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EFFECTS OF WASTE MATERIALS ON PHYSICAL AND MECHANICAL PROPERTIES OF BRICK

M A Kaiyum*, M Mintu Ali, and M Humayan Kabir

Department of Glass & Ceramic Engineering (GCE), Rajshahi University of Engineering and Technology (RUET), Rajshahi-6204, Bangladesh

Email-a.kaiyum.ruet11@gmail.com*, min2.gce11ruet@gmail.com, mhk.gce11@gmail.com.

Abstract- *Now-a-days industrialization gives us a lot but similarly the waste materials are also a curse for our society. Paper waste and sugar cane Bagasse are also important to minimize and reuse them. In this research work we use paper wastes and sugarcane wastes with clay brick so that we can minimize the waste as well as we can improve the quality and lower the cost of brick and investigated the mechanical and physical properties of bricks. Density, compressive strength, impact strength, bending strength of bricks varies with increasing waste percentage in comparison with local clay bricks. The prepared samples were dried on a hot plate at 150ºC for 24 hours to remove the moisture content from the body and fired at 1000ºC in electric kiln. Due to 6% paper and sugarcane waste the density was 1.26 gm/cm^3 and 1.80 gm/cm^3 respectively. The maximum firing shrinkage was 3.8% for sugarcane waste and 6.9% for paper waste respectively. The compressive strength was 9.45 MPa for paper waste and 10.2MPa for sugarcane bagasse.*

Keywords: Clay, mechanical properties, drying shrinkage, firing weight loss, bending strength.

1. INTRODUCTION

Brick is a very important construction material for very ancient time to present. Due to civilization the use of bricks or construction materials are increasing rapidly. The history of brick is very long. Fire brick was used in south east Anatolia in Turkey was about 3rd millennium BC **[1] [2].** First recorded example of used designed fire brick was used in Egyptian pyramids and the brick reinforced with straw **[3].** Housing and civilization is not possible without brick. Clay brick was also used for making the Great Wall of China **[4].**

Traditional brick is made of different types of clay and sand. In Bangladesh local countryside clay is used. Sometimes china clay, ball clay are also used in some advanced type brick manufacturing. Properties of brick depends on the composition and phases that are exist in brick **[5]**. And physical structure, firing temperature and time are also responsible for different properties of brick **[6].** Using of waste materials are main causes of this work. Basically waste materials are not only concern for Bangladesh but also for the world concern. Sugarcane bagasse are source of pozzolanic materials which is very important for brick **[7].** In this research work the different composition of paper waste and sugarcane bagasse are used and their effects are determined.

2. EXPERIMENTAL PROCEDURE

Raw materials play an important role in brick making process. Depending on different type of clay used as raw materials the properties and types of produced brick changes. For general burnt clay brick production which is used as construction material. Usually surface clay is used as main raw material. The brick making factories in Bangladesh uses locally available clay material for brick production. Clay was collected from local brick manufacturing industries and Paper Waste was collected from waste papers of everyday use. First clay material was collected from source. Collected clay materials were dried in natural atmosphere for 3 weeks. The composition was prepared as weight percentage (wt%).

Impurities like stones, leaves, wood, and roots were then removed from clay using sieve. Then clay was dried in hotplate at 100ºC. For 24 hours and excess water content was removed. Sugarcane bagasse was collected from source. Waste was then dried under sun for two weeks. Dried bagasse was then cut into small pieces. Collected paper was cut into small pieces. Mainly sample preparation includes that first the batch composition of samples is calculated. Then mixing, moulding of bricks, drying, firing was done to prepare the samples. The raw materials were taken as per batch calculation. The first batch contained only local clay with no addition of waste materials. Then weight percentage of paper waste was added to 2%, 4% and 6%; sugarcane bagasse waste was added to 2%, 4% and 6% respectively with decreasing the weight percentage of local clay. Mixed plastic clay was moulded into brick shape (5×2.5×1.5 inch). Here wooden mould box was used. The box was open at top and bottom end. The samples were fired at 1000ºC in electric kiln. The first heating rate was 5ºC/min and the temperature held at 300ºC for 60 minutes. The second heating rate was 5ºC/min with a soaking time of 2 hour and finally cooling was done.

3. RESULT AND DISCUSSION

Different tests was performed for determining the effects of waste materials on the physical properties of brick, these are discussed below.

