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EVALUATING THE PERFORMANCE AND ENVIRONMENTAL IMPACT OF GAUCRETE BRICKS AS A CONSTRUCTION MATERIAL FOR HOUSING

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Abstract:

The construction industry has been facing increasing pressure to adopt sustainable and eco-friendly building materials to address global environmental concerns such as resource depletion and climate change. This research paper examines the performance and environmental impact of Gaucrete bricks, a low-cost and innovative construction material made from agricultural waste. The study aims to evaluate the potential of Gaucrete bricks as a viable and sustainable solution for housing development.

Key Words: Eco-Friendly, Construction, Material, Housing

1. Introduction:

The construction industry has long been recognized as a significant contributor to various environmental issues, including resource depletion, waste generation, and greenhouse gas emissions [1]. As global concerns about climate change and environmental degradation intensify, there is a growing need for the industry to adopt sustainable and eco-friendly building materials and practices. One such material that has garnered attention in recent years is Gaucrete bricks, an innovative construction material made from agricultural waste. Gaucrete bricks have the potential to address several environmental challenges while also providing an affordable solution for housing development, particularly in rural and low-income areas [2]. The primary objective of this research paper is to evaluate the performance and environmental impact of Gaucrete bricks as a low-cost, eco-friendly construction material for housing. The study aims to provide a comprehensive analysis of Gaucrete bricks, encompassing their mechanical, physical, and thermal properties, as well as their environmental impact through life cycle assessment. Furthermore, the paper will explore low-cost housing solutions that utilize Gaucrete bricks and examine relevant policies, regulations, and market development factors that could promote the widespread adoption of this sustainable building material [3].

To evaluate the performance of Gaucrete bricks, various mixtures of cow dung, mud, and hydrated lime are prepared and tested. The samples are created by mixing the components in predetermined proportions and then molding them into bricks using a manual or hydraulic press. The bricks are air-dried for a specified period before being subjected to laboratory tests to assess their mechanical, physical, and thermal properties [4]. The compressive strength test is an essential measure of a brick's ability to withstand compressive loads. The test is conducted using a compression testing machine, where the brick is placed between two rigid plates, and a gradually increasing load is applied until the brick fails or breaks [5]. The maximum load applied is divided by the cross-sectional area of the brick to calculate the compressive strength. The results are compared across different mixtures to determine the optimal proportions for achieving the desired compressive strength [6]. The water absorption test evaluates the brick's ability to absorb water, which can impact its durability and performance. The brick is first weighed in a dry state (initial weight) and then submerged in water for a specified period (usually 24 hours). After submersion, the brick is removed, wiped to remove excess surface water, and weighed again (final weight) [7]. The water absorption is calculated as the percentage increase in weight compared to the initial weight. The test results are analyzed to identify the mixture with the best balance between strength and water resistance [8]. Thermal properties, such as thermal conductivity and specific heat capacity, are crucial factors affecting the insulation performance of bricks. To assess these properties, various tests can be conducted, such as the guarded hot plate method for thermal conductivity or the calorimeter method for specific heat capacity [9]. These tests involve measuring heat transfer rates and temperature changes under controlled conditions to calculate the thermal properties of the bricks. The results are compared across different mixtures to determine the optimal composition for achieving the desired insulation performance [10].

2. Aim:

The aim of the research on eco-friendly and natural construction materials, specifically Gaucrete Bricks, is to investigate their feasibility, sustainability, and potential benefits for housing construction. The research aims to assess the environmental impact of Gaucrete Bricks compared to conventional materials, such as concrete or clay bricks, by analyzing factors like carbon emissions, resource utilization, and waste generation. Additionally, the research seeks to evaluate the energy efficiency of Gaucrete Bricks and their insulation properties to understand their potential for reducing energy consumption in buildings.

3. Objectives:

- Study the manufacturing process of building materials made from cow dung.
- To analyze the efficient use of cow dung as a building material.

4. Methodology:

Conduct an extensive review of existing research, publications, and case studies related to Gaucrete Bricks, their properties, production techniques, and applications. This will help establish a solid foundation for the study and identify knowledge gaps that need to be addressed. Collect cow dung, mud, and hydrated lime samples from various sources to ensure a representative sample. Prepare different mixtures with varying proportions of the components to determine the optimal mix for desired properties. Conduct laboratory tests to assess the physical, mechanical, and thermal properties of the prepared Gaucrete Bricks samples. Tests may include compressive strength, water absorption, density, and thermal conductivity measurements. Analyze the results to identify the best-performing mixtures and correlate the properties with the composition.

