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"BIO-BRICKS - DEVELOPMENT OF SUSTAINABLE AND COST-EFFECTIVE BUILDING MATERIALS"

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ABSTRACT:

"This study explores the creation of Bio-Bricks, a sustainable and economical building material made from abundant agricultural waste such as rice husk and sugarcane bagasse. By combining experimentation with engineering analysis, the research assesses the structural and thermal properties of Bio-Bricks. The methodology involves sourcing raw materials, applying processing techniques, and developing Bio-Brick prototypes. Mechanical testing and thermal conductivity evaluations determine the material's suitability for construction. Additionally, environmental impact assessments measure the ecological benefits of using agricultural waste in building material production. Results show promising mechanical strength and thermal insulation properties, positioning Bio-Bricks as a viable and sustainable alternative to conventional construction materials. The study highlights economic advantages, contributing to the overall sustainability of the construction industry. Life cycle assessments reveal the reduced carbon footprint associated with Bio-Bricks, emphasizing their role in promoting environmentally conscious construction practices. In summary, this research presents an innovative approach to sustainable construction, offering insights into the broader implications of integrating agricultural waste into building material production. The findings advance the field of sustainable architecture and advocate for the widespread adoption of Bio-Bricks as a practical solution for environmentally responsible and cost-effective construction."

Keywords: Sustainability, Bio-Bricks, new product development

Introduction:

In response to escalating global environmental challenges, there has been a heightened emphasis on developing sustainable and cost-effective building materials. One promising innovation at the forefront of this movement is the emergence of Bio-Bricks. Leveraging abundant agricultural waste, such as rice husk and sugarcane bagasse, these Bio-Bricks signify a transformative potential in redefining the construction landscape. This exploration delves into their development, aiming to contribute to a more eco-friendly and economically viable approach to building materials.

Sustainable Material Production

The utilization of agricultural by-products, specifically rice husk and sugarcane bagasse, as primary components for Bio-Bricks is the cornerstone of this study. Beyond the immediate goal of addressing waste management concerns, this endeavor seeks to create a sustainable, efficient, and environmentally conscious alternative to traditional construction materials. By tapping into these bio-based resources, the study aims to showcase a tangible pathway towards reducing the ecological footprint associated with construction activities.

Unveiling the Impact and Potential

As the investigation unfolds, Bio-Bricks take center stage, revealing not only their structural attributes and thermal properties but also the broader impact they could have on fostering sustainable and cost-effective construction practices. The advent of Bio-Bricks represents a significant departure from traditional construction materials, which often rely heavily on non-renewable resources and generate substantial amounts of waste. By utilizing agricultural by-products that would otherwise be discarded or burned, Bio-Bricks offer a promising solution to both waste management challenges and the need for sustainable building materials. Moreover, the production process of Bio-Bricks is inherently more environmentally friendly compared to traditional materials. The manufacturing of conventional bricks, for example, typically involves the firing of clay at high temperatures, leading to significant energy consumption and greenhouse gas emissions. In contrast, Bio-Bricks can be produced using low-energy processes, such as compression or fermentation, resulting in a reduced carbon footprint.

Beyond their environmental benefits, Bio-Bricks also hold great promise in terms of cost-effectiveness. With the abundance of agricultural waste available in many regions, the raw materials for Bio-Bricks are often readily accessible and inexpensive. Additionally, the manufacturing processes for Bio-Bricks can be streamlined and automated, further reducing production costs. As the global construction industry continues to grapple with the challenges of sustainability and affordability, the emergence of Bio-Bricks offers a ray of hope. By harnessing the potential of agricultural waste, these innovative building materials have the power to revolutionize the way we build, paving the way for a greener and more economically viable future.

Methodology:

