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Examining the Existing Ventilation Strategies of Residential Buildings in Akwa Ibom and Cross River States, Nigeria

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Abstract

This study examines the existing ventilation strategies employed in residential buildings in Akwa Ibom and Cross River States, Nigeria, with the aim of assessing their effectiveness in achieving acceptable indoor environmental conditions and identifying opportunities for improvement. The study is premised on the importance of adequate ventilation in maintaining indoor air quality, thermal comfort, occupant health, and energy efficiency, particularly within the warm-humid climatic conditions of southern Nigeria. A mixed-method research approach is adopted, combining field observations, physical measurements, building surveys, occupant questionnaires, and interviews with relevant professionals. Selected residential buildings across representative locations in both states are evaluated based on their building orientation, window characteristics, room configuration, ventilation openings, shading devices, building materials, occupancy patterns, and the use of mechanical and natural ventilation systems. Indoor environmental parameters, including air temperature, relative humidity, and air movement, are assessed alongside occupants' perceptions of thermal comfort and ventilation adequacy. The study compares ventilation practices between the two states and examines the influence of building design and climatic factors on ventilation performance. The findings are expected to establish a baseline understanding of prevailing residential ventilation strategies, identify their strengths and limitations, and provide evidence-based recommendations for improving passive and hybrid ventilation practices. The study ultimately seeks to contribute to climate-responsive residential building design and healthier, more comfortable, and energy-efficient housing in the region.

Keywords: *Residential buildings, Ventilation strategies, Thermal comfort, Building design, Akwa Ibom State, Cross River State*

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Background to the Study
Ventilation is a fundamental environmental function of buildings. It provides outdoor air, removes internally generated pollutants and moisture, and contributes to thermal comfort by influencing indoor air movement. In naturally ventilated buildings, ventilation can also provide a significant means of reducing dependence on mechanical cooling. These functions make ventilation a central concern in sustainable building design, particularly in tropical and warm-humid environments.

The relationship between ventilation and building performance is particularly important in warm climates because thermal discomfort is influenced not only by air temperature but also by relative humidity and air movement. Prianto and Depecker (2003) demonstrated that architectural design has a significant influence on air movement and thermal comfort in tropical humid buildings. In such environments, increasing indoor air velocity can enhance convective and evaporative heat loss and consequently improve thermal sensation even when indoor temperatures remain relatively high. The implication is that building design in warm-humid climates should seek to promote useful air movement rather than relying exclusively on mechanical refrigeration. Natural ventilation has therefore become an important passive-design strategy. Alozie et al (2015) and Aflaki et al. (2015), in a major review of natural ventilation in tropical climates, identified building orientation, window-to-wall ratio, ventilation shafts, aperture configuration and louvred windows as important elements influencing ventilation performance. They further observed that the effectiveness of natural ventilation is closely connected to heat-avoidance strategies.

Accordingly, Alozie et al (2019) Cross-ventilation is particularly important because it can establish a continuous airflow path through occupied spaces. Jiang et al. (2023), in a comprehensive review of cross-ventilation research, identified cross-ventilation as one of the most effective forms of natural ventilation and emphasized the importance of airflow patterns, pressure differences, opening configuration and building characteristics. The relevance of ventilation to Nigerian buildings has been demonstrated for several decades. Ajibola (1997), examining housing in a warm-humid Nigerian context, found that many spaces in modern buildings were inadequately ventilated and argued for greater attention to window design as a means of achieving physiological comfort. Ajibola (2001) subsequently examined climate and building design in Nigeria from a bioclimatic perspective, reinforcing the importance of climatic variables such as temperature, humidity, air velocity and solar radiation in developing building-design recommendations.

The issue remains relevant because contemporary Nigerian buildings increasingly combine passive and mechanical systems. Air-conditioning is becoming more common in offices, commercial buildings, hotels, educational facilities and higher-income residences. However, dependence on mechanical cooling increases operational energy demand and can become problematic where electricity supply and maintenance are unreliable. A more appropriate approach for warm-humid Nigeria is therefore likely to involve the integration of passive ventilation, air movement, solar control and selective mechanical cooling. Akwa Ibom and Cross River States are particularly suitable for such an investigation. Major urban centers such as Uyo and Calabar are situated within a wet-humid environmental context in which ventilation and solar control are important determinants of indoor comfort. Local research and design documentation indicate that natural ventilation is being considered in buildings in both locations. A technical design study in Calabar, for example, developed a multipurpose building around natural ventilation and passive cooling, using a central courtyard as part of the airflow strategy (Abalum & Alozie, 2023, Okonkwo et al., 2022).

