

EXPERIMENTAL STUDY ON THE UTILIZATION OF RHA, SBA AND FLY ASH IN BRICKS

Dr. S.D.Nagrale¹, P.V.Thawri², V.S.Thorve³, A.Y.Tupe⁴, A.Rajput⁵, P.K.Terdal⁶

¹Professor, Dept. of Civil Engineering, AISSMS, Pune, India.

^{2,3,4,5,6} Student, Dept. of Civil Engineering, AISSMS, Pune, India.

Abstract : *This study investigates the high thermal conductivity of conventional clay bricks necessitates increased energy consumption for indoor climate control, highlighting a critical need for sustainable, energy efficient masonry alternatives. This study investigates the development of eco-friendly bricks by incorporating agricultural and industrial by-products, specifically Rice Husk Ash (RHA) and Sugarcane Bagasse Ash (SBA), which are typically discarded as waste. The research utilizes a structured mix design incorporating cement, fine sand, fly ash/wood ash, lime, SBA, and RHA in varying proportion. The methodology involves uniform material preparation using 190mm x 90mm x 90mm moulds, followed by rigorous laboratory testing to evaluate performance against Indian Standards, including compressive strength (IS 3495-2019 Part I), thermal conductivity (IS 1348-1981), and water absorption (IS 3495-2019 Part II) . The study aims to produce lightweight bricks with a porous microstructure that reduces the structural dead load while enhancing thermal insulation to improve indoor comfort . Results are compared against conventional bricks to determine an optimum mix ratio that satisfies structural durability requirements while promoting sustainable waste management in civil engineering.*

Keywords : *Eco-friendly bricks, Thermal insulation, Rice Husk Ash (RHA), Sugarcane Bagasse Ash (SBA), Sustainable construction, Waste management.*

I.INTRODUCTION

Traditional clay bricks are widely used in construction, but they have a major disadvantage: high thermal conductivity. This means they are poor insulators, causing buildings to heat up quickly in summer and cool down fast in winter, leading to high energy costs for air conditioning and heating. Additionally, producing these bricks consumes large amounts of natural clay and fertile topsoil. To address these issues, this research explores the development of "eco-friendly bricks" by reusing agricultural and

industrial waste. Specifically, this study utilizes Rice Husk Ash (RHA) and Sugarcane Bagasse Ash (SBA). These materials are produced in massive quantities by the rice and sugar industries and are often discarded in landfills, causing environmental pollution. By incorporating RHA and SBA into the brick mix (along with cement, sand, lime, and fly ash), we can create bricks that are lighter and more thermally efficient. These bricks feature a porous microstructure that acts as a thermal barrier, improving indoor comfort. The goal of this project is to develop a sustainable building material that reduces environmental waste, conserves natural resources, and lowers the overall carbon footprint of the construction industry.

II. AIMS AND OBJECTIVES

1. To utilize agricultural waste in brick production.
2. To use SBA and RHA as partial cementitious filter.
3. To use fly ash and lime as fine filler material.
4. To prepare bricks and test compressive strength.
6. To determine the environmental impact of using eco-friendly insulating bricks in construction.

III. MATERIALS USED

1. Ordinary Portland Cement
2. Fine Aggregate (Sand)
3. Rice Husk Ash (RHA)
4. Sugarcane Bagasse Ash (SBA)
5. Lime
6. Fly Ash
7. Potable Water

IV. MATERIAL PROPERTIES

The properties of materials used in the study are as follows:

1. Cement: Ordinary Portland Cement (OPC) of 53 grade was used. It conforms to relevant IS standards. Specific gravity = 3.15.
2. Fine Aggregate: (river sand) was used, conforming to Zone II as per IS standards.
3. SBA : It possesses pozzolanic properties, making it a suitable substitute for traditional construction materials.
4. Rice Husk Ash (RHA): It features high pozzolanic activity, which helps in improving the strength of the finished brick. It has a specific gravity of 2.11.
5. Fly Ash : It is used as a lightweight filler that helps increase the porosity of the brick, which significantly reduces heat transfer.
6. Lime : It acts as the binding agent for silicate materials like sand or quartz.
7. Water: Clean potable water was used for mixing and curing.

