Paper ID: ET-07

Energy Saving Brick from Rice Husk Ash

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Abstract

The main objective of thesis is to develop environment friendly and energy saving brick from rice husk ash (RHA). This brick is environment friendly as no need to burn like conventional brick which pollutes the air by emitting of huge quantity of toxic elements, containing suspended particulate matters rich in carbon particles and high concentration of carbon monoxides and oxides of sulphur (SO_x) that are harmful to eye, lungs and throat. As this is not burnt in fire so there is huge saving of heat energy and it is not compressed, as a result mechanical energy can be saved. The main components of this brick are rice husk ash, lime, sand, binder. Five batch experiments have been carried out with different composition of above components to get the desired compressive strength of the brick. Compressive strength of five batches of experiment are 1.18 N/mm^2, 1.6 N/mm^2, 1.9 N/mm^2, 2 N/mm^2 and 2.1 N/mm^2 respectively. Peak load of five batches of experiment are 3126 N, 6280 N, 9722 N, 10850 N and 12883 N respectively. Strain at brick *of five batches of experiment are 1.18 %, 2%, 2.4%, 3%, 3.6% respectively. The main application of this brick is to build one storeyed low cost house.*

Keywords: Compressive strength, calcium silicate hydrate (CSH) gel, energy saving brick, environment friendly, rice husk ash (RHA).

1. Introduction

Rice is one of the major agricultural crops of Bangladesh and at least in 75 countries of the world. Production of rice from paddy yields about 9.9 million tonnes of rice husk, 35 million tonnes of clear rice annually in Bangladesh. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter and the balance 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash. About 2.5 million tonnes of rice husk ash produced annually in Bangladesh. This huge amount of rice husk ash is disposed in nearby rivers of rice mills. Ash sedimentation changes the base level of the river and is one of the important reasons of flood. Numerous patents, publications, reviews and reports on rice husk beneficial utilizations have appeared during last two decades but its effective utilizations in bulk quantities has not been commercially established. In many countries rice husk has been put to use in some specific areas as renewable source of energy, development of pozzolana cementitious materials, acid resistant light weight concrete, and calcium heterosilicate bricks. Rice husk ash can utilizes in many aspects like production of Enhanced properties of RHA cement, Low cost building blocks, Refractory bricks, in the steel industry to produce of high quality flat steel, Lightweight construction materials, Silicon chips, Control of insect pests in stored food stuffs, Water purification, Vulcanizing rubber, Adsorbent for a gold-thio urea complex, Ceramics, Oil absorbent. In many countries around the world Initiatives were taken to develop lost cost building brick using Rice husk ash. The followings shed light on the research works on the utilization of rice husk and rice husk ash as a partial replacement material or stabilizing agent in building works. In [1] was carried out and extensive work on some characteristics of acha husk ash (AHA) / ordinary Portland cement concrete. Test results indicate that the compressive strength for all mixes containing AHA increases with age up to the 14 day hydration period but decrease to the 28 day hydration period while conventional concrete steadily up to 28 day hydration period. In [2] was worked on rice husk as stabilizing agent in clay bricks in which clay bricks were produced with 0% , 1%, 2%,3%,4%,5%, 10% rice husk. Some of the bricks were burnt in an electric furnace to a temperature of 1005^{o}C for about 3-4 hours. Compressive strength and absorption tests were carried out. It was concluded that the addition of the husk reduces the compressive strength of the bricks

and husk clay bricks become lighter as the percentage of husk clay increases. Followings were said [3] on the effect of rice husk and compressive strength and durability of burnt clay bricks. Test results show that rice husk has a decreasing effect on the compressive strength of the brick & increasing effect on the water absorption of the bricks. In [4] was carried out a resource work on the use of rice husk ash in concrete. Test results indicate that the most convenient and economical temperature required for the conversion into ash is 500^{o}C.Water requirement decreases as the fineness of RHA increases. The higher percentage of RHA contains the lower compressive strengths. As mentioned above huge amount of Rice husk ash produced in Bangladesh in every year, which can be utilized to develop low cost energy saving brick. A pilot plant study has been carried out to develop such brick. The main components of this brick are Rice husk Ash, Sand (Quartz), Lime ($CaCO_3$), Binder (port land cement) and Water. Five batches of experiment were performed with different composition of Rice husk Ash, Sand, Lime, Binder and Water. Main component was Rice husk ash varying 50-53 %. Other components, sand varying 7-20%, lime varying 26-34%, cement varying 0-6.5%. These components were mixed in mortar mixing machine and settled down in the aluminum block for obtaining desired shape and kept for 24 hrs for curing. The brick can be obtained either in pressing (applying compression force) or non-pressing (without applying compression force) process. But this pilot plant study was only limited to the non-pressing. As this brick was neither burnt nor pressed, obtained strength might not like conventional fired brick, so use of this brick limited to only one storeyed low cost house in rural area of Bangladesh**.**

