

Effect of Cavity Volume on the Properties of Sandcrete Blocks

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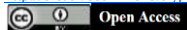
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ABSTRACT

Although sandcrete blocks are the most used walling material in Nigeria, their structural and physical performance is greatly impacted by differences in block shape, especially cavity volume and web thickness. This study investigates the effect of internal cavity volume on the properties of two-cell hollow sandcrete blocks. A cement–sand mix ratio of 1:6 and a water–cement ratio of 0.7 were used to create 450 × 225 × 225 mm hollow Sandcrete blocks with three cavity volume configurations: 187.5 × 175 mm × 450mm, 173 × 190 mm × 450mm, and 180 × 210 mm × 450mm, which corresponded to typical web thicknesses of 25 mm, 35 mm, and 15 mm, respectively. These blocks were then cured by the water spraying method for a maximum of 28 days. Key properties like compressive strength, density, and water absorption of the produced samples were investigated at different curing ages of 3–28 days. The results of the investigations show that, while water absorption decreases in proportion to rising web thickness and decreasing cavity volume, compressive strength and density increase. It was also discovered that sandcrete blocks with 35 mm web thickness and cavity volume of 173 mm × 190 mm × 450mm gave the best performance for both physical and structural properties. While sandcrete blocks with a 25 mm web thickness showed medium performance and the ones with a 15 mm web thickness gave the least performance. This study also recommended sandcrete blocks with a 15 mm web thickness for non-load-bearing applications due to their significant water absorption and poor strength. And sandcrete blocks with a 35 mm web thickness for heavy-duty applications due to superior density and strength. These findings offer regulatory bodies and block manufacturers useful advice in improving the quality, dependability, and structural integrity of sandcrete blocks in Nigeria.

1. Introduction

Sandcrete hollow blocks has continue to be the most popular walling units in Nigeria and many other regions of sub-Saharan Africa, due to their cost, ease of manufacturing, and compatibility with traditional construction methods, (Anosike et al., 2021; Akpuokwe et al., 2024; Abubakar et al., 2022. NIS. (2017) defined Sandcrete hollow blocks a mixture of cement, fine aggregate, and water that is molded into solid or hollow units with regulated dimensions. Although Sandcrete hollow blocks has been extensively used in Nigerian building industries, there are still ongoing worries about their structural dependability and durability, especially in light of the numerous reports of building distress and collapse (Ogbeide & Irogu, 2025; Oghenerukewve & Omotor, 2024; Boateng, F.G, 2020; Tian et al., 2024).

According to Ealefoh, D.E. (2024), Akorli et al., (2023), Small and medium-sized producers produces majority of sandcrete blocks in Nigeria using manual or semi-mechanized processes, sometimes with little regard for the geometric and dimensional specifications and standard procedures outlined in NIS. (2017) and associated guidelines (NBRRI, 2021). Ayésanmi et al. (2025) noted that uneven structural performance across production batches is caused by block manufacturers' infrequent consideration of web ratios during mold fabrication. Ikpeseni et al. (2023), Anosike & Oyebande, (2018), Olagunju, (2021), Awolusi, (2024), Abba et al., (2025) and Ogbeide & Irogu (2025) categorized sandcrete blocks as masonry units whose structural performance depends on a combination of material qualities, production procedures, curing practices, and geometric configuration. Owolabi et al., (2016),

Hamma et al., (2019), Ewa & Ukpata, (2020) FUDMA, (2026) discovered that most sandcrete blocks with the same overall size regularly show significant differences in hollow geometry, web thickness, and cavity volume. Olaniyi & Abiodun, (2024).then stated that the structural safety of sandcrete masonry walls is seriously threatened by these geometric irregularities, which have been directly connected to notable differences in compressive strength, dimensional stability, and water absorption of sandcrete hollow blocks.

The seriousness of this problem has been further escalated by extensive evaluations by Raheem et al. (2018) and Ajao et al. (2025), stating that Over 60% of commercially produced sandcrete blocks sampled in southwestern Nigeria did not fulfill the NIS (2021) compressive strength standards at 28 days. Ewa & Ukpata (2020) and Odeyemi et al. (2025) reported similar findings, attributing poor compressive strength mainly to incorrect mix proportions, high water content, and insufficient curing, block geometry, cavity volume and web thickness. Rather than isolating the inherent influence of block geometry under conventional mix proportions. Raheem et al., (2018); Alabi et al., (2021), Akinyele et al., (2024) Ibrahim, (2025), also focused on concentrated on the effect of material modification on the performance of sandcrete blocks, such as partially substituting cement with agricultural or industrial wastes. As a result, it is still difficult to quantify the separate effect of hollow size and web configuration on properties of sandcrete hollow blocks (Okeke et al., 2025).

Agunwamba et al. (2025), Ezeokonkwo and Nwoji, (2019) concluded in their work that cavity volume affects the Compressive strength, density, water absorption of sandcrete blocks. Agunwamba et al., (2025) Olaniyi & Abiodun, (2024), Odeyemi et al., (2025). Sathiparan and Jeyananthan (2025) further explained that even though hollow blocks are preferred in practice due to their lower self-weight, material consumption, and construction, Excessive cavity sizes can greatly reduce the effective load-bearing area and may cause stress concentration under axial loading, compromising its structural integrity. Musa et al., (2023) also stated in his work that compressive strength in structural masonry is more directly correlated with the block's effective load-bearing area than with its gross sectional area. And that this effective area is decreased by larger cavities, which causes stress concentration and early failure. This theoretical framework was supported by experimental investigations of Lawal and Raheem (2021) Alabi et al. (2021), who in their findings, concluded that Sandcrete blocks with narrower webs and greater cavities showed much lower compressive strength and higher water absorption. In a similar vein, Oladipo et al. (2022) also experienced an exponential decline in strength above a critical cavity threshold and a nonlinear relationship between cavity volume and compressive strength of sandcrete blocks.

