Fibre Reinforced Concrete Using Domestic Waste Plastics as Fibres

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Abstract- Fiber Reinforced Concrete (FRC) is a composite material consisting of cement based matrix with an ordered or random distribution of fiber which can be steel, nylon, polythene etc. The addition of steel fibre increases the properties of concrete, viz., flexural strength, impact strength and shrinkage properties to name a few. A number of papers have already been published on the use of steel fibres in concrete and a considerable amount of research has been directed towards studying the various properties of concrete as well as reinforced concrete due to the addition of steel fibres. Hence, an attempt has been made in the present investigations to study the influence of addition of polythene fibers (domestic waste plastics) at a dosage of 0.5% by weight of cement. The properties studied include compressive strength and flexural strength. The studies were conducted on a M20 mix and tests have been carried out as per recommended procedures of relevant codes. The results are compared and conclusions are made.

Index Terms- fiber reinforced concrete, domestic waste plastics, polythene fibers, compressive strength, flexural strength.

I. INTRODUCTION

Concrete in general has a higher brittleness with increase in strength. This is a major drawback since brittleness can cause sudden and catastrophic failure, especially in structures which are subjected to earthquake, blast or suddenly applied loads i.e., impact. This serious disadvantage of concrete can at least partially be overcome by the incorporation of fibers, especially, steel. The incorporation of fiber can cause a change in the failure mode under compressive deformation from brittle to pseudo-ductile, thereby imparting a degree of toughness to concrete.

In India, domestic waste plastics are causing considerable damage to the environment and hence an attempt has been made to understand whether they can be successfully used in concrete to improve some of the mechanical properties as in the case of the steel fibres. The primary objective of this investigation is to study experimentally the properties of fiber reinforced concrete containing polythene fibers. The properties of concrete, namely, compressive strength and flexural strength were studied.

II. EXPERIMENTAL INVESTIGATION

Detailed descriptions about the materials used, specimens tested and testing methods are essentials for an experimental investigation. Hence they are described in detail in the following sections.

A. Details of specimens

Table-1 shows the details of the various test specimens. It is intended to find experimentally the effect of addition of polythene fibers on the properties of concrete to be used for pavement construction. Hence the investigations are taken up to evaluate compressive strength and flexural strength of plain and fiber reinforced concrete specimens as per standards.

B. Casting and curing of specimens

The constituent materials of concrete, viz., Cement, Sand and aggregates were tested as per the relevant Indian codes of Practice and their properties are listed in Appendix-1. Concrete of M20 grade was designed as per the procedure given in Appendix 2. Concrete was mixed in a tilting type drum mixer and the specimens were cast as per the recommendations of IS: 516 - 1959. Fibres from the domestic waste were cut (Figure- 1) and added to the concrete at a dosage of 0.5% by weight of cement.

Standard steel moulds were used for casting of cubes of size 150mm x 150mm x 150mm and casting of cylinders of 150mm diameter and 300mm height (Figure-2)

Concrete was placed uniformly over the length of the mould in three layers and compacted satisfactorily. After compacting the entire concrete, the excess concrete at the top of the mould was stuck off with a wooden straight edge and the top finished by a trowel. Demoulding was done after 24 hours and the specimens were cured under water. After 7days and 28days, the cube specimens were removed from curing tank and taken for testing. After 28days, the cylinder specimens were removed from tank and taken for testing.

III. TESTING DETAILS

Two types of tests were performed on all concrete batches, namely, Compressive strength and Split tensile strength.

A. Compressive strength test

Six cubes of concrete mix were prepared and tested as per IS 516-1959 specifications (Figure-3) at the age of 7days and 28days. Three cylinders of concrete mix were prepared and tested as per IS 516-1959 specifications (Figure-4) at the age of 28days.

B. Splitting tensile strength test

Splitting tensile strength measurements were made on cylinder specimens according to IS 5816-1999 (Figure-5).

IV. TEST RESULTS

A. Compressive strength

The 7day and 28 day cube compressive strength of plain concrete and fiber reinforced concrete specimens obtained from tests are given in Tables 2 and 3. 28 day cylinder compressive strength are given in Table-4.

B. Split tensile strength

The Split tensile strength of plain concrete and fiber reinforced concrete specimens obtained from tests are given in Table-5.

