Partial Replacement of Cement with Fly Ash in Bricks

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Abstract- In India different waste are generated from the different industrial, mining, and agricultural process. This waste causing major environment problem due to lager area required for their disposal. There are many scopes to use such waste or by-product in many construction materials by using them as addition or replacement in different construction materials. Brick is the most important building material used in the construction. Basically, cement brick is the mixture of the cement, fine aggregate and water. The use of the cement brick increases the use of cement. So, the uses of different industrial waste or a byproduct to reduces the use of cement and also reduce the environmental problem. It also helps to reduce the cost of the materials and gives the ecofriendly material and sustainable materials. By using industrial waste in the cement brick enhance the physical and mechanical properties of the cement brick. This study is conducted to identify the different uses of industrial waste such as fly ash in cement brick. The cement is replaced by fly ash at 0%, 5%, 10% and 15%. These fly ash cement brick tested in compression test and water absorption. Test gives high compressive strength and low water absorption at 15% replacement of cement by fly ash. Concrete, steel and bricks are commonly used materials in construction practice, of which, bricks are most commonly used constituent. Masonry walls are commonly used in partition thereby large numbers of brick elements are required in construction of building. In this paper, various types of manufacturing of bricks were studied. Optimum percentage of fly ash using various combinations of material in the brick like lime, cement and clay are studied and their effect on different properties of bricks have been discussed. The parameters considered in this study are compressive strength, water absorption and durability of bricks with fly ash, and are checked with codal provisions for brick elements.

Index Terms - Cement brick, Fly ash, Industrial waste utilization, Eco-friendly, Economical

I. INTRODUCTION

In India, population are increase rapidly. Due to increase in the population demand of building and building materials are constantly increased. Cement bricks are manmade material widely used in construction. Most of the ingredient in cement bricks are cement, fine aggregate, coarse aggregate and water. In India, different industrial waste is generated from the different industry, mining and agricultural industries. This waste requires large area for the disposal this also causes the environment degradation. This waste can be used in cement bricks as a partially or fully replacement. Fly ash is also a one of the wastes that are generated in large amount. There are many uses of the fly ash in construction. Fly ash can also use in cement brick to make environment friendly and economical cement brick. Fly ash is nothing but it is a fine powder that is byproduct which is generated from the burning pulverized coal in the electric generation power plant. Large area is required for disposal of the industrial waste like fly ash. There are many uses of the fly ash in construction industry. In cement brick cement are replace by fly ash in different proportion. Which help for proper disposal and proper use of the industrial waste like fly ash. Fly ash bricks are a sustainable alternative to traditional clay bricks, gaining popularity due to their eco-friendly compostion and numerous advantages. Produced by utilizing fly ash, a byproduct of coal combustion from thermal power plants, these bricks offer several benfits such as reduced environmental impact, improved strength and cost- effectiveness. Their production contributes to waste reduction practies, making them a preferred choice for builders and developers worldwide.

A. Objectives

The investigation has been carried out with the following objectives.

1. To determine the compressive strength of concrete at normal 0 percent.
2. To determine the compressive strength at 5, 10, 15 percent.
3. To compare compressive strength for 0, 5, 10, and 15 percent.

II. RESEARCH SIGNIFICANCE

Two types of fly ash are commonly used in concrete: Class C and Class F. Class C are often high-calcium fly ashes with carbon content less than 2%; whereas, Class F are generally lowcalcium fly ashes with carbon contents less than 5% but sometimes as high as 10%. In general, Class C ashes are produced from burning subbituminous or lignite coals and Class F ashes from bituminous or anthracite coals. Performance properties between Class C and F ashes vary depending on the chemical and physical properties of the ash and how the ash interacts with cement in the concrete. Class F fly ash possesses only pozzolonic properties whereas class C fly ash possesses both cementitious and pozzolonic properties.

III. MATERIALS AND METHODOLOGY

A. Material required

1. Cement:

A binder, known as cement, is used to set, harden, and remain in other materials, binding them together. Cement, sand, and gravel combine to form concrete. OPC 53 grade cement was used throughout the project work.

2. Fine aggregate:

In this study, manufactured sand, which passes through a 4.75 mm sieve, is used as the fine aggregate. The samples are tested according to IS 2386.

3. Fly ash

Generally, fly ash is the fine particulate waste material. It is produced by pulverized coal-based thermal power station. Fly ash is generated from the combustion of the coal in thermal power plant. It is an environmental pollutant. It is nowadays used in cement, concrete and other cement-based applications in India. The fly ash. shows the physical properties of the fly ash.

