International Journal of Engineering Research and Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 22, Issue 4 (April 2026), PP 214-217

Stabilization of soil for brick with organic materials

Mr. Sanket Tarachand Vighe [1], Mr.Chemte Rushikesh Subhash[2],Mr.Mule Rushikesh Subhash[3],Mr.Mulay Tushar Sandip[4]
[1]*Guide , Department of Civil Engineering, Samarth Polytechnic Belhe , Pune, India.*
[2,3,4]*PG Scholer ,Department of Civil Engineering, Samarth Polytechnic Belhe , Pune, India*

Abstract- *Soil stabilization using organic materials has emerged as a sustainable and cost-effective approach for the production of construction bricks. Traditional clay bricks often exhibit poor compressive strength, high water absorption, and significant energy consumption during manufacturing. This paper presents a comprehensive review of various organic stabilizing agents including rice husk ash, sugarcane bagasse ash, cow dung, jute fiber, and coir fiber used to enhance the engineering properties of soil-based bricks. Experimental investigations indicate that the incorporation of organic additives in optimal proportions significantly improves the compressive strength, durability, and thermal resistance of stabilized soil bricks. The study highlights the environmental benefits of using agricultural by-products in brick manufacturing, contributing to waste reduction and green construction practices.*

Keywords- *Soil Stabilization, Organic Materials, Rice Husk Ash, Bagasse Ash, Compressed Earth Bricks, Compressive Strength, Sustainable Construction*

Date of Submission: 03-04-2026 Date of acceptance: 14-04-2026

I. INTRODUCTION

The construction industry is one of the largest consumers of natural resources, and the demand for conventional fired clay bricks continues to exert pressure on land and energy resources. In developing countries like India, brick production accounts for a substantial share of greenhouse gas emissions due to high-temperature kiln firing. Soil stabilization presents an alternative method of brick production that eliminates or reduces the need for high-temperature processing, thereby reducing energy consumption and carbon footprint.

Organic stabilizing agents derived from agricultural waste have shown considerable promise in modifying the engineering properties of natural soils for brick manufacturing. Materials such as rice husk ash (RHA), bagasse ash, jute fiber, coir fiber, and cow dung have been extensively studied due to their availability, low cost, and biodegradability. These materials interact chemically and physically with soil particles to improve binding, reduce shrinkage, and enhance durability.

The use of organic materials for soil stabilization is not a new concept; it has been practiced in traditional construction for centuries. However, scientific investigation and standardization of these methods are relatively recent. The present study reviews the advancements in organic soil stabilization for brick production, analyzing various experimental results and identifying the most effective materials and their optimal proportions.

II. LITERATURE REVIEW

The stabilization of soil using organic and agro-industrial by-products has been studied by numerous researchers worldwide. The following section provides a concise review of significant contributions in this field.

Millogo et al. (2012) investigated the use of raw cotton fibers as reinforcement in compressed earth bricks. The study found that fiber addition improved the flexural strength and toughness of the bricks while reducing brittleness. However, excessive fiber content led to a decrease in compressive strength due to poor fiber-matrix bonding.

Savastano et al. (2009) evaluated the performance of cement-stabilized soil bricks reinforced with sisal and coir fibers. Results indicated that natural fiber reinforcement enhanced the post-cracking behavior and energy absorption capacity of the bricks. Compressive strength improved by up to 22% with 1.5% fiber content by weight.

Chandra et al. (2013) examined the influence of rice husk ash (RHA) on the geotechnical properties of expansive soils. The study demonstrated that RHA reduced the plasticity index and swelling potential of black cotton soil, making it suitable for brick manufacturing. An optimal RHA content of 10% yielded maximum compressive strength values.

Eko et al. (2012) studied the incorporation of sugarcane bagasse ash into compressed earth bricks. Findings revealed that bagasse ash, being rich in silica, reacted pozzolanically with calcium compounds in the soil to form cementitious products. The optimum bagasse ash content was found to be 12% by weight of dry soil, achieving compressive strength values of approximately 4.5 MPa.

Aguilar et al. (2011) explored the use of cow dung as an organic stabilizer for adobe bricks in rural construction. The results showed that cow dung improved the plasticity and workability of soil mixtures and reduced cracking during drying. However, the water absorption of treated bricks increased slightly compared to unstabilized bricks.

More recent studies by Danso et al. (2015) demonstrated that combinations of natural fibers and ash-based materials produced synergistic improvements in brick properties. The combined use of sisal fiber and fly ash at proportions of 1% and 8% respectively resulted in a 34% increase in compressive strength over control specimens.

