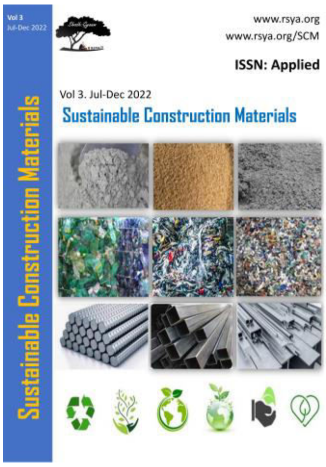

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Parameters of Biochar Clay Bricks with Water Entrainment and Sorptivity

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Abstract. In this study, clay bricks—which are common in most developing nations—were produced using biochar made from rice husk and sugarcane bagasse, which are typically regarded as waste in India. Due to its durability, capacity to absorb water, control of humidity, and ability to insulate due to air entrapment in its microporous structure, biochar has substituted clay in clay bricks. Compared to biochar produced using other techniques, biochar created from agricultural waste had a greater porous structure and offered superior insulation. This study looked at the possibility of using clay-replacing biochar, which is produced by combining rice husk with sugarcane bagasse in a 1:1 ratio. The biochar was ground on a 75-micron sieve. without adding anything to biochar. A total of 20% biochar, including 5% added during building, was used to make the bricks. Bricks with a charcoal percentage of more than 20% were rejected because they were cracked. Ten biochar-clay bricks were created by each procedure. Biochar was created by igniting sun-dried clay bricks in a kiln. Utilizing efflorescence and water absorption, brick quality was determined. Bricks made of biochar-clay were tested for alkali and absorption after curing. The least amount of efflorescence and a marginal improvement in absorption were seen in the bricks with a 15-day curing period and 15% charcoal and clay content.
Keywords: Clay Bricks, Water absorption, Sorptivity, Bio-Char

INTRODUCTION

The most typical agricultural wastes are rice husk and sugar cane bagasse. An estimated 24 million tonnes of rice husk are produced each year in India, and 100 million tonnes of sugarcane bagasse, which is converted into 4.4 million tonnes of rice husk ash, are also produced annually. These wastes should not be disposed of since they include airborne particles that might lead to respiratory issues. Burning agricultural trash causes environmental pollution to last for days. increasing the use of agricultural waste as a construction additive after being pyrolyzed. Biochar with different pore sizes is made when biomass volatiles and organic compounds are released during pyrolysis. Because its pores can both absorb and hold water, biochar can enhance soil. This study looks at how clay bricks that have been burned absorb water using biochar. The ability of biochar to retain water makes it a favourite for enhancing soil. Due to its intricate structure, wide tube network, and substantial surface area, biochar absorbs water effectively. In order to control indoor humidity, plaster absorbs moisture from the air. Efflorescence on biochar-clay bricks was investigated.

BIOCHAR'S APPLICATION IN CLAY BRICKS: A STATE-OF-THE-ART REVIEW

Recently, there has been a lot of interest in using biochar as a building material. Ying Yao et al. studied the characteristics of composites made of clay and biochar. The clay-biochar composite was found to have a much higher ability to bind a simulated contaminant. James Tsz Fung Wong et al. [4] examined the effect of biochar on the hydraulic conductivity of compacted Kaolin clay. The hydraulic conductivity did not considerably improve with the addition of 5 to 20 percent biochar. They concluded that biochar-modified clay that has been compacted can be employed as a landfill cover material without significantly altering the soil's hydraulic conductivity. Souradeep Gupta et al. [5] conducted study on the properties of Biochar-mortar composite and its economic potential. The scientists found that biochar lessens a mortar's permeability. The addition of 1-2 percent biochar to the mixture significantly reduced water absorption, it was also demonstrated. The effects of biochar in a reparative cement mortar were studied by Souradeep Gupta et al. [6]. They discovered that immobilising spores in biochar considerably decreased water absorption and coefficient of sorptivity in both repaired and undamaged samples. Biochar, which is created from food and wood waste, was used by Souradeep Gupta et al [7] as a green component in cement mortar. Researchers discovered that adding up to 2% of sawdust and rice waste biochar to food waste biochar greatly decreased capillary water absorption and water penetration in mortar under pressure. This resulted from biochar densifying the mortar material. Suchanya Wongrod et al. [8] investigated how well lead may be absorbed by biochar produced from digested trash. They discovered that using biochar as the sorption surface led to 2- to 10-fold increased lead sorption. The hydrologic capacity of biochars is reportedly affected by two significant pyrolysis-related processes, according to Weber and Quicker [9]: the attraction of the material to water changes as functional groups decrease, and the amount of water that may be adsorbed changes as porosity increases. Chun Y et al [10] and Pimchuai A [11] conducted several experiments on carbonised biomass water absorption and came to the conclusion that increasing the pyrolysis temperature increased the biochar's hydrophobic characteristics. This is due to the fact that greater temperatures lead the surface to become less polarised, resulting in increased hydrophobic characteristics. When the treatment temperature was increased to 500 °C or higher, Zornoza et al. [12] created no hydrophobic biochar from pig manure and agricultural waste, while producing biochar that was very hydrophobic at 300 °C. When evaluating biochar made from wood, leaves, and agricultural wastes using the molarity of an ethanol drop test at temperatures ranging from 300 to 600 °C, TJ Kinney et al. [13] also discovered a similar result. During his research into biochar as a potential building material, HP Schmidt [14] discovered that the porous nature of biochar allows air pockets to form in the biochar mixed plaster, which serve as insulation surrounding the room. Somerville and Jahanshahi [15] discovered that higher pyrolysis temperatures result in bigger porosity in the end product, with a maximum porosity of 72 percent at 850 °C. CE Grass chars have much larger porosities than woody biochars, reaching 80% at treatment temperatures between 350 and 700 °C, and are less temperature-dependent than wood throughout this range, according to Brewer et al. [16]. In their studies on the use of microporous carbon to control humidity, researchers Nakano T. et al. [17] and Abe L. et al. [18] found that biochar provided efficient and inexpensive means of regulating and controlling a room's humidity. Kitamura T. [19] got to the conclusion that coating biochar not only on the underside of the floor but also on the ceiling greatly helped to manage the humidity of the construction after examining the potential of wood waste charcoal to control humidity.

