AN INVESTIGATION ON THE BEHAVIOUR OF HYBRID TEXTILE FIBRE REINFORCED CONCRETE

Gajanan Akkimaradi[1], Prof. Kashinath B. Rugi[2], Dr. K. B. Prakash[3], Dr. Jagadish G Kori[4]

[1] M.Tech student, Structural Engineering, Government Engineering College, Haveri, Karnataka, India
[2] Assistant Professor, Dept of Civil Engineering, Government Engineering College, Haveri, Karnataka, India
[3] Principal, Dept of Civil Engineering, Government Engineering College, Haveri, Karnataka, India
[4] Head of the Civil Engineering Department, Government Engineering College, Haveri, Karnataka, India

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Abstract:- The main objective of this experimental investigation is to study the behaviour of hybrid textile fibre reinforced concrete in which different hybrid fibre combinations such as (Steel + Polypropylene fibre), (Steel + Polyester fibre) and (Steel + Nylon fibre) are used.

To achieve the above objective, following experimentsare planned.

a) To find out the workability characteristics of hybrid textile fibre reinforced concrete.

b) To find out the strength characteristic of hybrid textile fibre reinforced concrete such as compressive strength, flexure strength, shear strength and impact strength.

c) To find out the near surface characteristics such as sorptivity of hybrid textile fibre reinforcedconcrete.

d) To find out the resistance of hybrid textile fibre reinforced concrete to chloride attack.

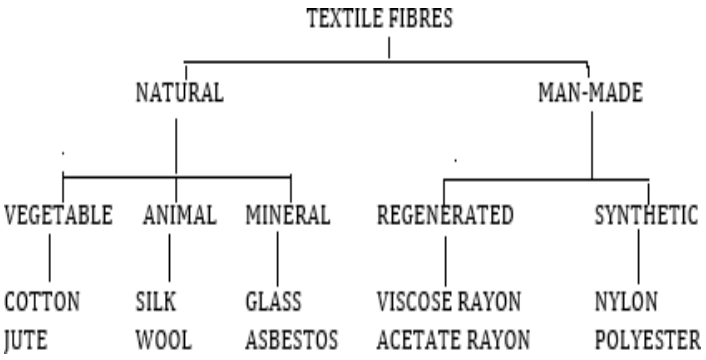
Key Words: Polypropylene fibre, steel fibre, nylon fibre, polyester fibre, RCPT.

1. INTRODUCTION

Hybrid textile fibre reinforced concrete can bedefinedas a composite material consisting of mixtures of cement, fine aggregates, coarse aggregates, water and discontinuous, discrete, uniformly dispersed textile fibres. It may also contain pozzolans and other admixtures commonly used with conventional concrete. The overall performance of textile fibre reinforced concrete relying on the properties of concrete and the fibres. The properties of fibres that are generally of activity are fibre concentration, fibre geometry, fibre orientation, and fibre distribution. The advent of textile-reinforced concrete has led to corrosion damage and the high costs associated with the rehabilitation and maintenance of steel-reinforced concrete being a part of the past. Concrete elements can be made thinner, more delicate and more efficient owing to tensile strengths that can easily exceed 3,000 N/mm^2, thus opening up a range of new applications in construction, exterior design and furniture. Not least, textile-reinforced concrete constructionischeaper and more attractive.

1.1 Classifications of textile fibres

Following chart gives the classifications of textile fibres.



2. MATERIALS

A) Cement

In this work, 43 Grade OPC conforming to IS: 8112 – 1989 was used with the brand name of Zuari. The properties of cement is given in table-1.

Table 1- Properties of cement

Properties	Values
Fineness	4%
Normal consistency	32%
Specific gravity	3.15
Initial setting time	43 min
Final setting time	360 min

B) Fine aggregates

In this experimental work sand used is collected from river Thungbadra, Karnataka, India. The properties of fine aggregates are given in table-2.

Table 2- Properties of fine aggregates

Properties	values
Particle shape, size	nd 4.75mm and down size
Specific gravity	2.64
Water absorption	1.0%

C) Coarse aggregates

Coarse aggregates were collected from crusher at Nellogal, Haveri, Karnataka, India. The properties of fine aggregates are given in table-3.

Table 3- Properties of coarse aggregates

Properties	values
Particle shape, size	ular 20mm and down size
Fineness modulus of 20mm aggregate	6.89
Specific gravity	2.68

D) Polypropylene fibre

In this project Recron 3s fibre CT-2424 is usedandit is developed after extensive research at Reliance Technology Centre. It is brought from Aahana enterprises, Chamarajpet, Bengaluru, Karnataka, India. The specifications of polypropylene fibres are given in table-4 and following figure 1 shows the sample of polypropylene fibre.

