab of the roof or the load applied from the subsequent slab of the roof. Compressive strength is the maximum load that a material can bear without breaking (Mokhtar, Sahat, Hamid, Kaamin, Kesot, Wen, & Lei, 2016).

The compressive strength of bricks and blocks for non-loadbearing partitions shall not be less than $1.4N/mm^2$, according to Ghana Building Code (2018), provided the bricks and blocks are satisfactory in all other respects. The compressive strength of masonry units in a wall of a one or two-story house or of a one or two-story building divided into flats shall not be less than $2.75N/mm^2$ for sandcrete blocks and $5.2N/mm^2$ for bricks (Ghana Building Code, 2018).

The quality of the sand, the type of cement, and the type of mould all play a role in compressive strength. Some cement blocks may have a density as low as $1.12N/mm^2$, making them vulnerable to seismic activity (Bamfo-Agyei, 2011). The compressive strength increases as the percentage of additive increases. The type of additive to use for this block is determined by the type of soil used.

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Cement as an additive is preferred for optimum strength in sandy soils, whereas clayey soils require the application of lime for high strength. Compressed earth blocks have a compressive strength of up to 16.2 MPa (Safinia & Alkalbani, 2016).

Table 1: Density and Crushing Strength of Sandcrete blocks.

Block Type	Concrete Density Kg/ m^3	Strength N/mm^2
Dense aggregate	1500-2100	2.8-3.5
Lightweight aggregates	700-1500	2.8-10.5
Autoclaved aerated	400-900	2.8-7.5

Source: (GhBC, 2018)

Identifying the Factors Contributing to the Production of Sandcrete Block in Meeting the Standard Strength of the Block

Quality of Sandcrete Blocks

The term "fitness for purpose" or "compliance with the specification" are both used to describe quality (Oyebade & Anosike 2012). The quality of constituent materials, aggregate batching, constituent material mixing, moulding/production method, curing, transportation and storage, mix ratio, and water content all affect the quality of sandcrete blocks. The compressive strength of sandcrete blocks is influenced by poor quality control, poor selection of constituent materials, and an insufficient curing period by the manufacturers (Anosike & Oyemade, 2011).

Quality is also defined by the manufacturing business dictionary as a measure of excellence or a state of being free of defects, deficiencies, and significant variations, as a result of strict and consistent adherence to measurable and verifiable standards to achieve uniformity of output that meets specific customer or user requirements. Quality was identified as one of the three key elements for developing a risk classification model for design and building projects (Ogunsanmi, Salako, & Ajayi, 2011). As a result, in the construction of projects, quality is a critical factor that must not be overlooked.

The sandcrete blocks are made up of cement, sand, and water that has been moulded into various shapes and sizes. However, due to the various production methods used and the properties of the constituent materials used, the quality of the blocks varies. The building units used in the construction of walls and partitions are known as blocks. They come in sizes and weights that are easy for bricklayers to handle, with a facing surface layer that is thinner than that of brick but conveniently dimensioned. The task of transferring the actual load from the overlaying structural element to the foundation is also accomplished with sandcrete blocks. The load-bearing wall, on the other hand, refers to the walls that act as supports for the entire structure, transferring the weight to the ground surface beneath it for stability (Duncan, Eluwa, & Musibau, 2012).

In Ghana, sandcrete blocks have been used for a long time. The importance of the blocks in the building and construction industry as part of local building materials cannot be overstated. It was

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also discovered that rivers ran through some areas of Cape Coast and Elmina, Ghana, making it easier to obtain river sand rather than clay for making blocks (Bamfo-Agyei, 2011). Furthermore, sand is easily obtained in some communities from borrow pits and riverbeds located in the environment, enhancing the use of sand for block making. Sandcrete blocks that have been properly manufactured have a wide range of properties, making them ideal for use in Ghana. High compressive strength, low shrinkage, low moisture movement, low thermal movement, and density and durability are just a few of them. Due to the discovery of cement, sandcrete blocks have been manufactured both manually and mechanically to meet the demand for construction materials. This was done without taking into account the blocks' strength and durability (Anosike & Oyemade, 2011). Several factors, however, influence the quality of sandcrete blocks. The most important are: constituent material quality, aggregate batching, constituent material mixing, moulding/production method, cement quality, transportation and storage, curing, water for mixing mix ratio, and water content.