2. Experimental

Rice husk can be utilized to produce energy efficient low cost brick. The brick can be obtained either by pressing (applying compression force) or non-pressing (without applying compression force) process. But this study was only limited to the non-pressing. As this brick was neither burnt nor pressed, obtained strength might not like conventional fired brick, so use of this brick limited to only one storeyed low cost house.

2.1. Process description

Rice husk Ash brick mainly consists of Rice husk Ash, Sand (Quartz), Lime ($CaCO_3$), Binder (port land cement) and Water. Rice husk Ash might contain coarse particle, that's why before feed to the mixture Sieving was done to remove unwanted coarse particle. Lime usually available in large lump size in market, which has less surface area, need to grind very smoothly. Lime was grinded and sent to the mixture .Sand was sieved before sending to the mixture. Appropriate amount of water was fed to the mixture for prefect mixing. After loading all materials to the mixture machine, Mixture machine was run for about 10 minutes until the prefect mixing was achieved. After mixing, materials were unloaded .Brick Block was filled with mixing materials. Then it was kept in room temperature for 24 hrs. After removing the blocks desired brick was obtained. Five batches of experiments were carried out with different composition of Rice husk Ash, Sand (Quartz), Lime ($CaCO_3$), Binder (port land cement).

2.2. Experimental Figures

Fig. 1. Mixing machine, curing aluminum blocks and RHA bricks

3. Chemistry involve in the process

When RHA is added to Portland cement, it reacts faster than fly ash in hydration process, which helps to improve the early age strength of brick, and also forms calcium silicate hydrate (CSH) gel around the cement particles which is highly dense and less porous. The formation of CSH gel in brick alters the micro structure of the brick with discontinuous pores. The pore refinement or densification reduces the permeability of brick and improves the resistance against chloride diffusion into brick.The following reactions take place during the mixing:

$$\text{Portland cement} + H_2O = CSH + Ca(OH)_2 \quad (1)$$

$$\text{Portland cement} + H_2O + RHA = CSH + \text{Unreacted silica} \quad (2)$$

There are two types of calcium silicate hydrate (CSH) gel which formed during reaction between RHA and Portland cement:

$$Ca(OH)_2 + SiO_2 = CaO.SiO_2.(H_2O) + CaO.SiO_2.2(H_2O) \quad (3)$$

4. Results

Table 1. Representation of experimental results

Components	1st Batch	2nd Batch	3rd Batch	4th Batch	5th Batch
RHA (%)	54.2	52.5	50	52	51.9
Sand (%)	19.5	17.5	15	10	7.8
Lime (%)	26.3	28	30	32	33.8
Cement (%)	0	2	5	6	6.5
Compressive strength (KN/mm^2)	$1.18x10^{-3}$	$1.6x10^{-3}$	$1.9x10^{-3}$	$2x10^{-3}$	$2.1x10^{-3}$
Peak load (N)	3126	6280	9722	10850	12883
Strain @ brick (%)	1.81	2	2.4	3	3.6

4.1. Graphical representation of results

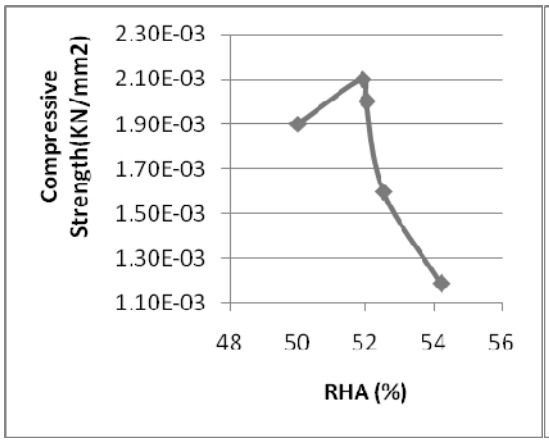

Fig. 2. Compressive Strength Vs RHA (%)

