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Experimental Study on Effect of Addition of Fly Ash 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.

Keywords: Fly Ash (FA), Plastic Fiber, Compressive Strength, Split Tensile Strength and Flexural Strength

I. INTRODUCTION

Concrete is a versatile material for civil engineering construction. It has ability to get cast in any form and shape. All basic ingredients of concrete are natural origin. But the properties of concrete can be change by adding some special natural or artificial ingredients. The concrete has many advantageous properties such as good compressive strength, durability, impermeability, specific gravity and fire resistance. However the concrete has some bitter properties, like- weak in tension, brittleness, less resistance to cracking, lower impact strength, heavy weight, etc. Some remedial measures can be taken to minimize these bitter properties of concrete. The some of the bitter properties of concrete are due to micro cracks at mortar aggregate interface. To overcome this, the fibers can be added as one of the ingredients of concrete. The fibers inclusion in cement base matrix acts as unwanted micro crack arrester. The prevention of prolongation of cracks under load can result in improvement in static and dynamic properties of cement based matrix. It has been found that the addition of small closely spaced and uniformly distributed fibers to concrete would act as crack arrestors and substantially improve the tensile strength, cracking resistance, impact strength, wear and tear and fatigue resistance [1]. The ductility of the concrete increases by the addition of fibers. Such a composite material is called fibre reinforced concrete. The fibre reinforced concrete is very much attracting the attention of researchers and builders as it has several applications in the civil engineering field. It is used for the production of pre-casting elements like pipes, hulls of ships, railway sleepers, beams, stairways, wall panels, roof panels, roof and floor tiles, manhole covers etc. In advanced applications FRC can be used in highway pavements, airport runway, deck slab construction, water retaining structures, marine structures, blast resistance structures, refractory structures etc.

A. Flyash

Fly ash is finely divided residue resulting from the combustion of powdered coal and transported flue gases and collected by electrostatic precipitator. Fly ash is the most widely used pozzolanic materials all over the world.

Fly ash was first used in large scale in the construction of Hungry Horse dam in America in the approximate amount of 30 percent by weight of cement.

In recent time, the importance and use of fly ash in concrete has grown so much that it has almost become a common ingredient in concrete, particularly for making high strength and high performance concrete. Extensive research has been done all over the world on the benefits that could be occurred in the utilization of fly ash as a supplementary cementitious material, High volume flyash concrete is a subject of current interest all over the world.

The use of flyash as concrete admixture not only extends technical advantages to the properties of concrete but also contributes to the environmental pollution control. In India alone, we produce about 75 million tons of flyash per year the disposal of which has become a serious environmental problem. The effective utilization of fly ash in concrete making is therefore attracting serious considerations of concrete technologies and government departments.

Secondly, cement is the backbone for global infrastructural development. It was estimated the global production of cement is about

1.3billion tons in 1996. Production of every ton of cement emits carbon dioxide to the ton of about 0.87ton. Expressing it in another way, it can be said that 7% of the world's carbon dioxide emission is attribute to Portland cement industry. Because of the significant contribution to the environmental pollution and to the high consumption of natural resources like limestone etc., we cannot go on producing more and more cement. There is a need to economies the use of cement with supplementary cementitious materials like flyash silica fume and slag.

ASTM broadly classifies flyash into two classes.

Class F: Fly ash normally produced by burning anthracite or bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only.

Class C: Fly ash normally produced by burning lignite or sub-bituminous coal. Some Class C fly ash may have CaO content in excess 10%. In addition to pozzolanic properties, Class C fly ash also possesses cementations properties.

