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# Editorial Board

Title

# EFFECT OF FLYASH ON THE PROPERTIES OF WASTE PLASTIC FIBRE REINFORCED CONCRETE – AN EXPERIMENTAL INVESTIGATION

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## Abstract:

The fibre reinforced concrete, which is defined as a composite material consisting of a material of cement mortar or concrete and discontinues discrete, uniformly distributed fibres has gained a wide popularity in the construction industry. The introduction of fibres into the concrete induces many desirable properties to the concrete and such concrete has wide varieties of applications in the field of civil engineering. Many types of fibres like steel, carbon, GI, glass, asbestos fibres can be used for the production of fibre reinforced concrete.

The plastic is causing an environmental pollution. The plastic is a non-biodegradable material. It do not undergo decay. To destroy this plastic, if it is burnt, it adds to air pollution by releasing many toxic gases. Thus, for environmentalists, the plastic has become a big headache.

Flyash is another industrial waste which is causing environmental pollution. The water in which flysah falls becomes unfit for drinking. The land on which it falls becomes infertile. The air becomes polluted since it spreads into atmosphere and causes lung problems.

In this paper an attempts has been made to study the properties of fibre reinforced concrete produced from waste plastic fibres and flyash which are the two environmental pollutions. The strength characteristics of waste plastic fibre reinforced concrete like compressive strength, tensile strength, flexural strength and impact strength are found when the flyash is added in different percentages like 0%, 30%, 50%, 70%, 90%, and 110%. Also the workability characteristic of waste plastic fibre reinforced concrete with flyash is studied.


**Key words:** Waste plastic fibres reinforced concrete, Flyash, Compressive, Tensile, Flexural and Impact strength

## 1.0Introduction:

It has been found that the addition of small closely spaced and uniformly distributed fibres to concrete would act as crack arrestors and substantially improve the tensile strength, cracking resistance, impact strength, wear and tear and fatigue resistance. The ductility of the concrete increases by the addition of fibres. 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 its advanced applications FRC can be used in highway payments, airport runway, deck slab construction, water retaining structures, marine structures, blast resistance structures, refractory structures etc.

Many types of fibres can be used in the production of FRC. The plastic is becoming a real headache for the environmentalists. The plastic is non biodegradable material. Soil cannot decay it. Water cannot dissolve or disintegrate it. But heat can burn it. But the moment the plastic is burnt, many toxic gases are produced and cause the air pollution. The inhalation of such toxic gases is very dangerous to health. Sustainable /safe methods of plastic destruction are not yet invented.

## 2.0 Experimental work:

### 2.1 Materials used

Cement: The cement used in the experimentation was 53-grade ordinary port land cement, which satisfies the requirements of IS: 12269-1987 specifications.

Fine aggregates: Locally available sand collected from the bed of river Bhadra was used as fine aggregate. The sand used was having fineness modulus 2.96 and conformed to grading zone-III as per IS: 383-1970 specification.

Coarse aggregates: The crushed stone aggregate were collected from the local quarry. The coarse aggregates used in the experimentation were 10mm and down size aggregate and tested as per IS: 383-1970 and 2386-1963 (I, II and III) specifications. The aggregates used were having fineness modulus 1.9.

Water: Ordinary potable water free from organic content, turbidity and salts was used for mixing and for curing throughout the investigation.

Plasticizer: To impart the additional desired properties, a plasticizer (Conplast P-211) was used. The dosage of plasticizer adopted in the investigation was 0.5% (by weight of cement).

Fibres: The waste plastic fibres were obtained by cutting waste plastic pots. The waste plastic fibres obtained were all recycled plastics. The plastic fibres were not obtained from granules. The fibres were cut from steel wire cutter and it is labour oriented.

