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EFFECTS OF COKE FURNACE SLUDGE ON PHYSICAL AND MECHANICAL PROPERTIES OF BRICK

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KeyWords

Firing Shrinkage, Drying Shrinkage, Bending strength, Impact Strength, Coke Furnace Slag, Local Clay, Compressive Strength, etc.

ABSTRACT

In this research waste materials (coke furnace sludge) is used to replace clay to investigate the mechanical and physical properties of bricks. The hand moulding process is used to make bricks to investigate the effects of coke furnace sludge on the mechanical and physical properties of brick. The drying and firing shrinkage shows acceptable results. Density compressive strength, impact strength, bending strength of bricks varies with increasing waste percentage in comparison with local clay bricks. Coke furnace sludge shows the least amount of loss on ignition among the waste bricks. By using coke furnace sludge, most of the bricks shows second class properties and many of them shows first class properties. So, the replacements of coke furnace sludge influence much in properties of the brick.

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Introduction

Use of waste materials is a very important idea now-a-days. All over the world it is a burning question to decrease the waste materials. Coke furnance sludge is also common waste materials. It is used in various building materials and landfills also. Use of sludge in brick is also an important idea.

Blast furnace slag can be used as cement materials and the sludge is colled from 1300-16000C verily rapidly to prevent crystallization **[1].** The amount of slag generation is roughly 300 kg per ton of pig iron produced, and the annual production of blast furnace slag (BF slag) in Japan exceeds 24 million t (all units herein are metri) **[2].** Recycling of waste generated from industrial and agricultural activities as building materials appears to be viable solution not only to such pollution problem but also to the problem of economic design of buildings. The brick industry is the most indicated technological activity sector to absorb solid waste due to the large quantity of raw material used by the sector as well as by the large volume of final products in construction **[3]**.

Brick can be produced in using different methods like hand shaping, moulding, and industrial shaping machine process. We used hand moulding process as it is the most used process in brick industries of our country. The inclusion of waste materials changes the mechanical and physical properties of brick. Also, during the moulding process requirement of water to achieve desired plasticity for moulding operation changes with varying amount of waste material percentage. Again, for utilization of brick in building operations the compressive strength, impact strength needs to full fill the standard requirement. Excess amount of waste material in clay can cause breakage of brick sample during drying and firing operation. The major challenge of this work is to find the suitable percentage of waste material to replace the clay material while keeping the properties within standard limit.

Raw Material

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 accordingly. 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. The raw materials used in this thesis are,

1. Local Clay:
Collected from local brick manufacturing industries.

2. Coke Furnace Sludge:
Collected from iron melting factory of Bangladesh.

Experimental Procedure

- Coke furnace sludge was collected from source.
- Collected coke furnace sludge was hammered into small pieces.
- Then crushed in jaw crusher to produce fine particles.
- Crushed sludge was sieved and stored.

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 coke furnace sludge was added to 10, 20, and 30%. The raw materials were weighed according to batch calculation by using electric balance. Then raw materials were mixed adding sufficient water to get sufficient plasticity of clay. Mixed plastic clay is moulded into brick shape (3 x 2 x 1 inch.). Here wooden mould box is used. The box is open at top and bottom end.

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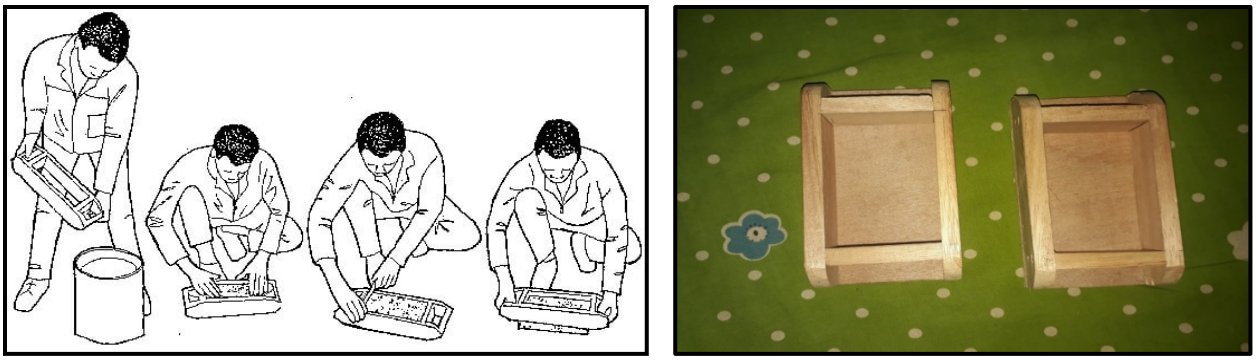

