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# Effect of different Waste Materials Addition on the Properties of Clay Bricks

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**Abstract:** The disposal of wastes becomes major problems in the world and effects to environment and becoming toxic. Fly ash is one of the many substances that causes air, water and soil pollution. Along with this some other materials like saw dust, rice husk, bagasse also effects the environment pollution and some disturbances to the human activities. In order to save the precious land and soil from being used in manufacturing building bricks and to save the environment from the waste. In this project, the experiment will be done to know whether these materials addition alters the properties of bricks or not. Based on experimental results such as compressive strength, impact strength, efflorescence test, firing shrinkage, apparent porosity, bulk density, water absorption of different batches were calculated. it was concluded that the bricks with the waste material admixture, gave the good quality.

**Keywords:** Clay, ash fly, rice husk, saw dust, bagasse, compressive strength, impact strength, efflorescence test, firing shrinkage, apparent porosity, bulk density, water absorption.

## I. INTRODUCTION

Bricks plays a major role in construction industry and disposing some waste materials can lead to pollute the environment directly or indirectly. Some make disturbance to human activity and some becomes toxic to the nature (such as industrial wastes like fly Ash). Hence it becomes crucial to reuse the vast amount of different waste materials. A lot of research has been done on recycling the waste products in our daily experiences. This project conducted to save the precious land and soil from waste materials by being used in manufacturing building bricks and to save the environment from the waste.

Surender Malik et al (2015) prepared 3 types of bricks the former one in 100% Clay, second one is a mixture of 5% Fly Ash in clay (95% Clay+5% Fly ash) and another as 5% mixture of rice husk ash in clay( 95% + 5% ) in six samples of each and conducted compressive strength test on compression testing machine and water absorption test, results as fly ash content brick gives more compressive strength than conventional clay bricks and less water absorption nature. Rice husk ash brick results more water absorption in nature but with stands less compressive strength. Clay brick had high specific gravity than remain bricks containing rice husk ash and fly ash. [1]

David N Githinji et al (2015) study states that clay bricks were fabricated using different proportions of sawdust and polystyrene material, it results increase in non-clay material tends to decrease the properties like compressive strength, bulk density and flexural strength and also increase some properties like porosity and water absorption capacity. Particle Image Velocimetry (PIV) method is used to observe the surface deformation under uniaxial loading and made a stress strain curve pure-clay bricks to exhibit brittle failure to be as result of strong bonding between clay particles. [2]

Utsarga Choudhury (2013) prepared bricks using industrial major waste fly ash as admixture to clay with different compositions and conduct various tests to make various measurements like Rolling limit, Drying shrinkage, Firing shrinkage, Apparent porosity, Bulk density, Water absorption, And states that increase in fly ash content in composition increases the rolling limit and bulk density and decreases properties like firing shrinkage, drying shrinkage, absorption and apparent porosity. [3]

Haili Cheng et al (2016) fabricate bricks from waste and broken clay bricks which are rejected in quality control department by inspection methods and some of waste bricks from building which are collapsed, and results are not best compared to normal fabricated bricks because thermal stresses are increased while firing the bricks and tends to cracks in bricks and alkali nature gets increased which increases efflorescence of bricks it effects the wall by forming white or gary layer. [4]

Kedsarin pimraksa et al (2001) prepared bricks with 100% fly ash but of different grades as sieved -63+40  $\mu\text{m}$  fly ash and sieved - 40  $\mu\text{m}$  fly ash in different proportions, it results very high compressive strength and bending strength as 56.3Mpa and 13.1Mpa respectively and does not losses weight after firing not more than 4% so it made firing easy. Due to there is zero percentage of clay

there is very less firing shrinkage compared to clay burnt bricks. Time taken for drying and firing also very less compared to conventional bricks and requires firing temperature of  $950^{\circ}$  where as conventional bricks requires  $1200^{\circ}$  temperature. [5]

