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An Experimental Investigation Use of Fly Ash As Partial Replacement Cement in Concrete

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ABSTRACT
Infrastructural development is at its peak all over the world and is a symbol of growth for any country. The most popular construction material is concrete which involves use of cement which is responsible for 7% of total world's carbon dioxide emissions. Carbon dioxide is the main threat in causing global warming of the environment. The attempts have been made to reduce CO_2 emissions in environment by all possible ways, but cement has not found a suitable replacement for it till date. Fly ash concrete is an effort in reducing cement content of construction. Fly ash concrete has economical and environmental advantages. It also makes concrete sustainable. In India, presently nearly 50% of fly ash produced is consumed. The paper aims at discussing the use of fly ash concrete in construction as a solution to address two environmental problems – one, disposal of huge amounts of fly ash, by production of thermal power plants, causing environmental degradation through large areas of landfills and two, high percentage of carbon dioxide emissions in the atmosphere from the cement industry.

Keywords: Concrete, CO_2, environment, fly ash

INTRODUCTION

Fly ash improves concrete's workability, pumpability, cohesiveness, finish, ultimate strength, and durability as well as solves many problems experienced with concrete today–and all for less cost. Fly ash, sometimes called flue ash, has been a popular supplementary cementations material (SCM) since the mid-1900s. For most concrete producers, fly ash is an important ingredient in concrete mix designs. Depending on the application, the type of fly ash, specification limits, geographic location, and climate, fly ash can be used at levels ranging from 15% to 25% (most common) to 40% to 60% (when rapid setting time is not required), reducing emissions by roughly the same amount - and helping to keep concrete products at an affordable price.

LITERATURE REVIEW

From the experimental results **Poon, Lam and Wong, (1999)** concluded that the replacement of cement by 15%, to 25% by fly ash results in lower porosity of concrete and no visible change in compressive strength. **Dr. N Bhanumaathidas and N Kalidas (2002)** said the utilization of fly ash has been a subject of great corner in India for the past two and half decades, the utilization has picked up for some year. This paper discusses the transition in the Indian fly ash scenario in concrete. **Siddique (2003)** concluded that the test results showed that the compressive strength of fly ash concrete mixes with 10% to 50% fine

aggregate replacement with fly ash were higher than control mix at all ages. The experimental results concerning the compressive strength development of concrete containing fly ash, the authors, **Hwang, Noguchi and Tomosawa, (2004)** concluded that the pores in concrete are reduced by addition of fly ash as replacement of sand. **Subramaniam, Gromotka, Shah, Obla and Hill, (2005)** investigated the influence of ultrafine fly ash on the early age property development, shrinkage and shrinkage cracking potential of concrete.
Comparing all the test results authors indicated the benefits of using ultrafine fly ash in reducing shrinkage and shrinkage strains and decreasing the potential for restrained shrinkage cracking.

MATERIAL:

The detail of various materials used in the experimental investigation will be:

- Coarse Aggregate - Crushed granite stone aggregate of maximum size 20 mm
- Sand (Fine Aggregate) - The fine aggregate used was sand passing through 4.75 mm sieve. The grading zone of fine aggregate was zone I as per IS specification.
- Cement - Ordinary Portland Cement (43 Grade)
- Water - Ordinary clean potable water free from suspended particles and chemicals was used for mixing and curing concrete.
- Fly ash- Fine residue produced from the combustion in thermal power plants

METHODOLOGY:

Experimental Procedure: To investigate the effect use of fly ash as partial replacement cement in concrete the concrete cubes were casted using 10% and 20% flyash and rest cement and were cured for 7, 14, 21 and 28 days and were tested for characteristic strength. The mould was filled in three layers tamping each layer 25 times. The compressive strength is taken as maximum compressive load resisted by per unit area.

- Size of cube: 150 mm x 150 mm x 150 mm
- Characteristic compressive strength of 20 N/mm^2
- Curing period of 7, 21, 28 days, cubes were tested and the average compressive strength recorded.