Ezeokonkwo & Nwoji, (2019), Raheem & Lawal, (2021), Nikmah, (2025) has all shown in their studies that geometric elements like block thickness, cavity volume, cavity orientation, and web configuration affect the physical performance of sandcrete blocks. Alabi et al. (2021) and Oloyede et al. (2023), also discovered that increasing the web thickness of Sandcrete blocks increases density and decreases water absorption. Also (Nikmah, (2025), Owolabi et al. (2016), Emekwisia et al., (2025) and Hamma et al. (2019),all agreed that decrease in cavity volume of sandcrete blocks will bring about decrease in density and higher water absorption.

Despite these recent researches on sandcrete hollow blocks, only little knowledge on the ideal cavity volume and web thickness needed to achieve balanced durability and structural performance has been given. (Olaniyan & Adefemi, 2025). This work will fill this crucial knowledge gap by investigating the impact of cavity volume on the structural and physical characteristics of two-cell hollow sandcrete blocks. The study will also separates the effects of cavity volume on compressive strength, density, and water absorption by keeping mix proportions, curing conditions, and overall block size constant. This will offers a controlled experimental framework of only geometric concerns into performance evaluation, rather than cobining it with other production factors just like other researches. The results of this study are also meant to further current knowledge and contribute to better quality control, optimal block design and enhanced structural safety in sandcrete block construction by providing engineers, block producers, and regulatory authorities with useful, geometry-based information on sandcrete block production.

2.0 Aim and Objectives

The aim of this work is investigate the effect of cavity volume on the structural and physical performance of two-cell hollow sandcrete blocks.

In order to ascheive the aim, the following specific goals were done:

1. To produce two-cell hollow sandcrete blocks with different cavity volume while keeping mix proportions, curing conditions, and block dimensions constant.
2. To assess the compressive strength of sandcrete blocks with various cavity volume at specified curing ages,
3. To Examine the density of the sandcrete blocks with various cavity volume
4. To evaluate the water absorption percent of the produced Sandcrete blocks.
5. To determine the ideal cavity volume arrangement for best physical and structural performance.
6. To compare the experimental results with the specifications of Nigerian Industrial Standard (NIS 2021).

3.0 Materials:

i. Sand

On the grounds of Nnamdi Azikiwe University in Awka, Anambra State, clean, crisp sand was gathered. A wire mesh with a diameter of 6 mm was used to sieve the sand. This is required to get rid of solid contaminants like wood, nylon, etc. To get rid of double salts and clay particles, pure water was used to wash the sand. After that, the sand was uniformly graded using procedures of Nuruddeen et al., (2025)

ii. Cement

For this investigation, Dangote Cement Company's Ordinary Portland Cement (OPC), which complies with Nuruddeen et al., (2025) procedures were utilized.

iii. Water

For this investigation, clean water devoid of suspended particles, salts, and oil pollution was utilized. The water came from a tap at the lab on the Nnamdi Azikiwe University campus in Awka, Anambra State.

iv. Mould

For this investigation, Metallic Mould for sandcrete blocks samples were procured from a local Blacksmith at Eke Awka Market Anambra State.

3.2: Methods

3.2.1 Sieve analysis

The test was carried out in accordance with ASTM C136/C136M-14 procedures.

$$\text{Percentage retained} = \frac{\text{Weight of soil retained}}{\text{Total weight of soil}} \times 100 \quad 3.1$$

$$\text{Percentage passing} = 100 - \text{Cumulative percentage retained} \quad 3.2$$

$$\text{Coefficient of uniformity } C_u = \frac{D_{60}}{D_{10}} \quad 3.3$$

Where; C_u = coefficient of uniformity, D_{60} = particle diameter of which 60% by weight of soil is finer, SSD_{10} = particle diameter of which 10% by weight of soil is finer

FM = Cumulative percentage retained by mass/percentage of individual fraction retained by mass

3.2.2 Moisture content

The test was carried out in accordance with ASTM C566-19 procedures

$$W = (M_2 - M_3) / (M_3 - M_1) \times 100 \quad 3.4$$

Where; W= Moisture content, M_1 =mass of weighing bottle

M_2 = mass of the bottle and the dry soil, M_3 = mass of bottle, soil and water

3.2.3 Specific gravity

The test was carried out in accordance with ASTM C127-20

$$G_s = \text{Specific Gravity} = \frac{(W_2 - W_1)}{(W_4 - W_1) - (W_3 - W_2)} \quad 3.5$$

Where; G_s = specific gravity, the weight of the pycnometer filled with water = W_4 , The weight of the empty pycnometer = W_1 , Weight of pyenometer +sand + water = W_3 , Weight of pyenometer +sand = W_2 .

3.2.4 Production of Hollow sandcrete Blocks

This study was carried at Concrete Laboratory of Civil Engineering Department, Nnamdi Azikiwe University Awka Anambra State, Nigeria. Sandcrete blocks were produced in accordance with NIS 87:2004 with the following procedures. The mix proportion used was one part of Ordinary Portland Cement to six parts of clean sharp sand (1: 6), with a water–cement ratio of 0.7. The mixing was done manually. The cement and sand were thoroughly mixed together to ensure homogenous mixture. After that, the mixture was put within the necessary manual mold. Compression was then applied. After that, the mold was carefully raised, and the molded block with the wooden is carefully stored in a nearby open area to cure. The blocks were moistened with water twice a day as part of the curing process for 28 days.



