Manufacturing of Organic Brick Using Saw Dust and Rice Husk- A Review

Aquib Zafar Ansari [1], Aastha Nagdawane [2], Mitali Meshram [3], Tashif Hussain[4], Vinit Galphat[5]

[1] Aquib Zafar Ansari, Assistant Professor, ACET Sadar, Nagpur, Maharashtra, India

[2] Aastha Nagdawane, Student Of Graduation, ACET Sadar, Nagpur, Maharashtra, India.

[3]Mitali Meshram, Student Of Graduation, ACET Sadar, Nagpur, Maharashtra, India.

[4]Tashif Hussain, Student Of Graduation, ACET Sadar, Nagpur, Maharashtra, India.

[5]Vinit Galphat, Student Of Graduation, ACET Sadar, Nagpur, Maharashtra, India.

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Abstract - Today Researchers worldwide are focusing on finding ways to use waste from industries and agriculture in the construction industry. This can be both cost-effective and help create a sustainable and clean environment. The main goal of this is to develop eco-friendly and energy-saving bricks using saw dust ash and rice husk ash. These are by-products from the furniture shop and rice grinding mills, respectively. The waste materials were analyzed for their chemical composition partical size distribution. In this study, the bricks were produced by mixing a specific proportion of saw dust ash (SDA),rice husk ash(RHA) and clay. The experimental results showed that these bricks are lighter, durable, environmentally friendly, and have increased strength due to their pozzolanic properties. They also have reduced permeability because of pore refinement.
KEYWORDS: Rice Husk Ash (RHA), Saw Dust Ash (SDA).

1.INTRODUCTION

Due to rapid population growth and industrialization, in this study, the bricks were produced by mixing a specific proportion of saw dust ash (SDA), rice husk ash (RH) and clay. Clay bricks that are available may not meet the desired quality standards. They might have lower compressive strength, higher water absorption, high efflorescence, increased wastage during transportation and handling, and uneven surfaces. These challenges have prompted engineers to explore alternative materials that can help reduce the overall cost of construction. Organic brick is a new circular housing construction component, created using entirely. reusable, recyclable materials taken from the local terrain. Rice husk and sawdust are abundant agricultural by-products, often considered waste materials with limited utilization. However, through innovative manufacturing processes, these materials can be transformed into high-quality building components, contributing to resource efficiency and waste reduction. Clay, a traditional building material, serves as a binding agent, enhancing the structural integrity and durability of organic bricks. organic bricks offer favorable thermal insulation properties, contributing to energy efficiency and indoor comfort in buildings. Their lightweight nature facilitates ease of handling and transportation, reducing construction time and costs. Despite the promising advantages of organic bricks, there remain challenges related to standardization, performance optimization, and widespread adoption in the construction industry. This review paper aims to provide a comprehensive overview of the manufacturing process, material properties, environmental impact, and potential applications of organic bricks made with rice husk and sawdust.

2. LITERATURE SURVEY

There are lots of researches done on bricks, local construction Materials, reuse of industrial wastes, environment sustainability which are studied well before fixing the objectives, aims and route map to achieve the goal of research. The research gap is Identified after the intensive literature review and decided to Put an effort on contributing something to environment and to safeguard the depleting resources by developing energy efficient eco-friendly bricks using industrial waste. Some of the studies by previous researchers are discussed below.

1. Amos Y. Iorliam, John T. Tile et al. -2023.

In this review paper, researcher studied about finding cheaper and more sustainable materials for making bricks instead of using expensive industrial stabilizers like cement or lime. They wanted to see if they could use a mixture of saw dust ash (SDA) and rice husk ash (RHA) to treat Makurdi clay and make burnt bricks for building structures. They tried different percentages of the SDA and RHA mixture. when they used a higher percentage of the waste mixture, the strength of the bricks decreased. So, using a combination of SDA and RHA can be a good alternative for making stronger and more affordable bricks. the production cost of traditional materials like sand Crete, soil cement, and soil lime bricks has been high because of the rising cost of cement and lime. Both are cheaper and more environmentally friendly. studies have shown that sawdust ash (SDA) and rice husk ash (RHA) contain calcium oxide (CaO), which can help cement soil and improve its strength.

