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Use of Rice Husk Ash as Substitute to Make Clay Bricks

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ABSTRACT: Concern for sustainable technology has increased research activities on the production of more durable construction materials. In recent times, Rice Husk Ash (RHA) has successfully been used as supplementary material in concrete, improving both strength and durability due to its high pozzolanic activity. However, the effectiveness of RHA depends greatly on its quality which entirely depends on its production process which are yet to be established completely. However, the focus of this paper is not identifying the best production process but to explore the effectiveness of one of the possible uses of RHA in the construction industry. Bricks of different percentage of RHA (15%, 25%, 35%) were made and tested for Water Absorption, Crushing Strength, Los Angeles Abrasion Value & Aggregate Impact Value. It was observed that although porosity increases due to RHA, it is still acceptable to use RHA in brick.

KEYWORDS: Bricks, Rice husk ash (RHA), Water Absorption, Crushing Strength.

I. INTRODUCTION

Rice is the major staple that is consumed worldwide and is grown on every continent except Antarctica [1]. In Bangladesh, about 39.3 million tons of rice is produced annually which generate about 9.83 million tons of RH after milling of the paddy. The chemical composition of RH is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions. Huge quantity of rice husk ash (RHA) is generated in Bangladesh during per-boiling of rice in rice mills. Rice husk ash (RHA) is the product of burning of Rice Husk (RH). RHA could be obtained as a waste product from the furnaces of rice parboiling units that utilize RH as their fuel [2]. Rice husk ash (RHA) is about 25% by weight of rice husk when burnt in boilers. RHA is a material with very low bulk density but of high silica content between 70-97% [3] and is a good super-pozzolan [4].

Rice husk wastes were used for animal feed, fertilizer and fuel for energy production, but little work has been carried out to develop utilization of rice husk ash (RHA) in the production of fired clay brick. Rice husk has been used as constituents of brick clay as RHA contains a greater amount of silica which is the main substance of brick clay. Silica exists in all clays in a state of chemical combination with alumina forming silicate of these constituents prevent cracking, warping and undue hardening. The particle size of RHA is so much finer having very small particle size of 25 microns and this RHA in turn contains around 85%~90% amorphous silica, content larger specific surface area, are some of the reasons why rice husk ash could play a great role in improving the material properties and durability.

The cost of brick constituents such as clay increases day by day. In the future, it will reach the capacity of rural people of the developing countries like Bangladesh. RHA has been used in Brazil as an aggregate in concrete mainly for making pre-cast blocks and slabs. Many efforts were taken to utilize rice husk ash as unique building materials. United States, Canada, European countries especially UK and some Asian countries such as Japan have accomplished several inimitable research works on rice husk ash. As Bangladesh produces a greater amount of rice husk, it is time that we focus on establishing innovative ways to utilize RHA, instead of discarding it as a waste product. It might be used as a partial replacement of clay in brick to produce high performance brick and concrete.

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The main objective of the present study is to manufacture of bricks using rice husk ash as a percentage (15%, 25% & 35%) of clay. In addition, ordinary clay bricks were also made and the bricks were compared on the basis of water absorption, crushing strength, Los-Angeles Abrasion Test, aggregate impact value and aggregate crushing value in order to check the acceptability of RHA bricks when compared to ordinary bricks.

II. RELATED WORK

Rice husk ash contains about 40% cellulose, 30% lignin and 25%-30% hydrated silica which is present in non-crystalline form. Although cellulose and lignin can be separated from the silica by chemical extraction, combustion is a more economical method. The method of burning is the key to the production of rice husk ash with high pozzolanic activity. Although consideration is the importance of recovering energy as a by-product of the process, since 3500 cal/gm heat energy is released of combustion of rice husk [5]

RHA is a carbon natural green product. Lot of ways are being thought of for disposing them by making commercial use of this RHA. RHA is a good super-pozzolan. This super-pozzolan can be used in a big way to make special concrete mixes. There is a growing demand for fine amorphous silica in the production of special cement and concrete mixes, high performance concrete, high strength, low permeability concrete, for use in bridges, marine environments, nuclear power plants etc. This market is currently filled by silica fume or micro silica, being imported from Norway, China and also from Burma. Due to limited supply of silica fumes in India and the demand being high the price of silica fume has risen to as much as US\$ 500/ ton in India. From RHA now manufacture organic micro-silica / amorphous silica, with silica content of above 89%, in very small particle size of less than 35 microns – silpozz for application in High Performance Concrete. Various uses of RHA are but not limited to: Geo-polymer [6,7], Concrete [8], Ceramic [9], Insulation [10], Emulsion Paint [11]

