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Experimental Study of Developed Sandcrete Bricks WRT the Mechanical Property

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Abstract
Sandcrete bricks are made up of sand, cement, and water. This study experimented the development of this brick with respect to their mechanical property (the compressive strength) over various curing periods. Sand was introduced in varied proportions of 5%, 10%, 15%, 20% and 25%, as a colourant to resemble fired red brick product. Sandcrete bricks were evaluated at 7, 14, 21, 28, and 35 days to determine the impact of curing time on their structural performance. The compressive strength tests revealed an initial strength of 0.82 N/mm² at 7 days, which increased to 1.59 N/mm² at 14 days. Further curing resulted in a notable rise to 3.88 N/mm² by 21 days and 4.57 N/mm² by 28 days. The strength continued to improve, reaching 5.23 N/mm² at 35 days. The data demonstrates a progressive increase in compressive strength with extended curing periods, indicating the potential for enhanced structural integrity of sandcrete bricks with time. This research highlights the importance of adequate curing time in achieving optimal compressive strength, suggesting that prolonged curing is essential for the development of durable sandcrete bricks. This suggests that the developed bricks can find application in building partition walls, perimeter walls and fencing, and in construction of temporary structures that do not require high load-bearing capacity.

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1. Introduction

The construction industry has long relied on traditional materials such as sandcrete for building essential structures, particularly in regions where cost-effectiveness and material availability are critical. Sandcrete, a composite material primarily composed of sand, cement, and water, is widely used for producing blocks and bricks that serve as the building blocks of many low-rise residential and commercial buildings. While sandcrete offers advantages such as ease of production, affordability, and adequate thermal insulation, its mechanical properties, particularly compressive strength, play a vital role in determining its suitability for various construction applications.

Researchers have experimented the development and properties sandcrete bricks, with respect to their compressive strength. The effects of utilizing volcanic ash as a pozzolanic material in the manufacturing of sandcrete bricks were investigated by Ogunbode *et al*. (2013) [5]. The results showed that up to 30% of cement could be successfully replaced with volcanic ash, improving compressive strength and resistance to sulfate attack.

Edeh & Achuenu (2014) [6], optimized sandcrete block mix design using response surface methodology for maximum compressive strength. Various mix ratios and curing times were tested, leading to a predictive model for achieving the best results.
Agbede & Manasseh (2009) [7]. Examined the effect of incorporating limestone powder as a partial replacement for cement in sandcrete blocks. The findings reveal that limestone powder improves the compressive strength and reduces the drying shrinkage of sandcrete blocks.
Ogunbode & Ayeni (2011) [8] conducted a comparative analysis of the compressive strength of sandcrete blocks made using different types of cement, including Ordinary Portland Cement (OPC) and blended cements. It concludes that blocks made with blended cements showed slightly lower initial strength but improved durability over time.
Bamigboye & Adesanya (2012) [9] investigated the effect of water-cement ratio on the strength and durability of sandcrete blocks. It showed the relationship between the water-cement ratio and the compressive strength of sandcrete blocks, and emphasized the importance of controlling the water-cement ratio which achieved optimal strength and minimized porosity.
Usman & Idris (2016) [11] explored the influence of environmental factors, such as temperature and humidity, on the curing process and strength development of sandcrete blocks. The research showed that controlled curing conditions significantly enhance compressive strength. The use of rice husk ash (RHA) in place of some of the cement in sandcrete bricks was studied by Olutoge *et al*. (2010) [10]. They discovered that adding RHA up to 20% in place of cement produced bricks that had a compressive strength that was comparable to that of traditional sandcrete bricks, as well as better resistance to chemical attack and a lower carbon footprint. This research therefore aimed at developing sandcrete bricks in order to analyse the effect of various curing periods on the compressive strength.

2. Materials and Methods

2.1 Materials

a) Sand: This sand was produced by natural disintegration of rocks, and is referred to as natural sand. It can also be got from crushing a yard stone or rock, which is also known as crushed stone. The sand used for this work was clean and free from loam, dirt, organic matter.

b) Cement: The type I ordinary Portland cement, which is classed as general cement for all-purpose application by ASTM C150, was the cement utilized.

c) Water: The water was pure and devoid of anything that may hurt living things.

Steel rule, digital weighing scale, and compressive strength test machine were other additional materials used for this research.

2.2 Methods

2.2.1 Mixing proportion

The calculation was done using the ratio of 1:6 =7

Where 1 = The proportion of cement (that is, one bag of cement), and 6 = The total mass of (that is, six wheel barrow full of sand). The measured weight of the sample (i.e. cement + sand) = 820g.

From the ratio above;

Mass of cement, C = $\frac{1}{7} \times$ 820g = 117.1g; Mass of sand = 820g - 177.1g= 702.9g

For 5% clay addition; Mass of clay used = $\frac{5}{100} \times$ 702.9g = 35.2g; Mass of sand used = 702.9 - 35.2 = 667.7g

For 10% clay addition; Mass of clay used = $\frac{10}{100} \times$ 702.9g = 70.29g; Mass of sand used = 702.9 - 70.29 = 632.6 1g

For 15% clay addition; Mass of clay used = $\frac{15}{100} \times$ 702.9g =105.4g; Mass of sand used = 702.9 - 105.4 = 597.5g.

For 20% clay addition, Mass of clay used = $\frac{20}{100} \times$ 702.9g = 140.58g; Mass of sand used = 702.9 - 140.58 = 562.32g.

