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Experimental Investigation on Fly Ash Bricks using Industrial Waste

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Abstract: Although there are several benefits to using fly ash, its early lack of hydration results in low strength. In order to establish the appropriate fly ash brick mix percentage, an experimental investigation was carried out in the study. In brick specimens measuring 230mm by 110mm by 90mm, the compressive strength of various mix proportion of fly ash (14-30%), gypsum (5.5-8%), lime (14.5-30%), crusher waste (42-45%), cement (5.5%) was investigated. The objective is to find out the optimum mix design for making brick so as to achieve the maximum compressive strength.
Keywords: Fly Ash Bricks, Industrial Waste, Experiment, Strength, Sustainability

I. INTRODUCTION

Fly ash, a residue resulting from the combustion of pulverized coal in thermal power plants, has been a significant environmental problem. However, due to its pozzolanic properties and environmental advantages, the construction industry has recently adopted it. Fly ash bricks have become increasingly popular as a substitute for traditional clay bricks due to their improved durability, insulation, and lower cost. Nonetheless, despite their advantages, further research is needed to investigate their properties and performance, especially their strength, durability, and suitability for various applications.

This study aims to assess the properties of fly ash bricks produced under different mix ratios and curing conditions through experimental analysis. The research will concentrate on the compressive strength, water absorption, and density of the bricks, as well as their behavior in various environmental conditions. The findings will provide valuable insights into the functionality and characteristics of fly ash bricks and their suitability for construction projects. Furthermore, the study will contribute to promoting eco-friendly building practices, which are critical in addressing environmental concerns on a global scale.

II. MATERIALS USED

Information about the procedures and characteristics of the substances used in this investigation.

A. Fly Ash

Fly ash is a finely separated byproduct of powdered coal burning that is carried by flue gases and collected by an electrostatic precipitator. Fly ash is widely divided into two classifications by ASTM.

Class F: Fly ash typically contains less than 5% CaO and is typically formed while burning anthracite or bituminous coal.

Class C: Some class C fly ash may include more than 10% CaO.

B. Lime

In the construction of buildings, lime is a crucial binding component. Basically, it is magnesium oxide (MgO) and calcium oxide (CaO) that are present in nature together. At room temperature, lime and fly ash combine to generate a compound having cementitious qualities. The high strength of the chemical is due to calcium silicate hydrates, which are created as a result of interactions between lime and fly ash.

C. Gypsum

Gypsum is a soft, crystalline rock or sand that naturally occurs as a non-hydraulic binder. Gypsum has several beneficial features, including a low bulk density, incombustibility, an excellent capacity for sound absorption, a good resistance to fire, a rapid drying and hardening with little shrinkage, a great surface quality, etc. Additionally, it can make a substance stronger or have more viscosity. A cubic centimeter of it has a specific gravity of 2.31 grams. Gypsum powder has a density of 2.8 to 3 grams per cubic centimeter.

D. Crusher Waste

It is quarry-derived granite waste. Because it is expensive to transport river sand from natural sources locally, it is not widely available. Also causes environmental issues due to the widespread depletion of these sources. River sand's appeal as a building material declines when alternatives are developed. A concrete industry must be located. Whose continuing usage has begun to create significant issues in terms of its cost, availability, and environmental impact. In this situation, quarry rock dust may be a more cost-effective option than river sand. Quarry rock dust is typically used on a big scale to smooth the surface of highways. It is also used to make hollow blocks and light-weight precast concrete elements.

E. Cement

A very fine powdery material known as cement is often composed of limestone (calcium), sand or clay (silicon), bauxite (aluminum), and iron ore, though it can also contain other materials like shells, chalk, marl, shale, clay, blast furnace slag, and slate. When cement and water are combined, a chemical reaction occurs that creates a paste that sets and hardens to bond the various building ingredients together.


Fig.1 Fly Ash


Fig.2 Lime


Fig.3 Gypsum


Fig.4 Crusher Waste


Fig.5 Cement

III. MIXTURE PROPORTION

The following mix proportions are determined through trial and error for making fly ash bricks. The different mix proportions are shown in Table.1

Table. 1 Various Mix Proportions

Proportion	Fly ash (%)	Lime (%)	Gypsum (%)	Crusher Waste (%)	Cement (%)	Water-Binder Ratio (%)
M1	33%	14%	5.5%	42%	5.5%	0.45%
M2	29%	18%	5.5%	42%	5.5%	0.45%
M3	27%	20%	5.5%	42%	5.5%	0.45%
M4	25%	16.5%	8%	45%	5.5%	0.45%
M5	23%	18.5%	8%	45%	5.5%	0.45%
M6	19%	22.5%	8%	45%	5.5%	0.45%
M7	17%	24.5%	8%	45%	5.5%	0.45%

IV. PREPARATION OF BRICKS

The bricks are cast using a standard hand mould, which has standard dimensions of 230 mm by 110 mm by 70 mm. They were poured in accordance with the established technique using different mix amounts. Prior to now, the necessary amount of fly ash, lime, gypsum, and crusher waste has been determined. The bricks are dried under sun from 24 to 48 hours, the dried brick are stacked and subjected for water spray curing once or twice a day.