2. Ms. Divya R. Jain et al. -2021.

Recycling waste materials such as fly ash, marble sludge, granite sludge, stone sludge, ceramic sludge, plastic, coal, wheat bran, sawdust, sugarcane bagasse (SBA), rice husk ash (RHA), residual coal, etc., undergo tests for brick properties such as compressive strength, soundness, hardness, and water absorption. Eco-bricks outperform traditional bricks, reducing soil erosion by repurposing industrial waste sludge (i.e., wastewater sludge). Boiler ash from thermal power plants and paper mills is also utilized. Various materials are employed to create eco-bricks, yielding positive outcomes. It's noted that the

28-day cylinder compressive strength is nearly 90% of the cube strength, exceeding that of OPC-based concrete. Compressive strength is assessed for different ratios of fly ash partially replacing cement (8:2, 4:6, 6:4, and 2:8) after 28 days of curing. Thus, we can affirm that the utilization of Eco-Bricks is cost-effective, energy-efficient, and commercially viable.

3. G. Grassi1, A. Erken, et al. - 2021.

In this review paper researcher explores the potential of customized 3D clay bricks as a sustainable building material, utilizing eco-friendly resources sourced from recycled materials. Four different fiber types were examined alongside various clay treatments, with specimens tested for compression strength and ductility. Experimentation aimed to determine the most effective fiber type and size for enhancing compression strength. Additionally, water absorption of the bricks was assessed. Researcher aim is to develop a simple, affordable, and rapid method for printing standardized clay bricks as components of a facade system with integrated evaporative cooling capabilities. This study explored the viability of 3D printing using earth, specifically clay bricks, demonstrating its potential for topological and cost optimization. By incorporating recycled PP fibers, the printed material showcased improved durability and mechanical properties. In comparison to conventional bricks, this method reduces material usage and increases exposure to the environment, facilitating better moisture dissipation. Additionally, substituting fibers with natural alternatives like bamboo or hemp could enhance mechanical properties while promoting sustainability.

4. Anusuri. Uma Maheshwari, et al. - 2020.

The researcher has studied that the rice husk is added up to 20% to clay, the strength gradually diminishes, and beyond the addition of 20% Rice Husk, the compressive strengths decrease rapidly. The optimal ratio for (RH + Clay) bricks was found to be 20% Rice Husk and 30% Clay. As the percentage of RHA increased, the water absorption of RHA-Clay bricks also increased. This brick manufacturing process can mitigate the environmental impact of wastes and alleviate disposal issues associated with waste. Utilizing rice husk in brick production can address the disposal dilemma, reduce expenses, and yield more environmentally sustainable bricks for construction.

5. P. Shubhnanda Rao and K. Ramchandar -2020.

The researcher aimed to enhance the mechanical properties, reduce energy consumption, and improve the cost-effectiveness and environmental friendliness of bricks by utilizing Iron Ore Tailings (IOTs). Various proportions of IOTs, sand, cement, and perlite were mixed to produce bricks of specific dimensions. These bricks underwent testing for compressive strength, water absorption, and thermal conductivity. The combination of IOTs, sand, cement, and perlite in a ratio of 50:25:20:5 yielded the most favorable results according to Indian Standard (IS) codes, establishing it as the optimal blend of raw materials. Model rooms constructed with these bricks were evaluated for thermal conductivity compared to rooms constructed with conventional fired bricks of the same dimensions and exposed to similar environmental conditions. The production of clay bricks involves numerous firing procedures that demand elevated temperatures. Sustaining these temperatures necessitates significant quantities of fuel, including wood, coal, biomass, etc., to be combusted in the kiln, leading to significant concerns regarding air pollution. The brick's strength increases as the proportion of IOTs is raised from 30% to 60%, but decreases with greater incorporation of perlite. However, the inclusion of 5% perlite demonstrated a greater benefit in reducing the brick's density. The temperature within rooms constructed with IOT-perlite bricks is less by around 2°C compared to those built with ordinary bricks, resulting in an 8% reduction in electricity consumption. This observation proved the thermal efficiency of non-fired IOT-perlite bricks. The cost analysis is determined by materials, labor, and transportation.