For 25% clay addition; Mass of clay used = $\frac{25}{100} \times$ 702.9 = 175.73g; Mass of sand used = 702.9 - 175.73= 527. 1 7g.

For the control sample; This was done without the clay, hence the Mass of sand = 702.9g; Mass of cement = 117.lg

2.2.2 Mixing Procedures

Using a shovel, the materials were hand combined in the different ratios determined above, and they were continually turned until the desired color and consistency were achieved. A small amount of water was sprayed on the mixture, and it was then further mixed to ensure uniformity and high workability. (Emekwisia *et al*., 2024) [12].

2.2.3 Moulding

In this experiment, the mixed composites were manually molded by placing them inside a 75 mm x 75 mm mould. Compaction was accomplished by continuously ramming with a wooden ram; the ram's surface was then smoothed off and the blocks were carefully placed on wooden pallets with gaps between them.

2.2.4 Curing

After being formed, the bricks were sprayed with water for the first three days. This was done to lessen the blocks' brittleness and increase their ultimate achievable strength.

2.5 Compressive Strength Test

The purpose of the compressive strength test was to determine the strength of the moulded block samples. The samples were tested at intervals of 7, 14, 21, 28, and 35days, as the maximum strength for the block samples was reached on the 35th day. The cubes' dimensions were measured and recorded to the nearest 1mm during the test, and their weights were recorded using a digital weighing balance. Metal plates were arranged carefully beneath the bed faces of the blocks to be tested and positioned in the center of the plates of the compression testing machine. Next, a uniform axial load was applied without shock until failure occurred, and the maximum load at failure was noted.

2.6 Compressive Strength Expression:

The compressive strength was calculated using this formula:

$$\text{Compressive strength} = \frac{\text{Maximum load at failure (N)}}{\text{Cross sectional area of block (mm}^2)}$$

3.0 Result and Discussions

3.1 Results

Result of compressive strength test carried out on developed sandcrete brick samples are stated below.

Table 1: Result of compressive strength test of the developed sandcrete bricks at 35% maximum clay addition.

Duration in Days	Dimension (mm^2)	Compressive Strength (N/mm^2)
7	75 x 75	0.82
14	75 x 75	1.59
21	75 x 75	3.88
28	75 x 75	4.57
35	75 x 75	5.23

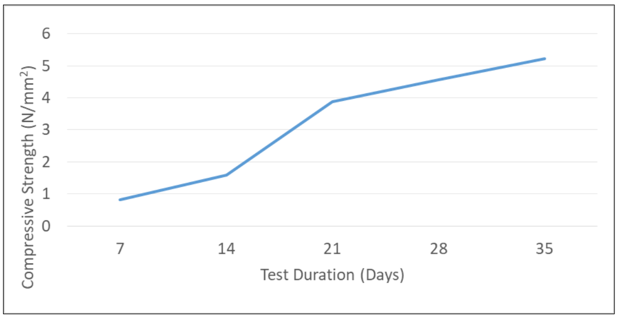

Fig 1: Graph of compressive strength test of the developed sandcrete bricks at 35% maximum clay addition.

The data obtained from the compressive strength tests on the sandcrete bricks over different curing periods provides valuable insights into the strength development of the material. At 7 Days (0.82 N/mm^2), the compressive strength is relatively low, indicating that the hydration process of the cement is still in its early phases. The cement particles are beginning to bond, but the matrix is not yet fully developed, resulting in limited strength. At the 14 Days (1.59 N/mm^2) test, the compressive strength has nearly doubled compared to the 7-day result. This significant increase reflects ongoing hydration, with more cement particles reacting and forming stronger bonds within the matrix. However, the strength is still moderate, as the hydration process is not yet complete. By the 21st Day, the strength showed a marked improvement, reaching 3.88 N/mm^2. This indicates that the majority of the cement has now hydrated, leading to a more developed and cohesive microstructure. The rapid gain in strength during this period suggests that the curing process is significantly influencing the material's performance. At the 28 Days (4.57 N/mm^2) test, the strength had a continued increase, though the rate of increase is slower compared to earlier stages. This plateauing trend is typical as the material approaches its maximum potential strength, with most of the hydration having occurred. The sandcrete is now reaching a point of maturity, where its mechanical properties are stabilizing. Finally, at the last test on the 35th Day, the compressive strength obtained an optimum strength of 5.23 N/mm^2. The continued, albeit slower, increase in strength indicates that the hydration process is nearing completion, and the material has reached its optimal strength. This suggests that further curing beyond 35 days may result in only marginal strength gains.

Conclusion

The research demonstrate a clear relationship between curing time and the compressive strength of sandcrete bricks. It confirms that curing duration significantly impacts the compressive strength of sandcrete bricks. The data indicates that the compressive strength of the sandcrete bricks increases significantly with extended curing periods, especially between 7 and 21 days. After 21 days, the strength continued to improve but at a slower rate, with the most considerable gains observed by 35 days. These findings highlight the importance of adequate curing time in achieving optimal compressive strength for sandcrete bricks. For optimal performance, structural integrity, and practical applications, it is recommended to allow sandcrete bricks to cure for at least 35 days to ensure they reach their maximum strength potential. This extended curing period is crucial for developing durable and reliable sandcrete bricks suitable for various construction purposes, particularly in low-rise building projects where structural integrity is essential.

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