Aakash S. Pawar et al (2008) prepare bricks with dry fly ash and wet clay on weight percentage in a range of 5%-50% with an increment of 5% and find out compressive strength for wet brick and dry brick and results 40% more strength than conventional clay bricks, water absorption also moderate for all proportions whereas best result was 19.3% by its weight, efflorescence nature is nil because there is no foreign material in all different compositions [6]

Aeslina Abdul Kadir et al (2012) they prepare bricks with several wastes like rubber, limestone dust, processed waste tea, fly ash, polystyrene in a range of 1%-50%, and find out various mechanical and physical properties it results plasticity of bricks increased due to addition of sludge, increases thermal conductivity due increase of porosity after firing, weight of the brick is reduced. An estimated energy saving upto 40% and economically it is available at cheap cost because solid waste materials are available at free of cost. [7]

## II. MATERIALS & METHODOLOGY

In this work, the experiment has been conducted to know whether waste materials addition alters the properties of fired clay or not. Different batches have been made by changing the different compositions of fly ash, rice husk, saw dust, bagasse. Bricks are made as green bodies and then fired to conduct different tests i.e. compression strength, soundness, efflorescence test, apparent porosity, water absorption, bulk density and firing shrinkage were done. These properties are studied with respect to different compositions.

Clay is a finely grained natural rock or soil material that combines one or more clay minerals with possible traces of quartz ( $\text{SiO}_2$ ), metal oxides ( $\text{Al}_2\text{O}_3$ ,  $\text{MgO}$ ) and organic matter. Clay can appear in various colours from white to dull grey or brown to deep orange red. Fusion point of clay is more than  $1600^{\circ}\text{C}$  due to which it is resistant to heat. Specific gravity of clay minerals are in the range from 2 to 3.3. The hardness generally falls below 2.5. High-grade fire clays can withstand temperatures of  $1775^{\circ}\text{C}$ . Typical fired clay must withstand a temperature  $1515^{\circ}\text{C}$ . The fired clay ranges from flint clay to plastic clay.

Fly ash is also known as flue ash. Fly ash is generally collected from electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Fly ash consists of Silicon dioxide ( $\text{SiO}_2$ ), Aluminium oxide ( $\text{Al}_2\text{O}_3$ ) and Calcium oxide ( $\text{CaO}$ ). Fly ash is spherical in shape, and the range is in between 5 to 300 micrometer due to the rapid solidification. Fly ash ranges in size from  $0.5\mu\text{m}$  to  $300\mu\text{m}$ .

The chemical properties of fly ash depend on the chemical content of coal burnt. Fly ash contains toxic material that is dangerous for human health and living organisms. It also pollutes the air, water and the environment. Hence, it should be reused rather than keeping it outside as dump material.

Rice husk are the hard protecting coverings of grains of rice. It is formed from hard materials, including opaline silica and lignin. Rice husk composes according to proximate analysis results 15% of fixed carbon, 67% of volatile matter & 18% of ash and according to ultimate analysis C-40%, H-5%, O-34.8%, N-0.8%, S-0.1%, ASH-19.5% & H.H.V(MJ/KG)-14.8. At  $550^{\circ}\text{C}$ - $800^{\circ}\text{C}$  amorphous ash is formed and higher temperature crystallization will occur.

Saw dust is a by product or waste product of wood working operations such as milling, planing, routing, drilling, and sanding. Sawdust is the main component of particleboard. Wood dust is a form of particulate matter, or particulates. Research on wood dust health hazards comes within the field of occupational health science, and study of wood dust control comes within the field of indoor air quality engineering.

Bagasse is the dry pulpy fibrous residue that remains after sugarcane or sorghum stalks are crushed to extract their juice. It is used as a bio fuel for production of heat, energy, and in the manufacturing of pulp and building materials. The high moisture content of bagasse typically 40-50 percent, generally used as a fuel. A typical chemical analysis of washed and dried bagasse might show: Cellulose 45-55 %, Hemicellulose 20-25 %, Lignin 18-24 %, Ash 1-4 %, Waxes <1 %.

Clay is the main component for the preparation of bricks. Clay is digged deep from the earth and the clay obtained is cleaned by removing stones unwanted materials which will cause trouble while burning the bricks because it produces cracks. After cleaning the clay is made to place in the atmosphere and made to be wet by the atmosphere. Later water is added to the clay and squeeze by the feet for small scale uses and tractors for large scale.