Figure 3.1: 225mm×225mm×450mm, with hollow sizes 187.5 mm×175 mm mould



Figure 3.2: 225mm×225mm×450mm with 180 mm× 210mm mould



Figure3.3: 225mm×225mm×450mm hollow size with hollow sizes 173 mm×190 mm

3.2.5 Compressive Strength Test

The compressive strength was determined at curing age 3, 7, 14, 21 and 28 days. The compressive strength test was in accordance with ASTM C140 / C140M-14

$$\text{Compressive strength} = \frac{\text{Ultimate Load (N)}}{\text{Cross sectional area (mm}^2\text{)}} \quad 3.6$$

3.5.2 Density Determination

The density Test was carried out in accordance with ASTM C140 / C140M-

$$\text{Density} = \frac{M}{V} \quad 3.6$$

M = Weight of the block in Kg., V = Net Volume of Block in m³ which is= Net area x Height
Net Area = Gross area of block – Area of holes.

3.5.3 Water Absorption Test

This Test was carried out in accordance with NIS 87:2004. Water absorption was then expressed as

$$W_A = (W_2 - W_1) / W_1 \quad 3.7$$

Where; W₁ = Initial weight, W₂ = Final weight

4. Results and Discussion

4. 1 Material Characterization Test.

4.1.1 Seive Analyis

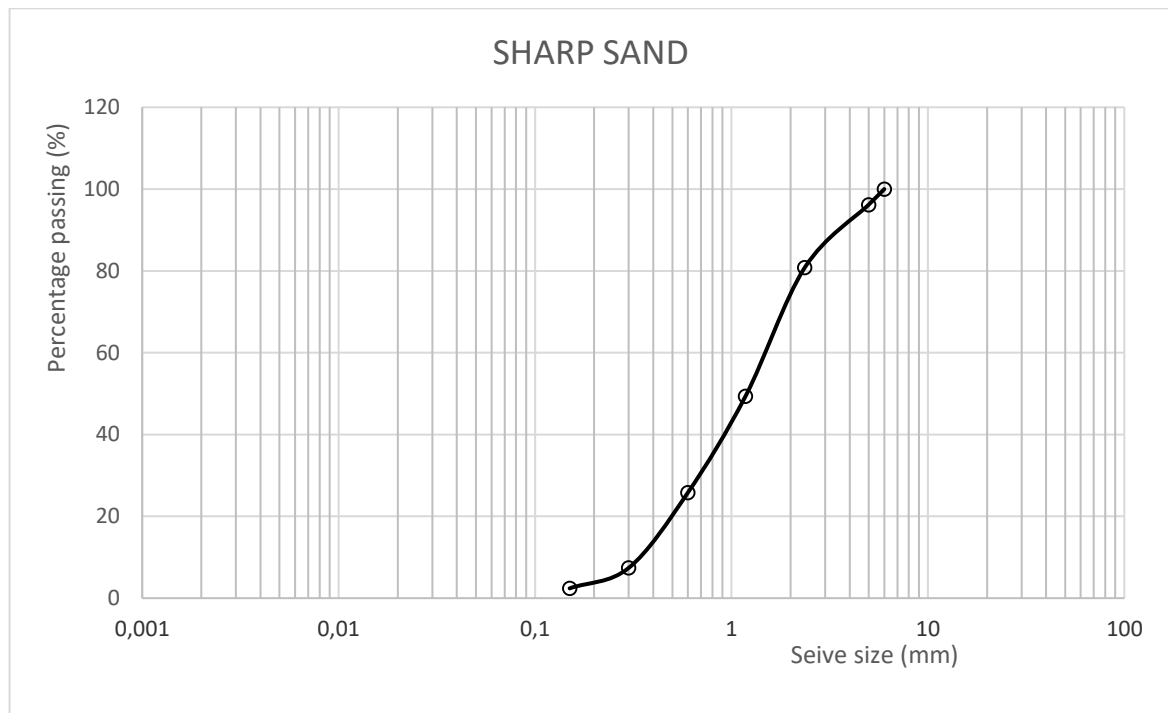


Figure 4.1: Sieve Analysis for sharp sand

From Figure 4.1, The size of the sand particles ranges from approximately 0.125 mm to 5 mm. 0–50% passing fine fraction (<0.6 mm). 50–80% of the medium portion (0.6–2 mm) passes. 80–100% of the coarse portion (>2 mm) passes. The curve flattens out at 2 mm and is steep in the 0.125–1 mm range, suggesting that the sand is primarily uniform with a tiny percentage of coarse particles. This is common for the sharp sand used in construction, which improves mortar bonding and workability. D10 (diameter at 10% passing): ~0.18 mm → indicates the finer particles. D50 (median size, 50% passing): ~1.0 mm → represents the average particle size. D90 (90% passing): ~3.5 mm → represents the coarse fraction. Uniformity coefficient (Cu): = D60/D10 D60 ~2 mm and D10 ~0.18 mm. Cu≈11.1

Sand is well-graded but has a tendency to be dominated by coarse particles. Excellent for sandcrete blocks and masonry mortars. It should also be noted that Strong mortar bonds, proper packing, and fewer voids are all ensured by well-graded sand. Particles larger than 5 mm may have an impact on cement consumption and block smoothness. The sand is crisp, well-graded, and primarily coarse with minor particles. It satisfies conventional grading standards (ASTM C136) and is appropriate for sandcrete block manufacture, plastering, and masonry applications.

