AN EXPERIMENTAL STUDY ON ECO FRIENDLY BRICKS

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Abstract: ***This experimental study was carried out to investigate the significance of clay soil bricks mixed with cow dung and fly ash to obtain a sustainable and ecofriendly building material. Burnt clay brick is one of the major and widely used building materials for construction around the world. The manufacturing of burnt clay bricks using waste materials can minimize the environmental overburden caused by waste deposition on open landfills and would also improve the brick performance at low production cost leading to more sustainable construction. Wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment. The method of producing traditional bricks from kiln is costly and induces pollution. Hence, in this work waste substance such as cow dung and fly ash is added as a replacement material for clay soil. Cow dung is used to manufacture eco-friendly bricks in some parts of the world. Fly ash is used as stabilizer which can give more compressive strength to the brick. Based on trial and error method replacement of waste substances was done. The bricks obtained by this process behaved similar to traditional bricks.***

Index Terms - **Fly ash, Cow dung, ecofriendly, sustainable, stabilizer and compressive strength**

I. INTRODUCTION

Housing is one of the basic needs for human life. The major mode of construction followed globally is brick masonry. Brick is considered as one of the oldest manufactured building materials in the world. Clayey soil bricks have been used since 4300 BC and are still in use even today. Clay brick is a combination of clay soil and water in a suitable proportion. It is formed primitively, naturally dried, and fired in kilns under controlled conditions. The clay bricks are known for its thermal insulating property which helps to maintain the temperature and keeps the building cool during summer. Hence, as a result, there is always a demand for clay brick. The raw materials involved in this process are clay, silt, shale and soft slate, which are obtained naturally. Generally, clay comprises of silica, alumina, lime, manganese, iron, sulphur, phosphates and certain ionic compounds. Soil is a cheap, environmentally friendly, and abundantly available building material and composition varies from place to place.

Traditional Moulded bricks:

Traditional Moulded bricks or Fired bricks are burned in a kiln which makes them durable. Modern, fired, clay bricks are formed in one of three processes – soft mud, dry press, or extruded. Depending on the location, either the extruded or soft mud method is the most common, since they are the most economical. Normally, brick contains ingredients like Silica (sand) – 50% to 60% by weight, Alumina (clay) – 20% to 30% by weight, Lime – 2 to 5% by weight, Iron oxide – ≤ 7% by weight, Magnesia – less than 1% by weight.

These bricks start with raw clay, preferably in a mix with 25–30% silt to reduce shrinkage. The clay is first ground and mixed with water to the desired consistency. The clay is then pressed into steel or wooden moulds with hand. The shaped clay is then burned at 900–1000 °C to achieve strength.

This study is driven by the objective of making extensive use of raw earth, containing a natural component of clayey soil, as the main building material, aided by a fibrous material which in this case is cow dung. This is to develop technologies that are energy saving, eco-friendly and sustainable. The principal processes and procedures for forming the bricks are researched, tested, analysed and discussed and appropriate conclusions and recommendations drawn from it.

II. MATERIAL USED

CLAY SOIL

Clay is a finely-grained natural material with traces of metal oxides, alumina, quartz and organic matter. In general, these are silicate deposits with water wrapped mineral structure. They are plastic in nature due to fine particles and their molecular bonding in wet condition and are hard and brittle in dry condition. Normally, color of clay ranges from white to dull grey or brown to orange red based on chemical substances present in it. The clay soil for this study was obtained at the banks of river Vaigai.

COW DUNG

Cattle manure is basically made up of digested grass and grain. Cow dung is high in organic materials and rich in nutrients. It contains about 3 percent nitrogen, 2 percent phosphorus and 1 percent potassium (3-2-1 NPK). In addition, cow manure

contains high levels of ammonia and potentially dangerous pathogens. Dried cow dung is an excellent fuel. In some cultures, dung from domestic cows or buffalo is routinely collected and dried for fuel, sometimes after being mixed with straw. Dried cow dung has high calorific values. Pieces of dung are lit to provide heat and a flame for cooking. Dried dung has lost its objectionable odour. From ancient times, cow dung has been used as construction material. It is mixed with clay and used as protective coating for walls and floors. Addition of cow dung increases the plasticity of city which in turn is helpful in reducing the crack formation.

FLY ASH

Fly ash, known as pulverized fuel ash, is a residue obtained after coal combustion. It is composed of fine particulate matter rich in oxides of silica, calcium and aluminium. Nowadays, in modern power plants, fly ash is captured by electrostatic precipitators or other particle filtration equipment after combustion of coal. Fly ash is collected from the NLC India Limited, *Neyveli Thermal Power Station, Tamil Nadu.* The application of fly ash in brick decreases bulk density, permeability, hydraulic conductivity and modulus of rupture. Fly ash does not affect soil aggregation.

SILT

Silty soils are finer granular materials of a size between sand and clay. Silty soils also tend to be dark colored soils. Silt is formed as a result of the breakdown of humus. Silty soils with clay matter in them will hold a lot of water. It is because the water molecules will be trapped among the tiny particles of silt and clay. Silt has a moderate specific area with a typically non-sticky, plastic feel. Silt usually has a floury feel when dry, and a slippery feel when wet. Silt can be visually observed with a hand lens, exhibiting a sparkly appearance.