Table 4- Specifications of polypropylene fibre

Specifications	Value
Material	Polypropylene triangular fibre
Type	CT 2424
Filament diameter	25 Microns
Cut length	12mm
Tensile strength	600kg/cm2

Fig 1: Sample of polypropylene fibre

E) Nylon fibre

In this project work the nylon fibrer is brought from Aahana enterprises, Chamarajpet, Bengaluru, Karnataka, India. The nylon fibre was added by 0.5% of volume. The properties of nylon fibres are given in table-5 and following figure 2 shows the sample of nylon fibre.

Table 5- Properties of nylon fibre

Properties	values
Length	12 mm
Diameter	24 micron
Density	1.14 g/cc
Elongation at break	15-45%
Elasticity	Very good

Fig 2: Sample of nylon fibre

F) Polyester fibre

In this project work the polyester fibrer is brought from Aahana enterprises, Chamarajpet, Bengaluru, Karnataka, India. The polyester fibre was added by 0.5% of volume. The specifications of polyester fibres are in given table-6 and following figure 3 shows the sample of polyester fibres.

Table 6- Specifications of polyester fibre

Specifications	Value
Length	12 mm
Diameter	24 micron
Density	1.3g/cc
Water absorption	0.1%
Refractive index	1.58-1.64
Flammability	Self-extinguishing

Fig 3: Sample of polyester fibre

G) Steel fibre

In this project work Steel fibres was brought from STEWOLS INDIA (P) LTD Nagpur Industrial Estate Kamptee Road Uppalwadi ,Nagpur, Maharastra Krnataka, India. The properties of steel fibres are given in table-7 and following figure 44 shows sample of steel fibres.

Table 7- Properties of steel fibre

Properties	Value
Average thickness	0.75mm
Length	60mm
Density	7850 kg/m^3
Tensile strength	8500 kg/m^2

Fig 4: Sample of steel fibre

3. MIX DESIGN

Mix design of M30 grade concrete is done according to IS: 10262-2009 and arrived mix proportion is given table-8.

Table 8- Mix proportion

Mix proportion			
Water	Cement	Fine aggregate	Coarse aggregate
197 Litre/m3	438 kg/m3	655.9656 kg/m3	1129.464 kg/m3
W/C- 0.45	**1**	**1.497**	**2.578**

4. EXPERIMENTAL RESULTS

4.1 Workability test results

Following table-9 gives the workability test results and following fig. 5, fig 6, fig 7 gives the graphical representation of workability.

Table 9- Workability test results

Description of concrete	**Slump (mm)**	**Compaction factor**	**Vee- Bee (sec)**
Conventional concrete	**20**	**0.861**	**29**
Steel + Polypropylene fiber	**0**	**0.34**	**46**
Steel + Polyester fiber	**0**	**0.43**	**41**
Steel + Nylon fiber	**0**	**0.372**	**45**