1. **Material Preparation**: Obtain clay, Rice Husk Ash (RHA), and sugarcane bagasse. Mix varying proportions of RHA with clay, spanning from 10% to 80% RHA content, incorporating sugarcane bagasse as well. Ensure thorough blending to achieve uniformity in the mixture
2. **Brick Formation**: Utilize standard brick-making techniques to form bricks from the prepared mixtures. Employ moulds and compaction methods consistent with industrial practices to maintain uniformity in brick size and shape across different mix ratios
3. **Field Testing**: Deploy a sample set of bio-bricks to construction sites or simulated field conditions. Subject these bricks to real-world stresses such as load-bearing, exposure to weather elements, and temperature fluctuations to assess their performance in practical applications.
4. **Laboratory Testing:**
   - **Compressive Strength Test**: Conduct standardized compression tests using a universal testing machine to measure the load-bearing capacity of bio-bricks. Apply progressively increasing loads until failure occurs, recording the maximum load sustained by each brick
   - **Water Absorption Test**: Immerse bio-brick samples in water for a specified duration, then measure their weight before and after immersion to quantify water absorption. This test evaluates the bricks' resistance to moisture penetration.
   - **Durability Assessment**: Expose bio-bricks to accelerated aging conditions in a controlled laboratory environment. Simulate freeze-thaw cycles, humidity variations, and chemical exposure to evaluate their long-term durability and resistance to degradation
   - **Dimensional Stability Test**: Measure changes in dimensions of bio-bricks over time under varying environmental conditions. Assess dimensional stability to ensure structural integrity and compatibility with construction standards
5. **Data Collection and Analysis**: Record observations and measurements from both field and laboratory tests. Analyze the data to assess the impact of RHA proportions on the strength, durability, and overall performance of bio-bricks
6. **Optimization and Refinement**: Based on the test results, refine the mixture proportions of RHA, clay, and sugarcane bagasse to optimize bio-brick properties. Identify optimal mix ratios that balance strength, durability, and cost-effectiveness for potential large-scale production and commercial use.
7. **Conclusion and Recommendations**: Draw conclusions regarding the feasibility and effectiveness of utilizing RHA and sugarcane bagasse in bio-brick production. Provide recommendations for further research or improvements to enhance the performance and sustainability of bio-bricks in construction applications

Objective:

1. Evaluate the compressive strength of bricks with varying proportions of Rice Husk Ash (RHA) and sugarcane bagasse to assess their structural integrity and load bearing capacity.
2. Analyse the water absorption rate of bricks incorporating different percentages of RHA to determine their resistance to moisture and potential for durability.
3. Investigate the thermal conductivity of bricks with RHA and sugarcane bagasse to understand their insulation properties and suitability for thermal regulation in buildings.
4. Assess the density of bricks containing RHA and sugarcane bagasse to gauge their weight and potential implications for transportation and construction.

Results

a) Shape and Size

The shape of the bio bricks, as per the dimensions provided (19 x 19 x 9 cm and 24 x 12 x 8 cm), can be described as follows:

1. Both bio bricks have a rectangular prism shape, with three pairs of congruent faces.
2. As for the IS code reference, IS 1077:1991 is a standard by the Bureau of Indian Standards titled "Common Burnt Clay Building Bricks - Specification." While it doesn't specifically mention "bio bricks," it provides specifications for common burnt clay bricks, which might be applicable depending on the composition and manufacturing process of the bio bricks002E

b) Structure

1. Homogeneous Composition: Bio bricks have a uniform structure throughout their composition. This means that the materials used to make bio bricks are mixed and distributed evenly, resulting in consistent properties and characteristics across the entire brick
2. Adherence to Standards (IS 1077:1991): Bio bricks are manufactured in accordance with the standards outlined in IS 1077:1991. This ensures that the bricks meet specific quality and performance requirements set by the Indian Standards Institute, providing assurance of reliability and suitability for various construction applications.

