

Effects of Polyethylene Terephthalate and Steel Fibre in Hybrid Fibre Reinforced Concrete

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Abstract

Objectives: Hybrid Fibre Concrete (HyFRC) which make use of Polyethylene Terephthalate (PET) and Steel Fibre (SF) is considered in this research. HyFRC mechanical properties such as splitting tensile strength, compressive strength and flexural strength will be studied. **Methods/Findings:** By using IS 10262-2009 code, M40 grade HyFRC was designed with steel and PET fibre were included upto 0.5% by volume of concrete. Experimental investigation showed that superior performance was achieved in HyFRC when using the hybrid fibre form instead of single fibre concretes. This investigation concluded that concrete containing PET fibres of 0.12% and steel fibres of 0.38% grouping as the best combination to be engaged in HyFRC for mechanical properties such as splitting tensile strength, compressive strength and flexural strength. **Application/Improvements:** Optimum proportion of fibres in HyFRC was identified from the mechanical properties results. Thus the crack pattern and ductility behaviour will be studied by using beam column specimens.

Keywords: Polyethylene, Steel Fibre

1. Introduction

Concrete is quite a fragile composite material. In order to conquer the weakness, metallic or polymeric kinds of fibres have been considered. In¹ reality, sufficient mechanical properties, tensile and strain capacity cannot be achieved by single fibre. As a result, combination of two or more fibres was introduced and had been made as HyFRC containing dispersed randomly oriented fibres². Hybrid fibre combination of 0.5% volume fraction such as carbon, steel, polypropylene fibres and polyester were introduced and mechanical properties were compared with the normal concrete mix. In³ investigated the mechanical properties such as splitting tensile strength, compressive strength and flexural strength of high strength concrete with non-metallic polypropylene and

metallic steel fibres, glass fibres and polyester at 0.5% volume fraction, outcome showed that non-metallic fibres slow down the formation of micro cracks whereas metallic steel fibres contributed energy absorbing mechanism and hybrid combination showed improvement in concrete properties and overall cost of production of concrete was reduced⁴.

In⁵ investigated to improve the crack resistance and tensile property with recycled PET fibres in concrete. Compressive strength and toughness of concrete was enhanced by immersion of steel fibres. Owing to the PET fibres superior ductility, fineness plastic cracks were controlled. In this research, hybrid fibres were mixed with concrete to enhance the splitting tensile strength, compressive strength and flexural strength. This investigation

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reports the strength properties of HyFRC compared with the controlled concrete mix.

2. Materials and Experimental Work

2.1 Materials

All the concrete mixes were prepared with Portland Pozzolona Cement, fine aggregate of river sand with 2.65 specific gravity and conforming to BIS 383 (1970) and

coarse aggregate with 2.60 specific gravity and aggregate retaining on 12.5 mm sieve and passing through 20 mm sieve⁶. Specimens were casted along with workability enhancing admixture of Superplasticizer (Conplast SP 430) with 1.22 specific gravity, chloride free admixture. Recycled PET and steel fibres physical and mechanical properties are listed in Table 1.

2.2 Concrete Mix Proportioning

To acquire the target strength of 40 MPa at 28 days concrete mix was prepared accordingly. To maintain the

Table 1. Mechanical and Physical Properties of Steel and PET fibres

Property Description	Steel fibre	Recycled PET
Specific Gravity	7.8	1.35
Tensile Strength	1700	970
Length (mm)	50	38
Diameter (mm)	0.5	0.025
Aspect Ratio (l/d)	100	1520

Table 2. Concrete Mix Proportions

Cement kg / m ³	FA kg / m ³	CA kg / m ³	Water lit / m ³	SP lit / m ³
394.32	717.288	1152.58	157.728	3.945

Table 3. Dosage of Steel fibre and Recycled PET fibre Combinations in this study

Concrete Mix	V _f	V _f	Fibre Dosage kg / m ³	
	SF %	RPET %	Steel	RPET
SFRC	0.5	-	39	-
HyFRC1	0.12	0.38	9.36	5.13
HyFRC2	0.25	0.25	19.50	3.38
HyFRC3	0.38	0.12	29.64	1.62
PERC	-	0.5	-	6.75

workability ranges from 75-125 mm, Superplasticizer dosage was varied. Detailed concrete mix proportion quantities of this investigation study⁷ and volume fractions of steel fibres and recycled PET fibres existed were presented in Tables 2-3 respectively.