4.1 Material Used:

The optimal proportion of cow dung, mud, and hydrated lime for making good Gaucrete Bricks can vary depending on the specific properties of the materials used, as well as the desired performance characteristics of the bricks. However, a general guideline for the mixture proportions could be as follows:

- Cow dung: 40-60% - Cow dung provides the organic matter and fibrous structure that helps bind the other components together, as well as contributes to the thermal insulation properties of the bricks.
- Mud (soil): 30-50% - Mud, which typically consists of a mixture of clay, silt, and sand, serves as the primary filler material in the bricks, providing bulk and strength to the mixture.
- Hydrated lime: 5-15% - Hydrated lime acts as a stabilizer and binder, improving the overall strength, durability, and water resistance of the bricks.

4.2 Study Area: Sheela by Pass, Rohatk

5. Test Report:

MICRO ENGINEERING & TESTING LABORATORY
(An ISO 9001:2015, ISO 14001:2015 and IS/ISO/IEC-17025:2017 Certified Laboratory)

Office: I-4, First Floor, Mukund House, Azadpur, Delhi-110033 T: 27678188, 80 | M: +91 9871143785
Laboratory: Plot No. 43, HSIDC, Indl. Estate, Rai, Sonepat, Haryana-131029 T: 0130 4017631 | M: +91 9215515652
Email/Website: info@metl.co.in, metlsonit@yahoo.com, www.metl.co.in

TEST REPORT

Description of Sample: Bricks (Cow Dung)

Report No. METL/20-21/047/0003/51
Date of Report: 01/03/2021
Date of Testing: 17-02-01/03/2021
Date of Receipt: 16/02/2021

Issued to:

M/s GAUCRETE VEDIC BHAWAN
SHEELA BYEPASS, ROHTAK (HARYANA)

1. Compressive Strength:

S. No.	Compressive Strength (Small) N/mm²	Compressive Strength (Big) N/mm²	Method of test
1.	11.0	2.0	IS-3495 (P-1) 2019
2.	4.80	2.2	
3.	3.9	2.8	

2. Water Absorption:

S. No.	Water Absorption % age w/w	Water Absorption % age w/w	Method of Test
1.	12.4	17.3	IS-3495 (P-2) 2019
2.	14.2	19.0	
3.	14.7	18.5	

3. Efflorescence

S. No.	Test Result	Test Result	Method of Test
1.	Nil	Nil	IS-3495 (P-3) 2019
2.	Slight	Slight	
3.	Nil	Nil	
4.	Slight	Slight	
5.	Nil	Nil	

4. Dimensions

S. No.	Dimension measured in mm			Method of Test
1.	Length of 5 bricks	1145	1487	IS-1077-1992 Reaff-2016
2.	Width of 5 bricks	575	740	
3.	Height of 5 bricks	380	476	
5.	Thermal Conductivity, W/m.k	----	0.11	IS: 3346-1980
6.	Fire Resistance up to 350 °C	No Combustable	No Combustable	BS 476 (P-20)
7.	Weight by 1 Brick, gm	1780	3418	-----
8.	Density, Kg/m³	890	855	IS: 13630 (P-2)

End of Report

Authorised Signatory

Terms & Conditions
1. The result listed refer only to the tested samples and applicable parameters endorsement of product is neither inferred nor implied.
2. Total liability of our Lab. is limited to the invoiced amount.
3. Samples will be destroyed after 60 Days from the date of issue of test report.
4. This report is not be reproduced wholly or in part and cannot be used as an evidence in the court of law and should not be used in any advertising media without our special permission in writing.

UABI

Figure 1: Test Report of Gaucrete bricks

To ensure the quality, durability, and safety of Gaucrete bricks, made from cow dung, mud, and hydrated lime, a series of rigorous tests have been conducted according to international and Indian standards. These tests have included IS 3495 (Part 1), IS 3495 (Part 2), IS 3495 (Part 3), IS 1077, IS 3346-1980, BS 476(P-20), and IS 13630 (P-2). Each of these tests has assessed a different characteristic of the bricks. IS 3495 (Parts 1, 2, and 3) tests verified the bricks' water absorption, efflorescence, and compressive strength, demonstrating their durability and suitability for construction purposes. The IS 1077 test confirmed that the bricks meet the requirements for common burnt clay building bricks, including size, shape, and strength standards. All this test down by Micro Engineering & testing laboratory and figure 1 shows test results.

In the IS 3346-1980 test, the hardness of the Gaucrete bricks was evaluated, ensuring their resistance to wear and tear. The BS 476(P-20) test examined the bricks' fire resistance, an essential safety measure for any building material. Lastly, the IS 13630 (P-2) test determined the bricks' water absorption, apparent porosity, apparent relative density, and bulk density, further verifying their physical properties and durability. The results of all these tests have been positive, indicating that Gaucrete bricks meet or exceed the standards for quality, strength, safety, and durability. The detailed test reports, which provide further information on the methods and results, are attached for reference. These comprehensive tests offer confidence in the performance and environmental benefits of Gaucrete bricks as a sustainable and effective building material.

