Comparative Study of Waste Pet Bottle Fibers And Polypropylene Fiber Reinforced Concrete

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Abstract :

In this experimental study fibers derived from waste PET (Polyethylene Terephthalate) bottles are used as a fibers in concrete and test results are compared with Polypropylene fiber reinforced concrete. The objective of this study is to evaluate the performance of PET fiber reinforced concrete compared to polypropylene fiber reinforced concrete and normal concrete. Mix design for M30 Grade of concrete has been made and fibers were added 0%, 0.5%, 1.0%, 1.5%, 2.0% by weight of cement. The workability of fresh concrete is determined by slump cone and compaction factor test also results of compressive strength were studied.The use of waste PET bottle fiber in concrete has been shown interesting improvements in concrete performance and offers potential alternative to polypropylene fibers.

IndexTerms– Fiber Reinforced Concrete, Polyethylene Terephthalate, Workability, Compressive Strength.

1. INTRODUCTION

The construction material is continuously evolving. In plain concrete structural cracks (micro cracks) develop even before loading due to drying shrinkage or other causes of volume change. When loaded, the microcrack propagate and open up and owing to the effect of stress concentration, additional cracks form in places of minor defects. The developed microcracks is the main cause of inelastic deformations in concrete.It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties. And this type of concrete is known as fiber reinforced concrete.In the field of concrete construction, the use of fibers has been steadily increasing over the past years in an effort to overcome the inborn tensile strength and toughness limitations of plain concrete. The ability to enhance flexural and tensile performance of the concrete matrix, together with the opportunity for improving its durability, pushed boundaries in developing new materials to be used as fibers. The major advantage of fiber reinforced concrete is to transform a brittle concrete into ductile material.

The environmental problems related to waste is one of the main challenge to dispose and manage. It has become one of the major environmental, economical and social issues. Recycling is the most promising waste management process for disposal of waste materials. The waste utilization in Civil Engineering construction has become an attractive alternative for disposal and protecting environment.Generation of plastic waste is one of the fastest growing areas. Collection, hauling and disposal of plastic waste creates an additional environmental impact. The present study highlights fibers are obtained by simply cutting the waste plastic bottles that is PET fibers reinforced concrete and results are compared with polypropylene fibers reinforced concrete for different proportion of fibers.

2. LITERATURE REVIEW

Erlon Lopes Pereira et al. [1] concluded that the load capacity of an ecological concrete produced with PET fibers is greater than the load capacity of conventional concrete. This is because the insertion of fibers from PET bottles into concrete improved the mechanical properties of the ecological concrete in terms of compression, tension and bending. The volume of fibers in the concrete affects its compression resistance while the fiber length does not affect this property. **Azad A. Mohammed [2]**in this study reinforced concrete beams contained PET waste particles, tested and analysed and found that using PET waste shredded particles in concrete as sand replacement there is a reduction in compressive strength.**Ruben Paul Borg et al. [3]** concluded that reduction in crack width for 1% fiber content, increase in flexural strength with increase in fiber content and deformed fibers gives better result than straight one. on other side slightly decrease in compressive strength as the fiber content increases also longer fibers are found effective**. Aswathy N. [4]** reported that workability of plain PET fibers reinforced concrete was decreased with the increase in percentage of fibers volume fraction, The optimum strength was obtained at 1% of fibers content and change in nature of failure occur from brittle to ductile when plastic fibers were introduced into the concrete. **J.M.Irwan et al. [5]** concluded that the compressive strength of the concrete increase at 0.5% is about 9.1% than the normal concrete, further increase in dose compressive strength decreases. Splitting tensile strength increases as dose of pet fiber increases. in addition, high dosage of fiber will cause workability problem.**T. Ochi et al. [6]**this study investigated development of recycled PET fiber and its application as concrete reinforcing fiber and described a method that can be used to produce concrete-reinforcing PET fiber from used PET bottles. The main problem behind the development of PET fiber was its alkali resistance and they encountered no

problems when using these fibers in normal concrete**.MahmoundNili et al. [7]**concluded that the increase of polypropylene fiber in the mixture from 0.2% to 0.5% increase the compressive strength, splitting tensile strength and flexural strength. Addition of silica fume into fibrous and non fibrous mixture improves strength**.NandithaMandava et al. [8]** come to know that addition upto 1.5% of polypropylene fiber by weight of cement increase the strength property after that strength tends to decrease**. Milind V. Mohod [9]** come to know that addition of fibers in concrete decreases the workability and optimum value of fiber content is 0.5% for both tensile and flexural strength. **Sundar R. et al.[10]** concluded that addition of Polypropylene fibers in concrete significantly improves tensile strength and flexural strength of concrete.