6. Mary Lissy P N et al. - 2018.

The clay brick manufacturing industry faces challenges due to high firing temperatures, leading to air pollution from burning fuels like wood and coal. This project aims to reduce firing temperature to 600°C, cutting production costs and mitigating environmental impact. It proposes using industrial waste like quarry dust and glass powder as substitutes for river sand, further lowering costs. The compressive strength of 21.31 N/mm2 is achieved with a specific mix ratio of Cement: Sand: Red earth: Glass Powder: Quarry Dust = 4:1:1:1.5:2.5. This strength, attained at 600°C, meets the requirements set by National Standards. Experimental results show that a specific mix ratio meets national standards for compressive strength even at reduced firing temperatures.

7. Jose Adolfo Lozano-Miralles-2018.

The aim of this research was to conduct a life cycle analysis (LCA) to assess the environmental consequences of fired clay bricks integrating organic waste. In this research, various samples of ceramic material have been utilized in bricks, sourced from local resources in the nearby geographic region of Bailén, Jaén. The production process, encompassing extraction, screening, drying, and firing of the materials, has been executed in a manner akin to industrial manufacturing, enabling the findings to be applicable to larger production scales. This comparative LCA study examines the entire lifecycle from extraction of clay and organic waste to the production of bricks, including transportation, crushing, shaping, drying, and firing. Local sustainability within the framework of a circular economy approach serves as the foundation for this experimental investigation. Potential environmental impacts are assessed and contrasted utilizing the ReCiPe midpoint LCA methodology within SimaPro 8.0.5.13. These outcomes, derived from this approach, are juxtaposed with those acquired through another methodology—Impact 2002+v2.12. The LCA findings indicate that integrating organic waste into bricks is advantageous from an environmental perspective and presents a promising alternative in terms of environmental impacts, resulting in a reduction of 15–20% across all studied impact categories. Consequently, the viability of incorporating organic additives into clay bricks was validated, as this augmentation demonstrated to enhance their efficiency and sustainability, thereby mitigating their environmental footprint. In this study, the environmental effects of two types of brick samples were examined through life cycle analysis: one comprising a conventional sample, and the other incorporating mixture of clay and organic waste. The findings were utilizing two distinct methodologies.

8. Trupti D. Khati, et al. -2017.

In this review paper, Researchers investigate that utilizing RHA and MD bricks in construction mirrors the application of traditional clay bricks, offering lighter weight and superior strength. Moreover, by repurposing RHA and MD waste, sourced abundantly from rice mills and marble cutting sites, we not only address environmental pollution but also foster a sustainable solution to waste management. Optimal compressive strength is achieved in RHA and MD bricks when using a mix ratio of 30% rice husk ash and 70% marble dust, surpassing red clay bricks by 1.92 times and fly ash bricks by 1.33 times. These bricks exceed the minimum compressive strength requirements, falling within the 5 to 7.5 class designation. Increasing the proportion of marble dust results in denser bricks with reduced water absorption, contrasting with the higher porosity of ordinary red clay bricks. By eliminating the firing process from brick manufacturing, CO2 emissions are mitigated, aligning with eco-environmental practices for brick production.

