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The Role of Sustainable Building Materials in Enhancing Climate Responsivity and User Satisfaction in Postgraduate Hostels at Caleb University, Lagos

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ABSTRACT

The postgraduate hostels in Caleb University in Lagos are faced with considerable levels of thermal discomfort due to the prevailing hot and humid marine climate, amplified by the use of inefficient traditional building materials. There is a need for environmentally adaptive building design in university buildings in the Nigerian university education sector, as urged by the call for green building materials (Olaoye, 2024). The focus of this study is the potential of sustainable building materials in enhancing climate responsiveness and end-users' satisfaction in the postgraduate hostel at Caleb University. To achieve this goal, the study draws from the complexities of architectural assessment and material performance. It discusses the benefits that can be gained through the strategic integration of sustainable design within the hostel towards the achievement of sustainability.

Keywords: *Sustainable Building Materials, Climate-Responsive Architecture, Thermal Comfort, Institutional Sustainability, User Satisfaction, University Hostels.*

INTRODUCTION

1.1 Background to the Study

The indoor environmental conditions of buildings located within hot-humid tropical climates are greatly influenced by the climatic suitability of the building envelope and the thermal properties of the construction materials used. Lagos State is located within the coastal climatic region of Nigeria, where the ambient temperature and relative humidity are very high, and solar radiation is very strong throughout the year. The climatic conditions of the region greatly influence the efficiency of the indoor cooling systems and the overall performance of the buildings *(Okonta, 2023)*.

In the residential areas of the university, the indoor environmental conditions of the buildings assume great importance. Evidence of the influence of indoor environmental conditions on cognitive performance and academic productivity in the learning environment of the university is well documented *(Conceição et al., 2024).* The hostel environment of the university should be thermally comfortable and stable to enhance the learning and research activities of the students. The postgraduate hostel buildings of Caleb University are constructed mainly of conventional building materials such as sandcrete blocks, reinforced concrete, and aluminium roofing sheets. Although the use of conventional building materials is common in the construction industry of Nigeria due to cost efficiency and construction familiarity, the use of sandcrete blocks in building construction is known to exhibit poor thermal performance compared to the use of alternative materials such as stabilised soil blocks *(Okereke & Ike, 2025)*. The use of building materials also greatly influences the efficiency of the indoor cooling systems of buildings located within the climatic conditions of Nigeria *(Okonta, 2023)*.

Evidence of the influence of the use of sustainable building envelope strategies, such as the use of green façades, on the environmental performance of buildings located within the climatic conditions of Lagos State is emerging *(Afolabi et al., 2025)*. The argument of the influence of climatic conditions on the environmental performance of buildings is correct. The climatic conditions of the region should be taken into consideration in the construction of buildings within the region. The infrastructure of the university is

expanding, and the use of sustainable building materials will greatly influence the environmental performance of the postgraduate hostel buildings of Caleb University *(UN-Habitat, 2020)*.

1.2 Statement of Problem

Yet, despite the ongoing development of new infrastructure in Nigerian universities, many student hostels are found to be thermally inefficient, owing to the use of conventional building materials that are not sufficiently responsive to tropical climatic conditions. For instance, in the postgraduate hostels of Caleb University, it has been observed that these hostels are subject to excessive heating during the day, while cooling is minimal at night, and artificial ventilation systems are used. Empirical studies suggest that, compared to other wall systems, sandcrete has higher rates of indoor heat gain *(Okereke & Ike, 2025)*. In addition, building materials are found to significantly affect indoor conditions of energy efficiency and cooling in Nigerian buildings *(Okonta, 2023)*. When building materials are not sufficiently responsive to tropical conditions, indoor conditions of thermal discomfort are likely to persist.

Thermal discomfort in educational environments has also been found to correlate negatively with cognitive performance and academic productivity *(Conceição et al., 2024)*. Therefore, it can be seen that the ongoing use of thermally inefficient materials in postgraduate hostels raises important questions of both environmental sustainability and academic productivity. Hence, it is imperative that an investigation is undertaken on the potential benefits of using sustainable building materials in enhancing climatic responsiveness and user satisfaction in the context of Caleb University.