Fly ash: The flyash used in the experimentation was obtained from "Harihara polyfibres plant" Harihara (Kumarpatnam). It satisfies the requirements of IS: 3812-1981 specification. Physical and chemical properties of flyash are given in Table No 2.1

Table 2.1: Physical and chemical properties of fly ash (IS: 3812-1981)

| Properties | Results | Permissible limit as per IS: 3812-1981 |
|---|---|---|
| A. Physical properties<br>Fineness-specific surface in $m^2/kg$ by Blaine permeability method | 410 | 320 (Minimum) |
| Compressive strength at 28 days in $MN/mm^2$ | 83.33% to 137.28% of the corresponding plain cement mortar cubes | Not less than 80% of the strength of corresponding plain cement mortar cubes |
| B. Chemical Properties | | |
| 1. Silica dioxide ($SiO_2$) | 60.1% | $SiO_2$ = 35%(Minimum) |
| 2. Aluminum oxide ($Al_2O_3$) | 14.77% | - |
| 3. Iron or Ferrous oxide ($Fe_2O_3$) | 2.84% | $SiO_2 + Al_2O_3 + Fe_2O_3$ = 70%(Minimum) |
| 4. Magnesium oxide (MgO) | 0.6% | 5 %( Maximum) |
| 5. Calcium oxide (CaO) | 1.2% | - |
| 6. Sulphur trioxide ($SO_3$) | 0.58% | 2.75%(Maximum) |
| 7. Sodium oxide ($Na_2O$) | 1.45% | 1.5% (Maximum) |
| 8. Soluble salt | 0.54% | - |
| 9. Loss of ignition | 11.34% | 12%(Maximum) |

* Data taken from the production centre

### 2.2 Experimental procedure

The main objective of this experimental investigation is to find out the effect of addition of flyash and replacement of cement by flyash on the workability and strength characteristics of waste plastic fibre reinforced concrete

Concrete was prepared by a mix proportion of 1: 1.374: 2.42 with a W/C ratio of 0.46 which correspond to M30 grade of concrete. The different percentage addition of flyash was adopted in the experimental programme are 0%, 5%, 10%, 15%, 20%, 25%. Waste plastic fibres having an aspect ratio 30 (thickness = 1mm, length = 30mm and breadth = 5mm) were added in the dry mix at the rate of 0.5% (by volume fraction). All the specimens were cast and tested after 28 days of curing as per IS specifications. When the mix was wet the workability test like slump test, compaction factor test and flow tests were carried out.

After 28 days of water curing the specimens were weighed for their density and tested for their strength. The different strength parameters of waste plastic fibre reinforced concrete like compressive strength, tensile strength, flexural strength and impact strength were found for different percentage addition/replacement of cement by Micro silica-600 as the case may be. The compressive strength tests were conducted as per IS: 516-1959 on specimens of size 150 x 150 x 150 mm. The tensile strength tests were conducted as per IS: 5816-1999 on specimens of diameter 150 mm and length 300mm. Indirect tension test (Brazilian test) was conducted on tensile strength test specimens. Flexural strength tests were conducted as per IS: 516-1959 on specimens of size 100 x 100 x 500mm.Two point loading was adopted on a span of 400 mm, while conducting the flexural strength test. The impact strength tests were conducted as per ACI committee-544 on the panels of size 250 x 250 x 30 mm. A mild steel ball weighing 1.216 kg was droped from a height of one meter on the impact specimen, which was kept on the floor. The care was taken to see that the ball was droped at the center point of specimen every time. The number of blows required to cause first crack and final failure were noted. From these numbers of blows, the impact energy was calculated as follows.

Impact energy = mghN

= w/g x g x h x N

= whN (N-m)

Where, m = mass of the ball

w = weight of the ball =1.216 kg

g = acceleration due to gravity

h = height of the drop =1m

N = average number of blows to cause the failure.

**Experimental results of waste plastic fibre reinforced concrete with different percentage addition of flyash.**

## 3.0 Experimental results

The following Tables give the details of the experimental results

**3.1 Compressive strength test results:** The following Table No 3.1 gives the compressive strength test results of waste plastic fibre reinforced concrete with different percentage addition of flyash