9. Mrs. K. Saranya, et al. -2016.

In this review paper, The researcher looked into the Durability of bricks made with industrial sludge. The findings showed that the sludge can replace up to 40% of the weight of the earth brick while still maintaining satisfactory strength. The compressive strength of the brick without sludge was 11.7 MPa, and with 5% sludge, it increased to 17.6 MPa. However, adding more than 5% sludge caused a decrease in compressive strength to 10.5 MPa. As for water absorption, when the sludge exceeded 10% of the weight, the water absorption gradually increased. This study demonstrates that adding sludge to bricks not only provides a safe way to dispose of industrial waste but also helps in brick production.

10. Syed M.S. Kazmi, Safeer Abbas, et al. -2016.

In this review paper, researcher focuses on the use of rice husk and rice husk ash in the production of bricks. Fired clay bricks have been widely used in construction for a long time, but the extensive use of natural clay deposits has led to a shortage of this material. As a result, researchers are exploring the use of new materials or waste materials from various industries. In this case, the study examines the potential of using rice husk ash and sugarcane bagasse ash in brick production. Rice husk is the outer cover of the rice kernel and is abundantly available in Pakistan. When rice husk is burned, it produces ash, which can be a challenge to dispose of. However, this ash, known as rice husk ash (RHA). bagasse ash is obtained in a range of 24–30%. The research suggests valuable recycling method, contributing to conservation efforts.

11. Sutas Janbuala et al. -2015.

In this review paper, researcher has investigated the objective of study is to see how using rice husk and rice husk ash affects the porosity and properties of lightweight clay bricks. Clay bricks are a common construction material made from clay and other materials. They're strong, but heavy and not great for thermal insulation. In the past, lightweight bricks made from concrete became popular because they were lighter and had better thermal insulation. This study explores using different ingredients, like industrial sludge, to make clay bricks even lighter. Researchers have looked at things like grass, urban river sediments, tobacco waste, cigarette butts, and recycled paper residues.

12. Mohammad Shahid Arshad et al. -2014.

The researchers utilized clay as a binding material for both paper mill waste and bricks made from orange peels and coconut waste. Orange peels were cut into 2cm to 3cm pieces and sun-dried for 15 days before being mixed with clay and paper mill waste to form bricks. The bricks were then sun-dried for 10 to 12 days and fired in a muffle furnace at 900°C for various durations. Coconut waste proved to be more effective than orange peels and paper mill waste for brick production. Its lightweight nature makes it easy to handle and utilize in brick making. Mixing coconut waste with clay allowed for the creation of bricks with varying compositions. Shorter coconut waste fibers yielded better results compared to longer fibers. The process of making bricks with coconut waste is straightforward, suitable even for unskilled laborers. This study found that up to 60% of the clay content can be replaced by natural waste materials in brick manufacturing.

13. Gokhan And Osman -2013.

In this review paper, The researcher looked into the durability of bricks made with industrial sludge. The findings showed that the sludge can replace up to 40% of the weight of the earth brick The compressive strength of the brick without sludge was 11.7 MPa, and with 5% sludge, it increased to 17.6 MPa. However, adding more than 5% sludge caused a decrease in compressive strength to 10.5 MPa. For water absorption, when the sludge exceeded 10% of the weight, the water absorption gradually increased. This study demonstrates that adding sludge to bricks not only provides a safe way to dispose of industrial waste but also helps in brick production.

14. Sajjad Ahmad et al.- 2013.

In this review paper, The researcher proposed a method for producing high-quality, long-lasting fire bricks using a blend of RHNP, RHCB, SDCB, CDCB, CDNP, and SDCD in a 2:3 ratio by volume. The resulting bricks meet recommended fuel standards, with no significant difference in flue gas temperature compared to fuel wood. This approach offers an eco-friendly alternative to traditional wood burning, reducing pressure on rural household fuel budgets. The production process is simple and cost-effective, utilizing organic waste to create efficient, durable bricks that alleviate reliance on wood for energy. These eco-friendly bricks are resilient and easily transportable without damage, presenting significant market potential.