Advantages of flyash

Flyash from thermal power plants is one of such waste, which can e put to different useful purposes. The utilization of flyash has following advantages:

1) Conversion of waste into wealth.
2) Saving in expenditure for disposal
3) Increasing availability of much needed construction materials
4) Reduction in air/water pollution

B. Plastic Waste Fibre

Economic growth and changing consumption and production patterns are resulting into rapid increase in generation of waste plastics in the world. The world's annual consumption of plastic materials has increased from around 5 million tons in the 1950s to nearly 100 million tons. Thus, 20 times more plastic is produced today than 50 years ago. This implies that on one hand, more resources are being used to meet the increased demand of plastic, and on the other hand, more plastic waste is being generated. In Asia and the Pacific, as well as many other developing regions, plastic consumption has increased much more than the world average due to rapid urbanization and economic development. Due to the increase in generation, waste plastics are becoming a major stream in solid waste. After food waste and paper waste, plastic waste is the third major constitute at municipal and industrial waste in cities. Even the cities with low economic growth have started producing more plastic waste due to increased use of plastic packaging, plastic shopping bags, PET bottles and other goods/appliances using plastic as the major component. Plastic pollution involves the accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat, or humans. Many types and forms of plastic pollution exist. Plastic pollution can adversely affect lands, waterways and oceans. Plastic reduction efforts have occurred in some areas in attempts to reduce plastic consumption and promote plastic recycling. The prominence of plastic pollution is correlated with plastics being inexpensive and durable, which lends to high levels of plastics used by humans. Efforts to reduce the use of plastics and to promote plastic recycling have occurred. Some supermarkets charge their customers for plastic bags, and in some places more efficient reusable or biodegradable materials are being used in place of plastics. Some communities and businesses have put a ban on some commonly used plastic items, such as bottled water and plastic bags use of plastic in concrete upto some percentage has shows better results. Disposal of large quantity of plastic bag may cause pollution of land, water bodies and air. The proposed concrete which is made up by adding plastic fibers in concrete may help to reuse the plastic as one of the constituent's material of concrete, to improve the certain properties of concrete.

C. Objectives

The main objective of this project is to study

1) The hardened properties of concrete by adding waste plastic fibers and fly ash and to compare it with the compressive and split tensile strength of ordinary concrete.
2) To find the optimum percentage of waste plastic fibers and fly ash which makes the concrete to improve its hardened properties.

II. BACKGROUND AND RELATED WORK

Prahallada and Prakash (2013) have studied the properties of fibre reinforced concrete produced from waste plastic fibres and flyash which are the two environmental pollutants. They have concluded that 10% addition of flyash yield good workability in waste plastic fibre reinforced concrete.

Vidivelli and Mageswari (2010) carried out the investigation on concrete with partial replacement of cement by fly ash. They concluded that compressive strength, split tensile strength and flexural strength were enhanced by about 10% to 20% replacement of cement by fly ash.

Moinul and saiful (2012) studied the effect of fly ash on strength development of mortar and optimum use of fly ash in mortar. Fly ash mortar mix with cement replacement level upto 50% exhibit satisfactory results for both compressive and tensile strength. The optimum fly ash content may be about 40% of cement.

Baboo et al (2012) studied the properties of fresh and hardened waste virgin plastic concrete sand was partially replaced by waste plastic flakes in 0%, 5%, 10%, 15% by volume with and without Complast SP320 superplasticizer. They observed that compressive strength values of waste plastic concrete mixtures decreased at all curing age, the compressive strength tends to increase by 5% when superplasticziers was added to the waste plastic mix concrete. Flexural strength was decreased with the increase in percentage of plastic waste.

Nibudey et al (2013) carried out the experimental work by using material like polyethylene terephthalate (PET) plastic waste. The plastic waste were added from 0% to 3% with 0.5% variation. It was observed that inclusion of fibers content affects flow properties of concrete. The density was also affected but made concrete slightly light weight material. The optimum strength was observed at 1% of fiber content for both compressive and split tensile strength, there after reduction in strength was observed.

III. EXPERIMENTAL WORK

MATERIALS

A. *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%

B. *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.

Table 2: Physical properties of Fine Aggregates

Properties	Results
Specific gravity	2.62
Water absorption	1.45%

C. *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%

D. *Fly Ash*

Class F fly ash collected from Udupi Power Corporation Limited Padubidri, Udupi District, Karnataka was used. Table 4 shows the physical properties of fly ash.

