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Assessment of suitability of Fly Ash and Rice Husk Ash burnt clay bricks

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Abstract- The proposed study involves the experimental investigation of effect of fly ash and rice husk ash on the properties of burnt clay bricks. Determination of properties of the bricks casted with varying proportions of admixtures is taken up to ascertain whether the admixtures can be used for the production of clay bricks. On seeing the present day demand for bricks, an attempt is made to study the behavior of bricks manufactured using, different waste materials like rice husk ash and fly ash The main aim of this research was to compare the compressive strength of the bricks, so for this purpose different percentage of materials were separately added 5%, 10%, 15%, 20% and 25% by weight and then the compressive strength of the bricks was established, and then with the help of graph a comparison between compressive strength of bricks, made out of clay, Fly Ash, Rice husk ash and combination of all these was determined. The bricks were made, sun dried and burnt in a kiln, and then with the help of Compression Testing Machine (C.T.M.) finely their compressive strength was calculated. From this test in this research work it was concluded that the bricks with fly ash as the waste material admixture, gave the highest compressive strength. The fly ash admixture, in line with its pozzolanic nature, was able to contribute in attaining denser products with higher compressive strength, higher water absorption rates, better durability and better overall performance. The effects of the addition of rice husk ash and combination of fly ash and rice husk ash by percentage-clay mix was also investigated.
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Index Terms- Bricks, Clay, Compressive strength, Fly Ash, Rice Husk Ash, Water absorption.

I. Introduction

A brick is a block made of clay burnt in a kiln. It is one of the primary building materials known to mankind. Bricks are composed of inorganic non-metallic material and are widely used as building components all over the world. Over time, bricks have appeared, gained prominence, lost importance and then come to the forefront again with various styles of architecture. Burnt bricks were used in ancient Indian, Babylon, Egypt and Roman civilizations. Bricks find mention in the Bible; the tower of Babel was built with burnt bricks.

The need for locally manufactured building materials has been emphasized in many countries of the world because of their easy availability and low cost. Bricks also have been regarded as one of the longest lasting and strongest building materials, made from locally available sources, used throughout history. Ordinary building bricks are made of a mixture of clay, which is subjected to various processes, differing according to the nature of the material, the method of manufacture and the character of the finished product. After being properly prepared the clay is formed in molds to the desired shape, then dried and burnt. Burnt bricks are usually stronger than sundried bricks, especially if they are made of clay or clayey material. Burnt clay bricks are weaker compared to bricks made of cement in terms of strength and durability. Another important factor adding to the disadvantages of burnt clay brick is the environmental impact involved in the manufacturing process of clay bricks. To overcome these drawbacks an attempt has been made to increase the overall efficiency of clay brick by adding other suitable materials along with clay in the manufacturing process. In this project, we have tried to study the effects of adding fly ash and rice husk ash to the conventional clay bricks. The effect of addition of fly ash and rice husk ash, in varying percentages, to different properties of clay bricks such as compressive strength, water absorption etc. is investigated.

The construction industry in India contributes to about 10 % of the Gross Domestic Progress (GDP), registering an annual growth of about 9 %. Clay fired bricks form the backbone of the construction industry which is valued at approximately US$ 70.8 billion. The brick sector in India, although unorganised, is tremendous in size and spread. India is the second largest brick producer (China dominates with 54 % share) in the world. It is continuously expanding on account of a rapid increase in demand for bricks in infrastructure and housing industries. In order to meet this demand, over 150,000 brick units provide direct employment to more than 8 million workers. During the eleventh Five-year Plan period (2007-2012), the annual demand of 220 million bricks per year was estimated to be generating revenues of over US$ 5.3 billion.

