Chapter

Experimental Investigation on Clay Bricks Using Babul Sawdust Bricks

Praveen Kumar R., Balaji D.S. and Navaneethakrishnan G.

Abstract

The construction practices of today demands production of alternative building materials, which consume less energy and can be used for construction. One such material is the babul tree sawdust bricks. In this work, the babul sawdust is prepared using the locally available babul tree in India. Hence, an attempt is made to stabilize these blocks using clay and sawdust. The saw dust percentage has been varied from 0 to 50% by weight. The results show the variation in properties such as compressive strength, initial rate of absorption and water absorption are studied and compared.

Keywords: babul sawdust, clay, compressive strength, water absorption

1. Introduction

Earth has been the most widely known and abundantly available material for human society to use it in construction. From the days of Egyptian and Mesopotamian earth is main part of any construction in its different forms [1]. Nowadays, several research fields on materials recycling environmentally friendly and energy conservation are operated. Many previous researches have obtained valuable results to use the industrial wastes in various forms of construction materials production [2]. So we are used babul sawdust in manufacturing of bricks. In addition, demand for clay bricks with higher insulating capacity is increasing. For this purpose, we used babul sawdust and other organic materials most frequently used as pore formers [3]. These materials had properties which resembled those of lightweight brick materials. The Babul sawdust is the byproduct of sawing babul tree timbers. The recycling of the wood chips such as sawdust which offers the required properties of ceramic products. The chemical composition of the sawdust is 60.8% of carbon, 33.83% of oxygen, 5.19% of Oxygen and 0.90% of Nitrogen [4]. In this study, investigation of the sawdust suitability to use in combination of ceramic material was carried out. The clay bricks made with the mixture of sawdust and ceramic material have advantage compared to traditional bricks in the aspect of action of degreasing, low density and alveolar appearance, improved mechanical strength. Various experimental works and reviews related to the study of saw dust have been carried out [5].

The cohesive nature of the clay imparts plasticity to the soil under moist conditions. The thin film of water absorbed ensures the strong adherence between the layers leads to plasticity. The mineral present in the clay acts as a natural binding agent. The affinity of the clay towards water results in swelling and shrinking when it dries,

Figure 1.
Babul tree and saw dust.

especially it is prominent when montmorillonite is present. Stability agents like lime added to the soils with the clay content of above 30%. Particle size is ranges from less 0.002 mm to greater than 2 mm. Babul tree known for the exploitation of the ground water and its impact on reduction of the water table. Even it grows in the drought hit areas with no ground water by absorbing the water molecules in the air (humidity), leaving the place dry and affects the rainfall also. The roots of the babul tree destroy the soil nutrients. It produces carbon dioxide more than the oxygen generation which makes it unlikely even for the birds to have their shelter. The seeds and the parts of the babul tree is of no use to the humans and animals. Earlier the babul tree seed was sowed in various drought hit regions of India for firewood purpose. After knowing the ill effects on the environment, many global organizations steps forward to create awareness. The Babul Tree and saw dust is shown in **Figure 1**.

2. Experimental work

2.1 Specific gravity test of sawdust

It is defined as the ratio of the density of any substance to the density of some other substances taken as standard, water being the standard for liquids and solids, and hydrogen or air being the standard for gases. Weigh a clean and dry le chatelier flask of bottle with its stopper noted as W1. Clay sample filled half of the flask (about 50 gram) and weigh it with its stopper noted as W2. Add water to in the flask till it is half full. Mix with glass rod thoroughly to remove entrapped air. Continue stirring and add more water till the graduated mark. The Specific gravity test instrument is shown **Figure 2**. Then the pychnometer is completely filled with water, wiped of the outside and weighed again W3. The pychnometer is then emptied and filled with water and weighed W4.

$$\text{Specific gravity} = \frac{(w_2 - w_1)}{(w_2 - w_1) - (w_3 - w_4)} \times 100 \quad (1)$$

Weight of empty bottle, w_1 = 0.673
Weight of soil, w_2 = 1.22
Weight of soil and water, w_3 = 1.83
Weight of water, w_4 = 1.5

Figure 2.
Specific gravity test instrument.