III. Laboratory studies

The Various tests conducted on the samples are conducted in the laboratory based on IS code: *IS3495 (part1-4):1992.*

A. Compressive strength test

Place the specimen with flat face s horizontal and mortar filled face facing upwards between plates of the testing machine. Apply load axially at a uniform rate of 14 N/mm^2 (140 kg/cm^2) per minute till failure occurs and note maximum load at failure. *Compressive Strength of Bricks = Maximum Load at Failure (N)/Average area of bed face (mm^2)*

Load applied: 4 *KN/sec*

According to IS 3495 (Part 1): 1992, the minimum compressive strength of bricks is 3.50 N/mm^2. The bricks with crushing strength between 7 and 14 N/mm^2 are said to be grade A and those having above 14 N/mm^2 are grade AA.

B. Water absorption test

Dry the specimen in a ventilated oven at a temperature of 105 °C to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (M1) specimen too warm to touch shall not be used for this purpose. Immerse completely dried specimen in clean water at a temperature of 27+2°C for 24 hours. Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water (M2).

Calculation of Water Absorption of Bricks:

Water absorption, % by mass, after 24 hours' immersion in cold water in given by the formula, the average of result shall be reported. When tested as above, the average water absorption shall not be more than 20% by weight up to class 12.5 and 15% by weight for higher class.

Absorption % = w_2-w_1/w_1 x 100

C. Efflorescence test

Efflorescence is a whitish crystalline deposit on surface of the bricks. Usually magnesium sulphate, calcium sulphate and carbonate of sodium and potassium are found in efflorescence. A good quality brick should not contain any soluble salts in it. If soluble salts are there, then it will cause efflorescence on brick surfaces. To know the presence of soluble salts in a brick, placed it in a water bath for 24 hours and dry it in shade. After drying, observe the brick surface thoroughly. If there is any white or grey colour deposits, then it contains soluble salts and not useful for construction.

Nil- If there is no noticeable deposit of efflorescence.

Slight- when less than 10% of exposed area of brick is covered by a thin layer of salt.

Moderate- When there is a heavier deposit than under 'slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

Heavy – When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.

Serious-when there is heavy deposit of salt acquired by powdering and/or flaking of exposed surface.

IV. RESULTS AND DISCUSSION

A. Compressive strength test

The compressive strength test is done in the laboratory for the samples and the results are shown in Table 1.

B. Efflorescence test

The efflorescence test is done in the laboratory for the samples and the results are shown in Table 3.

C. Water absorption test

The Water absorption test is done in the laboratory for the samples and the results are shown in Table 2.

TABLE 1
Compressive strength of samples

Brick sample	Compressive strength of brick(N/mm^2)
3%	**4.152**
5 %	**3.467**
7%	**2.314**
10 %	**2.064**
15 %	**1.252**
3%+7%F	**6.891**
6%+14%F	**5.622**

TABLE 2
Water absorption test of samples

Brick samples	Dry weight (M1)	Wet weight (M2)	$(M_2-M_1)\div M_1 \times 100$
3%	2.534	2.745	12%
5%	2.366	2.684	13%
7%	2.152	2.483	15.5%
10%	2.015	2.420	20%
15%	1.862	2.352	26%
3%+7%F	2.866	3.122	7%
6%+14%F	2.594	2.879	9%

TABLE 3
Efflorescence test on samples

Brick sample	Efflorescence
3%	Nil
5%	Nil
7%	Nil
10%	Nil
15%	Nil
3%+7%F	Nil
6%+14%F	Nil

C. Field test

The field test also conducted to ensure the hardness, colour, shape and size, structure of bricks. Some of them showed best results and some has failures.

- 10 &15% of cow dung added samples has imperfect shape and size had more voids inside, which result in low compressive strength and has high water absorption.
- Other samples (3%,5%,7%) shown similar characteristic as normal clay bricks.

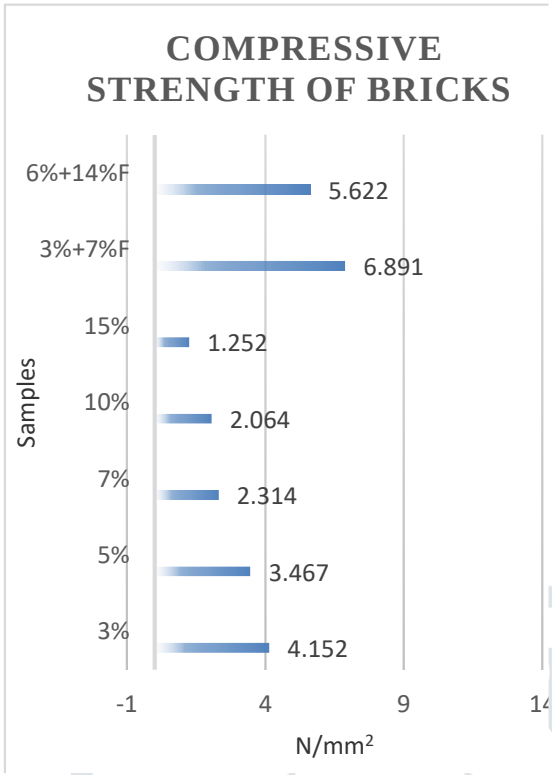

Figure 1: Compressive Strength of bricks

V. CONCLUSION

Cow dungs can be used as admixture in clay soil to produce bricks. It can be cost effective. These bricks are produced eco-friendly by adding cow dung as internal fuel to burn the brick in kiln. Less strength is obtained due to partial replacement of clay with Cow dung.

The factor that affect strength of the bricks:

- The method of Hand mixing and Moulding leads to less compaction of brick and proper mixing does not take place.
- Voids in the brick increased due to burning of cow dung.
- More voids increase the water absorption and decrease compressive strength on bricks.

In order to avoid the reduction of compressive strength the fly ash is added to retain the strength of the brick.

- By adding fly ash, the void pores are filled and water absorption get decreased.
- Fly ash act as a stabilizer to increase the strength of bricks which cow dung added.

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