a) **b)**

Fig.1: a) Hand molding of Brick [4], b) Hand Made Brick Mold

Results and Discussion:-

Drying Shrinkage:-

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

Table 5. 1: Drying Shrinkage of Bricks

Name	Waste%	Drying Shrinkage
Coke Furnace Sludge	0	13.76
	10	11.04
	20	12.18
	30	10.67

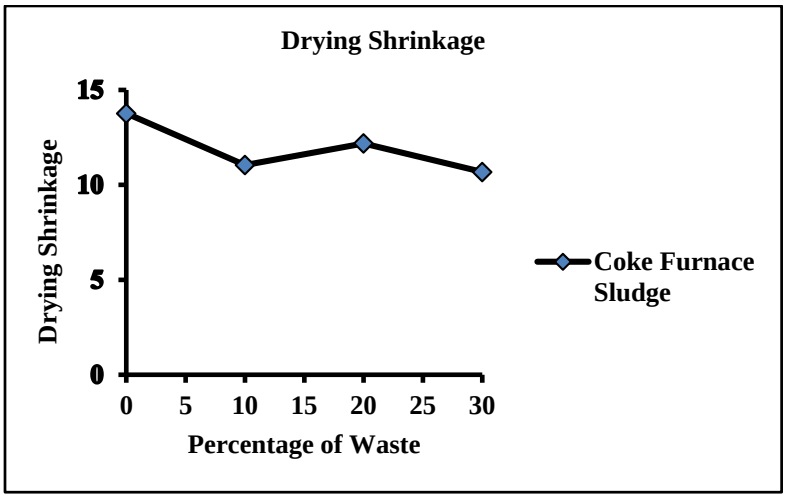

Fig.-2: Drying Shrinkage of Coke Furnace Sludge waste Brick.

The figure that is given shows the drying shrinkage of coke furnace sludge waste brick. Mainly in the figure the data shows that drying shrinkage of coke furnace sludge brick increases to a certain point then it. In figure, coke furnace sludge brick shows the highest value of drying shrinkage when using twenty percent waste.

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Firing Shrinkage

The figure that is given shows the firing shrinkage of coke furnace sludge brick. Mainly in the figure the data shows that firing shrinkage of coke furnace sludge brick increases to a certain point then it decreases, firing shrinkage of paper waste brick increases by increasing the waste percentage.

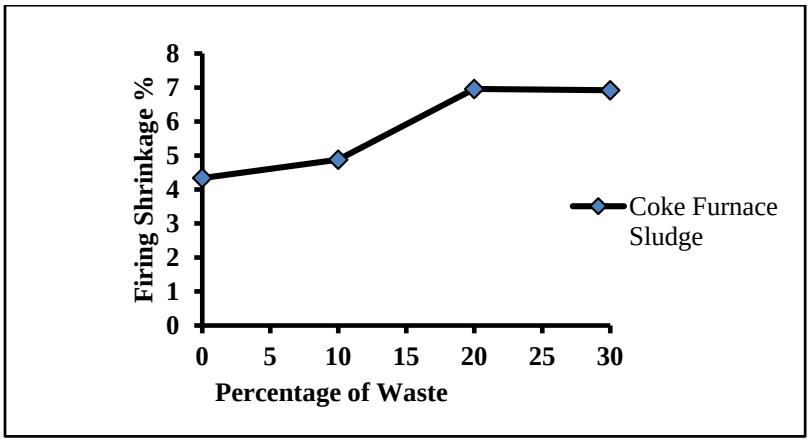

Fig.-3: Firing Shrinkage of Coke Furnace Sludge waste Brick.