The university of California in the early 1970S showed that the silica in rice husk ash can be maintained in a highly pozzolanic state, if the temperature of combustion is kept below 7000 c and if the ash is not held too long at a high temperature. The ash consisting mostly of silica was found to be completely amorphous, porous and easy to grind. The surface area of the lightly ground product 55 sq meter/kg and it became the basis of production of lime pozzolone and Portland type cements processing excellent strength and durability characteristics. In the U.S.A huge piles of husks near centralized rice milling area present a serious waste disposal problem. Based on the scientific work at the University of California, Pelt designed an air suspension furnace which converted rice husk in to a highly pozzolanic ash. Since energy recovering rather than the initial plant cost in of more interest to US entrepreneurs, the half tons and seven tons per hour rice-husk burning furnaces installed respectively in California and Arkansas were equipped with boilers for making steam. Also, due to the great demand for the acid resting cements in the US only Portland cement based rice husk ash cements were produced [12]

National Research Development Corporation (NRDC) in India has developed insulating bricks from rice-husk ash which can be used for insulation of all types of industrial furnaces, particularly ceramic kiln and furnaces in steel and cement plants as well as in non-ferrous and petro-chemical industries. The item has a good demand in India [12]. Scientists at the India institute of science in Bangalore have succeeded in extracting silica, used in industrial and pharmaceutical application from rice husk ash. Silica is normally generated from sand, which is extracted after fusion of high temperature. This procedure requires energy and is investment intensive; scientist said 'India produces nearly 20 million tons of rice husks per annum that contain about 80% silica, which otherwise goes as waste.

The Pakistan Council for Scientific and Industries Research (PCSIR) produced amorphous RHA by over night. Combustion of rice husk in used oil drums, which were fitted with chimneys in order to obtain a good air draft and to keep the combustion temperature low. The experimental cements produced by inter-grading the ash with lime gave a significantly lower strength than Portland cement, but the product was considered for use as a masonry cement [12]

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III. METHODOLOGY

Good brick clay should be such a mixture of pure clay and sand that when prepared with water, it can easily be moulded and dried without cracking and warping. This study discussed about manufacture of rice-husk ash (RHA) brick.

Rice-husk was considered a value less by-product of rice milling. At the mills, disposal of the hulls was achieved by burning them in heaps near the mills. Even through, the ashes have been potential pozzolanic materials suitable for use in lime-pozzolans mixes and for Portland cement replacement. The ashes used in this study were obtained from burning of rice husk in the incinerator. The chemical composition of brick clay and RHA are presented in Table 1 [13].

Table 1: Difference between RHA and brick clay

Properties	Brick clay	RHA
Silica (SiO ₂)	55%	93.15%
Alumina (Al ₂ O ₃)	30%	0.21%
Iron oxide (Fe ₂ O ₃)	8%	0.21%
Magnesia (Mgo)	5%	0.45%
Lime (CaO)	1%	0.41%
Potash (K ₂ O)	--	22.31%
Loss on ignition	--	2.36%
Other matter	1%	--
<i>p^H</i>	--	9.83

Silica is the major constituent of the brick earth which exist in the clay either as free or combined constituent as free sand. It exists in chemical composition with alumina as silicate of alumina. The presence of this constituent prevents brick from shrinkage, cracking, warping and undue hardness. But excess of this constituent about 50%~60% makes the bricks brittle, weak and destroy cohesion. RHA contain a greater amount of silica about 93%, so it will reduce the strength and the weight of the brick considerably.

RHA has been collected from the rice milling boiler, where the rice husk used as fuel for boiling paddy. It has been taken white ash 12 hours after the burning from the boiler. The black ash which contain carbon should not use as a brick clay. Collected white RHA have been properly grinded in the laboratory. After grinding, harmful element and unwanted substance has been separated from the RHA.

Measuring RHA by Volume of Brick-Clay

The total volume of brick clay is (26 ×12.8 × 7.5) 2496 cm³. It has been mixed RHA with brick clay in several percentages such as 15%, 25% and 30% by volume. These percentages of RHA have been presented in Table 2:

Preparation of Brick Clay

After measuring the several volumes of RHA for the various treatments, the RHA have been mixed with brick clay in the brickfield by the help of field worker. The brick clay has been moulded with hand thoroughly on the ground. It has been manufactured the number of 3 bricks for every treatment.

