EFFECTS OF RICE HUSK IN CLAY BLOCKS

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ABSTRACT

Rice Husk Ash (RHA) is one of the agricultural waste byproducts available widely in the world and contains large amount of silica. This study aims to produce light weight block aggregate with sufficient strength utilizing RHA at low cost. In Bangladesh, stones cannot be used as coarse aggregate in infrastructure work as stones are not available here. They are imported from abroad. For this reason, brick aggregates are cheaper and more widely used in Bangladesh than stone aggregates. Clay is the raw material for producing brick aggregate. Rice husk ash can be utilized to produce better quality block aggregates with lower cost replacing clay content in the bricks. In this study six different types of RHA from different mills are characterized through XRD & SEM. The result of XRD confirmed the amorphous state of rice husk ash. Fineness test of RHA is also conducted and the result shows that the highest fineness of 2720 cm^2 /gm was obtained for “RHA 3” sample which was uniformly burnt. At the same time characterization of clay was also conducted. The results of the tests conducted for determination of clay property assured the clay sample as “silty clay” with specific gravity of 2.59 and 14% optimum moisture content. The unconfined compressive strength was found to be 28MPa. Blocks were produced with six different types of rice husk ash with different composition by volume with clay. Then the mixture was manually compacted in mould and then subjected to dry in oven at 120°C for 7 days. After that dried blocks were placed in furnace at 1200°C to produce ultimate blocks. Loss on ignition test, apparent density, crushing strength test, efflorescence test and absorption test were conducted.

With addition of RHA in blocks cold crushing strength first decrease with increasing percentage of RHA and then increase in 40% RHA then again decrease. The sample having 40% rice husk ash from “RHA 3” shows maximum crushing strength of 60 MPa while the highest strength was obtained for 100% clay was 48.1 MPa. Moreover, absorption and firing shrinkage of blocks are also minimum at 40% RHA combination. RHA can be used to reduce volume and weight of clay in blocks up to 40% as found for the samples tested in the present study.

Keywords: *Rice husk ash, Pozzolanic material, Cementitious, Furnace, Finest particles.*

1. INTRODUCTION

Various researches are trying to replace clay from bricks as its use is decreasing the top soil from the earth. Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. This rice husk is mostly used as a fuel in the boilers for processing of paddy. RHA is a carbon neutral green product. Lots 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 brick aggregates. Pozzolan increases the mechanical strength of the aggregates. That is why in this study we tried to mix RHA with pure clay to see the difference.

Most of the husk from the rice milling industry is either burnt or dumped as waste in open fields and a small amount is used as fuel for boilers, electricity generation, etc. (RHA market study, 2003). Paddy on an average consists of 72% of rice, 5 - 8% of bran, and 20 - 22% of husk, on weight basis (Ou et al., 2007; Basha et al., 2005; Bouzoubaa and Fournier, 2001; Prasad et al., 2000). This husk contains about 75 - 80 % organic volatile matter and the balance 20 - 25 % of the weight of this husk is converted into ash during the firing process, is known as rice husk ash (RHA). This husk is used as fuel in the rice mills to generate steam for the parboiling process. This RHA usually contains around 85% - 97% amorphous silica with small amount of alkalis and other trace elements (Ou et al., 2007; Basha et al., 2005; Bui et al., 2005; Asavapisit and Ruengrit, 2005; Adylov et al., 2003; Bouzoubaa and Fournier, 2001; Saha et al., 2001; Prasad et al., 2000; Natio, 1999). This silica is highly porous and light weight, with exceedingly external surface area. Rice husk ash (RHA) is a term describing all types of ash produce from burning rice husks which vary considerably according to burning techniques. The silica in the ash undergoes structural transformations depends on conditions (time and temperature) of combustion.