3.1 Drying Shrinkage

Drying shrinkage is defined as the contracting of a moulded brick due to the loss of capillary water. The table-1 of drying shrinkage with waste percentages and the figure-1 between drying shrinkage and waste percentages is given below.

Type	Waste%	Drying Shrinkage (%)
Local clay	0	10.23
Paper Waste	2	11.21
	4	13.12
	6	15.37
Sugarcane Waste	2	9.24
	4	8.78
	6	10.5

Table-1: Drying shrinkage

Mainly in the figure the data shows that drying shrinkage of paper waste brick increases by increasing the waste percentage, drying shrinkage of sugarcane brick also increases by increasing waste percentage. Paper waste brick shows the highest value of drying shrinkage when using six percent waste. Sugarcane waste brick also shows the highest value of drying shrinkage when using six percent waste.

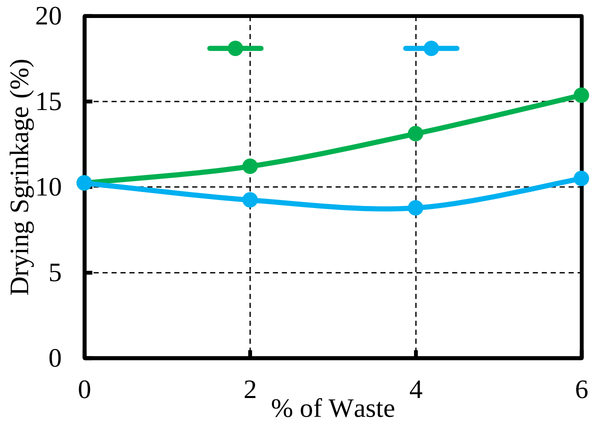

Fig.1: Drying shrinkage vs waste percentage

3.2 Firing Shrinkage

The values of firing shrinkage with waste percentages and the graph between firing shrinkage and waste percentages is given below.

The figure-2 that shows the firing shrinkage of local clay, paper waste and sugarcane waste brick. Mainly in the figure the data shows that firing shrinkage of paper waste brick increases by increasing the waste percentage, firing shrinkage of sugarcane brick also increases first then decreases by increasing waste percentage. Paper waste brick shows the highest value of firing shrinkage when using six percent waste. Sugarcane waste brick also shows the highest value of firing shrinkage when using six percent waste.

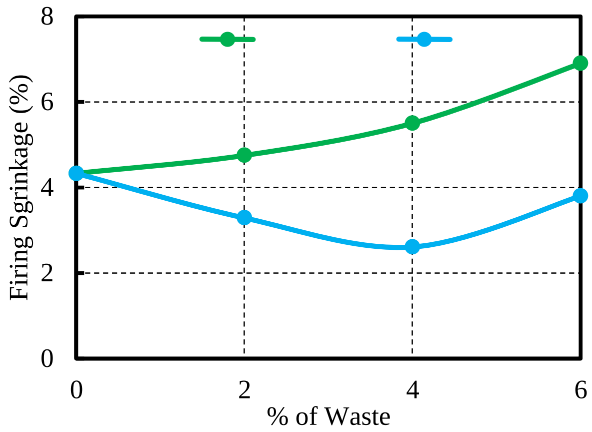

Fig.2: Fringing shrinkage vs waste percentage

3.3 Density

The values of density with waste percentages is shown in figure-3. Which is given below.

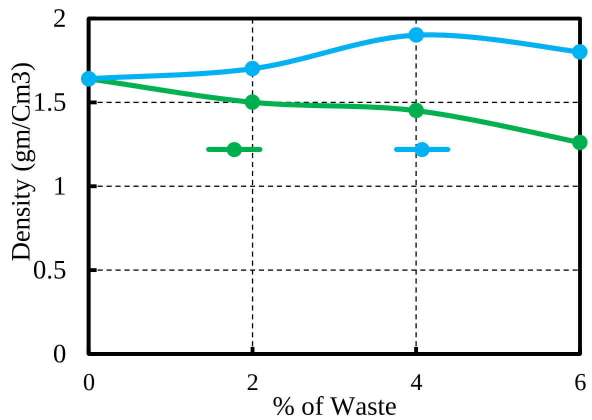

Fig.3: Density vs waste percentage

The figure-3 that is given, shows that the density of local clay, paper waste and sugarcane waste brick. Mainly in the figure the data shows that density of paper waste brick decreases by increasing the waste percentage, density of sugarcane brick also decreases first by increasing waste percentage. In figure. Paper waste brick shows the highest value of density when using two percent waste. Sugarcane waste brick shows the highest value of density when using 4% percent waste.

