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STUDY OF VARIOUS MATERIALS USED IN CONSTRUCTION OF ECO-FRIENDLY BRICKS: A REVIEW PAPER

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Abstract *– The construction sector is one of the major contributors to resource depletion and environmental pollution due to the extensive use of conventional building materials. Burnt clay bricks require large quantities of natural soil and high energy for firing which leads to land degradation and increased carbon emissions. Fly ash an industrial waste generated from coal-based thermal power plants presents a serious disposal problem but offers significant potential for reuse in construction materials. This review paper examines previous research related to the development of eco-friendly bricks using fly ash as a primary ingredient. The reviewed studies are analyzed based on materials used production techniques. The findings from the literature indicate that fly ash bricks provide adequate strength, reduced water absorption, lower weight and improved sustainability when compared to conventional clay bricks. Based on the literature view it was understood that stone dust and sand possess similar properties. Therefore, stone dust is being utilized as a substitute for sand in our project.*

Key Words**:** ***Fly ash bricks, Sustainable construction materials, Eco-friendly bricks, Industrial waste utilization, Mechanical properties, green construction.***

1. INTRODUCTION

The construction industry consumes a large number of natural resources and simultaneously generates industrial waste leading to serious environmental concerns. Fly ash produced from coal-based thermal power plants is one such waste material that requires safe and effective disposal. One sustainable solution is the utilization of fly ash in brick manufacturing. This review paper presents a critical analysis of previous research on the development of eco-friendly bricks using fly ash. The study focuses on material characteristics, strength behavior, durability performance and environmental advantages. In addition, laboratory test results of cement, fly ash, and stone dust are discussed to evaluate their suitability for fly ash brick production. Based on the reviewed literature and experimental data fly ash bricks are identified as sustainable alternatives to conventional burnt clay bricks with reduced environmental impact and satisfactory performance.

2. LITERATURE REVIEW

Amar Singh, Kriti Mishra, Mayank Kashyap Himanshu Tiwari, Anjali Tiwari (2025)

This review paper analyzes various studies related to the development of environmentally friendly bricks produced by incorporating fly ash and agricultural waste materials. It discusses different waste resources utilized methods of brick production and the evaluation of their physical and mechanical characteristics. Research shows that the partial replacement of traditional materials with industrial and agro-based by-products reduces environmental impact and supports resource conservation. Several investigations highlight that these sustainable bricks provide sufficient compressive strength, reduced density and better thermal insulation when compared to conventional clay bricks. However, challenges such as long-term durability, standardization of quality and large-scale commercialization still need attention. In conclusion eco-friendly bricks offer a promising and sustainable alternative for modern construction practices.

Bogdan Bogdanov, Irena Markovska, Yancho Hristov, Dimitar Georgiev (2012)

This review paper evaluates earlier studies on the production of sustainable bricks prepared using fly ash and different agricultural waste materials. It examines various mix proportions, manufacturing processes and the mechanical and physical properties observed by researchers. Incorporating industrial and agro-residues in brick production contributes to waste management and reduces dependency on natural raw materials. Findings from several studies show that these eco-friendly bricks demonstrate adequate compressive strength, lower unit weight and improved thermal insulation compared to traditional clay bricks. However, challenges related to uniformity of raw materials and long-term performance still need detailed research. Overall, the review highlights that bricks made from waste materials provide a practical and environmentally friendly solution for sustainable construction.

Alae Shakir, Sivakumar Naganathan, Kamal Nasharuddin Bin Mustapha (2013)

This review paper analyzes previously published studies on the development of eco-friendly bricks made with fly ash and agricultural residues. It examines the types of waste materials used, manufacturing approaches adopted and the performance characteristics achieved in different research works. The incorporation of industrial and agro-waste in brick production supports waste management and reduces environmental degradation. Many investigations report that such bricks provide satisfactory compressive strength, lighter weight and enhanced thermal insulation compared to conventional clay bricks. However, concerns related to long-term durability, consistency of raw materials and feasibility of large-scale manufacturing still require further research. In summary, bricks produced from waste materials present a sustainable and promising solution for modern construction needs.

Mebrahtom Teklehaimanot, Haregeweni Hailay, Tamrat Tesfaye (2021)

This review study examines previously published work on the development of sustainable bricks produced with fly ash and agricultural residues. It summarizes the types of materials selected, the manufacturing methods applied and the physical and mechanical performance reported by various researchers. The substitution of traditional raw materials with waste-derived components contributes to environmental protection and reduces the consumption of natural resources. Findings from multiple studies suggest that these bricks provide adequate compressive strength, reduced weight and improved thermal insulation compared to conventional clay units. Despite these benefits, issues such as long-term durability, uniform quality control and large-scale implementation still require further investigation. Overall, the findings support the potential of eco-friendly bricks as a sustainable option for modern construction.