Bangladesh is the fourth highest paddy rice producing country all over the world and rice husk is abundantly produced. Recently RHA has attracted more attention to the researchers as an additive of cement. During growth, rice plants absorb silica from the soil and accumulate it into their structures. The accumulated silica concentrated by burning at high temperatures in RHA, which makes the ash valuable. The chemical composition of rice husk is found to vary from sample to sample due to the differences in the type of paddy, crop year, climate and geographical conditions (Chandrasekhar et al., 2003).

Rice husk is the outer covering of paddy and accounts for 20% – 25% of its weight. It is removed during rice milling and is used mainly as fuel for heating in homes and rice milling industries in Bangladesh. Its heating value of 13 – 15 MJ/kg (Natarajan et al., 1998; Jenkins, 1989) is lower than most woody biomass fuels. However, it is extensively used in rural Bangladesh because of its widespread availability and relatively low cost. In the major rice-producing countries, much of the husk produced from the processing of rice is either burnt or dumped as waste (Chindaprasirt et al., 2009; Mathur, 2006; Chindaprasirt and Rukzon, 2006). The RHA is usually producing through controlled and uncontrolled combustion process. Uncontrolled combustion process is used in most of the cases in Bangladesh. The characteristic of RHA depends on the combustion process and variation of temperature. The fine particulate matter which is carried away from the combustion zone by the flue gas produces fly ash. The ash produced with stoker and suspension fired boilers is closed to 100% amorphous.

The proportion of bottom ash to fly ash depends upon the boiler type and operating conditions. Critical economic and environmental situations of the current days encourage companies and researchers to develop and improve technologies intended to reduce or minimize industrial wastes. As a consequence, much effort has been expended in different areas, including the agricultural production. In recent years, studies have been carried out by different researchers using wastes generated from the agricultural and industrial activities as concrete-making materials. Wastes such as rice husk, sawdust, cork granules and coconut pitch have been used as filler or aggregate for concrete

(Ramaswamy et al., 1983; RCTT, 1979; Paramasivam and Loke, 1978; Cook et al., 1977; Mehta, 1977).

2. METHODOLOGY

Processing of raw materials included selecting the suitable types of raw materials to be used for preparing the specimens, primary processing of these materials to make them suitable for next operation and determining chemical compositions. The raw materials used in this experiment were: normal clay, rice husk ash and water.

2.1 Material Preparation

The clay used here was normal clay, collected from Azimpur where excavation was done for construction of foundation. The lumps of the clay were crushed to make fine particles and then normally dried for several days to remove the inherent moisture so that it cannot vary the moisture amount used for making specimen. The clay particles were sieved to avoid any unwanted foreign particles like stones, large aggregates or other substances and to get homogeneous fine clay. On the other hand, Rice Husk Ash was collected from 6 different mills and then blended for 5 minutes in a blender; then passed through no.100 sieve.

2.2 Clay and RHA Characteristics Determination

Moisture absorption test, Fineness Test, XRD and SEM test were done to characterize the rice husks from different mills.

Field identification, Specific gravity test, Atterberg limit test, Optimum moisture content test, Unconfined Compression test were done to characterize the clay.

2.3 Specimen Preparation

Clay and ash were taken by volume percentage shown in Table 3.1 of total brick volume

Table 1: Different proportion of clay and RHA

Clay content (volume%)	Rice husk ash (volume%)
80	20
70	30
60	40
50	50
40	60

For the mixing process, clay and RHA were taken in a bowl. With 20% moisture of total volume, proper hand mixing was done. For different percentages of RHA, repeatedly the process was done. Water was added to provide sufficient bonding so that they can hold together during molding. A total of 93 cube specimens were prepared using mould size of 2in x 2in x 2in. Thus, 90 cube specimens were prepared for volume fraction of RHA and the other 3 was clay specimen. Then the specimens were dried in oven for 7 days to remove excess moisture and then it was fired in an oven at 1200°C for 6 hours.

2.4 Test Program

The test program of cube specimens involved compressive strength test, loss on ignition test, apparent density test, water absorption test and efflorescence test of the blocks incorporating RHA with clay for different percentages.

