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A Study on Fly Ash Bricks by using Lime and Gypsum

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***Abstract*: Fly ash is produced in vast quantities as a by-product of the burning of fossil fuels for the thermal generation of electricity. At present 10-15% of the fly ash produced in Australia is utilized in cement manufacturing and concrete industry, with the remaining majority requiring costly disposal processes. Due to growing environmental concerns and the need for cleaner production, the management of fly ash has become an important issue facing the power generation industry. For that reason, many researchers are actively working to find new and improved methods of combating the fly ash waste disposal problem, particularly by establishing its useful and economic utilization. One such example that is gaining considerable interest in many parts of the world is the utilization of fly ash in brick manufacturing. This paper examines the potential for using Class F fly ashes from Queensland as major constituents in the manufacture of common residential building bricks. Scaled-down pressed bricks were made by varying proportions of fly ash, sand, hydrated lime, sodium silicate and water. Both fired, oven dried and air-cured bricks were tested for their properties including compressive strength, tensile strength, water absorption, and durability. In the paper, the test results are analyzed and effects of variables discussed. Recommendations and conclusions as to whether or not the fly ash bricks can perform adequately alongside the clay bricks are included.**

***Keywords*: Cement, Fly ash, gypsum, lime**

1. Introduction

Construction is a booming industry and requires a huge amount of material and the demand for all these materials is increasing exponentially. Out of the total dead load of the building the load of the masonry accounts for about 25 to 40% which is substantially a big share. By reducing the weight of a brick in the masonry, a considerable amount of unwanted load from the structure can released. This will reduce the load and bending moment on beam column- foundations, resulting into smaller sections and eventually cost reduction. The environmental impact of the material also can‟t be overlooked. The conventional bricks are made of clay, due to unsustainable mining and high self-weight, cement bricks were introduced. However, the production of cement is not eco-friendly. As the production of every one tone cement approximately generates one tone of carbon dioxide (CO2) This makes it important to redesign the masonry. (Dinesh W.Gawatre, Laxmikant N. Vairagade).

Brick manufacturing is confined to the non-monsoonal months and produces 3.5 Billion bricks per year which emits 1.8 million tons of CO2. India being a vast country enormous amount of waste generated, which poses a great challenge for the waste management. Some of the wastes like fly ash, plastic, rice husk ash, sugarcane sludge etc. have a great potential to be used as a construction material.

2. Objectives

To formulate a new process for manufacture a composite brick with the use of waste material. And compare it with the conventional bricks for compressive strength, efflorescence and water absorption which are the main properties to be checked in a brick. The main objectives for brick to be fulfilled when compared with the conventional bricks are:

- To obtain light in weight.
- To obtain sustainable brick made from sustainable materials.
- To obtain a brick with good physical properties
- To obtain a brick with good chemical properties.
- To obtain a brick that does not pose any threat to humans or environment health
- To obtain a durable brick.
- To obtain a brick with proper finished edges.
- To obtain also punch/ impact resistant brick
- To obtain cost effective brick.

3. Methodology and materials

Laboratory investigations carried out on cement, coarse aggregates (Thermocol beads) and also on concrete which are used for test specimens have been presented. This chapter of thesis contains physical properties of various materials used throughout the experimental work.

A. Materials used

The varies materials used in the experimental works are

1. Cement.
2. Lime
3. Gypsum

4. Fly Ash
5. Water

1) Cement

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and many plasters. It consists of a mixture of calcium silicates, aluminates and ferrites. Ordinary Portland cement of 53 grade of Ambuja Cement confirming to IS 12269 standards was used. Test result are taken as it is as given by company. The cement shall be measure on the weight basis each bags weighing 50kg which is equal to 35liters in volume. All standard test shall be carried out to ensure that the cement is of required quality.

2) Fly Ash

In India 60% of the energy requirement is fulfilled from thermal power plants. In which coal is burnt, the disposal of the increasing amounts of thermal waste from coal-fired thermal power plants, this disposal of the thermal waste is called fly ash. Fly ash is composed of the noncombustible mineral portion of coal consumed in a coal fuelled power plant. Fly ash is a powdery substance obtained from the dust collectors in the electrical power plants that use coal as fuel. There are two basic type of fly ash.

3) Water

Water used for the Floating concrete is potable water. This is to ensure that the water is reasonably free from such impurities as suspended solids, organic matter and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value.

4. Procedure

A. Cube Making (brick)

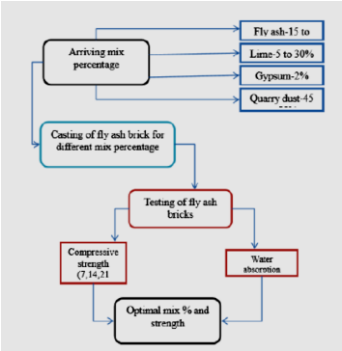

Fig. 1. Cube making procedure

Procedure for casting of bricks

Method 1

- First all the materials was taken in proportion and mixed it well in a tray.
- Prepared the mould by properly cleaning it and applying the mixture of glycerin and dextrin evenly.
- Then filled the material in the mould in three layers by tamping each layer 25 times.
- Close the mould from above and kept it in oven at 300°C.
- The mould was then removed from the oven and allowed to cool at room temp.
- Finally after cooling the block was removed from mould and tested.

