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Use of Plastic Fiber in the Concrete

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Abstract- Concrete is strong in compression however weak in tension. The tensile strength as well as ductile property of concrete could be improved by addition of fibers. Polyethylene Terephthalate (PET) fiber obtained from various industries was used. The mix of pet fiber plain concrete was design for a compressive strength of 26 MPa at 28 days curing time with a water cement ratio of 0.45. Cylindrical and beam specimens with 0.5%, 1%, 1.5%, and 2% fibers volume were casted. This project mainly studied includes flexural strength, splitting tensile strength, compressive strength and bond strength. The test result show that the slump and compaction factor is reduced at higher percentages of fibers. But up to 1.5 to 2.0 % addition of fibers the slump and compaction factor is not hampered so much. It was observed that the concrete was good enough workable up to 1.5 to 2.0 % addition of fibers. also with the increase in fiber content bond strength will increases.

Index Terms- Concrete, waste plastic bottles, fibers, cube and cylinder, compressive strengths, tensile strength, flexural strength.

1. INTRODUCTION

Concrete is a basic material for civil engineering construction. All basic ingredients of concrete are natural. But the properties of concrete can be change by adding some plastic fiber. The concrete has many advantageous properties such as good compressive strength, durability, specific gravity and fire resistance but tensile strength of the concrete is very much low means it can be neglected. But tensile property of the concrete can be increase by addition of plastic fiber. Research conducted for this to utilization of plastic bottles of various brands like coca cola, Bislery etc.

And mix them in the concrete by taking some aspect ratio. The use of plastic has increases substantially all over the world it leads to create large quantities of plastic-based waste. Plastic waste is the one of the challenge to dispose and manage as it is non-biodegradable material which is harmful to our beautiful environment. The polyethylene teraphthelne (PET) bottles are recycled and used in concrete.

2. OBJECTIVES

The main objectives of this research proposal are to evaluate the possibility of using full water bottle and granulated plastic waste materials. The following were also proposed.

1. Check the compression strength of concrete block when plastic bottle can be used as core part of concrete block.
2. As partial substitute for the fine aggregate in concrete composites.
3. To investigate the mechanical behavior of the components by using fibers.
4. To determine the percentage of plastic fiber which gives more strength when compared to control concrete.
5. It is counted as one of the foundation for green project

3. MIX MATERIALS

The material details are as follows:

A. Cement

For this research, locally available cement which is of the ordinary Portland cement type (53 grade) was used throughout the work. Specific gravity of cement was 3.09.

B. Fine Aggregate

Locally available fine aggregate used was 4.75 mm size confirming to zone II with specific gravity 2.67. The testing of sand was conducted as per IS: 383-1970.Water absorption and fineness modulus of fine aggregate was 1.35% and 2.806respectively.

C. Coarse Aggregate

Coarse aggregate used was 20mm and less size with specific gravity 2.80. Testing of coarse aggregate was conducted as per IS: 383-1970. Water absorption and fineness modulus of coarse aggregate was Nil and 6.203 respectively.

D. Water

The water used was potable, colourless and odourless that is free from organic impurities of any type.

E. PET Fiber

PET fiber is a waste material which is obtained from industries. we collect the pet bottle from the restaurants. They were cut after removing the top and bottom of the bottle. The length of fibers was kept 35 mm and the breadth was 1 mm. The aspect ratio (AR) of waste plastic fibers was 35 (AR-35) .The plastic fibers used were having specific gravity 1.36, water absorption 0.00 %. The different fractions for two aspect ratios were used in this experimentation

4. EXPERIMENTAL WORK AND TEST

A. Mix Design

Mix design carried out for M20 grade of concrete by IS 10262:2009, having mix proportion of 1:1.50:2.92 with water cement ratio of 0.40. The partial replacement of Fine aggregate by 0.5 % to 2.0 % of PET fiber. Chemical admixtures are not used in the work.