3.4 Compressive Strength

The values of compressive strength with waste percentages is shown in the following Figure-4. The figure shows that the compressive strength of local clay, paper waste and sugarcane waste brick. Mainly in the figure the data shows that compressive strength of paper waste brick decreases by increasing waste percentage (Compared with Sugarcane), compressive strength of sugarcane brick increases with waste percentage. In figure, Paper waste brick shows the highest value of compressive strength when using four percent waste. Sugarcane waste brick also shows the highest value of compressive strength when using four percent waste.

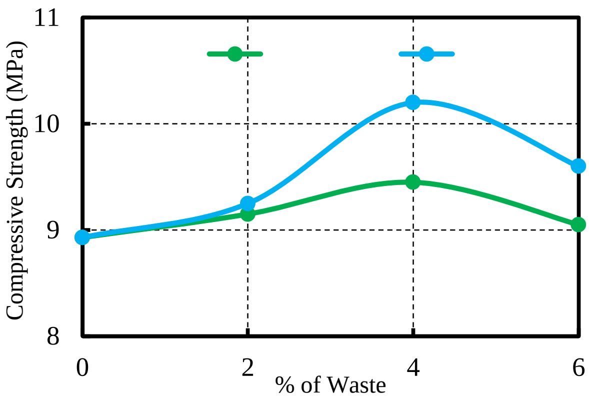

Fig.4: Compressive strength Vs waste Percentages

3.5 Impact Strength

Impact strength is the capability of the material to withstand a suddenly applied load and is expressed in terms of energy. The values of impact strength with waste percentages is given in following figure-5.

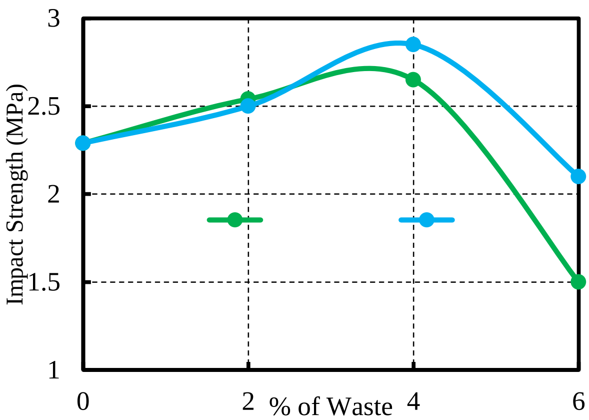

Fig.5: Impact Strength Vs waste Percentages

The figure that is given, shows the impact strength of local clay, paper waste and sugarcane waste brick. Impact strength of paper waste brick decreases by increasing waste percentage Compared with Sugarcane), impact strength of sugarcane brick increases first by increasing waste percentage then it decreases when 6% sugarcane waste was added.

3.6 Bending Strength

The flexural strength **(σ_f)** represents the highest stress experienced within the material at its moment of yield. The values of bending strength was calculated by using three point bending method **[8].** The flexural strength **(σ_f)** can be write as the following Eq.1.

$$\sigma_f = \frac{3FL}{2HB^2} \quad (1)$$

The resultant bending strength is given in the following table-2.

Table-2: Bending Strength of Bricks

Type	Waste%	Bending Strength (MPa)
Local clay	0	2.28
Paper waste	2	2.5
	4	2.65
	6	2.1
Sugarcane waste	2	3.5
	4	3.65
	6	3.14

From the table-2 it is found that the highest values of bending was 3.65 MPa, which is found for sugarcane waste (4%). After that the values decreases at 6% waste.

4. CONCLUSION

The present analysis of this works shows that the maximum amount of sugarcane bagasse and paper waste was 6%. After that composition the properties are decreases gradually. It can be conclude that the amount of waste materials should be kept below or equal to 4 %. Future work may be used both of the waste materials together. At 4% weight of waste shows higher density and higher values of compaction, as a result the better result or mechanical properties was found at that composition.

5. REFERENCES

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6. NOMENCLATURE

Symbol	Meaning	Unit
σ_f	Flexural Strength	(MPa)

F	Load	(N/mm^2)
L	Length of the sample	(mm)
H	Height of the sample	(mm)
B	Width of the sample.	(mm)