Fig.6 Mixing of Material

Fig.7 Casting of Bricks

Fig.8 Air Curing of Bricks

Fig.9 Water Curing of Bricks

V. TESTING OF BRICKS

We have taken some fly ash bricks to conduct Compressive strength test and Water absorption test to justify the quality of bricks. The experiment and result are explained below:

A. *Compressive Strength Test*

Bricks' compressive strength is examined using the universal testing apparatus. Bricks are stored for testing when the curing process is complete. Bricks are placed in a calibrated compression testing equipment with a 3000 KN load capacity and a consistent force delivered at a rate of 2.9 KN/min to test the specimens. The maximum load at which the specimen fails to cause any further increases in the indicator reading on the testing apparatus is known as the load at failure.

Table.2 Compression Test Result

Mix Proportion	Length (mm)	Breadth (mm)	Depth (mm)	Load (KN)	Compressive Strength (N/mm^2)
M1	228	100	70	110	4.284
M2	228	100	73	120	5.263
M3	228	100	70	130	5.701
M4	228	100	71	150	6.578
M5	228	100	72	160	7.017
M6	228	100	71	170	7.456
M7	228	100	72	190	8.333

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B. Water Absorption Test

Fly ash Bricks should not soak up more water than 12%. The bricks that will be put to the test should be dried in an oven at a temperature of between 105 and 115 degrees Celsius until they reach a constant weight (W1). Clean water should be submerged totally dry and weighed W1 bricks for 24 hours at a temperature of 27 to 20 degrees Celsius. Remove the bricks, remove all water residue, and weigh right away (W2).

Weight loss due to water absorption = (W2 - W1/W1) x 100

Table.3 Water Absorption Test Result

Mix Proportion	Dry Weight (W1) kg	Wet Weight after 24 hours (W2) kg	% of Water Absorption
M1	3000	3480	16%
M2	3144	3641	15.8%
M3	3096	3541	14.4%
M4	3064	3480	13.6%
M5	3230	3633	12.5%
M6	3000	3369	12.3%
M7	3134	3473	10.8%

