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The Structural and Engineering Advantages of Sandcrete Blocks Over Fired Clay Bricks: A Comparative Analysis

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Abstract

The choice of walling material is a foundational decision in civil engineering and architectural design, significantly influencing the structural integrity, cost-effectiveness, and sustainability of a built environment. In many developing nations, sandcrete blocks and fired clay bricks represent the two most prevalent masonry units. This article provides a comprehensive technical analysis of the structural advantages of sandcrete blocks—manufactured through the hydraulic bonding of cement, sand, and water—compared to traditional fired clay bricks. By evaluating compressive strength, dimensional precision, thermal-moisture dynamics, and logistical efficiency, this paper argues that sandcrete blocks offer superior structural consistency and construction expediency, particularly in rapidly urbanizing climates.

Keywords: Sustainable Construction, Construction Engineering, Structural Engineering.

1.0 Introduction

Masonry remains the primary method for low-to-medium-rise construction globally. As global urbanization intensifies, the demand for reliable, cost-effective, and structurally sound building materials has surged. Fired clay bricks, an ancient technology, have long been criticized for their non-standardized dimensions and high energy consumption during the kilning process. Conversely, sandcrete blocks—composites of sand, Portland cement, and water—have emerged as the standard for modern construction in much of Sub-Saharan Africa and other tropical regions. This article examines the structural superiority of sandcrete, focusing on the chemical processes of hydration, the logistical advantages of modularity, and the mechanical reliability provided by cementitious bonding.

DEFINITION

Sandcrete (sandscreed) blocks are precast masonry units made of cement, sand, and water used mainly for walls, while fired clay bricks are ceramic building units made from clay baked at high temperatures for durability and strength.

Sandcrete (Sandscreed) Blocks

Sandcrete blocks—also referred to as sandscreed or concrete blocks—are precast composite masonry units made from a mixture of Portland cement, sand, and water. These blocks are moulded into various sizes, commonly 450mm x 225mm x 225mm or 450mm x 150mm x 225mm, and can be either solid or hollow, with hollow blocks having core voids typically taking up around one-third of the block's volume

Key characteristics of sandcrete blocks include:

• Minimum compressive strength of 2.5 N/mm² for 150 mm blocks and 3.45 N/mm² for 225 mm blocks as per Nigerian Industrial Standards (NIS 87:2007)

• Usually produced with a cement-to-sand ratio of 1:6 to 1:8, with careful water-cement ratio for optimal strength, commonly 0.5

• Reasonably priced, **resistant to rust, pests, and rot**, and widely used for walls in single-storey buildings in Nigeria and other African countries

• Typically used for **load-bearing and non-load-bearing walls**, though their strength is lower than fired clay bricks and they are not ideal for columns

1.1 Fired Clay Bricks

Fired clay bricks are building units made from clay (sometimes mixed with sand and lime) that are shaped and baked at high temperatures in kilns, which transforms the clay into a durable ceramic material

Key characteristics of fired clay bricks include:

• High compressive strength and durability, typically ranging from 7 to 14 N/mm² for Class A bricks, suitable for load-bearing walls

• Higher water absorption than sandcrete blocks, often around 14–15%, but still below the 20% threshold for good masonry material

• Exceptionally long lifespan, often exceeding 100 years, with minimal maintenance requirements

• Resistant to harsh environmental conditions including heat, wind, and water, making them suitable for diverse climates

• Traditionally used for centuries and preferred in applications demanding strength, fire resistance, and aesthetic finish

PRODUCTION

Sandscreed blocks are made from a mixture of sand and cement and cured through water hydration, while fired clay blocks are shaped from clay and hardened by kiln firing.

Sandscreed Blocks Production

Materials: The primary ingredients include sharp sand, Portland cement, and water. Optional additives like small amounts of lime or industrial admixtures can improve workability.

Production Steps:

1. Batching and Mixing: Sand and cement are mixed in a desired ratio, commonly 6:1 sand to cement, to obtain a uniform blend. Water is gradually added to achieve a plastic consistency without excess moisture.

2. Molding: The mixture is cast into block molds. Molds can be wooden or steel and sized to standard block dimensions (e.g., 450×225×150 mm or smaller). Manual tamping or vibration ensures compaction and reduces voids.

3. Demolding: Blocks are removed from molds after initial setting, usually 24 hours.

4. Curing: The blocks are cured by water spraying or immersion for 7–14 days, allowing the cement to hydrate fully, which increases strength and durability. Proper curing prevents cracking and ensures adequate +compressive strength.

Advantages: Sandscreed blocks are lightweight, relatively easy to produce on-site, and suitable for low- to medium-strength applications.

1.2 Fired Clay Blocks Production

Materials: Natural clay or clay soil mixes may include sand to control shrinkage, and water for plasticity.