Batch mixing is the process of mixing the compositions of different materials to the clay and make the composition to be mould in the respective shape.

The batch mixing is done by using hands or by grinding machine for a perfect mixture of the compositions and for preparation of good mixture. Compositions of bricks are in Table.1

Table.1: brick samples of clay, fly ash, rice husk, saw dust and bagasse

Bricks	clay	Fly ash	Rice husk	Saw dust	Bagasse
B1	100	-	-	-	-
B2	80	20	-	-	-
B3	80	-	20	-	-
B4	80	-	-	20	-
B5	80	-	-	-	20
B6	80	10	10	-	-
B7	80	10	-	10	-
B8	80	10	-	-	10
B9	80	-	10	10	-
B10	80	-	10	-	10
B11	80	-	-	10	10
B12	70	10	10	10	-
B13	70	10	-	10	10
B14	70	-	10	10	10
B15	70	10	10	-	10

Moulding of bricks is the process that mixed clay with different compositions as required and that mixed clay is placed in the mould box to get specified shape to the bricks. The moulding of bricks is done by two methods hand moulding and machine moulding. While placing the mixture of clay in to the mould box some fine ash should be sprinkled in to the mould box for easy removal of mould from it.

Drying of bricks is the natural process of exposing the bricks to the sun light for removing moisture content in the bricks which may lead to form cracks while burning. The drying of bricks is usually done 7-10 days based on the weather conditions. In some cases artificial methods are used for drying of bricks.

Burning of bricks is the main and important process for preparation of hard and strong bricks. Bricks are placed in the kiln and made to be burnt at a temperature of 1100°C - 1200°C for removing of moisture content in the bricks and to gain good strength in the bricks.

### III. RESULTS AND DISCUSSION

The tests performed in the laboratory to certify the quality of a brick are described below.

#### A. Compressive Strength Test

Compression is the process of applying axial load on the brick on universal testing machine to check the compressive strength of the brick. Basically 5 samples are to be tested and make average to the 5 samples to get the compressive strength. The value of the compression strength is noted at the point where the brick shows a slight crack.

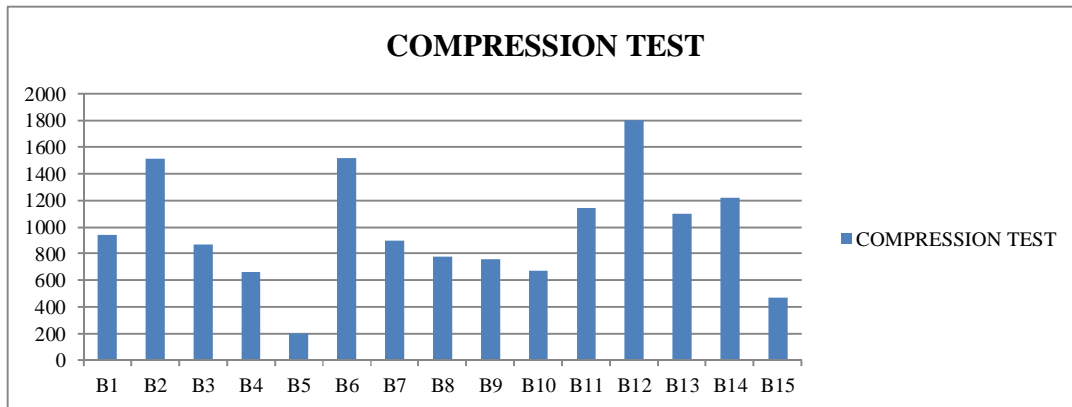


Fig.1: compressive strength of bricks of different compositions

It could be observed from the fig.1 that shows brick-12 (B12) has highest compression strength due to its composition of rice husk, saw dust and fly ash, all these materials don't possess blow holes because these are of small sized materials whereas brick-5 (B5) shows very less compressive strength because its composition having only bagasse which creates blow holes of large size so it gives less compressive strength.

