# Experimental Study on Effect of Addition of Flyash on the Properties of Plastic Fibers Reinforced Concrete

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***Abstract*** **- In this paper an attempt has been made to study the properties of fibre reinforced concrete produced from plastic fibers and fly ash. In India, plastic are causing considerable damage to the environment and hence an attempt has been made to understand whether they can be successfully used in concrete to improve some of the mechanical properties as in the case of steel fibers. M40 grade concrete was used. The experimental work was carried out on cubes, cylinders and beams which were casted in laboratory and their behavior under test were observed at 7, 28 & 56 days. Fly ash were varied by 5%, 10%, 15%, 20%, 25% and 30% by weight of cement with plastic waste at a constant dosage of 0.5% and 1.0% by volume of concrete. On hardened concrete compressive strength, flexural strength and split tensile strength was conducted.**

***Key Words: Fly Ash (FA), Plastic Fiber, Compressive Strength, Split Tensile Strength and Flexural Strength .***

## INTRODUCTION

Concrete is the most commonly used material for civil engineering construction. The basic ingredients of the concrete are crushed granular rock as coarse aggregate, natural river sand as fine aggregate, cement as binder material, water which is free from impurities and salts. The combined mixture of these materials with water through a chemical reaction called hydration the mixture get hardens and gain strength to form rock like mass known as concrete. Concrete has the ability to get cast in any form and shape. The main applications of the concrete are construction of roads, bridges, sidewall, high rise structures, residential buildings and runways etc., concrete is strong in compression, specific gravity, fire resistance, durability, impermeability. However the concrete has some bitter properties like weak in tension, brittleness, low impact strength, heavy weight and less resistance to cracking etc. In order to overcome the bitter properties of concrete many researches has been undergone by using different kind of fibers which acts as crack arrestors. It has been found that inclusion of fibers in concrete improve the tensile strength, impact strength, fatigue resistance, wear and tear and cracking resistance. A composite material consisting of conventional concrete or mortar reinforced by the dispersal of short discrete and discontinuous fibers of specific geometry is known as fiber reinforced concrete. Fiber reinforced concrete is used for the production of precast elements like pipe, hulls, railway sleepers etc. In advanced fiber reinforced concrete can be used in highway pavement water retaining structures and airport runways etc.

### *A. Flyash*

Flyash is obtained from electrostatic precipitators in Thermal Power Stations generally contains amorphous silica and alumina. India alone produces about 75 million tons of flyash per year the disposal of which has become a big environmental problem. Flyash acts as a supplementary cementitious material which can be replaced to cement at various percentages.

ASTM broadly classifies flyash into two classes.

Class F : Class F flyash is having only pozzolanic properties which is produced by burning anthracite or bituminous coal having less than 5% CaO

Class C : Class C flyash as pozzolanic properties in addition to it posses cementitious properties which is produced by burning lignite or sub bituminous coal having CaO content in excess 10%

### *B. Plastic waste fibers*

Plastic is a non biodegradable material disposal of plastic has become a big headache. Plastic cannot be decayed by soil or dissolve it by water. Use of plastic is increasing day by day due to an economic growth and production patterns which is resulting in generation of plastic waste in the world. Plastic waste can be burnt and re-used but during the burning of plastic toxic gases is released to the environment which is harmful to health. Different kind of plastic waste products are plastic broom sticks, water bottles, polythene covers etc. Now a day’s trend of using plastic waste in concrete has been developed many research has undergone on this. Many type of fibers like glass fibers, plastic fibers, synthetic fibers etc can be used in the production of fiber reinforced concrete.

## 2. BACKGROUND AND RELATED WORK

**Vidivelli and Mageswari (2010)** This paper reports that the investigation was carried out on concrete with partial replacement of cement by flyash. Flyash was replaced to cement at various percentages like 10%, 20%, 30% and 40%. Ordinary Portland cement of 53 grade, natural river sand, coarse aggregate of size 20mm was used. The mix was designed for 1:1.66:3.61. The workability was maintained 40-60mm. The w/c ratio was varied from 0.48 to 0.39[3]. Various tests like compressive, flexural and split tensile strength were carried out at the ages of 28, 45, 60, 90 and 180 days. It was observed that compressive flexural and tensile strength increased at 10% and 20% replacement of flyash at all the ages of curing like 28, 45, 60, 90 and 180 days and reduction was observed at 30% and 40% replacement of flyash at the ages of curing like 28, 45, 60, 90 and 180 days compared to conventional concrete.

**Jayeshkumar et al, (2012)** This paper reports that an attempt was made by using thermal industry waste (flyash) in concrete as a partial replacement to cement. The flyash was partially replaced to cement at various percentages like 10%, 20%, 30%, and 40%. The concrete mix was designed for M-25 grade and M-40 grade. Ordinary Portland cement, natural river sand, coarse aggregate of size 20mm were used with w/c ratio of 0.40 for M-25 and 0.30 for M-40 concrete. Tests like compressive and tensile strength was conducted and test results was compared to conventional concrete. It was observed that usage of flyash reduced the strength of concrete as the flyash percentage increased both compressive and split tensile strength was decreased.

