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Mechanical Properties of Hybrid Fibre reinforced Concrete with Available of Rural Fibres

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Abstract

In general Fibre Reinforced Concrete (FRC) can improve the strength properties of hardened concrete; likewise this investigation is to find the mechanical properties of Hybrid Fibre Reinforced Concrete (HyFRC) with the combination of Recycled Polyethylene therephthalate (RPET) and steel (ST) fibres. The M25 grade of concrete was designed by using the codal provisions of IS 10262-2009. Mechanical properties such as Compressive strength,Tensile strength and Flexural Strength of specimens were found out for the various mix proportions of Hybrid Fibre Reinforced Concrete RPET.75ST0.25, RPET0.5ST0.5, and RPET0.25ST0.75 for the volume fraction for 1.5%. Totally 36 number of specimens were casted, out of which nine numbers of control and twenty seven were hybrid fibre reinforced concrete specimens. From this the optimum value of hybrid fibre was found as with the combination of RPET0.25ST0.75 fibres. Because of the steel fibre the optimization value of the concrete get increase and the RPET fibre gives a little participation in strength. The compressive strength of the HyFRC can improve 19% than the control mix, the tensile strength of the HyFRC can improve 10% than the control mix and the flexural strength of the HyFRC can improve 13.80% than the control mix.

Keywords: Fibre Reinforced Concrete, Hybrid Fibre Reinforced Concrete, Recycled Polyethylene Terephthalate fibre, Steel Fibre, Volume fraction, Compressive strength, Flexural Strength and Tensile strength..

Introduction

The Concrete is a mixture of cement, sand, brick or stone ballast and water, which when placed in forms and allowed to cure, becomes hard like stone. It is much stronger in compression than tension. This may often crack ridden connected to plastic and hardened states, drying shrinkage and the like. To improve such type of weakness numerous studies on fibre reinforced concrete have been performed. The fibre can make the failure mode more ductile by increasing the tensile strength of concrete. The addition of recycled polyethylene terephthalate fibres (RPET) and steel fibres is called as hybrid fibre reinforced concrete (HyFRC). In this modern era, lots of non-biodegradable like plastics wastes and electronic wastes were polluting the nature of earth and developing of strengthening the concrete by adding these wastes should improve its mechanical properties, and this may reduce the disposal of wastes in land by increnation and dumping method. Polyethylene Terephthalate (PET) is one of the non-biodegradable materials which are widely used in food, liquid storage containers, and in textile industries also.

This paper further investigated the strength improving develop of HyFRC containing 1.5% volume of steel and RPET fibres in comparison with the plain concrete, and to find the mechanical properties of HyFRC under compression, splitting tension and flexure.

Materials and Experimental Methods

Material Used

Cement: Portland Pozzolona Cement of 53 grades was used in this entire investigation.

Fine Aggregate: Locally available river sand conforming in Indian standard.

Coarse Aggregate: Locally available quarry stone in good strength passing through 20 mm and retain in 10mm sieve.

Water: Ordinary portable water without acidity and alkanet available in well or pump.

Super Plasticizer: Conplast SP 430 is used to reduce the frictional properties of concrete.

Fibre:

Steel Fibre: Binding wire as a steel fibre was used. The length of the fibre was 50 mm, diameter 1mm and aspect ratio is 50.

RPET Fibre: Recycled polyethylene Therapthalate which is used in textile industry is used. The length of the fibre was 38 mm, diameter of the fibre is 25 micron and the aspect ratio of the fibre is 1900.

SPECIFIC GRAVITY	
Cement	3.15
Fine Aggregate	2.64
Coarse Aggregate	2.60
Steel Fibre	7.48
RPET Fibre	1.34
Water	1.00

Tab: 1 Specific Gravity Of Material

Fig: 1 – RPET Fibre

Fig: 2 – ST Fibre

Mix Proportion

Using the properties of materials as listed above the mix design has been adopted from IS 10262:2009 to design for M25 grade of concrete. Based on the various design stipulations the mix ratio was obtained for all the specimens and the following table shows the results obtained.

