Eco-friendly fly ash composite brick: A novel approach towards Sustainable Development

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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 fly ashes as major constituents in the manufacture of common residential building bricks. Scaled down pressed bricks were made by varying proportions of fly ash, sand, limestone, gypsum, LDPE (low density polyethylene) 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.

 Keywords—Fly ash, Brick, Waste disposal.

 **I.INTRODUCTION**

Fly ash is by product of coal combustion, which occurs in thermal power plants. It consists of small, solid particles that are carried away in the flue gas and collected by electrostatic precipitators or baghouses before being released into the atmosphere. Fly ash is typically composed of silicon dioxide (SiO2), aluminum oxide (Al2O3), calcium oxide (CaO), and magnesium oxide (MgO).

Fly ash is created in a large amount particularly by warm power plants. Plastics are generated in large amount with increase in population. Disposal of waste materials including waste plastic bags has become a serious problem. The waste plastics in house hold is large and increases with time. Both cause severe environmental problems. The main aim of our project is to utilize those plastics and fly ash in the manufacturing of bricks. In this paper, the fly ash bricks are casted and plastics were powdered and added up to 20% with an interval of 5%. Fly ash bricks are manufactured with plastics and undergo compressive strength test, water absorption test and efflorescence test. Here the strength properties of plastic bricks comprising of waste plastics, fly ash as the constituents and the design considerations for pavement block incorporating waste plastic bags is presented. It will be definitely cost economical when compared with the normal fly ash bricks.

The brick of size 190 mm × 90 mm × 90 were thrown in the research center utilizing the waste plastic powder in proportions of fly ash bricks. The specimen was blended with an adequate measure of water to acquire working consistency for molding. The mold was loaded with the lime, fly ash, quarry dust and waste plastic powder without permitting any air bubble. The surplus blend was expelled and top surface was pulled down. For the hand formed bricks, no weight was used to the stamp. The weight formed bricks were set up by applying of 50 KN. The formed block was put aside to dry for two days, shielding from direct sun. The examples were drenched in water at room temperature for 24 hoursand from there on, the examples were held out of water. These examples were cured by sodden jute packs for 7, 14 and 21 days.

 **II.OBJECTIVES**

* To manufacture fly ash based brick as a measure of reusing fly ash waste.
* To Study fly ash brick strength, dimensional stability, and water absorption.
* To study the cost-effectiveness in comparison to traditional brick.

**II.** **MATERIALS AND METHODS**

# Materials used:

The materials used for the experiment were: Fly ash, sand, LDPE (low density polyethylene), gypsum, water, limestone. Weighing machine or Oven, mold etc.

# Methodology:

# Collection of Fly Ash

Fly ash is a by-product of burning coal in thermal power plants, and it can be collected and reused in various applications. The collection of fly ash typically involves the use of electrostatic precipitators (ESPs) or baghouses, which are devices that capture the fly ash particles from the flue gases before they are released into the atmosphere. In an ESP, the fly ash particles are charged and then attracted to electrodes, where they are collected and removed. In a baghouse, the flue gases are passed through fabric filters, which trap the fly ash particles. The collected fly ash can then be transported to storage facilities for further processing and use.

# Mixing of Raw Materials

Fly ash bricks are made by mixing a combination of raw materials that include fly ash, sand or stone dust, lime, gypsum, And Low-Density Polyethylene.

1. **Fly Ash**

 Fly ash is obtained from thermal power plants where coal is burned. The ash is collected from the exhaust gases and stored in silos for further use. The fly ash is then sieved to remove any large particles and mixed with water to form a slurry.

1. **m- sand**

m- Sand is added to the fly ash slurry in a specific proportion. The purpose of adding sand or stone dust is to improve the strength and durability of the bricks.

1. **Lime**

Lime is added to the mixture in a specific proportion to provide the necessary binding properties to the bricks. The lime reacts with the silica present in the fly ash and forms a complex compound that acts as a binder.

1. **Gypsum**

Gypsum is added to regulate the setting time of the fly ash bricks. Gypsum also helps to prevent the cracking of bricks during the drying process.

1. **Low density polyethylene**

Low density polyethylene acts as a binding agent in the composite, helping to improve the strength and durability of the resulting brick.

1. **Moulding**

The mixture is then poured into moulds of desired shapes and sizes. The moulds are generally made of metal or plastic.

# Curing

The curing process of fly ash bricks is a crucial step that helps to enhance their strength and durability.

1. **Water curing**

After the bricks are moulded, they need to be kept moist for at least seven days. This process is known as water curing. During this period, the bricks are covered with wet gunny bags or straw to prevent evaporation of moisture.

1. **Drying**

After the water curing process, the bricks are taken out of the moulds and kept in a shady area for drying. This process takes around 7-10 days depending on the weather conditions. During this period, the bricks should be kept away from direct sunlight to prevent cracking.

1. **Natural cooling**

After the steam curing process, the bricks are taken out of the chamber and allowed to cool naturally. This process takes around 24 hours. The bricks should not be cooled suddenly as it may lead to cracking.

# Demoulding

Demoulding of fly ash bricks is an important step in the brick-making process, as it involves removing the newly formed bricks from their moulds without damaging them.

**III.** **TESTING PROCEDURE**

# SHAPE AND SIZE TEST

Shape and size of bricks are very important consideration. All bricks used for construction should be of same size. The shape of bricks should be purely rectangular with sharp edges. Standard size consists of length x breadth x height as 19cm x 9cm x 6cm. To perform this test, select 20 fly ash bricks randomly from group and stack them along its length, breadth and height and compare. So, if all bricks similar size, then they are qualified.

# COMPRESSIVE STRENGTH TEST

Crushing strength of bricks is determined by placing brick in compression testing machine. After placing the brick, apply load on it until brick breaks. Note down the value of failure load and find out the crushing strength value of brick. Crushing strength of brick is 3.50 N/mm2. If it is less than 3.50 N/mm2, then it is not useful for construction purpose. The crushing strength of brick is expressed in N/mm2, and it is calculated by dividing the maximum load and the area of the brick.

*Table 3.1: Material ratio for brick test*



*Table 3.2: Stresses in Fly Ash Brick using Different Proportion of Lime, LDPE, Gypsum, Sand and Stone Dust*



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| *Fig 3.1: Load Vs Stress graph for sample 1* | *Fig 3.2: Load Vs Stress graph for sample 2* |
| *Fig 3.4 : Load Vs Stress graph for sample 3* | *Fig 3.5: Load Vs Stress graph for sample 4* |

# WATER ABSORPTION TEST

Water Absorption test is conducted on brick to find out the amount of moisture content absorbed by brick under extreme condition. In this test, sample dry bricks are taken and weighed. For a good quality brick, the amount of water absorption should not exceed 20% of weight of dry brick.

*% Water Absorbed = [(Wt - Wo) / Wo] \* 100 Where:*

*Wt = weight of the material after being immersed in water Wo = initial weight of the material before immersion in water For,*

Sample 1 - [2100.19 – 2395.5/ 2395.5] \* 100 =16.502%

Sample 2 - [1850 – 2006.1/ 2006.1] \* 100 =7.78%

Sample 3 - [1500 – 1690.8/ 1690.8] \* 100 =11.28%

Sample 4 - [1500 – 1681.7/ 1681.7] \* 100 =10.80%

**IV.** **COST ESTIMATION**

*Table 4.1: cost estimation*



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