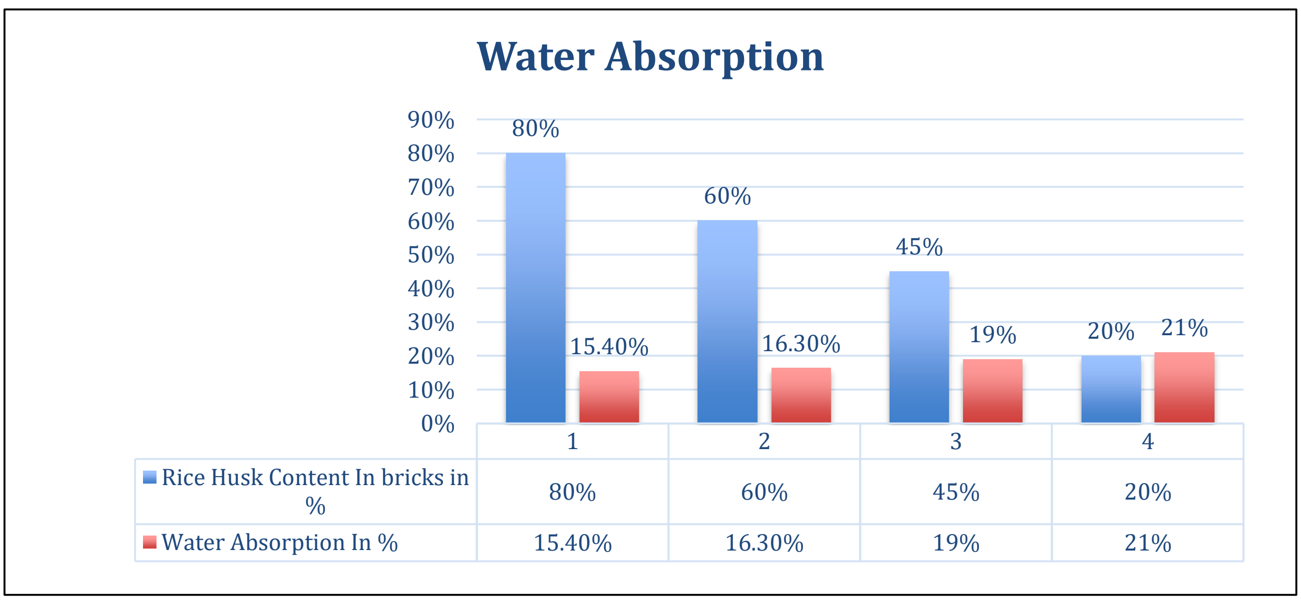
c) Sound

1. **Ringing Sound**: Bio bricks produce a distinctive ringing sound when struck, indicating their quality and integrity. This ringing sound is a characteristic feature of well-made bricks and is often used as an indicator of their strength and durability.
2. **Consistency and Standardization**: The ringing sound of bio bricks is consistent and standardized according to the guidelines specified in IS 1077:1991. This means that the sound produced by bio bricks adheres to certain predetermined criteria, ensuring uniformity and reliability in their quality assessment during manufacturing and construction processes

1. Bio-Bricks from Rice husk

Sr. No.	Mixture= Rice Husk+ Lime Slurry	Weight (gms)	Compressive Strength (N/mm2)	Structure	Shape & Size (cm)	Soundness test
1	80% + 15% + 5%	1900	9.01	Homogeneous	Rectangular with sharp edges 24x12x8	Clear ringing sound
2	60% + 25% + 15%	1800	8.5	Homogeneous	Rectangular with sharp edges 24x12x8	Clear Ringing Sound
3	45 % + 35% + 20%	1750	7.2	Homogeneous	Rectangular with sharp edges 24x12x8	Clear Ringing Sound
4	60% + 30% + 10%	1590	5.6	Small Lumps/fluffy	-	No sound