V. METHODOLOGY

1. Collection of raw materials from site.
2. Prepare mould of size (190mm*90mm*90mm).
3. Raw materials were sieved uniformly.
4. Materials were mixed in suitable proportions.
5. Three bricks of size(190mm*90mm*90mm) were cast.
6. Bricks were demoulded after 24 hours.
7. Bricks were water cured.
8. Bricks were tested in Compression Testing Machine and Water absorption test.

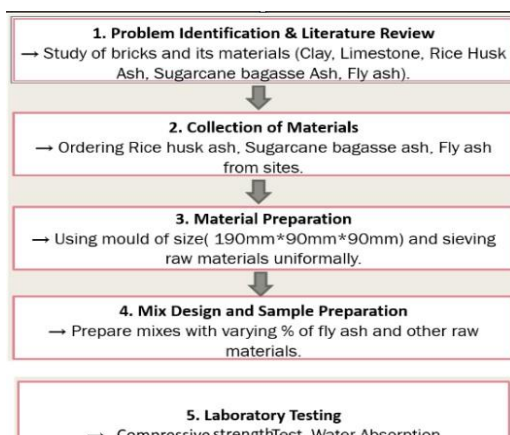


FIG1- FLOWCHART OF BRICK PREPARATION AND TESTING PROCEDURE

V. MIX DESIGN

Concrete mix was prepared using a nominal mix proportion suitable for M30 grade concrete. Partial quantity of conventional materials was carried out as follows:

For B1

- Cement used in bricks : 18%
- Fine sand : 30%
- Fly ash: 22%
- SBA : 10%
- RHA : 15%
- Lime : 5%
- Water-cement ratio: 0.45

For B2

- Cement used in bricks : 15%
- Fine sand : 40%
- Fly ash: 23%
- SBA : 12%
- RHA : 5%
- Lime : 5%

For B3

- Cement used in bricks : 25%
- Fine sand : 35%
- Fly ash: 12%
- SBA : 8%
- RHA : 10%
- Lime : 10%

All materials were mixed thoroughly to achieve uniform consistency before casting the bricks.

VI. OBSERVATIONS AND TEST RESULTS

Brick Size = 190 mm × 90 mm × 90 mm

Loaded Area = 13500 mm²

CUBE NO.	WEIGHT (kg)	FAILURE LOAD (KN)	COMPRESSIVE STRENGTH (MPa)
B1	2.48	575.5	42.62
B2	2.54	410.4	30.4
B3	2.52	501	37.11

TABLE I. BRICK TEST RESULTS CUBE NO. WEIGHT (kg)
FAILURE LOAD (KN) COMPRESSIVE STRENGTH (MPa)

Average Compressive Strength = 36.71 MPa

*Formula Used: Compressive Strength = Load / Area
(Load in Newton, Area in mm²).*