Despite the importance of ventilation, there remains a need for a consolidated assessment of the strategies currently employed in Akwa Ibom and Cross River. Existing studies tend to focus on individual buildings, individual building types or broader Nigerian contexts. Consequently, there is value in examining the existing ventilation approaches comparatively and identifying their strengths, limitations and implications for climate-responsive design.

This paper therefore examines the existing ventilation strategies employed in Akwa Ibom and Cross River States. Specifically, it seeks to:

1. Identify the principal ventilation strategies employed in buildings in the two states;
2. Examine the architectural characteristics associated with these strategies;
3. Assess their likely contribution to thermal comfort, indoor air quality and energy efficiency;
4. Identify constraints limiting the effectiveness of existing ventilation approaches; and
5. Propose directions for improved ventilation design and future empirical investigation.

The paper therefore argues that effective ventilation in Akwa Ibom and Cross River should be understood as a building-system performance issue, rather than simply a matter of providing windows or fans.

Literature Review

Ventilation in Buildings

Ventilation is the intentional introduction, movement and removal of air within a building. It can occur naturally through openings or mechanically through fans and air-handling equipment. Its functions include supplying outdoor air, diluting or removing pollutants, controlling moisture and supporting thermal comfort. The World Health Organization identifies adequate outdoor-air flow as necessary for removing indoor-generated pollutants and moisture or diluting their concentrations to acceptable levels. Ventilation can be natural or mechanical, but both approaches require appropriate design and implementation. (Alozie 2014). Ventilation should therefore be distinguished from simple air circulation. A ceiling fan, for example, can increase indoor air velocity without introducing outdoor air. It may improve thermal comfort but does not necessarily improve indoor-air quality. Conversely, an open window may provide outdoor-air exchange without generating sufficient air movement for thermal comfort. (Alozie, 2014. Abalum &Alozie ,2023).

Natural Ventilation

Natural ventilation relies primarily on environmental forces rather than mechanical equipment. The two major driving mechanisms are wind pressure and buoyancy. Wind-driven ventilation occurs when differences in pressure develop across building openings because of wind interaction with the building envelope. Air enters through openings experiencing relatively high pressure and leaves through openings experiencing lower pressure. Buoyancy-driven ventilation, commonly called stack ventilation, results from differences in air density associated with temperature differences. Warm air rises and can escape through high-level openings, drawing replacement air through lower openings. In wet-humid climates, wind-driven ventilation is very important because the temperature differences required to generate strong buoyancy-driven flows may not always be large. Aflaki et al. (2015) emphasized the importance of orientation, opening configuration and ventilation shafts in enhancing natural ventilation in tropical buildings.

Mechanical Ventilation and Air-Conditioning

Mechanical ventilation uses fans and associated systems to move air. Air-conditioning systems go further by treating indoor air to control temperature, humidity, cleanliness and distribution. The principal advantage of mechanical systems is their ability to provide predictable indoor conditions. Their principal disadvantage in the Nigerian context is the associated energy demand and dependence on electricity and maintenance. Mechanical cooling should consequently be considered alongside the building envelope and passive strategies rather than as an isolated solution.

Mixed-Mode Ventilation

Mixed-mode ventilation combines natural ventilation and mechanical cooling. A building may operate with open windows and fans when outdoor conditions are favourable and use air-conditioning during periods of high temperature, humidity or inadequate outdoor air movement. This approach can potentially reduce mechanical cooling hours while retaining the reliability of mechanical systems when required. However, its success depends on appropriate controls and occupant understanding.