**B. Impact Test**

In impact testing the brick is made to be dropped from a different heights. this test is conducted to get the impact strength of the bricks by observing the height when it shows cracks and to be noted. Good quality bricks can resist more impact load when it dropped from more height.

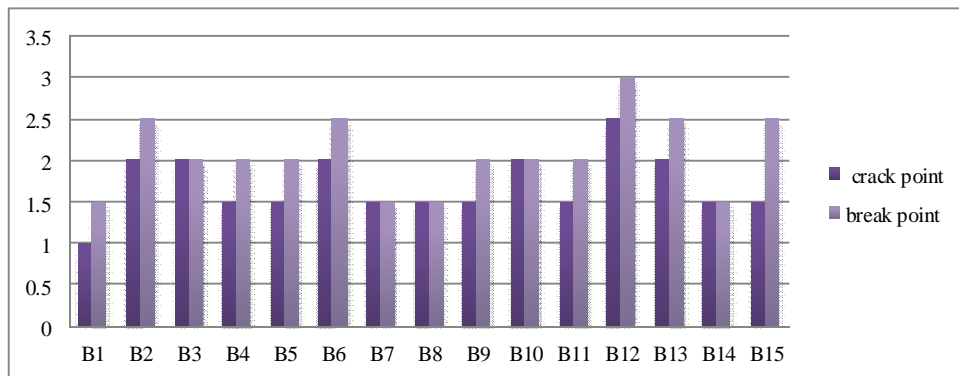


Fig.2: impact strength of bricks of different composition

It could be observed from fig.2 that brick-12 (B12) shows high impact strength because it does not have any internal defects and having composition of fly ash, rice husk and saw dust where as brick-6 (B6) shows low impact strength and having composition of fly ash and rice husk, so saw dust is the extra material added to B-12 compared to B-6, so it may increase the impact strength of the brick and firing temperature may alter the impact strength.

**C. Efflorescence Test**

The test is conducted to check weather the brick contains alkaline nature or not. In this process the bricks are soaked in the water for 24 hours. After soaking of bricks a layer of alkaline nature is formed on the brick in representation of white colour on the brick. If the alkaline nature high in the brick it is not suited for futher processes.

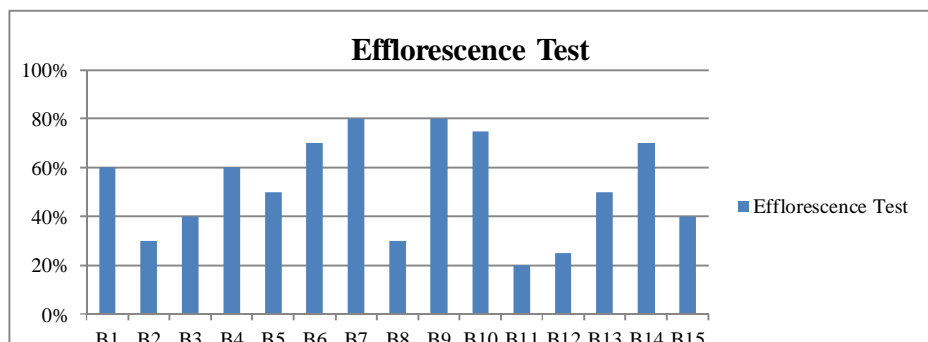


Fig.3: efflorescence percentage of bricks of different composition

It could be observed form the fig.3 that shows brick-7 (B7) and brick-9 (B9) are more efflorescence in nature because of producing more amount of alkaline substances while firing whereas compared to brick-11(B11) has very less amount of efflorescence nature because it does not producing much amount of alkaline substances while firing.