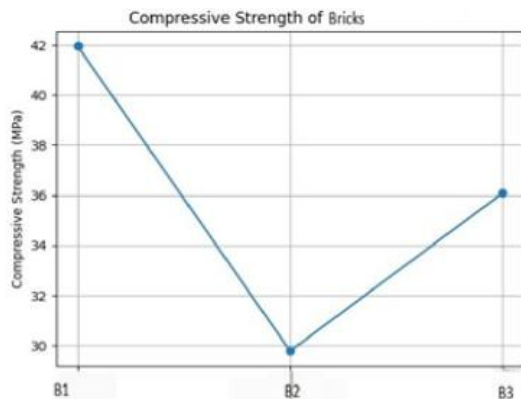


FIG3- COMPRESSION TESTING OF BRICKS

PROPERTY	NORMAL BRIKS	MODIFIED BRICKS
AVG STRENGTH	30 MPA	36.71 MPA
SUSTAINABILITY	LOW	HIGH
WASTE UTILIZATION	NO	YES

TABLE II : COMPARISON OF NORMAL AND MODIFIED
BRICK

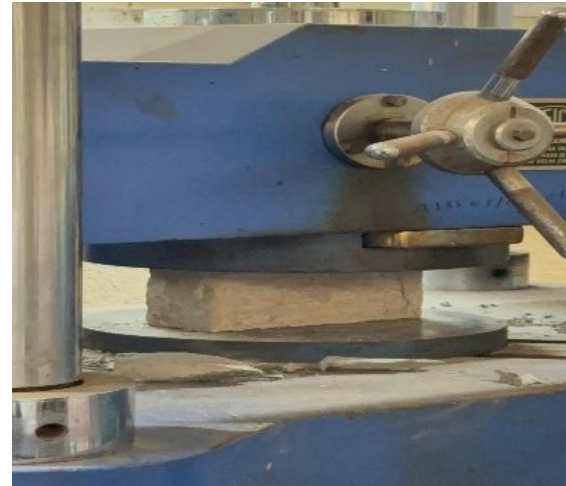


FIG4- FAILURE OF CUBE UNDER LOAD



FIG 5 : FAILURE OF BRICK

VII. DISCUSSION

The experimental results indicate that the incorporation of waste materials has a noticeable effect on the compressive strength of concrete. Brick B1 exhibited the highest strength of 42.62 MPa, which may be attributed to proper compaction and uniform distribution of materials. Brick B2 showed comparatively lower strength, possibly due to the presence of voids, improper mixing, or uneven curing conditions. Brick B3 demonstrated moderate strength, indicating consistent performance. The addition of SBA and RHA improved the filler effect and reduced voids in concrete. Fly ash contributed to better particle packing and secondary hydration reactions due to its pozzolanic nature although slight variations in strength were observed. Overall, the results confirm that the modified provides satisfactory strength and can be used for construction applications.

VIII. ADVANTAGES OF THIS MIX

1. Reduces agricultural and industrial waste.
2. Reduces landfill disposal.
3. Saves natural resources.
4. Eco-friendly material.
5. Cost effective.
6. Promotes sustainable development.

IX. LIMITATIONS

1. Due to the porous nature of ash, these bricks can absorb more moisture, which may affect long-term durability if not treated.
2. Increasing the percentage of RHA or SBA beyond the optimal level (usually 10-15%) can lead to a decrease in compressive strength.
3. The chemical properties of the ash depend on the burning temperature of the husk and bagasse, which can lead to inconsistent brick quality.
4. Long-term strength behaviour was not analysed.
5. Variations in waste material properties may affect results.

X. CONCLUSION

This experimental investigation demonstrates that cement, RHA, SBA, Fine sand, Fly ash, Lime can be effectively incorporated as partial replacement materials in concrete production without significantly compromising performance. The average compressive strength achieved was 36.71 MPa, indicating that the developed mix satisfies the strength requirements for a wide range of structural and non-structural building applications. The results confirm that the inclusion of these waste-derived materials contributes to adequate mechanical properties while maintaining overall material stability. In addition to structural performance, the proposed approach offers notable environmental benefits by promoting the recycling of agricultural waste, thereby reducing landfill disposal and minimizing environmental pollution. Therefore, the utilization of agricultural waste such as RHA and SBA presents a viable and sustainable alternative in modern construction practices. The findings highlight their potential for future application in eco-friendly construction, encouraging further research and large-scale implementation in sustainable infrastructure development.

XI. FUTURE SCOPE

1. Durability and Weathering Analysis : Future studies can focus on long-term durability tests, such as freeze-thaw cycles and resistance to chemical attacks (sulphate and chloride), to ensure the bricks withstand diverse climatic conditions.

2. Waterproofing Solutions : Since ash-based bricks tend to have higher water absorption, research into eco-friendly hydrophobic coatings or chemical additives can be conducted to make them more water-resistant.

3. Optimization of Mix Designs : Using machine learning or advanced computational modelling to determine the absolute "golden ratio" of SBA and RHA that provides the maximum thermal insulation without compromising compressive strength.

4. Acoustic Insulation Studies : Beyond thermal properties, these porous bricks likely possess excellent sound insulation qualities. Future research could evaluate their effectiveness in noise reduction for urban high-rise buildings.

