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COMPERATIVE ANALYSIS OF CEMENT BLOCK AT PARTIAL REPLACEMENT OF FLY ASH

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ABSTRACT

The construction industry is continually seeking sustainable alternatives to traditional building materials to mitigate environmental impact while maintaining structural integrity. In this study, we investigate the feasibility of using fly ash as a partial replacement for cement in concrete blocks. Fly ash, a byproduct of coal combustion, possesses pozzolanic properties that can enhance the strength and durability of concrete. Our research focuses on a comparative analysis of cement blocks with varying proportions of fly ash replacements. We evaluate the compressive strength, density, water absorption, and durability characteristics of these blocks compared to conventional cement blocks. Through a series of laboratory experiments and statistical analysis, we aim to determine the optimal percentage of fly ash replacement that balances environmental benefits with structural performance.

Additionally, we explore the economic implications of incorporating fly ash in cement blocks, considering factors such as material cost, production efficiency, and long-term maintenance requirements. By providing insights into the mechanical, physical, and economic aspects of fly ash incorporation, our study contributes to the body of knowledge on sustainable construction practices and offers practical recommendations for industry stakeholders.

Keywords: Fly Ash, Cement Blocks, Partial Replacement, Sustainable Construction, Compressive Strength, Durability, Environmental Impact, Economic Analysis.

INTRODUCTION

The construction industry plays a significant role in global sustainability efforts, as it accounts for a substantial portion of energy consumption, greenhouse gas emissions, and resource depletion. In this context, the exploration of alternative materials and technologies that can reduce environmental impact without compromising structural performance is paramount. One such material under scrutiny is fly ash, a byproduct of coal combustion in thermal power plants. Fly ash possesses pozzolanic properties, making it an attractive candidate for partial replacement of cement in concrete products such as blocks. The incorporation of fly ash not only utilizes a waste material but also offers potential benefits such as improved workability, reduced heat of hydration, and enhanced long-term durability. However, the effectiveness of fly ash as a cement replacement depends on various factors, including its chemical composition, fineness, and dosage.

This study aims to conduct a comprehensive comparative analysis of cement blocks with varying levels of fly ash replacement. By systematically altering the percentage of fly ash in the concrete mixture, we seek to evaluate its impact on key properties such as compressive strength, density, water absorption, and durability. Through a series of laboratory experiments and statistical analysis, we aim to identify the optimal proportion of fly ash replacement that maximizes environmental benefits while maintaining or improving structural performance.

Furthermore, this research extends beyond technical considerations to examine the economic implications of incorporating fly ash in cement blocks. We assess factors such as material cost, production efficiency, and long-term maintenance requirements to provide a holistic understanding of the feasibility and viability of fly ash utilization in the construction industry.

By shedding light on the mechanical, physical, and economic aspects of fly ash incorporation, this study contributes to the ongoing discourse on sustainable construction practices. Our findings have the potential to inform decision-making processes for industry professionals, policymakers, and other stakeholders involved in the design, production, and utilization of cement-based building materials. In summary, this research endeavors to bridge the gap between environmental sustainability and structural performance in the construction sector through the comparative analysis of cement blocks with partial replacement of fly ash.

OBJECTIVES

- **Evaluate Mechanical Properties**: The primary objective is to assess the mechanical properties, particularly compressive strength, of cement blocks with varying levels of fly ash replacement. This involves conducting laboratory tests to determine how different proportions of fly ash affect the strength and structural integrity of the blocks.

- **Investigate Physical Properties:** Another objective is to examine the physical properties of cement blocks with fly ash substitution, including density and water absorption. Understanding how fly ash influences these properties is crucial for ensuring the durability and performance of the blocks in real-world applications.

- **Assess Durability Characteristics:** The study aims to evaluate the durability characteristics of cement blocks with partial replacement of fly ash. This involves testing the blocks for resistance to factors such as freeze-thaw cycles, sulfate attack, and alkali-silica reaction to assess their long-term performance and sustainability.

- **Conduct Comparative Analysis:** The comparative analysis involves comparing the properties of cement blocks with fly ash replacement to those of conventional blocks made entirely of cement. By systematically analyzing the differences between the two types of blocks, researchers can identify the benefits and potential drawbacks of incorporating fly ash.