Workability: Workability of cubes mixed was measured before casting of cubes. The workability maintained was medium i.e. slump was maintained between 75 mm to 100 mm.

Test Results: The concrete cubes were tested on a Universal Testing Machine of capacity 1000 kN. The tests were carried out at Shri Siddheshwar Women's Polytechnic, Solapur.

TEST RESULTS FOR M20 GRADE CONCRETE:

The concrete cubes were tested in Compression Testing Machine. The tests were carried out at Shri Siddheshwar Women's Polytechnic, Solapur for M20 grade of concrete.

Table: Compressive Strength of Concrete in N/mm^2

	Normal Concrete	10 % Fly Ash in Cement	20 % Fly Ash in Cement
7th Day Test	19.142	22.006	21.371

14th Day Test	23.321	26.580	25.292
21st Day Test	26.911	27.696	29.374
28th Day Test	30.595	31.739	32.532

	Change in Strength for 10 % Fly Ash in Cement	Change in Strength for 20 % Fly Ash in Cement
7th Day Test	2.864	2.229
14th Day Test	3.259	1.971
21st Day Test	0.785	2.463
28th Day Test	1.144	1.937

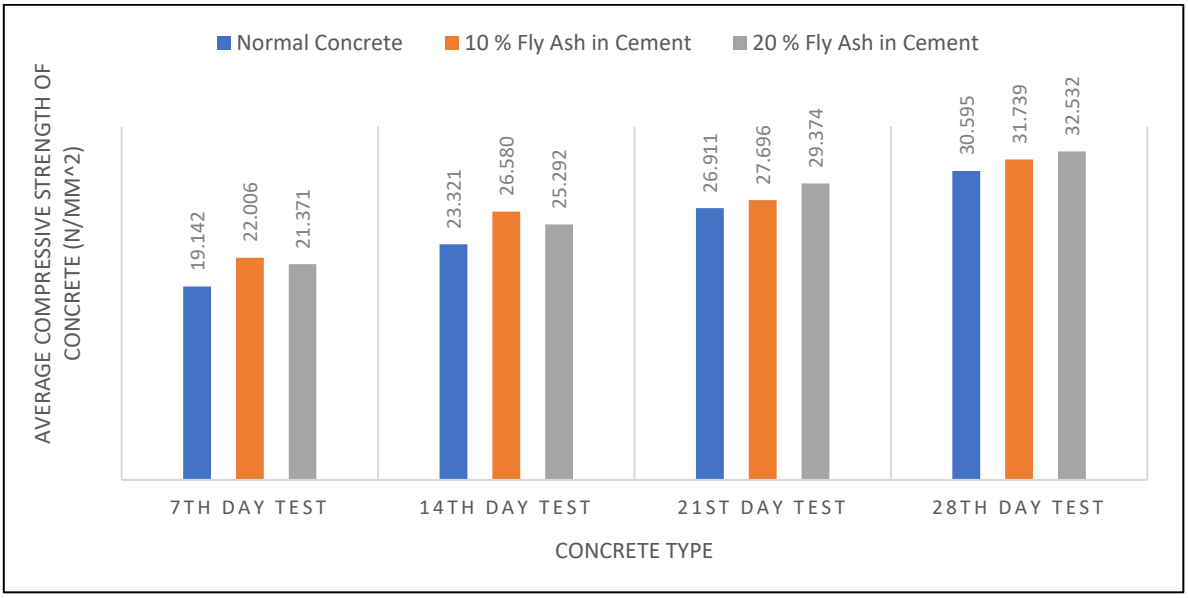

Figure: Compressive Strength of Concrete in N/mm^2

CONCLUSION

- From the results it can be said that, the compressive strength of concrete with the usage of fly ash no major changes as compared to conventional or normal concrete.
- Fly ash upto 20% can be used in partial replacement of cement.
- This will help in managing thermal power plant waste thus contributing to solid waste management.

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