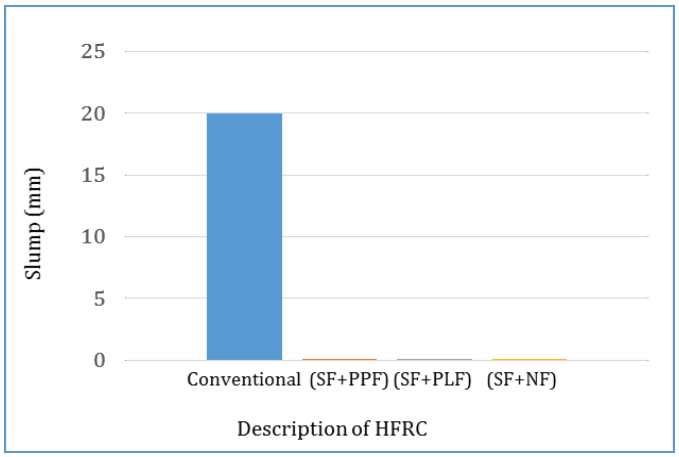


Fig. 5- Graphical representation of slump

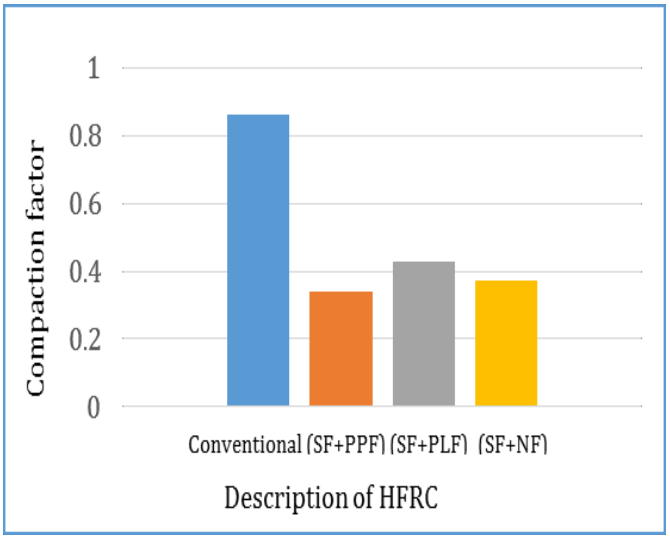


Fig. 6- Graphical representation of compaction factor.

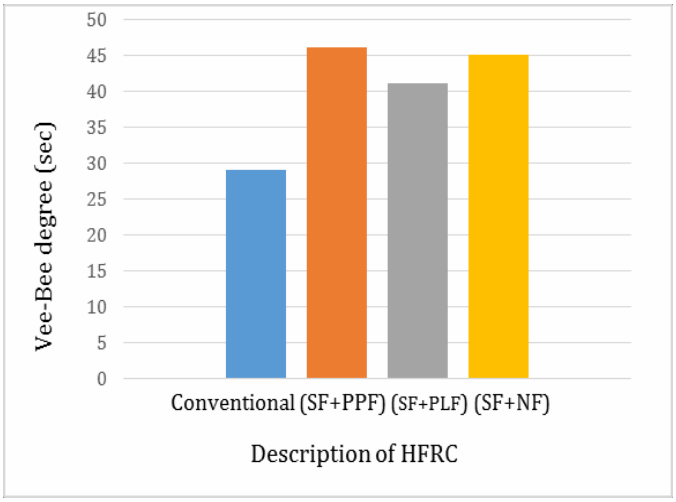


Fig. 7- Graphical representation of Vee-Bee consistometer.

4.2 Compressive strength test results

Following table-10 gives the compressive strength test results and following fig. 8 gives the graphicalrepresentation of compressive strength.

Table 10- Compressive strength test results

Description of concrete	**Compressive strength (MPa)**	**% increase or decrease compressive strength w.r.t** reference mix
Conventional concrete (Ref. mix)	**30.37**	**0**
Steel + Polypropylene fibre	**37.78**	**24.40**
Steel + Polyester fibre	**35.85**	**18.04**
Steel + Nylon fibre	**33.19**	**9.28**

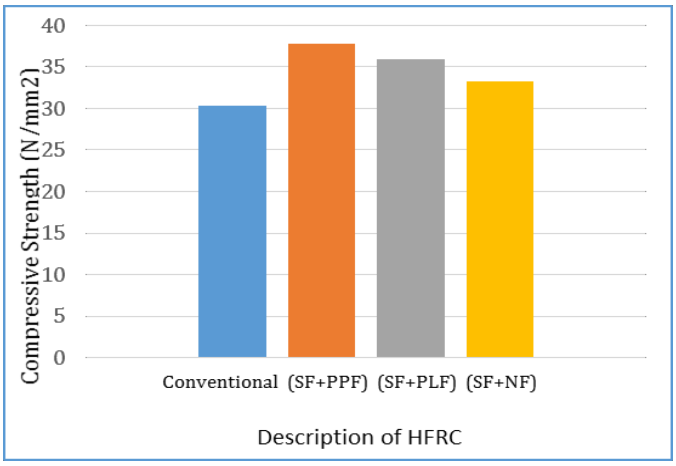


Fig. 8- Graphical representation of compressive strength.

4.3 Tensile strength test results

Following table-11 gives the tensile strength test resultsand following fig. 9 gives the graphical representation of tensile strength.

Table 11- Tensile strength test results

Description of concrete	Tensile strength (MPa)	% increase or decrease tensile strength w.r.t reference mix
Conventional concrete (Ref. mix)	**2.4**	**0**
Steel + Polypropylene fibre	**3.54**	**47.5**
Steel + Polyester fibre	**2.97**	**23.75**
Steel + Nylon fibre	**2.83**	**17.92**

