

Comparative Fire Resistivity of Building Materials in Makurdi Markets: Implications for National Safety Code Revision

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Abstract

Market fires remain a critical safety challenge in Nigeria, inflicting heavy human, economic, and infrastructural losses. This study evaluates the fire resistivity of building materials in Makurdi markets and their role in fire propagation. Using a mixed-methods approach, including surveys, on-site observations, and analysis of fire incident records, the research compared timber, plywood, corrugated aluminum, galvanized iron, and fiber-cement. Findings reveal a predominance of highly combustible materials, particularly timber and plywood, which exacerbate fire spread, while fiber-cement and reinforced concrete demonstrate superior fire resistance but are largely avoided due to higher costs. These results highlight the urgent need for targeted policy interventions, such as context-specific updates to the National Fire Safety Code, promotion of fire-resistant material alternatives, and incentive schemes to offset economic barriers. By linking material performance to regulatory and practical strategies, the study offers actionable recommendations for enhancing market resilience, minimizing vulnerability, and improving urban fire safety governance in Nigeria.

Keywords: Fire outbreaks, building materials, market fires, Nigeria, fire resistivity, National Fire Safety Code

1. Introduction

For millions of Nigerians, markets are vital socioeconomic hubs that provide jobs, commerce, and income. However, frequent fire outbreaks that destroy livelihoods and jeopardize urban safety have put them in greater danger. Fire accidents have resulted in considerable property damage and fatalities in Nigerian marketplaces such as Balogun (Lagos), Ariaria (Aba), Sabon Gari (Kano), and Wadata (Makurdi) (Oladokun & Ishola, 2010; Federal Fire Service, 2016). Research indicates that the use of combustible building materials, crowded layouts, and subpar electrical installations are important contributors to the spread of fires (Adamu, 2013; Gbenga, 2014). Despite the National Fire Safety Code's existence, markets remain vulnerable due to lax enforcement and a lack of context-specific regulations.

By determining fuel load, heat release rates, flame spread, and structural stability during fire exposure, building materials significantly control fire initiation, development, and severity in urban market contexts (Babrauskas, 2016; Drysdale, 2019). The choice of materials frequently decides whether a little flame turns into a massive blaze in Nigerian markets, where booths are closely spaced and building is mostly informal.

The majority of market facilities in Makurdi, the capital of Benue State, are built with inexpensive, easily accessible materials including aluminum roofing sheets, plywood partitions, wooden frame, and galvanized iron components. Due to financial limitations and lax enforcement of regulations, these materials predominate in important commercial hubs including Wurukum, Modern Market, and North Bank markets. Although metal roofing materials are non-combustible, they undergo strength degradation and heat transmission at high temperatures, which facilitates the spread of fire to nearby combustible elements and speeds up structural failure (Buchanan & Abu, 2017; Hurley et al., 2020). In contrast, timber and plywood have high combustibility and encourage rapid flame propagation. When these materials interact in densely packed market layouts, compartmentation is greatly reduced, firebreaks are limited, and evacuation times are shortened.

While research on Nigerian markets has repeatedly shown that combustible building materials are a major cause of fire losses (Afolayan et al., 2021), there are still few empirical, location-specific evaluations for medium-sized cities like Makurdi. Effective fire safety regulation is hampered by this evidence gap, which also compromises material-based design guidelines.

In order to remedy this shortcoming, this study compares the fire resistance of popular Makurdi market building materials. The research offers localized evidence to guide safer material selection and promote changes to Nigeria's National Fire Safety Code by analyzing their igniting behavior, thermal response, and contribution to fire spread. In Makurdi's urban markets, the shift from reactive fire response to proactive fire risk mitigation requires such material-focused, context-sensitive regulation.

2. Literature Review

2.1 Fire as a Hazard

One of the most damaging risks to human settlements is still fire, which can cause long term economic upheaval, urban decline, and regulatory reform in addition to immediate fatalities.

In the past, significant urban fire incidents have been pivotal moments in the development of fire safety engineering and construction codes. Early fire-resistant building techniques were sparked by incidents like the Great Fire of London in 1666, but more recent urban fire disasters continue to highlight flaws in material standards, planning regulations, and enforcement procedures (Harding, 1990). The ongoing connection between fire danger and the built environment is highlighted by these historical examples.

Established fire science models are frequently used to explain the behavior and development of fire inside structures. The Fire Growth Curve depicts the temporal progression of fire from ignition through growth, flashover, and decay, whereas the Fire Triangle conceptualizes fire as the interaction of three basic elements: fuel, heat, and oxygen (Drysdale, 2011). Building materials are crucial to this framework because they are the main fuel source that controls the possibility of ignition, the spread of flames, the pace at which heat is released, and the length of the fire. The rate at which a fire spreads and the intensity of its effects are directly influenced by material characteristics such as combustibility, thermal conductivity, surface spread of flame, and structural response to heat.

As a result, a key component of fire safety strategy is the choice and control of construction materials. Poor material selection can turn little ignition occurrences into major catastrophes in high-density urban settings, especially in informal and semi-formal marketplaces. Effective fire risk reduction thus requires an understanding of material behavior within established fire models, which informs both design practice and the development of evidence-based fire safety rules.