Thermal Comfort and Ventilation in Warm-Humid Environments

Thermal comfort is the condition in which occupants' express satisfaction with their thermal environment. It depends on environmental variables, including air temperature, mean radiant temperature, relative humidity and air velocity, as well as personal variables such as clothing and metabolic activity. ASHRAE Standard 55 recognizes both standard and adaptive methods for assessing thermal comfort. The 2023 edition consolidated these approaches and provides procedures for evaluating satisfactory thermal environments.

The adaptive approach is especially relevant to naturally ventilated buildings. de Dear and Brager (1998), based on a large international database of thermal comfort observations, demonstrated that occupants of naturally ventilated buildings tolerate a wider range of indoor temperatures and that thermal expectations are influenced by outdoor climate, behavioral adaptation and previous thermal experience. Nicol and Humphreys (2002) similarly argued that adaptive thermal comfort provides a useful basis for sustainable thermal standards because occupants can modify their behavior and expectations in response to changing conditions. This is particularly relevant to southern Nigeria, where occupants may control windows, doors, fans, blinds, clothing and other environmental variables. However, adaptive comfort should not be interpreted as a justification for poorly performing buildings. The objective remains to provide reasonable environmental conditions while giving occupants meaningful control. Prianto and Depecker (2003) showed that air movement within naturally ventilated buildings depends on architectural design elements as well as outdoor wind conditions. Therefore, ventilation design must be considered as an interaction between climate and architecture.

Climatic and Building Context of Akwa Ibom and Cross River

Akwa Ibom and Cross River occupy a humid southern Nigerian context characterized by relatively high temperatures and atmospheric moisture. Such conditions create a strong need for effective air movement and solar-heat control. In wet-humid environments, high humidity can reduce the effectiveness of evaporative cooling from the human body. Increasing air velocity can partly compensate by improving evaporation and convective heat loss. Prianto and Depecker (2003) therefore emphasized the importance of interior air velocity in achieving comfort under tropical humid conditions. The climatic context also means that natural ventilation cannot be evaluated independently of solar control. A building with large unshaded openings may have good airflow but excessive solar heat gain. Aflaki et al. (2015) concluded that natural ventilation performs most effectively when integrated with heat-avoidance techniques. The implication for Akwa Ibom and Cross River is that effective ventilation should form part of a broader passive-design system incorporating: building orientation; external shading; appropriate window configuration; roof design; building depth; internal airflow pathways; vegetation and site planning; controllable openings; and appropriate use of fans.

Methodology

Research Approach

This paper adopts an evidence-based narrative review and comparative assessment approach. It does not claim to present new field measurements. Instead, it synthesizes published scholarly research, Nigerian building studies, standards and relevant technical literature to examine ventilation strategies applicable to Akwa Ibom and Cross River States. This approach is appropriate for establishing a conceptual and empirical foundation for subsequent fieldwork Particular attention was given to studies addressing building orientation, opening configuration, cross-ventilation, thermal comfort and occupant adaptation. The evidence includes studies from Nigeria and other tropical regions. Nigerian studies are used to provide contextual relevance, while international tropical studies provide the theoretical and methodological foundation. Existing ventilation strategies were examined under the following dimensions: ventilation mechanism; architectural components; occupant control; thermal-comfort potential; indoor-air-quality implications; energy implications; climatic suitability; and implementation constraints. The findings were synthesized qualitatively.

Existing Ventilation Strategies in Akwa Ibom and Cross River States

Openable Windows and Doors: Openable windows and doors represent the most basic natural-ventilation strategy. They allow outdoor air to enter occupied spaces and permit indoor air to escape. Their usefulness is strongly influenced by opening location, orientation, size, surrounding obstructions and occupant behavior. Ajibola (1997) identified window design as a significant factor in the ventilation of warm-humid Nigerian buildings and found that many modern spaces were inadequately ventilated. The presence of windows therefore cannot be interpreted as proof of effective ventilation. In Akwa Ibom and Cross River, windows may be opened during periods of favorable weather but closed during heavy rainfall, excessive solar exposure, security concerns, noise or insect intrusion. Consequently, actual ventilation may differ substantially from the theoretical ventilation capacity of a building.