Table 3.1: Compressive strength test results of waste plastic fibre reinforced concrete with different percentage addition of flyash

| Percentage addition of flyash | Specimen identification | Weight of specimen (N) | Density ($kN/m^3$) | Average density ($kN/m^3$) | Failure load (kN) | Compressive strength (MPa) | Average compressive strength (MPa) | Percentage increase or decrease of compressive strength w. r. t reference mix |
|---|---|---|---|---|---|---|---|---|
| 0 (Ref mix) | A | 80.15 | 23.74 | 23.99 | 680 | 30.22 | 30.07 | --- |
| | A | 81.13 | 24.03 | | 660 | 29.33 | | |
| | A | 81.67 | 24.19 | | 690 | 30.66 | | |
| 5 | B | 81.25 | 24.07 | 23.94 | 780 | 34.66 | 33.7 | + 12 |
| | B | 81 | 24 | | 700 | 31.11 | | |
| | B | 80.2 | 23.76 | | 795 | 35.33 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | C | 81 | 24 | 23.95 | 765 | 34 | 33.99 | + 13 |
| | C | 81.23 | 24.06 | | 750 | 33.33 | | |
| | C | 80.32 | 23.79 | | 780 | 34.66 | | |
| 15 | D | 79.2 | 23.46 | 23.63 | 705 | 31.33 | 32.51 | + 8 |
| | D | 79.8 | 23.64 | | 730 | 32.44 | | |
| | D | 80.32 | 23.79 | | 760 | 33.77 | | |
| 20 | E | 79.37 | 23.51 | 23.53 | 630 | 28 | 30.51 | + 1 |
| | E | 79.47 | 23.54 | | 680 | 30.22 | | |
| | E | 79.48 | 23.54 | | 750 | 33.33 | | |
| 25 | F | 78.32 | 23.2 | 23.32 | 655 | 29.11 | 28.88 | - 4 |
| | F | 79.08 | 23.43 | | 660 | 29.33 | | |
| | F | 78.72 | 23.32 | | 635 | 28.22 | | |

The above results can be depicted in the form of graph as shown fig 3.1

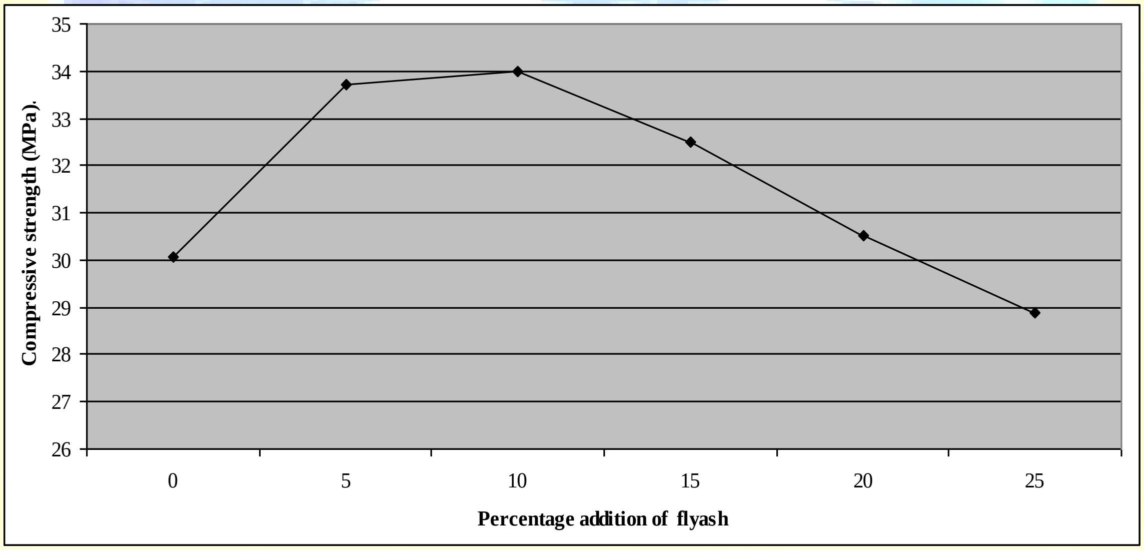


Fig 3.1: Variation of compressive strength of waste plastic fibre reinforced concrete with different percentage addition of flyash

**3.2 Tensile strength test results:** The following Table No 3.2 gives the tensile strength test results of waste plastic fibre reinforced concrete with different percentage addition of flyash