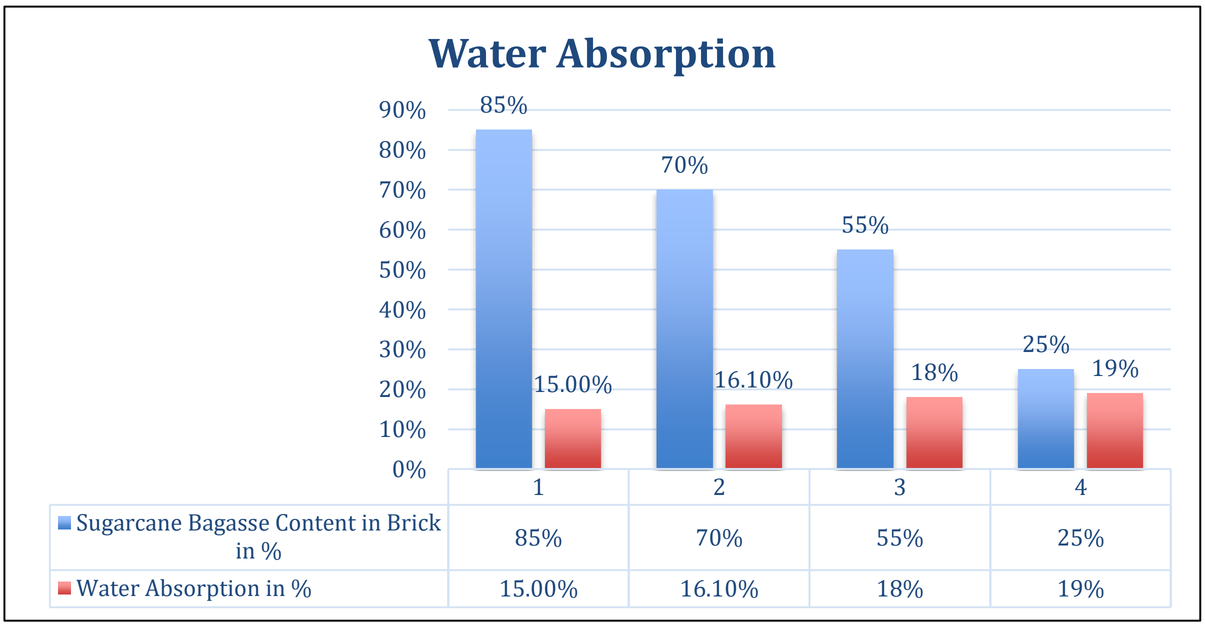
Water Absorption Readings



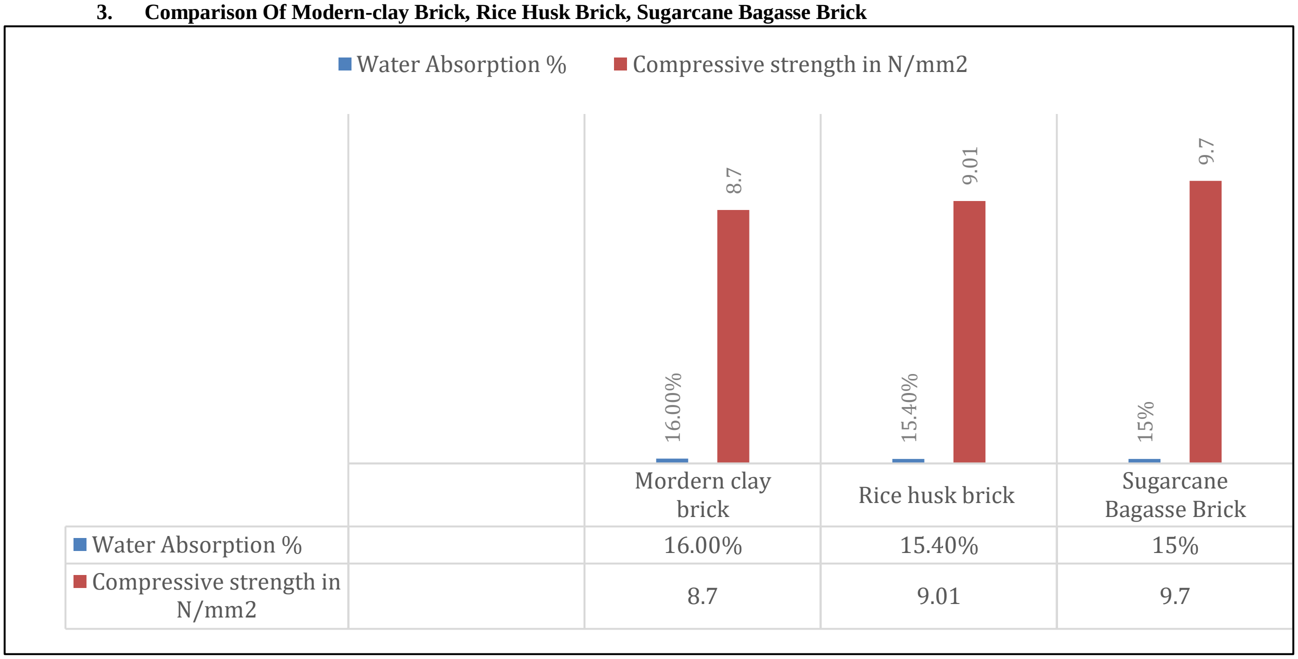
2.Bio Bricks from Sugarcane Bagasse

Sr. No	Mixture = Rice Husk+ Lime Slurry+ Cement	Weight (gms)	Compressive Strength (N/mm2)	Structure	Shape & Size (cm)	Soundness test
1	85%+10% + 5%	2000	9.7	Homogeneous	Rectangular with sharp edges 24x12x8	Clear Ringing
2	70% + 20% + 10 %	1900	8.6	Homogeneous	Rectangular with sharp edges 24x12x8	Clear Ringing
3	55 % + 35% + 10%	1820	7.44	Homogeneous	Rectangular with sharp edges 24x12x8	Clear Ringing
4	25% + 60% + 15%	1650	6.3	Small Lumps/fluffy	-	No sound