4.1.2 Specific gravity

Table 4.1

Specific gravity for sharp sand		
Pycnometer No	1 st Trial (g)	2 nd Trial (g)
Weight of pycnometer (w_1)	423.50	423.50
Weight of pycnometer +water (w_4)	623.40	623.60
Weight of pycnometer +sand (w_2)	510.50	505.50
Weight of pycnometer +sand + water (w_3)	675.60	676.40
Weight of sand	87.00	82.00
Weight of sand + water	165.10	170.90
Weight of water	199.90	200.10
Specific gravity = $\frac{(W_2 - W_1)}{(W_4 - W_1) - (W_3 - W_2)}$	2.50	2.81
Average specific gravity = 2.66g		

The specific gravity of sharp sand was determined using the pycnometer method in two trials to guarantee measurement reproducibility and reliability. The findings are shown in Table 4.1. Based on the test findings in both trials, the empty pycnometer's weight (W_1) stayed at 423.50 g, indicating that the equipment was properly calibrated and handled. Stable test conditions and negligible experimental

error were indicated by the weight of the pycnometer filled with water (W_4), which varied very little between trials (623.40 g and 623.60 g). The weight of sand ($W_2 - W_1$) varied slightly between the two experiments (87.00 g and 82.00 g), which could be explained by slight variances in sample quantity or moisture condition. Specific gravity of Trial 1 is 2.50 while Specific gravity of Trial 2 is 2.81. Average Specific Gravity then becomes 2.66. The average value of 2.66 that was found is within the usual range of 2.60 to 2.70 for natural siliceous sands. This shows that there are no excessive amounts of light organic debris or porous particles in the sand, and it is clean, dense, and mineralogically sound. For laboratory aggregate testing, the difference between the two trials is acceptable and falls within typical experimental bounds. Since a greater specific gravity is typically associated with better packing density, fewer voids, and better mechanical performance, a specific gravity of 2.66 indicates that the sharp sand is appropriate for the manufacture of sandcrete blocks.

4.1.3 Moisture content

Table 4.2

Moisture Content of Sharp Sand

Container No	1	2	3	4
Mass of cup + wet sand	104.86	105.90	89.30	82.95
Mass of cup + dry sand	98.35	99.25	84.00	78.40
Mass of cup	29.55	22.25	29.20	29.25
Mass of dry soil	68.80	70.40	54.80	49.15
Mass of water	6.51	6.65	5.30	4.55
Water Content	9.46	9.45	9.67	9.26
Average Water Content				9.47

The result of moisture content test as shown in Table 4.2 indicates that the dry sand mass ranged from 49.15 g to 70.40g while the mass of water lost during drying varied from 4.55 g to 6.65 g,

It was discovered that the average moisture content of sharp sand's were found to be 9.47%. This indicates the sharp sand was somewhat moist, which is typical of fine aggregates kept in tropical areas under natural climatic circumstances.

These results helped in the selection of water cement ratio during sandcrete block production, since higher moisture content of the sharp sand can significantly increase the water-to-cement ratio if left unchecked during sandcrete block production. Very high water cement ratio will generally result in lower cement concentration which could lower the compressive strength of sandcrete blocks. Nevertheless, the sand is still appropriate for making sandcrete blocks since a very low water cement ratio of 0.5 was used during mixing.

Finally, the moisture content test verifies that the sharp sand utilized in this study had a consistent average moisture content of roughly 9.47%, which is within allowable bounds for fine aggregates. (NIS 2021) Hence, proper moisture correction during mixing is crucial for very moist sharp sand to guarantee constant quality and high performance sandcrete blocks,.

4.2 Production of Sandcrete Hollow Blocks Samples

Table 4.5

Dimensions of produced Sandcrete Blocks Samples

Sample	Overall Block Size (Length×Width × Depth)	Hollow/ Cavity Block (Length×Width × Depth)	Size	Corresponding Web Thickness
A	225mm×225mm×450mm	187.5 mm×175 mm ×450mm		15mm
B	225mm×225mm×450mm	180 mm× 210mm ×450mm		25mm
C	225mm×225mm×450mm	173 mm×190 mmc×450mm		35mm