B. Compressive, Flexural and Split Tensile Strength

Concrete prepared with different percentage replacement of fine aggregate by 0.5 % to 2.0 and cured under normal condition as per recommendations of IS and were tested at 3,7 days and 28 days for determining the compressive, flexural and split tensile strength compared with the test results of conventional concrete.

Photo No. 2 Casting of cube

5. TEST RESULTS

A. Compressive Strength

A cube compression test is performed on standard cubes of of size 150 x 150 x 150 mm after 3, 7 and 28 days of immersion in water for curing. The compressive strength of specimen is calculated by the following formula:

$$f_{cu} = Pc / A$$

Where
P_c = Failure load in compression, KN
A = Loaded area of cube

Tab.No.1 Compressive strength test for cube3 days

Sr. No.	% Of PET Fiber	C/S Area mm^2	Load KN	Compressive Strength N/mm^2	Avg. Compressie Strength N/mm^2
1	0	22500	195	8.67	8.74
2			197	8.75	
3			198	8.80	
4	0.5	22500	201	8.93	9.02
5			203	9.02	
6			205	9.11	
7	1	22500	207	9.20	9.19
8			206	9.15	
9			208	9.24	
10	1.5	22500	214	9.51	9.50
11			213	9.46	
12			215	9.55	
13	2	22500	212	9.42	9.40
14			213	9.46	
15			210	9.33	

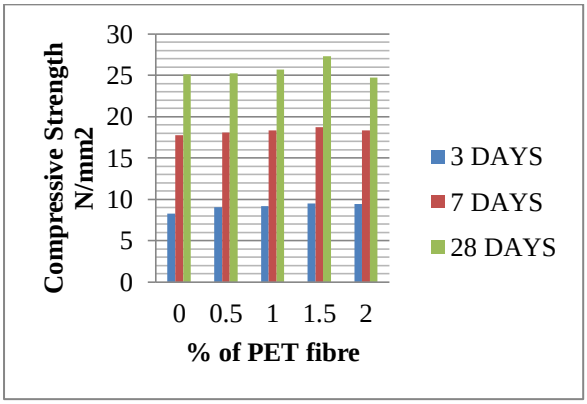
Tab. No. 2 Compressive strength test for cube7 day

Sr. No.	% Of PET Fiber	C/S Area mm^2	Load KN	Compressive Strength N/mm^2	Avg. Compressive Strength N/mm^2
1	0	22500	398	17.68	17.77
2			400	17.77	
3			402	17.86	
4	0.5	22500	405	18.00	18.05
5			406	18.04	
6			408	18.13	
7	1	22500	410	18.22	18.32
8			412	18.31	
9			415	18.44	
10	1.5	22500	418	18.57	18.69
11			420	18.67	
12			424	18.84	
13	2	22500	415	18.44	18.32
14			412	18.31	
15			410	18.22	

Tab. No. 3 Compressive strength test for cube28 day

Sr. No.	% Of PET Fiber	C/S Area mm^2	Load KN	Compressive Strength N/mm^2	Avg. Compressive Strength N/mm^2
1	0	22500	588	26.13	26.28
2			592	26.31	
3			594	26.40	
4	0.5	22500	596	26.48	26.57
5			598	26.57	
6			600	26.67	
7	1	22500	602	26.75	26.85
8			604	26.84	
9			607	26.97	
10	1.5	22500	610	27.24	27.32
11			613	27.30	
12			617	27.42	
13	2	22500	608	27.00	27.04
14			611	27.15	
15			607	26.97	

Graph 1 Graph for Compressive Strength of Cube



B. Spilt Tensile Strength

The cylindrical specimens of diameter 150 mm and length 300 mm were cast with PET bottle fibers of aspect ratio 25 in volume fraction 0.0%, 0.5%,1.0%,1.5%, and 2.0%. And the specimen loaded for ultimate compressive load under UTM for each mix. The split tensile strength test was carried out as per IS: 516-1979. This test was carried on specimens at the 28 days of curing. The split tensile stre416ngth of cylinder is calculated by the following formula:

$$ft = 2P / \pi D L$$

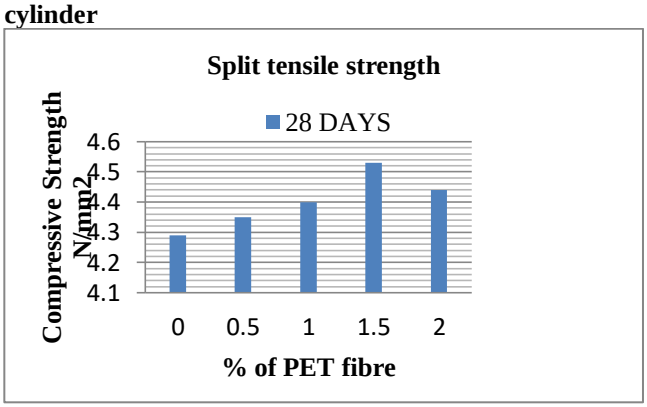
Where,

f_t=split Tensile strength, MPa
P=Load at failure, N
L =Length of cylinder, mm
D =Dia. Of cylinder, mm

Tab. No. 5 Split Tensile Test on Cylinder after 28 Days

Sr. No.	% Of PET Fiber	Load at Failure (KN)	Tensile Strength (N/mm^2)	Average Tensile Strength N/mm^2
1	0	302	4.27	4.29
2		304	4.30	
3		305	4.31	
4	0.5	306	4.33	4.35
5		308	4.35	
6		310	4.38	
7	1	315	4.45	4.40
8		318	4.50	
9		317	4.48	
10	1.5	320	4.52	4.53
11		322	4.55	
12		321	4.54	
13	2	315	4.45	4.44
14		18	3.96	
15		19	4.18	

Graph 2.Graph for split tensile Strength of cylinder



C. Flexural Strength

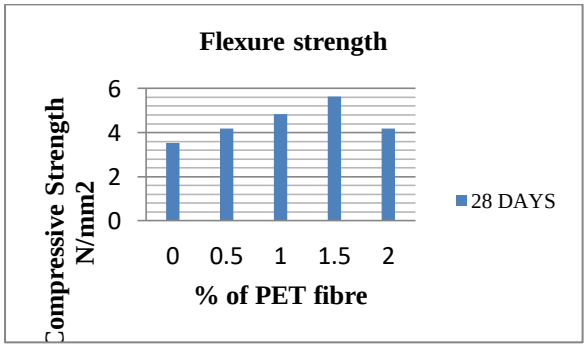
Three beam section of size 150x150x750mm were casted and cured for 28 days. The flexural strength is determined by the
Where,

f_{cr} = Flexural strength, MPa
P_f = Central load through two point loading system, N
L = Span of beam, mm
b = Width of beam, mm d = Depth of beam, mm

Tab. No. 5 Flexural Test after 28 Days

Sr. No.	% of PET Fiber	Load at Failure (KN)	Flexural Strength (N/mm^2) $0.7\sqrt{fck}$	Average Flexural Strength/m^2
1	0	15	3.34	3.53
2		18	3.96	
3		15	3.30	
4	0.5	19	4.18	4.18
5		18	3.96	
6		20	4.4	
7	1	21	4.62	4.84
8		23	5.06	
9		22	4.84	
10	1.5	24	5.28	5.64
11		25	5.50	
12		28	6.16	
13	2	20	4.40	4.18
14		312	4.41	
15		316	4.47	

Graph 3 Graph for flexure Strength of beam



6. CONCLUSION

1. As d concrete ingredients united.
2. Indirect tensile strength test result demonstrate that inclusion of 1.5% PET fiber volume fraction enhanced tensile strength a maximum .
3. From this experimental project work about 4 to 5% compressive strength of concrete will be increased.
4. From this experimental project work about 8 % split strength of concrete will be increased.
5. From this experimental project work about 59 % Flexural strength of concrete will be increased.

It was observed during experimentations that normal concrete specimens were suddenly broken into two pieces either cubes or cylinders but PFRC specimens did not suddenly break and failure was ductile.

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