Cross-Ventilation

Cross-ventilation involves openings on different sides of a room or building, allowing pressure differences to drive air through the occupied space. It is arguably the most important passive ventilation strategy for warm-humid buildings. Jiang et al. (2023) identified cross-ventilation as a major natural-ventilation mechanism and reviewed the effects of opening configuration, pressure differences and airflow patterns on its performance. The effectiveness of cross-ventilation depends on: inlet opening location; outlet opening location; opening area;wind direction; wind speed; building orientation; internal partitions; and surrounding buildings. A building with large openings on opposite façades may achieve strong airflow, whereas a building with equivalent opening area concentrated on one façade may experience much weaker ventilation. The relevance of this strategy is evident in the Calabar technical design study of Okonkwo et al. (2022), which proposed a building configuration intended to facilitate natural ventilation and passive cooling through spatial organization around a central courtyard.

Single-Sided Ventilation

Single-sided ventilation occurs where openings are primarily located on one façade. Air can enter and leave through the same opening because of fluctuating wind pressures and local turbulence. Although simpler to implement, single-sided ventilation is generally less effective than cross-ventilation, especially in deep rooms. This strategy may nevertheless be unavoidable in buildings where site constraints, security requirements or adjacent development restrict openings on multiple façades. The design implication is that single-sided ventilation should preferably be supported by shallow room depths, appropriately sized openings and high-level outlets where possible.

Louvre Windows

Louvres provide adjustable openings that can remain partially open under conditions where conventional windows may need to be closed. They are potentially valuable in southern Nigeria because they can provide ventilation while offering some control over rain, glare and solar exposure. Aflaki et al. (2015) identified louvred-window configuration and aperture form as areas of importance in tropical ventilation design. Their effectiveness nevertheless depends on blade geometry, opening orientation, pressure differences and maintenance.

High-Level Openings

High-level openings can facilitate the removal of warm air and can contribute to buoyancy-driven ventilation. They are particularly useful in spaces with high ceilings or large internal volumes. When combined with lower-level openings, they can establish a vertical airflow path. However, the effectiveness of stack ventilation depends on temperature differences and the vertical separation of openings. It should therefore generally complement rather than replace wind-driven ventilation in warm-humid southern Nigeria.

Courtyards

Courtyards can contribute to natural ventilation by creating internal outdoor spaces around which rooms can be organized. The Calabar study by Okonkwo et al. (2022) provides a locally relevant example in which a central courtyard was used to support natural airflow and passive cooling in a proposed multipurpose development. Courtyards can improve access to outdoor air, daylight and shaded transitional spaces. Their performance, however, depends on geometry, orientation, vegetation, surrounding building height and thermal conditions within the courtyard. A poorly designed courtyard can become a heat reservoir rather than a cooling resource.

Ceiling Fans

Ceiling fans are widely applicable to warm-humid buildings because they increase indoor air velocity at relatively low energy consumption compared with compressor-based air-conditioning. Their principal thermal-comfort benefit comes from increasing air movement across occupants' skin. However, a fan does not automatically provide outdoor-air exchange. Consequently, ceiling fans should be considered a thermal-comfort enhancement strategy rather than a complete ventilation strategy. The most effective arrangement is usually to combine ceiling fans with openable windows or other outdoor-air pathways.

Wall-Mounted and Portable Fans

Wall-mounted and portable fans can provide directional air movement and can be useful where ceiling fans are impractical. They may also be used to encourage air movement through a space. Nevertheless, their performance depends strongly on location and direction. Where fans merely recirculate indoor air, they improve perceived thermal comfort but have limited effect on pollutant dilution.

Mechanical Air-Conditioning

Air-conditioning provides a high degree of control over indoor temperature and, depending on the system, humidity. It is therefore particularly attractive in offices, hotels, commercial buildings, health facilities and high-occupancy spaces where thermal conditions need to remain relatively stable. The disadvantage is energy consumption. In warm climates, increased reliance on mechanical cooling can substantially increase building operational energy demand.Bastide et al. (2006) demonstrated the potential for natural ventilation and bioclimatic design to reduce air-conditioning periods in tropical buildings. Their approach emphasized first reducing building-envelope heat gains and then optimizing natural ventilation airflow. This principle is highly relevant to Akwa Ibom and Cross River: reducing heat gain should precede or accompany mechanical cooling.