Figure 4.2 225mm×225mm×450mm with 187.5 mm×175 mm Cavity

4.3 Physical Properties Test

4.3.1 Density Test

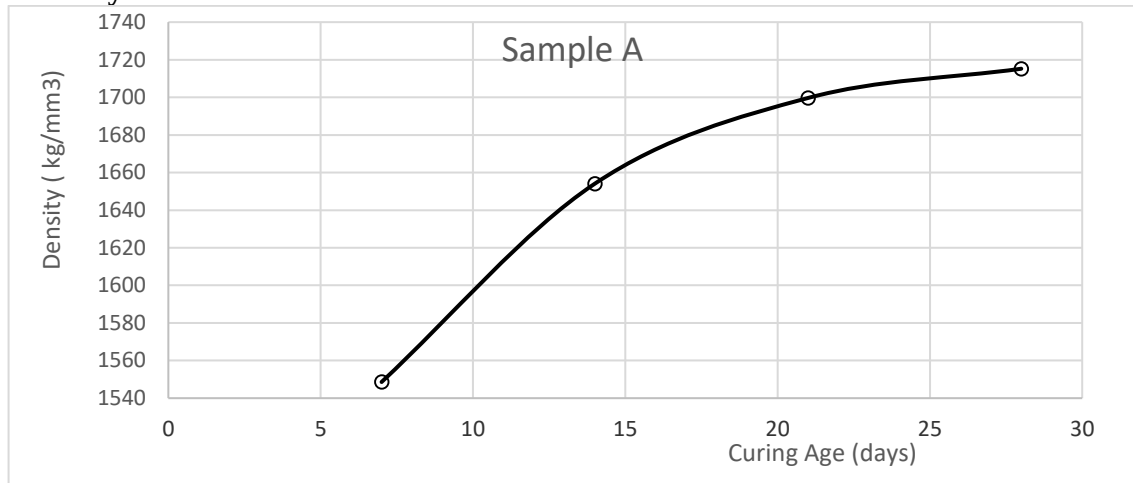


Figure 4.3: Density result of Sample A with cavity of 180mm × 210mm

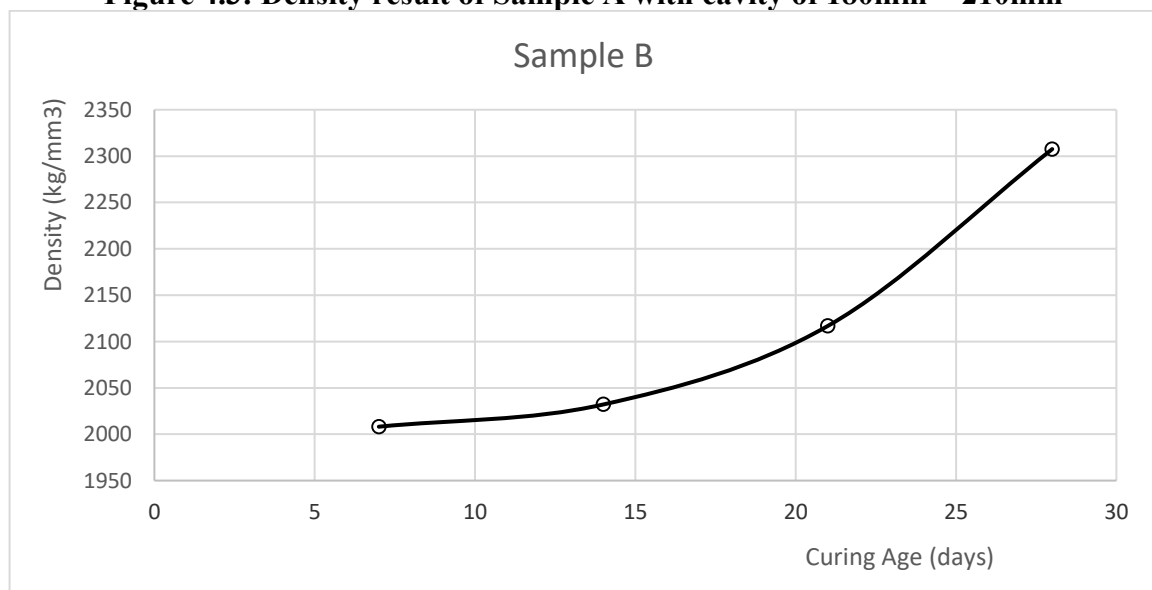


Figure 4.4: Density result of Sample B with cavity of 175mm × 187.5mm

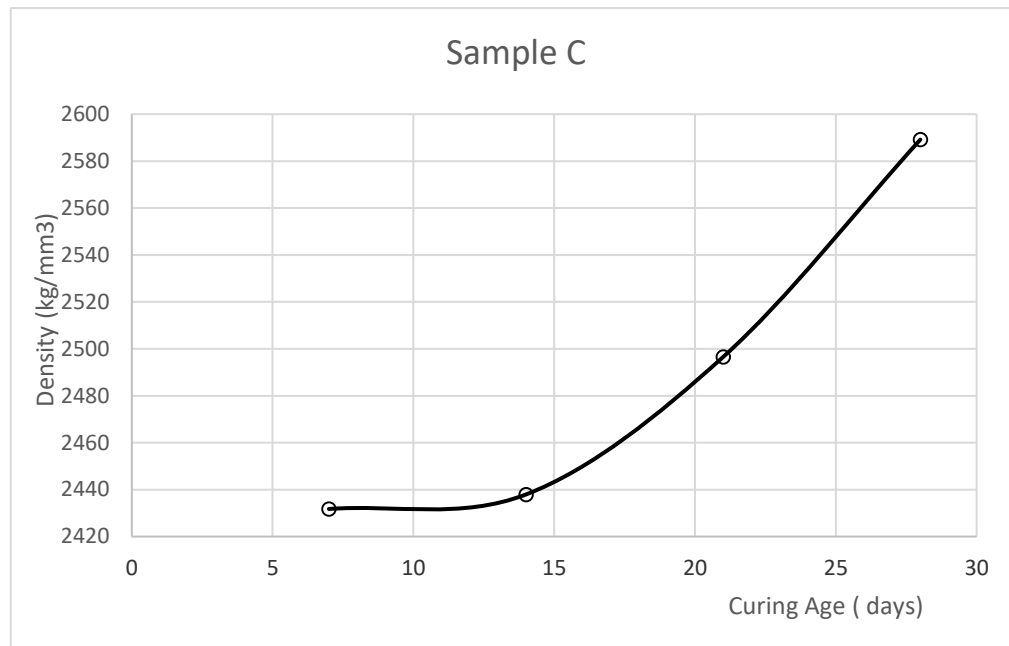


Figure 4.5: Density result of Sample C with cavity of 173mm × 190mm

Out of the three samples, Sample A had the greatest cavity dimensions (180 mm × 210 mm) and the lowest density values. This behavior is anticipated since greater cavities lower the block's effective solid volume, which results in decreased block matrix compactness, more internal voids, and a lower total mass per unit volume. Sample A's lower density suggests a lighter block, which could be useful for handling and lower dead load but could have a detrimental effect on mechanical strength and durability if the cavity size is too large.

