Production of Sustainable Alternative Building Block Using Rice Husk Ash

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Abstract

In today's society, environmental contamination is the most concerning issue. One of the main businesses that pollutes the environment is the construction sector. Burnt clay brick, which is the most widely used building material in Bangladesh, emits a large quantity of greenhouse gases. Alternative sustainable construction materials may be able to help with this issue and provide a better atmosphere. The building industry and society as a whole gain sustainably from the use of rice husk ash (RHA) in construction.. At present, the building blocks made from alternative materials are extensively used worldwide. This paper focuses on an experimental investigation conducted on the blocks made of Rice Husk Ash (RHA).

Keywords*: Rice Husk Ash, Burnt clay Brick, Sustainable, Alternative, Environment pollution*

1.0 INTRODUCTION

Burnt clay brick have been used for long in building construction and its demand is increasing rapidly with the passage of time [1]. In the burning process of clay brick air is polluted and necessary clay is collected from agricultural land. As a result, agricultural land is being diminished. Using alternative light weight block in building construction, foundation cost can be reduced as foundation treatment is directly related to the load of the structures. The generation of bricks, due to Hg substance in crude materials and high temperature condition, is a critical source of few poisonous components counting Hg, and risk gasses into the environment [2]. At present, energy use has become a burning question word wide, in which building consume between 20 and 40 percent of the total energy consumption in developed countries [3]. Energy consumption can be reduced using alternative building blocks [4]. Bangladesh is a tropical country. Tropical climates with typical concrete homes that are poorly ventilated can see high temperatures that are typically higher than the outside dry bulb temperature [5]. Building masonry and other cement-based materials are used largely throughout because of their numerous beneficial characteristics, including availability, affordability, and durability [6].

Unwanted thermal energy may build up in homes and buildings due to a number of factors, including air infiltration through walls, radiation or convection induced heat transfer, heat from interior appliances, equipment, and inhabitants, and solar radiation. In the tropics, where cement-based building materials, such as concrete, are often utilized, undesirable thermal energy storage is an important issue. Long-term thermal energy absorption can be accomplished with concrete and other cement-based materials, particularly when exposed to high ambient temperatures, which in tropical climates fluctuate between 31ºC (88 F) in the winter to 34ºC (93 F) in the summer [7]. Climate change is a major social issue that requires significant energy reductions in the building industry. To reduce energy consumption and improve the comfort level of the interior environment, suitable construction materials that may act as thermal barriers must be used in order to avoid heat [8]. It is unable to absorb water due to its closed cell structure. It is impermeable to impact and has strong thermal insulation qualities [9]. The development segment plays a cardinal part in financial development. Development industry straightforwardly accounts for 23% of worldwide carbon dioxide (CO_2) emanation [10]. The Housing and Building Research Institute in Bangladesh has started a study on these building materials. A number of studies on the production and characteristics of alternative building blocks in their native setting were conducted in Dhaka. Researchers are searching for concrete substitutes that don't sacrifice strength in order to reduce the cost of building concrete structures. By replacing some of the cement content with other kinds of auxiliary materials, the main cost of concrete may be minimized. In seven of the nation's largest cities, brick kilns are the main source of air pollution, especially during the dry season when the majority of bricks are produced, making the air quality in these areas "severely unhealthy." According to a government examination conducted over five years, Dhaka and Narayanganj have the most filthy air. Gazipur comes in third, followed by Khulna, Rajshahi, Chattogram, and Barisal.

Fig. 1: Brick kilns top polluter in Bangladesh (Captured by Authors)

The soil of the crop land is being cut and taken to the kiln. The soil is losing its fertility as the upper part of the land i.e. the top soil goes down. As a result, hundreds of acres of land have become uncultivated and there is a danger of food shortage. In the aman season, as soon as the paddy is harvested, the process of cutting the soil from the crop land and taking it to the brick kiln begins. The owner off the brick kiln and some unscrupulous soil traders are showing greed for money to the farmers by cutting the soil with the help of workers or machines.