Batching of Aggregates
Batching is the process of weighing or volumetrically measuring the ingredients for a batch of sandcrete blocks and putting them into a mixer. The ingredients are precisely measured for each batch to produce a uniformly high-quality concrete mix (Ajagbe, Ganiyu, & Adeniji, 2013). The process of batching entails calculating the quantities of the materials (cement, water, aggregate, and sometimes admixtures). By reducing segregation when mixing, proper batching improves the workability of blocks (Kazemian, Yuan, Cochran, & Khoshnevis, 2017). It aids in the creation of a smooth surface on the blocks. There are two types of batching: weight and volume. Weight batching is preferred because it is unaffected by bulking (increase in the total volume of moisture over the same dry mass) of sand (Chudley & Greeno, 2006). Because mixing cement in gauge boxes could compromise the strength of the blocks, it is not permitted. Ghana Building Code (2018) states that volume batching should be planned so that full bags of cement are used. If the quality of the blocks is to be maintained in both individual and subsequent batches, the correct amount of each material must be batched. The accuracy of the batching is reduced if the ingredients are measured incorrectly. Variations in the properties and quality of the blocks produced are caused by poor batching accuracy.

Mixing of Constituent
Material mixing can be done either manually or mechanically. When mixes are thorough and uniform, good quality sandcrete blocks are produced (Baiden, & Tuuli, 2004). Thorough mixing is required for the production of uniform quality sandcrete blocks after the correct amount of materials have been placed in the mixer. By thoroughly mixing all of the ingredients, the mass should become homogeneous, uniform in colour, and consistent.

Thorough mixing entails evenly distributing the sandcrete block ingredients and evenly spreading the cement-water paste onto the aggregates' surfaces. If this is not done, the blocks discharged will not be of the same quality throughout the mix. Hand mixing and machine mixing are the two methods used to mix the constituents of sandcrete blocks.

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Cement Quality

According to Jaya, Bakar, Johari, & Ibrahim (2011), cement refers to the bonding materials used in construction with stones, sand, bricks, and building blocks. Cement is a construction material that binds stones, bricks, and sand together (Jayawardane, Ukwatta, Weerakoon & Pathirana, 2012). Cement is made in a controlled environment, and the final product is of satisfactory quality. The conditions under which cement is stored before use, on the other hand, can affect its quality. As a result, cement is stored at least 150 mm above ground level in well-ventilated shelters.

Transportation and Storage

Sandcrete block transportation and storage can have a negative impact on the quality of the blocks. Freshly made sandcrete blocks should be placed on pallets on level ground. To minimise breakage and defacement, bricks must be unloaded one at a time and arranged in a regular tier (Ghana Building Code, 2018). The height of the stuck must not exceed 1.2 metres, and the length of the stuck must not exceed 3 metres (Ghana Building Code, 2018). On a levelled dry surface, place hardened blocks on a raised platform. Sandcrete blocks should normally be transported on pallets on dump trucks to the construction site; however, this precaution is sometimes disregarded.

On-site blocks are manually moved using a "head" or a wheelbarrow. The stack should be built in such a way that air can freely circulate each block and the stack is shaded. After a block has been moulded, it should never be left to dry out in the sun.

Curing

Curing is the act of keeping newly cast blocks moist so that proper hydration and hardening can take place. After being removed from the machine, the blocks must be left on pallets undercover in separate rolls, one block high, with a spacing between each block for at least 24 hours, and kept wet by weathering through a fire watering hose (Anosike, 2011). The blocks can then be lifted off the pallets and stacked, while the blocks are still wet. After the previous period, the sandcrete blocks may be piled under cover for at least seven (7) days, not more than five sandcrete blocks high.