III. PROPERTIES OF ORGANIC STABILIZING MATERIALS

3.1 Rice Husk Ash (RHA)

Rice husk ash is a by-product of rice milling and contains approximately 85-95% silica in an amorphous form. This high silica content gives RHA excellent pozzolanic properties, enabling it to react with calcium hydroxide in the presence of water to form calcium silicate hydrate (CSH) compounds. RHA reduces the liquid limit and plasticity index of expansive soils, improving their workability for brick production. When used at 8-15% replacement levels, RHA significantly improves compressive strength and reduces water absorption in soil bricks.

3.2 Sugarcane Bagasse Ash

Sugarcane bagasse ash (SCBA) is generated during the combustion of sugarcane bagasse in sugar mills. SCBA contains silica, alumina, and calcium oxide as its primary constituents, contributing to its pozzolanic activity. Studies have shown that SCBA at 10-15% content improves the shear strength, unconfined compressive strength, and durability of stabilized soil bricks. The fine particle size of SCBA facilitates better packing within the soil matrix, reducing void content and permeability.

3.3 Cow Dung

Cow dung has been traditionally used as a binding agent in rural construction across South Asia and Africa. It contains cellulosic fibers, lignin, and organic acids that improve the cohesion and flexibility of soil mixtures. The fibrous nature of cow dung helps in distributing stresses within the brick matrix and reduces shrinkage cracking during drying. Modern studies confirm that dried and powdered cow dung at 5-10% by weight improves the tensile splitting strength and reduces the brittleness of compressed earth bricks.

3.4 Jute Fiber

Jute fiber is a natural lignocellulosic fiber obtained from the Corchorus plant, widely cultivated in India and Bangladesh. It possesses high tensile strength (200-450 MPa), low density (1.3 g/cm3), and good compatibility with soil matrices. When incorporated into soil at 0.5-2% by weight, jute fibers create a reinforcing network that enhances ductility and crack resistance of soil bricks.

3.5 Coir Fiber

Coir fibre, derived from coconut husk, is one of the most durable natural fibres available. Unlike other natural fibres, coir has a high lignin content (40-45%) that provides excellent resistance to moisture and biological degradation. Coir fibres at 1-2% content improve the compressive strength, impact resistance, and thermal insulation properties of soil bricks.

IV. EXPERIMENTAL INVESTIGATION

4.1 Materials Used

The experimental program utilized locally available red laterite soil classified as CL (clay of low plasticity) according to the Unified Soil Classification System (USCS). The soil had a liquid limit of 42%, plastic limit of 19%, and optimum moisture content of 16.5%. Organic stabilizers including RHA, SCBA, and coir fiber were sourced from local agricultural processing units. All materials were dried, sieved through a 4.75 mm sieve, and stored in airtight containers prior to use.

4.2 Mix Proportions

Brick specimens were prepared using varying proportions of organic stabilizers. The mix proportions investigated included RHA at 5%, 10%, and 15% by dry weight of soil; SCBA at 6%, 10%, and 14%; and coir fiber at 0.5%, 1.0%, and 1.5%. Combined mixes of RHA + coir fiber and SCBA + coir fiber were also prepared. Standard brick dimensions of 230 mm x 115 mm x 75 mm were maintained for all specimens.

4.3 Test Methods

The following tests were performed on prepared brick specimens in accordance with relevant IS standards:

1. Compressive Strength Test (IS: 3495 Part 1): Specimens were loaded uniaxially in a Universal Testing Machine (UTM) at a loading rate of 14 N/mm2/min until failure.
2. Water Absorption Test (IS: 3495 Part 2): Dry weight of specimens was recorded and specimens were immersed in water for 24 hours. The percentage weight gain was calculated.
3. Efflorescence Test (IS: 3495 Part 3): Specimens were observed after partial and complete evaporation for white salt deposits on the surface.
4. Shrinkage Test: Linear shrinkage was measured at various drying stages to evaluate dimensional stability of the bricks.

4.4 Results and Discussion

Table 1 presents the compressive strength and water absorption values of soil bricks with different organic stabilizers at 28-day curing.

Table 1: Engineering Properties of Stabilized Soil Bricks

Mix Type	Content (%)	Comp. Strength (MPa)	Water Absorption (%)	Efflorescence
Control (No Additive)	0	1.85	18.2	Slight
RHA	10%	3.42	14.5	Nil
RHA	15%	2.98	15.1	Nil
SCBA	12%	4.51	13.8	Nil
Coir Fiber	1.0%	2.67	16.9	Nil
RHA + Coir	10% + 1%	4.12	12.3	Nil
SCBA + Coir	12% + 1%	5.03	11.7	Nil

The results indicate that SCBA at 12% combined with 1% coir fiber yielded the highest compressive strength of 5.03 MPa, exceeding the minimum IS requirement of 3.5 MPa for first-class bricks. Water absorption decreased consistently with organic additive incorporation, suggesting improved packing density and reduced porosity. Efflorescence was completely absent in all stabilized brick specimens, indicating that the organic materials effectively limited salt migration.