Mixed-Mode Ventilation

Mixed-mode ventilation combines natural ventilation with mechanical systems. This strategy may be especially appropriate in Akwa Ibom and Cross River because climatic conditions vary over time. Natural ventilation can be used during favorable periods, while air-conditioning can be activated when outdoor temperature, humidity or air quality becomes unsuitable. Mixed-mode systems can potentially reduce energy consumption without sacrificing comfort, provided that control systems are properly designed. The principal challenge is avoiding simultaneous operation of open windows and air-conditioning. Such operation can result in energy wastage and poor control.

Architectural Factors Influencing Ventilation Effectiveness

Building Orientation

Orientation determines how building façades interact with prevailing winds and solar radiation. Aflaki et al. (2015) identified building orientation as one of the key variables affecting natural ventilation in tropical buildings. Orientation should therefore be considered simultaneously with solar control. A building should not be oriented solely to maximize wind exposure without considering excessive solar gain. Haase and Amato (2009) demonstrated through simulation that climate and orientation influence thermal comfort and cooling requirements in warm and humid climates.

Opening Size

Opening size affects the potential quantity of air entering and leaving a building. However, opening area alone is not a sufficient indicator of ventilation performance. The relationship between inlet and outlet areas, pressure distribution and airflow resistance must also be considered. Mba et al. (2021), in an empirical study of 60 public primary school buildings in Enugu, found that the size and position of wall openings significantly affected natural ventilation efficiency and thermal comfort. This finding from a neighboring southeastern Nigerian context is highly relevant to the design of buildings in Akwa Ibom and Cross River.

Opening Position

The position of openings determines airflow pathways. Opposing openings support cross-ventilation, while openings on the same façade may provide only limited single-sided ventilation. Openings should therefore be located to enable airflow to reach occupied zones rather than simply satisfy a minimum window-area requirement.

Building Depth

Deep floor plans make natural ventilation more difficult because air may not penetrate effectively into central areas. Shallow floor plates, courtyards and ventilation corridors can improve airflow access. Bastide et al. (2006) emphasized airflow-network optimization as an important component of tropical building design.

Internal Partitions

Internal walls and enclosed rooms can interrupt airflow paths. Where natural ventilation is important, internal layouts should be designed to maintain air pathways between inlet and outlet openings. Transoms, internal louvres, ventilated doors and appropriate spatial organization can sometimes improve airflow without sacrificing all privacy requirements.

External Obstructions

Neighboring buildings, boundary walls, vegetation and other structures can alter wind patterns around a building. Urban densification may therefore reduce the natural-ventilation potential assumed during initial design. The site should consequently be evaluated as part of the ventilation system.

Shading

Solar shading is not itself ventilation, but it strongly affects ventilation performance. Large unshaded openings may increase solar heat gain to the point that natural ventilation cannot maintain comfort. Aflaki et al. (2015) identified heat avoidance as essential to maximizing the effectiveness of natural ventilation in tropical buildings. Appropriate shading strategies include: deep roof overhangs; verandas; balconies; horizontal projections; vertical fins; external louvres; and vegetation.

Ventilation, Indoor Air Quality and Moisture

Ventilation should not be assessed solely in terms of thermal comfort. Indoor air quality is influenced by the concentration of pollutants, carbon dioxide, moisture and biological contaminants. WHO guidance emphasizes that sufficient outdoor-air flow is necessary to remove or dilute indoor-generated pollutants and moisture. Moisture is particularly important in warm-humid environments. Persistent dampness can encourage microbial growth and mold. The WHO's guidelines on dampness and mold conclude that persistent dampness and microbial growth are associated with adverse respiratory and allergic health effects and should therefore be prevented or remediated. This has important implications for Akwa Ibom and Cross River. Ventilation strategies should provide sufficient air exchange while preventing rain penetration and excessive moisture accumulation. Poorly designed natural ventilation can allow wind-driven rain into buildings. Poorly maintained mechanical systems can also fail to control indoor humidity adequately. Consequently, the objective should be controlled ventilation, not simply maximum ventilation.