V. ANALYSIS OF TEST RESULTS

A. Comparison of compressive strength

The influence of the addition of 0.5% fiber on the mixes tested is compared with plain concrete mix and the results are tabulated in Tables 6, 7 and 8. It is seen from the Tables that the compressive strength is increased by 2.45%. It is well established that addition of fibres do not contribute much to improvements in the compressive strength of concrete and the results of the present study also indicate the same.

B. Comparison of split tensile strength

Table-9 shows the comparison results of split tensile strength of the concrete mixes with and without fibers. Split tensile strength of fiber reinforced concrete specimen is 26.8% more than plain concrete. Generally, it should be borne in mind that the flexural strengths are increased to the tune of 20-25% with the addition of steel fibers. However, the present fibers, being obtained from domestic waste do not exhibit appreciable improvements in the flexural strength of concrete as in the case of steel fibers.

Table-1. Details of specimens.

S. No.	Name of test	Specimen	% of fiber added	No. of specimens
1.	Compressive strength test	Cube 150mm x 150mm x 150mm	0%	6 Nos.
			0.5%	6 Nos.
		Cylinder 150mm dia and 300mm height	0%	3 Nos.
			0.5%	3Nos.
2.	Tensile test	Cylinder 150mm dia and 300mm height	0%	3 Nos.
			0.5%	3 Nos.

Table-2. Results of 7days cube compressive strength.

Grade of concrete	% of fiber used	Sample No.	Load (N)	Compressive strength (N/mm^2)
M20	0%	1	505000	22.44
		2	500000	22.22
		3	485000	21.56
	0.5%	1	510000	22.67
		2	500000	22.22
		3	490000	21.78

Table-3. Results of 28days cube compressive strength.

Grade of concrete	% of fiber used	Sample No.	Load (N)	Compressive strength (N/mm^2)
M20	0%	1	755000	33.56
		2	745000	33.11
		3	740000	32.89
	0.5%	1	805000	35.78
		2	785000	34.89
		3	765000	34.00

Table-4. Results of 28days cylinder compressive strength.

Grade of concrete	% of fiber used	Sample No.	Load (N)	Compressive strength (N/mm^2)
M20	0%	1	440000	24.90
		2	430000	24.33
		3	425000	24.05
	0.5%	1	460000	26.03
		2	450000	25.46
		3	435000	24.61

Table-5. Results of 28days cylinder split tensile strength test.

Grade of concrete	% of fiber used	Sample No.	Load (N)	Tensile strength (N/mm^2)
M20	0%	1	205000	2.90
		2	200000	2.83
		3	200000	2.83
	0.5%	1	210000	2.97
		2	205000	2.90

		3	200000	2.83

Table-6. Comparison of 7 days cube compressive strength test results.

Grade of concrete	**Average Compressive Strength at 7 days** (N/mm^2)		**Increase in compressive strength of concrete by addition of fiber (C2-C1)/C1 x 100%**
	Plain concrete, C1	**0.5% with fiber C2**	
Sample 1	22.44	22.67	1.02
Sample 2	22.22	22.22	0.00
Sample 3	21.56	21.78	1.02

Table-7. Comparison of 28 days cube compressive strength test results.

Grade of concrete	**Average compressive strength at 28 days** (N/mm^2)		**Increase in compressive strength of concrete by addition of fiber (C2-C1)/C1 x 100%**
	Plain concrete, C1	**0.5% with fiber C2**	
Sample 1	33.56	35.78	6.61
Sample 2	33.11	34.89	5.38
Sample 3	32.89	34.00	3.37

Table-8. Comparison of 28 days cylinder compressive strength test results.

Grade of concrete	**Average compressive strength at 28 days** (N/mm^2)		**Increase in compressive strength of concrete by addition of fiber (C2-C1)/C1 x 100%**
	Plain concrete, C1	**0.5% with fiber C2**	
Sample 1	24.90	26.03	4.54
Sample 2	24.33	25.46	4.64
Sample 3	24.05	24.61	2.33

Table-9. Comparison of 28 days split tensile strength test results.

Grade of concrete	**Average split tensile strength at 28 days** (N/mm^2)		**Increase in Split tensile strength of concrete by addition of fiber (C2-C1)/C1 x 100%**
	Plain concrete, C1	**0.5% with fiber C2**	
Sample 1	2.90	2.97	2.41
Sample 2	2.83	2.90	2.47
Sample 3	2.83	2.83	0.00

Figure-1. Waste domestic plastics are made in to fibre.