3. EXPERIMENTAL WORK

3.1 MATERIALS

3.1.1. Cement

Cement used in the investigation was 53 Grade ordinary Portland cement. The physical properties of cement are as given in table1.

Table1: The Properties of Cement

Sr. No	Properties	Results
1	Fineness	4.22 %
2	Specific Gravity	3.12
3	Normal Consistency	31 %
4	Initial Setting Time	45 Min.
5	Final Setting Time	240 Min.

3.1.2. Fine Aggregate

The river sand was used as fine aggregate confirming to zone II of IS 383-1970. Table 2 shows the physical properties of fine aggregates.

3.1.3. Coarse Aggregate

Locally available crushed stone aggregates with nominal size 20 mm was used. Table 2 shows the physical properties of coarse aggregates.

Table 2: Properties of coarse aggregate and fine aggregate

Sr. No	Properties	Fine aggregate	Coarse aggregate
1	Specific Gravity	2.73	2.69
2	Water Absoption	0.3	0.4
3	Fineness Modulus	3.24	6.87

3.1.4. Water

Potable water was used for mixing and curing as per IS 456:2000.

3.1.5. Fibers

a) PET Fibers: The post consumed PET mineral water bottles were collected and the fibers were cut after removing the neck and bottom of the bottle. The length of fiber was kept 50 mm and breadth was 2 mm for this experiment having aspect ratio 62.
b) Polypropylene Fibers:For this study monofilaments fine polypropylene fibers were used. The fibers were supplied by reliance industry by name Recron 3s having length 12 mm, Tensile strength 4000-6000 Kg/cm^2**,** Melting point > 250ºC.

3.1.6. Plasticizer

Emceplast BV Plasticizer was used 0.2% by weight of cementfor present investigation.It may be use 0.15 to 0.3 percent by weight of cement depending upon application.

3.2. Experimental Methodology

3.2.1. Mix Design

The design mix of 1:1.66:2.78 (M30) with plasticizer 0.20% by weight of cement with cement content of 413 kg/m^3 is adopted for normal concrete. The mix were designed by using IS 10262-2009. The PET fibers and Polypropylene fiberswere added 0, 0.5, 1.0, 1.5, 2.0% by weight of cement.

3.2.2. Workability test

The workability of concrete was determined with the help of slump cone and compaction factor test for each percentage of PET fibers and Polypropylene fibers.

Photo 1.Slump cone test **photo 2. Compaction factor test**

3.2.3. Compressive strength test

Concrete cubes specimens (150 mm x 150 mm x150 mm) were tested for computingcompressive strength.

4. RESULTS AND DISCUSSION

Workability was determined with the help of slump cone and Compaction factor test for normal concrete and also for each proportion of PET and Polypropylene fiber reinforced concrete. As we increase fiber percentage workability starts goes on decreasing. The results of workability are as shown in Table 3. Compressive strength test also conducted on normal concrete and each proportion of PET and Polypropylene fiber reinforced concrete. Compressive strength increases upto1.5% fiber content after that strength starts decreasing in case of PET FRC andCompressive strength increases upto1% fiber content after that strength starts decreasing in case of Polypropylene FRC.The results of Compressive strength are as shown in Table 4 and Table 5.