Fig. 2: Agricultural top soil cutting for brick kiln (Captured by Authors)

Millions of tons of rice husk are generated annually as a byproduct of industrial and agricultural captured by the albums activities; upon complete combustion, the husk yields 20–25% RHA by weight. In concrete, rice husk ash (RHA) is regarded as a highly pozzolanic substance that may partially substitute cement. When RHA is used in concrete as a partial replacement for cement, it reduces the cost of building concrete, makes it easier to recycle waste from the incineration or combustion of rice husk used in industrial and agricultural projects, and lessens the amount of CO_2 pollution caused by the cement production process [11]. The utilization of squander RHA has been basically centered on clay substitutions for terminated clay bricks [12]. The mechanical and structural qualities of RHA for use in concrete, both with and without additional ingredients, are being studied by researchers. The use of RHA in concrete as a partial substitute of cement has been thoroughly studied in terms of strength, durability, mechanical strength, and physical attributes. The rice milling business uses a large amount of field-grown paddy. The main use for this rice husk is as fuel in boilers that process paddy. Another usage for rice husk is as a fuel for electricity production. When burned in boilers, rice husk ash (RHA) makes up around 25% of the total weight of rice husk.An estimated 70 million tons of RHA are generated globally each year. Relationship models between compressive quality of concrete and the substitution proportion of RHA have been created within the writing for the security plan of RAC [13]. This RHA poses a serious risk to the environment, harming both the land and the vicinity where it is disposed of. Approximately 78% of the weight of the paddy is obtained as rice, broken grains, and bran after milling. The remaining 22% of the rice is used to make husk. This husk is burned in rice mills to produce steam, which is needed for parboiling. Around 75% of this husk is made up of organic volatile materials, with the remaining During the RHA fire process, this husk loses 25% of its weight in ash.. The proportion of Fly Ash and RHA of 50:50 were chosen to deliver rice husk cinder and fly fiery remains geopolymer empty pieces [14]. In turn, this RHA has 85 to 90 percent amorphous silica. Among the several precast concrete materials used in construction is the Sand Cement Concrete Block [15].

2.0 METHODOLOGY AND EXPERIMENTAL PROGRAM

Cement, sand, and rice husk ash are the materials used in this study. The ASTM Test Method C 29 was adopted to determine the unit weight of rice husk ash. The Fineness Modulus of Sand was measured using the Standard Test Method for Sieve Analysis of Fine Aggregate (ASTM C 136). Rice husk ash was used by volume as percentage of total volume as (5%,10% and 15%).

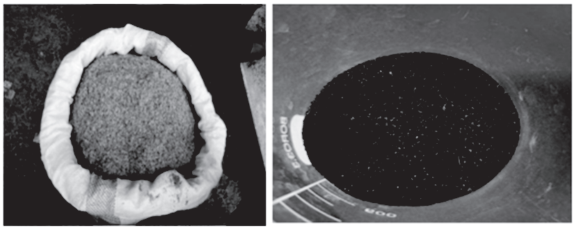

Fig. 3: Rice Husk and Rice Husk Ash (Captured by Authors)

2.1 Casting of Building Blocks

Four kinds of building blocks were built so as to perform tests on compressive strength, density, water absorption, and thermal insulation. The size of the block was 9.5” X 4.5” X 2.75” which is same as burnt clay brick. The number each Type of block casted was 3. The total number of block produced was 12. For making block lightweight and sustainable Rice Husk Ash was used. All the specimens are shown in figure 4.

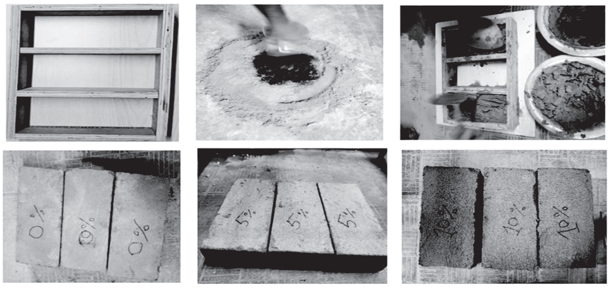

Fig. 4: Different types of building blocks using Rice Husk Ash (Captured by Authors)

2.2 Determination of Compressive strength

Compressive strength test of bricks are performed according to ASTM C67-03 to measure the load bearing capability of bricks during compression with the use of compression testing equipment. This is one of the most important and significant properties of building block. In this report the compressive strength of different types of building block including burnt clay brick were determined at the age of 28 days. The typical setup for compressive strength of building block is shown in the Figure 5. The compressive strength was determined by using equation (1).

$$C = P/A \tag{1}$$

where, C = Compressive strength

P = Failure load

A = Contact area.