Figure-2. Casting of cylinders.

Figure-3. Compressive strength testing on cubes.

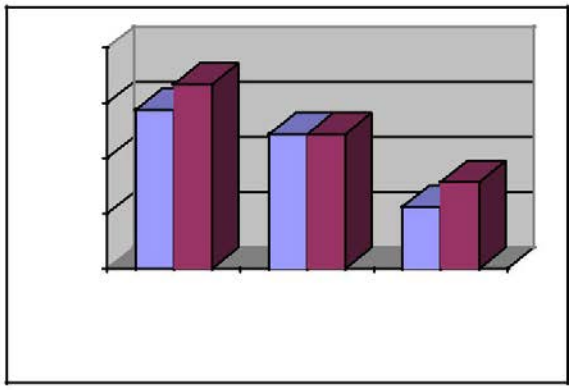


Figure-6. Comparison of 7 days cube compressive strength test results.

Figure-4. Compressive strength testing on cylinders.

Figure-5. Split tensile strength testing on cylinders.

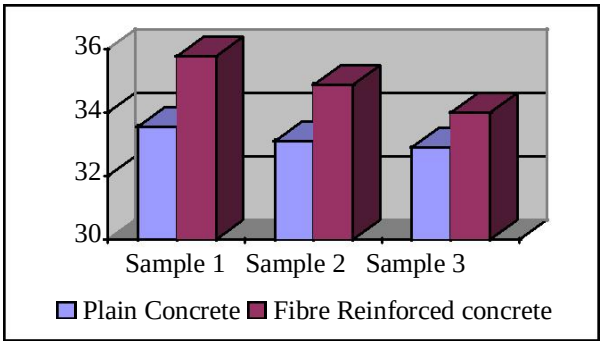
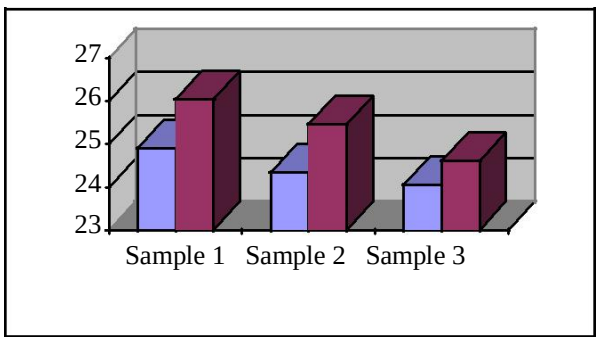


Figure-7. Comparison of 28 days cube compressive strength test results.



Plain Concrete Fibre Reinforced concrete

Figure-8. Comparison of 28 days cylinder compressive strength test results.

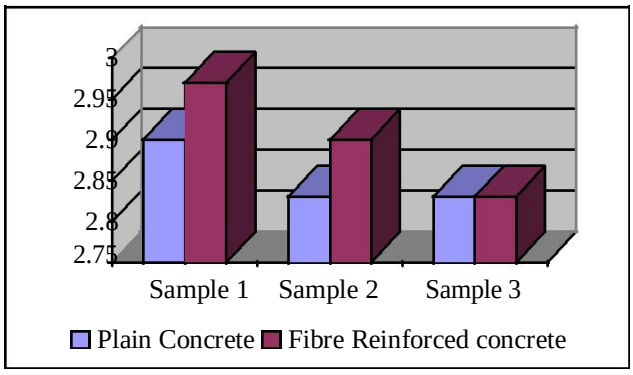


Figure-9. Comparison of 28 days split tensile strength test results

VI. CONCLUSIONS

The following conclusions are presented based on experimental results from the present investigation. Addition of 0.5% of polythene (domestic waste polythene bags) fiber to concrete

i) Increases the cube compressive strength of concrete in 7 days to an extent of 0.68%;

ii) Increases the cube compressive strength of concrete in 28 days to an extent of 5.12%;

iii) Increases the cylinder compressive strength of concrete in 28 days to an extent of 3.84%;

iv) Increases the split tensile strength to an extent of 1.63%; and

v) The increase in the various mechanical properties of the concrete mixes with polythene fibers is not in same league as that of the steel fibres.

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