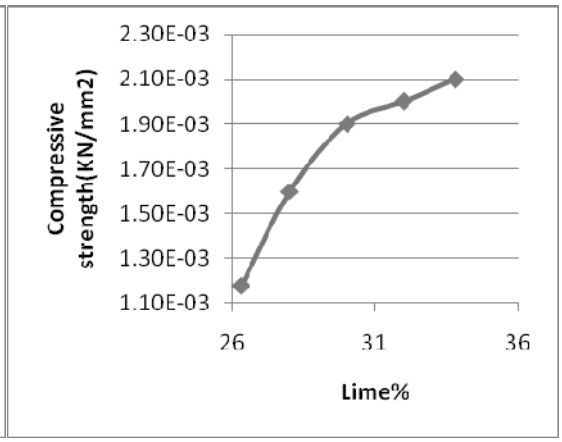

Fig. 3. Compressive Strength Vs Lime (%)

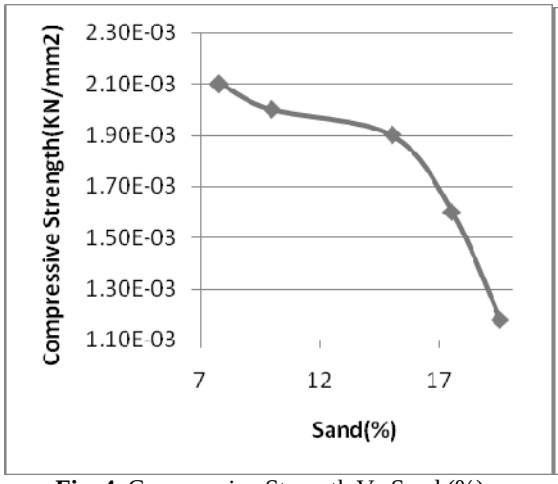

Fig. 4. Compressive Strength Vs Sand (%)

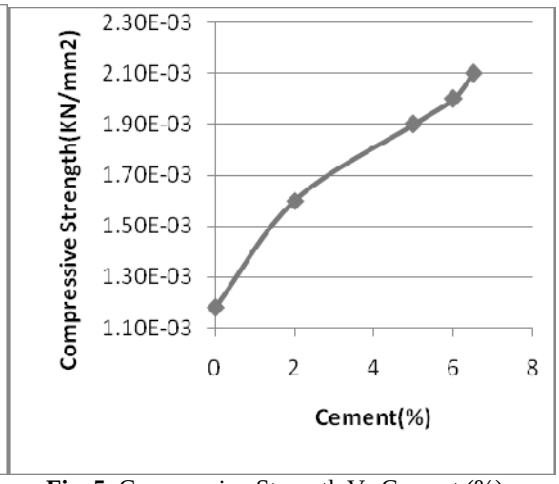

Fig. 5. Compressive Strength Vs Cement (%)

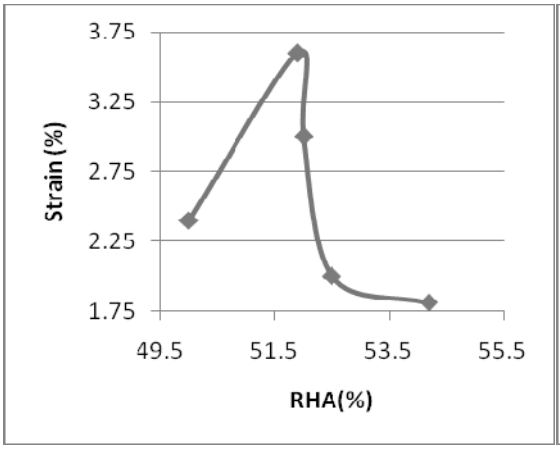

Fig. 6. Strain Vs Sand (%)