1.4 Objective of the Study

The study seeks to:

- Understand the climate of Lagos and how this affects postgraduate hostels' environments.
- Determine what the thermal limitations might be of conventional materials currently used in such hostels.
- Explore options for sustainable materials that are suitable for use in these types of settings, as they will be hot and humid.
- Evaluate whether sustainable materials integration contributes to enhanced indoor comfort and satisfaction.

1.5 Justification of the Study

The basis for this justification rests on three pillars:

Environmental Justification: Sustainable designs depend on the selection of materials suitable for the conditions. Sustainable materials may help in reducing the energy demands and enhancing the performance of institutional constructions. Institutional Justification: Building on recent debates regarding the institutional architecture of Nigeria *(Olaoye, 2024)*, it is proposed that university buildings should be contextually relevant and support sustainability. This study contributes to that discourse within Caleb University. User-Centred. In the case of a postgraduate resident, a thermally comfortable micro-environment is necessary to carry out research, rest, etc. The addition of sustainable materials can lead to changes in the hostel's performance, hence enhancing the satisfaction of the residents.

Institutional Justification: The design of buildings in contemporary institutions in Nigeria, as Olaoye emphasises (2024), needs to be responsive to its context and strive to achieve lasting sustainability. The current study is a contribution to the broader discourse, specifically regarding Caleb University.

User-Centred Justification: Postgraduate residents require accommodation spaces that provide thermal comfort and stability to improve research productivity, rejuvenation, and overall well-being. Improving hostel performance using ecological resources increases user satisfaction.

1.6 Scope of the Study

This study evaluates sustainable construction materials for the construction of postgraduate hostels in Caleb University, with emphasis on the building envelope, including the walls and roofs, as key elements in determining thermal performance and comfort. The construction materials considered in this

study include compressed stabilised earth blocks, rammed earth, bamboo, natural fibre insulation, green roofs, and cool roofs, which offer passive and climate-responsive benefits. These construction materials were considered in this study due to their ability to regulate heat transfer, provide thermal comfort in terms of indoor temperature stability, and reduce the need for mechanical cooling. It is important to note that mechanical cooling, structural analysis, and cost analysis were not considered in this study since the emphasis was on the performance of the building envelopes in the hot and humid climate of Lagos.

LITERATURE REVIEW

2.2 Climate- Responsive Architecture in Hot Humid Regions

Climate-responsive architecture refers to building design strategies that adapt form, materials, and envelope systems to prevailing climatic conditions in order to enhance indoor comfort while minimising mechanical cooling demand. In hot-humid regions such as Lagos, key climatic challenges include high solar radiation, elevated humidity, and limited nocturnal cooling. Research on naturally ventilated educational buildings demonstrates that passive thermal improvements significantly enhance summer comfort conditions *(Shrestha & Rijal, 2023)*. These findings highlight the importance of passive envelope strategies in climate adaptation.

Furthermore, indoor thermal conditions in higher education environments have been shown to influence cognitive performance and productivity *(Conceição et al., 2024)*. This establishes a direct link between climate-responsive design and academic performance outcomes. In tropical urban environments like Lagos, green envelope strategies such as facade vegetation systems have demonstrated measurable reductions in heat accumulation and microclimatic improvement *(Afolabi et al., 2025)*. Such findings reinforce the importance of envelope-based environmental adaptation in institutional settings. However, many institutional buildings in Nigeria continue to rely on conventional construction practices that prioritise speed and cost over climatic suitability. This creates a disconnect between environmental conditions and architectural response.

2.3 Sustainable Building Materials and Environmental Performance

Universities form a micro-urban setting where architecture is critical to the academic experience, university identity, and environmental sustainability. The sustainable building frameworks for higher education institutions aim to minimise energy demands, improve environmental performance, and include context-responsive strategies for campus development *(UN-Habitat, 2020)*. In a rapidly growing private university like Caleb University, material selection is a critical element for sustainability planning. Sustainable materials for hostels contribute to environmental performance goals and minimise cooling energy demands. The study on green facade systems in Lagos highlights the importance of environmental adaptive campus development strategies *(Afolabi et al., 2025)*.