According to Figure 4.5 Sample C had the highest density value, followed by Sample B, then Sample A. This may be attributed to increased solid content, improved packing density, and more uniform mass distribution caused by smaller cavity dimensions. Also it has been shown that Sample B has the most balanced arrangement that improves material efficiency without significantly raising block weight.

Sample C had the greatest density. This can be attributed to its smallest cavity dimensions (173 mm × 190 mm, higher mass per unit volume, lower porosity, and greater block compactness. Given that higher density is typically linked to increased compressive strength and less water absorption. (Ajao et al., 2025), Sample C is will probably perform better structurally and durably than Samples A and B.

According to Nigerian Building and Road Research Institute (NBRRI, 2006) Sample A is classified as low-density blocks and is suitable for non-load-bearing applications where a lighter weight is preferred. Sample B, on the other hand, are classified as a moderate-density blocks and it offers a balance between material economy and structural performance. Sample C are classified as high-density blocks, which is best suited for load-bearing applications.

The results across Figures 4.3–4.5 confirm that hollow geometry plays a critical role in determining the physical properties of sandcrete blocks. And also highlight the need for geometric control during the production of sandcrete blocks

4.3.2 Water Absorption test

Table 4.6a

Water Absorption Results for Sandcrete hollow Block samples at 1 Hour

Sample	Test No.	Initial Weight, W_1 (kg)	Final Weight, W_2 (kg)	Water Absorption (%)	Average WA (%)
A	1	19.8	22.8	15.2	17.1
	2	20.0	23.7	18.5	
	3	20.3	23.9	17.7	
B	1	27.9	31.5	12.9	12.8
	2	27.6	31.0	13.0	



Sample	Test No.	Initial Weight, W_1 (kg)	Final Weight, W_2 (kg)	Water Absorption (%)	Average WA (%)
	3	27.8	31.3	12.6	
C	1	28.8	32.2	11.8	11.2
	2	28.9	32.1	11.1	
	3	28.6	31.7	10.8	

Table 4.6b**Water Absorption Results for Sandcrete hollow Block samples at 24 Hour**

Sample	Test No.	Initial Weight, W_1 (kg)	Final Weight, W_2 (kg)	Water Absorption (%)	Average WA (%)
A	1	18.9	23.9	26.5	24.5
	2	19.8	24.1	21.7	
	3	19.0	23.8	25.3	
B	1	27.0	33.1	22.6	22.2
	2	27.1	33.4	23.2	
	3	27.3	33.0	20.9	
C	1	28.7	33.7	17.4	18.8
	2	29.3	34.3	17.1	
	3	28.6	34.9	22.0	

Table 4.6a, has shown that Sample A's water absorption percent at one hour ranges from 15.2% to 18.5%. And the average water absorption percent of sample A was 17.1% for one hour immersion in water. This comparatively high water absorption percent suggests a higher rate of early water penetration. And this is a result of the bigger cavity volume and lower web thickness of the sample, which lead to increased porosity. The water absorption percent in Sample B varied from 12.6% to 13.0% and the average water absorption percent was 12.8% for one hour immersion in water. This indicates that a more balanced cavity design results in increased compactness and decreased linked pore gaps. The water absorption percent in Sample C varied between 10.8% and 11.8% and an average 1-hour water absorption of 11.2%. Out of all the samples, 1-hour water absorption percent of Sample C was the lowest. This suggests Sample C has a denser block structure with smaller voids and thicker webs that prevent rapid water from penetrating.

Table 4.6b, has shown that Sample A's water absorption percent ranged from 21.7% to 26.5% after 24 hours immersion in water, and an average water absorption percent of 24.5%. This is comparatively high, as such high absorption may have a serious impact on long-term durability and resistance to moisture-related deterioration since it indicates greater porosity. The water absorption percent in Sample B ranged from 20.9% to 23.2%. With an average of 22.2%. It has also be shown from the test results that, Sample B shows better resilience to extended exposure to water than Sample A. Also, the water absorption percent for Sample C ranged from 17.1% to 22.0% and an average of 18.8%. Out of the three samples, Sample C had the lowest water absorption percent at 24 hours immersion in water. This also shows that smaller cavities and higher solid content improves resistance to long-term water absorption.

More so, the results from Water Absorption test has unequivocally demonstrated that water absorption increases with immersion time for every sample. Sample A had the highest water absorption percent followed by Sample B, then Sample C for both the 1-hour and 24-hour. According to this pattern, blocks with thicker webs and smaller cavities absorb less water than those with bigger cavities. This shows that the pore structure and moisture transport properties of sandcrete blocks are strongly influenced by hollow geometry.

High water absorption percent may result in decreased durability, greater vulnerability to cracking, and strength loss under service conditions. Hence Samples with low water absorption percent like

Sample C, are best suited for situations where moisture resistance and longevity are crucial, particularly in exposed or load-bearing masonry walls.

Finally, these results support the density Test findings and highlight the necessity of controlled cavity volume to improve sandcrete blocks' longevity and structural performance.