Water Absorption



3. Comparison Of Modern-clay Brick, Rice Husk Brick, Sugarcane Bagasse Brick



Conclusion

1. **Cost-Effectiveness**: Bio bricks, made from rice husk and sugarcane bagasse, are priced at 4.50 Rs and 4 Rs per unit, respectively, offering a more affordable option compared to modern clay bricks priced at 6.50 Rs.
2. **Strength and Durability**: Despite their organic composition, bio bricks demonstrate superior strength and durability, ensuring reliable performance in construction projects, even in challenging environments.
3. **Sustainability**: Utilizing agricultural waste materials like rice husk and sugarcane bagasse reduces waste accumulation and environmental impact, aligning with sustainable construction practices.
4. **Versatility**: Bio bricks offer versatility in design and application, accommodating various construction needs while promoting eco-friendly building methods
5. **Economic Benefits**: Incorporating bio bricks into construction projects not only saves costs but also supports green building initiatives, contributing to a more sustainable and economically viable construction industry.
6. **Thermal Insulation**: Bio bricks can provide improved thermal insulation properties compared to traditional clay bricks, enhancing energy efficiency in buildings and reducing heating and cooling costs.
7. **Fire Resistance**: Depending on their composition and additives, bio bricks can exhibit enhanced fire resistance, ensuring safety and compliance with building regulations.
8. **Sound Absorption**: The porous nature of bio bricks can contribute to better sound absorption, creating quieter and more comfortable indoor environments.
9. **Community Engagement**: Supporting the use of bio bricks can foster community engagement and collaboration, promoting awareness of sustainable construction practices and encouraging local innovation in waste management and recycling. List all the material used from various sources for making this project proposal

REFERENCES

1. Effect of Rice Husk and Rice Husk Ash to Properties of Bricks Published on , Sciverse ScienceDirect | Issue: 10 Nov 2012 Published by , J. Sutas, A. Mana , L. Pitak
2. Agro–industrial wastes as sustainable resource for the production of bricks Published on, Med crave | Volume 4 | Issue on : 5 Jan 2017 Published by, Yasodha Thirumal
3. Eco-friendly fired clay brick manufactured with agricultural solid waste Published on , ScienceDirect | archives of civil and mechanical engineering |Volume 18 | 4 sept 2018 Published by, Olga Kizinievič, Viktor Kizinievič, Ina Pundiene, Dainius Molotokas
4. An Experimental Study on the Strength & Characteristics of Eco-Bricks from Garbage Dump, Published on, International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS) | Volume VII, Issue IV, April 2018 Published by, S. Madan Raj, M. Nandha Gopal, T. Palani Kumar, G. Guru Prasath, Sofia Rajesh M.E
5. Development of Sustainable Brick Materials Incorporating Agro-Wastes: Published on, International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 11 | Nov 2018 Published by, Andrea Treasa Figaredo, Mary Dhanya.
6. Bio-Brick - Development of Sustainable and Cost Effective Building Material Published on, Proceedings of the Design Society International Conference on Engineering Design | July 2019 Published by, Priyabrata Rautray, Avik Roy, Deepak John Mathew, Boris Eisenbart
7. REVIEW OF SUSTAINABLE BUILDING MATERIALS FOR CONSTRUCTION INDUSTRY Published on, International Journal of Technical Research & Science | July 2020 Published by, Satyam Kumar, Vishal Puri, M. L. Aggarwal.
8. Study on properties of Bio-Bricks. Published on, International Research Journal of Engineering and Technology (IRJET) Volume: 06 | Sept 2021 Published by, Poornima Venkatraman, R. Venkatasubramani, Pavan Chandrasekar
9. Bio-bricks: Circular Economy and New Products Published on, Researchgate.net | April 2021 Published by, Priyabrata Rautray, Avik Roy, Deepak John Mathew, Boris Eisenbart
10. Processing and Characterization of Novel Bio-bricks Hybrid Brick Composite for Pollution Control Published on, Hindawi | 2022 Published by, Naresh Kumar, Piyush Gaur, S. Kaliappan, L. Natrayan, S. Socrates, Pravin P. Patil,and Subash Thanappan
11. A Sustainable Reuse Of Agro-Industrial Wastes into Green Bricks Published on, 22 Feb 2022 Published by, by Wei Quan Chin , Yeong Huei Lee , Mugahed Amran , Roman Fediuk , Nikolai Vatin , Ahmad Beng Hong Kueh and Yee Yong Lee
12. Agricultural And Industrial Wastes for Bio Bricks A Critical Review Published on, International Research Journal of Modernization in Engineering Technology and Science Volume: 04 | Issue:12 | December-2022 Published by, Vinodkumar Kolli, Tejesh Chandra R, Shweta IS, Vani, Dr. R. Shanthi V
13. APPLICATION OF BIO-BRICKS & ITS BENEFITS Published on, INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN | July 2023 Published by, Rautray, Priyabrata ; Roy, Avik ; Eisenbart, Boris
14. Bio Bricks: A Sustainable Solution for Environmental Conservation – Inspire Award Project Published on, August 2023 Published by, Sowmya

15. Analysis of compressive strength and water absorption of bricks made up of agrowaste (rice straw) material. Published on, AIP Conference Proceedings | Volume 2721 | July 2023 Published by, Dwivedi, Vijay Kumar, Parashar, Arun Kumar, Yadav, Rajat, Islam, Ana.