4.1 Test results of fresh concrete

Table 3: Workability of fiber reinforced concrete

% Fibers	PET fiber reinforced concrete		Polypropylene fiber reinforced concrete	
	Slump (mm)	Compaction factor	Slump (mm)	Compaction factor
0.0	85	0.890	85	0.890
0.5	82	0.884	79	0.887
1.0	71	0.873	66	0.868
1.5	64	0.850	53	0.849
2.0	53	0.839	46	0.836

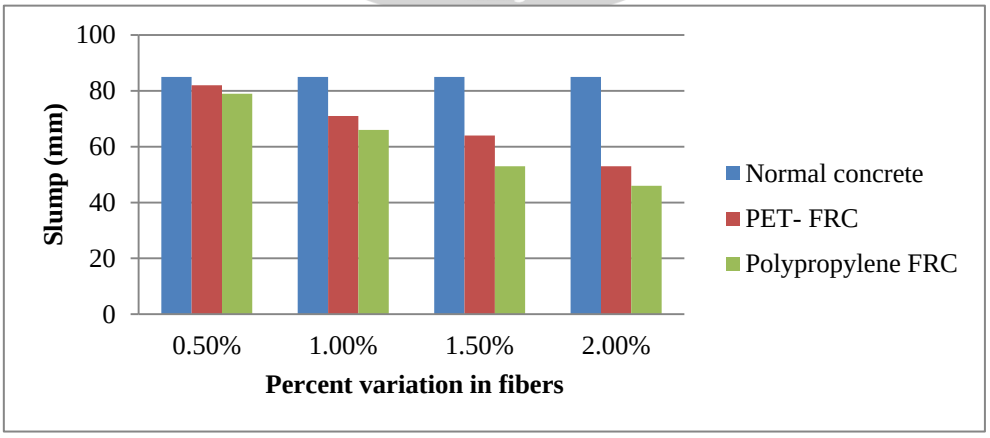

Figure 1:Comparison of Workability of Normal concrete, PET FRC and Polypropylene FRC by Slump Cone test

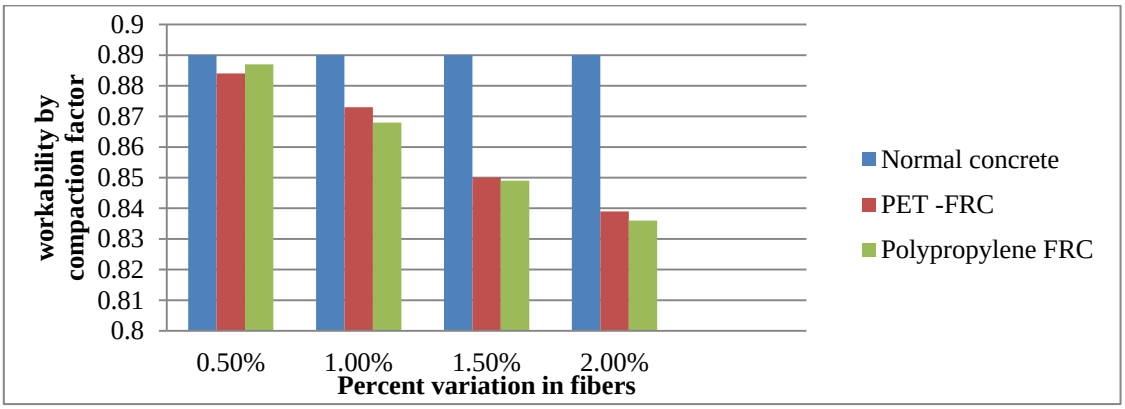

Figure 2:Comparison of Workability of Normal concrete, PET FRC and Polypropylene FRCby Compaction factor test

4.2 Test results of compressive strength

Table 4: Compressive strength of PET fiber reinforced concrete

% Fibers	Compressive Strength in N/mm^2	
	7 days	28 days
0.0	24.96	39.40
0.5	25.12	39.86
1.0	25.89	40.64
1.5	26.61	41.95
2.0	25.42	40.32