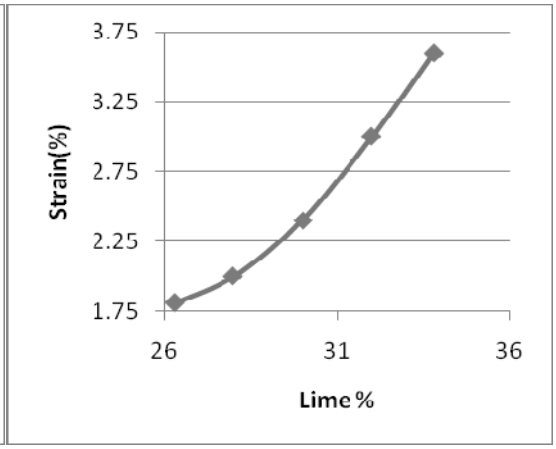

Fig. 7. Strain Vs Cement (%)

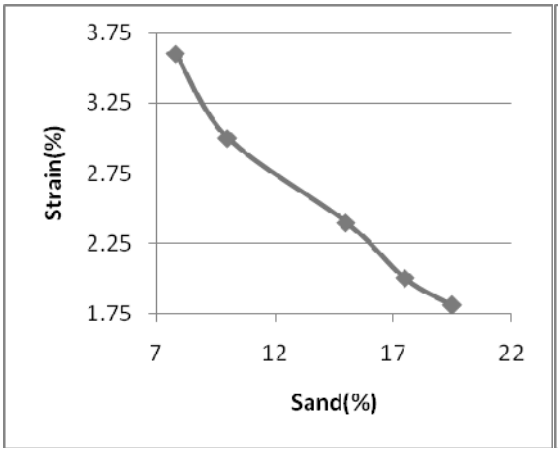

Fig. 8. Strain Vs Sand (%)

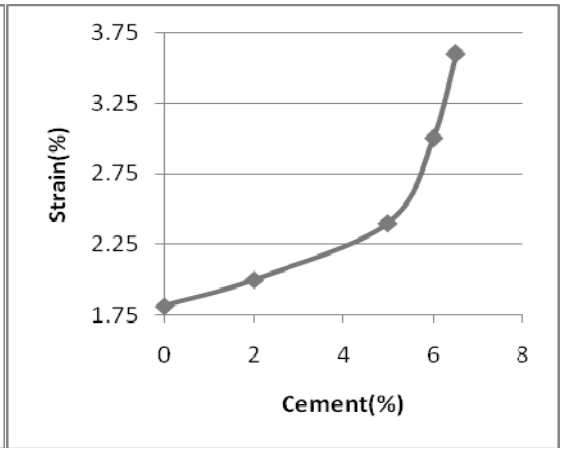

Fig. 9. Strain Vs Cement (%)

5. Result Analysis & Discussions

From the graphs, it is clear that compressive strength, peak load and strain of brick depend on the composition of brick. Binder (port land cement) plays very important role for compressive strength and pick load .From the result of first batch of experiment that compressive strength and pick load of brick is very low without binder. Because in presence of binder (Portland cement), Rice husk ash reacts with binder and forms calcium silicate hydrate (CSH) gel around the cement particles which is highly dense and less Porous, increase the strength of brick. From graph, it can be described that compressive strength and pick load increases with increase in the percentage of binder in the brick. Lime ($CaCO_3$) also plays important role for improving the strength of the brick. Compressive strength and pick load increases with increasing lime percentage. As rice husk ash is the main component of the brick, its percentage was kept around 50 %.So increase in the sand amount resulting decrease in the binder and lime amount. Also From graph, Compressive strength and pick load decreases with increasing sand percentage. Strain at brick is another important parameter of brick .From graph, it is clear that Strain at brick increases with increasing in binder and lime amount and decreases with increasing in sand amount.

6. Conclusion

Compressive strength observed from the pilot plant study for this brick is not sufficient to build high storeyed buildings. So the use of this brick should be limited to build one storeyed low cost houses. Compressive strength and peak load of the brick can be improved by increasing the amount of binder & lime. Ultimately the cost will be increased and it will not be feasible. So optimum amount of binder & lime can be increased to improve the Compressive strength of the brick. It is also important to study the behavior of this brick for long term exposure with environment. So further study can be extended to analyze the exposure behavior with different environment parameters like rain, humidity, sunlight, gaseous composition of air etc.

7. Acknowledgements

The supports from the Department of Chemical Engineering, Bangladesh University of Engineering & Technology & Pilot Plant and Process Development Centre, Bangladesh Council of Scientific and Industrial Research are gratefully acknowledged.

8. References

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