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Eco-Sustainable Building Materials in Cameroon: Straw in Contemporary Architecture

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Abstract:- The construction industry in Cameroon is facing increasing pressure to adopt more sustainable practices to mitigate environmental degradation and promote energy efficiency. This article explores the potential of straw as an eco-sustainable building material, particularly in the context of contemporary architecture in Garoua-Cameroon. Straw, a renewable resource, offers several benefits, including low embodied energy, excellent thermal insulation, and local availability, making it an ideal material for sustainable construction in the region. This article reviews global examples of straw-based architecture, examines the advantages and challenges of using straw in construction, and proposes practical applications for straw in Cameroon. Finally, it discusses the implications of adopting eco-sustainable practices in the country's construction industry and highlights the need for updated building regulations and training programs to support the wider use of alternative building materials.

Keywords:- *Eco-Sustainable Materials, Straw Construction, Contemporary Architecture, Garoua- Cameroon, Environmental, Sustainability.*

I. INTRODUCTION

Eco-sustainability in the construction industry is becoming a global priority, driven by the urgent need to reduce carbon emissions and resource depletion. In Cameroon, the construction sector has traditionally relied on energy-intensive materials like concrete, steel, and brick, contributing to environmental degradation. As the country seeks to modernize and develop, there is a growing awareness of the importance of sustainable building practices. This article explores the integration of straw—a readily available, eco-friendly material—into contemporary architecture in Cameroon, with a focus on Garoua.

Straw, a byproduct of cereal production, has been used in various forms for centuries in traditional construction methods. In recent years, straw-bale construction has gained attention for its environmental benefits and adaptability in contemporary design. By examining global case studies, exploring the properties of straw, and considering the socio-economic context of Garoua, this article aims to present straw as a viable solution for sustainable construction in Cameroon.

II. THE NEED FOR ECO-SUSTAINABLE BUILDING PRACTICES IN CAMEROON

The construction industry is one of the largest contributors to environmental degradation, accounting for significant amounts of greenhouse gas emissions, energy consumption, and waste generation globally. In Cameroon, rapid urbanization and population growth have increased demand for housing and infrastructure, exacerbating environmental issues related to deforestation, resource extraction, and pollution.

Eco-sustainable building practices aim to reduce the environmental impact of construction by using renewable resources, minimizing energy consumption, and promoting resource efficiency. By integrating eco-friendly materials such as straw into construction practices, Cameroon can reduce its carbon footprint while addressing the country's housing needs.

III. PROPERTIES AND BENEFITS OF STRAW AS A BUILDING MATERIAL

Straw is a byproduct of cereal crops such as wheat, rice, barley, and oats. After the grain is harvested, the remaining stalks can be compacted into bales, which are used in construction for their thermal insulation properties, affordability, and environmental sustainability.

A. Thermal Insulation

Straw is an excellent insulator due to the air pockets between its fibers. These air pockets trap heat, providing high thermal resistance and reducing the need for artificial heating and cooling. This makes straw-bale construction particularly suitable for hot climates like that of Garoua, where cooling costs are a major concern. According to Jones and Fowles (2010), straw-bale walls can achieve insulation values of up to R-50, which significantly outperforms conventional insulation materials like fiberglass or foam.

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B. Embodied Energy

Embodied energy refers to the total energy required to produce, transport, and use a building material. Straw has a much lower embodied energy compared to traditional materials like steel, concrete, and brick. For example, studies by Lawrence (2009) show that straw has an embodied energy of 0.4 MJ/kg, while concrete has an embodied energy of 1.4 MJ/kg, and steel's embodied energy can reach 32 MJ/kg. This low embodied energy makes straw a highly sustainable option for construction.

C. Local Availability

Straw is widely available in Cameroon, particularly in agricultural regions like Garoua, where it is often discarded as waste after grain harvesting. Utilizing straw for construction not only provides an eco-friendly alternative to imported building materials but also helps reduce agricultural waste. By incorporating straw into local building practices, Cameroon can promote a circular economy that supports sustainable resource use.

D. Affordability

Straw is one of the most affordable building materials, making it an ideal choice for low-income communities. The cost of straw is typically much lower than that of conventional building materials, and because it is locally available, transportation costs are minimized. Research by King (2006) highlights that the use of straw-bale construction can reduce the overall cost of a building by up to 30%.

IV. GLOBAL CASE STUDIES OF ECO-SUSTAINABLE MATERIALS IN SUSTAINABLE ARCHITECTURE

A. Other Eco-Sustainable Materials

➢ *The Green School, Bali, Indonesia*

The Green School in Bali is a well-known example of sustainable architecture that uses natural materials like bamboo and straw to create an eco-friendly educational environment. The school's campus is built using locally sourced materials and incorporates passive solar design and natural ventilation to minimize energy use. The use of straw in roofing and insulation demonstrates its versatility and effectiveness in hot, tropical climates (Johari, 2018).

Fig 1. Green School in Bali, Indonesia (Johari, 2018).