Andrea Treasa Figaredo, Mary Dhanya (2018)

This review article gathers and analyzes earlier investigations on the production of sustainable bricks made from fly ash and agricultural waste materials. It outlines the different by-products used as partial or complete substitutes for conventional brick components and highlights the manufacturing techniques adopted in various studies. The inclusion of these waste materials in brick fabrication not only reduces disposal problems but also lowers the overall environmental footprint of construction. Findings from the literature show that such bricks typically achieve satisfactory compressive strength, lighter density and enhanced thermal insulation when compared with ordinary clay bricks. However, concerns related to long-term durability, variation in raw material properties and the need for proper standardization still require attention. Overall, the study emphasizes that bricks manufactured from waste resources offer significant promise for sustainable building practices.

Moh. Tauqeer Moh Mujeeb, Rohan C. Damahe, Preet R. Gupta, Chetan D. Waykar, Sayali S. Gaidhane (2025)

This review paper analyzes previously reported research on the development of sustainable bricks prepared from fly ash and agricultural waste by-products. It examines different mix proportions, production method and the mechanical and physical performance observed in earlier studies. The use of industrial and agro-residues in brick manufacturing assists in minimizing landfill waste and reduces reliance on natural resources. Several research findings suggest that these sustainable bricks provide adequate compressive strength, lighter weight and better thermal insulation than conventional clay bricks. Nevertheless, concerns such as durability over time, uniform material quality and scalability of production still need detailed study. In conclusion, eco-friendly bricks are recognized as a practical and sustainable alternative for modern construction practices.

Siddhant S. Shah, Prof. Mahesh M. Makwana (2019)

This review paper provides a detailed evaluation of previous studies on the production of sustainable bricks developed with fly ash and agricultural waste materials. It outlines the various waste products incorporated, the manufacturing methods adopted and the physical and mechanical properties reported by researchers. The integration of waste-based materials into brick production supports efficient waste utilization and helps conserve natural resources. Findings from the literature indicate that such bricks commonly achieve satisfactory compressive strength, lower bulk density and improved thermal insulation compared to traditional clay bricks. Despite these advantages, aspects such as long-term durability, uniformity of raw materials and large-scale implementation require further investigation. Overall, eco-friendly bricks are considered a promising and sustainable alternative for the construction sector.

P. Prathyusha and Kolli Ramujee (2021)

This review paper presents a summary of previous research focused on the production of sustainable bricks made from fly ash and agricultural waste materials. It discusses various mix designs, manufacturing methods and the mechanical and physical properties observed in earlier studies. The use of industrial and agricultural by-products in brick production helps reduce environmental pollution and decreases dependence on natural resources such as clay. Research findings show that these alternative bricks can achieve adequate compressive strength, lower density and improved thermal insulation when compared to conventional clay bricks. However, issues related to durability over long periods, consistency in raw material quality and large-scale manufacturing require further investigation. Overall,

sustainable bricks are considered a promising solution for environmentally responsible construction.

Sayan Ghar, Bidisha Dey (2025)

This review article summarizes earlier research on the production of environmentally friendly bricks made with fly ash and agricultural by-products. It examines the types of waste materials used, manufacturing processes adopted and the mechanical and physical properties reported in various studies. Utilizing industrial and farm-based residues in brick production helps manage solid waste efficiently while reducing the consumption of natural clay resources. Previous findings generally show that these bricks achieve satisfactory compressive strength, reduced weight and better thermal insulation compared to conventional clay bricks. However, further research is required to address issues related to long-term performance, material consistency and large-scale manufacturing feasibility. Overall, sustainable bricks are considered a viable alternative for promoting greener construction practices.

M P Iniya, K Sabarinathan, G Shanmugavel Murugan, V Rishi (2025)

The study investigates the production of sustainable masonry blocks by utilizing recycled industrial and agricultural by-products, mainly fly ash (40–60%) and rice husk ash (15–20%), combined with lime, cement, and river sand. The objective is to minimize environmental impacts linked to waste accumulation and to reduce pollution from conventional brick manufacturing, which depends on kiln firing and generates significant carbon emissions. Brick samples measuring 230 × 110 × 75 mm were prepared and tested to determine their physical and mechanical performance, including compressive strength and water absorption. The results showed compressive strength values ranging from 5.61 N/mm^2 to 10.19 N/mm^2, with one mix proportion performing better than standard clay bricks. Water absorption values were observed between 2.94% and 12.47%, remaining well within the acceptable limit of 20%. The findings suggest that these sustainable bricks provide a strong, economical and environmentally friendly option suitable for low-cost housing, particularly in developing regions.