3. RESULTS AND DISCUSSION

The comparison of RHA samples produced from different mills are discussed and a viable method has been suggested to manufacture good quality Rice Husk Ash in controlled conditions in rural areas of Bangladesh.

3.1 Characteristics of RHA

Result of moisture absorption test of 6 types of RHA is shown below in Figure 4.1 where we can see that RHA 4; which is a mixing of RHA and nutshell absorbs more moisture from the atmosphere than all other RHA types.

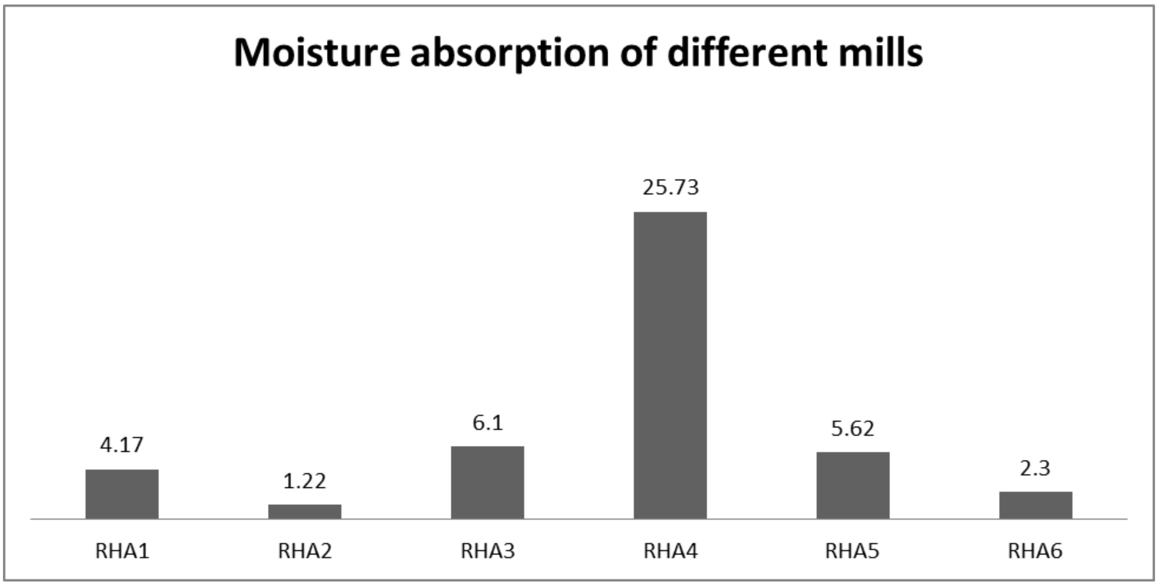

Figure 1: Moisture absorption of different mills

The result of fineness is given below in Table 4.1 where RHA 3 shows better fineness than others. The more the fineness of the RHA, the more contact area of the particles will contribute to the strength of the blocks.

Table 2: Fineness of RHA from different mills

Sl. No.	Types of RHA	Blaine fineness (cm^2/gm)
1	RHA 1	1150
2	RHA 2	1685
3	RHA 3	2720
4	RHA 4	1755
5	RHA 5	1673
6	RHA 6	1937

From the XRD and SEM tests, it was observed that the RHA were on amorphous states. Figure 2 shows the XRD results for RHA 3 that is the finest among others. In case of all samples of rice husk ash, no sharp peak was observed in XRD analysis indicates that the ash is non-crystalline form. A rather broad peak spanning 2θ angle range of 18-30° which is characteristic of amorphous structures is observed.

On the other hand, the particle size and texture of RHA were analyzed with SEM (Scanning Electron Microscope) and the observation is shown in Figure 3 that represents the result for RHA 3. It is clear from 300- and 3000-times magnification that the shape of the ash particle is angular in texture. The porosity and the formation of the binder can be seen by using SEM analysis. The formation of the pore and binder can be analysed corresponding to the various applications of the manufactured aggregate.

