

Development of light weight bricks using red clay and rice-husk

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Introduction

Bricks are one of the oldest building materials that can be made at relatively low cost. They have been in continual use for more than 5000 years and still used in Sri Lanka, because of their many advantages (El-Mahllawy *et al.*, 2013). Mud bricks, burned bricks and cement bricks are types of bricks using in construction purposes (Society of Civil Engineers, 1996). The composition of red clay minerals used in brick production is SiO₂ (60.67%), Al₂O₃ (15.18%) and Fe₂O₃ (7.61%) (Hettiarachchi *et al.*, 2010). Certain admixtures such as rice-husks, sawdust, etc. are added to brick raw mixtures to produce different effects such as color, high strength, or low weight in the finished product. Admixtures consists of organic matter are burned out when bricks undergo firing. Consequently, porous bricks are produced. This permits the control of the bulk density of brick products and help in producing lighter bricks with low material cost. In this research work, bricks are made using red clay and 5 wt. % of rice-husk or 5 wt. % of rice-husk ash as admixtures. The fabricated bricks were analyzed to measure material properties such as compressive strength, weight, volume, density, water absorption, and color changes during firing process. Results are then compared with the values obtained from commercial bricks.

Methodology

Preparation of prototype bricks

The dimensions of the bricks studied in this project were 25% of the commercial brick dimensions. Accordingly, length 4 1/4" (10.79 cm) x width 2 3/4" (6.98 cm) x height 1 1/4" (3.17 cm) mold was used to make prototype bricks. Bricks were made with both premixed clay (obtained from brick makers) and dried clay with rice husk.

Procedure 1 (Premixed Clay)

The amount of water added to the clay material was unknown as it was obtained as a wet sample from the brick makers. The purpose of making bricks with this premix is to set standards for tensile strength and weight of the bricks similar to market quality bricks. Accordingly, five brick blocks were made with premixed clay (500 g). These bricks are labeled as sample 1.

Procedure 2 (Dried Clay)

Clay material and rice-husk sample were dried until a constant weight was obtained (2-3 days). Then dried clay and a known amount of water were mixed to produce bricks to be used as the control (sample 2) to compare the effect of rice husk. The same amount of clay and water were mixed with either five percent of rice-husk (sample 3) or rice-husk ash (sample 4). In each case, five bricks were made. All the brick samples were dried under sunlight for four days. Firing process of the bricks was

done using a common rice-husk burning kiln or using an electrical furnace at 1000 C during this research.

All bricks were tested for compressive strength, weight, volume, density, water absorption, and color changes. Bricks made with rice husk (sample **3** and **4**) were compared against premix samples (sample **1**) and bricks made without rice husk (sample **2**).

Results and Discussion

Density of the prototype bricks

The dimensions and weight of the bricks were recorded for all samples before and after firing. These data were used to calculate the volume and density of bricks. According to the results, volumes of unfired bricks samples are almost equal, but after firing the bricks have different values for volume due to evaporation of water and burning of organic matter during firing process. The lowest density was recorded for sample with rice husk (**3**) compared to the control sample (**2**). Also addition of rice husk in sample **3** resulted in lower density compared to the sample with rice husk ash (**4**). This observation is in agreement with the expected trend in density where rice husk burning will result higher loss in weight compared to rice husk ash.

Table 01. Changes in density of bricks

	Density/gcm ⁻³			
	1	2	3	4
Before Fired	2.00	1.97	1.82	1.84
After Fired	1.94	1.93	1.69	1.79

Water Absorption of the prototype bricks

The amount of water absorbed by bricks were measured by dipping the sample in to a beaker filled with water (400 – 500 ml) for 60 minutes followed by measuring the change in weight of the brick. The percentage of weight rise is given as amount of water absorbed by the brick. Water absorption of the red clay bricks with rice husk are less than others, due to water resistant nature of rice husk. Also this value is within the accepted standards of construction bricks, (Brick Industry Association, 2007) which indicate higher durability for such bricks.

Table 02: Water absorption of fired bricks

Samples	1	2	3	4	Commercial Brick
Water Absorption (%)	3.43	3.02	1.55	2.04	6.33

Strength of the prototype bricks

Bricks made with rice husk indicated higher tensile strength (measured by Universal Tensile Machine, J. T. M. Technology) compared to other types of bricks as shown in Figure 1. Main composition of rice husk is SiO₂ (93.59%)(German *et al.*, 1985). Therefore, enhanced Si-O bonds between red clay and silica from rice husk could be a reason for higher tensile strength (Cleerfield, *et al.*, 1982). SiO₂ presents as SiO₄ units inside the body of the brick block and each oxygen atom

interacts with other impurities such as Al^{3+} , Fe^{2+} and etc. Thus, the formation of strong bonds inside the brick results it hard to break. (Sutas *et al.*, 2012, German *et al.*, 1982).

Color change

The unfired clay bricks were brown in color and became red after firing. It is because of chelation of iron with oxides and silicates in clay when supplying heat energy.

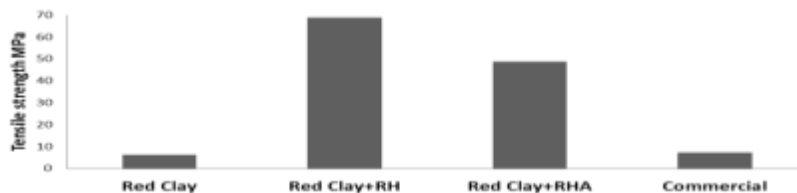


Figure 01. Compressive strength of brick samples

Conclusions

By addition of rice-husk into the red clay, we observed an increase in the strength, decrease in the water absorption, and decrease in the density of the brick block. Final conclusion of this research suggests that by adding admixture of rice-husk into the red clay we can develop light weight bricks with high compressive strength than commercial bricks or red clay with rice-husk ash.

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