Considering all the points discussed above, there is a need to find some alternative so as to reduce the impact of clay brick manufacturing process on the environment and at the same time increase the overall performance of the bricks. This research aims to achieve both the mentioned improvements by using admixtures along with clay during the manufacturing process. Certain group of admixtures are added to increase the bond between the particles and thus the strength of the brick. Such admixtures are either cementitious or pozzolanic materials. Pozzolanic materials include the traditional lime. The recent non-traditional pozzolanic admixtures used for brick production include wood ash, sawdust ash and fly ash. A second category of admixtures includes organic matter, such as rice husks, sawdust, coal, etc., which burn out when the bricks undergo firing. They regulate the temperature to which the brick is fired during burning, which is of paramount importance. The higher the firing temperature, the higher is the quality of the finished product. The addition of admixtures serves the following purposes:

1. Addition of pozzolanic admixtures like fly ash, wood ash etc. increases the strength of the brick.
2. As the organic admixture like saw dust, rice husk ash, etc. burn out they leave pores in the product. This permits the control of the bulk density of brick products and help in producing lighter porous bricks. The pores produced as the admixtures are burnt out permit the heat to reach innermost part of the core, thereby avoiding un-burnt cores.
3. The admixtures result in more uniformly burnt bricks, especially when the firing is being done outside of factory conditions, in which case inability to reach the minimum desired temperature of 1000 °C results in un-burnt cores especially in solid bricks.
4. Overall, there is a reduction in fuel and power expenditures involved in the brick manufacturing process.

II. MATERIAL USED FOR THE STUDY

2.1 CLAY:

Clay used for brick manufacturing should have the following properties:

- Plastic when mixed with water
- Have enough tensile strength to keep its shape
- Clay particles must fuse together

Clay soils are compounds of silica and alumina. Calcareous clays have calcium carbonate and will burn to a yellow or cream color. Non-calcareous typically contain feldspar and iron oxides, and will burn to a brown, pink or red, depending on the amount of iron oxide. The silica in the clay, when fired at 900-1200 degrees C, will turn to a glassy phase. This process, called vitrification, will turn the clay to a crystalline structure. Therefore, for the process of vitrification temperature is important. If under-fired, the bonding between the clay particles will be poor and the brick will be weak. If the temperature is too high, the bricks will melt or slump. Vitrification does not have to be complete, and does not actually occur in many of the small traditional brickmaking plants around the world. However, the vitrification does occur enough to give sufficient strength to the brick. It takes approximately 3 cubic meters of clay soil to make 1000 bricks.

2.2 FLY ASH:

Fly ash is the by-product of coal combustion collected by the mechanical or electrostatic precipitator (ESP) before the flue gases reach the chimneys of thermal power stations in very large volumes. All fly ash contain significant amounts of silicon dioxide (SiO2), aluminum oxide (Al2O3), iron oxide (Fe2O3), calcium oxide (CaO), and magnesium oxide (MgO). However, the actual composition varies from plant to plant depending on the coal burned and the type of burner employed. Fly ash also contains trace elements such as mercury, arsenic, antimony, chromium, selenium, lead, cadmium, nickel, and zinc.

These particles solidify as microscopic, glassy spheres that are collected from the power plant‘s exhaust before they can ―fly‖ away — hence the product‘s name: Fly Ash. Chemically, fly ash is a pozzolan. When mixed with lime (calcium hydroxide), pozzolans combine to form cementitious compounds.

The power requirements of the country are rapidly increasing due to growth of industries.65% of the total power produced in India is by thermal power plants and hence there is an increase in fly ash production. Further Indian coal contains 30 to 40% of ash content which further gives rise to air pollution, soil pollution, disrupts ecological cycles and causes other environmental hazards. Fly ash also contains traces of toxic substances which may affect human health, plant life and also the land on which fly ash is deposited. The disposal of this waste material is a matter of great concern from the environmental and ecological point of view. The safest and gainful utilization of fly ash has been one of the topics of research over the last few decades. The options of ash utilization including the ash based products are at development stage and need to be made more environments friendly by bringing ash revolution. It is estimated at present nearly 160 million ton fly ash is produced every year.

2.3 RICE HUSK ASH:

Rice husk ash (RHA) is obtained by burning rice husk. Physical properties of RHA are greatly affected by burning conditions. When the combustion is incomplete, large amount of un-burnt carbon is found in the ash. When combustion is completed, grey to whitish ash is obtained.