**Patil et al, (2012)** This paper reports that an attempt was made for the proper utilization of flyash and to find its better way of disposal and reuse. The concrete was designed for M-20 grade mix 1:1.5:3 by volume and w/c ratio of 0.5 was taken. The flyash was replaced to cement at different percentages like 0%, 5%, 10%, 20% and 25%. It was observed that 0% flyash (i.e., conventional concrete) compressive strength was maximum for 60 days of curing later on it became nearly constant. 5% replacement of flyash showed high compressive strength upto the age of 21 days later on compressive strength was decreased. 10% replacement of flyash increased the compressive strength about 6% compared to the conventional concrete at the age of 90days of curing. The decrease in compressive strength was observed after 10% replacement of flyash.

**Kandasamy and Murugesan (2011)** This paper reports that an attempt was made to study the influence of addition of Polythene fibers in fiber reinforced concrete. The concrete mix was designed for M20 grade. Ordinary Portland cement, locally available river sand and coarse aggregate was used. Polythene fibers were added at the dosage of 0.5%. Sample casted were cured for 7days and 28 days. Cube samples of 150*150*150mm were tested for compressive strength cylinder samples of 150mmdia and 300mm height were tested for split tensile strength. It was observed that addition of polythene fibers at 0.5% dosage increased cube and cylinder compressive strength at 7 days and 28days. Split tensile strength also increased.

**Baboo et al, (2012)** This paper reveals the study on fresh and hardened properties of waste virgin plastic mix concrete. The concrete mix was designed for M30 grade. Sand was partially replaced by waste plastic flakes in varying percentages like 0%, 5%, 10% and 15% by volume. Superplasticizer Conplast SP320 was used. Samples were prepared by using plasticizer and without using superplasticizer. It was observed that fresh density decreased below the reference mix at 5%, 10% and 15% of waste plastic flakes, dry density of all mixtures was reduced at al curing ages. Workability was low when superplasticizer was added workability becomes medium till 10% of plastic content. Compressive strength decreased when superplasticizer was not used. Compressive strength increased when superplasticizer was used till 10% of plastic flakes at 15% there was a reduction. As the percentage of waste plastic flake increased flexural strength decreased.

**Chandrashekar et al, (2012)** This paper reports the experimental investigation carried out on steel fiber reinforced concrete subjected to repeated loading. Steel fibers of different dimensions like (0.5mmØ *30mm) and (50*2.5*0.5mm) were used mixes were named as HS1 (0.25% flat fibers and 0.25% wire fibers) and HS2 (0.50% flat fibers and 0.5% wire fibers). Beams were casted of dimension (500*100*100) mm and it was subjected to two point flexural loads at frequency of 2Hz. Tests like compressive strength for 7, 28, 56 and 90 days, split tensile strength for 28days, flexural strength for 28 and 90 days and modulus of elasticity for 28 days was carried out. It was observed that compressive strength increased 8% for HS1 fibers and 18% for HS2 fibers. HS2 compressive strength was more than HS1. Increase in tensile strength was observed to be 28% to 42% and improvement in elastic modulus was found to be 36% to 50%

**Prahallada and Prakash (2013)** This paper reviews that an attempt was made to study the properties of fibre reinforced concrete produced from waste plastic fibre and flyash. Flyash was added in different percentages like 0%, 5%, 10%, 15%, 20% and 25%. Plastic fibre was added in dry mix at the rate of 0.5% by volume fraction. The concrete mix was designed for M30 grade. Ordinary Portland cement of 53 grade, natural river sand, locally available crushed aggregate of 10mm down size, portable water free from impurities and salts was used. O.46 w/c ratio was adopted. Flyash used was obtained from Harihara Polyfibres Plant (Kumarpatnam). All the samples were tested at 28days of curing. It was observed that impact strength, workability, tensile strength, flexural strength, compressive strength increased upto 10% addition of flyash into it after 10% addition of flyash all the strengths was decreased.

## 3. MATERIALS AND EXPERIMENTAL CONDITIONS

## MATERIALS

### *3.1 Cement*

43 grade OPC conforming to IS 8112-1989 was used for this investigation. Table 1 shows the physical properties of cement.

**Table 1: Physical properties of Cement**

| Properties | Results |
|---|---|
| Specific gravity | 3.1 |
| Standard consistency | 31% |
| Initial setting time | 38min |
| Final setting time | 480min |
| Fineness | 5.3% |

### *3.2 Fine Aggregate*

Natural river sand passing through IS 4.75mm sieve conforming to zone II of IS 383-1970 was used as fine aggregate. Table 2 shows the physical properties of fine aggregates.