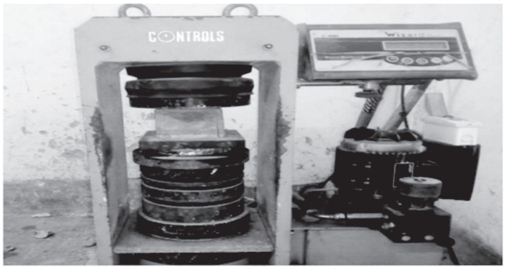

Fig.5: Typical Setup of Compressive strength Test (Captured by Authors)

2.3 Determination of Water Absorption

Water absorption test on bricks are conducted according to ASTM C-67-80 to determine durability property of bricks such as degree of burning, quality and behavior of bricks in weathering. A brick having water absorption of less than 7% provides better resistance to damage by freezing. This process is shown in figure 6.

Fig.6: Water Absorption Test (Captured by Authors)

2.4 Determination of Density

Density is a unit of measurement used to compare an object's mass to volume. A high density item is one that has a lot of matter in a given volume. A low density item is one that has little substance in the same volume. One may calculate an object's density by dividing its mass by its volume.

3.0 RESULTS

3.1 Compressive Strength of Building Blocks

Compressive strength of block was determined for 28 days of curing. The compressive strength found for Burnt clay block, 0% RHA block, 5% RHA block, 10% RHA block and 15% RHA block were 4040, 3000,1750, 1500 and 1110 psi respectively. The compressive strength of 5% RHA block and 10% RHA block were in the range of 1500 to 1800 psi. Figure 7 shows the bar diagram of the compressive strength of several building blocks.

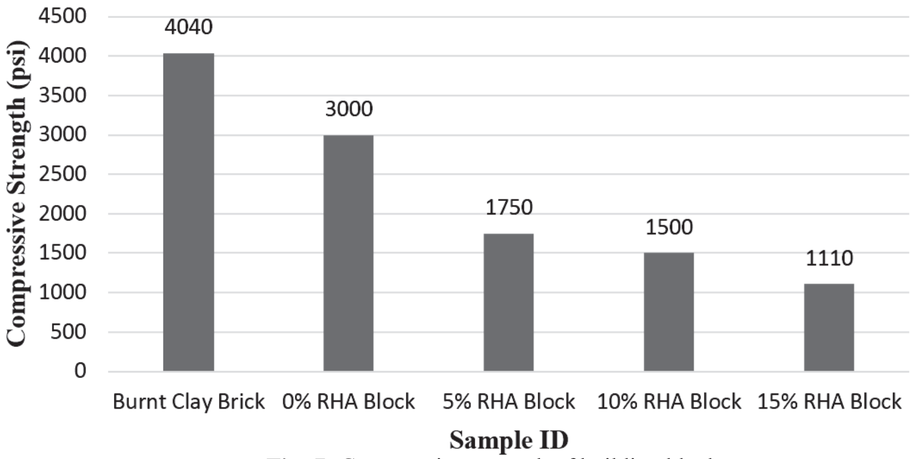

Fig: 7: Compressive strength of building blocks.

3.2 Water absorption of Building Blocks

Bricks are put through a water absorption test to find out how compact they are. Bricks absorb more water as their pore count increases. Bricks' physical characteristics are measured with this technique. A brick that absorbs water at a rate lower than 7% is more resilient to freezing-related damage. Figure 8 displays the five different types of building blocks' water absorption. The water absorption of Burnt clay block, 0% RHA block, 5% RHA block, 10% RHA block and 15% RHA block were 18.16%, 15%, 9%, 13% and 12.3% respectively.