2.2 Sieve analysis test of sawdust

A sieve analysis is a procedure used to assess the particle size distribution of a granular soil. It is performed on any type of non-organic or organic granular material including sands, crusher rocks, clays, granite, feldspars, soil, coal, grain and seeds down to a minimum size depending on the exact method. About 1000 grams of oven dried soil retained as 75 micron sieve is taken. The soil is sieve through the set of sieves as per the order of arrangement indicated sieve sizes: 4.75 mm, 2.36 mm, 1.18 mm, 600 μ, 425 μ, 300 μ,150 μ,75 μ and pan. The cover is placed over the top of stack of the sieves. The set of sieves is shaken for about 10 minutes giving both horizontal and vertical movements. The soil retained in each sieve is transferred to separate plates and weighted accurately. Cumulative weight retained cumulative percentage retained and percentage passing are calculated. The Sieve analysis instrument is shown in **Figure 3**.

$$\text{Percentage of retained} = \frac{\text{weight of material retained in each seive}}{\text{weight of sample taken for the test}} \times 100 \quad (2)$$

$$\text{Percentage of passing} = 100 - \text{Percentage of retained}$$

$$\text{Effective size of clay} = 90\,\text{microns}$$

2.3 Liquid limit test of sawdust

The liquid is arbitrarily defined as the water, in percent at which a part of soil in a standard cup and cut by a groove of standard dimensions will flow together. Weighed about 120 g of soil passing through 420 μ I.S sieve. The soil sample is placed on the evaporating dish and thoroughly mixed with water using spatula. The casagranda's device is checked to have a correct fall of 10 mm and placed a portion of the prepared paste over the brass cap. The groove is made in the middle of

Figure 3.
Sieve analysis instrument.

the soil cake using the grooving tool. It is rotated at the rate of 2 blows per second and the relations are counted until the groove closes over a length of 12 mm. At center of test sample, a small quantity is collected in a container and its weight is noted. The sample is dried in the oven for 24 hrs. and weighed. The difference of the two weights will give the moisture content. The experiment is repeated by adding more water. Four trials are made, so that the numbers of blows are more than 25 in two cases and less than 25 in other two cases. In each trial moisture are determined. The Liquid limit test results shown in **Table 1**. The Liquid limit test instrument is shown in **Figure 4**.

2.4 Plastic limit test of sawdust

The plastic material is defined as the moisture content at which the plastic material can be molded into a shape and the material will retain that shape. If the moisture content is below the plastic limit, it is considered to behave as a solid material. A sample of about 50 gram is taken in a glass plate and mixed thoroughly with water, rolled into ball shape and made into thread with a diameter of 3 mm. The process of making thread by kneading and rolling again is repeated until the soil ceases to be

Weight of dry soil (gms)	Quantity of water	Percentage of water added	Number of blows
120	22	18	112
120	26	21	73
120	30	25	55
120	32	26	26
120	34	28	13

Table 1.
Liquid limit test results.

Figure 4.
Liquid limit test instrument for measurement.

Observation (gm)	Trial 1	Trial 2
Weight of can (W_0)	11.7	13.4
Weight of wet soil with can (W_1)	12.6	14.6
Weight of dry soil with can (W_2)	12.4	14.3
Weight of water (W_2–W_1)	0.2	0.3
Weight of dry soil (W_2–W_0)	0.7	0.9
Moisture content (W%)	28.57	33.3

Table 2.
Tabulation for plastic limit test.

plastic and crumbles. The sample of the crumbled soil was collected together and placed in a container. The test is repeated twice more with fresh samples. The average of the three water contents gave the plastic limit value. The Tabulation for plastic limit test **Table 2**. The Plastic limit test instrument as shown in **Figure 5**.

2.5 Shrinkage limit of sawdust

The shrinkage limit is the maximum water content at which a reduction in water content does not significantly reduce the volume of the soil mass. After a certain point, when the water content continues to drop, air begins to seep into the soil's voids, maintaining the void's volume. Mix 30gm of soil that has passed through a 425 μ sieve with distilled water.. Without adding air bubbles, the water should be enough to make the soil pasty in the shrinkage dish. As soon as the shrinkage dish is filled with red soil, weigh it. The dish should be dried in both the air and an oven. With the dry soil paste, weigh the shrinkage dish. Determine the dish's empty mass after cleaning and drying it. Weigh a second, empty, ceramic dish that will be used to measure the weight of mercury. Keep the shrinkage dish inside a sizable porcelain dish, overflow it with mercury, and scoop out the extra by pressing a plate of plain glass firmly over the dish's top. Wipe the outside of the glass cup to remove any adhering mercury, and then place it in another dish. Place a dry soil paste on the surface of the mercury and submerge it under the mercury by pressing with glass plate with

Figure 5.
Plastic limit test instrument.

Trial no	1	2	3	4
Water content (%)	65.77	79.55	63.94	69.75
Shrinkage limit (%)	12.11	9.04	9.26	9.18

Table 3.
Tabulation for shrinkage limit.

prongs. Transfer the mercury displaced by the soil paste to the mercury weighing dish and weight. The tabulation for Shrinkage limit as shown in **Table 3**. The Shrinkage Limit Instrument is shown in **Figure 6**.