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Table 2: Physical properties of Fine Aggregates

| Properties | Results |
|---|---|
| Specific gravity | 2.62 |
| Water absorption | 1.45% |

### *3.3 Coarse Aggregate*

20mm down size natural crushed stones were used as coarse aggregate. Table 3 shows the physical properties of coarse aggregates.

Table 3: Physical properties of Coarse Aggregates

| Properties | Results |
|---|---|
| Specific gravity | 2.65 |
| Water absorption | 0.39% |

### *3.4 Fly Ash*

Class F fly ash collected from Udupi Power Corporation Limited Padubidri, Udupi District, Karnataka was used.

Table 4: physical properties of Fly Ash

| Properties | Results |
|---|---|
| Specific gravity | 2.5 |
| fineness | 2.28% |

### *3.5 Plastic Fibers*

The waste plastic fibers were collected from the waste plastic brooms. The fibers were cut for 3cm length based upon the aspect ratio.

Table 5: Basic Properties of waste Plastic Fiber

| Properties | Results |
|---|---|
| Specific gravity | 0.97 |
| Diameter of plastic fibre | 0.18 |
| Length of plastic fibre | 3cm |

### *3.6 Water*

Ordinary Portland water available in the laboratory was used in this investigation both for mixing and curing.

### *3.7 Superplasticizer(SP)*

Conplast SP430 was used as a superplasticizer. It was used to increase the workability of concrete mix without increasing water-cement ratio.

### *3.8 Mix Design*

The mixes were designed using IS 10262-2009 after considering many trail mixes, the design mix of 1:1.61:2.65 (M40) along with superplasticizer 0.75% by weight of binder with cement content of 425 Kg/$m^3$ is adopted for control concrete. The plastic fiber of constant volume fraction 0.5% and 1% was adopted.

### *3.9 Preparation of specimen*

Concrete was produced by machine mixing and materials are batched by weight. 100*100*100mm cube moulds, 100mm dia * 200mm cylinder moulds and 100*100*500mm beam moulds. The concrete moulds are placed and compacted on table vibrator and placed in cool temperature around ±25$^0$C, after 24 hours moulds were demoulded and kept for curing in curing tank by immersing fully. Curing was done upto 7 days for cubes and 28 days for other specimens like beams and cylinders


Fig 1: Casting of specimen

### *3.10 Tests*

The cube specimens were tested for compressive strength, cylinder specimens of 100mm dia for split tensile strength and beam specimen for flexural strength. Compression testing machine was used to test compressive strength at 7 days, split tensile strength at 28 days and flexural strength at 28 days

Fig 2: Compressive strength Test

Fig 3: Split Tensile Strength Test

Fig 4: Flexural Strength Test

## 4 RESULTS AND DISCUSSIONS

### *A. Compressive strength*

The Chart 1 shows the graphical representation of 7 days compressive strength of flyash concrete at different percentage of fly ash. It was observed that 5% replacement of flyash enhanced strength of concrete.

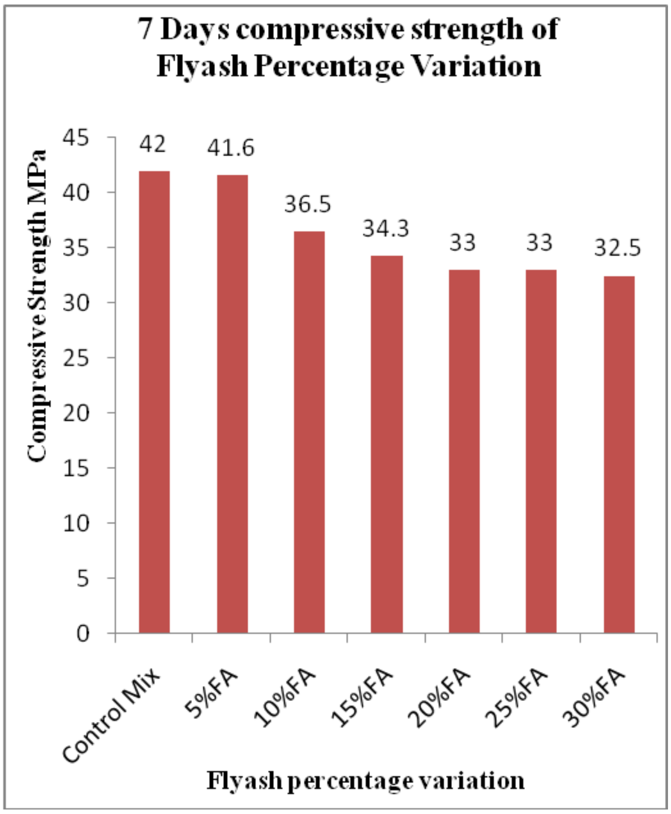


Chart 1: 7 Days compressive strength of flyash percentage variation.

The Chart 2 shows the graphical representation of 7 days compressive strength with replacement of cement by flyash at different percentages and 0.5% plastic fibers (constant) as additive. The maximum strength was observed at 0.5% fibers + 5% fly ash.