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Table 2: Difference between RHA and brick clay

Serial	% of RHA	Volume of RHA (cm^3)	Volume of Soil (cm^3)	Replication
A	15	1130	6358	3
B	25	1885	5603	3
C	35	2652	4954	3

Drying of Brick

Before burning it is necessary to dry the bricks, so that they are sufficiently hard to be handled and stocked in the burning kiln without any injury. The moulded bricks were dried by being placed on their edges for sometimes and then piled in open order in long row and stacks.

Burning of Brick

Bricks are burnt for impart hardness and strength to brick and increase the density. The experimental bricks have been burned in clamps or kilns where the temperature is raised to about 2100°F

IV. EXPERIMENTAL RESULTS

Several tests were conducted on the bricks of various percentage of RHA and compared with the ordinary bricks made entirely of clay. The results are presented graphically.

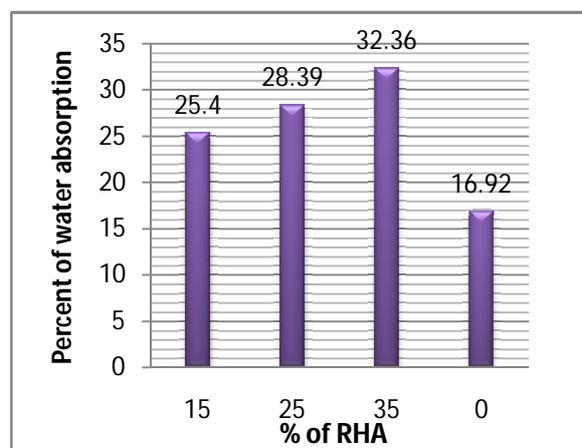


Fig. 1: Water Absorption Vs % RHA

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Water Absorption of Bricks

The water absorption test of Brick is defined as the weight of water, expressed as a percentage of the dry weight, which is taken up under a given test method. It should not absorb more than 20% of its dry weight of water when kept immersed for 24 hours [14]. The results are shown below in Fig. 1.

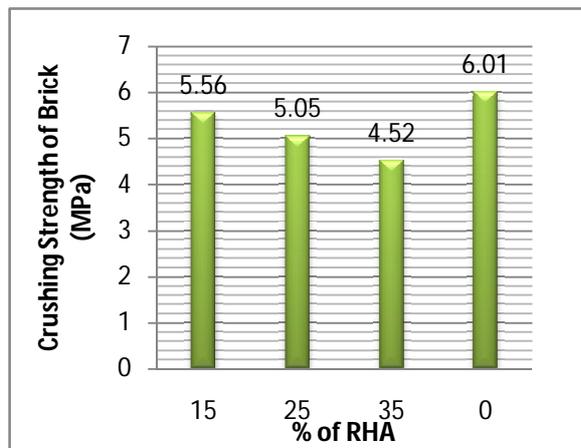


Fig. 2: Crushing Strength of Bricks Vs % RHA

Crushing Strength of Bricks

The crushing strength of bricks having different RHA proportion has been obtained which are given below Fig. 2. The figure shows that crushing strength of RHA bricks are gradually decreased with increasing the percent of RHA and for all percentage of RHA crushing strength is lower than that of ordinary bricks.

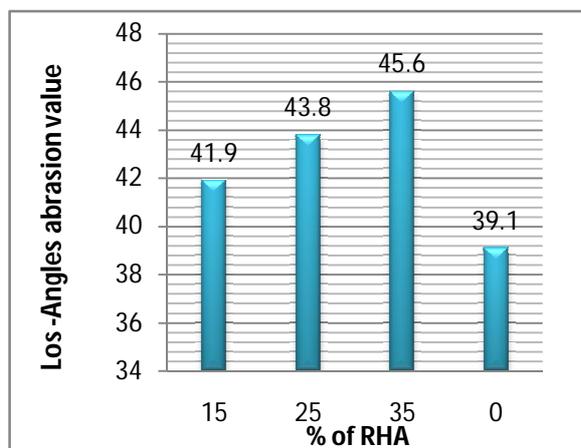


Fig.3: Los Angeles Abrasion Value Vs % RHA

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Los Angeles Abrasion Value

The abrasion value of coarse aggregate obtained by crushing bricks having different RHA proportion has been obtained which are given below Fig. 3. The figure shows that the abrasion value of RHA bricks increases gradually with increasing the percent of RHA.

