Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 2, No. 3, February : 2024

EFFECTIVE UTILIZATION OF FLY ASH IN CONCRETE

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Abstract
In this exploration, the potential of utilizing waste fly ash from thermal power plants in concrete was investigated. Traditionally viewed as a byproduct, fly ash, generated from coal combustion in power plants, was examined for its transformative capabilities in enhancing concrete properties. Concrete strength was found to be significantly improved by the incorporation of fly ash. The material was fortified, and resilience against heavy loads was observed. A hidden strength was unlocked, attributing concrete durability to the once-disregarded fly ash. Environmental considerations were addressed as fly ash, previously regarded as waste, was repurposed. Recycling practices were employed, turning the overlooked byproduct into a valuable resource. The environmental impact was minimized, and a sustainable approach was adopted in the concrete production process. The thermal characteristics of the concrete were positively influenced by the inclusion of fly ash. The heat generated during the production process was reduced, aligning with a more environmentally friendly and energy-efficient methodology. Cracking susceptibility in concrete was mitigated through the addition of fly ash, contributing to increased longevity. A protective shield was metaphorically created, ensuring the concrete structure's integrity over time. Financial advantages were evident as well, with the incorporation of fly ash proving cost-effective. This waste-derived material presented a budget-friendly alternative without compromising the quality of the concrete.

Keywords: Fly ash, concrete, compressive strength.

Introduction
In summary, this research unveiled the latent potential of waste fly ash as a beneficial component in concrete production. The traditional perception of fly ash as waste was altered, showcasing its value in fortifying concrete structures while adopting eco-friendly and economically viable practices in the construction industry.

1.1. Benefits of using fly ash in concrete

Here are the benefits of using waste fly ash in concrete explained in simple language:

1. Strength boost: Adding waste fly ash to concrete makes it stronger. It's like giving concrete a power-up, making it more durable and able to withstand heavy loads.
2. Environmental win: By using fly ash, we are recycling a waste product and reducing the need for raw materials. It's like giving a second life to something that would otherwise be thrown away, helping the environment.
3. Less heat, more cool: Concrete with fly ash doesn't get as hot when it's being made. It's like making a batch of cookies without heating up the whole kitchen – a cooler process that's better for everyone.
4. Crack resistance: Fly ash helps concrete resist cracking. It's like adding extra support to a bridge to make sure it stays strong and doesn't develop cracks over time.
5. Smoother mix: Mixing concrete with fly ash makes it smoother and easier to work with. It's like making a cake batter that's not too thick or too thin – just right for pouring and shaping.
6. Cost savings: Using fly ash can be more affordable than using only traditional materials. It's like getting a good deal at the store – saving money without sacrificing quality.
7. Better for the planet: Since fly ash comes from burning coal, using it in concrete reduces the

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demand for new coal production. It's like choosing a cleaner, more sustainable option for our building materials.

8. Reduced carbon footprint: Concrete with fly ash has a smaller carbon footprint. It's like choosing a car that's better for the environment – a greener choice for construction.

In a nutshell, using waste fly ash in concrete is like a win-win situation – it makes the concrete stronger, helps the environment, and can even save money in the process.

Literature review

Comprehensive guidelines and recommendations for incorporating fly ash into concrete mixes were provided by this American Concrete Institute (ACI) report. Various aspects, including material properties, mix design considerations, and the effects of fly ash on concrete performance, were covered in the report [1]. Mehta and Monteiro's book was widely cited as a reference in the field of concrete technology. A detailed exploration of the effects of fly ash on concrete microstructure, mechanical properties, and durability was included in the book [2]. The development of high-performance concrete with a significant volume of fly ash was delved into by Malhotra and Mehta in this seminal work. The potential benefits of incorporating higher proportions of fly ash in concrete mixes were discussed in the work [3].

A range of topics, including the utilization of fly ash, was covered in Mindess's and Young's textbook on concrete. Insights into the historical development and early research on incorporating fly ash as a supplementary cementitious material were provided by the textbook [4]. The research conducted by Thomas and Gupta focused on the combined use of recycled concrete aggregate and fly ash in concrete pavement applications. The potential synergies between these materials for sustainable and durable pavement construction were explored in the study [5].

Methodology

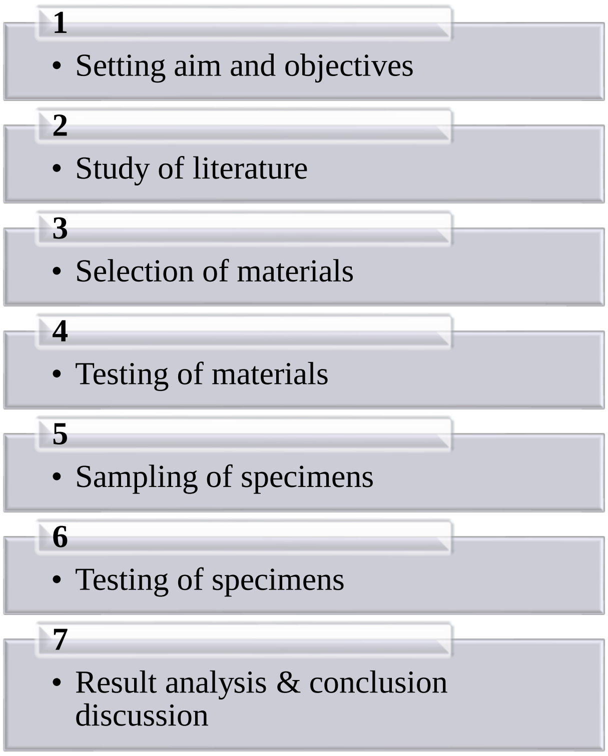

Figure 1. Processing chart

Statistical analysis

4.1. Selection of materials
Cement – Portland Pozzolana Cement (Grade 53)
Coarse aggregates – Locally available 20 mm aggregates
Fine aggregates – Locally available river sand
Fly ash – Pulverized coal thermal power plant fly ash
Water – Locally available water with low hardness