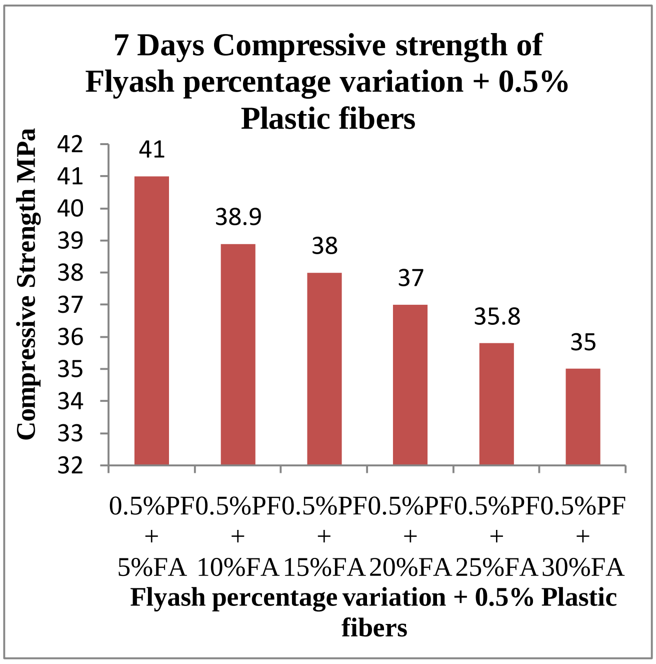


Chart 2: 7 Days Compressive strength of Flyash percentage variation + 0.5% Plastic fibers

The Chart 3 shows the graphical representation of 7 days compressive strength with replacement of cement by flyash at different percentages and 1.0% plastic fibers (constant) as additive. The maximum strength was observed at 1.0% fibers + 5% fly ash.

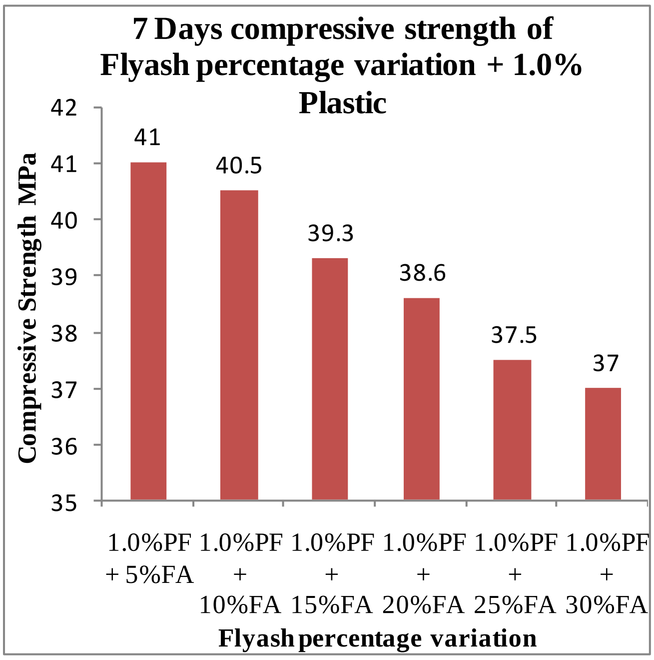


Chart 3: 7 Days compressive strength of Flyash percentage variation + 1.0% Plastic fibers

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The Chart 4 shows the graphical representation of 28 days compressive strength of flyash concrete at different percentage of fly ash. It was observed that 10% replacement of flyash enhanced strength of concrete.

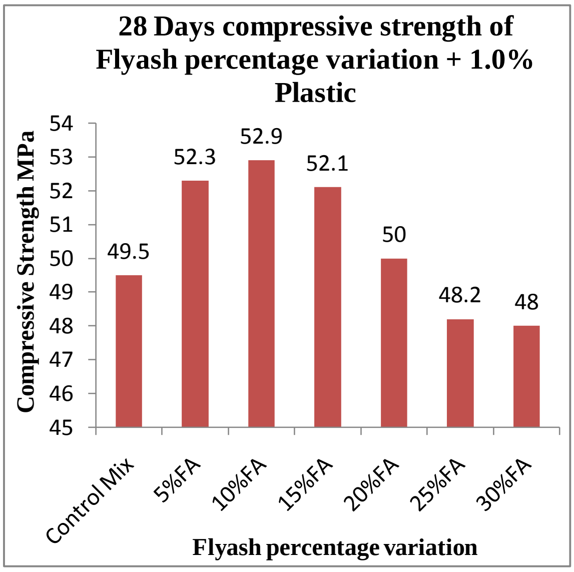


Chart 4: 28 Days compressive strength of flyash percentage variation

The Chart 5 shows the graphical representation of 28 days compressive strength with replacement of cement by flyash at different percentages and 0.5% plastic fibers (constant) as additive. The maximum strength was observed at 0.5% fibers + 20% fly ash.