Table 3.2: Tensile strength test results of waste plastic fibre reinforced concrete with different percentage addition of flyash

| Percentage addition of fly ash | Specimen identification | Failure load (kN) | Tensile strength (MPa) | Average tensile strength (MPa) | Percentage increase or decrease of tensile strength w. r. t reference mix |
|---|---|---|---|---|---|
| 0 (Ref mix) | A | 210 | 2.97 | 3.2 | --- |
| | A | 240 | 3.39 | | |
| | A | 230 | 3.25 | | |
| 5 | B | 230 | 3.25 | 3.25 | + 2 |
| | B | 220 | 3.11 | | |
| | B | 240 | 3.39 | | |
| 10 | C | 250 | 3.53 | 3.29 | + 3 |
| | C | 230 | 3.25 | | |
| | C | 220 | 3.11 | | |
| 15 | D | 220 | 3.11 | 3.2 | 0 |
| | D | 250 | 3.53 | | |
| | D | 210 | 2.97 | | |
| 20 | E | 230 | 3.25 | 3.18 | - 1 |
| | E | 225 | 3.18 | | |
| | E | 220 | 3.11 | | |
| 25 | F | 220 | 3.11 | 3.08 | - 4 |
| | F | 205 | 2.9 | | |
| | F | 230 | 3.25 | | |

The above results can be depicted in the form of graph as shown fig 7.2

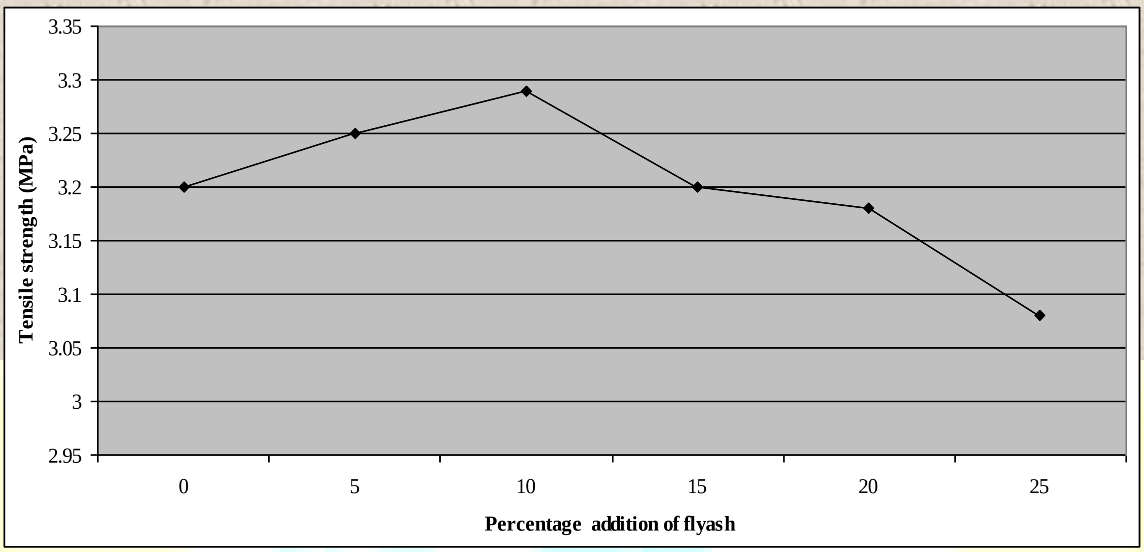


Fig 3.2: Variation of tensile strength of waste plastic fibre reinforced concrete with different percentage addition of flyash

**3.3 Flexural strength test results:** The following Table No 3.3 gives the flexural strength test results of waste plastic fibre reinforced concrete with different percentage addition of flyash