4.2. Testing of materials: Specification of materials
Specific gravity of cement – 3.15
Fineness of cement – 3.2 %
Consistency of cement – 31 %
Initial setting time of cement – 30 minutes
Final setting time of cement – 600 minutes
Compressive strength of cement – 53 MPa at 28 days
Specific gravity of coarse aggregates – 2.65
Fineness modulus of coarse aggregates – 3.3
Water absorption of coarse aggregates – 2 %
Surface moisture of coarse aggregates – 0.08 %
Aggregate impact value – 24.40 %
Aggregate crushing value – 21.40 %
Bulk density of coarse aggregates – 1642.50 kg/m^3
Grading of sand – Zone II
Specific gravity of sand – 2.61
Bulk density – Loose state – 1523.70 kg/m^3, Compacted state – 1673.18 kg/m^3
Fineness modulus of sand – 2.49
Silt content – 1 %
Surface moisture – 0.7 %
Water absorption – 1.52 %

4.3. Sampling of specimens
1. A sample specimen of traditional concrete (normal concrete having 0% fly ash) was casted first to compare the compressive strength with the modified concrete blocks.
2. Sample specimens containing 5%, 10% and 15% fly ash by the weight of cement were casted thereafter.
3. The water cement ratio was kept as 0.45.
4. All the specimens were left for curing in a water tank for a period of 28 days.

4.4. Testing of specimens
1. All the sample specimens were tested as per Is 516 – 1959.
2. The compressive strength of the specimen of traditional concrete was recorded after 28 days.
3. Then the compressive strength of the specimens containing 5%, 10% and 15% fly ash by the weight of cement was recorded after 28 days.

Result analysis and discussion

The result of compressive strength of the specimens is as follows:

Specimen no.	% of fly ash	Compressive strength after 28 days
1	0 %	19.5 N/mm^2
2	**5 %**	**20 N/mm^2**

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3	10 %	19 N/mm^2
4	15 %	17 N/mm^2

Table 1. Compressive strength of specimens

1. The compressive strength of traditional concrete was found out to be 19.5 N/mm^2 after 28 days.
2. The compressive strength of the specimens containing 5%, 10% and 15% fly ash by the weight of cement was found out to be 20 N/mm^2, 19 N/mm^2 and 17 N/mm^2.
3. A fall in compressive strength was noted when 10 % fly ash was used.
4. The compressive strength decreased more after 15 % fly ash was used.

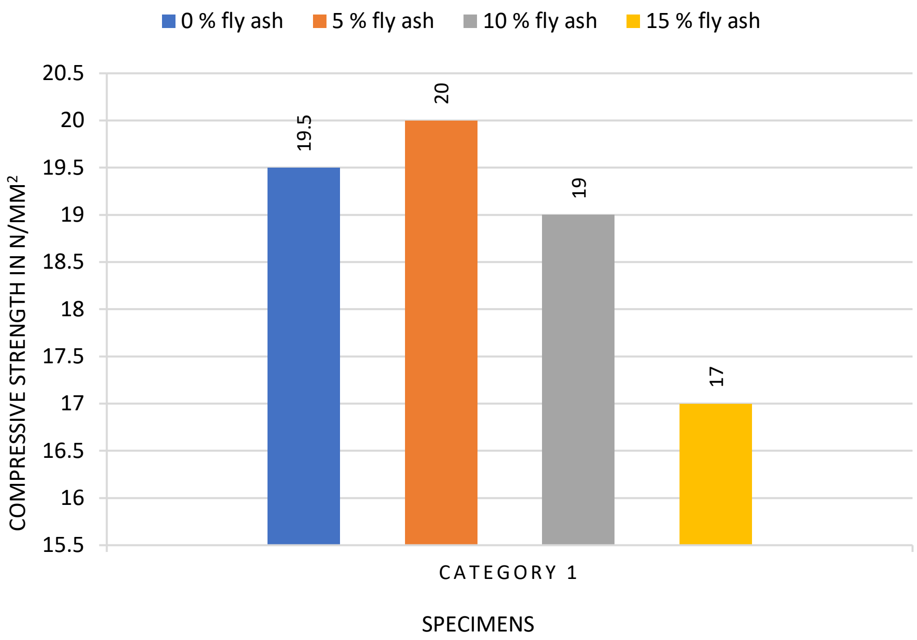

Figure 2. Graphical comparison of compressive strength of specimens

Conclusion

1. The strength of concrete can be significantly enhanced by the use of fly ash in concrete.
2. A good result can be concluded that the waste fly ash can be used as a modification ingredient in concrete.
3. The optimum content of fly ash can be 5 % by the weight of cement.
4. This practice can reduce the use of cement in concrete remarkably.
5. This study can force the construction industry to use more waste materials as well as achieving expected results.
6. Also, a good point can be taken into consideration that this research can help reduce the impact of construction industry on the environment and regulate the exploitation of resources.

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