- **Optimize Mix Design:** One of the objectives is to optimize the mix design of cement blocks with fly ash replacement to achieve the desired properties while minimizing material costs. This may involve adjusting the proportions of cement, fly ash, aggregates, and other additives to achieve the optimal balance of performance and economy.

- **Evaluate Economic Feasibility**: The study aims to assess the economic feasibility of using fly ash as a partial replacement for cement in concrete blocks. This involves analyzing the cost implications of incorporating fly ash, including material costs, production efficiency, and long-term maintenance requirements, to determine the cost-effectiveness of fly ash utilization.

- **Provide Practical Recommendations:** Based on the findings of the comparative analysis, the study aims to provide practical recommendations for industry stakeholders, including engineers, architects, and construction professionals. These recommendations may include guidelines for optimal fly ash replacement levels, mix design strategies, and best practices for incorporating fly ash in concrete block production.

CHALLENGES

- **Material Variability:** Both cement and fly ash can vary significantly in their properties depending on their source and production process. Ensuring consistency in the materials used for the comparative analysis can be challenging.
- **Optimal Replacement Ratio:** Determining the optimum ratio of fly ash to cement for partial replacement requires extensive testing and analysis. Finding the balance between cost-effectiveness, strength, durability, and other properties is not always straightforward.
- **Strength and Durability:** Fly ash can influence the strength and durability of cement blocks. Achieving the desired strength while ensuring long-term durability is crucial but can be challenging due to the complex interaction between cement and fly ash.
- **Setting Time and Workability**: Fly ash can affect the setting time and workability of concrete mixes. Balancing these properties with the desired strength and durability can be tricky and may require adjustments to the mix design and curing process.
- **Quality Control**: Ensuring consistent quality across different batches of cement blocks with varying levels of fly ash replacement requires rigorous quality control measures and standardized testing procedures.

METHODOLOGY

- Firstly we have clean all the mold properly sure that any concrete partical is not remain into the block .

- Then we have apply the oil into the mold with the help of brush by which we can easily remove the block .
- Then we have measure all the material as pr the calculation.
- Then we have mix the material properly.
- Then we have fill the concrete into the mold in 3 layer.
- Tamp 25 time with tamping road at every layer.
- Demold the block after 24 hr and drop it into water for curing.
- Test 3 block or 10% and 3 block or % after 14 days.
- Then test the remaining block after 28 days.

MATERIAL CALCULATION

We have to create 12 concrete block of M15 garde of concretr in which the 6 block are made up of 10% Fly Ash and 90%of cement and 6 block are made up of 15% Fly Ash and 85% of cement. In which we have test 3 block of 10% and 3 block of 15% fly ash after 14 days and remaining are test after 28 days.

Hear are the calculation for the six block.

STEP-1 MOLD VOLUME CALCULATION

SIZE OF BLOCK=150X150X150 mm.

=3375000 MM.

CONVERTING mm TO m^3 AND CALCULATIN FOR 6 BLOCK

$=337500x1x10^{-9}x6$

$=0.02025\ m^3$ ------------------(1)

STEP-2 CONVERTING WET TO DRY

For converting wet to dry we have to multiply 1.54 by eq.(1)

=0.02025x1.54

$=0.031185\ m^3$ ------------------(2)

STEP-3 CALCULATING CEMENT SAND AGGREGATE FOR M15(1:2:4)

i. FINE AGGREGATE

$=\frac{0.031185x2}{7}$

$=0.00891\ m^3$

DENSITY OF FINE AGGREGATE= 2650

=0.00891x2650

=23.6 kg

ii. CORAS AGGREGATE

$=\frac{0.031185x4}{7}$

$=0.0178\ m^3$

DENSITY OF FINE AGGREGATE= 2550

=0.0178x2550

=45.44 kg

iii. CALCULATING CEMENT

$=\frac{0.031185x1}{7}$

$=0.0178\ m^3$

DENSITY OF CEMENT =1440

=0.0044x1440

=6.415 kg -------------------(3)