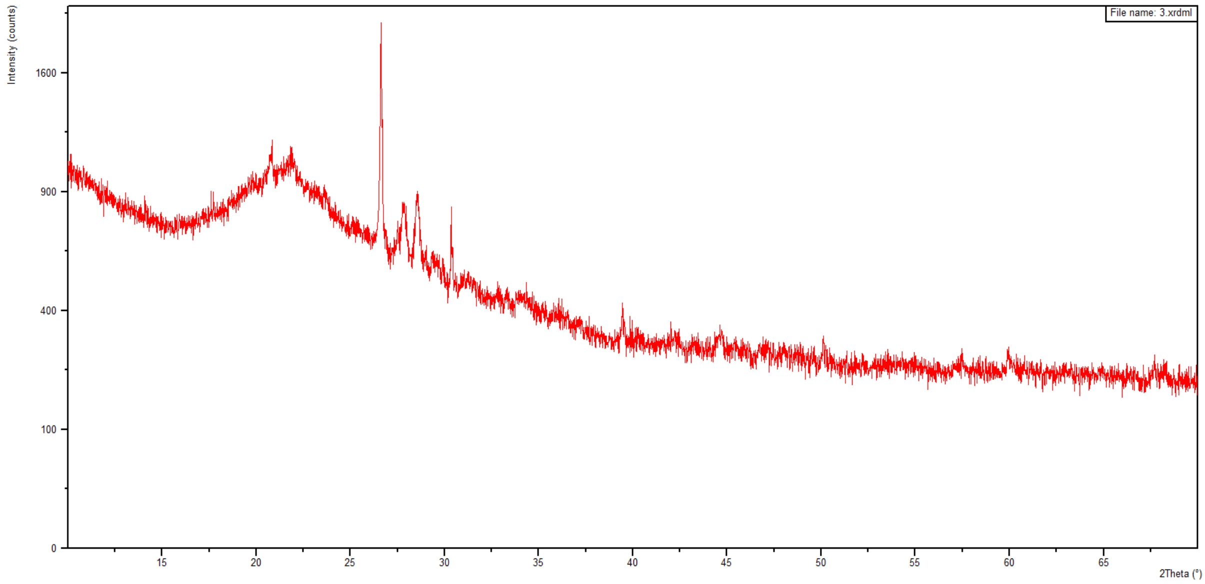

Figure 2: XRD result of RHA 3

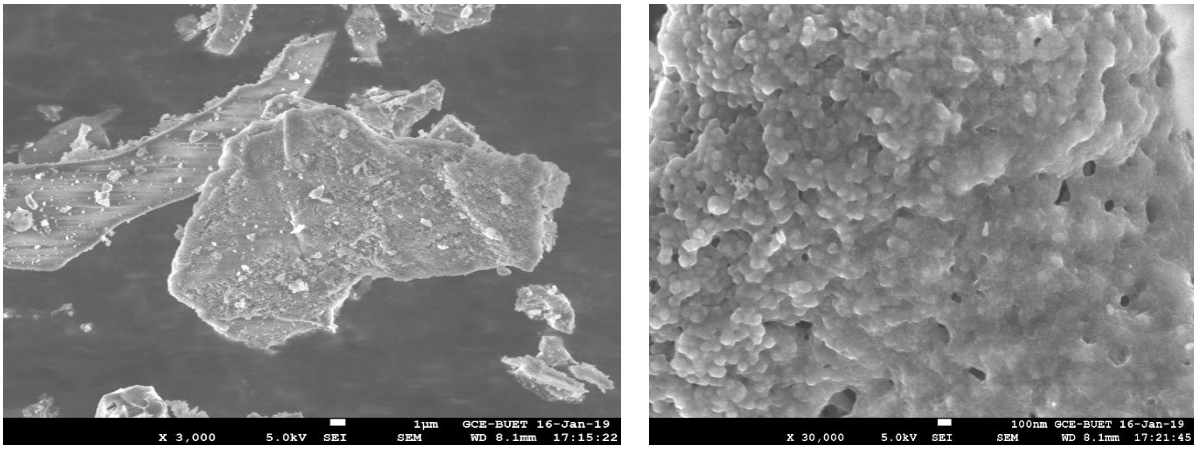

Figure 3: SEM image of RHA 3

3.2 Characterization of Clay

From the field identification test it was observed that the clay sample type was 'silty clay'. And specific gravity was 2.59, also maximum relative density was 2gm/cm3 at 14% moisture content. At 15% strain compressive strength of the soil sample is 28 MPa.

3.3 Effects of RHA on blocks