The amorphous content depends on burning temperature and holding time. Optimum properties can be obtained when rice husks are burnt at 500 - 700°C and held for short time, this temperature at which the husk is being burnt is less than that required for formation of clinkers in cement manufacturing process, the resulting ash can be used as a replacement of cement in concrete. The Rice Husk ash used in plain cement concrete oft en achieves economy and cost savings and imparts specific engineering properties to finished products. The chemical composition of RHA produced by utilizing the fluidized bed type furnace is reported to be SiO2 (80-95%), K2O (1- 2%) and un-burnt carbon (3-18%). The pozzolanic activity of rice husk ash is effective in improving the strength.

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III. MATERIAL TESTING

3.1SPECIFIC GRAITY:

The specific gravity test was done using pycnometer for all samples passing through 4.75mm IS sieve.

TABLE NO. 3.1 SPECIFIC GRAVITY OF MATERIALS USED

Sl.No	Material	Specific Gravity
1	Clay	2.25
2	Fly Ash	2.00
3	Rice Husk Ash	0.45

IV. ANALYSIS AND RESULTS

4.1 COMPRESSIVE STRENGTH TEST:

The compressive strength of the samples prepared was determined in a Compression testing Machine. For the research 3 samples of each composition were tested and average of the results is as tabulated below.

TABLE NO. 4.1COMPRESSIVE STRENGTH TEST RESULTS

Sl. No.	Type of Sample	Avg compressive strength (MPa)
1	100% Clay	4.938
2	95% Clay + 5% Fly ash	5.074
3	90% Clay + 10% Fly ash	5.126
4	85% Clay + 15% Fly ash	5.457
5	80% Clay + 20% Fly ash	5.801
6	75% Clay + 25% Fly ash	6.081
7	95% Clay + 5% Rice Husk ash	5.027
8	90% Clay + 10% Rice Husk ash	4.806
9	85% Clay + 15% Rice Husk ash	4.288
10	80% Clay + 20% Rice Husk ash	3.991
11	75% Clay + 25% Rice Husk ash	3.823
12	95% Clay + 2.5% Fly ash + 2.5% Rice Husk ash	3.786
13	90% Clay + 5% Fly ash + 5% Rice Husk ash	5.039
14	85% Clay + 7.5% Fly ash + 7.5% Rice Husk ash	5.199
15	80% Clay + 10% Fly ash + 10% Rice Husk ash	5.509
16	85% Clay + 12.5% Fly ash + 12.5% Rice Husk ash	5.753

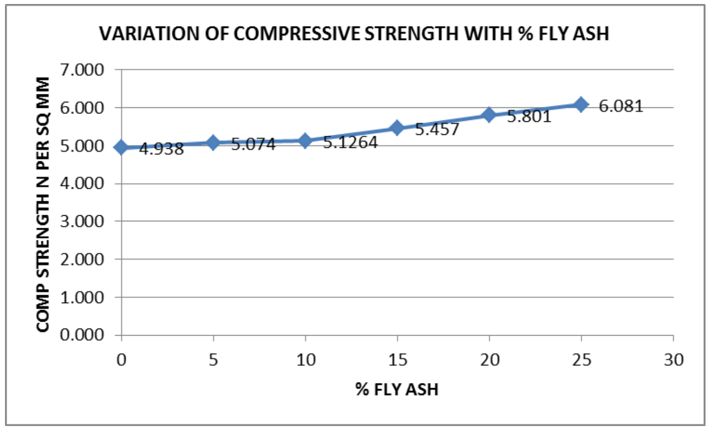

Figure 4.1: Compressive strength of Fly ash bricks.

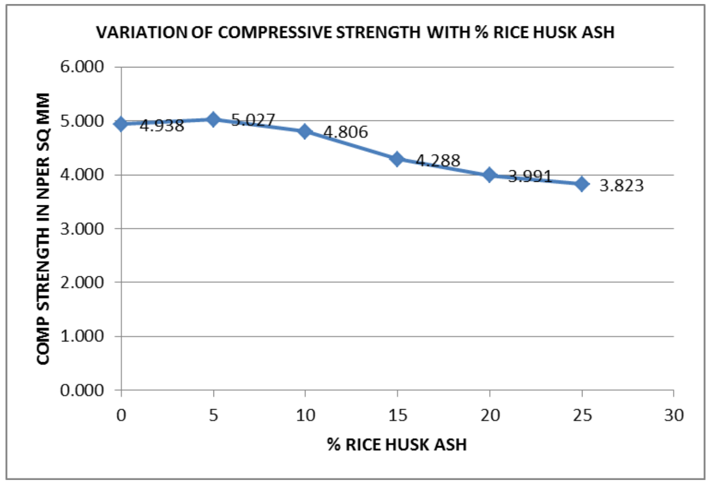

Figure 4.2: Compressive strength of Rice Husk ash bricks.