STEP-4 REDUCING 10% FLY ASH FROM CEMENT

i. FOR 10% FLY ASH

$=\frac{10x6.415}{100}$

Fly ash 10% =0.6415 kg

ii. FOR 90% CEMENT

$=\frac{90x6.415}{100}$

Cement 90%=5.7735 kg

Here we have to use 0.6415 kg fly ash and 5.7735 kg of cement

STEP-4 REDUCING 15% FLY ASH FROM CEMENT

i. FOR 15% FLY ASH

$$= \frac{15 \times 6.415}{100}$$

Fly ash 15% =0.9622 kg

ii. FOR 85% CEMENT

$$= \frac{85 \times 6.415}{100}$$

Cement 85%=5.4527 kg

Here we have to use 0.9622 kg fly ash and 5.4527 kg of cement

STEP-5 WATER CEMENT RATIO CALCULATION

We have take 0.5% water cement ratio

=3.207 ltr

RESULTS

Compressive strength test

We have use M15 grade of concrete whose ratio is (1:2:4) and perform the compressive strength test after 14 days on 3 block of 10 % fly ash and 90 % of cement and same as for the 15% fly ash and 85% cement . After 28 day we have again perform the same test on the remain block of 10% & 15% of fly ash and note down the result.

OBSERVATIONS:

- Strength normal cube samples cured for 14 &28 days days.

Sl.No	Days	Load (in N)	Length (in mm)	Breadth (in mm)	Compressive strength in (N/MM^2)
1.	14 days	180	150	150	15.73

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2.	28 days	190	150	150	18.5

Table 4.1.1

- Strength of 10% fly ash cube samples cured for 14 days.

Sl.No	Load (in N)	Length (in mm)	Breadth (in mm	Compressive strength in (N/MM^2)
1.	180	150	150	8
2.	190	150	150	8.44
3.	230	150	150	10.22

Table 4.1.2

Average compressive strength=8+8.44+10=8.81 N/MM^2

3

- Strength of 10% fly ash cube samples cured for 28 days.

Sl.No	Load (in N)	Length (in mm)	Breadth (in mm)	Compressive strength in (N/MM^2)
1.	360	150	150	13.33
2.	380	150	150	13.77
3.	430	150	150	19.11

Table 4.1.3

Average compressive strength=13.33+13.77+19.11 =15.40 N/MM^2

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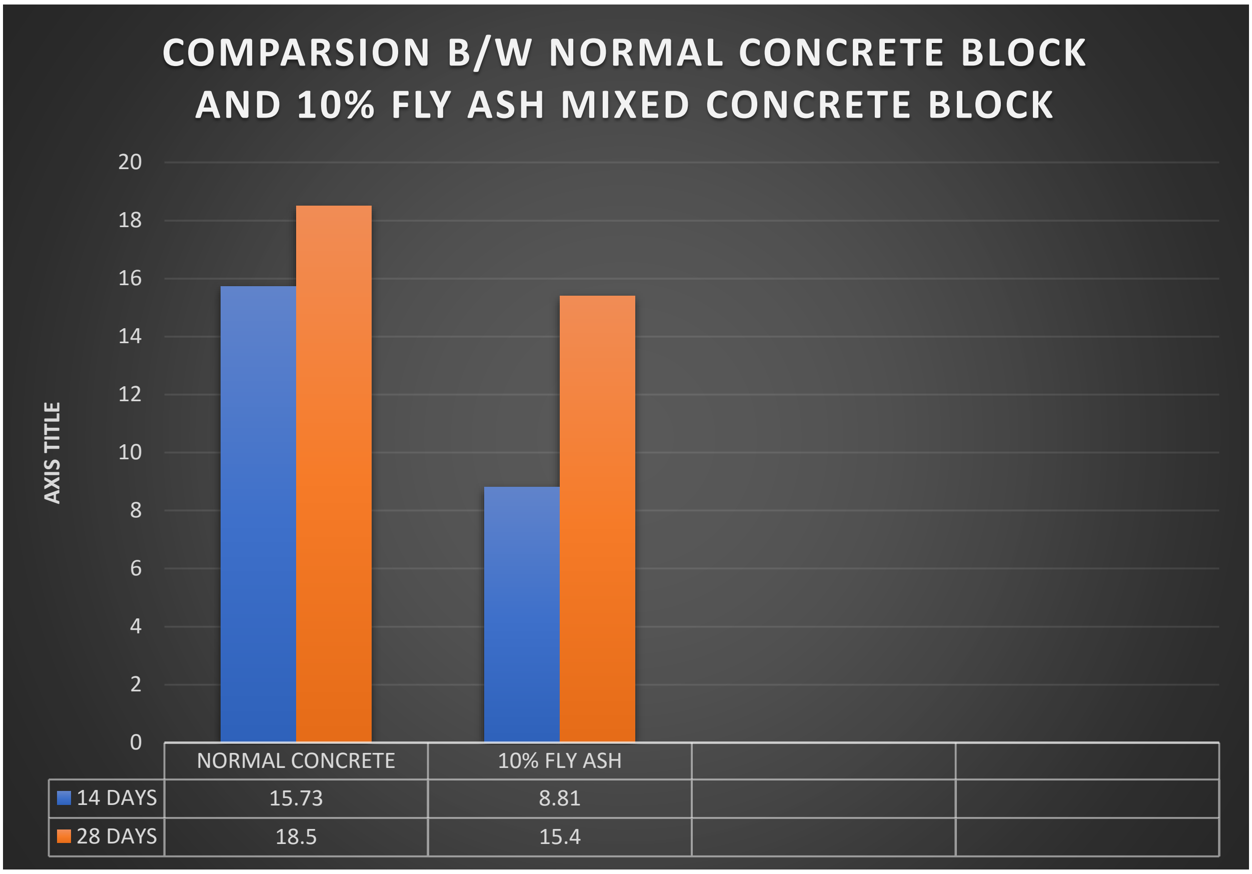