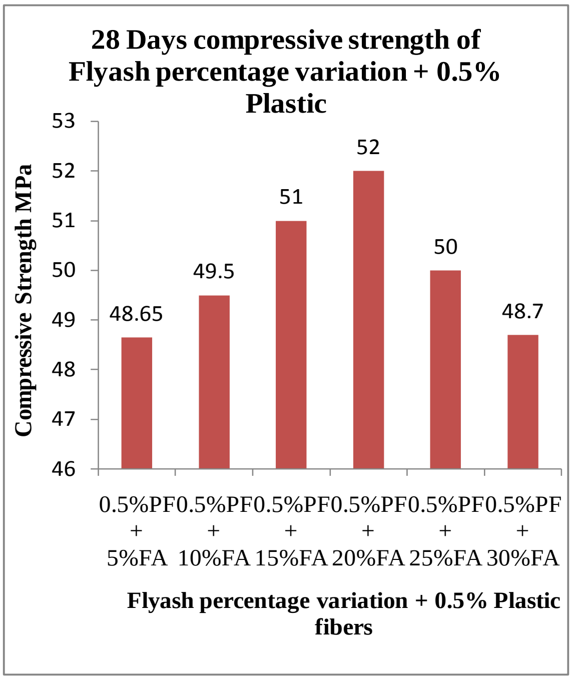


Chart 5: 28 Days compressive strength of Flyash percentage variation + 0.5% Plastic fibers

The Chart 6 shows the graphical representation of 28 days compressive strength with replacement of cement by flyash at different percentages and 1.0% plastic fibers (constant) as additive. The maximum strength was observed at 1.0% fibers + 15% fly ash.

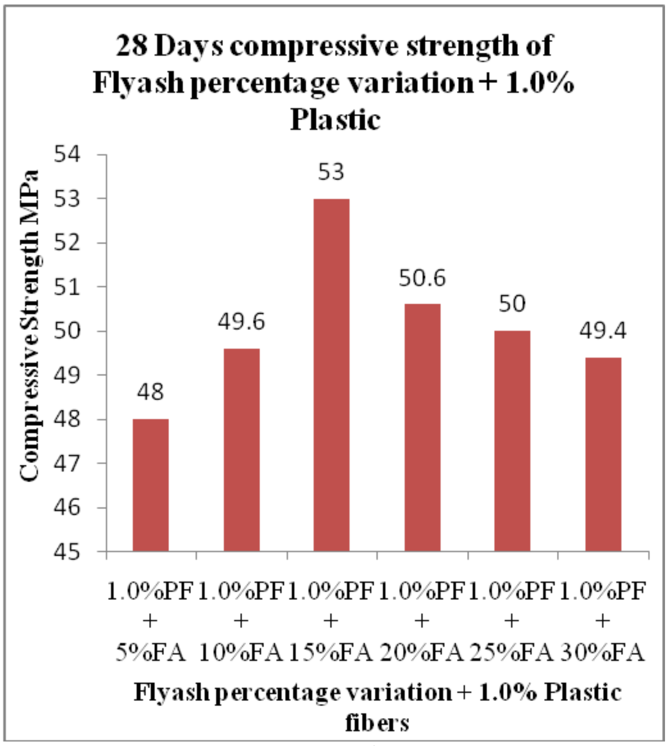


Chart 6: 28 Days compressive strength of Flyash percentage variation + 1.0% Plastic fibers

The Chart 7 shows the graphical representation of 56 days compressive strength of flyash concrete at different percentage of fly ash. It was observed that 15% replacement of flyash enhanced strength of concrete.

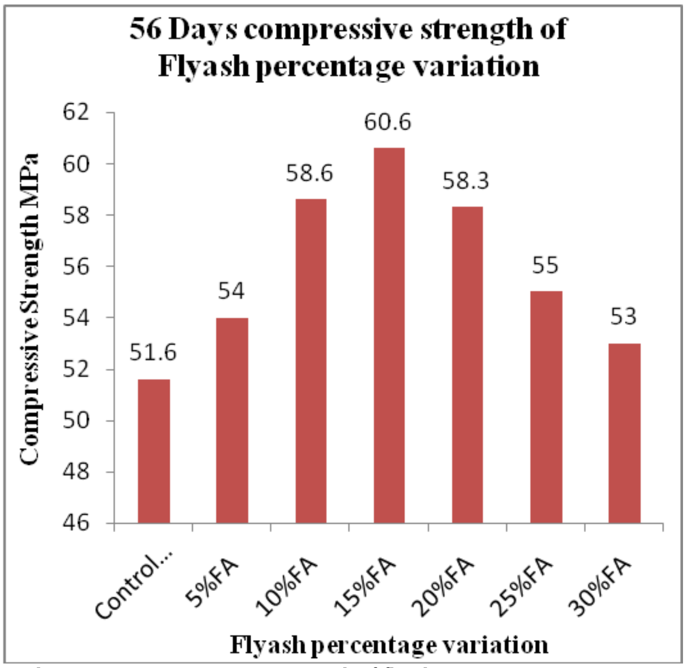


Chart 7: 56 Days compressive strength of flyash percentage variation

The Chart 8 shows the graphical representation of 56 days compressive strength with replacement of cement by flyash at different percentages and 0.5% plastic fibers (constant) as additive. The maximum strength was observed at 0.5% fibers + 15% fly ash.