The result of loss on ignition test in given below in Figure 4, where the straight line represents the loss on ignition of 100% clay blocks. It is observed that at 40% RHA, the loss is less for most of the RHA types except RHA 4.

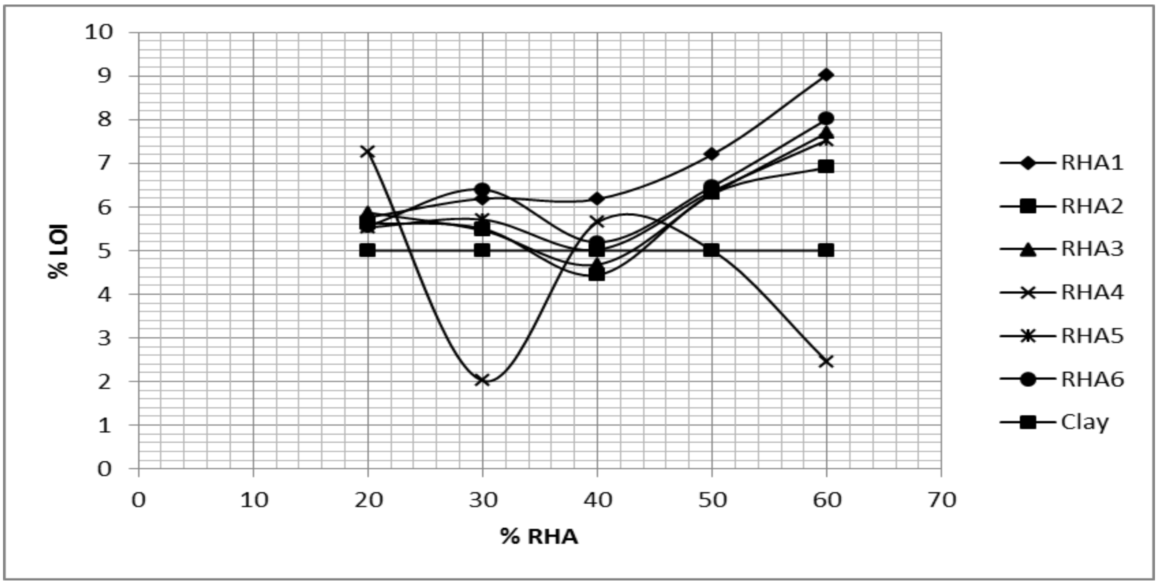

Figure 4: Loss on ignition for different percentages of RHA for RHA from different mills

The apparent density for different percentages of RHA is given below for RHA 3 as it is the finest in Figure 5 which again indicates lowest density at 40% of RHA.