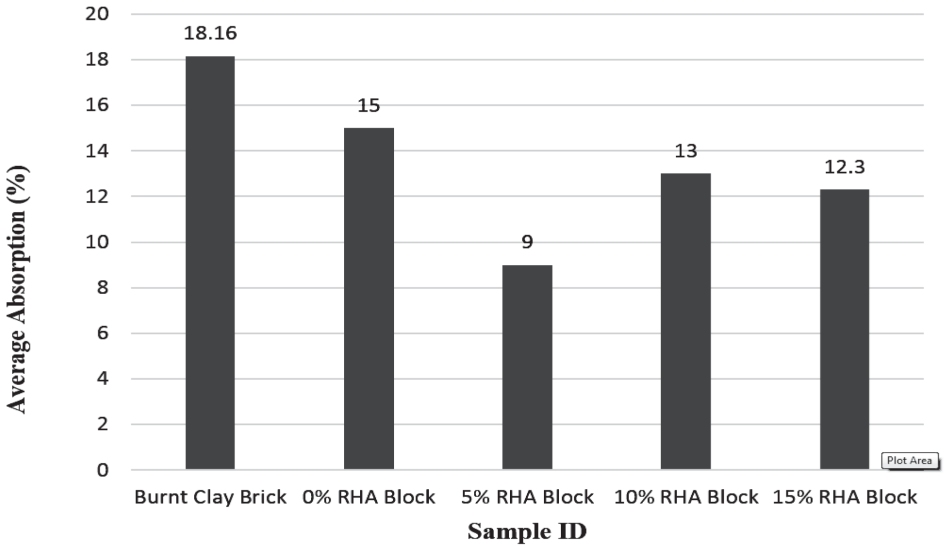

Fig. 8: Absorption of Different Types of Building Block

3.3 Density of Building Blocks

The bulk density of 5 types of block were determined. Among these, 4 types of block were prepared. Burnt clay brick was collected from market for test purposes. The bulk density of of Burnt clay block, 0% RHA block, 5% RHA block, 10% RHA block and 15% RHA block were 1880, 1815, 1800, 1790 and 1765 kg/m3 respectively. The water absorption of 5 types of building block are shown in figure 9. These value indicate that blocks made of Rice Husk Ash are lighter than burnt clay block.

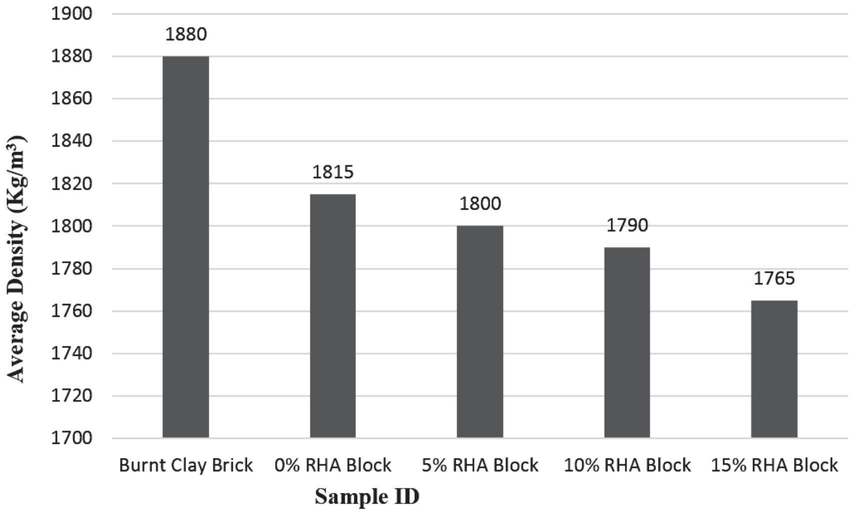

Fig. 9: Density of Different Types of Building Block

4. CONCLUSIONS

The main objective of this research project is to examine the practicality of rice husk ash (RHA) as a sustainable alternative construction material. In this study, the density of blocks with rice husk ash is less than that of burnt clay blocks and 0% RHA blocks, signifying that these kinds of blocks are lighter than traditional commercial blocks. It was discovered that blocks with rice husk ash having a slightly lower compressive strength than blocks made of burned clay and blocks with 0% RHA. The compressive strength of 5% RHA block and 10% RHA block were in the range of 1500 to 1800 psi which satisfy the minimum range criterion as minimum compressive strength of building block is 1500 psi. The water absorption of Burnt clay block, 0% RHA block, 5% RHA block, 10% RHA block and 15% RHA block were 18.16%, 15%, 9%, 13% and 12.3% respectively. All these values are less than 20%. The water absorption of 5% RHA block, 10% RHA block and 15% RHA block are less than burnt clay block. This research verifies that the block made of RHA are effectively addressing the shortcomings of traditional concrete blocks while enhancing their environmental features.

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