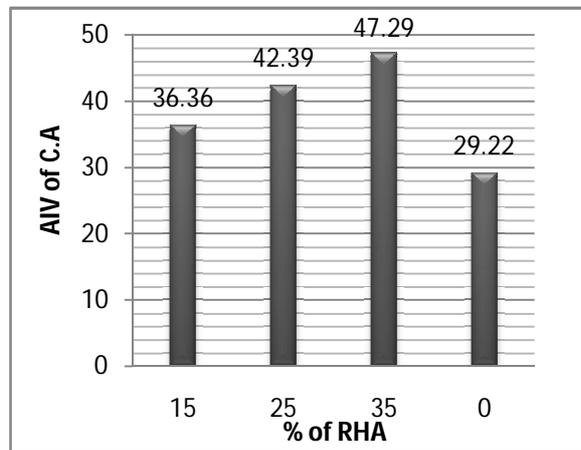


Fig.4: Aggregate Impact Value Vs % RHA

Aggregate Impact Value (AIV)

The Aggregate impact value (AIV) of coarse aggregate (CA) from bricks having different RHA proportion has been obtained which are given in Fig. 4. The figure shows that aggregate impact value (AIV) of RHA bricks are gradually increased with increasing the percent of RHA.

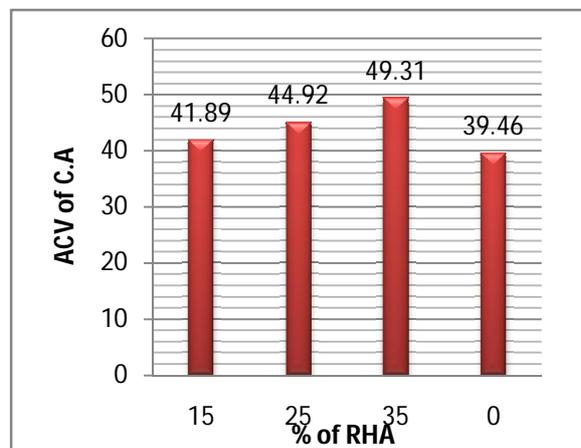


Fig. 5: Aggregate Crushing Value Vs % RHA

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Aggregate Crushing Value (ACV)

The Aggregate crushing value (ACV) of coarse aggregate (CA) of bricks having different RHA proportion has been obtained which are given in Fig. 5. It can be observed from the figure that the ACV of RHA bricks are gradually increasing with the increase of the percent of RHA.

V. CONCLUSION

It has been observed that in general bricks made of 15%, 25% and 35% RHA are closer to ordinary 2nd class bricks based on all the tests (Crushing strength of bricks, Water absorption of bricks, Los-Angeles abrasion value of coarse aggregate and Aggregate impact value of coarse aggregate) conducted. Specific observations:

- 1) 1st Class bricks should absorb less than 20% and 2nd Class bricks should absorb between 21% and 25% of their own dry weight when immersed in water for 24 hours. However, it was observed that water absorption for 15%, 25% and 35% RHA bricks were 25%, 28% and 32% respectively. Which is an increase in water absorption by astounding 50%, 68% and 91% when compared to the water absorbed by ordinary bricks (17% of dry weight). Hence, it is evident that porosity increases significantly by the incorporation of RHA into the bricks.
- 2) The average crushing strength of ordinary brick was 6.01 MPa. In comparison, bricks made of 15%, 25% and 35% RHA respectively had 5.56 MPa, 5.05 MPa and 4.52 MPa crushing strength. Thus, a reduction of crushing strength by 7%, 16% and 25% respectively.
- 3) The average Abrasion value of coarse aggregate using ordinary bricks was 39%. In comparison, bricks made of 15%, 25% and 35% RHA showed an average abrasion value of 42%, 44% and 46% respectively. Therefore, the increase in abrasion values are respectively 9%, 13% and 18%.
- 4) Aggregate crushing value (ACV) of coarse aggregate for using 15%, 25% and 35% RHA bricks was 42%, 45% and 49% and ordinary brick is 39%.
- 5) The Aggregate Impact Value (AIV) of coarse aggregate made from ordinary brick was 29%. However, for bricks made using 15%, 25% and 35% RHA the values were 36%, 42% and 47% respectively. Thus, corresponding to an increase of AIV by 24%, 45% and 62% compared to ordinary bricks. AIV is more appropriate for stone aggregates, hence the results bear minimal significance here.

It is recommended that depending upon all the above test results, rice husk ash (RHA) can be used as a constituent of brick clay where 2nd class bricks are required and the replacements are effective for about 15% RHA and 85% clay.

This investigation has demonstrated a feasible way of using incinerated RHA as brick clay to produce a decent quality brick. However, further research is required to identify the best method to produce RHA and its effect on the optimum percentage of RHA in bricks.

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