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STUDY ON UTILIZATION OF WASTE PET BOTTLE FIBER IN CONCRETE

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ABSTRACT

Waste plastic bottles are major reason of solid waste disposal. Polyethylene Terephthalate (PET) is usually used for carbonated beverage and water bottles. The waste plastic bottles are difficult to biodegrade and involves processes either to recycle or reuse. The construction industry is in require of finding cost effective materials for increasing the strength of concrete structures. In this paper deals with the possibility of using the waste PET bottles as the different aspect ratio of 17, 33, 50, size of fibre added in to the concrete with 0.5%, 1%, and 1.5% PET bottle fibres for fine aggregate were produced and compared against control mix with no replacement. Cube specimens, cylinder specimens of 27 numbers each were cast cured and tested for 3 day, 7 day and 28 days strength. Compression test, splitting tensile test and flexural strength tests were done and the results were compared with control specimens.

Finally, optimum dosages of PET fiber volume fractions, such as 1% to attain maximum compressive strength and maximum tensile strength were found for the mix.

KEYWORDS: Plastic Bottles, Polyethylene Terephthalate, Biodegrade, Fibre

INTRODUTION

Concrete is the most widely used construction material due to its high compressive strength, long service life, and low cost etc. However, concrete has inbuilt disadvantages of low tensile strength and crack resistance also. To improve the weaknesses of the material, number of studies on fiber reinforced concrete has been performed. The research result showed that addition of fibers considerably improves the performance of concrete. The use of fiber reinforced concrete has increased in the last decade. Poly Ethylene Terephthalate commonly abbreviated PET. It is thermoplastic polymer resin of the polyester family and is used in synthetic fibers, PET is one of the most important and extensively used plastics in the world, especially for manufacturing beverage container, food and other liquid containers PET bottles are also recycled as-is (re-used) for various purposes PET bottles are filled with water and left in the sun to allow disinfection by ultraviolet radiation.

Most of PET bottles used for beverage container are thrown away after single usage and disposed PET bottles are treated by landfill and burning, which is create serious environmental problems Waste is the one of the challenge to dispose and manage. It has one of the major environmental, economical and social issues.

PET bottles in fiber form can be used to get better the mechanical properties of concrete. The compressive strength, tensile strength and flexural strength behavior of concrete is discussed. The PET fibers addition in concrete is an innovative material that can be promote in construction field.

FIBER DIMENSION AND QUANTITY INFORMATION

Dimension Details

Table 1

S. No	Aspect Ratio	Dimension (mm)
1	17	50 x 3
2	33	100 x 3
3	50	150 x 3

Quantity Details

Table 2

S. No	Dimension (mm)	Quantity (%)		
1	50 X 3	0.5	1	1.5
2	100 X 3	0.5	1	1.5
3	150 X 3	0.5	1	1.5

The percentage of fiber indicates quantity of fiber from the weight of cement.

CONCRETE MIX PROPORTIONING

Table 3

Contents	Cement	Fine Aggregate	Coarse Aggregate	W/c Ratio
Mix proportion per m^3	437.77 kg	650kg	1108.548kg	197 kg
Mix ratio	1	1.48	2.54	0.45

TESTING OF MATERIALS

Testing of Mortar Cube

Table 4(i)

S. No	Type of Specimen	3rd Day Strength (N/mm^2)	7th Day Strength (N/mm^2)	28th Day Strength (N/mm^2)
1	Mortar Cube	7.58	13.11	43.88

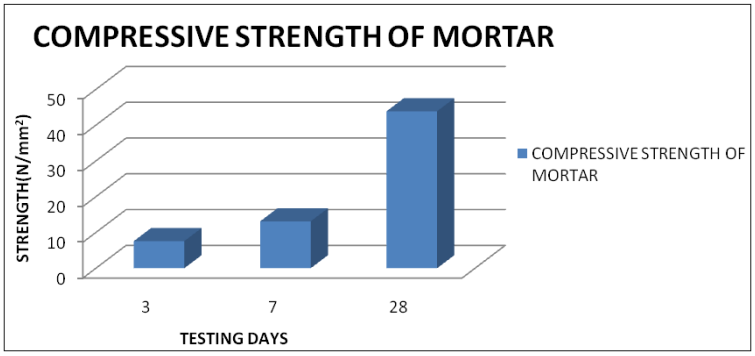

Figure 1: Compressive Strength of Mortar

TESTING OF STANDARD CONCRETE

Table 4(ii)

S. No	Type of Specimen	3rd Day Strength (N/mm^2)	7th Day Strength (N/mm^2)	28th Day Strength (N/mm^2)
1	Cube	16.43	21.16	26.0
2	Cylinder	2.86	3.47	3.56

TESTING OF FIBER CONCRETE

Conditional Concrete for 50 X 3 mm Fibre

Table 5(i)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	0.5%	17.97	25.88	30.16
2	Cylinder	0.5%	2.72	2.85	10.37