15. S.P Raut A., R.V Ralegonkar et al.- 2012.

Researchers have utilized diverse waste materials and methodologies to create bricks, notably developing porous and lightweight bricks with reduced thermal conductivity and acceptable compressive strength. This was achieved by incorporating paper processing residues into earthenware bricks to introduce pores, following chemical analysis of both the paper waste and brick raw material. Mixtures with varying proportions of brick raw materials and paper waste (up to 30% by weight) were prepared and compressed using a hydraulic press. Subsequent tests were conducted on the bricks in accordance with various standards, focusing on parameters such as water absorption and compressive strength, with recommended minimum values for characteristic compressive strength ranging from 3 to 5 MPa for both non-load-bearing and load-bearing solid fired clay bricks. Additionally, a review of different methodologies for designing and developing Waste-based Composite Bricks (WCB) was undertaken, analyzing the physico-mechanical and chemical properties of the bricks incorporating various waste materials in alignment with existing literature and standards.

16. K.C.P. Faria, et al. -2012.

This study explores the utilization of sugarcane bagasse ash waste as a resource for clay brick production, by replacing up to 20 wt.% of natural clay. Clay brick samples were fabricated and subjected to various tests to assess their technological properties, including linear shrinkage, water absorption, apparent density, and tensile strength. The microstructure of the sintered bricks was analyzed using scanning electron microscopy (SEM), revealing that the sugarcane bagasse ash waste primarily consists of crystalline silica particles. The findings suggest that incorporating sugarcane bagasse ash waste as a filler in clay bricks can improve their properties, presenting a viable and sustainable approach for its reuse. By utilizing common clay and powdered sugarcane bagasse ash waste as raw materials, this method offers a promising avenue for the eco-friendly disposal of this abundant waste.

17. Fatai Olufemi Aramide-2012.

In this review paper, researcher has studied that the people didn't want pores in ceramic products because it made them more prone to cracking. But now, there are more and more applications where porous ceramics are needed. Porous ceramics are used in things like catalyst supports, filters, insulators, and bio ceramics. These materials have thermal specific pore sizes and structures, as well as other important properties like chemical resistance and thermal and mechanical shock resistance. it also helps with temperature control and protection.

18. Francisco M. Fernandes et al. -2010.

Clay brick masonry stands as one of humanity's oldest and most resilient construction methods. It involves the manual stacking of small components, with or without mortar. The utilization of clay bricks expanded notably during the Roman era and evolved to optimize its advantages. Through medieval and modern periods, clay brick masonry remained prevalent, leveraging fired clay—a widely available raw material worldwide. Its extensive use demonstrated its efficacy in providing structural integrity against diverse climatic conditions and insulation against temperature variations. Understanding the fundamental physical, chemical, and mechanical properties of clay bricks, along with the attributes of their raw materials and manufacturing process, is essential. The production of fired clay bricks follows a longstanding process divided into four stages. Initially, raw clay is extracted and prepared, then stockpiled in open-air storage. Subsequently, the clay undergoes crushing and mixing with water, a process known as tempering. Historically, this mixing was done manually, with water quantity adjusted based on the element type being manufactured. Finally, formed clay elements are extracted from molds and dried in covered spaces, often makeshift shelters with wooden frames and thatched roofs known as hovels. Ultimately, the concluding phase involved enhancing the hardening of the bricks. The bricks underwent additional airdrying outdoors or were placed in a kiln or clamp, exposed to temperatures around 1,000ºC, where they were fired. This process significantly augmented their strength and durability, both mechanically and chemically. These bricks underwent examination to assess physical attributes like porosity, density, and water absorption and thermal expansion and mechanical properties such as compression testing, modulus of elasticity, tensile strength etc. The review of literature and the experiments conducted by the authors reveal significant porosity (15–40 vol.%) and water absorption (10–20 vol.%). Suction levels can be notably high (up to 0.35 g cm^-2 min^-1), while the apparent density is comparatively low (1,500–1,800 kg m^-3). Compressive strength exhibits considerable variation, with values typically falling between 1.5 to 30 MPa. No discernible patterns were identified concerning the age or source of the bricks, given the limited dataset available. It was demonstrated that a non-destructive test enables a thorough evaluation of the compressive strength of aged clay bricks, utilizing suitable correlations.