Table 4: physical properties of Fly Ash

Properties	Results
Specific gravity	2.5
fineness	2.28%

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E. 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

F. Water

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

G. Superplasticizer(SP)

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

H. 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.

I. 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

J. 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

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Fig 2: Compressive strength Test

Fig 3: Split Tensile Strength Test

Fig 4: Flexural Strength Test

IV. RESULTS AND DISCUSSIONS

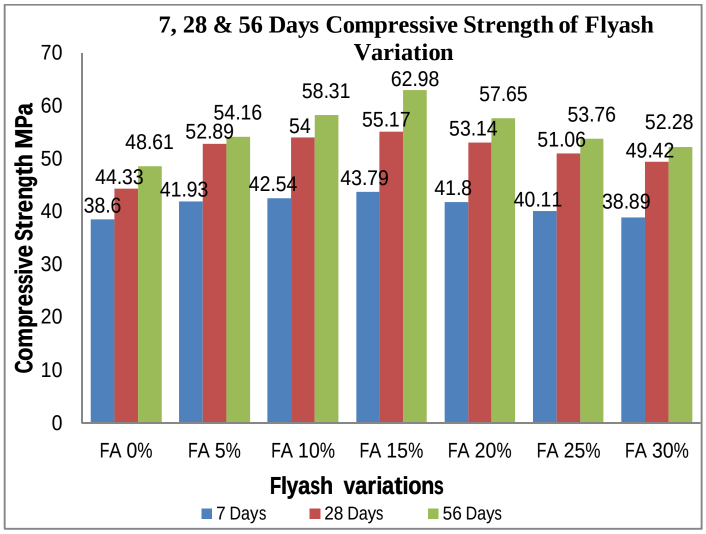

Fig 5: 7, 28 & 56 days compressive strength of FA variation

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The figure 5 shows the graphical representation of 7, 28 & 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 at all the ages of curing

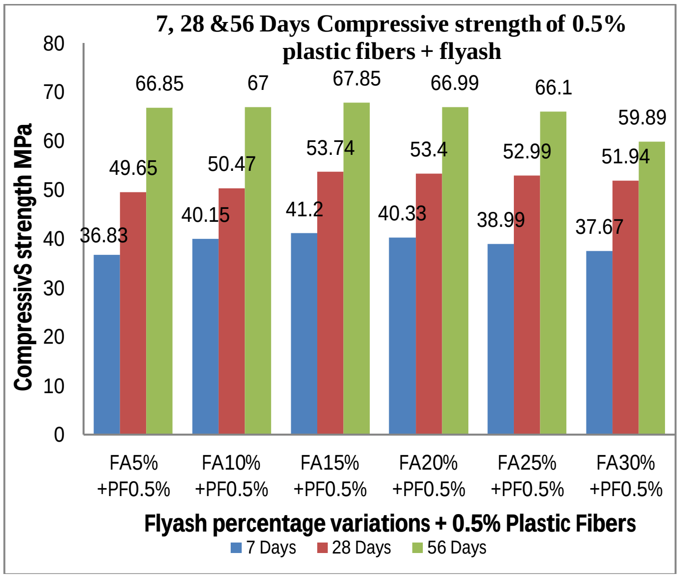

Fig 6: 7, 28 & 56 days compressive strength of 0.5% fibres + FA variation

The figure 6 shows the graphical representation of 7, 28 & 56 days compressive strength with replacement of cement by flyash at different percentages and 0.5% plastic fibres (constant) as additive. The maximum strength was observed at 0.5% fibres + 15% fly ash at all the ages of curing.