Table 5(ii)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	1.0%	25.10	36.20	41.64
2	Cylinder	1.0%	11.70	11.76	11.90

Table 5(iii)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	1.5%	25.16	33.87	36.70
2	Cylinder	1.5%	9.43	9.96	11.12

Conditional Concrete for 100 X 3 mm Fibre

Table 5(iv)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	0.5%	18.80	20.20	31.84
2	Cylinder	0.5%	5.91	7.69	11.0

Table 5(v)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	1.0%	25.19	35.06	41.64
2	Cylinder	1.0%	9.42	11.08	13.25

Table 5(vi)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	1.5%	25.16	34.07	38.88
2	Cylinder	1.5%	9.11	10.86	11.20

Conditional Concrete for 150 X 3 mm Fibre

Table 5(vii)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	0.5%	23.40	34.52	35.58
2	Cylinder	0.5%	10.42	10.53	11.04

Table 5(viii)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm2)	7th Day Strength (N/mm2)	28th Day Strength (N/mm2)
1	Cube	1.0%	24.32	33.56	36.64
2	Cylinder	1.0%	9.30	10.11	10.81

Table 5(ix)

S. No	Type of Specimen	Percentage of Fibre Used	3rd Day Strength (N/mm^2)	7th Day Strength (N/mm^2)	28th Day Strength (N/mm^2)
1	Cube	1.5%	23.43	34.15	37.94
2	Cylinder	1.5%	9.1	9.87	10.82

COMPARISION TABLES

Compressive Strength for 0.5% Fiber Used Concrete

Table 6(1.1)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
3	16.43	17.97	18.80	23.40

Table 6(1.2)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
7	21.16	25.88	20.20	34.52

Table 6(1.3)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
28	26.0	30.16	31.84	35.58

Compressive Strength for 1% Fiber Used Concrete

Table 6(2.1)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
3	16.43	25.10	25.19	24.32

Table 6(2.2)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
7	21.16	36.20	35.06	33.56

Table 6(2.3)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
28	26.0	41.64	41.64	36.64

Compressive Strength for 1.5% Fiber Used Concrete

Table 6(3.1)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
3	16.43	25.16	25.16	23.43

Table 6(3.2)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
7	21.16	33.87	34.07	34.15

Table 6(3.3)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
28	26.0	36.70	38.88	37.94

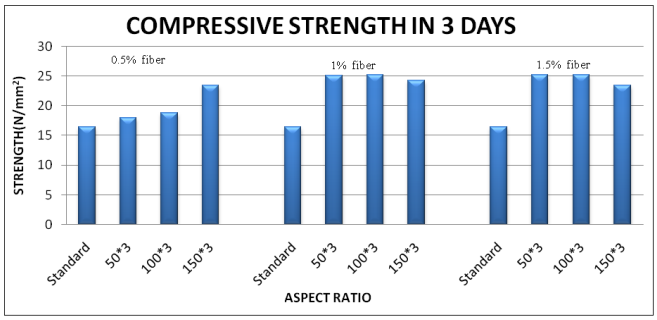

Figure 2: Compressive Strength in 3 Days

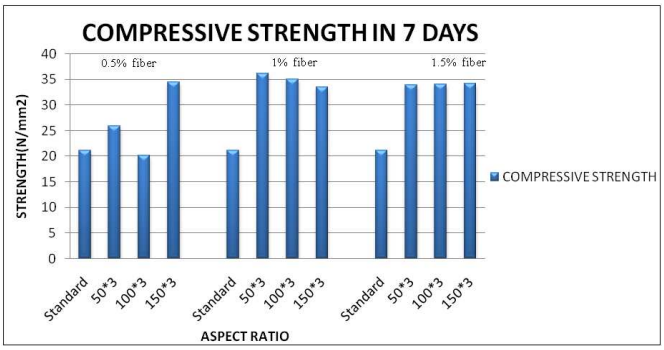

Figure 3: Compressive Strength in 7 Days

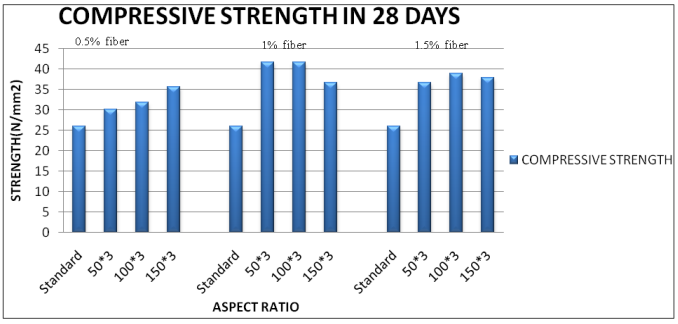

Figure 4: Compressive Strength in 28 Days

Tensile Strength for 0.5% Fiber Used Concrete

Table 6(4.1)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
3	2.86	2.72	5.91	10.42