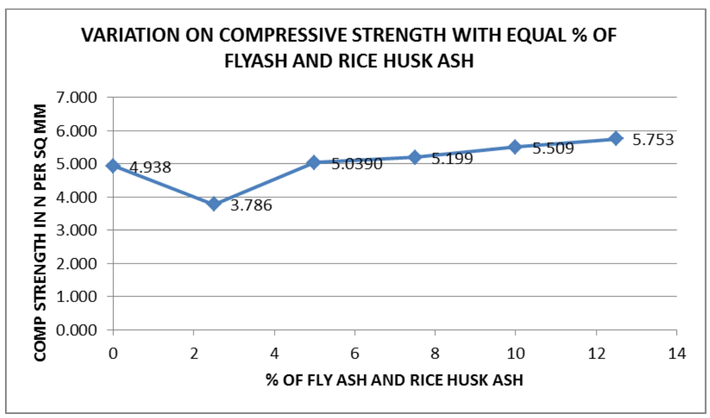

Figure 4.3: Compressive strength of Fly ash and Rice Husk ash bricks.

4.2 WATER ABSORPTION TEST:

The water absorption of the samples prepared was determined by 24 hour cold water immersion test. For the research 6 samples of each composition were tested and average of the results is as tabulated below.

TABLE NO. 4.2 WATER ABSORPTION TEST RESULTS

Sl. No.	Type of Sample	Water Absorption (%)
1	100% Clay	4.75
2	95% Clay + 5% Fly ash	9.81
3	90% Clay + 10% Fly ash	11.84
4	85% Clay + 15% Fly ash	14.58
5	80% Clay + 20% Fly ash	15.07
6	75% Clay + 25% Fly ash	16.43
7	95% Clay + 5% Rice Husk ash	8.16
8	90% Clay + 10% Rice Husk ash	12.78
9	85% Clay + 15% Rice Husk ash	13.66
10	80% Clay + 20% Rice Husk ash	14.43
11	75% Clay + 25% Rice Husk ash	16.16
12	95% Clay + 2.5% Fly ash + 2.5% Rice Husk ash	11.21
13	90% Clay + 5% Fly ash + 5% Rice Husk ash	13.36
14	85% Clay + 7.5% Fly ash + 7.5% Rice Husk ash	15.05
15	80% Clay + 10% Fly ash + 10% Rice Husk ash	16.38
16	85% Clay + 12.5% Fly ash + 12.5% Rice Husk ash	17.09

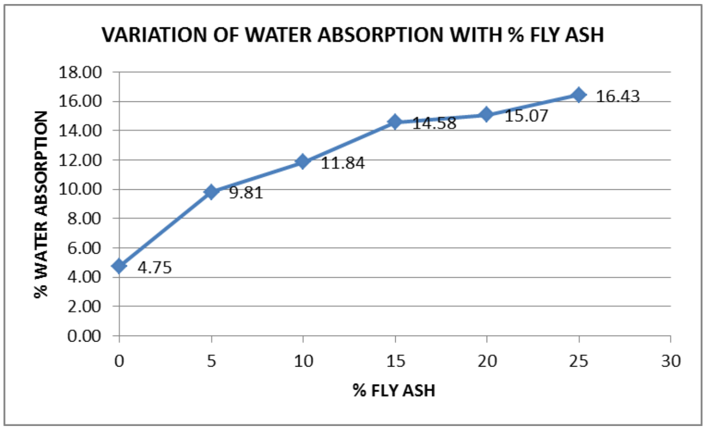

Figure 4.4: Water absorption of Fly ash bricks.