Curing allows for optimum hydration and hardening of sandcrete blocks by keeping the moisture content at a safe level. Covering the blocks with moist materials such as polythene sheets, spraying them with water (or steam), or applying curing agents, among other approaches, can be used to achieve this (Yusuf & Hamza, 2011). The presence of moisture has an impact on the cement's hardening. After the blocks have been shaped, they must be kept moist for curing. Then it's time to dry to a point where it's in balance with the surroundings. All blocks are water cured for 10-14 days before being air-cured for another 15 days.

Because sandcrete blocks are laid over such a broad area, the curing procedure utilized can have a big impact on their qualities (strength and shrinkage). The most appropriate cure procedure is wetting (Yusuf & Hamza, 2011).

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Water for Mixing

One of the most important components in concrete is water, which plays a crucial function in the manufacturing process. Drinking water is generally deemed safe for use in the manufacturing of sandcrete blocks. Because water contributes to the creation of the strength-giving cement gel, the quantity and quality of water must be carefully evaluated. Curing can be done with water that is acceptable for mixing. Curing water should not leave any streaks or residue on the surface (Jankovi, Nikoli, Bojovi, Lonar, & Romakov, 2011).

Recycled waters from cities, mining, and many other industrial processes can be utilized safely as sandcrete block mixing waters. Water that is fit for drinking is the criteria for producing sandcrete blocks. This water should be free of impurities including suspended particles, organic materials, and dissolved salts. As indicated in the study, potable water from an approved public or community system was used (Ghana Building Code, 2018).

Mix Ratio

The cement and sand are mixed dry, then sprayed with water, which should induce the cement to hydrate. Blocks are made from cement/sand combinations with a water/cement ratio of 50 to 75 percent and 1 part cement to 6 or 8 parts sand (1:6 or 1:8). The compressive strength of sandcrete blocks is affected by the mix ratio (Raheem, Momoh, & Soyingbe, 2012). Because cement is the most essential and expensive component of the block, commercial producers of these sandcrete blocks minimize the amount of cement required to achieve various specifications to save money and enhance profits (Okafor & Ewa, 2012).

The strength of sandcrete blocks is assumed to be affected by the water-cement ratio and the degree of compaction (Ijalan et al., 2016). The strength of commercial sandcrete blocks is is negatively affected when the usual mix ratio specification for sandcrete blocks is not followed (Mohammed & Anwar, 2014).

Water Content

The water-cement ratio is the weight of water to the weight of the mix. Lowering the percentage improves the mix's strength and durability while making it more difficult to work with and shape. Compressive strength is decreased in sandcrete blocks with a lower mix ratio (Raheem et al., 2012).

Compaction

To minimize voids in the mixed components, the material is compacted after the moulds have been filled. The compaction procedure increases not only the quality but also the durability of sandcrete blocks. The compacted blocks are then pushed out of the moulds and set on a flat surface.

RESEARCH METHODOLOGY

An experimental research design was adopted in this study. The focus of this research methodology is on well-defined variables that are manipulated, controlled, and assessed. In the Cape Coast North

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constituency, solid 36 sandcrete blocks with dimensions of 450x225x125mm were tested for strength. The experiments were conducted at the Materials Laboratory of Cape Coast Technical University, which is part of the Civil Engineering Department. Purposeful sampling was used to select the 9 sandcrete block companies in operation in the research area. Samples were taken to a laboratory for compression testing after drying and curing the blocks for 7, 14, 21, and 28 days.

A silt test was also used to assess the amount of silt and clay in fine particles in a sample soil. Data were analyzed descriptively using tables and the Pearson Correlation Coefficient to examine if the weight of the sandcrete blocks affected the compressive strength of the sandcrete blocks.