Table 3.3: Flexural strength test results of waste plastic fibre reinforced concrete with different percentage addition of flyash

| Percentage addition of fly ash | Specimen identification | Failure load (kN) | Flexural strength (MPa) | Average flexural strength (MPa) | Percentage increase or decrease of flexural strength w. r. t reference mix |
|---|---|---|---|---|---|
| 0 (Ref mix) | A | 12.2 | 4.88 | 4.98 | --- |
| | A | 12.4 | 4.96 | | |
| | A | 12.8 | 5.12 | | |
| 5 | B | 13 | 5.2 | 5.2 | + 4 |
| | B | 12 | 4.8 | | |
| | B | 14 | 5.6 | | |

| | | | | | |
|---|---|---|---|---|---|
| 10 | C | 14.8 | 5.92 | 5.76 | + 16 |
| | C | 14 | 5.6 | | |
| | C | 14.4 | 5.76 | | |
| 15 | D | 13.6 | 5.44 | 5.46 | + 10 |
| | D | 15 | 6 | | |
| | D | 12.4 | 4.96 | | |
| 20 | E | 14.2 | 5.68 | 5.09 | + 2 |
| | E | 11.6 | 4.64 | | |
| | E | 12.4 | 4.96 | | |
| 25 | F | 10.8 | 4.32 | 4.4 | - 12 |
| | F | 10.2 | 4.08 | | |
| | F | 12 | 4.8 | | |

The above results can be depicted in the form of graph as shown fig 3.3

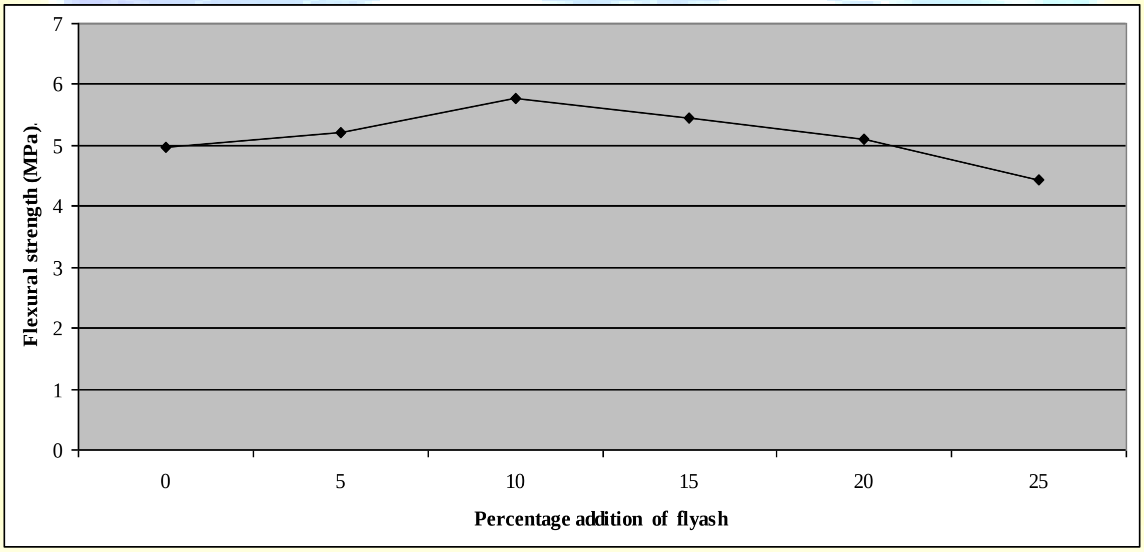


Fig 3.3: Variation of flexural strength of waste plastic fibre reinforced concrete with different percentage addition of flyash

**3.4 Impact strength test results:** The following Table No 3.4 gives the impact strength test results of waste plastic fibre reinforced concrete with different percentage addition of flyash

Table 3.4: Impact strength test results of waste plastic reinforced concrete with different percentage addition of fly ash