Loss on Ignition:-

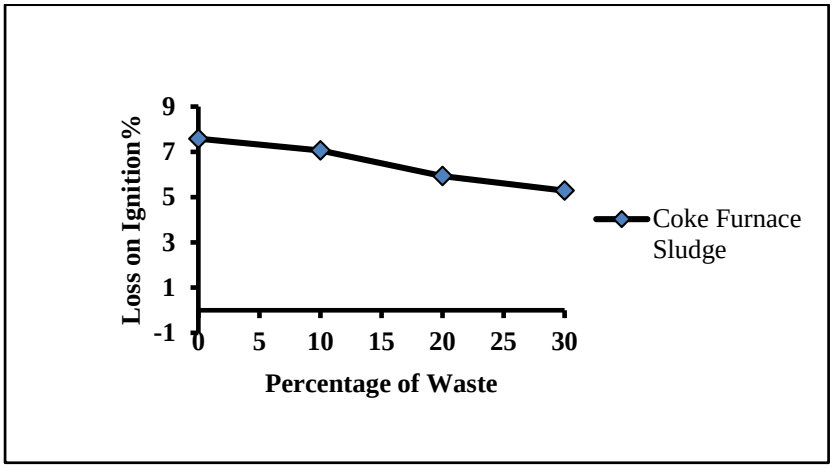

Fig.-3: Loss on Ignition of Coke Furnace Sludge Waste Brick.

The figure that is given shows the loss on ignition of coke furnace sludge waste brick. Loss on ignition is a test used in inorganic analytical chemistry, particularly in the analysis of minerals. The volatile materials lost usually consist of "combined water" (hydrates and labile hydroxy-compounds) and carbon dioxide from carbonates. Mainly in the figure the data shows that loss on ignition of coke furnace sludge brick decreases by increasing waste percentage. In figure, coke furnace sludge brick shows the highest value of loss on ignition when using ten percent waste.

Compressive Strength:-

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart).The figure that is given shows the compressive strength of coke furnace sludge waste brick. Mainly in the

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figure the data shows that compressive strength of coke furnace sludge brick increases with waste percentage then it decreases. In figure, coke furnace sludge brick shows the highest value of compressive strength when using 20 percent waste. And then gradually decreases.

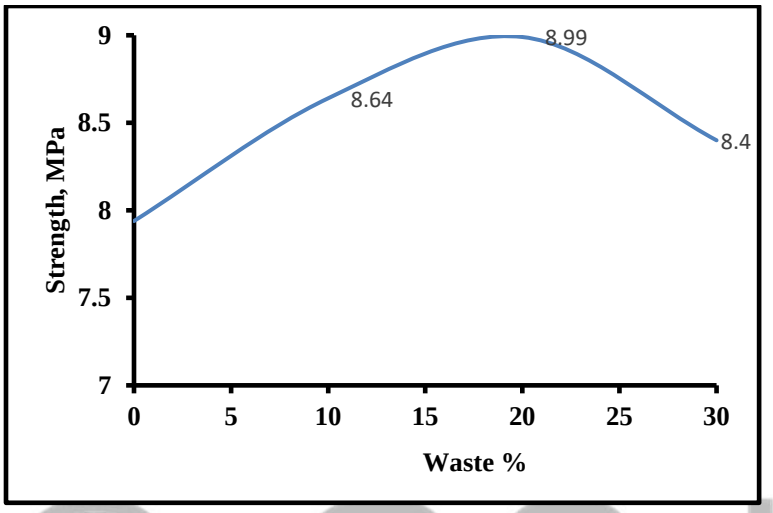

Fig.-4: Compressive of Coke Furnace Sludge Waste Brick.

Bending Strength:-

Bending strength, also known as modulus of rupture or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test.

For a rectangular sample under a load in a three-point bending, the formula is,

$$\sigma = \frac{3FL}{2bd^2} \text{---------} \text{---------} \quad (1)$$

Where,
F = The load (force) at the fracture point (N).
L = The length of the support span.
b = Width.
d = Thickness.