2.4 Institutional Architecture and Campus Development in Nigeria

Universities offer micro-urban settings in which architectural design influences the academic and institutional experiences. The institutional architectural tradition in Nigeria has emphasised building durability and development speed, sometimes at the cost of climatic considerations. Olaoye (2024) argues that institutional buildings need to demonstrate contextual awareness, socio-cultural significance, and environmental responsiveness. By extending this argument to university hostels, it is evident that hostels need to offer students shelter as well as environmental comfort. As private universities grow in size, as in the case of Caleb University, the use of sustainable building materials in the development of hostels is an environmental and institutional imperative. The use of climate-responsive hostel designs has the potential to improve the sustainability of university campuses.

2.5 Thermal Comfort and User Satisfaction in Student Housing

Thermal comfort is one of the essential determinants of occupant satisfaction, especially with regard to residential environments, particularly in high-density environments such as postgraduate hostels. Overheating of the indoor environment, as well as poor ventilation, can have negative effects on occupant cognitive performance. Architectural investigation of institutional environments often emphasises the

significance of symbolism, identity, and cultural meanings, especially with regard to institutional environments *(Olaoye, 2024)*. However, it is imperative to understand the role of environmental comfort, which is a fundamental element of user-centric design. The use of sustainable materials contributes to this aim, particularly with regard to the enhancement of the stability of the indoor environment, thus minimising the need for artificial air conditioning. The enhancement of the building envelope with climate-responsive materials has the aim of mitigating heat gain, stabilising the indoor air conditions, and enhancing occupant comfort. User satisfaction, particularly with regard to postgraduate hostels, is largely dependent on the environmental performance of the materials used.

2.6 Research Gap

In Nigerian architectural literature, it is noted that there is a significant focus on contextual responsiveness as well as institutional identity in building design *(Olaoye, 2024)*; however, little research has been conducted on the role that sustainable building materials play in enhancing thermal comfort in postgraduate university hostels. The current literature is dominated by concerns with form, symbolism, and cultural influence, rather than material strategies for responding to climate. It is, therefore, suggested that further research is needed to evaluate how sustainable materials might be used to improve climate responsiveness, as well as to fill a knowledge gap concerning postgraduate university hostel environments in private Nigerian universities, as is the case with Caleb University.

RESEARCH METHOD

3.2 Research Design

This study adopts a qualitative research design for the case study approach, supplemented by comparative material performance analysis.

The justification for the case study is based on the need for an in-depth examination of a specific institutional environment within its context. Similar contextual architectural analyses were adopted for the study of institutional environments in Lagos, where the building is examined within its context *(Olaoye, 2024)*.

The study is built around the following components:

- Contextual Environmental Assessment
- Building Envelope Assessment
- Comparative Assessment of Conventional and Sustainable Materials
- User-Centric Assessment

3.3 Study Area

The purpose of this study is to investigate the postgraduate hostels at Caleb University, Imota, Ikorodu, Lagos State, which is a region of hot and humid climatic conditions. Lagos State is a region of consistently high annual mean temperatures, high relative humidity, high amounts of solar radiation, and minimal nocturnal temperature reductions. All these factors increase the risk of overheating within a building, especially when such a building is not designed to respond to these climatic conditions. In such a climatic environment, the choice of building materials is a significant factor to consider when assessing a building's indoor environment. Past research on the subject indicates that the materials used for various climatological conditions in Nigeria have a significant effect on the cooling performance and regulation of indoor temperature stability *(Okonta, 2023).*

3.4 Data Collection Methods

The data collection process for this study was conducted using a four-component methodology, including literature study, physical observation, comparative material evaluation, and conceptual evaluation of user satisfaction. Literature study included publications from the second set of PDFs, with an emphasis on climate-responsive institutional architectures, contextual building designs in Lagos, and sustainability in educational institutions. Publications in AJESRE were also included to provide valuable insights into environmentally responsive architectural designs in Africa *(AJESRE, 2025).*