Production Steps:

1. Preparation of Clay: The clay is excavated, screened, and sometimes weathered to remove stones and ensure uniform texture.

2. Mixing and Molding: Water is added to form a plastic clay mass, which is then pressed into molds, either manually or using press machines. Shapes may be solid or perforated.

3. Drying: Blocks are air-dried to remove excess moisture for several days to prevent cracking during firing.

4. Firing: Blocks are fired in a kiln at temperatures typically between 900–1100°C. This process vitrifies the clay, giving the blocks high compressive strength, hardness, and durability.

5. Cooling and Handling: After firing, blocks are cooled gradually and then stored for use.

Advantages: Fired clay blocks are highly durable, fire-resistant, and suitable for load-bearing walls. Perforated varieties can reduce weight and provide better thermal insulation.

2.0 Constituent Materials and Chemical Dynamics

The structural performance of a masonry unit is inherently tied to its composition.

2.1 The Hydration Process in Sandcrete

Unlike fired clay, which relies on the physical transformation of silicate minerals through high-temperature sintering, sandcrete relies on the chemical process of hydration. When water is added to the cement-sand mix, the calcium silicate hydrate (C–S–H) gel forms, acting as a binder that encases the aggregate. This process allows for the development of strength over time (curing), providing a more predictable structural profile than the brittle, often irregular outcomes of kiln-firing clay.

2.2 Material Uniformity

Sandcrete blocks benefit from the homogeneity of Portland cement. Industrial standards for cement are rigorous, ensuring that every batch of mortar is chemically consistent. Fired clay bricks, by contrast, are subject to the mineralogical variations of the local soil utilized and the heat distribution within the kiln, which often leads to "under-fired" or "over-fired" units, introducing structural weaknesses and inconsistencies across a single masonry face.

3.0- Dimensional Precision and Structural Loading

One of the primary structural advantages of sandcrete is the size of the mould and the resulting dimensional accuracy.

3.1 Standardization and Moulding

Sandcrete blocks are typically manufactured in standard dimensions (e.g., 450mm x 225mm x 150mm/225mm). The metal moulds used in production ensure high dimensional tolerance. In structural masonry, the accumulation of errors due to uneven unit sizes—common in traditional clay bricks—leads to eccentric loading. Eccentricity in load-bearing

walls is a primary cause of structural cracking and premature failure. Because sandcrete blocks are uniform, they facilitate an even distribution of vertical loads across the wall cross-section.

3.2 Mortar Efficiency

Due to their larger size and flat surfaces, sandcrete blocks require significantly less mortar compared to the smaller, often irregular, fired clay bricks. A reduction in mortar volume (which is typically the weakest link in masonry) enhances the overall shear strength of the wall. Thinner, more consistent joints minimize the potential for shrinkage cracks and improve the compressive strength of the composite wall system.

4.0 Compressive Strength and Durability

4.1 Mechanical Strength

Sandcrete blocks designed for load-bearing purposes exhibit a superior compressive strength-to-weight ratio. Through the controlled addition of cement, the structural engineer can specify the exact MPa rating required for a project. Fired clay bricks are often limited by the quality of the raw clay; if the clay has high organic content or poor plasticity, the brick's structural strength is capped regardless of the firing temperature.

4.2 Resistance to Environmental Degradation

Durability is a major component of structural safety. Sandcrete, particularly when properly cured, demonstrates high resistance to moisture ingress. While clay bricks are porous and prone to "spalling" (the flaking off of surface layers) when subjected to repeated freeze-thaw cycles or extreme humidity, sandcrete blocks exhibit lower permeability. This prevents the corrosion of internal steel reinforcements in reinforced masonry applications.

5.0 Application and Logistical Advantages

The structural integrity of a building is also a function of its construction speed and the ability to maintain quality control during the erection phase.

- **Speed of Construction:** Because one sandcrete block replaces several clay bricks, the "labour-per-square-meter" cost drops, and the potential for human error during the laying process is minimized.

- **Surface Aesthetics:** The colour and texture of sandcrete blocks are uniform, providing an excellent substrate for plastering and rendering. The mechanical bond between sandcrete and Portland-based plasters is chemically superior (due to the shared cementitious base) compared to the bond between clay and cement mortar, reducing the risk of delamination.

6.0 Critical Comparison: Limitations and Considerations

While sandcrete offers structural advantages, it is not without constraints. The structural efficiency of sandcrete depends entirely on:

1. Curing: The necessity of water-curing for 7 to 28 days to reach design strength.

2. Aggregate Quality: The use of clean, washed sand is critical; the presence of silt or clay particles reduces the C–S–H bonding efficiency.

However, even with these requirements, sandcrete remains a more predictable medium than clay, which suffers from "fire-cracking" and unpredictable warping during the cooling phase of production.

Sandscreed blocks offer superior structural strength, durability, and dimensional stability compared to fired clay blocks, making them suitable for modern

construction needs.