Occupant Behavior and Ventilation Control

Ventilation performance is partly determined by occupants. Occupants decide when to open or close windows, operate fans, adjust blinds and activate air-conditioning.de Dear and Brager (1998) demonstrated that occupants of naturally ventilated buildings exhibit behavioral and psychological adaptation to prevailing thermal conditions. Similarly, Nicol and Humphreys (2002) emphasized the role of adaptive behavior in thermal comfort. In Akwa Ibom and Cross River, occupant control may be influenced by: rainfall; insects; security; noise; privacy; glare; outdoor pollution; temperature; humidity; and electricity availability. A technically well-designed ventilation system can therefore perform poorly if occupants cannot or will not operate it as intended. The design implication is that ventilation controls should be simple, accessible and understandable.

Comparative Evaluation of Existing Ventilation Strategies

The major strategies can be evaluated according to their principal functions and limitations.

Table 1.

Strategy	Primary function	Thermal-comfort potential	Outdoor-air exchange	Relative energy demand	Major limitation
Openable windows	Natural ventilation	High when wind is available	High	Very low	Rain, security and low wind
Cross-ventilation	Through-flow ventilation	Very high	High	Very low	Requires suitable opposing openings
Single-sided ventilation	Local ventilation	Low–moderate	Moderate	Very low	Limited penetration
Louvre windows	Controlled ventilation	High	High	Very low	Configuration and maintenance
High-level openings	Exhaust/stack ventilation	Moderate	High	Very low	Limited buoyancy under some conditions
Courtyard	Airflow and microclimate modification	High when well designed	High	Very low	Poor geometry can cause heat accumulation
Ceiling fan	Increased air velocity	High	Low by itself	Low	Does not guarantee fresh air
Wall/portable fan	Directed air movement	Moderate–high	Low by itself	Low	Mainly recirculates air
Air-conditioning	Cooling/dehumidification	Very high	Depends on system	High	Energy and maintenance
Mixed-mode	Natural + mechanical	Very high	High when naturally operated	Moderate	Requires effective control

The comparison confirms that ventilation strategies should not be evaluated using a single performance criterion. Cross-ventilation, for example, performs well in terms of energy and thermal comfort but is dependent on outdoor conditions. Air-conditioning provides reliable comfort but has higher energy requirements. The most appropriate strategy is therefore often a combination.

Discussion

From Opening Provision to Ventilation Performance

One of the most important findings of the review is that the provision of openings does not necessarily guarantee effective ventilation. This distinction is particularly important in Nigerian building practice. Ajibola (1997) reported inadequate ventilation in warm-humid Nigerian housing despite the presence of windows. Similarly, Mba et al. (2021) demonstrated that opening size and position influenced natural ventilation efficiency in Nigerian classrooms. Ventilation design should therefore focus on the relationship between openings and airflow paths.

Cross-Ventilation as a Priority Strategy

Cross-ventilation deserves particular attention in Akwa Ibom and Cross River. It has several advantages: low operational energy; potential for high air movement; direct connection with outdoor air; suitability for warm-humid conditions; and compatibility with ceiling fans and shading. Alozie, et al (2023) Jiang et al. (2023) confirm the importance of cross-ventilation research and identify pressure differences, airflow patterns and opening configuration as major determinants of performance. However, cross-ventilation cannot be guaranteed simply by placing windows on opposite walls. The building's orientation, wind environment, opening areas and internal configuration must work together.

Fans as a Complementary Strategy

Ceiling fans offer an important opportunity for low-energy thermal comfort. However, they should not be confused with ventilation systems. Their primary benefit is increased air velocity. A recommended strategy is therefore: openable windows + cross-ventilation + ceiling fans + solar shading**.** Such a combination can provide outdoor-air exchange and enhanced thermal comfort while retaining relatively low energy demand.

The Role of Air-Conditioning

Air-conditioning remains appropriate where natural ventilation cannot achieve acceptable conditions. 12Examples include: spaces with high internal heat gains; periods of very high humidity; buildings requiring strict environmental control; spaces exposed to external pollution or noise; areas where security prevents window opening; and periods of inadequate outdoor airflow. The objective should therefore not be to eliminate mechanical cooling but to reduce unnecessary dependence on it. Bastide et al. (2006) demonstrated the potential for bioclimatic design and natural ventilation to reduce air-conditioning periods in tropical buildings.