➢ Strength of 15% fly ash cube samples cured for 14 days.

Sl.No	Load (in N)	Length (in mm)	Breadth (in mm	Compressive strength in (N/MM^2)
1.	300	150	150	13.33
2.	200	150	150	8.88
3.	270	150	150	12

Table 4.1.4

Average compressive strength=13.33+8.88+12 =11.40 N/MM^2

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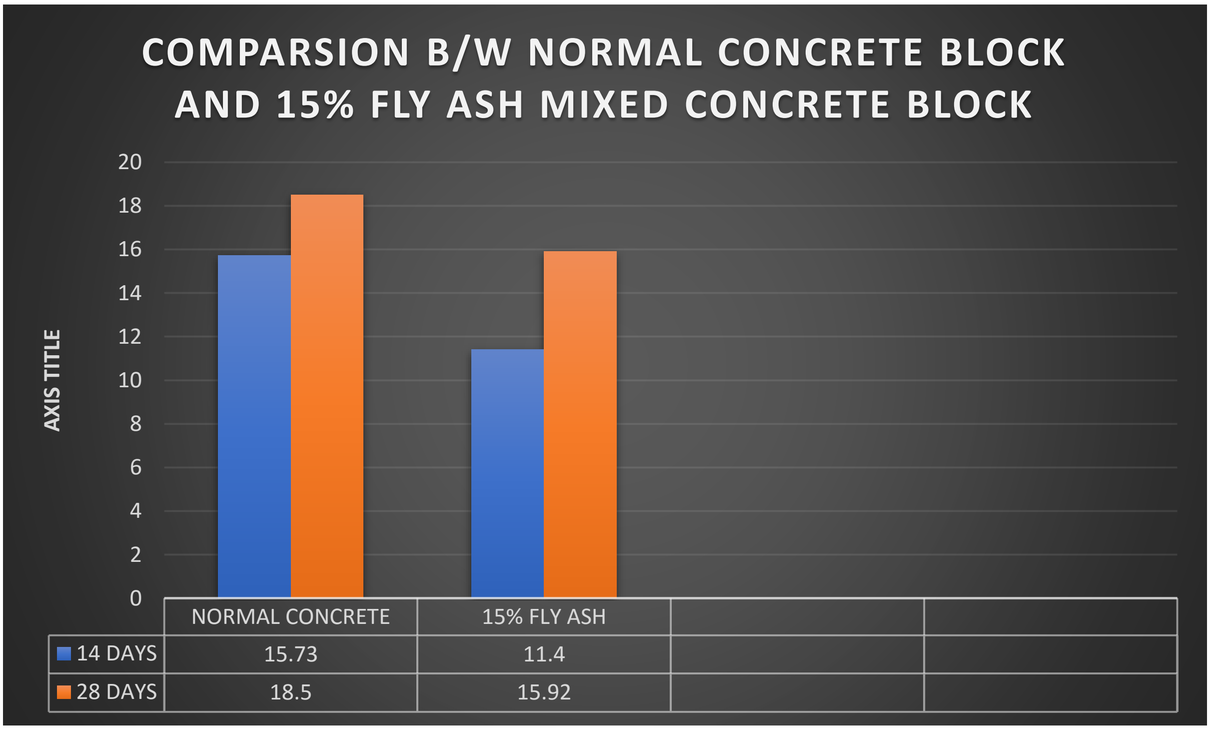
➢ Strength of 15% fly ash cube samples cured for 28 days.