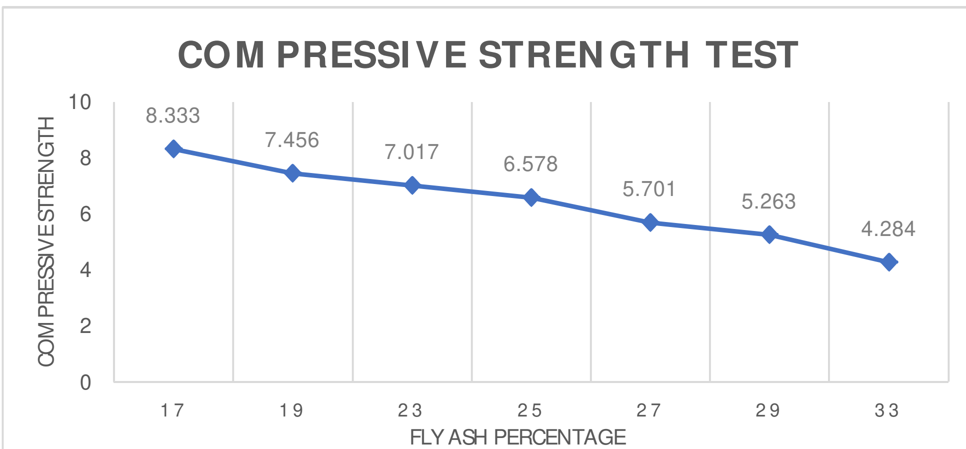

Fig .10 Compression Test Result Graph

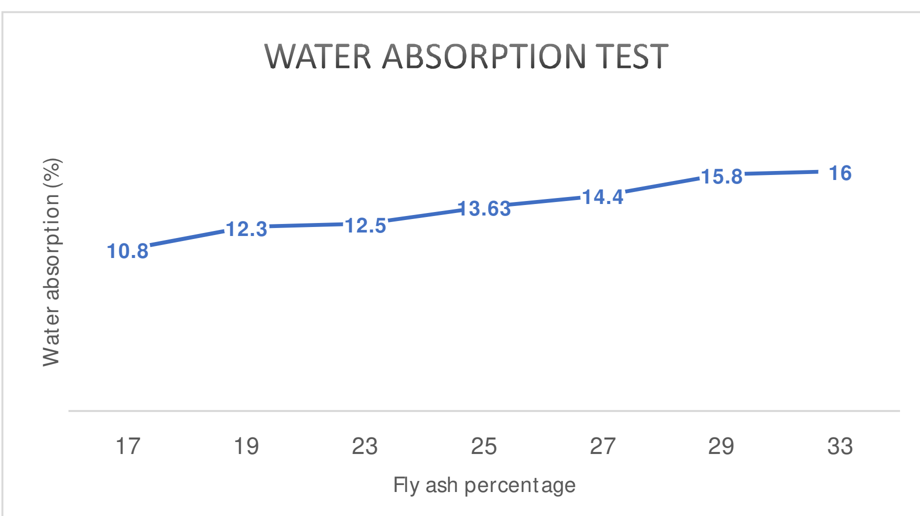

Fig.11 Water Absorption Test Result Graph

VI. CONCLUSION

Based on the experimental study, following conclusions can be drawn regarding the strength behavior of fly ash brick. The study was conducted to find the optimum mix percentage of fly ash brick. However the brick specimen of size 230mm x 110mm x 90mm were cast for different mix percentage of fly ash (17–33%), gypsum (5.5-8%), lime (14–24.5%), and quarry dust (42–45%), cement (5.5%).However the specimens have been tested for seven mix proportions. The mechanical properties such as compressive strength were studied for different mix proportions, at different curing ages. From the results it was inferred that, among the seven proportions the maximum optimized compressive strength is obtained for optimal mix percentage of Fly ash - 19% Lime -22.5% Gypsum-8% Crusher waste-45% Cement-5.5%

Compressive strength = 8.333 N/mm2

% Water absorption = 10.8%

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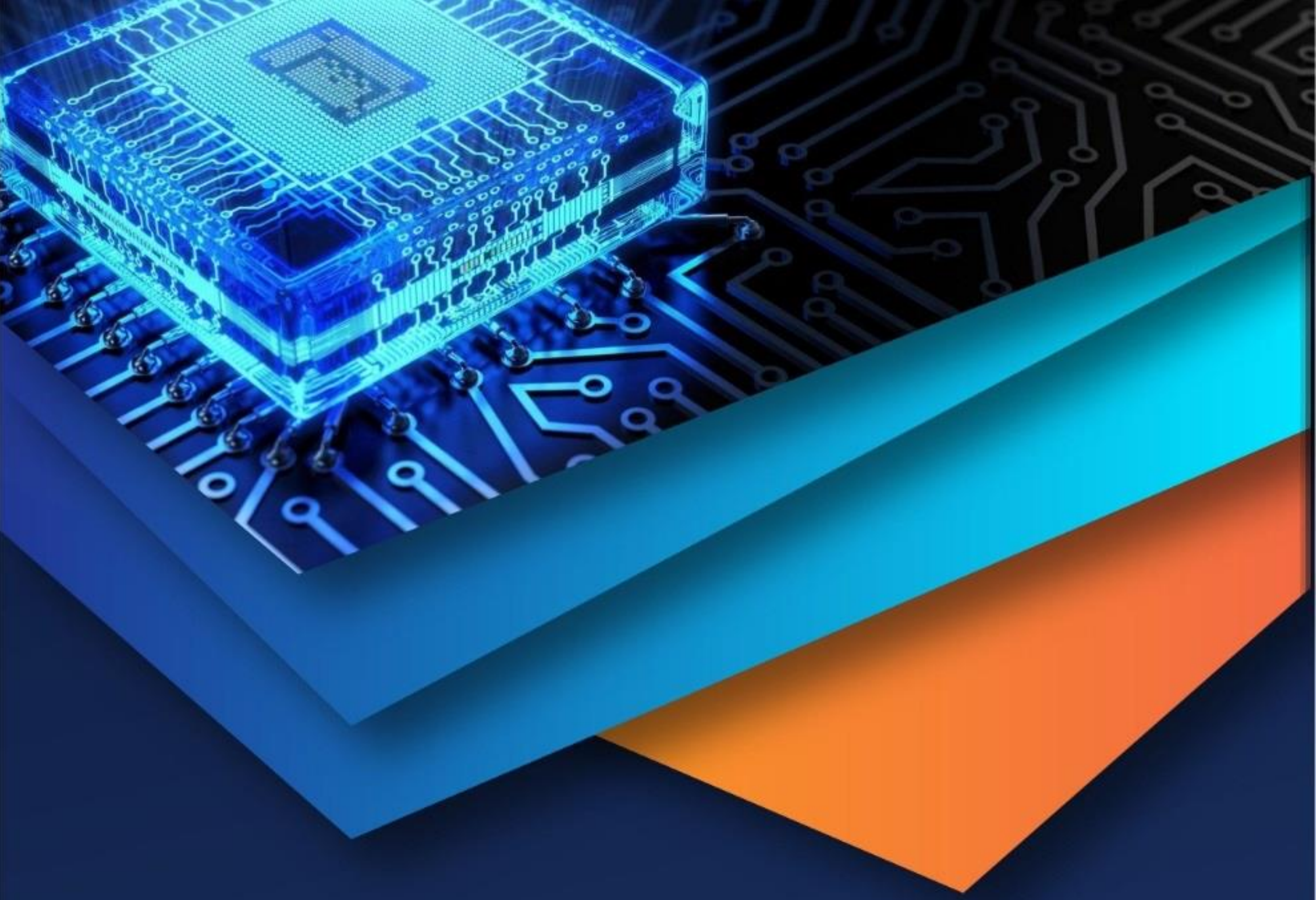

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