4. Water:

Water plays a crucial role in both the mixing and curing processes of concrete, ensuring its strength and durability.

B. Tests on materials

S. No	Materials	Name of Tests	Results
1.	Cement	Specific gravity	3.15
		Initial and final setting time	15%
2.	Fly Ash	Fineness test	16.26%
3.	Fine aggregate	Sieve analysis	2.65
		Specific Gravity	2.22

TABLE 1.1 Test results on different materials.

C. Methodology

Clearly define the objective of the experiment such as assessing the compressive strength, durability or other properties of the fly ash bricks.List all materials required, including fly ash, cement,water,aggregate (fine aggregate). Also, specify the equipment needed, such as a mixer, molds,compression testing machine etc… Outline the procedure for preparing the fly ash bricks, including the mixing proportions, curing methods and molding process. Identify the variables to be tested such as different ratios of fly ash to cement, curing durations or additives. Choose an appropriate experimental design, such as a randomized complete block design or factorial design, to minimize bias and ensure the results. Describe how data will be collected, including the measurements to be taken (e.g., compressive strength, water absorption), the number of replicates for each treatment and the testing schedule. Detail the procedure for testing, water absorption testing, and any other relevant tests. Specify the statistical methods that will be used to analyze the data, such as analysis of variance or regression analysis, to determine the effects of different variables on the properties of the bricks. Ensure that appropriate safety measures are in place for handling materialsand equipment and following proper procedures for mixing and curing. Consider any ethical considerations, such as ensuring the experiment complies with environmental regulations and guidelines.

IV. EXPERIMENTAL INVESTIGATION

Collect the necessary materials including fly ash, cement, fine aggregate (sand) and water and determine the proportions of each ingredient based on the desired properties of the bricks. This may involve conducting trials to find the optimal mix for strength, durability

and cost-effectiveness. Thoroughly mix the dry ingredients (fly ash, cement and fine aggregate) in a concrete mixer or by hand using a shovel or hoe. Make sure the mixture is homogeneous and free of clumps.

Figure(a): Fly Ash

Figure(b): Fine Aggregate

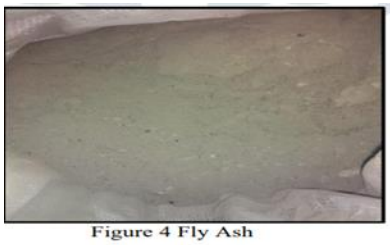


Figure 4 Fly Ash

A. Mix design

Cement brick mixes with replacement of cement by fly ash is done. As shown in table 3 fly ash is replace with cement in different proportions. Fly ash is replace with cement at 0%, 10%, 20%, 30% and 40%.

B. Casting and curing

After that curing should be done. Allow the bricks to cure in a controlled environment for a specified period of time. This typically involves keeping the bricks moist and at a consistent temperature to promote hydration of the cement and development of strength.

Casting the concrete cubes

Figure(d): Curing the cubes for 7, 14, & 28 days.

Figure(e): Cubes tested under compressive testing machine.

V. RESULTS AND DISCUSSION

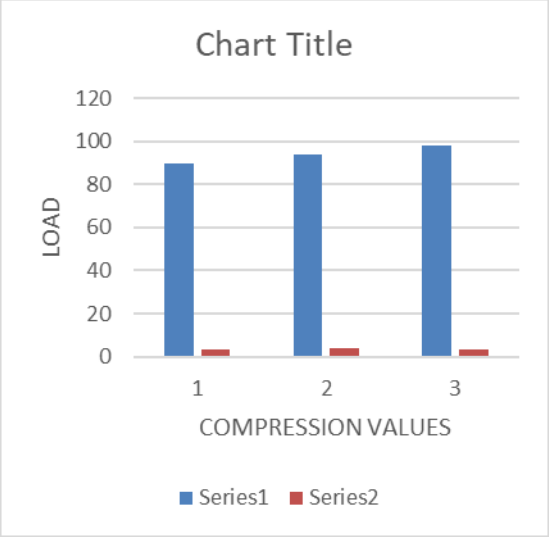
A. Compressive strength of fly ash bricks

A Compression test on fly ash bricks is typically conducted to determine their compressive strength. This involves applying a compressive load to the bricks until they fail, and measuring the maximum load they can with stand. The results of this test help determine the suitability of fly ash bricks for construction purpose and ensure they meetr relevant standards and specifications.