The arrangement of the experimental procedure is summarized in the flow chart shown in figure 1

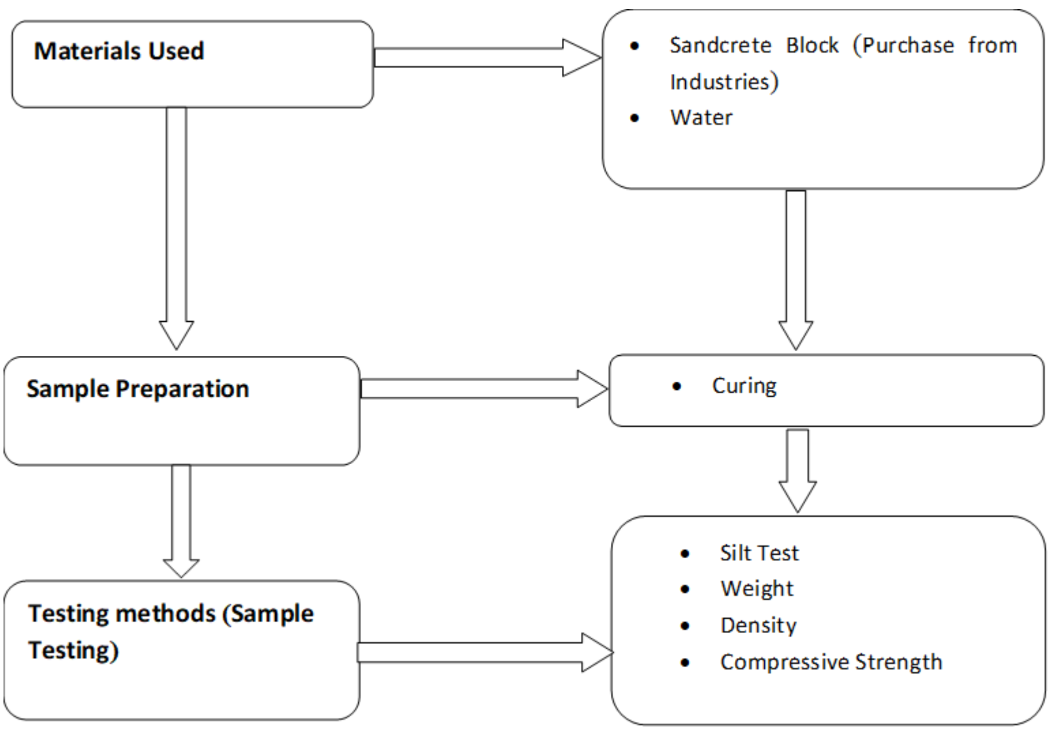

Figure 1: Flow Chart of the Experimental Procedure

FINDINGS AND DISCUSSION

This section displays data from the measuring and testing of sandcrete blocks acquired from the nine sandcrete block manufacturing factories.

The sandcrete blocks were made in all of the industries we visited using an automatic block forming machine that compacted and vibrated the mix in a steel mould. The moulds were removed immediately after compaction and a dry combination of cement, sand, and a reasonable amount of water was employed.

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Table 1 Recorded data & Calculations of Silt Test

Block industry A		**Sample**			**Average Result %**
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	76	58	64	6.15
02	Volume of Silt after 3 hours V_2	4	5	4	
03	%Silt by volume $V_2/V_1 \times 100$	5.26%	8.62%	6.25%	
Block industry B		**Sample**			
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	70	60	76	6.32
02	Volume of Silt after 3 hours V_2	4	4	4.5	
03	%Silt by volume $V_2/V_1 \times 100$	5.71%	6.67%	6.58%	
Block industry C		**Sample**			
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	66	78	70	6.05
02	Volume of Silt after 3 hours V_2	3.5	5	4.5	
03	%Silt by volume $V_2/V_1 \times 100$	5.30%	6.41%	6.43%	
Block industry D		**Sample**			
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	76	58	64	6.71
02	Volume of Silt after 3 hours V_2	4	5	4	
03	%Silt by volume $V_2/V_1 \times 100$	5.26%	8.62%	6.25%	
Block industry E		**Sample**			
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	61	76	66	6.29
02	Volume of Silt after 3 hours V_2	3	6	4	
03	%Silt by volume $V_2/V_1 \times 100$	4.92%	7.89%	6.06%	
Block industry F		**Sample**			
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	58	60	64	7.98
02	Volume of Silt after 3 hours V_2	5	4.5	5	
03	%Silt by volume $V_2/V_1 \times 100$	8.62%	7.5%	7.81%	