5. Automation in Manufacturing : Exploring the feasibility of large-scale industrial production using automated pressing machines and standardized curing chambers to ensure consistent quality control.

6. Carbon Credit Analysis: Investigating the potential for these bricks to earn carbon credits by calculating the exact reduction in CO₂ emissions compared to traditional coal-fired kiln bricks.

7. Hybrid Reinforcements : Researching the addition of natural fibres (like coconut coir or jute) into the RHA-SBA mix to improve the tensile strength and crack resistance of the bricks.

XII. REFERENCES

- Dakwale, V.A. & Ralegaonkar, R.V. (2014). Development of sustainable construction material using construction and demolition waste. *IJEMS*, 21, 451-457.
- Wahid, S.A., Rawi, S.M., & Desa, N.M. (2014). Utilization of Plastic Bottle Waste in Sand Bricks. *J. Basic & Applied Sci. Res.*, 1(35-44).
- Shiri, N.D., Kajava, P.V., Ranjan, H.V., Pais, N.L., & Naik, V.M. (2015). Processing of Waste Plastics into Building Materials Using a Plastic Extruder and Compression Testing of Plastic Bricks. *J. Mechanical Engineering & Automation*, 5(3B): 39-42.
- Muyen, Z., Barna, T.N., & Hoque, M.N. (2016). Strength properties of plastic bottle bricks and their suitability as construction materials in Bangladesh. *Progressive Agriculture*, 27(3): 362- 368.
- Dinesh, S., Dinesh, A., & Kirubakaran, K. (2016). Utilization of waste plastic in manufacturing of bricks and paver blocks. *IJAE Research*, 11(3).
- Thirugnanasambantham, N., Kumar, P.T., Sujithra, R., Selvaraman, R., & Bharathi, P. (2017). Manufacturing and Testing Of Plastic Sand Bricks. *IJOSER*, 5(4).

- Aiswaria, K., Abdulla, K., Akhil, E.B., Lakshmi, H.V.G., & Jimmy, J. (2018). Manufacturing and Experimental Investigation of Bricks with Plastic And M-Sand. *IJIRSET*, 7(6).
- Akinwumi, I.I., Domo-Spiff, A.H., & Salami, A. (2019). Shredded waste plastic stabilized soil for producing compressed earth bricks. *Case Studies in Construction Materials*, 11 e00241.
- Raut, S.P., Ralegaonkar, R.V., & Mandavgane, S.A. (2020). Development of Sustainable Construction Material Using Industrial and Agricultural Solid Waste: A Review of Waste-Crete Bricks. *Construction & Building Materials*, 25(10): 4037-4042.
- 10–17. Indian Standards (IS 1077:1992, IS 3495:1992, IS 4031:1996, IS 2720:1980, 13757:1993, etc.) related to clay brick specifications, compressive strength, water absorption, and testing procedures.
- Raut, C. P. Gomez Published 15 February 2017 Development of thermally efficient fibre-based eco-friendly brick reusing locally available waste materials.
- CHRISTENA hanna; Abdel Monteleb Aly; Sayed shebl September and October 2022 An empirical study on the thermal behaviour of rice husk in eco-friendly brick for external walls of buildings.
- M.M. Ahmed, Sally A. Ali, Dalia Tarek, Ibrahim M. Maafa, Ahmed Abutaleb, Ayman Yousef, Marwa Kamal Fahmy 2024 Development of biobased lightweight and thermally insulated bricks.
- <https://www.sciencedirect.com/science/article/pii/S0950061816319729>
- <https://ijcrt.org/papers/IJCRT2505833.pdf>
- <https://www.irejournals.com/formatedpaper/1701718.pdf>
- <https://www.sciencedirect.com/science/article/pii/S0950061824010729>
- <https://www.sciencedirect.com/science/article/pii/S0950061823035262>
- https://www.researchgate.net/publication/365334286_Experimental_Study-Brick
- https://www.researchgate.net/publication/365334286_Experimental_Study_on_Eco-Bricks