Sl.No	Load (in N)	Length (in mm)	Breadth (in mm	Compressive strength in (N/MM^2)
1.	350	150	150	15.55
2.	350	150	150	15.55
3.	380	150	150	16.66

Table 4.1.5

Average compressive strength=15.55+15.55+16.66 =15.92 N/MM^2



Workability test

Workability may be defined as the ease with which concrete can be mixed, placed, compacted and finished. Slump test is the most commonly used method of measuring the workability of concrete in a laboratory or at the site of work. It is used conveniently as a control test and indicates the uniformity of concrete from batch to batch. The vertical settlement of a standard cone of freshly prepared concrete is called a slump.

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- Normal concrete slump cone test

Sr.no	W/C ratio	Height of mould (h_1 mm)	Subsidized Height (h_2 mm)	Slump (h_1 -h_2) mm
1.	0.50	300mm	220mm	80mm
	0.50	300mm	210mm	90mm
	0.50	300mm	195mm	105mm

Table 4.2.1

- 10% fly ash mixed concrete slump cone test

Sr.no	W/C ratio	Height of mould (h_1 mm)	Subsidized Height (h_2 mm)	Slump (h_1 -h_2) mm
1.	0.50	300mm	215mm	85mm
	0.50	300mm	210mm	90mm
	0.50	300mm	195mm	105mm

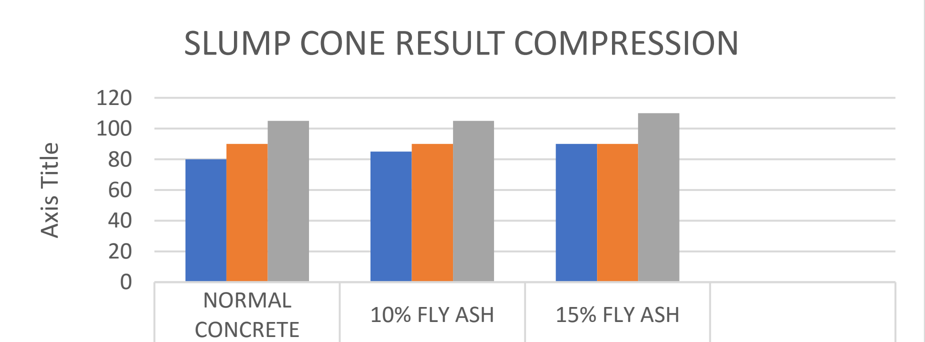
Table 4.2.2

- 15% fly ash mixed concrete slump cone test

Sr.no	W/C ratio	Height of mould (h_1 mm)	Subsidized Height (h_2 mm)	Slump (h_1 -h_2) mm
1.	0.50	300mm	210mm	90mm
	0.50	300mm	210mm	90mm
	0.50	300mm	190mm	110mm

Table 4.2.3

In slump cone test the obtain value are compared below with the help of chart.



	NORMAL CONCRETE	10% FLY ASH	15% FLY ASH
Series 1	80	85	90
Series 2	90	90	90
Series 3	105	105	110

CONCLUSION

- **Performance Parity:** The comparative analysis has revealed that cement blocks with partial replacement of fly ash exhibit comparable performance characteristics to conventional cement blocks. Despite the substitution of a portion of cement with fly ash, the compressive strength and durability of the blocks remain within acceptable ranges for construction applications.

- **Enhanced Durability:** An intriguing finding of this study is the enhancement of durability properties observed in cement blocks containing fly ash. The pozzolanic reaction between fly ash and calcium hydroxide contributes to denser microstructures and reduced permeability, thereby improving resistance to adverse environmental factors such as sulfate attack and alkali-silica reaction.

- **Economic and Environmental Benefits:** The utilization of fly ash as a partial replacement for cement presents notable economic and environmental advantages. By reducing cement consumption, which is a significant source of carbon emissions in the construction sector, the incorporation of fly ash promotes sustainability and resource efficiency. Furthermore, the availability of fly ash as a byproduct of coal combustion offers a cost-effective alternative to conventional cement production.

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