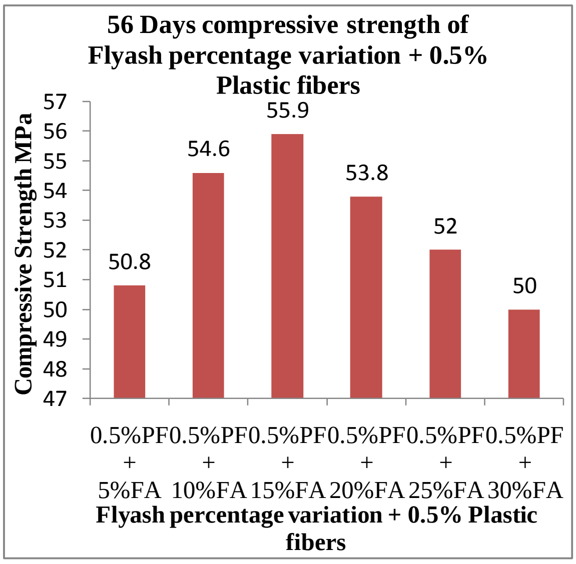


Chart 8: 56 Days compressive strength of Flyash percentage variation +0.5% Plastic fibers

The Chart 9 shows the graphical representation of 56 days compressive strength with replacement of cement by flyash at different percentages and 1.0% plastic fibers (constant) as additive. The maximum strength was observed at 1.0% fibers + 15% fly ash.

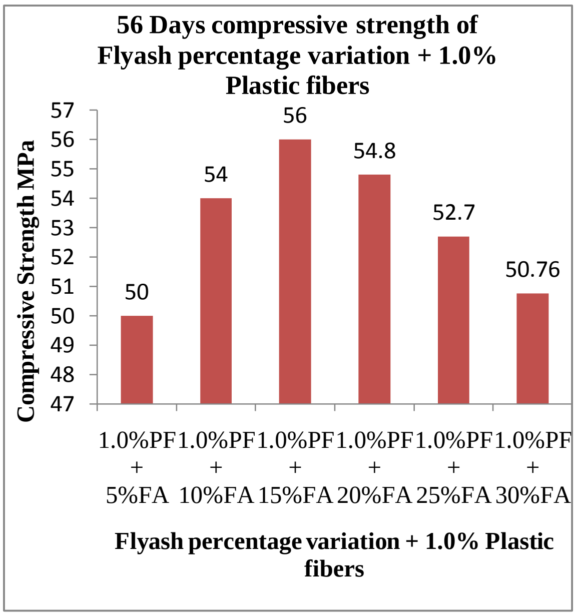


Chart 9: 56 Days compressive strength of Flyash percentage variation + 1.0% Plastic fibers

*B. Split tensile strength*

The Chart 10 shows the graphical representation of 28days split tensile strength of flyash concrete at different percentage of fly ash. The maximum strength was observed at 5% replacement of fly ash.

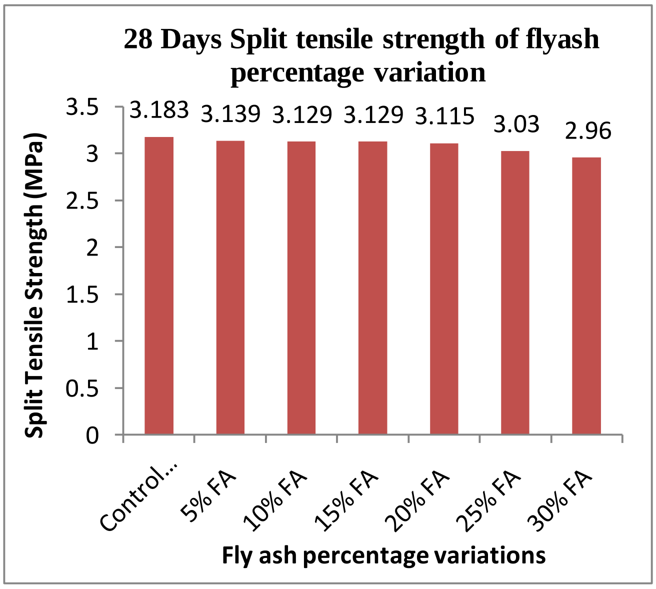


Chart 10: 28 Days Split tensile strength of flyash percentage variation

The Chart 11 shows the graphical representation of 28 days split tensile strength with replacement of cement by flyash at different percentages and 0.5% plastic fibers (constant) as additive. The maximum strength was observed at 0.5% fibers + 5% flyash.