SI NO	CUBE	CROSS-SECTIONAL AREA(MU2)	LOAD(KN)	COMPRESSIVE STRENGTH (N/MM2)
1	1st	230*110*75	90	3.1
2	2nd	230*110*75	94	4.1

3	3rd	230*110*75	98	3.5

COMPRESSION TEST ON FLY ASH BRICKS



COMPRESSION TEST ON FLY ASH BRICKS

B. WATER ABSORPTION TEST ON FLY ASH BRICKS

A water absorption test on fly ash bricks is typically conducted to assess their porosity and durability. Here's a basic outline of how its done.

Sample Preparation:- Obtain a sufficient number of fly ash bricks from the batch to be tested. Ensure they are clean and dry.

Initial Weight Measurement:- Weigh each brick individually using a sensitive scale and record their intial weights.

Immersion:- Fully immerse each brick in water at room temperature for a specific duration. The duration can vary but commonly ranges from 24 to 48 hours.
Removal From Water:- after the immersion period, remove the bricks from water and allow them to drain for a short period to eliminate excess surface water.
Final Weight Measurement:- Once drained, weigh each brick again and record their final weights.

Calculations:- Calculate the water absorption percentage using the formula:

Water Absorption(%) = [(Final Weight-Initial Weight) / Initial Weight] * 100

Analysis:- Compare the water absorption percentages of the tested bricks to specifications. Lower water absorption indicates better quality and durability.

This test helps in evaluating the quality of fly ash bricks by assessing their ability to resist water penetration, which is crucial for their performance in various applictions such as construction.

Indian Standard Used For Water Absorption Of Fly Ash Bricks:-

- IS:5454-1978 [Method for ssmpling of clay Bricks]
- IS:3495(Part 2)-1992 [Method of test of burnt clay building bricks]
- IS:13757-1992[Burnt clay fly ash building bricks-specification]

Calculations:-

Water absorption (%)		
Size of brick 230mm X 110mm X 75mm		
Brick mixes	7 days	28 days
A1 (0%)	14.54	13.36
B1 (5%)	14.09	14.40
B2 (10%)	13.45	12.08
B3 (15%)	12.65	12.32

TABLE NO:-10

Average of water absorption of fly ash bricks :- 12%

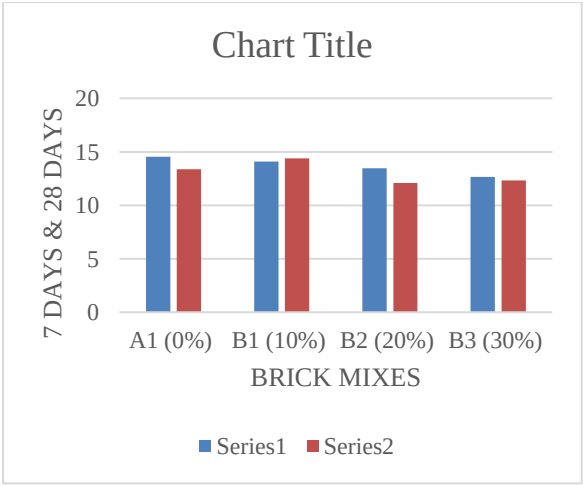


FIG: -16

WATER ABSORPTION TEST ON FLY ASH BRICKS

Results: -
The average of results obtained from each specimen shall be reported as :
Water Absorption(%) = 12%

CONCLUSION

Based on the experimental investigation on fly ash cement brick the following conclusion are made:

1. Compressive strength is increases with increase in fly ash in cement brick.
2. Water absorption is decreases with increase in fly ash in cement brick.
3. By using fly ash in cement brick help to use the industrials waste in proper manner, also reduce the environmental degradation.
4. It Help to produce the eco-friendly cement brick.
5. It is found that the 30% replacement gives higher compressive strength 26.01 N/mm^2 and water absorption 3.23%.
6. The cost of the cement brick is also Reduces with increase in fly ash in cement brick.
7. The manufacturing of bricks using fly ash is environment friendly.
8. The fly ash 70 to 80% used in manufacturing bricks is beneficial to increase in compressive strength.
9. Lime makes good combination with fly ash which increases durability of brick element.
10. Using fly ash in bricks reduces manufacturing cost of brick element.

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