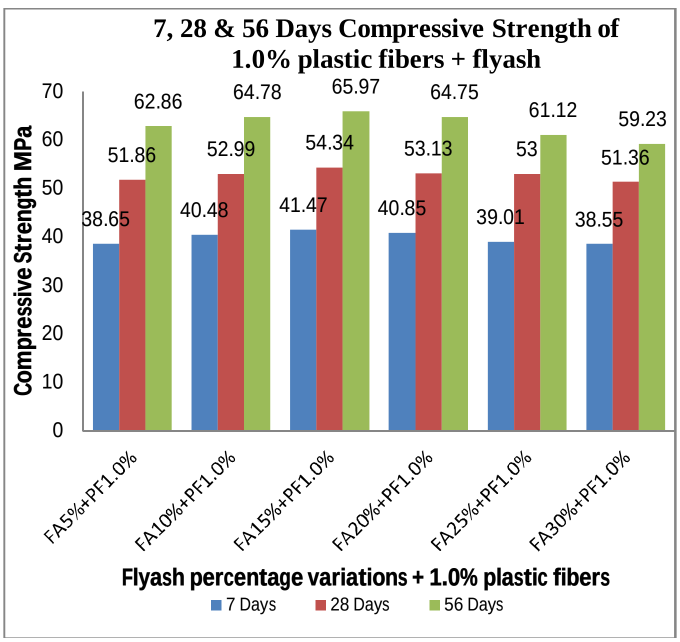

Fig 7: 7, 28 & 56 days compressive strength of 0.5% fibres + FA variation

The figure 7 shows the graphical representation of 7, 28 & 56 days compressive strength with replacement of cement by flyash at different percentages and 0.5% plastic fibres (constant) as additive. The maximum strength was observed at 0.5% fibres + 15% fly ash at all the ages of curing.

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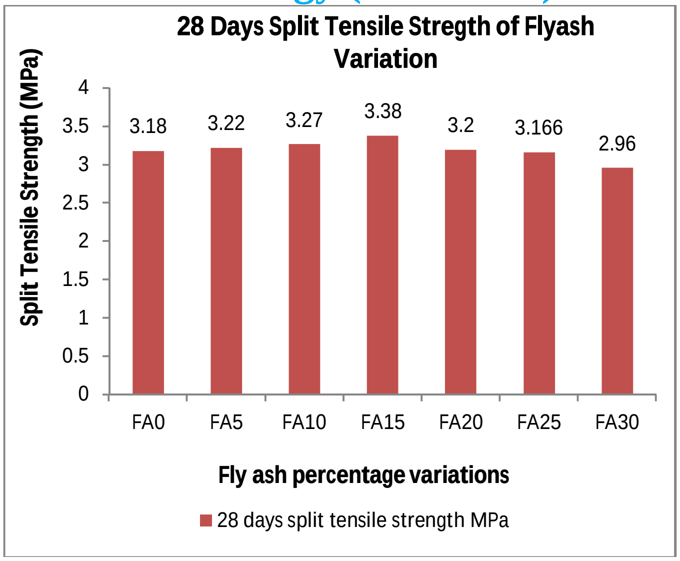

Fig 8: 28 days split tensile strength of FA variation

The figure 8 shows the graphical representation of 28days split tensile strength of flyash concrete at different percentage of fly ash. The maximum strength was observed at 15% replacement of fly ash.