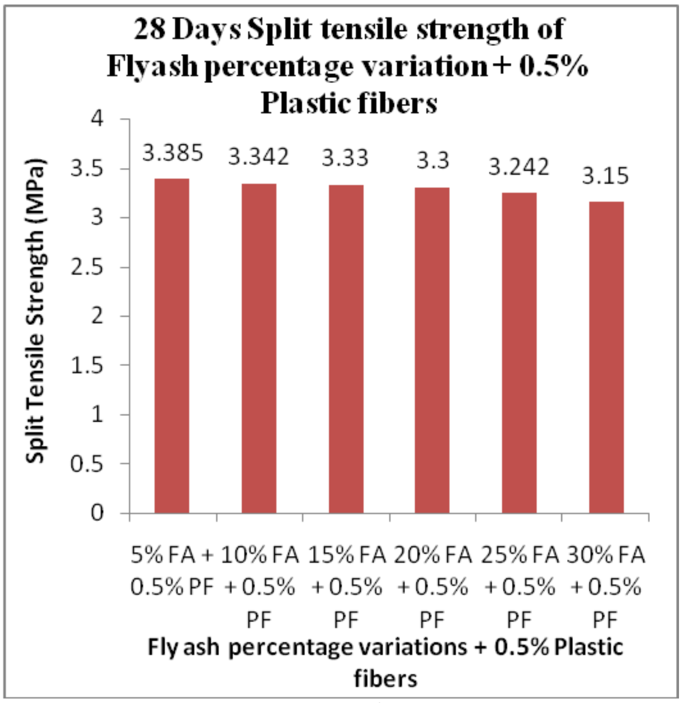


Chart 11: 28 Days Split tensile strength of Flyash percentage variation + 0.5% Plastic fibers

The Chart 12 shows the graphical representation of 28 days split tensile strength with replacement of cement by flyash at different percentages and 1.0% plastic fibers (constant) as additive. The maximum strength was observed at 1.0% fibers + 10% fly ash.

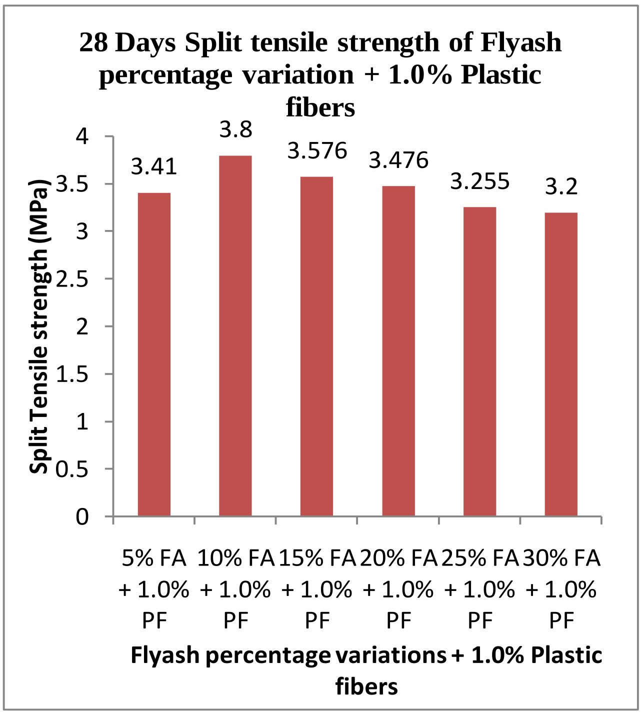


Chart 12: 28 Days Split tensile strength of Flyash percentage variation + 1.0% Plastic fibers

*C. Flexural strength*

The Chart 13 shows the graphical representation of 28 days compressive strength of flyash concrete at different percentage of fly ash. The maximum strength was observed at 5% replacement of fly ash.

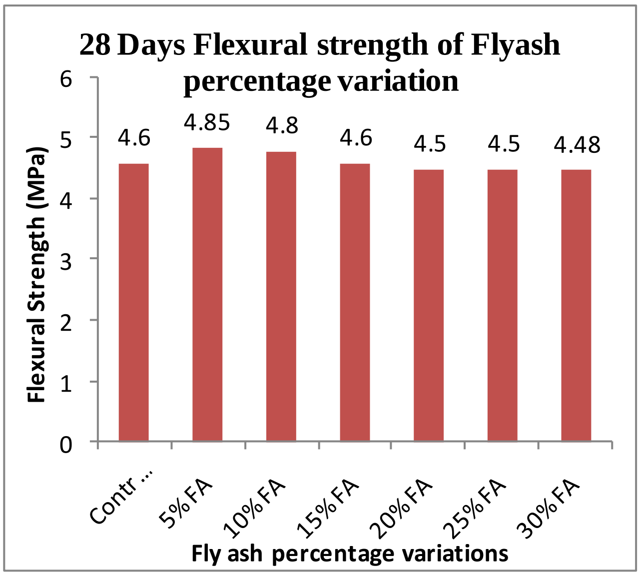


Chart 13: 28 Days Flexural strength of Flyash percentage variation

The Chart 14 shows the graphical representation of 28 days flexural strength with replacement of cement by flyash at different percentages and 0.5% plastic fibers (constant) as additive. The maximum strength was observed at 0.5% fibers + 5% fly ash.