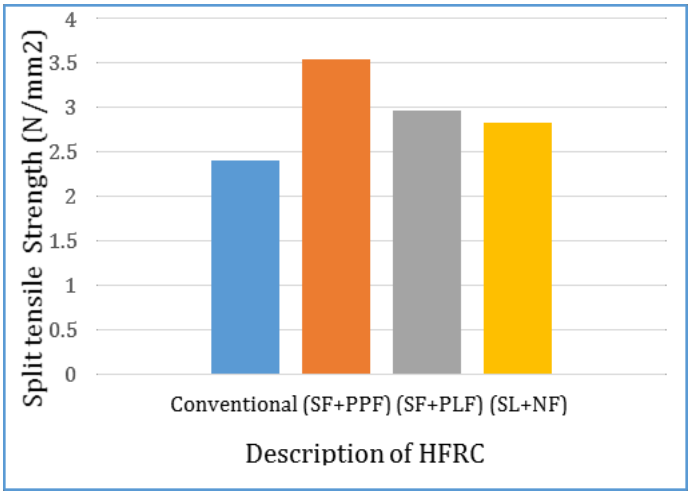


Fig. 9- Graphical representation of tensile strength.

4.4 Flexural strength test results

Following table-12 gives the flexural strength test results and following fig. 10 gives the graphical representation of flexural strength.

Table 12- Flexural strength test results

Description of concrete	Flexural strength (MPa)	% increase or decrease flexural strength w.r.t reference mix
Conventional concrete (Ref. mix)	**4.73**	**0**
Steel + Polypropylene fibre	**10.3**	**117.75**
Steel + Polyester fibre	**9.23**	**95.13**
Steel + Nylon fibre	**8.57**	**81.18**

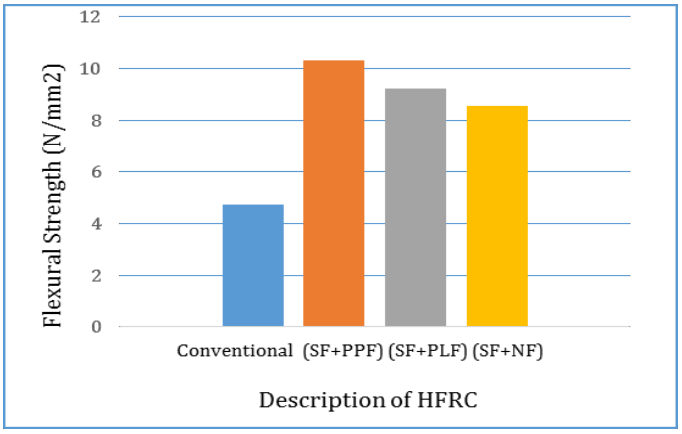


Fig. 10- Graphical representation of flexural strength.

4.5 Shear strength test results

Following table-13 gives the shear strength test results and following fig. 11 gives the graphical representation of shear strength.

Table 13- Shear strength test results

Description of concrete	Shear strength (MPa)	% increase or decrease shear strength w.r.t reference mix
Conventional concrete (Ref. mix)	**4.26**	**0**
Steel + Polypropylene fibre	**16.85**	**295.53**
Steel + Polyester fibre	**13.33**	**212.91**
Steel + Nylon fibre	**11.11**	**160.80**

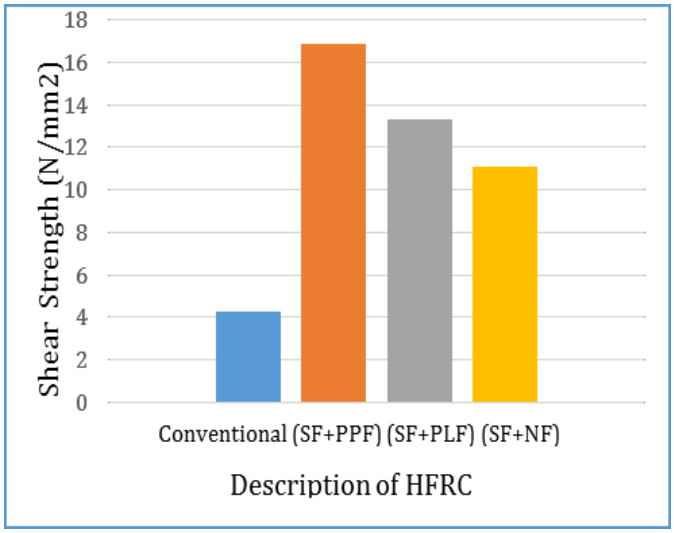


Fig 11- Graphical representation of shear strength.

4.6 Impact strength test results

Following table-14 gives the impact strength test results and following fig. 12 gives the graphical representation impact strength.

