Experimental Study on Structural Behavior of Concrete by Varying Percentage of Plastics as Fibers

Mohd Imran Ali[1] Syed Arfath[2] Shaik Abdulla[3]
[1]M. Tech Student (Structural Engineering) [2,3]Assistant Professor
[1,2,3]Department of Civil Engineering
[1,2,3]Khaja Banda Nawaz College of Engineering, Gulbarga-585104

Abstract— In this experiment waste (Polyethylene Terephthalate) PET fibers are added to concrete by the weight of cement. Used PET bottles are selected for this research because PET bottles are thrown by using only once and they are non-biodegradable in nature, which is causing major environmental problem all around the world. Main purpose of this investigation is to analyze the result of waste plastic bottles fibers as addition in concrete by the weight of cement. PET bottles are easily available for free of cost and that are collected. and they are cut in the form of fiber by removing top and bottom portion, and they are cut into size of 25 mm length and 0.7 mm width with a aspect ratio of 35 (AR 35).Study was conducted on M30 grade of concrete, PET fibers were added to the mix by the varying percentage of 0%, 0.5%, 1%, 1.5%, 2%, 2.5%, and 3% by weight of cement. The weight of plastic fibers was in grams. Total 126 specimens were prepared such as 42 cubes, prism and cylinders respectively. The specimens were tested for compression test, split tensile test and flexural test only after curing for 7 days and 28 days. Highest strength of concrete was noted at 1% addition of plastic fibers to the concrete, based on this result beams were casted and results were analyzed after 28 days of curing.

Key words: Cement, strength characteristi, Polyethylene Terephthalate, Fiber reinforced concrete

I. INTRODUCTION

Concrete is a vital material in the construction field the property of concrete is influenced by it constituents of concrete. The strength of concrete is influenced by properly mixing of three things that are cement, aggregate and water.

Usually using higher grade cement provide many advantages for strong concrete, they provide 10%-20% of cement saving consumption and also provide several benefits one of the important benefits is the faster rate of development of strength Aggregate are the basic unit of concrete it gives physique appearance to the concrete it slash creep and shrinkage a known fact is that both fine and coarse aggregate take 70% to 80% of the mass of concrete

Among several waste products .Waste plastic bottles should be given special consideration as plastic is un biodegradable and also it causes environmental problems.

As previous history plastic bottles were commercially used in 1947, it was not so popular because of its expensive cost, till 1960 they become first choice of consumer and manufacturer after the introduction of light weight a high density polyethylene.

According to report India 5.6 million tones plastic annually. The capital city of India gives rise to 689.5 metric tons per day

Fiber reinforced concrete (FRC) Fibers is added or partially replaced with fibrous materials to increase its structural integrity. There are different types of fibers that can be added or replace in concrete such as steel fibers, natural fibers, glass fiber, synthetic fibers and plastic fibers. Practically fibers are partially replaced or added to the concrete from 0.1% to 3% by the volume The aspect ratio is calculated by dividing (L/D) that is length divided by it diameter or width.

A. *Advantages Of Adding Fibers*

1) Addition of fibers help in development of mix cohesion
2) It helps in desirable pumpability of concrete
3) It has great resistance to explosive at the time of sever fire
4) Diminish crack width and holds the crack tightly and improve durability of concrete

B. *Objectives:*

1) M30 GRADE OF CONCRETE MIX IS DESIGN BY THE METHOD OF IS: 10262-2009.
2) PET FIBERS IS TO BE ADDED BY 0% 0.5 % 1 % 1.5% 2% 2.5% 3%, BY THE WEIGHT OF CEMENT
3) TO ANALYZE THE STRENGTH ACTION OF M30 GRADE CONCRETE AND CONVENTIONAL CONCRETE AND TO DRAW GRAPH BETWEEN STRENGTH OF 0%,0.5%, 1%, 1.5%, 2% .2.5%, 3 %

II. MATERIAL USED

A. *Cement:*

Ordinary Portland cement confirming to IS: 12269-1987 was used. Ultra-tech cement 53 grade procured from single source, properties of which are tested in the laboratory

B. *Fine Aggregate (Fa):*

Fine aggregate used in this experiment is locally available river sand, which belong to zone II of IS code 383-1970

C. *Coarse Aggregate (Ca):*

In the present investigation aggregate available from local crusher was used. Only one size fraction i.e. 20mm down size coarse aggregate confirming to IS code ,was used. Different test such as specific gravity, bulk density etc was carried out in laboratory for coarse aggregate

D. *Water:*

Water use for mixing should free from organic matters and salts it can also be said that water suitable for drinking is suitable for mixing its pH should be between 6 to 8. In the present work potable tap water was used for both casting and curing.