Fire safety and Market risk in Makurdi

2.2 Market Fires in Nigeria

In Nigeria, market fires continue to be a problem for urban safety; frequent occurrences have been reported in Lagos, Kano, Aba, and Makurdi. According to Federal Fire Service official statistics, these incidents have resulted in significant economic losses and a large number of fatalities in brief periods of time. Market fire outbreaks are frequently linked by empirical research to electrical system malfunctions, poor spatial design, and the widespread

use of flammable building materials (Adamu, 2013; Gbenga, 2014). Market infrastructure still mostly relies on timber and plywood stall structures, which increases structural vulnerability to quick fire spread despite the recurring occurrence of these tragedies.

2.3 Fire Resistivity of Building Materials

Building materials' fire performance is frequently assessed using factors including heat release rate, ignition temperature, and structural stability under thermal stress. While wood, thatch, and polymer-based products ignite easily and accelerate the spread of fire, non-combustible materials, such as steel, reinforced concrete, and fiber-cement boards, show greater fire resistance (Quarles, 2013; Sikazwe, 2015). However, fire resistance factors are rarely taken into account while choosing materials in Nigerian market contexts. Rather, decision-making is dominated by availability, cost, and construction informality, which leads to the widespread use of materials with subpar fire performance.

2.4 Fire Safety Codes and Governance

The National Fire Safety Code of Nigeria lays out the fundamental standards for fire safety, although it only includes a few restrictions that are specific to the material practices, informality, and geographical density of market developments. In contrast, British fire regulations and international standards like those of the National Fire Protection Association emphasize material specification, compartmentation, and passive fire protection as essential strategies for preventing the spread of fire (NFPA, 2016; Building and Construction Authority, 2017). Due to institutional fragmentation and lax regulatory enforcement, market facilities in Nigeria are particularly vulnerable to fire dangers.

2.5 Research Gap

Although market fire incidents in Nigeria are extensively reported, systematic investigations into the fire resistivity of materials commonly used in these settings remain scarce. Existing studies largely emphasize causation and emergency response, with limited focus on material performance and its regulatory implications. This study addresses this gap through a comparative assessment of building materials used in Makurdi markets, linking empirical fire resistivity outcomes to policy deficiencies and opportunities for improved fire safety governance.

3. Methodology

Study Area and Research Design

In order to gain a comprehensive understanding of market stall construction practices and their impact on fire hazard, this study used a mixed-methods methodology that integrated both quantitative and qualitative techniques. The need to integrate numerical data with context-specific insights in order to increase the validity and dependability of the outcomes led to the choice of this design. The study was conducted in Makurdi, Benue State, Nigeria, with a focus on the primary commercial hub of the city, Wadata Market, as well as a few selected nearby satellite markets. These locations were specifically chosen due to their high concentration of traders, history of fire incidents, and reliance on combustible building

materials.

Procedures for Collecting Data

1. Investors' Survey: Structured questionnaires were distributed to a purposeful sample of 120 traders drawn from different market sectors. The survey collected quantitative data on stall construction materials, fire incident experiences, accessible fire prevention methods, and traders' perceptions of fire safety.

2. Observational Assessment: Methodical field observations were used to document the types of building materials used in stalls, market layouts, and obvious fire safety precautions (such as fire extinguishers, hydrants, or emergency service access routes). This provided empirical evidence for trader complaints and illustrated practical challenges in fire preparedness.

4. Results

Results show that fire resistance varies significantly amongst materials. Plywood and wood, which are frequently used for stalls, showed poor fire resistance, starting fires fast and accelerating their spread. Although they offered some protection, galvanized iron and corrugated aluminum distorted when exposed to extreme heat. The strongest resistance was shown by reinforced concrete and fiber-cement sheets, which preserved structural integrity for longer. Despite being aware of the fire risks, traders stated that they chose plywood and wood because they were more affordable.

Table 1 summarizes comparative fire resistivity ratings of selected materials.

Table 1: Fire Resistivity of Building Materials in Makurdi Markets

Material	Fire Resistivity	Performance
Timber	Low	Ignites easily; rapid flame spread
Plywood	Low	Highly combustible; accelerates fire
Aluminum sheet	Moderate	Resistant initially; deforms under heat
Galvanized iron	Moderate	Provides short-term resistance
Fiber-cement	High	Non-combustible; durable under fire
Reinforced concrete	High	Strong endurance; resists structural collapse

5. Discussion

The findings are consistent with research from around the world showing that combustible materials make market environments more vulnerable to fire (Drysdale, 2011; Quarles, 2013). The prevalence of plywood and wood in Makurdi markets is a reflection of socioeconomic limitations, as vendors put cost over security. This emphasizes the necessity of policy assistance and subsidies in order to encourage the use of non-combustible materials. Due to informality and lax regulation, Nigerian marketplaces lack the passive protection and compartmentation that international rules highlight.

6. Conclusions

The importance of building materials in determining market fire vulnerability is highlighted in this study. In Makurdi markets, timber and plywood continue to be the most popular materials, but there is a significant risk of fire. Because of their high cost, fiber-cement and reinforced concrete are underutilized despite their improved fire resistance. Nigerian markets may greatly improve fire safety by amending the National Fire Safety Code to include material criteria, enforcement, and subsidies. These results add to the current conversation on urban resilience and disaster risk reduction.

7. Recommendations

The study's recommendations are as follows:

1. The National Fire Safety Code should be revised to incorporate material-specific market criteria.
2. Programs that provide financial assistance for fire-resistant materials like reinforced concrete and fiber-cement.
3. Enforcing electrical certification and inspection for market stalls.
4. Market design that incorporates passive fire protection and compartmentation.
5. Increasing market union and fire department capacity to guarantee prompt reaction.

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