MIX PROPORTION OF HyFRC

MATERIAL	CEMENT (kg/m^3)	F.A (kg/m^3)	C.A (kg/m^3)	STEEL FIBER (kg/m^3)	PET FIBER (kg/m^3)	WATER (kg/m^3)	S.P (kg/m^3)
CONT. MIX	404.44	711.13	1160	-----	----	182	4.04
ST0.25PET0.75	404.44	711.13	1160	29.44	10.05	182	4.04
ST0.50PET0.50	404.44	711.13	1160	58.88	6.70	182	4.04
ST0.75PET0.25	404.44	711.13	1160	88.31	3.35	182	4.04

Experimental Methodology

Compressive Strength Test:

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were casted for M25 grade of concrete. The moulds were filled with % RPET0.25ST0.75, RPET0.50ST0.50 and RPET0.75ST0.25 fibres. After 24 hours the specimens were demoulded and were transferred to curing tank where in they were allowed to cure for 28 days. These specimens were tested in compression testing machine. In each category, three cubes were tested and their average value is reported.

Tensile strength test:

For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. For the control mix and Hybrid fibre concrete.

Flexural test:

For flexural strength test, prism specimens of dimensions 500 x 100 x 100 mm were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. For the control mix and Hybrid fibre concrete.

Discussions of Result

SL. NO	SPECIMEN	SAMPLES	NO. OF CURING DAYS	COMPRESSIVE STRENGTH (MPa)	TENSILE STRENGTH (MPa)	FLEXURAL STRENGTH (MPa)
1	CONTROL MIX	1	28	27.35	3.47	3.8
2		2		28.00	3.58	4.1
3		3		27.57	3.25	4.3
4	RPET.75 ST0.25	1		32.00	4.57	4.7
5		2		33.21	4.89	5.1
6		3		32.89	5.11	4.9
7	RPET.5 ST0.5	1		39.55	5.94	5.8
8		2		40.00	6.15	5.75
9		3		38.89	6.53	5.55
10	RPET.25 ST0.75	1		42.67	7.07	5.9
11		2		43.56	7.42	6.7
12		3		42.89	7.21	6.7