19. Aliu Adekunle O. et al. -2006.

Researcher has concluded that Rice husk ash and sawdust can effectively supplement cement, with sawdust recommended at a maximum of 10% and rice husk ash permissible up to 15% of the cement content. This blend is suitable for lightweight structures. Sawdust and rice husk disposal traditionally involves incineration or open-air burning, posing risks to air and the environment. However, research suggests they can be recycled for construction, serving as binder replacements. The combination of rice husk ash and sawdust can be utilized in normal weight concrete production, with sawdust replacement showing optimal performance up to 10%. Additionally, up to 15% rice husk can be used without compromising strength for lightweight structures. While these materials can supplement cement, sawdust should not exceed 10%, and rice husk ash is permissible up to 15% of cement. The blend is suitable for lightweight structures and reduces concrete production costs. Utilizing local materials in construction can mitigate hazardous emissions and foster a cleaner, safer environment.

20. Ahamada Zziwa, Simon Kizito, et al. -2006.

A researcher has investigated the bricks made up of sawdust-cement composites using sawdust. Sawdust represents a significant underutilized byproduct. It's estimated that in Uganda, wood loss in the form of sawdust accounts for approximately 18-20% of the volume of logs, as reported by the Ministry of Water, Lands, and environment. Portland cement was mixed with sawdust. The sawdust particles were between 2.5-3.5 mm in diameter. Prior to brick formation, particles were soaked in water for 24 hours to reduce the amount of water-soluble sugars and were finally air-dried to approximately 5% moisture content. A total of 48 bricks were manufactured in the laboratory of the Faculty of Forestry and Nature Conservation, following volume ratios of sawdust to cement (3:2 and 2:1). The mass was measured using a weighing scale, and the density was calculated from the mass and volume of the bricks. The composites underwent compressive strength testing using a universal testing machine, as they exhibited cracking under compression. The mean compressive strength values were 1.61 N/mm^2 and 1.986 N/mm^2 for composites sized 50 x 50 x 50 mm with sawdust to cement ratio of 3:2 and 2:1, respectively; and 1.778 N/mm^2 and 2.21N/mm^2 for composites sized 100x100x100mm with sawdust to cement ratios of 3:2 and 2:1, respectively. Analysis of variance (ANOVA) revealed significant differences ($P<0.05$) in the strength values between the two compositions. When soaked, the composites swelled regardless of the cement to sawdust ratio, and their compressive strength when wet was approximately 40% of their dry weight strength. The composite bricks were deemed unsuitable for paving and construction of medium-heavy load walls. However, due to their lightweight nature, they could be utilized for interior wall paneling and decoration, particularly when minimal exposure to moisture is anticipated. wood and cement composite bricks can decrease the total weight of construction projects, it gives typically low density and weight. These composite bricks can be utilized for interior wall paneling and ornamentation, especially when enhanced with decorative mosaics.

3. CONCLUSIONS

In addition to the findings mentioned, the study underscores the importance of considering the long-term durability and performance of bricks in real-world applications. While the incorporation of organic materials shows promise for reducing environmental impact and resource usage, it's crucial to assess their effects on structural integrity over time, especially in varying environmental conditions. Moreover, the observed differences in compressive strength, water absorption, and hardness highlight the need for tailored approaches to brick production based on specific project requirements and environmental considerations. Further research avenues may include exploring alternative organic additives, refining manufacturing processes, and conducting lifecycle assessments to comprehensively evaluate the sustainability and performance of organic bricks. Ultimately, this study contributes to advancing sustainable construction practices by offering insights into the potential benefits and challenges associated with integrating organic materials into brick manufacturing processes.

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