6. Results:

At Initial stage diligently mixing the raw materials in a large container, ensuring a proper blend of cow dung, mud, and hydrated lime as per seen in figure 2. With focused determination, meticulously add water to the mixture, achieving a dough-like consistency that can be easily molded.

Figure 2: Initial stage diligently mixing the raw materials

The process of making Gaucrete bricks, a sustainable building material created by combining cow dung, mud, and hydrated lime. The figure 3 shows the hands-on approach, as the worker transfer the well-mixed material into brick molds or wooden frames, compacting it evenly to create the desired shape and density. As the process continues, the subsequent stages of drying and curing, emphasizing the importance of careful handling and protection from excessive moisture. The overall scene conveys the eco-friendly nature of Gaucrete brick production and highlights the human effort involved in creating these sustainable construction elements.

Figure 3: Transfer of the well-mixed material into brick molds

During the initial drying process, the freshly molded Gaucrete bricks are placed in a designated area to begin the evaporation of moisture. The bricks are carefully arranged in rows or stacks, allowing air to circulate around them. This stage is crucial to reduce the water content within the bricks, enhancing their strength and stability. The bricks in their semi-wet state, with visible signs of moisture on their surfaces. The drying area is typically shaded or covered to protect the bricks from direct sunlight, which could lead to rapid drying and potential cracking. This controlled environment ensures a gradual and uniform drying process, promoting the development of a solid structure. As shown in figure 4 the initial phase of transformation as the bricks gradually lose moisture, setting the foundation for subsequent curing and final drying stages.

Figure 4: Initial drying process of Gaucrete bricks

Gaucrete bricks present a low-cost alternative for housing construction, especially in rural and low-income areas. The materials required for the production of Gaucrete bricks, such as cow dung, mud, and hydrated lime, are abundant, locally available, and inexpensive compared to conventional construction materials like cement or clay. Furthermore, the manufacturing process of Gaucrete bricks is energy-efficient and can be carried out using simple, low-cost equipment or even manual labor. Figure 5 shows Gaucrete bricks used constructed building.

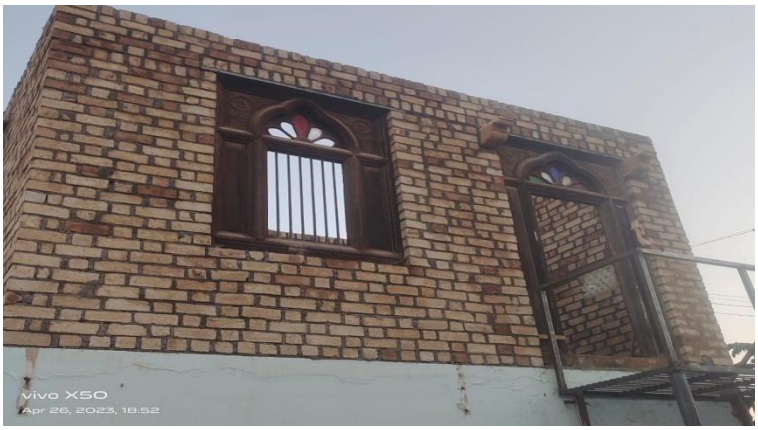

Figure 5: Home made by using Gaucrete bricks(Eco-Friendly Construction Material)

Sources: Clicked by Research Scholar

6. Conclusion:

Gaucrete bricks have emerged as a promising eco-friendly and low-cost construction material for sustainable housing development. Through a comprehensive analysis of their properties, production techniques, applications, and environmental impact, it is evident that Gaucrete bricks offer significant benefits for the construction industry and the environment.The performance evaluation of Gaucrete bricks demonstrates their satisfactory mechanical strength, water absorption characteristics, and thermal properties. These bricks can provide reliable structural integrity while offering good insulation and thermal efficiency, contributing to energy savings and improved indoor comfort.

Furthermore, the environmental impact assessment reveals that Gaucrete bricks have a lower carbon footprint compared to conventional building materials. By utilizing agricultural waste and reducing resource consumption, Gaucrete bricks help mitigate environmental concerns such as waste generation, deforestation, and greenhouse gas emissions. They also offer an opportunity for waste management and sustainable utilization of cow dung.Low-cost housing solutions using Gaucrete bricks present an affordable alternative for housing development, particularly in rural and low-income areas. The availability of local resources, the low production costs, and the simplicity of manufacturing techniques make Gaucrete bricks an accessible option for cost-

effective housing construction.However, for the widespread adoption of Gaucrete bricks, supportive policies, financial incentives, and market development efforts are crucial. Governments should implement regulations that encourage the use of eco-friendly construction materials, provide financial support to builders and homeowners, and promote awareness through education and outreach initiatives. Developing a robust supply chain and fostering collaborations among stakeholders are essential for the sustainable growth of the Gaucrete bricks industry.

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