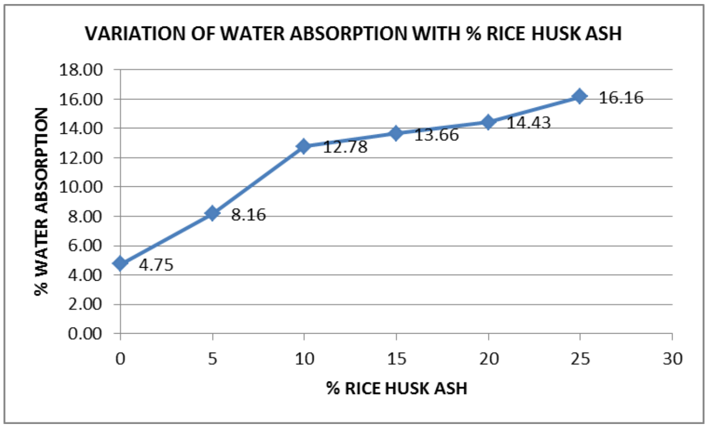

Figure 4.5: Water absorption of Rice Husk Ash bricks.

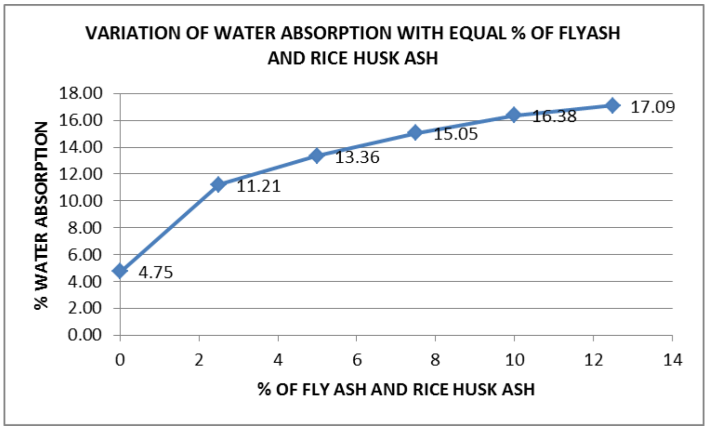

Figure 4.6: Water absorption of Fly Ash and Rice Husk Ash bricks.

4.3. BLOCK DENSITY TEST:

The block density of the samples prepared was found out by considering the dry weight and overall volume of 6 samples and the average of the results is as tabulated below.

TABLE NO. 4.3: BLOCK DENSITY TEST RESULTS

Sl. No.	Type of Sample	Block Density (Kg per cubic meter)
1	100% Clay	1828.707
2	95% Clay + 5% Fly ash	1825.580
3	90% Clay + 10% Fly ash	1822.743
4	85% Clay + 15% Fly ash	1771.367
5	80% Clay + 20% Fly ash	1760.398
6	75% Clay + 25% Fly ash	1734.171
7	95% Clay + 5% Rice Husk ash	1811.157
8	90% Clay + 10% Rice Husk ash	1799.099
9	85% Clay + 15% Rice Husk ash	1783.044
10	80% Clay + 20% Rice Husk ash	1767.668
11	75% Clay + 25% Rice Husk ash	1729.405

Sl. No.	Type of Sample	Block Density (Kg per cubic meter)
12	95% Clay + 2.5% Fly ash + 2.5% Rice Husk ash	1814.726
13	90% Clay + 5% Fly ash + 5% Rice Husk ash	1802.044
14	85% Clay + 7.5% Fly ash + 7.5% Rice Husk ash	1789.672
15	80% Clay + 10% Fly ash + 10% Rice Husk ash	1772.079
16	85% Clay + 12.5% Fly ash + 12.5% Rice Husk ash	1735.154

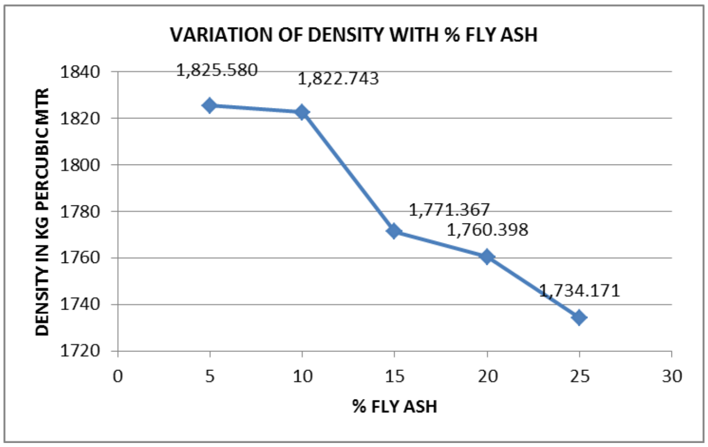

Figure 4.7: Block Density of Fly ash bricks.