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Block industry G		**Sample**			**Average Result %**
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	66	76	64	6.21
02	Volume of Silt after 3 hours V_2	4	6	3	
03	%Silt by volume $V_2/V_1 \times 100$	6.06%	7.89%	4.69%	
Block industry H		**Sample**			
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	66	78	70	6.05
02	Volume of Silt after 3 hours V_2	3.5	5	4.5	
03	%Silt by volume $V_2/V_1 \times 100$	5.30%	6.41%	6.46%	
Block industry I		**Sample**			
Sample No.	**Description**	**ml**	**ml**	**ml**	
01	Volume of Sample V_1	66	78	70	6.25
02	Volume of Silt after 3 hours V_2	4	6	3.5	
03	%Silt by volume $V_2/V_1 \times 100$	6.06%	7.69%	5%	

Source: Laboratory Test (2021)

The results from table 1 showed a negatively strong significant influence of silt content on the compressive strength of sandcrete blocks, indicating that the higher the silt content, the lower the compressive strength of blocks. The percentage of silt in natural sand should not exceed 6% otherwise the sand needed to be washed or rejected (Ghana Building Code, 2018). However, the results from the nine sandcrete factories exceeded 6% of the silt content. Therefore, the silt content of a sandcrete block can be considered a factor influencing the compressive strength of blocks. This finding agreed with the findings of Bashir & Kour (2018), which confirmed the higher the silt content, the lower the compressive strength of sandcrete blocks.

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Table 2. Test results for Sandcrete Blocks at Day 7

Sample/ Block Industries	**Volume of Block (m^3)**	**Weight (kg)**	**Area (mm^2)**	**Density (kg/m^3)**	**Max. Load (KN)**	**Compressive Strength (N/mm^2)**
A	0.0123624	24.589	98900	1988.999	160	1.618
B	0.0118125	23.701	94500	2006.434	130	1.376
C	0.0129375	27.208	103500	2103.004	155	1.498
D	0.0115	20.003	92000	1742.000	150	1.630
E	0.0115	20.284	91000	1763.826	145	1.593
F	0.0129375	23.064	103500	1782.725	130	1.256
G	0.0115	23.135	92000	2011.739	145	1.576
H	0.0115	23.819	91000	2071.217	155	1.703
I	0.0123625	23.599	98900	1905.683	155	1.567
Average	0.01204582	23.267	961400	1930.625	147.22	1.535

Source: Laboratory Test (2021)

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Table 3. Test results for Sandcrete Blocks at Day 14

Sample/ Block Industries	**Volume of Block (m^3)**	**Weight (kg)**	**Area (mm^2)**	**Density (kg/m^3)**	**Max. Load (KN)**	**Compressive Strength (N/mm^2)**
A	0.0123624	25.389	98900	2053.711	170	1.719
B	0.0118125	24.481	94500	2024.728	150	1.587
C	0.0129375	28.158	103500	2129.149	180	1.739
D	0.0115	21.020	92000	1827.826	120	1.304
E	0.0115	21.042	91000	1829.739	190	2.088
F	0.0129375	23.643	103500	1827.478	145	1.401
G	0.0115	24.136	92000	2098.783	135	1.467
H	0.0115	24.689	91000	2146.869	175	1.923
I	0.0123625	24.399	98900	1943.629	160	1.618
Average	0.01204582	24.109	961400	1986.879	158.33	1.650

Source: Laboratory Test (2021)

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Table 4. Laboratory test results for Sandcrete Blocks at Day 21

Sample/ Block Industries	**Volume of Block (m^3)**	**Weight (kg)**	**Area (mm^2)**	**Density (kg/m^3)**	**Max. Load (KN)**	**Compressive Strength (N/mm^2)**
A	0.0123624	24.069	98900	1946.936	180	1.820
B	0.0118125	24.151	94500	2000.083	165	1.746
C	0.0129375	26.927	103500	2036.068	200	1.932
D	0.0115	19.845	92000	1725.652	135	1.467
E	0.0115	21.619	91000	1879.913	150	1.648
F	0.0129375	22.648	103500	1750.570	155	1.498
G	0.0115	23.180	92000	2015.652	150	1.630
H	0.0115	23.581	91000	2046.174	160	1.758
I	0.0123625	23.619	98900	1910.536	165	1.668
Average	0.01204582	23.293	961400	1923.509	162.22	1.685