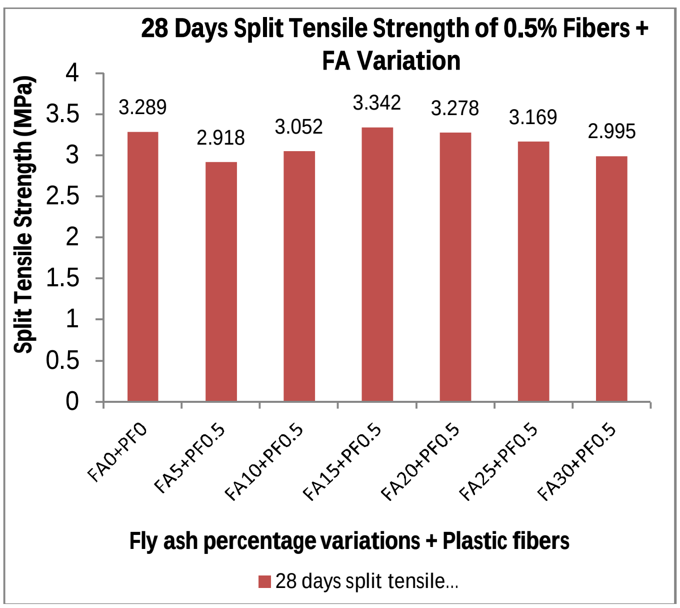

Fig 9: 28 days split tensile strength of 0.5% fibres + FA variation

The figure 9 shows the graphical representation of 28 days split tensile strength with replacement of cement by flyash at different percentages and 0.5% plastic fibres (constant) as additive. The maximum strength was observed at 0.5% fibres + 15% fly ash

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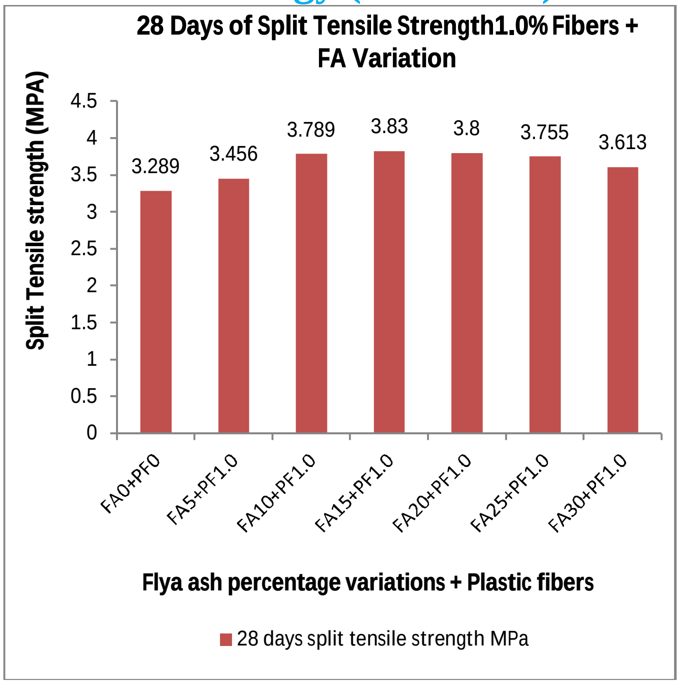

Fig 10: 28 days split tensile strength of 1.0% fibres + FA variation

The figure 10 shows the graphical representation of 28 days split tensile strength with replacement of cement by flyash at different percentages and 1.0% plastic fibres (constant) as additive. The maximum strength was observed at 1.0% fibres + 15% fly ash.

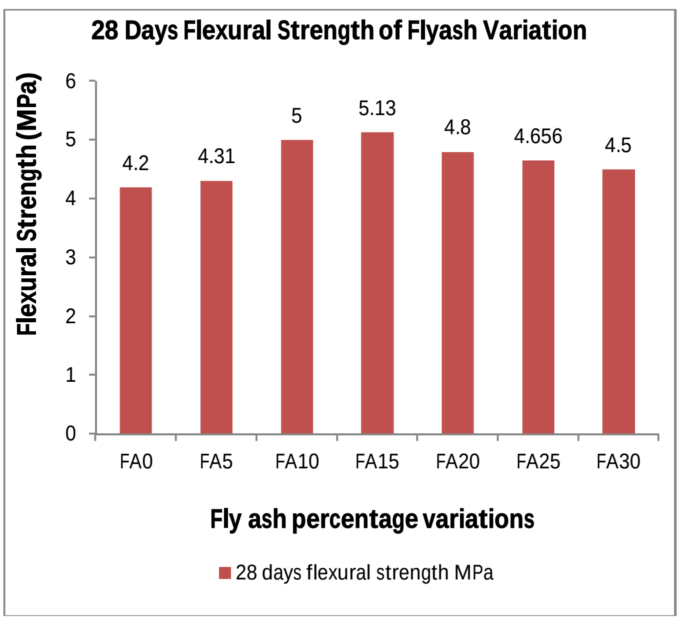

Fig 11: 28 days flexural strength of FA variation

The figure 11 shows the graphical representation of 28 days compressive strength of flyash concrete at different percentage of fly ash. The maximum strength was observed at 15% replacement of fly ash.