| Percentage addition of fly ash | Specimen identification | Number of blows required to cause | | Average number of blows required to cause | | Impact strength (N-m) required to cause | | Percentage increase or decrease of impact strength w. r. t reference mix | |
|---|---|---|---|---|---|---|---|---|---|
| | | first crack | final failure | first crack | final failure | first crack | final failure | first crack | final failure |
| 0 (Ref mix) | A | 5 | 17 | 5.33 | 14.33 | 53.72 | 144.44 | --- | --- |
| | A | 6 | 14 | | | | | | |
| | A | 5 | 12 | | | | | | |
| 5 | B | 4 | 17 | 5.66 | 17.33 | 57.05 | 174.68 | + 6 | + 21 |
| | B | 6 | 18 | | | | | | |
| | B | 7 | 17 | | | | | | |
| 10 | C | 8 | 22 | 6.67 | 22.66 | 67.23 | 228.41 | + 25 | + 58 |
| | C | 5 | 24 | | | | | | |
| | C | 7 | 22 | | | | | | |
| 15 | D | 6 | 22 | 4.33 | 21.66 | 43.64 | 218.33 | + 19 | + 51 |
| | D | 3 | 21 | | | | | | |
| | D | 4 | 22 | | | | | | |
| 20 | E | 2 | 14 | 4 | 15 | 40.32 | 151.2 | + 25 | + 5 |
| | E | 4 | 11 | | | | | | |
| | E | 6 | 20 | | | | | | |
| 25 | F | 2 | 10 | 3.66 | 10.66 | 36.89 | 107.45 | + 31 | - 26 |
| | F | 4 | 10 | | | | | | |
| | F | 5 | 12 | | | | | | |

The above results can be depicted in the form of graph as shown fig 3.4

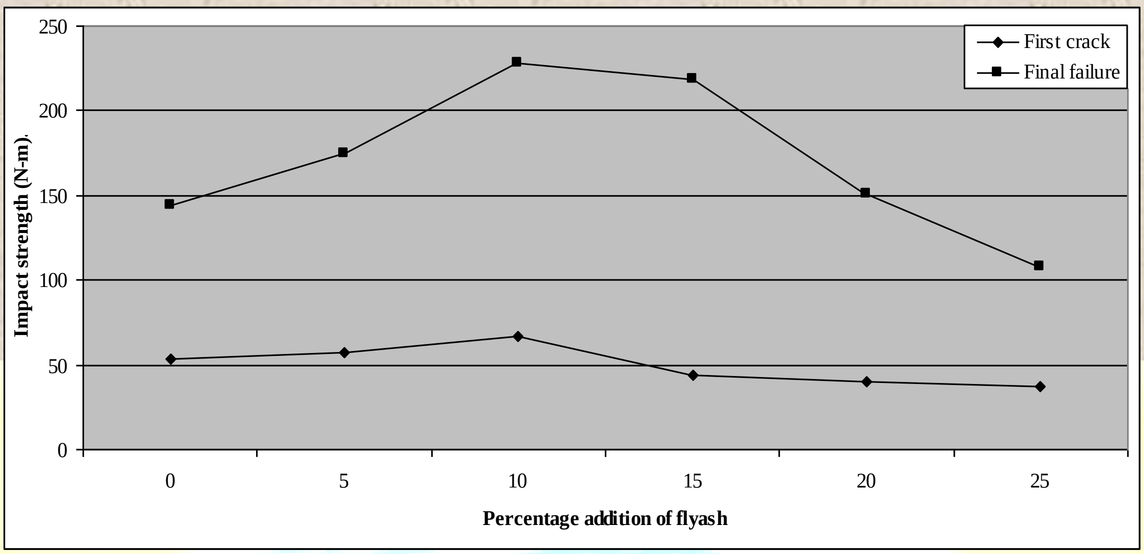


Fig 3.4: Variation of impact strength of waste plastic fibre reinforced concrete with different percentage addition of flyash

**3.5 Workability test results:** The following Table No 3.5 gives the overall results of workability of waste plastic fibre reinforced concrete with different percentage addition of flyash

Table 3.5: Workability test results of waste plastic reinforced concrete with different percentage addition of flyash

| Percentage addition of fly ash | Workability through | | |
|---|---|---|---|
| | Slump (mm) | Compaction factor | Percentage flow |
| 0 (Ref mix) | 0 | 0.87 | 12.38 |
| 5 | 0 | 0.83 | 12.53 |
| 10 | 0 | 0.89 | 11.02 |
| 15 | 0 | 0.86 | 11.67 |
| 20 | 0 | 0.83 | 10.91 |
| 25 | 0 | 0.84 | 10.05 |

The above results can be depicted in the form of graphs as shown in fig. 3.5 to 3.7