The bending strength of bricks from different manufacturer vary in bending strength.

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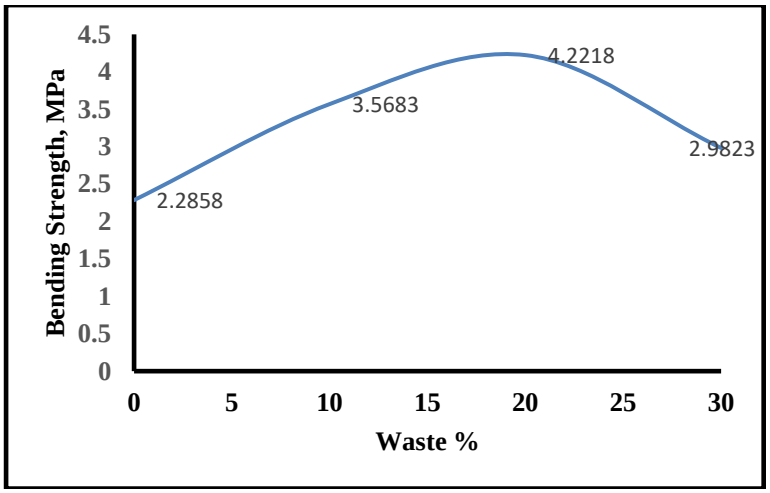

Fig.-5: Bending Strength of Coke Furnace Sludge Waste Brick.

The figure that is given shows the bending strength of coke furnace sludge. In the figure the data shows that bending strength of coke furnace sludge brick increases first then decreases by increasing waste percentage. In figure, coke furnace sludge brick shows the highest value of bending strength when using twenty percent waste.

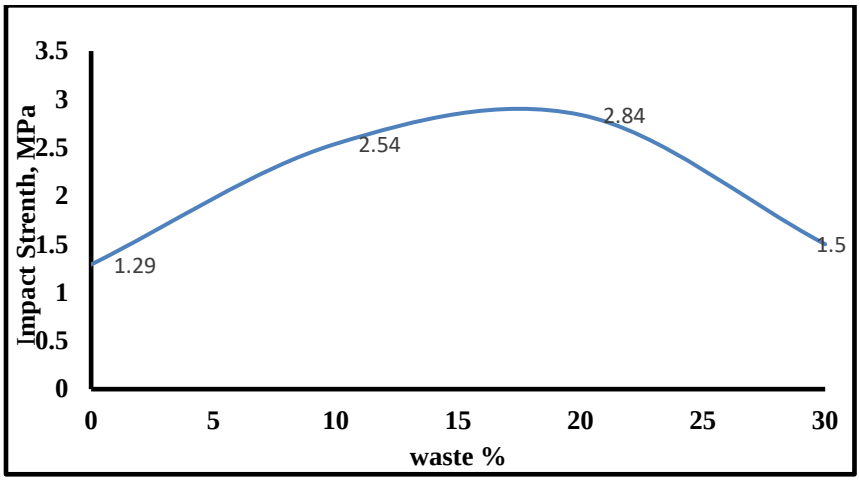

Fig.-6: Impact of Coke Furnace Sludge Waste Brick.

The figure that is given shows the impact strength of coke furnace sludge brick. Impact strength is the capability of the material to withstand a suddenly applied load and is expressed in terms of energy. Often measured with the Izod impact strength test or Charpy impact test, both of which measure the impact energy required to fracture a sample. The data shows that impact strength of coke furnace sludge brick increases by increasing waste percentage. After 20% of waste the value decreases.

Conclusion:-

Brick like coke furnace sludge brick was easily be made by hand moulding process. This type of bricks shows more important properties in the comparison of local clay brick. The firing temperature of these bricks are 1300°C. The properties like drying shrinkage, firing shrinkage, loss on ignition, density, compressive strength, impact strength is changed up to a certain percentages of waste materials. Most of the properties like bending strength, compressive

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strength and impact strength increases with increasing sludge percentage. Height value was found for 20% waste material of coke furnace sludge.

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