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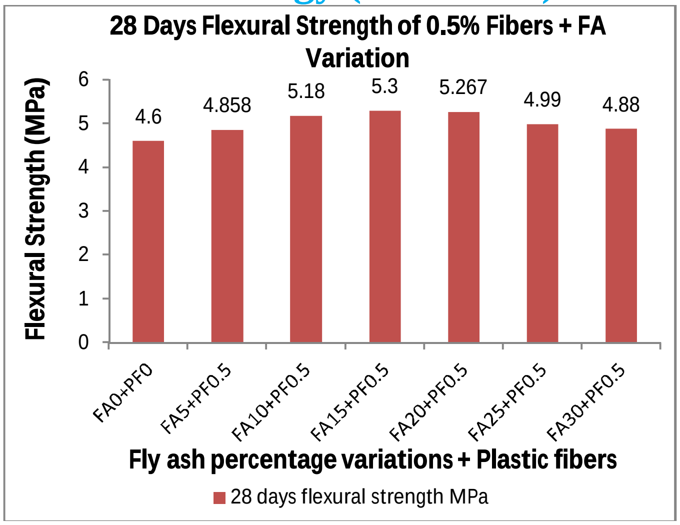

Fig 12: 28 days flexural strength of 0.5% fibres + FA variation

The figure 12 shows the graphical representation of 28 days flexural strength with replacement of cement by flyash at different percentages and 0.5% plastic fibres (constant) as additive. The maximum strength was observed at 0.5% fibres + 15% fly ash.

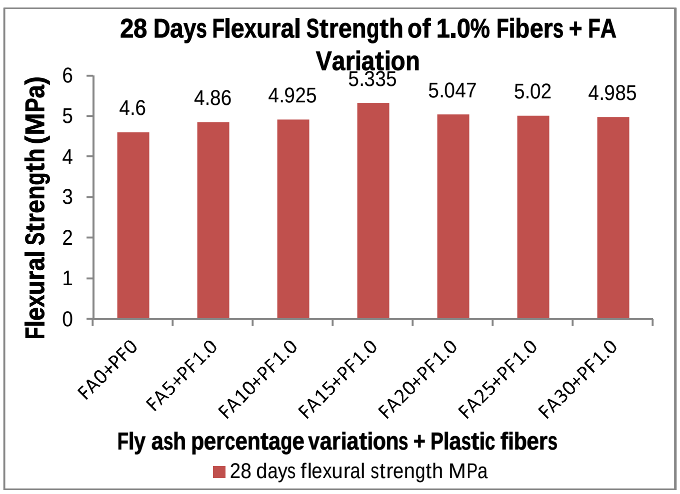

Fig 13: 28 days flexural strength of 1.0% fibres + FA variation

The figure 13 shows the graphical representation of 28 days flexural strength with replacement of cement by flyash at different percentages and 1.0% plastic fibres (constant) as additive. The maximum strength was observed at 1.0% fibres + 15% fly ash.

V. CONCLUSION

Based on the experimental investigation the following conclusion are drawn

A. Compressive strength has increased at 15% replacement of flyash with cement at 7, 28 and 56 days.
B. Compressive strength was gained at 15% for the combination of 0.5% plastic fiber and 15% fly ash at 7, 28 and 56 days.
C. Compressive strength for the combination of 1.0% plastic fiber with addition of fly ash had increased at 15% fly ash replacement.
D. Split tensile strength of fly ash concrete, concrete with the combination of fly ash + 0.5% plastic fibers and 1.0% plastic fibers was increased at 15% replacement for 28 days curing period.
E. Flexural strength was increased at 15% for fly ash + cement, 0.5% plastic fibers + fly ash and 1.0% plastic fibres + fly ash combinations for 28 days curing,

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