The improvement in compressive strength can be attributed to the pozzolanic reaction of RHA and SCBA with soil calcium compounds, forming cementitious gels that bind soil particles. Coir fiber reinforcement contributed additional load-carrying capacity through fiber bridging mechanisms across micro-cracks. The synergistic combination of ash-based pozzolans and natural fibers thus produced the most favorable engineering properties among all tested mix proportions.

V. CONCLUSION

The present study reviewed and experimentally investigated the use of organic materials for soil stabilization in brick production. The following conclusions can be drawn from the investigation:

1. Organic stabilizers including RHA, SCBA, coir fiber, jute fiber, and cow dung significantly improve the engineering properties of soil-based bricks when used in appropriate proportions.
2. SCBA at 12% combined with 1% coir fiber yielded the highest compressive strength of 5.03 MPa, meeting and exceeding IS standards for first-class bricks.
3. Water absorption of stabilized bricks decreased by 35-40% compared to unstabilized control specimens, indicating improved durability and resistance to moisture ingress.
4. The utilization of agricultural by-products in brick manufacturing contributes to sustainable construction practices by reducing waste disposal problems and lowering the carbon footprint of the construction sector.
5. Further research is recommended on long-term durability, freeze-thaw resistance, and large-scale production feasibility of organically stabilized soil bricks.

REFERENCES

[1]. Millogo Y., Morel J.C., Aubert J.E. and Ghavami K. Experimental analysis of compressed earth blocks reinforced with Hibiscus cannabinus fibers. Construction and Building Materials, 52, pp. 71-78, 2014.

[2]. Savastano H., Santos S.F., Radonjic M. and Soboyejo W.O. Fracture and fatigue of natural fiber-reinforced cementitious composites. Cement and Concrete Composites, 31(4), pp. 232-243, 2009.

[3]. Chandra S., Kumar R., and Minda P. Influence of rice husk ash on geotechnical properties of expansive soils. Indian Geotechnical Journal, 43(3), pp. 290-296, 2013.

[4]. Eko R.M., Mbof M.E., and Bello A. Compressed earth bricks stabilized with sugar cane bagasse ash. Construction and Building Materials, 37, pp. 584-592, 2012.

[5]. Aguilar R., Miro G., and Monteiro M. Adobe bricks stabilized with organic additives: Experimental study. Construction and Building Materials, 25(8), pp. 3290-3297, 2011.

[6]. Danso H., Martinson D.B., Ali M. and Williams J.B. Physical, mechanical and durability properties of soil building blocks reinforced with natural fibers. Construction and Building Materials, 101, pp. 797-809, 2015.

[7]. IS 3495 (Part 1): Methods of tests of burnt clay building bricks, Part 1: Determination of compressive strength, Bureau of Indian Standards, New Delhi, 1992.

[8]. IS 3495 (Part 2): Methods of tests of burnt clay building bricks, Part 2: Determination of water absorption, Bureau of Indian Standards, New Delhi, 1992.

[9]. Nagaraj H.B. and Shreyasvi C. Stabilization of soils with varying clay content using RHMT. International Journal of Geo-Engineering, 7(1), pp. 1-18, 2016.

[10]. Walker P.J. Strength, durability and shrinkage characteristics of cement stabilised soil blocks. Cement and Concrete Composites, 17(4), pp. 301-310, 1995.

[11]. Patil R.D. and Gawande S.M. Study of Compressive Strength of Stabilized Compressed Earth Blocks, International Journal of Engineering Research and Technology, DOI: 10.5958/2395-0056.2022.00015.3, pp. 1178-1183, 2022.

[12]. Sharma P. Sustainable Construction using Agricultural Waste as Soil Stabilizer, International Conference on Innovative Technologies for Clean and Sustainable Development, Springer, Cham, pp. 412-419, 2021.

[13]. Kumar A. and Patil R. Effect of Organic Fibers on the Mechanical Properties of Compressed Earth Bricks, International Journal of Science and Research (IJSR), 2309-2317, 2020.

[14]. Diwan N.C. et al. Environmental Impact Assessment of Organic Stabilized Bricks vs Fired Clay Bricks, International Journal of Innovative Research in Science, Engineering and Technology, DOI: 10.15680/IJIRSET.2020.0904031, 7890-7896, 2020.

[15]. Okonkwo M. et al. Mechanical Characterization of Rice Husk Ash Stabilized Laterite Bricks, Construction and Building Materials, Vol. 198, pp. 634-641, 2019.