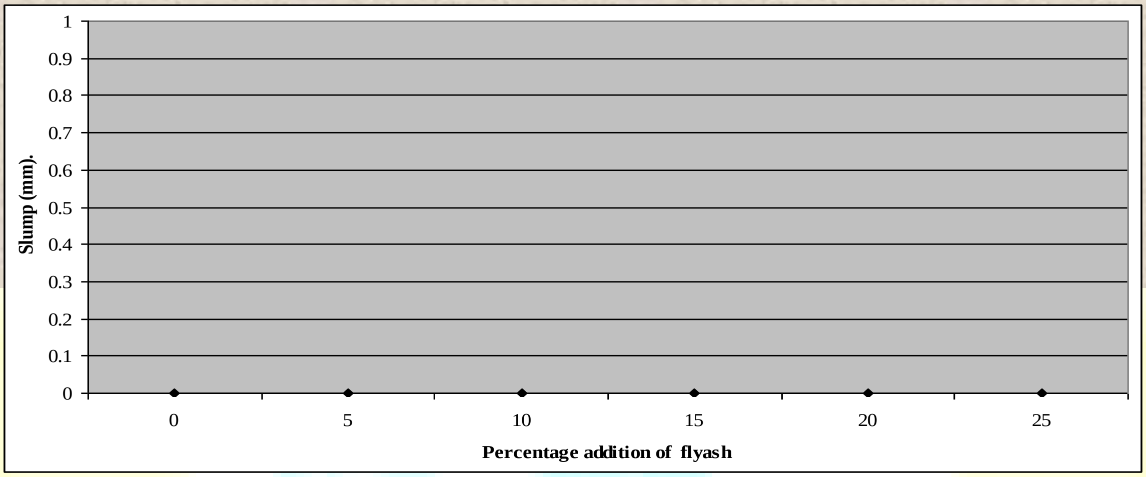


Fig 3.5: Variation slump of waste plastic fibre reinforced concrete with different percentage addition of flyash

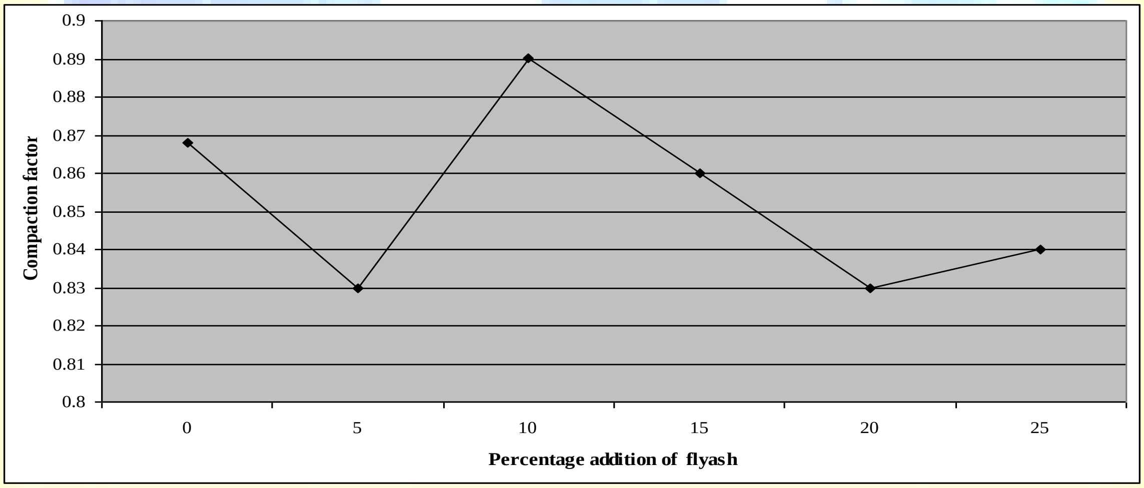


Fig 3.6: Variation of compaction factor of waste plastic fibre reinforced concrete with different percentage addition of flyash