6.1 Strength and Load-Bearing Capacity

Sandscreed blocks are made from a mixture of cement, sand, and water, which ensures high compressive strength. Unlike fired clay blocks that rely on baked clay particles, sandscreed blocks can achieve greater uniformity and load-bearing capacity, making them more suitable for structural walls in multi-storey buildings.

6.2 Durability and Resistance

Unlike fired clay blocks, which may develop cracks over time due to shrinking or uneven firing, sandscreed blocks are less prone to cracking and erosion. They are more resistant to weathering, moisture penetration, and chemical attack, which enhances the longevity of the structure.

6.3 Dimensional and Surface Stability

Sandscreed blocks have precise dimensions and uniform shapes, reducing the need for excessive plastering and improving the consistency of walls. Fired clay blocks often suffer from warping and irregularity during firing, which can lead to uneven walls and extra finishing work.

6.4 Lightweight and Handling

Sandscreed blocks are relatively lighter than traditional fired clay blocks, which facilitates easier handling, transportation, and faster construction. This also reduces the dead load on foundations, which is particularly beneficial in areas with soft or expansive soils.

6.5 Fire Resistance and Thermal Performance

While fired clay blocks have moderate fire resistance, properly cured sandscreed blocks can be designed to have excellent fire resistance. Additionally, they provide better thermal insulation, reducing heat transfer in warm climates, which is advantageous in Umudike, Nigeria.

6.6 Environmental and Economic Considerations

Sandscreed blocks do not require fuel-intensive firing, unlike clay blocks, which reduces both environmental impact and production cost. They can also incorporate by-products or local sand, making them cost-effective and sustainable.

In summary, sandscreed blocks combine high compressive strength, durability, dimensional stability, and ease of handling, giving them clear structural advantages over traditional fired clay blocks in modern construction projects.

APPLICATION

Sandcrete blocks and fired clay bricks are widely used masonry units in Nigerian construction, with sandcrete blocks commonly used for cost-effective non-load-bearing walls, and fired clay bricks preferred for durable load-bearing structures. Sandcrete Blocks

Composition and Production: Sandcrete blocks are precast masonry units made from cement, sand, and water, typically with a cement-to-sand ratio of 1:6 to 1:9

. They can be **solid or hollow**; hollow blocks contain cores that reduce weight while allowing for reinforcements.

Applications:

• **Load-bearing walls:** Hollow sandcrete blocks with adequate compressive strength (≥ 3.45 N/mm² for 225 mm blocks) can support multi-story buildings

• **Partition and non-load-bearing walls:** Solid or hollow blocks with lower strength (≥ 2.5 N/mm²) are suitable and allow faster wall erection

• **Industrial and residential buildings:** Their standardized dimensions (e.g., 450 x 225 x 225 mm) simplify construction and reduce plaster consumption.

Advantages:

• Cost-effective and readily available across Nigeria

• Resistant to pests, rot, and rust.

• Quick construction due to larger unit sizes and lower density.

• Moderate durability and consistent mechanical properties when properly produced

Limitations:

• Lower water resistance compared to fired clay bricks; prolonged exposure to moisture may affect durability

• Typically, less suitable for structures requiring very high compressive strength.

Fired Clay Bricks

Composition and Production: Fired clay bricks are manufactured from clay, sand, and water and fired at high temperatures (900–1200°C) in kilns to achieve hardness and durability

. The firing process reduces water absorption and improves compressive strength.

Applications:

• **Load-bearing walls:** Ideal for high strength masonry with compressive strength often ranging from 3,000 to 15,000 psi

• **Fire -resistant and durable structures:** Used in both residential and industrial buildings where longevity and environmental resistance are key

• **Eco-sensitive constructions:** Certain clays from Nigeria can be used as refractory bricks for industrial furnaces due to high alumina and silica content

Advantages:

• High durability; lifespan over 100 years with minimal maintenance

• Excellent performance in harsh weather, high temperatures, and moisture exposure.

• Better mechanical and thermal stability compared to sandcrete blocks

Limitations:

• Higher cost due to energy-intensive firing and topsoil usage.

• Slower construction because of smaller unit sizes and more joints.

• Environmental impact: Kiln firing emits CO2 and contributes to air pollution

7.0 Conclusion

The transition toward sandcrete block technology in modern masonry represents a move toward greater structural predictability and engineering reliability. By replacing the erratic, heat-dependent process of clay firing with the controlled, chemical hydration of cementitious composites, sandcrete provides a more uniform, load-bearing solution.

The dimensional stability of sandcrete allows for better management of structural loads, while its material consistency ensures that the architectural design intent is realized without the variables associated with natural clay sourcing. For professional applications, particularly in large-scale residential and commercial infrastructure, sandcrete blocks represent the superior choice for structural integrity, speed, and long-term durability.

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