Method 2

- This method all the material was taken in proportion and well mixed in a dry state.
- All the material was melted in an oven
- And poured it in the well greased mould.
- Allowed it to cool at room temperature.
- And all the standard tests were conducted.

Tests conducted on bricks.

- Compressive strength of bricks
- Water Absorption test
- Shape and size test
- Hardness test
- Fire test

5. Results and discussions

A. Laboratory tests

- *Determination of compressive strength:* Apparatus used for the test A compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which coincides with the centre of the plate, shall be used. Preconditioning of brick Remove unevenness observed in the bed faces to provide two smooth and parallel faces by grinding. Immerse in water at room temperature for 21 hours. Remove the specimen and drain out any surplus moisture at room temperature. Fill the frog (where provided) and all voids in the bed face flush with cement mortar (1 cement, clean coarse sand of grade 3 mm and down). Store under the damp jute bags for 24 hours followed by immersion in clean water for 3 days. Remove, and wipe out any traces of moisture.
- *Procedure for testing:* Place the specimen with flat faces horizontal, and mortar filled face facing upwards between two 3-ply plywood sheets each of 3 mm thickness and carefully centered between plates of the testing machine. Apply load axially at a uniform rate of 14 N/mm^2 (140 kgf/cm^2) per minute till failure occurs and note the maximum load at failure. The load at failure shall be the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.
- *Determination of water absorption:* IS 3495 (Part 2): 1992 24-hoar Immersion Cold Water Test Apparatus. A sensitive balance capable of weighing within 0.1 percent of the mass of the specimen; and a ventilated oven. Preconditioning. Dry the specimen in a

ventilated oven at a temperature of 105 to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (MI). Specimen warm to touch shall not be used for the purpose.

B. *Procedure*

Immerse completely dried specimen in clean water at a temperature of 27 f 2°C for 24 hours. Remove the specimen and wipe out any traces of water with a damp cloth and weigh the specimen. Complete the weighing 3 minutes after the specimen has been removed from water

C. *Results*

After programming various test on the bricks it was found that with increase in percentage of fly ash the blocks become brittle and addition of fly ash makes the block light in weight so the proportion of fly ash to fly ash should be just enough so that all the fly ash is binded properly.

Trial 1……Proportion

The first trial of the brick was made by taking fly ash (70%) lime (20 %) and gyp (10%) The standard size of brick 19 x 9 x 9cm.

Table 1
Compression test & Water Absorption test

Specimen No	Compressive Strength (N/mm^2)	Water Absorption %
Brick 01	2.46	7.14
Brick 02	2.44	6.66
Brick 02	2.09	7.33

Trial 2:

The first trial of the brick was made by taking fly ash (60%) lime (20 %) and gyp (20%) The standard size of brick 19 x 9 x 9cm.

Table 2
Compression test & Water Absorption test

Specimen No	Compressive Strength (N/mm^2)	Water Absorption %
Brick 01	2.46	7.14
Brick 02	2.44	6.66
Brick 02	2.09	7.33

Trial 3:

The first trial of the brick was made by taking fly ash (50%) lime (25 %) and gyp (25%) The standard size of brick 19 x 9 x 9cm.

Table 3
Compression test & Water Absorption test

Specimen No	Compressive Strength (N/mm^2)	Water Absorption %
Brick 01	2.64	3.23
Brick 02	2.69	4.23
Brick 02	2.23	3.87

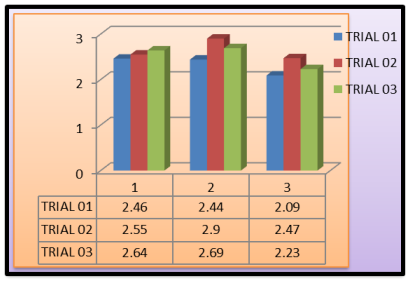

Fig. 2. Comprehensive strength

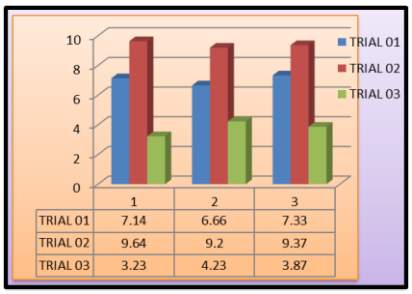

Fig. 3. Water absorption

Fig. 4. Bricks

6. Conclusion

After casting of bricks using fly ash in several proportions it was found that the use of waste material as ingredients has made the resulting brick economical, strong and environmental friendly. Both the methods tried have their own advantages and disadvantages. The material gets homogeneously mixed and gives higher strength (7.3MPa) in second method. But the heat requited for the trial was also more. And in the first method the brick had a porous structure and light in weight. But while casting by this method in full sized brick the heat did not reach till the centre and fly ash did not melt properly

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