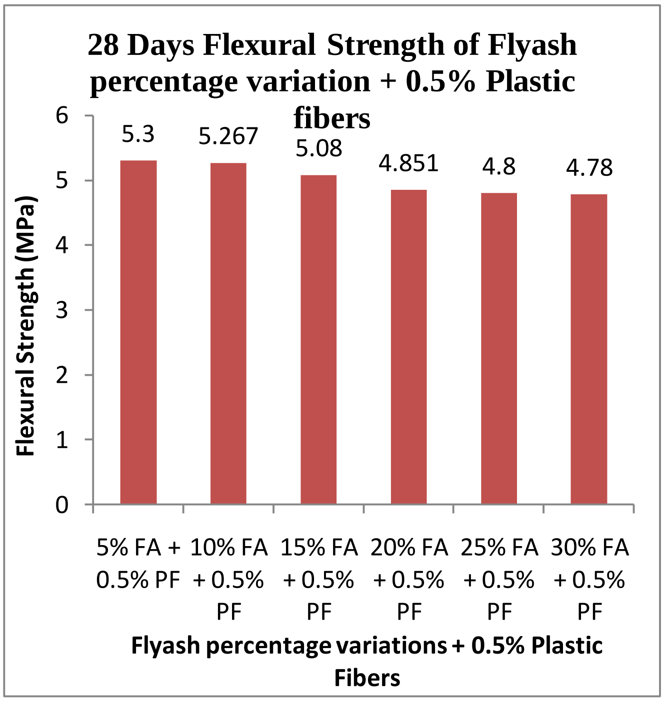


Chart 14: 28 Days Flexural Strength of Flyash percentage variation + 0.5% Plastic fibers

The Chart 15 shows the graphical representation of 28 days flexural strength with replacement of cement by flyash at different percentages and 1.0% plastic fibers (constant) as additive. The maximum strength was observed at 1.0% fibers + 5% fly ash.

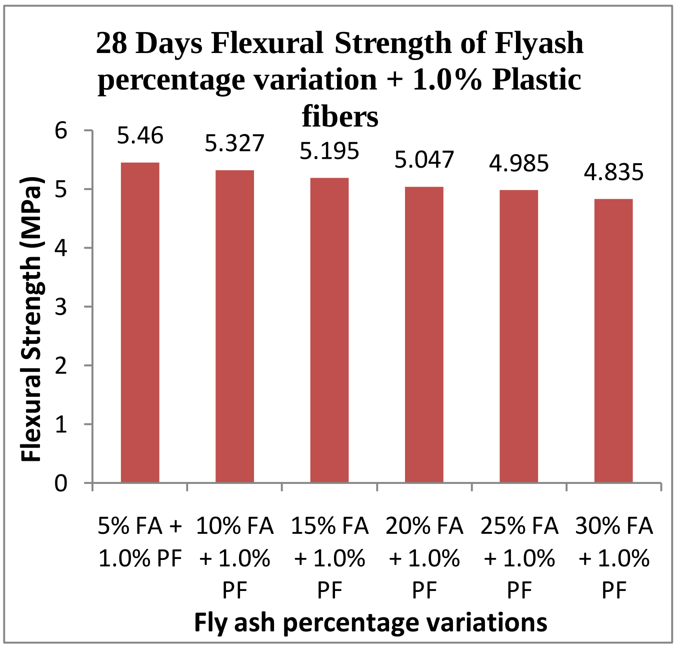


Chart 15: 28 Days Flexural Strength of Flyash percentage variation + 1.0% Plastic fibers

## 5 CONCLUSIONS

Generally this research shows that addition of plastic fibers with flyash improved the mechanical properties of concrete. The conclusions that can be drawn from this research based on the experimental results are as follows

- Compressive strength was low at early ages of curing (7 days ) than the conventional concrete after that strength has increased at 28,56 and 90 days of curing with flyash variation and intrusion of plastic fibers at two constant dosages of 0.5% and 1.0%.
- Split tensile strength was increased at 28 days compared to the conventional concrete with flyash variation and intrusion of plastic fibers at two constant dosages of 0.5% and 1.0%.
- Flexural strength was increased at 28 days compared to the conventional concrete with flyash variation and intrusion of plastic fibers at two constant dosages of 0.5% and 1.0%.
- Thus flyash and plastic fibers can be used in the production of fiber reinforced concrete.

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