4.4 Structural Properties Test

4.4.1 Compressive Test

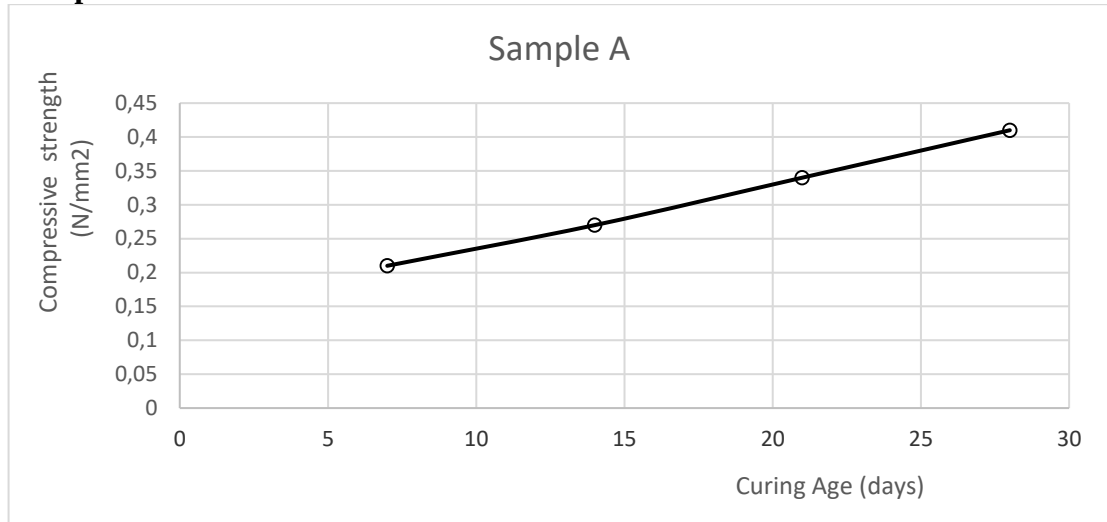


Figure 4.6: Compressive strength test result of Sample A with cavity of 180mm × 210mm

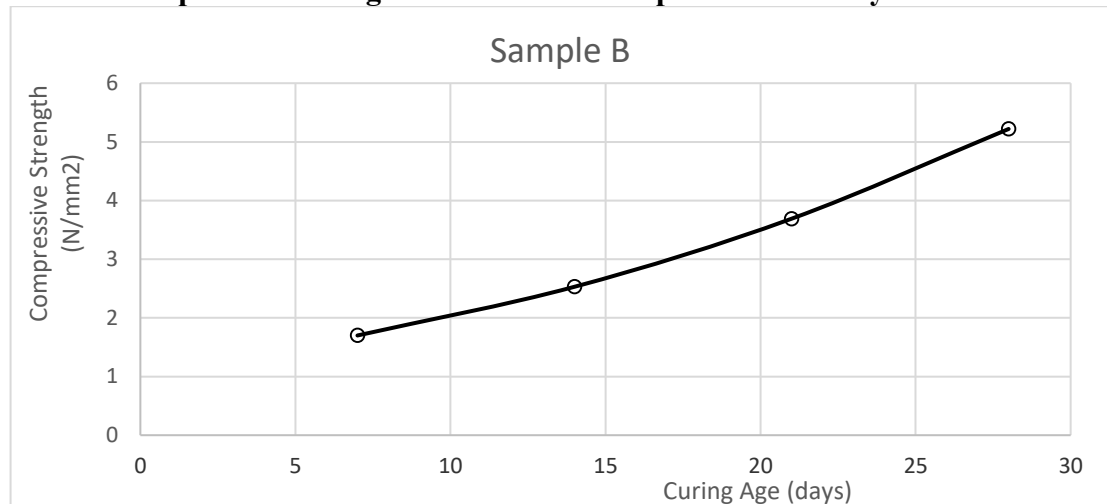


Figure 4.7: Compressive strength test result of Sample B with cavity of 175mm × 187.5mm

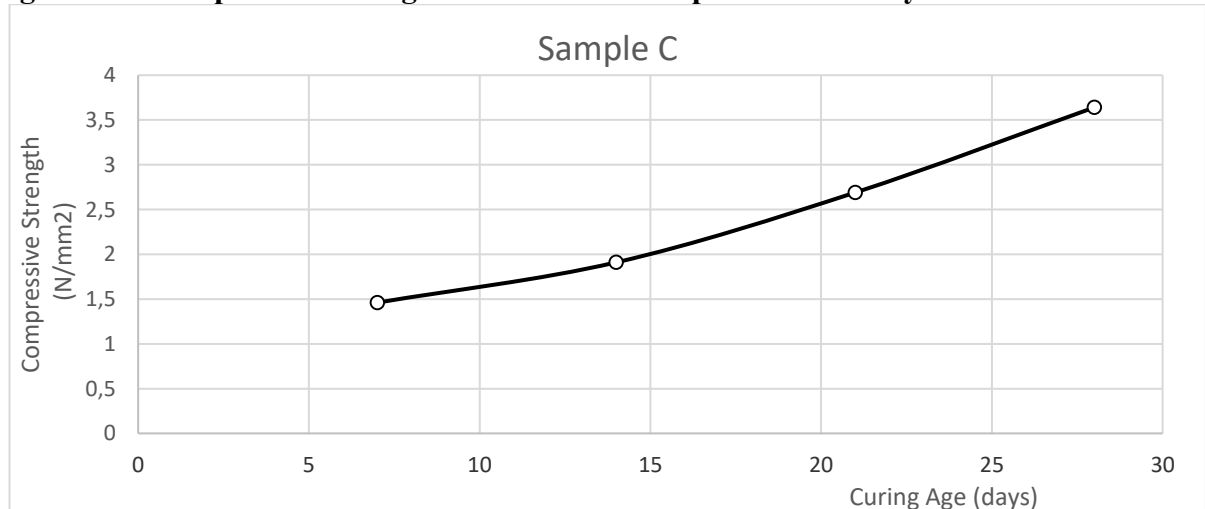


Figure 4.8: Compressive strength test result of Sample C with cavity of 173mm × 190mm

From Figure 4.6 - 4.8, It has been shown that out of the three samples, Sample A had the greatest cavity dimensions (180 mm × 210 mm) and the lowest compressive strength values. Large cavity

volume, which drastically reduces the effective load-bearing surface; thinner web thickness, which causes stress concentration under axial loading; and increased internal voids, which weaken the block matrix, are the reasons for the decreased strength. These findings suggest that although Sample A blocks use less material and are lighter, their structural performance might not be sufficient for load-bearing applications.