➢ *EcoArk Pavilion, Taipei, Taiwan*

EcoArk is another innovative project that showcases the use of sustainable materials in construction. The pavilion, built from recycled plastic bottles and straw, demonstrates the potential of combining alternative materials to create durable, eco-friendly structures. The use of straw in this context provides thermal insulation and adds structural integrity to the lightweight plastic panels (Chen, 2012).

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Fig 2. EcoArk Pavilion in Taipei, Taiwan (Chen, 2012).

B. Straws

- *The SCL Straw-Bale House, Italy*

Designed by Jimmi Pianezzola Architetto, the SCL Straw-Bale House in Italy integrates straw into its structural and insulation elements, providing a high-performance, energy-efficient building. The house combines traditional construction techniques with modern design to create a sustainable living space that meets contemporary standards of comfort and environmental responsibility (Architectural Record, 2019).

Fig 3. SCL Straw-Bale House, Front Facade (Architectural Record, 2019)

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➢ *Straw Flea House, Austria*

The Straw Flea House in Austria, designed by Juri Troy Architects, showcases the use of straw bales as structural and insulating materials in a modern architectural context. This house highlights the adaptability of straw to various design styles and climates, emphasizing its potential for use in contemporary housing solutions (Troy, 2020).

Fig 4. Straw Flea House, Austria (Troy, 2020).

V. PROPOSED APPLICATION: STRAW-BALE CONSTRUCTION IN GAROUA, CAMEROON

Garoua, a city located in northern Cameroon, faces significant challenges related to housing shortages, rising energy costs, and environmental degradation. The region's hot and dry climate makes energy-efficient building designs critical for reducing cooling costs and improving living conditions. Straw-bale construction offers a practical and sustainable solution to these challenges.

➢ *Design Proposal*

- *Straw-Bale Walls:* The proposed design features thick straw-bale walls that provide excellent insulation against the heat. These walls would be plastered with natural materials like clay or lime to enhance durability and create a weatherproof barrier.
- *Passive Cooling Systems:* To minimize the need for mechanical air conditioning, the house design incorporates passive cooling techniques such as cross-ventilation, shading, and thermal mass strategies.
- Solar Power Integration: Solar panels can be installed on the roof to generate electricity, further reducing the house's reliance on non-renewable energy sources.
- Rainwater Harvesting: A rainwater harvesting system can be included to collect and store water for irrigation and household use, reducing the demand on municipal water supplies.

This design addresses the environmental, economic, and social challenges faced by communities in Garoua, offering an affordable and eco-friendly alternative to conventional housing.

VI. CHALLENGES OF STRAW-BASED CONSTRUCTION IN CAMEROON

While straw-bale construction offers many advantages, several challenges must be addressed for its successful implementation in Cameroon:

➢ *Moisture Management:*

Straw is vulnerable to moisture, which can lead to mold and structural decay if not properly protected. In regions with high humidity or heavy rainfall, special care must be taken to ensure adequate waterproofing and ventilation (Lawrence, 2009).

➢ *Building Codes and Regulations*

In many countries, including Cameroon, building codes have not yet been updated to accommodate alternative building materials like straw. This regulatory gap may pose obstacles to

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the widespread adoption of straw-bale construction (Chen, 2012).

- *Lack of Skilled Labor*

Straw-bale construction requires specific skills and techniques that are not widely practiced in Cameroon. Training programs for architects, builders, and laborers would be necessary to develop the expertise required for straw-based projects (King, 2006).

- *Social Acceptance*

There may be resistance to the use of straw in modern construction due to perceptions of it being a "primitive" material. Educational campaigns and demonstration projects can help change public perceptions and showcase the benefits of straw-bale construction.

VII. FUTURE PROSPECTS FOR ECO-SUSTAINABLE CONSTRUCTION IN CAMEROON

The future of eco-sustainable construction in Cameroon is promising, particularly with the growing global focus on reducing carbon emissions and promoting resource efficiency. By embracing eco-sustainable materials like straw, Cameroon can develop affordable, energy-efficient housing solutions that align with international sustainability goals.

To achieve this, the government must take steps to update building codes, provide incentives for sustainable construction, and invest in training programs to equip local builders with the skills needed to work with alternative materials. Educational campaigns that highlight the environmental and economic benefits of eco-sustainable construction will also be crucial in gaining public support.

Furthermore, the success of eco-sustainable construction in Cameroon will depend on collaboration between architects, engineers, policymakers, and local communities. By working together, stakeholders can create innovative solutions that address the country's housing challenges while promoting environmental responsibility.

VIII. CONCLUSION

Straw presents a viable and sustainable building material for the future of construction in Cameroon. Its thermal properties, low embodied energy, local availability, and affordability make it an ideal choice for regions like Garoua, where the demand for energy-efficient housing is high. While challenges such as moisture management and regulatory barriers exist, the benefits of straw-bale construction far outweigh the obstacles.

By integrating straw into contemporary architecture, Cameroon can lead the way in eco-sustainable construction in Africa, creating buildings that are not only environmentally friendly but also culturally relevant and economically accessible. The time has come for Cameroon to embrace the potential of straw and other eco-sustainable materials, paving the way for a greener, more sustainable future.

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