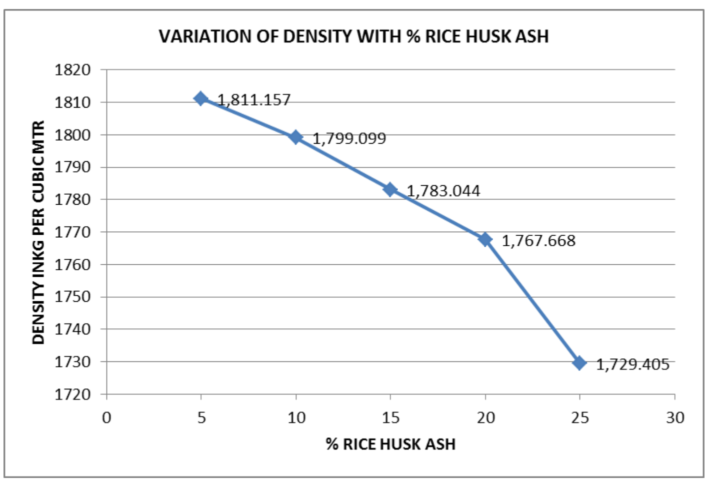

Figure 4.7: Block Density of Rice Husk ash bricks.

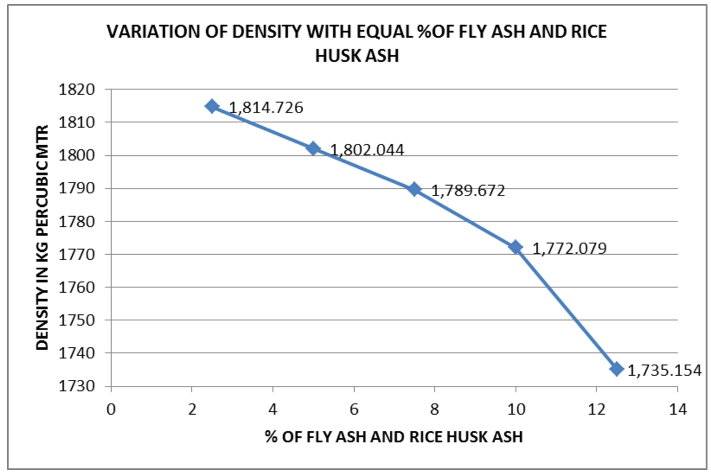

Figure 4.9: Block Density of Fly ash and Rice Husk ash bricks.

V. CONCLUSIONS

From the experimental results obtained, it can be concluded that

1. The clay burnt bricks manufactured with fly ash and rice husk ash had similar appearance when compared to the conventional clay bricks.
2. The clay bricks having fly ash as an admixture showed the best performance, having a compressive strength of about 23% greater than that of conventional bricks. The percentage of water absorption for these bricks was found to be more than that of conventional bricks but still within the prescribed maximum limit as per Indian Standards.(Maximum allowable water absorption as per Indian Standards is 20%) Hence fly ash can be used as an admixture with clay bricks.
3. The brick having rice husk ash as an admixture showed lower compressive strength and higher percentage of water absorption when compared to the conventional clay bricks. Also, for higher percentages of rice husk ash, the edges were found to be irregular in nature. Hence, rice husk ash is not recommended to be used as an admixture with clay bricks.
4. The bricks having both fly ash and rice husk ash as admixtures in equal proportions showed a marginal increase in strength for higher percentages of admixture. The water absorption of these bricks was found to be more than that of conventional bricks. Addition of both the admixtures together gives only a small increase in performance, hence it is not highly recommended

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