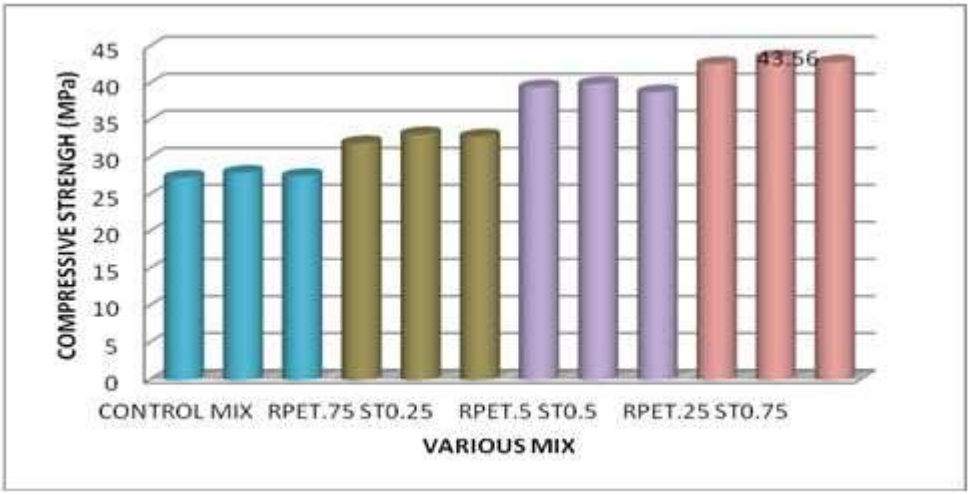

Fig: 3 – Compressive Strength for Various Mix Proportion

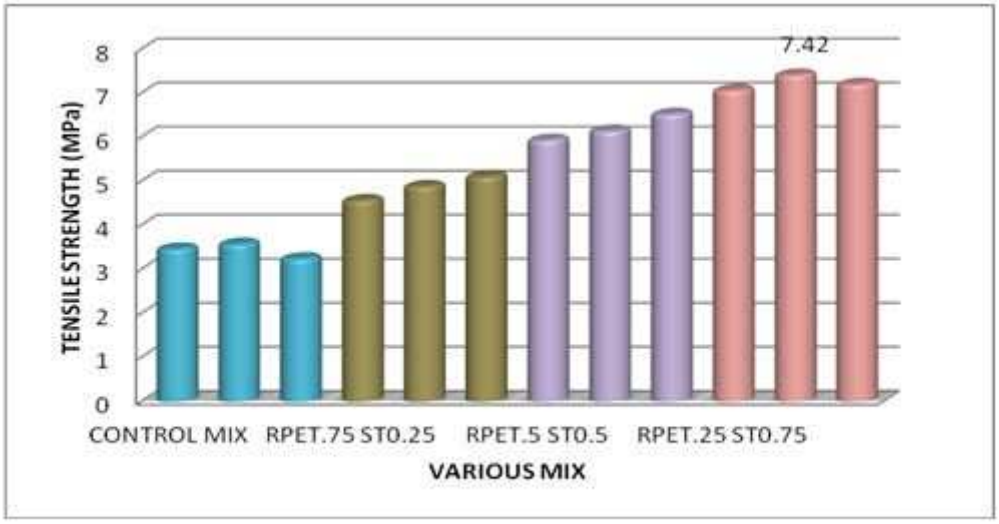

Fig: 4 – Tensile Strength for Various Mix Proportion

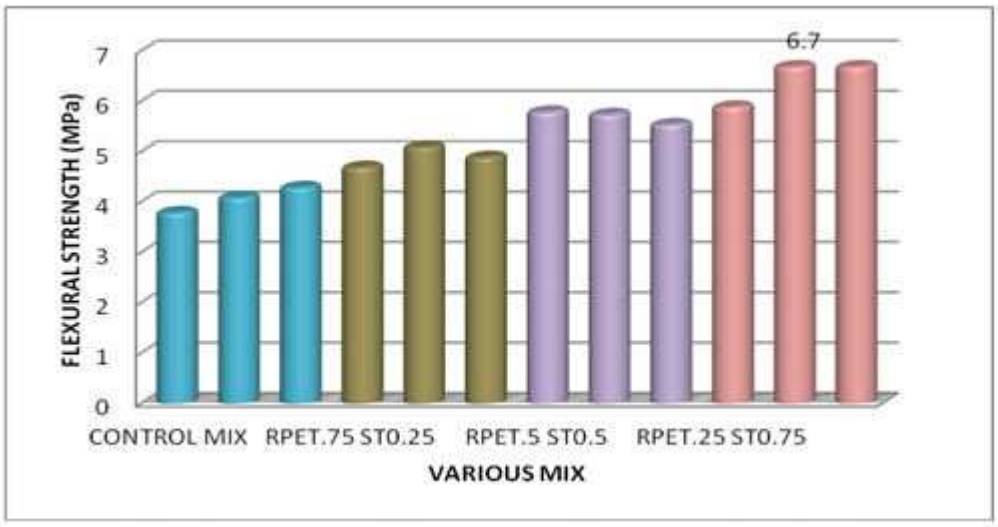

Fig: 5 – Flexural Strength for Various Mix Proportion

- Through the result compressive strength of the control mix is find out as 28 N/mm^2. The optimum value of compressive strength of the hybrid fibre is finding in the combination of ST0.75PET0.25 as 43.56 N/mm^2 and the comparison hybrid fibre should increase as 55.60 %.
- The split tensile test of the control mix is 3.60 N/mm^2. The optimum value of the hybrid fibre is 7.40 N/mm^2. The hybrid fibre is increase in the strength of tensile strength as 107.30 % at the mix proportion of ST0.75PET0.25.
- The flexural strength of the hybrid fibre is 4.3 N/mm^2 and for the control mix is 6.70 N/mm^2. By comparing the control mix the hybrid fibre should increase in the value of 55.80 %.

Conclusion

Hybrid Fibre Reinforced Concrete utilizes two complementary fibres to improve the properties of concrete, and the performance of Hybrid Fibre Reinforced Concrete is better than that of single Fibre Reinforced Concrete.

- The strength of the HyFRC is greater than the Control mix.
- Using the RPET fibre as high ratio is does not give the full strength to the concrete, due to adding of Steel Fibre increase its strength.

- When the Steel Fibre increase in volume with RPET the strength also increase.
- The Compressive Strength of hybrid fibre reinforced concrete containing of ST0.75PET0.25 for the volume fraction 1.5% is 55.60 % higher than the control mix.
- The Flexural Strength of hybrid fibre reinforced concrete containing of ST0.75PET0.25 for the volume fraction 1.5% is 55.80 % higher than the control mix.
- The Split Tensile strength of hybrid fibre reinforced concrete containing of ST0.75PET0.25 for the volume fraction 1.5% is 107.30 % higher than the control mix.

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