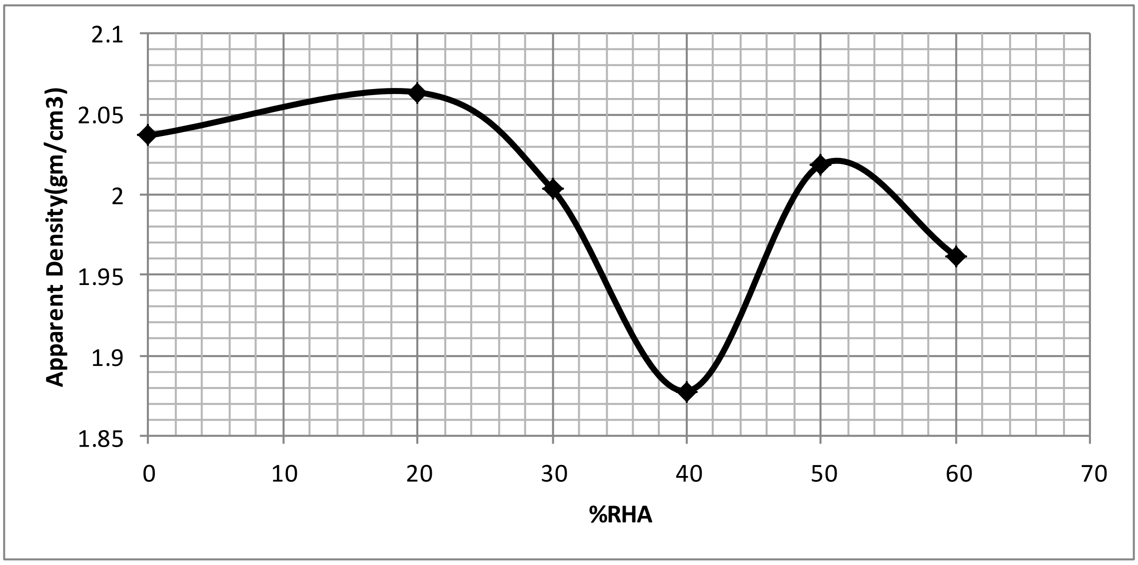

Figure 5: Apparent density of RHA3 for different percentages of RHA

The result of absorption test is given below in Figure 6. This figure denotes that absorption is less for 40-50% for most of the RHA. It was also seen from previous figure that the density is less for 40%. That means at 40% RHA, the blocks not only become light weighted but also become more compacted.

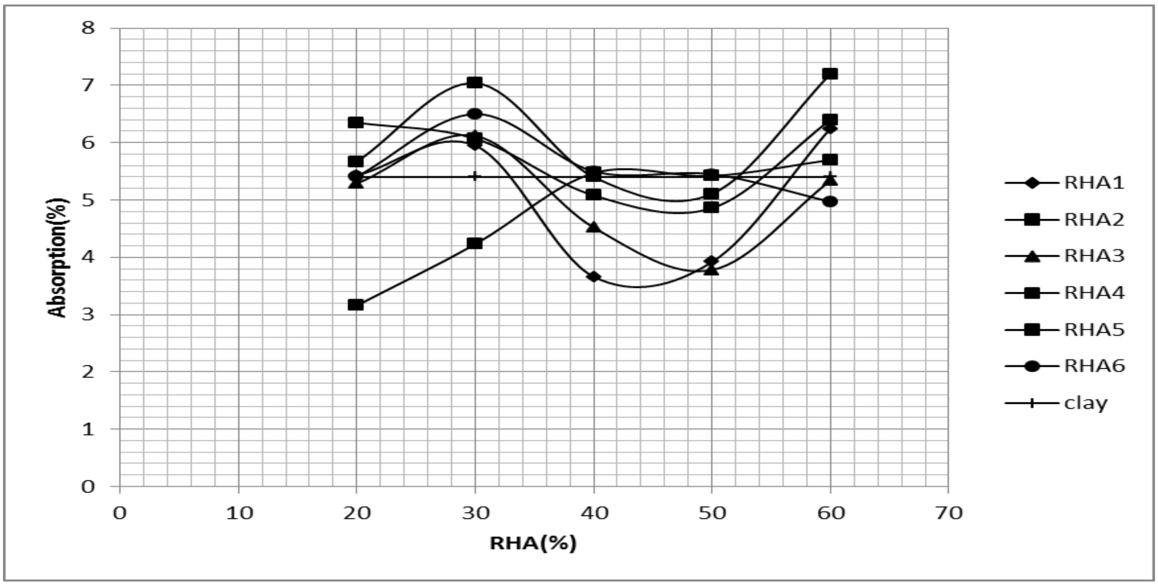

Figure 6: Absorption of blocks incorporating different percentages of RHA from different mills

The result of compressive strength test is given below in Figure 7. This figure also indicates that for 40% of RHA the compressive strength of the blocks incorporating finer RHA is higher than the blocks containing 100% clay.