Mixed-Mode Ventilation as a Practical Direction

For contemporary buildings in southern Nigeria, mixed-mode ventilation may offer the most practical balance. A building can operate naturally when: outdoor temperature is acceptable; humidity is tolerable; wind is sufficient; outdoor air quality is acceptable; and rainfall is not disruptive. Mechanical cooling can then be used when these conditions are not satisfied. Such a strategy requires effective controls and clear operating procedures.

Implications for Building Design in Akwa Ibom and Cross River

The review suggests that future buildings in the two states should be designed according to the following principles., Orientation should consider both prevailing winds and solar radiation. Where possible, rooms should have inlet and outlet openings on different façades. Deep spaces should be broken up with courtyards, ventilation corridors or other strategies that improve Openings should be externally shaded to reduce solar heat gain., High-level openings can

Ceiling fans should be used to increase air speed and extend the period during which natural ventilation remains thermally acceptable., Windows, louvres and shading devices should be easily controlled by occupants. Security grilles, protected louvres, verandas and overhangs should be incorporated without eliminating ventilation. Mechanical cooling should supplement rather than automatically replace passive ventilation., post-occupancy evaluation should be used to determine whether the intended ventilation strategy actually works.

Recommendations

Based on the evidence reviewed, the following recommendations are proposed. Architects should prioritise climate-responsive orientation, cross-ventilation, external shading, controllable openings and appropriate building depth Ventilation provisions in building regulations should progressively move beyond minimum opening-area requirements towards performance-oriented criteria. Developers should recognize passive ventilation as an investment in reduced operating energy rather than simply an architectural feature. Occupants should be provided with simple operating guidance explaining when to use windows, fans and air-conditioning. Future studies should employ simultaneous environmental measurement and occupant surveys and should include both wet- and dry-season observations.

Conclusion

This paper examined existing ventilation strategies employed in Akwa Ibom and Cross River States, Nigeria, through an evidence-based review of tropical ventilation research and Nigerian building studies. The review identified openable windows and doors, cross-ventilation, single-sided ventilation, louvres, high-level openings, courtyards, ceiling fans, wall-mounted fans, mechanical air-conditioning and mixed-mode systems as the major ventilation approaches relevant to buildings in the region. Natural ventilation remains particularly important because of the warm-humid environmental conditions. Cross-ventilation is especially promising because it can provide significant air movement with very low operational energy requirements. However, its effectiveness depends on orientation, opening size and position, building depth, internal layout, surrounding obstructions and prevailing wind conditions. The review further demonstrates that ventilation and thermal comfort are related but distinct. Fans can improve thermal comfort by increasing air velocity without necessarily providing outdoor-air exchange. Conversely, open windows may provide outdoor air without generating sufficient air movement. Effective ventilation design must therefore address both outdoor-air exchange and thermal comfort.

Mechanical air-conditioning remains necessary for some building types and climatic conditions, but excessive dependence on mechanical cooling increases energy demand. Mixed-mode ventilation offers a practical alternative by allowing buildings to exploit natural ventilation when conditions are favorable and mechanical cooling when necessary. The central conclusion is that effective ventilation in Akwa Ibom and Cross River should be approached as an integrated climate-responsive building-design problem. The most appropriate strategy is not simply to maximize openings but to optimize airflow paths while simultaneously controlling solar heat gain, rainfall, security, humidity and occupant requirements. The evidence supports a design hierarchy in which heat avoidance, effective cross-ventilation, controllable openings and air movement are prioritized before mechanical cooling. Where natural ventilation cannot maintain acceptable conditions, mixed-mode operation should be considered. Future empirical research should examine representative buildings in Uyo, Calabar and other urban centers in the two states using environmental measurements, occupant surveys, building audits, airflow simulation and energy monitoring. Such research would provide the quantitative evidence required to develop state-specific ventilation guidelines and strengthen the scientific basis for sustainable building design in warm-humid southern Nigeria.

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