Table 6(4.2)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
7	3.47	2.85	7.69	10.53

Table 6(4.3)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
28	3.56	10.37	11.0	11.04

Tensile Strength for 1% Fiber Used Concrete

Table 6(5.1)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
3	2.86	11.70	9.42	9.30

Table 6(5.2)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
7	3.47	11.76	11.08	10.11

Table 6(5.3)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
28	3.56	11.90	13.25	10.81

Tensile Strength for 1.5% Fiber Used Concrete

Table 6(6.1)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
3	2.86	9.43	9.11	9.1

Table 6(6.2)

Testing Day	Standard Concrete	Fiber Concrete(Aspect Ratio)		
		50 * 3	100*3	150*3
7	3.47	9.96	10.86	9.87

Table 6(6.3)

Testing Day	Standard Concrete	Fiber Concrete (Aspect Ratio)		
		50 * 3	100*3	150*3
28	3.56	11.12	11.20	10.82

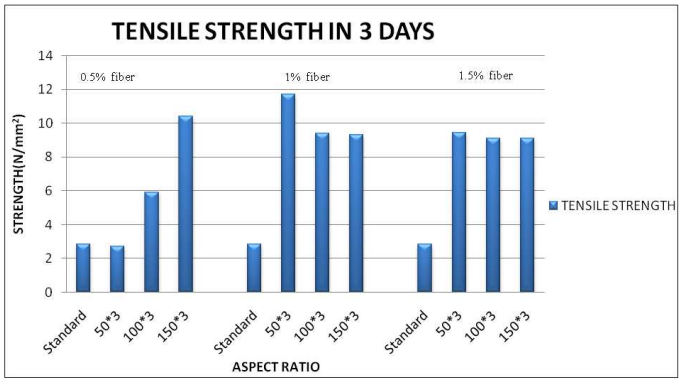

Figure 5: Tensile Strength in 3 Days

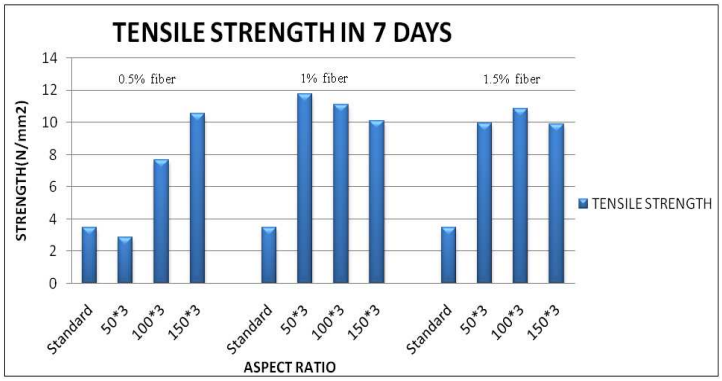

Figure 6: Tensile Strength in 7 Days

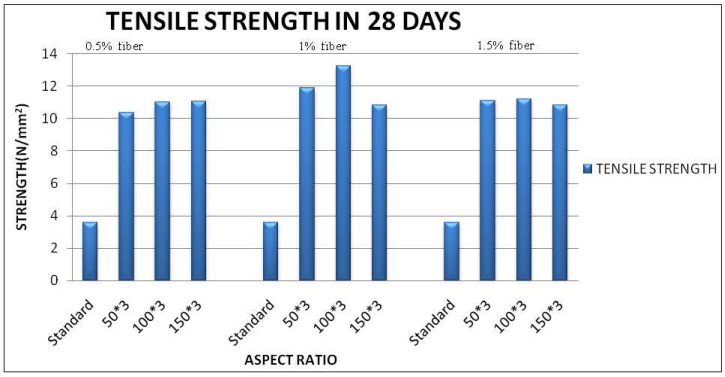

Figure 7: Tensile Strength in 28 Days

CONCLUSIONS

- The maximum percentage increase in compressive strength, split tensile strength at 1% of fiber content were 0.5 %, 1% and 1.5 % for aspect ratio 17, 33 and 50aspect ratio 50 respectively over control concrete (0% fibers).
- The significant improvements in strengths were observed with inclusion of plastic fibers in concrete. The optimum strength was observed at 1% of fiber content for all type of strengths.
- From this experimental investigation, the PET bottles would appear to be low-cost materials which would help to resolve solid waste problems and preventing environment pollution.
- It can be Identified form test results that development in strength was higher for aspect ratio 33.
- PET fibers increased both ductility and energy absorption of the axially compressed concrete samples. The highest ductility belonged to the specimens with PC=1.5%. However, the ductility and energy capacity decreases as the fiber increases.
- Indirect tensile strength test result demonstrate that inclusion of 0.5% PET fiber volume fraction enhanced tensile strength a maximum value by 23%.
- The empirical assumption that tensile strength of concrete is approximately one-tenth of compressive strength was verified.
- From this experimental project work about 30-35 % strength of concrete will be increased.

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