METHODOLOGY

Clay Used for Clay Bricks

Clay bricks were made using topsoil, which was simple to come by in the area. The surface was cleansed, and mining was done down to a depth of two metres before selecting the clay deposit, which was free of boulders and organic pollutants.

Production of Biochar

Biochar was made using rice husk and sugarcane bagasse in an equal ratio. Before pyrolysis, the waste was sun-dried to remove moisture. The trash was pyrolyzed at 500 °C. A decentralised system was used to create the formation, and it included a gas-burning kiln and an airtight container with a tiny aperture to let out the gases produced during the process while preventing the container from bursting. The biochar was cooled after the pyrolysis process and then kept in airtight containers. About 20% of the biochar was produced in its entirety. Before being mixed with the clay bricks, the biochar was ground into tiny pieces in a commercial grinder. [4-7].

Brick Formation

The weight of the biochar samples was increased by 5% to produce the bricks. Crushed and treated raw materials, mostly charcoal and soil, are used to make clay bricks. The components are then extruded into shape. The components are powdered, water is added, they are squeezed and extruded from a die made for a specific shape. The bricks are dried after being made to remove any excess moisture that can cause cracking. Over 20% biochar-containing bricks were disregarded because of cracks that developed during the drying process. After that, bricks are transported to gigantic furnaces called kilns on carts. The bricks are then chilled after being heated in a high-temperature kiln to a temperature of between 800-1000 °C. The brick is reinforced and hardened throughout the burning process. They are allowed to cool after being fired [20].

Tests Conducted

The dimensions of the bricks were determined to the nearest 1 mm. Five specimens must be tested for each sample [21].

water absorption

The specimen is dried until it reaches a mass that is largely constant at 105°C to 115°C in a ventilated oven. The specimen is then allowed to cool to room temperature before being weighed (M1). This method is not applicable to specimens that are warm to the touch. Dry samples are immersed in clean water for 24 hours at a temperature of 27.2 °C. The object is then removed, and any remaining water is wiped off with a moist cloth before the weight is calculated. Three minutes after the specimen is taken out of the water, it is weighed (M2).

Efflorescence Test

The ends of the bricks are positioned in a dish of water that is submerged to a depth of 25 mm. The setup is kept in a warm (20 to 30 °C) well-ventilated environment until the specimens have absorbed all of the water in the dish and the excess water has evaporated. Once the water has been absorbed and the bricks appear to be dry, fill the dish with a similar amount of water and let it evaporate as before. After the second evaporation, inspect the bricks for efflorescence [23]. Liability for efflorescence must be specified as follows: The value is zero if the efflorescence deposit is not evident. when a thin layer of salt covers no more than 10% of the brick's exposed surface. A heavier than "light" coating that completely covers the exposed brick surface (up to 50%), without flaking or powdering. There is no surface flaking or powdering when a sizable salt deposit covers 50% or more of the exposed brick surface. when exposed portions have flaking, powdering, and/or a significant salt buildup.

RESULTS AND DISCUSSION

Water Absorption Test

The tests were finished following the 2002 "Methods of Tests on Burnt Clay Building Bricks Part 2" criteria from IS 3495 Part 2.