E. *Plastic:*

PET is a polyethylene Terephthalate is a plastic resin and most common type of polyester .all the chemical property are mention in table.

1	Chemical formula	$(C_{10}H_8O4)n$
2	Melting point	$>250^0c$, $260^0c>350^0$
3	Thermal conductivity	0.15 to 0.24 W $m^{-1}k^{-1}$
4	Youngs modulas	2800-3100mpa
5	density	1.38g (cm^3)
6	IUPAC ID	Ploy (ethylene Terephthalate)

III. Concrete Mix Design

According to my disserertation work, the mix design was carried out for M30 grade by referring IS 10262-2009 and some of the points were taken from IS 456-2000 and for mix design computed as 1:1.48:2.68 with water cement ratio of 0.45

IV. Casting and Curing

Casting is done in moulds of size (150x150x150) mm cubes, (100x100x100) mm prism and cylinder of size (100x300) mm diameter and height respectively. Total 126 specimen were prepared All this moulds are cleaned from dust at the corner and oil is applied to the surface for easy removal of specimens. These moulds are casted with concrete in 3 layers each of one third (1/3) height of mould, each layer is compacted by giving uniform and even blows to the entire cross section of the mould.

After filling the mould till the brim and compacting the top surface are smooth with the trowel and are kept for 24 hour in mould, and after 24 hours the specimen is removed from the mould and is kept for curing in water tank and the water is regularly changed after 3 days for the purpose of better curing.

V. Experimental Programme

The main aim of this investigation is to study the properties of concrete using PET fibers as addition to concrete by the weight of cement and compare the results between conventional and PET fibers added to concrete. In order to select the material for mix design, preliminary tests are conducted on materials such as cement, fine aggregate, coarse aggregate and plastic fibers. Different materials used in the work and their test results are presented below.

VI. Test Results on Hardened Properties of Concrete:

A. Compressive Strength Test:

One of the important properties of concrete is compressive strength. It gives conception of all characteristic of concrete .Compressive strength test result are used to find out that the concrete mix is match with the requirement of the target strength Fc. To obtain good results As the time of 7days and 28 days complete the specimens are removed from the water tank and kept out so that they can get dry and give good results. Surface of the specimen is cleaned and test is carried out in compression testing machine and in universal testing machine.

Mix	% Of Fiber	Average Compressive Strength For 7 Days	Average Compressive Strength For 28 Days
1	0	25.288	38.73
2	0.5	26.01	41.00
3	1	28.631	42.50
4	1.5	27.541	40.70
5	2	26.669	38.00
6	2.5	25.75	36.70
7	3	23.25	32.350

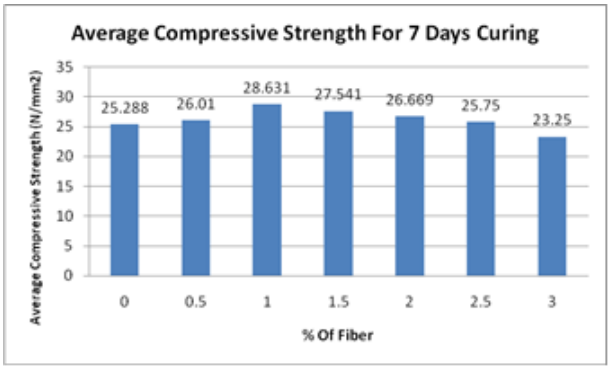

Fig. 1:

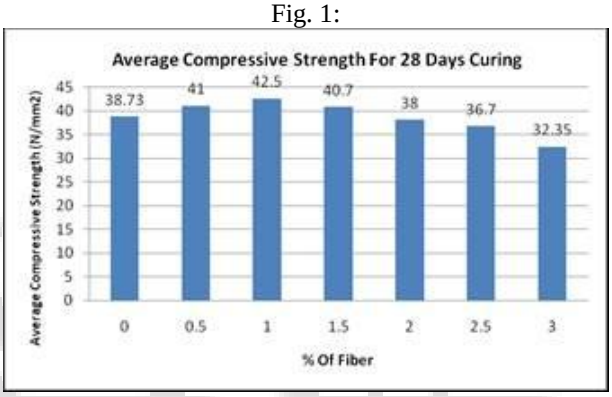

Fig. 2:

B. Split Tensile Strength Test

The tensile strength of concrete one of the main property of concrete, in which a cylindrical specimen is placed with it axis horizontal in between the compressive platen, due to this compressive load is equally distributed over the surface, so to induce transverse tension.

Mix	% Of Fiber	Average Split Tensile Strength For 7 Days Curing	Average Split Tensile Strength For 28 Days Curing
1	0	2.317	2.914
2	0.5	2.420	3.585
3	1	2.605	3.770
4	1.5	2.537	3.654
5	2	2.270	3.007
6	2.5	2.190	2.672
7	3	1.900	2.49

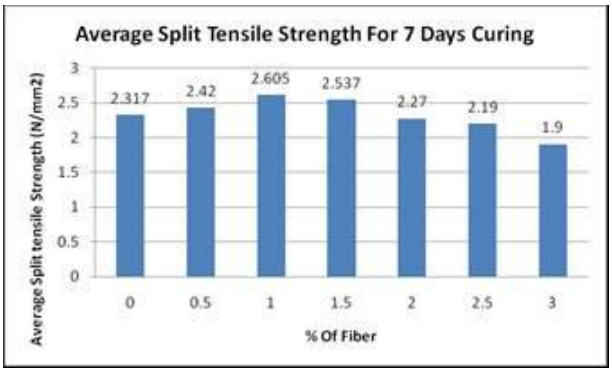

Fig. 3:

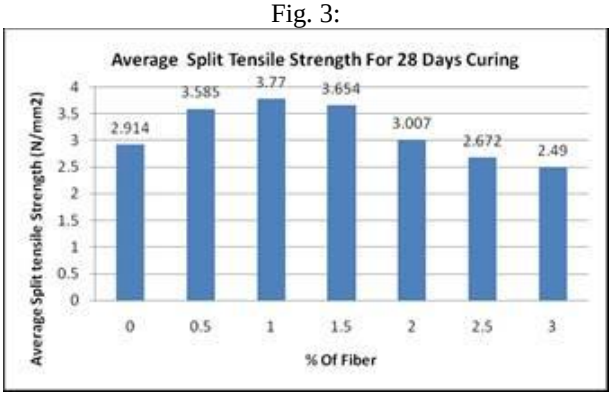

Fig. 4:

C. Flexural Strength Test

This test were carried on prism of in order to calculate the flexural strength of prism

Mix	% Of Fiber	Average Flexural Strength For 7 Days Curing	Average Flexural Strength For 28 Days Curing
1	0	3.202	4.185
2	0.5	3.398	4.12
3	1	3.746	4.709
4	1.5	3.398	4.513
5	2	3.268	4.251
6	2.5	3.137	4.055
7	3	2.745	3.597

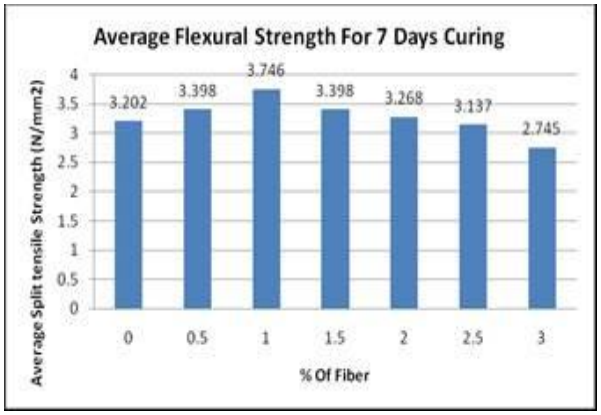

Fig. 5:

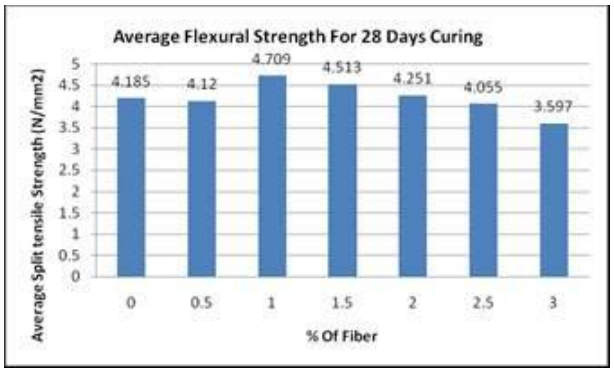

Fig. 6:

VII. DISCUSSION

A. Compressive Strength:

Compressive strength of M30 grade concrete after 7 days of curing increases from 25.288 N/mm2 to 28.631 N/mm2 for 1% addition of PET fibers. It is found that there was 14 % increment in compressive strength for M30 grade concrete at 7 days of curing.

Compressive strength of M30 grade concrete after 28 days of curing increases from 38.40 N/mm2 to 42.44 N/mm2 for addition of cement by PET fibers. It is found that there was a 9.75% increment in compressive strength for M30 grade concrete at 28 days of curing.

Test Results were also compared from the formula given below:

1) compressive strength of concrete with plastic fiber can be predicted with equation:

$$\sigma cf = 40.84 + 4.762wf - 2.667wf2$$

B. Split Tensile Strength:

Split tensile strength of M30 grade concrete after 7 days of curing increases from 1.608 N/mm2 to 1.908 N/mm2 for 1% addition of PET fibers by the weight of cement. It is found that there was 18% increment in split tensile strength for M30 grade concrete at 7 days of curing.

Split tensile strength of M30 grade concrete after 28days of curing increases from 2.915 N/mm2 to 3.770 N/mm2 for 1% addition of PET fibers by the weight of cement. It is found that there was 29 % increment in split tensile strength for M30 grade concrete at 28 days of curing.

Test Results were also compared from the formula given below

Whereas split tensile strength can be predicted by using equation: [1]

$$\sigma cf = 3.525 + 0.478wf - 0.274wf2$$

C. Flexural Strength

Flexural strength of M30 grade concrete after 7 days of curing increases from 3.202 N/mm2 to 3.725 N/mm2 for 1% addition of PET fibers by the weight of cement. It is found that there was 16% increment in flexural strength for M30 grade concrete at 7 days of curing.

Flexural strength of M30 grade concrete after 28 days of curing increases from 4.251 N/mm2 to 4.709 N/mm2 for 1% addition of PET fibers by the weight of

cement. It is found that there was 11 % increment in flexural strength for M30 grade concrete at 28 days of curing.

VIII. CONCLUSION

1) Compressive strength was increase with 14 % and 9.75 % after 7 days 28 days at 1 % fiber, respectively compare with 0% fibers concrete.
2) Split tensile strength was increase by 18 % and 29 % after 7 days 28 days at 1% fiber, respectively compare with 0% fibers concrete.
3) Highest strength of concrete is observed at 1% of fiber content for compressive and split tensile strength.
4) By increasing the addition of plastic fiber in concrete there is a decrease in compressive, split tensile, flexural strength.
5) During test it is noted that concrete specimen with 0% plastic fiber will break down suddenly or brittle failure into two pieces.
6) During experiment it was also noted that specimen with plastic fiber fails in transverse direction with rounded projection.
7) If plastic fibers of high dosage is added to the concrete it will leads to workability problem, and segregation, porosity and total decrease in concrete strength.
8) It has been concluded that, fiber content will have great effect on concrete.
9) Length of fiber will not affect workability.
10) Designing phase with PET fibers with interlocking property is much advantageous.
11) Concrete with PET fiber are economical and has long life.

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