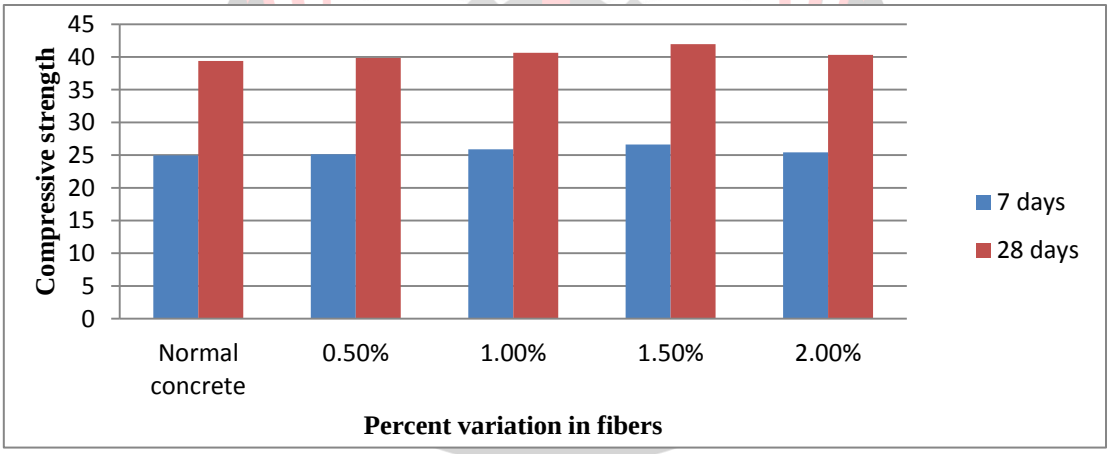

Figure 3: 7 and 28 days Compressive strength of PET-FRC at various proportion of fibers

Table 5: Compressive strength of Polypropylene fiber reinforced concrete

% Fibers	Compressive Strength in N/mm^2	
	7 days	28 days
0.0	24.96	39.40
0.5	25.80	41.52
1.0	27.34	43.86
1.5	25.14	41.62
2.0	23.54	38.17

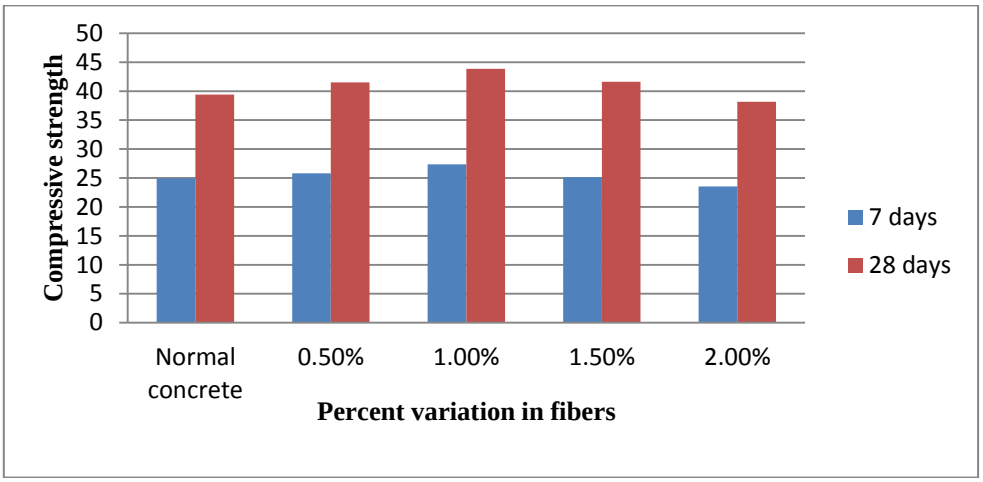

Figure 4: 7 and 28 days Compressive strength of Polypropylene FRC at various proportion of fibers

5. CONCLUSIONS

Based on experimental investigation following conclusions are drawn

1) The workability of Waste PET bottle fiber reinforced concrete decreases as we increase percentage of fibers in concrete under slump cone and compaction factor tests.
2) The workability of Polypropylene fiber reinforced concrete decreases as we increase percentage of fibers in concrete under slump cone and compaction factor tests.
3) The decrease in workability in both fiber types is due to resistance to movement of aggregates offered by the fibers.
4) The workability of Polypropylene fiber reinforced concrete is less compared to PET fiber reinforced concrete for same percentage of fibers addition due to water absorption of polypropylene fibers.
5) Improvement in compressive strength of concrete is observed for 0.0% to 1.5% of PETfibers by weight of cement.
6) Optimum dose of polypropylene fibers is 1% by weight of cement.
7) The fibers obtained from waste PET bottles, helps to improve compressive strength of concrete which is one of the innovative material having low cost that can be used in construction field also use of such material solve problem of solid waste disposal and prevents environmental pollution also.

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