Source: Laboratory Test (2021)

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Table 5. Laboratory test results for Sandcrete Blocks at Day 28

Sample/ Block Industries	**Volume of Block (m^3)**	**Weight (kg)**	**Area (mm^2)**	**Density (kg/m^3)**	**Max. Load (KN)**	**Compressive Strength (N/mm^2)**
A	0.0123624	24.569	98900	1987.381	225	2.275
B	0.0118125	23.351	94500	1933.830	190	2.011
C	0.0129375	26.941	103500	2037.127	250	2.415
D	0.0115	20.566	92000	1788.348	125	1.359
E	0.0115	21.740	91000	1890.435	130	1.429
F	0.0129375	23.106	103500	1785.971	160	1.546
G	0.0115	23.434	92000	2038.174	205	2.228
H	0.0115	23.101	91000	2008.783	200	2.198
I	0.0123625	23.825	98900	1927.199	200	2.022
Average	0.01204582	23.403	961400	1933.028	187.22	1.943

Source: Laboratory Test (2021)

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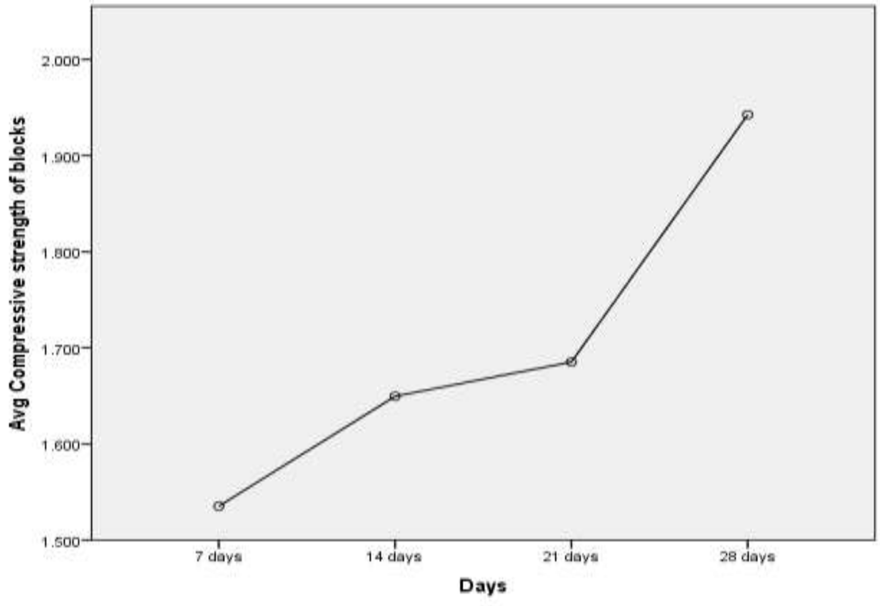

Figure 2: Average Compressive Strength of Sandcrete Blocks

Tables 2 to 5 and Figure 2 show the average compressive strength of the sample blocks when they were tested. The compressive strengths of the blocks increased by 0.115 N/mm^2 from day 7 to day 14 as can be shown. There was also a 0.035 N/mm2 increase from day 14 to day 21. Finally, from day 21 to day 28, there was a 0.258 N/mm^2 increase This finding agreed with the findings of Bamfo-Agyei (2011) and Iffat (2015). According to the findings, significant compressive strength increases occurred between days 7 and 14 and days 21 and 28, with the latter being the most significant. Between days 14 and 21, there were minute compressive strength increases. The compressive strengths of the sample blocks rose overtime on average.