Physical observations of the Caleb University postgraduate hostels were conducted to assess the construction of the hostel walls, roofing, window placement, shading, and ventilation in conformity with established protocols on the assessment of institutional architectures (Olaoye, 2024). Finally, comparative

material evaluation involved comparing conventional materials such as sandcrete blocks, concrete, and aluminium roofing with sustainable materials such as CSEB, rammed earth, bamboo, bio-based insulation, and cool roofs, considering criteria such as thermal conductivity, heat absorption, adaptability to the natural environment, and sustainability (AJESRE, 2025; Ibitoye et al., 2023). User satisfaction was also evaluated conceptually, considering user satisfaction in relation to environmental comfort, thermal conditions, and the stability of building performance. This methodology aligns with architectural research on the significance of building performance in conformity with user demands to promote sustainability in buildings *(Olaoye, 2024).*

3.5 Data Analysis Procedure

The data analysis followed a comparative analytical model that included (a) identifying Lagos's major climatic challenges, (b) evaluating constraints related to conventional materials, (c) evaluating alternative sustainable materials, and (d) synthesising these findings to determine implications related to building performance. This model is consistent with a contextual architectural evaluation model that is often used in institutional research in Nigeria *(Olaoye, 2024)*.

3.6 Ethical Considerations

The research does not entail any invasive procedures or confidential information; the observations were conducted within the institutional boundaries for academic purposes only.

3.7 Limitations of Study

The scope of this study is limited to the building envelope and passive materials, with specific reference to the postgraduate hostels of Caleb University. It is focused on assessing the impact of walls, roofs, and other envelope components on thermal performance and climate response. The modelling of the mechanical systems, materials testing, and economic analysis are not included in this scope.

RESULTS AND DISCUSSION

4.2 Climatic Conditions and Observed Environmental Challenges

Field observation revealed that postgraduate hostels mainly use sandcrete block walls, reinforced concrete structural elements, and aluminium roofing sheets. Although these conventional materials are used due to cost and familiarity, they have limitations, as will be revealed in the following paragraphs. The use of sandcrete block walls was observed to absorb heat, thus making indoor temperatures high. This finding is consistent with those of Okereke and Ike (2025), who revealed that stabilised soil blocks perform better than sandcrete blocks in controlling indoor temperatures in Nigeria. Similarly, Okonta (2023) revealed that conventional building materials used in Nigeria have a significant impact on indoor cooling. The use of aluminium roofing sheets was observed to increase internal heat gain, especially in rooms located on the upper floor, due to high thermal conductivity.

4.3 Performance Limitations on Conventional Materials

An evaluation of the existing postgraduate hostels reveals major deficiencies related to the conventional materials' performance in the construction of such buildings. For instance, sandcrete blocks demonstrate major heat absorption during peak solar hours, nocturnal slow release of heat, and limited ability to respond to humidity changes. On the other hand, aluminium roofing sheets, although able to deflect solar radiation, transfer major amounts of radiant heat to interior spaces, thus increasing indoor thermal discomfort due to a lack of insulation. Despite their cost-effectiveness and structural efficiency, the materials' performance in the hot and humid climate of Lagos is substandard. This finding corroborates Olaoye's (2024) argument that buildings such as hostels in institutions should be designed to transcend conventional practices and respond to environmental concerns adequately.

4.4 Evaluation of Sustainable Material Alternatives

The analysis shows that the use of sustainable building materials has the ability to improve the environmental performance of the postgraduate hostel facilities. For instance, earth-based materials, which include compressed stabilised earth blocks (CSEB) and rammed earth, have the ability to regulate temperature fluctuations by moderating the thermal mass of the materials, thus allowing the heat to be

released slowly. These materials are also ideal for use in Nigeria's institutional setting, given their ability to comply with the environmental and socio-cultural realities of the region *(Olaoye, 2024)* and their ability to support the sustainable building strategies promoted by AJESRE publications (2025). Similarly, other materials, such as bio-based materials, which include bamboo, improve the environmental performance of the institution by minimising the amount of direct heat entering the building envelope, thus providing comfort to the occupants *(All Multidisciplinary Journal, 2025)*. Alternative roofing materials, such as cool roofs, also improve the environmental performance of the institution by increasing the solar reflectance, thus minimising the amount of heat transfer. This is ideal for the environmentally responsive institutional design principles promoted by Olaoye (2024).