2.6 Compressive strength test of bricks

This test is carried out to determine the brick's compressive strength. It is also known as the brick's crushing strength. Six brick samples are typically brought to a laboratory for testing and examined one by one. A brick specimen is placed on a crushing machine during this test, and pressure is applied until the brick breaks. It is taken into account the maximum pressure at which bricks are crushed. Each of the six specimens is tested separately, and the average result is used to determine the compressive strength of bricks. Make a note of the specimen's dimensions. The specimen should be placed between compression grips. Apply the load now. Gradually raise the load and record the load at which the specimen fails. Divide the load by the contact surface area to determine the compressive strength. Find the materials' average compressive strength by testing three specimens. **Table 4** displays the outcomes of the compression strength test. **Figure 7** depicts the Brick in a loading condition. **Figure 8** displays the Compressive Strength Chart.

Figure 6.
Shrinkage limit instrument.

Saw dust	Compressive strength value			Average (N/mm^2)
	S1	S2	S3	
0%	7.1	7.3	7.35	7.25
10%	7.55	7.9	7.8	7.75
20%	7.6	7.8	7.46	7.62
30%	7.27	7.55	7.26	7.36
40%	7.27	7.01	7.2	7.16
50%	6.95	7.01	7.04	7

Table 4.
Compressive strength test results.

2.7 Water absorption test of bricks

In this test, dry bricks that have been weighed are submerged in fresh water for 24 hours. Following immersion, the items are removed from the water and dried with a cloth before the brick is weighed while still wet. The water detected by brick accounts for the weight discrepancy. Next, the water absorption is computed. Brick's quality increases with how little water it absorbs. An excellent brick will not absorb 20% of its own weight. The sawdust bricks used in **Figure 9** water absorption tests. The results of the water absorption test are displayed in **Table 5**.

2.8 Efflorescence test of bricks

Alkalies in bricks are harmful, and by absorbing moisture, they turn the surface of bricks gray or white. This test is carried out to determine whether alkalies are

Figure 7.
Brick under loading condition.

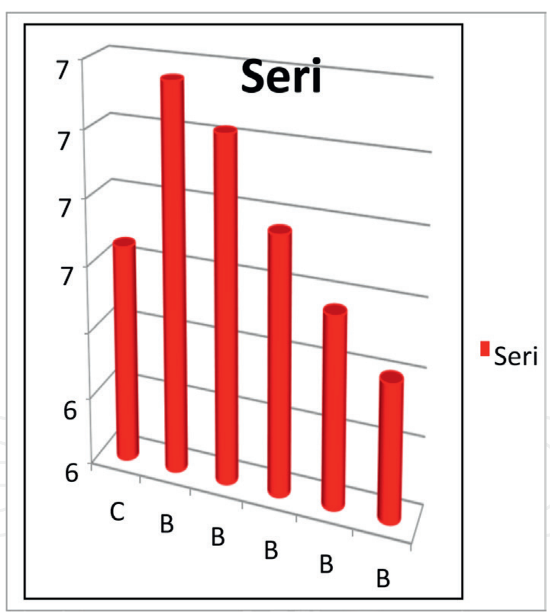

Figure 8.
Compressive strength chart.

present in bricks. In this experiment, a brick is submerged in fresh water for 24 hours, removed, and then given time to dry into the desired shape. It is evidence that there are no alkalies in brick if the whitish layer is not visible on the surface. The presence of alkalies is acceptable if it covers about 10% of the brick surface and is visible. It is moderate if that represents 50% of the surface. Alkalies have a significant negative impact on brick if they are present in excess of 50%. The Brick after Efflorescence test as shown in **Figure 10**. The results of Efflorescence test as shown in **Table 6**.

DOI: http://dx.doi.org/10.5772/intechopen.107082

Figure 9.
Sawdust bricks during water absorption test.

Sawdust percentage	Weight of brick (kg)	Water absorption value (percentage)
0	3	21
10	2.91	20.1
20	2.85	18.9
30	2.8	17
40	2.77	15.5
50	2.7	14

Table 5.
Water absorption test result.