TABLE 1. 24 hr Immersion Cold Water Test for each sample of brick

Biochar content	0 % (%)	5 % (%)	10 % (%)	15 % (%)	20 % (%)
B1	13.66	13.72	11.36	15.04	18.5
B2	11.11	8.36	11.47	17.55	19.34
B3	10.03	9.45	12.08	15.63	18.17
B4	15.18	12.14	11.01	16.96	18.14
B5	14.54	13.87	12.12	17.67	18.63
Average	**12.96**	**11.51**	**11.61**	**16.57**	**18.56**
Std. Dev.	**0**	**1.025**	**0.955**	**2.553**	**3.960**

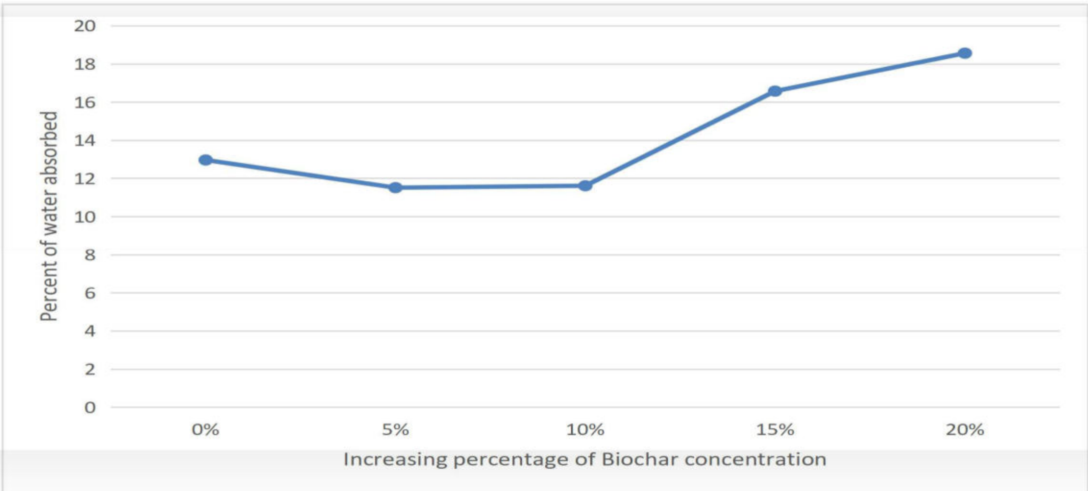

FIGURE 1. Variation of Water Absorption with increasing Biochar concentration

Efflorescence Test

The tests were completed in accordance with IS 3495 Part 3's 2002 "Methods of Tests on Burnt Clay Building Bricks Part 3" specifications.

TABLE 2. Efflorescence Test for each sample of brick

Biochar content	0 %	5 %	10 %	15 %	20 %
B1	Moderate	Nil	Nil	Nil	Nil
B2	Nil	Nil	Moderate	Nil	Nil
B3	Moderate	Nil	Nil	Nil	Nil
B4	Nil	Moderate	Nil	Nil	Nil
B5	Nil	Nil	Nil	Nil	Nil

Discussion

The quantity of water absorbed by the bricks drastically increased as the concentration was elevated, and following the addition of biochar, the amount of water absorbed by the bricks dropped by up to 10%. The reduction in the amount of water the bricks absorbed with the addition of biochar was another finding. The root cause of this phenomena was discovered to be biochar's strong absorption and adsorption capacities. It is an impressive accomplishment that the water absorption rate of the bricks is substantially lower than the maximum level allowed for first-class bricks. It was found that the efflorescence had, on average, diminished following the addition of 15 and 20 percent biochar since there was almost no efflorescence detected after the addition of biochar.

CONCLUSION

This study looked into the possibility of enhancing clay bricks with biochar, which is formed at 500 degrees Celsius from agricultural waste materials including rice husk and sugarcane bagasse. The researchers observed how the increasing addition of biochar affected the fundamental physical characteristics of clay bricks and came to the following conclusions: Even bricks with a higher biochar content that had a higher water absorption rate were well below the maximum allowable limit. The amount of water that was absorbed by bricks with a 5 percent biochar concentration was significantly less than the amount of water that was absorbed by bricks with no biochar in them. The biochar-clay bricks formed with greater biochar concentrations (between 15 and 20 percent), which are still within the acceptable range of an ideal first-class brick, may offer excellent humidity management due to their extremely absorbent and hydrophilic character. This might be the case since these bricks meet the standards for a good first-class brick. As the biochar level rose, less efflorescence was observed on the brick samples. This happened as a result of replacing the calcium carbonate-containing clay with biochar, which led to a decrease in the overall calcium carbonate concentration in the bricks. It was found that the weight of clay bricks dropped when they were burned as the amount of biochar in the bricks increased. The bricks became lighter as a result, which simplified and reduced the cost of transportation.

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