**D. Apparent Porosity**

Apparent porosity is relationship between volume of pore space to the volume of solid space in a brick it is given by an equation as follows,  $Apparent\ porosity = \frac{W - D}{W - S} \times 100$

**E. Firing Shrinkage**

Firing shrinkage varies according to the temperature of kiln, it is a variation of length before and after firing it is given by an equation,  $Firing\ shrinkage\ (\%) = \frac{(L - l)}{L} \times 100$

**F. Bulk Density**

Bulk density is nothing but degree of compaction of the solid body actually it varies to same material according to its condition like powder or taped here brick is a solid body so we consider it as a taped material and find out using equation,  $Bulk\ density = \frac{D}{W - S} \times 100$

**G. Water Absorption**

The amount of water absorbed by a brick is known as water absorption it varies according to the porosity of that brick. It is calculated using the relation,  $Water\ absorption = \frac{W - D}{D} \times 100$

**H. Soundness Test**

In this test two bricks of same composition are chosen randomly and made to be struck with one another if the sound produced from them is pure bell sound without breaking then it is said to be good brick. This test is conducted for testing the brick against sudden impact.

Table.2: results of properties such as apparent porosity, bulk density, water absorption, firing shrinkage, soundness

BRICK TYPE	APPARENT POROSITY	BULK DENSITY	WATER ABSORPTION	FIRING SHRINKAGE(%)	SOUNDNESS
B1	28.8	162.9	17.7	1.793	Nil
B2	39.6	128.1	30.9	-0.612	Heavy
B3	38.4	129.9	29.5	-1.487	Moderate
B4	35.4	131.4	26.9	2.012	Nil
B5	38.8	127.1	30.5	-0.174	Moderate
B6	35.4	137.4	25.7	2.012	Nil
B7	37.7	129.7	29.1	0.699	Nil
B8	36.9	129.7	28.4	-1.487	Nil
B9	38.8	128.02	30.3	0.699	Nil
B10	38.6	127.3	30.3	0.262	Moderate
B11	37.7	128.06	29.4	0.043	Moderate
B12	33.1	134.4	24.6	0.262	Heavy
B13	39.4	127.2	30.9	-0.612	Heavy
B14	36.3	129.8	28.0	0.481	Moderate
B15	38.7	127.6	30.3	0.699	Nil

Table.2 shows that the maximum value of apparent porosity is obtained in brick-2(B2) of composition clay and rice husk and minimum in brick-1(B1) of composition clay and fly ash because rice husk is a larger particle whereas fly ash is 200mesh size so porosity of brick-2 is high then all compositions

Table.2 shows that Bulk density of the brick-1 (B1) is more than all bricks because it only contains fly ash so there no chance of cavity where as brick-5 (B5) is very less due to bagasse produce cavities in bricks which effects the bulk density



Table.2 shows that more porous in nature will results in more water absorption as comparing with apparent porosity and water absorption, brick-2(B2) absorbing more amount of water when compared to all other bricks whereas brick-1(B1) absorbs very slight amount of water.

Table.2 shows that Firing shrinkage is more in bricks-4&6 (B4 & B6) were decreased its length due to firing with 2.012% whereas bricks-3&8 (B3 & B8) were increased its length due to firing

Table.2 shows that Bricks-3,12 & 13 (B3,B12 & B13) gives good metallic sound whereas B1,B4,B6,B7,B8,B9 & B15 gives non-metallic sound

#### IV. CONCLUSIONS

From the experimental data results can concluded as follows:

- A. Appearance of all the bricks was same as the normal conventional clay bricks
- B. The mechanical property of brick-12(B12), brick-2(B2) and brick-6(B6) gives good compressive strength which was 52% better than conventional clay bricks
- C. Impact strength of B12 is more than all bricks where it shows a crack when dropped from 2.5m and broken from 3m where as conventional clay brick brick-1(B1) fails from 1m height
- D. Efflorescence nature of B12 and B11 is 25%and 20% respectively whereas clay brick has 60% over the entire surface of the brick
- E. There is very less shrinkage in firing for brick B11 and B12 as 2%
- F. The bricks of all compositions are lighter in weight than conventional clay brick
- G. The manufacturing cost and time is reduced for these bricks because these composition bricks require less amount of heat than clay bricks

After observing all these results we can conclude that brick-12 (B12) and brick-2(B2) has good quality which results in high compressive strength, impact strength with moderate porosity and water absorption capacity and don't have much alkaline nature

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