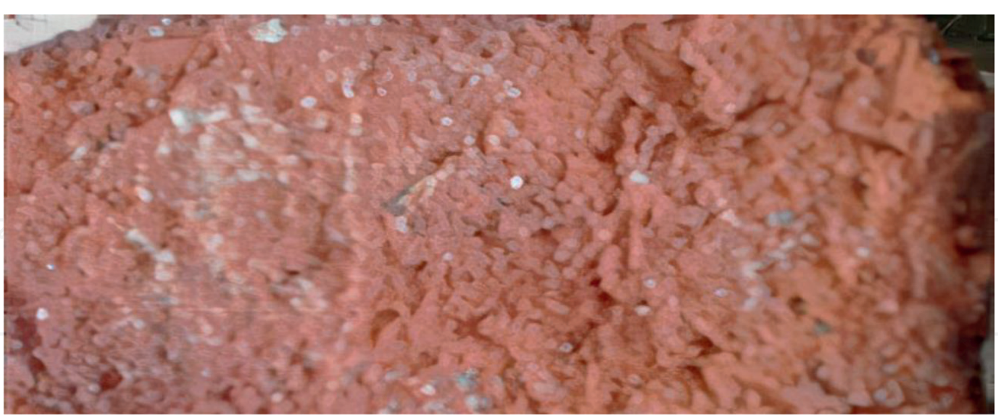

Figure 10.
Brick after efflorescence test.

2.9 Density test of bricks

All bricks' weights are measured individually. Then calculate the chamber brick and babul sawdust brick's length, width, and depth. Finally, use the following formula to determine the density of bricks. The Chamber Brick Density Test is displayed in **Table 7**. The Sawdust Brick Density Test is presented in **Table 8**.

Sawdust percentage	weight of brick(kg)	Efflorescence (gms)
0	3	0.45
10	2.95	0.45
20	2.89	0.39
30	2.83	0.33
40	2.77	0.32
50	2.7	0.35

Table 6.
Tabulation of efflorescence test.

S. No	Sample	Size (m)			Weight (kg)	Volume (m^3)	Density (kg/m^3)
		L	B	D			
1	1	0.22	0.10	0.08	3	0.0017	1764.70
2	2	0.22	0.10	0.08	3.15	0.0017	1789.77
3	3	0.22	0.10	0.08	3.05	0.0017	1794.11

Table 7.
Density test for chamber brick.

S.No.	Sawdust (%)	Size(m)			Weight (kg)	Volume (m^3)	Density (kg/m^3)
		L	B	D			
1	0	0.22	0.10	0.08	3	0.0017	1764.70
2	10	0.22	0.10	0.08	2.91	0.0017	1711.76
3	20	0.22	0.10	0.08	2.85	0.0017	1676.47
4	30	0.22	0.10	0.08	2.8	0.0017	1647.05
5	40	0.22	0.10	0.08	2.77	0.0017	1629.42
6	50	0.22	0.10	0.08	2.7	0.0017	1588.23

Table 8.
Density test for sawdust bricks.

3. Conclusion

- Effective utilization of the available resources without harming the environment is a major concern in the present situation.

- Many countries takes various initiatives through implementation of policies and awareness programs.

- Considering the ill effects of the babul tree on the environment, an alternate method which is environmentally friendly to utilize its byproducts (sawdust) is important. Based on the investigation, the Babul sawdust seems to be a potential replacement for the clay in brick making.

- The findings show that about 50% of babul sawdust is the ideal amount to replace clay soil, producing a block with a high compressive strength value of 7 N/mm^2 with water absorption value of 14% and efflorescence value of 0.35. Compared to regular bricks, this brick has a high efficiency and cost-effective. We are using this tree sawdust as a replacement material of clay in brick.

- Babul sawdust may one day be able to partially replace clay in the production of brick blocks.

Author details

Praveen Kumar R.[1]*, Balaji D.S.[2] and Navaneethakrishnan G.[3]

1 Department of Marine Engineering, AMET University, Chennai, Tamilnadu, India

2 Department of Mechanical Engineering, AMET University, Chennai, Tamilnadu, India

3 Department of Mechanical Engineering, K. Ramakrishnan College of Technology, Trichy, Tamilnadu, India

*Address all correspondence to: praveen71989@gmail.com

References

[1] Panwar NL. Design and performance evaluation of energy efficient biomass gasifier based cookstove on multi fuels. Mitigation and Adaptation Strategies for Global Change. 2009;**14**(7):627-633

[2] Pathak BS, Patel SR, Bhave AG, Bhoi PR, Sharma AM, Shah NP. Performance evaluation of an agricultural residue-based modular throat-type down-draft gasifier for thermal application. Biomass and Bioenergy. 2008;**32**(1):72-77

[3] Nsamba HK, Hale SE, Cornelissen G, Bachmann RT. Sustainable technologies for small-scale biochar production—A review. Journal of Sustainable Bioenergy Systems. 2015;**5**(01):10

[4] Boob TN. Performance of saw-dust in low cost sandcrete blocks. American Journal of Engineering Research. 2014;**3**(4):197-206

[5] Jain M, Mudhoo A, Garg VK. Swiss blue dye sequestration by adsorption using Acacia nilotica sawdust. International Journal of Environmental Technology and Management. 2011;**14**(1-4):220-237