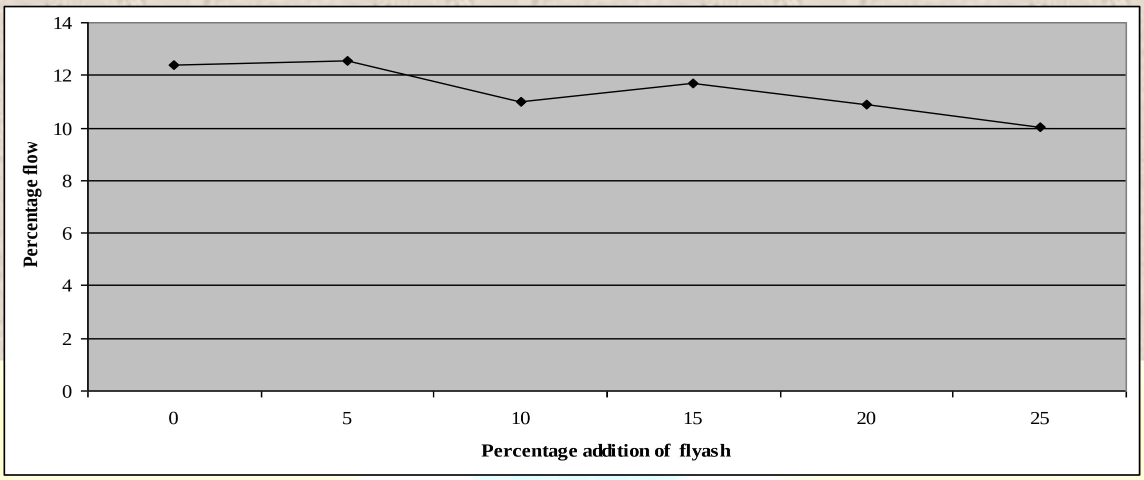


Fig 3.7: Variation of percentage flow of waste plastic fibre reinforced concrete with different percentage addition of flyash

## 4.0 Observations and Discussions:

Based on the experimental results the following observations were made

1. It has been observed that the waste plastic fibre reinforced concrete show an increasing trend in the compressive strength upto 10% addition of fly ash into it. After 10% addition of fly ash the compressive strength starts decreasing. Thus, the waste plastic fibre reinforced concrete shows a higher compressive strength when 10% fly ash is added and the percentage increase in the compressive strength is 13%

   It has been observed that the waste plastic fibre reinforced concrete show an increasing trend in the tensile strength upto 10% addition of fly ash into it. After 10% addition of flyash the tensile strength starts decreasing. Thus, the waste plastic fibre reinforced concrete shows a higher tensile strength when 10% fly ash is added and the percentage increase in the tensile strength is 3%

   It has been observed that the waste plastic fibre reinforced concrete show an increasing trend in the flexural strength upto 10% addition of flyash into it. After 10% addition of fly ash the flexural strength starts decreasing. Thus, the waste plastic fibre reinforced concrete shows a higher flexural strength when 10% fly ash is added and the percentage increase in the flexural strength is 16%

It has been observed that the waste plastic fibre reinforced concrete show an increasing trend in the impact strength upto 10% addition of flyash into it. After 10% addition of fly ash the impact strength starts decreasing. Thus, the waste plastic fibre reinforced concrete shows higher impact strength when 10% flyash is added and the percentage increase in the impact strength for first crack is 25% and final failure is 58% respectively.

**This may be due to the fact that 10% addition of fly ash may induce maximum workability through which a thorough compaction can be achieved which aids in higher strengths. Also it may be due to the fact that 10% addition fly ash may fill all the cavities and induce right pozzolonic reaction.**

**Thus it can be concluded that 10% flyash addition will induce higher strength properties to waste plastic fibre reinforced concrete.**

2. It has been observed that the maximum workability is achieved when 10% of flyash is added. After 10% addition of flyash the workability decreases. The concrete becomes stiff as the percentage of flyash increases beyond 10%.

   This may be due to the fact that 10% addition of flyash may act as ball bearings thus reducing the friction and enhancing the workability.

   Thus it can be concluded that 10% addition of flyash yield good workability in waste plastic fibre reinforced concrete.

## 5.0 Conclusions:

1. It can be concluded that 10% addition of flyash will induce higher strength properties and good workability properties to waste plastic fibre reinforced concrete.
2. Thus flyash can be used in the production of waste plastic fibre reinforced concrete

6.0 **Acknowledgements:**

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