3. CONCLUSION ON LITERATURE REVIEW

An examination of previous research indicates that the use of fly ash and agricultural by-products in brick manufacturing provides a viable and sustainable alternative to conventional clay bricks. Available studies suggest that such bricks can attain acceptable compressive strength, lighter weight and improved thermal performance, while helping to reduce environmental impact and conserve natural resources. The utilization of industrial and agricultural waste materials also promotes effective waste ` and lessens dependence on traditional raw inputs. However, further investigation is necessary to address concerns related to durability over time, consistency of raw materials, quality control and scalability of production. Overall, sustainable bricks show considerable potential for green construction, though continued efforts are required to improve standards and support large-scale implementation.

4. LABORATORY TEST ON MATERIALS

4.1 Cement

Cement is a finely ground binding material widely used in construction for producing concrete and mortar. The quality and performance of cement are evaluated through several important physical tests. The standard consistency test is conducted to determine the amount of water required to prepare a cement paste of normal plasticity, which is essential for further testing. The initial and final setting time tests are performed to assess the time required for cement paste to begin hardening and to attain sufficient rigidity, ensuring proper handling and finishing during construction. The soundness test is carried out to evaluate the volumetric stability of cement and to detect the presence of excess free lime or magnesia that may cause undesirable expansion. These physical tests are fundamental in understanding the behavior and suitability of cement for safe and durable construction applications.

Cement is the main binding material in construction. To ensure good quality bricks or concrete, different laboratory tests are performed according to Indian Standard (IS) codes.

Fig 1: - Cement

❖ **Test Including: -**

Sr No.	Name of Test	Result	IS Code Recommended	Range According to IS Code
1	Normal Consistency of Cement	33%	IS 4031(Part-4): 1988	26% to 33%
2	Initial and Final Setting Time of Cement	Initial- 30 min Final- 450 min	IS 4031(Part-4): 1988	Minimum Initial Time 30 min Maximum Final Time

				600 min
3	Finess Modulus of cement	1%	IS 4031(Part- 1 & 2): 1988	Less than 10%
4	Specific Gravity of Cement	3.12	IS 4031(Part-11): 1988	3.10 to 3.16
5	Soundness Test of Cement	0.23 cm	IS 4031(Part-3): 1988	Not More than 1 cm

4. 2. Fly Ash

Fly ash is a fine powder produced as a by-product of coal combustion in thermal power plants and is widely used as a supplementary cementitious material in concrete and other construction applications. Among its physical properties, specific gravity and fineness are important parameters used to evaluate its quality and performance. The specific gravity test is conducted to determine the relative density of fly ash, which is essential for accurate mix proportioning in concrete. The fineness test, including assessment through sieve analysis or fineness modulus, is carried out to study the particle size distribution of the material, as particle size influences workability, strength development and overall behavior in cementitious mixes. These physical tests help in understanding the fundamental characteristics of fly ash before its practical use in construction.

Fig 2: - Fly-Ash

❖ **Test Including: -**

Sr No.	Name of Test	Result	IS Code Recommended	Range According to IS Code
1	Specific Gravity of Fly Ash	2.09	IS 1727: 1967	1.9 to 2.8
2	Finess Modulus of Fly Ash	24%	IS 460: 1962	15% to 30%

4. 3. Stone Dust

Stone dust is a fine material obtained as a by-product during the crushing of stones and is commonly used as a partial replacement for sand in construction works. To evaluate its suitability as a construction material, certain physical tests similar to those conducted on other fine materials are performed. The specific gravity test is carried out to determine its relative density, which is important for mix proportioning and volume calculations. The fineness test, including sieve analysis or fineness modulus determination, is conducted to assess particle size distribution, as it influences workability, strength, and compaction characteristics in concrete or mortar. These physical tests help in understanding the fundamental properties of stone dust and ensure its effective and safe use in construction applications.

Fig 3: - Stone Dust

❖ **Test Including: -**

Sr No.	Name of Test	Result	IS Code Recommended	Range According to IS Code
1	Specific Gravity of stone dust	2.52	IS 2386(Part-3): 1963	2.4 to 2.9
2	Finess Modulus of stone dust	3.03%	IS 2386(Part-1): 1963	2.2% to 3.2%
3	Moisture Content of Stone Dust	3.2%	IS 2386(Part-3): 1963	1% to 5%
4	Bulk Density of Stone Dust	1.48 g/cm3	IS 2389(Part-3): 1963 & 383:2016	1.4 to 1.5 g/cm^3
5	Silt Content of Stone Dust	10%	IS 2386(Part-2): 1963	Up to 15%

5. CONCLUSION

The laboratory test results confirm that cement, fly ash, and stone dust comply with the specified IS code standards. The cement demonstrates proper consistency, acceptable setting

time, suitable fineness, correct specific gravity and good soundness, indicating reliable quality and stability. Fly ash shows appropriate density and particle fineness, making it suitable for improving strength and workability in brick production. The stone dust also possesses proper grading, bulk density and controlled silt content. Overall, the materials are appropriate for manufacturing strong, durable and good-quality fly ash bricks. Since stone dust and sand show nearly similar properties our brick-making project used stone dust as a replacement for sand.

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