Sample B's compressive strength readings were intermediate; they were higher than Sample A's compressive strength but lower than Sample C's compressive strength. Reduced cavity size in comparison to Sample A, improved web thickness that improves stress distribution, and increased effective solid area are the reasons for the enhanced performance. Depending on compliance with standard strength standards, Sample B can be used for both non-load-bearing and moderately load-bearing walls due to this configuration's suggested balanced structural response.

Sample C had the highest compressive strength results while having the smallest cavity dimensions (173 mm × 190 mm). Increased web and face shell thickness, a larger effective load-bearing surface, decreased porosity, and enhanced compactness are the reasons for the better performance. Because of these qualities, It has been discovered from Figures 4.6–4.8 that, Sample C is the most structurally reliable of the three samples in terms of compressive strength, Sample yielded medium performance while Sample A yielded the least performance. This pattern shows that compressive strength rises with decreasing cavity volume and increasing web thickness. The results backs the previous findings from the water absorption and density tests, where Sample C also showed the lowest water absorption and maximum density, suggesting a strong correlation between geometric configuration, physical properties, and mechanical performance.

Sample A blocks can only be used in non-load-bearing partitions with low strength requirements. Sample B blocks provide a balance between structural performance and material efficiency. According to the minimum compressive strength required by Nigerian Industrial Standards (NIS 2017) and Nigerian Building and Road Research Industrial Standards (2021), Sample C blocks are very suitable for load-bearing masonry.

Finally, the results of compressive strength test has shown that the compressive strength of sandcrete blocks is significantly influenced by its cavity volume. Since larger effective bearing surface brings about better stress distribution, blocks with thicker webs and fewer voids will have higher compressive strength.

5.1 Conclusion

The following conclusions are reached in light of the experimental findings and analyses:

- i. All block types showed a constant increase in compressive strength with an increase in curing age, demonstrating the significance of sufficient curing time in the manufacturing of sandcrete blocks.
- ii. The compressive strength sandcrete blocks samples decreases geometrically as the cavity volume increases,
- iii. The density of sandcrete blocks samples decreases geometrically as the cavity volume increases.
- iii. The water absorption values at both 2hours and 24hours of sandcrete blocks samples increases geometrically as the cavity volume increases
- ii. All block types investigated in this study produced compressive strength values that satisfy the minimum standards of NIS 87:2004.
- iv. Sample C with 35 mm web thickness and cavity volume of 173 mm×190 mmc×450mm gave the best performance for both physical and structural properties.
- vii. Overall, the study shows that without changing the traditional cement sand mix, geometric optimization of hollow sandcrete blocks can greatly improve structural performance.

5.2 Recommendations

The following are Recommendations of this study:

- i. Because differences in cavity geometry have a substantial impact on block performance, sandcrete block makers should pay special attention to mold accuracy and web thickness control.
- ii. Regulatory bodies should include Geometric requirements such as web thickness and maximum cavity capacity during their regular sandcrete block quality control inspections.

- iii. Future research should be done on the performance of hollow sandcrete blocks using various cement–sand mix ratios. So as to ascertain the combined impact of material composition and geometry.
- iv. Research should be done on how well-graded aggregates and other fine aggregates affect strength and water absorption of sandcrete hollow blocks.
- v. A comparative research should be done on how various curing techniques and curing times affects the performance of sandcrete hollow blocks. So as to determine the most effective curing procedure for sandcrete blocks in field conditions.
- vi. A cost-performance study should be done to find the best cost-effective hollow block shape for different construction applications.

5.3 The Study's Limitations

This study has the following limitations:

- i. The study was limited to two-cell hollow sandcrete blocks with set external dimensions other block configurations were not applied.
- ii. Only one cement–sand mix ratio used. This may not accurately reflect how blocks made with richer or leaner mixtures might behave.
- iii. Only Compressive strength, Density and water absorption were investigated. Other Properties like flexural strength, durability in harsh settings, and thermal performance except were not taken into account.
- iv. All experiments were carried out in controlled laboratory settings. This may not accurately reflect changes that occur during the fabrication and use of blocks on-site.

5.4 Contribution to Knowledge

- i. This study will contribute to the knowledge of sandcrete block research by the following ways:
- ii. It has shown experimentally that the cavity volume and web structure generally affect the compressive strength and water absorption behavior of sandcrete blocks.
- iii. The study demonstrated a direct correlation between cavity volume, solid thickness, and strength performance of sandcrete hollow blocks.
- iv. It recommends useful advice in improving the quality of sandcrete hollow blocks to manufacturers and designers, by identifying the best sandcrete hollow block that strikes a balance between strength, weight, and water absorption.
- v. It focuses on optimization of cavity geometry rather than only material composition, hence offering a practical solution to raise the standard and safety of sandcrete masonry units.

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