The average compressive strength at 28 days is 1.943N/mm^2, on the other hand, revealed that sandcrete blocks in the Cape Coast North Constituency fell short of the Ghanaian norm of 2.8 N/mm^2. Furthermore, the weight and densities of sandcrete blocks were demonstrated to affect the compressive strengths of the blocks. Individual densities of sandcrete blocks (450x225x150) from industrial enterprises range from 1725.65 kg/m^3 to 2053.71 kg/m^3, according to the findings. As a consequence, it was determined that increasing block weight and density would likely result in a moderate improvement in strength.

Identification of Factors Influencing the Compressive Strength of Sandcrete Blocks

This part examined the data to determine the physical qualities (factors) of sandcrete blocks that affect their compressive strengths. The weight and density of the sandcrete blocks were chosen as the study's variables. For this study, the Pearson correlation coefficient was calculated.

Weight
To see if the weight of sandcrete blocks has any effect on the compressive strengths of sandcrete blocks, a Pearson Correlation Coefficient was determined. The Pearson's Correlation Coefficient data are shown in Table 6.

Table 6: Pearson Correlation Coefficient to determine whether Weight of Blocks influenced their Compressive Strengths

		Weight of Blocks	Compressive strength of blocks
Weight of Block in Air	Pearson Correlation	1	.332*
	Sig. (2-tailed)		.048
	N	36	36
Compressive strength of blocks	Pearson Correlation	.332*	1
	Sig. (2-tailed)	.048	
	N	36	36
*. Correlation is significant at the 0.05 level (2-tailed).			

The Pearson correlation coefficient for weight and compressive strength was calculated and found to be moderately positive ($r(34) = 0.332$, p less than 0.05).

Where r denotes Pearson correlation, 34 denotes Degree of Freedom (N – 2), N is the number of samples, and p denotes the significance level. The findings revealed a fairly strong positive influence of weight on sandcrete block compressive strength, implying that heavier sandcrete blocks are expected to be moderately stronger. As a result, the weight of a sandcrete block might be regarded a component affecting the blocks' compressive strength. This finding was consistent with Sadek's (2012) findings, which showed that the compressive strength of sandcrete blocks rose as the weight of the sandcrete blocks increased.

Density
To see if the density of sandcrete blocks affected the compressive strengths of sandcrete blocks, a Pearson's Correlation Coefficient was determined.

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Table 7: Pearson Correlation Coefficient to determine whether the densities of blocks influenced their Compressive Strengths

		Compressive strength of blocks	Density of blocks
Compressive strength of blocks	Pearson Correlation	1	.389*
	Sig. (2-tailed)		.019
	N	36	36
Density of blocks	Pearson Correlation	.389*	1
	Sig. (2-tailed)	.019	
	N	36	36
*. Correlation is significant at the 0.05 level (2-tailed).			

The density and compressive strength Pearson correlation coefficients showed a moderate positive connection (r (34) = 0.389, p 0.05).

Where r denotes Pearson correlation, 34 denotes Degree of Freedom (N – 2), N is the number of samples, and p denotes the significance level. The findings revealed a moderately significant effect of density on sandcrete block compressive strength, implying that denser sandcrete blocks would be considerably stronger. As a result, a sandcrete block's density might be considered a factor determining the compressive strength of the block. This conclusion corroborated Iffat's (2015) findings, which suggested that denser blocks result in higher compressive strengths.

CONCLUSION

The compressive strengths of sandcrete blocks produced in commercial sandcrete block industries are found to be below the acceptable national standard indicated in the Ghana Building Code, according to this study. The compressive strength of the sandcrete blocks rose as the cure time increased. The compressive strength of the sandcrete blocks was shown to be influenced by the weight and density of the blocks.

Because sandcrete blocks account for nearly all wall construction in Ghana's construction industry, there may be a significant risk in employing them, particularly for multi-story buildings where high loads such as roofs are supported by block walls. This could be the cause of the majority of building collapses in Ghana.

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The Ghana Standard Authority, the Ministry of Works and Housing, and professional groups must therefore act quickly to regulate the production of commercial sandcrete blocks in Ghana.

The Ghana Standard Authority's Engineering Department must also inspect the sandcrete block producers on a regular basis. Low cement content to maximize profit and poor curing conditions appear to be the main causes of the sandcrete blocks' low strengths.

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