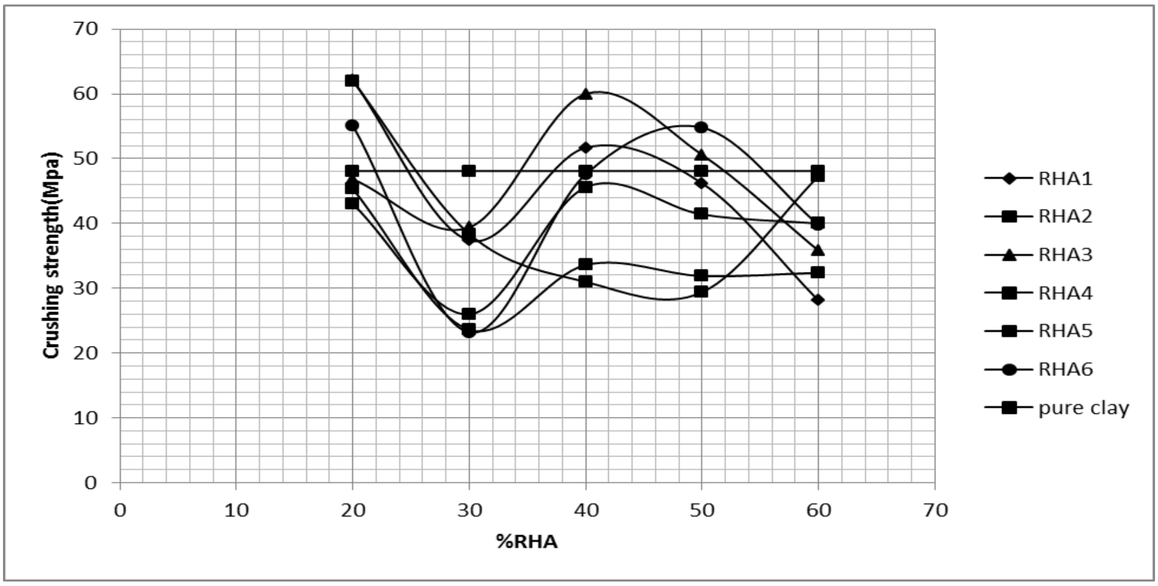

Figure 7: Compressive strength of blocks incorporating different percentages of RHA from different mills

Efflorescence test of the blocks were done by putting the blocks in a bowl of water for 7 days and the results were observed. The efflorescence effects on the blocks incorporating RHA was negligible.

4. CONCLUSIONS

The experiments were conducted for the development of blocks incorporating rice husk ash in this study. To fulfill the requirement of the objectives the experiments were conducted and subsequent results are presented. On the basis of the extensive experimental observations and discussions the following conclusions are drawn.

i) RHA performance increases if it is uniformly burnt from the mill and if the fineness is greater than 2500 cm^2/gm; in this experiment RHA 3 showed these properties properly.

ii) Crushing strength is first lowered with increasing percentage of RHA and then suddenly increases in 40% RHA, then again decreases.

iii) The crushing strength is higher than clay up to 40 % RHA combination for the finer RHA. So 40% volume of clay brick can be replaced by RHA.

iv) The absorption rate for 40% RHA is lower than other combinations; even pure clay.

v) Efflorescence effect is not excessively observable.

vi) L.O.I is also lowest for 40% RHA except RHA 4.

vii) The combination of RHA and clay only performs better than the combination of RHA, nutshell and clay.

viii) Apparent density decreases at 40 % that indicates light weight of the brick aggregates.

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