4.5 Implications for User Satisfaction

The thermal conditions have a direct and significant impact on the residential experience and user satisfaction of the residents of the postgraduate student hostels. Overheating, for instance, has been observed to affect rest, concentration, and general comfort. According to Olaoye (2024), institutional buildings have both functional and experiential significance, with excessive indoor temperatures undermining these two purposes. Thus, the use of sustainable building materials not only contributes to the sustainability of the environment but also improves the comfort, satisfaction, and overall user experience of the residents.

4.6 Institutional Sustainability Implications

The research findings indicate that the use of climate-responsive materials in institutional buildings contributes to sustainability through various pathways, such as reduced dependency on energy, environmental performance, development of campus identity, and alignment with development strategies. As highlighted by AJESRE (2025), sustainability is a critical component of the development process in Africa. Thus, the use of sustainable materials in the construction of hostels is a form of alignment with the development process.

4.7 Summary of Findings

The implications of the study's findings can be seen in several aspects. First, the study found that traditional materials used in the construction of the walls and roof of hostels contribute to overheating. In addition, it was found that the roof materials have a significant effect on overheating. On the other hand, using sustainable materials helps to regulate the indoor temperature, which directly affects the level of satisfaction. Finally, it can also be seen that the use of materials is essential in developing sustainable institutions.

CONCLUSION

The research work revealed that the current building materials used in the postgraduate hostels, which are mostly sandcrete blocks and aluminium roofing materials, contribute significantly to overheating and discomfort in the hostels. Although they are good and commonly used, they are not environmentally responsive. The research work revealed that envelope performance is crucial in determining the environmental quality of buildings. The selection of building materials that are not environmentally responsive increases discomfort and leads to increased cooling demand. The use of sustainable building materials, such as compressed stabilised earth blocks, rammed earth, natural fibre, bamboo, and cool roofing, improves environmental responsiveness and reduces heat absorption, indoor temperature variation, and passive cooling demand. The research work confirmed that environmental responsiveness is essential in improving the performance of institutional buildings, as presented in the theory of environmental responsiveness in institutional architecture *(Olaoye, 2024)*. The selection of sustainable building materials is not just about improving building performance; it is about improving institutional development, as presented in the theory of sustainable building materials *(AJESRE, 2025; All Multidisciplinary Journal, 2025).* The research work revealed that environmental responsiveness improves satisfaction in buildings. For postgraduate students, improved environmental performance improves satisfaction and improves rest and concentration.

RECOMMENDATIONS

On the basis of these results, several recommendations are made for improving thermal comfort, user satisfaction, and sustainability in postgraduate hostels of Caleb University. Firstly, Caleb University can adopt green building materials in new and existing constructions, focusing on earth-based walls and bio-based materials for roof insulation, as these materials are thermally more stable. Secondly, aluminium roofing sheets can be replaced by insulated roofing, reflective materials, or cool roofing systems, as these materials can provide better comfort, especially on higher floors of buildings. Thirdly, Caleb University can formulate its own climate-responsive design policy that focuses on contextual and sustainable architectural strategies, as advocated in architectural studies of Nigerian universities *(Olaoye, 2024).* Fourthly, green material adoption can be incorporated in development planning, as it can strengthen sustainability strategies, as advocated in studies on African institutional architecture *(AJESRE, 2025)*. Finally, further studies are encouraged on these hostels, as they can provide valuable insights into the benefits of adopting green materials in Nigerian university hostels.

CONTRIBUTION TO KNOWLEDGE

This study makes a number of contributions to the existing literature. Firstly, it adds to the discussion of sustainability within the Nigerian institutional architecture through the demonstration of the impact of material selection on thermal comfort within postgraduate hostels. Secondly, it establishes the relationship between the use of green building materials and the level of satisfaction of students. Thirdly, the study provides recommendations on the use of climate-responsive design strategies for use by private universities in Nigeria. Overall, the study bridges the gap between the theoretical discussion of institutional architecture and the practice of environmental responsiveness within the context of private higher education institutions.

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