2.3 Concrete Preparation and Casting Details

Steel fibre and recycled PET fibres at 0.5% by volume of concrete were mixed to each concrete mix of hybrid fibre reinforced concrete. Superplasticizer was mixed with 1% by weight of cement in the fibre reinforced concrete for improving the workability. Standard set of specimen sizes such as cubes, cylinder and prism were casted for testing the 28 days properties such as Splitting tensile strength,

Compressive strength and Flexural strength of the concrete.

3. Results and Discussion

3.1 Workability Test

Workability measurement, Slump value of various concrete mixes is listed in Table 4. Slump ranges from 75 mm to 125 mm resulted from the prepared concrete mix.

3.2 Compressive Strength Test Results

For measuring compressive strength of fibre concrete specimens were casted with M40 grade of concrete and size of 150 mm x 150 mm x 150 mm cubes⁸. Concrete was ready with 0.5%SF, 0.12%RPET & 0.38%SF, 0.25%RPET

Table 4. Workability Test Results

Mix	Slump (mm)
SFRC	108
HyFRC1	92
HyFRC2	83
HyFRC3	78
PFRC	72

Table 5. Compressive Strength Results

Concrete Mix	Spec. 1	Spec. 2	Spec. 3	Avg. Compressive Strength (MPa)
SFRC	47.00	49.20	48.10	48.10
HyFRC1	49.34	49.18	50.20	49.57
HyFRC2	47.00	46.28	43.00	45.43
HyFRC3	40.20	39.43	40.56	40.06
PERC	38.02	36.70	37.22	37.31

& 0.25%SF and 0.38%RPET & 0.12%SF. Specimens were allowed for 28 days of curing after demoulding of specimens from 24 hours of casting. Results of compressive strength values are given in Table 5. Compressive strength value of fibre concrete was measured by 2000kN capacity of compressive testing machine. In^o each mix of concrete, three cubes were casted and their average value was reported as final value.

3.3 Splitting Tensile Strength Test Results

For measuring splitting tensile strength of fibre concrete specimens were casted with a size of 300 mm height and 150 mm diameter⁸. Specimens were allowed for 28

days of curing after demoulding of specimens from 24 hours of casting. Results of splitting tensile strength values are given in Table 6. Splitting tensile strength values of fibre concrete was measured by 2000kN capacity of compressive testing machine in that specimens placed horizontally⁹.

3.4 Flexural Strength Test Results

For measuring flexural strength of fibre concrete specimens were casted with a size of 100 mm x 100 mm x 500 mm⁸. Specimens were allowed for 28 days of curing after demoulding of specimens from 24 hours of casting. Results of flexural strength values are given in Table

Table 6. Splitting Tensile Strength Results

Concrete Mix	Spec. 1	Spec. 2	Spec. 3	Avg. Splitting Tensile Strength (MPa)
SFRC	4.34	3.98	4.10	4.10
HyFRC1	4.16	4.28	4.17	4.17
HyFRC2	4.16	4.08	3.99	4.00
HyFRC3	3.87	3.72	3.90	3.80
PERC	3.56	3.80	3.39	3.39

Table 7. Flexural Strength Results

Concrete Mix	Spec. 1	Spec. 2	Spec. 3	Avg. Flexural Strength (MPa)
SFRC	5.40	5.39	5.06	5.28
HyFRC1	5.32	5.41	5.30	5.34
HyFRC2	4.80	5.02	4.84	4.84
HyFRC3	4.58	4.42	4.70	4.57
PERC	4.08	4.21	4.36	4.22

7. Flexural strength value of concrete was measured by using 100 kN capacity Flexural Testing Machine⁹.

4. Conclusion

In this research work, strength and properties of Hybrid Fibre (RPET and Steel Fibre) Concrete was evaluated. The test results indicated that concrete with enhanced strength was achieved at minimum fibre volume portion. The mechanical properties such as splitting tensile strength, compressive strength and flexural strength outcome obviously revealed that higher strength was achieved with the fibre volume fraction in combination of steel fibre with 0.38% and RPET fibre with 0.12%.

5. References

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