Table 14- Impact strength test results

Description of concrete	Impact strength (MPa)	% increase or decrease impact strength w.r.t reference mix
Conventional concrete (Ref. mix)	**2248.44**	**0**
Steel + Polypropylene fibre	**3187.57**	**41.76**
Steel + Polyester fibre	**3029.91**	**34.76**
Steel + Nylon fibre	**2303.28**	**2.43**

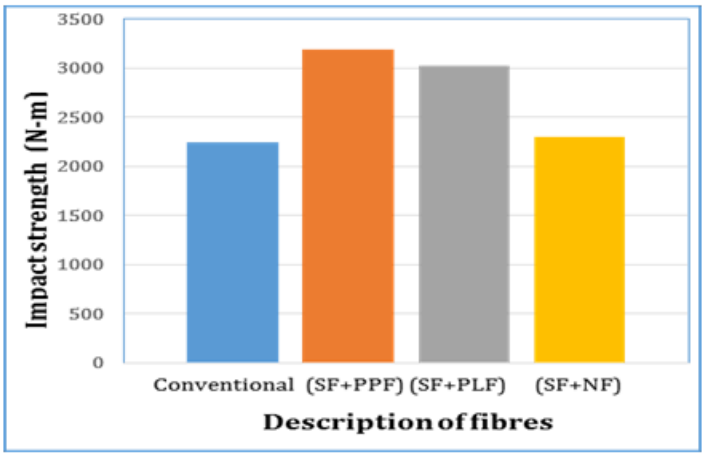


Fig. 12- Graphical representation of impact strength.

4.7 Results of sorptivity

Following table-15 gives the sorptivity results and following fig. 13 gives the graphical representation of sorptivity.

Table 15- Results of sorptivity

Description of concrete	Sorptivity ($mm/sec^{0.5}$)	% increase or decrease sorptivity w.r.t reference mix
Conventional concrete (Ref. mix)	**5.23**	**0**
Steel + Polypropylene fibre	**3.63**	**-30.59**
Steel + Polyester fibre	**4.45**	**-14.91**
Steel + Nylon fibre	**4.48**	**-14.34**

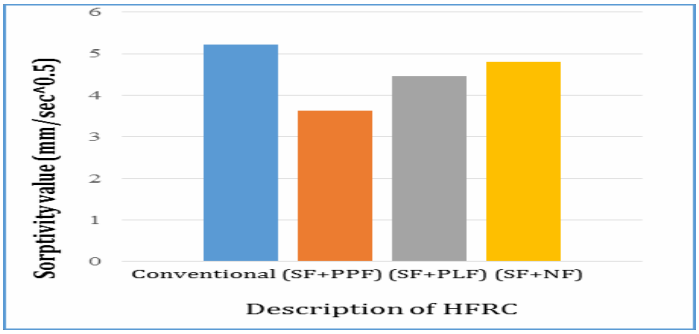


Fig. 13- Graphical representation of sorptivity

4.8 Results of RCPT

Following table-16 gives the RCPT results andfollowing fig. 14 gives the graphical representation of RCPT.

Table 16– Results of RCPT

Description of concrete	RCPT value (coulombs)	% increase or decrease RCPT value w.r.t reference mix
Conventional concrete (Ref. mix)	**1571.67**	**0**
Steel + Polypropylene fibre	**897.93**	**42.86**
Steel + Polyester fibre	**953.28**	**39.34**
Steel + Nylon fibre	**1073.61**	**31.68**

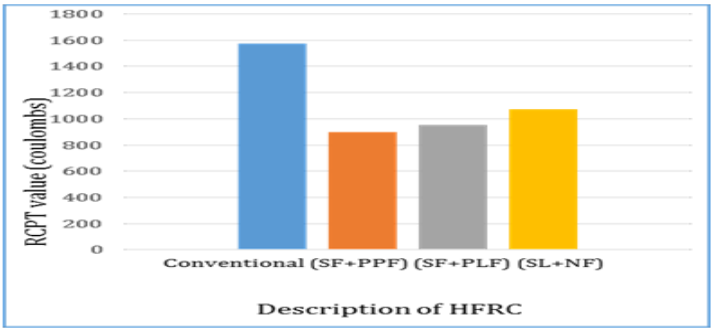


Fig. 14– Graphical representation of results of RCPT

5. CONCLUSIONS

1) Workability exhibited by the hybrid textile fibre reinforced concrete is very low. The workability of concrete produced by (steel fibre + polyester fibre) is comparatively higher than concrete produced by(steel fibre + polypropylene fibre) and (steel fibre + nylon fibre fibre).

2) Compressive strength, split tensile strength, flexural strength, shear strength and impact strength of hybrid textile fibre reinforced concrete is higher as compared to the conventional concrete without fibres. Also the hybrid textile fibre reinforced concrete produced from the combination of (steel fibre + polypropylene fibre) exhibits higher compressive strength as compared to that of (steel fibre + polyester fibre) and (steel fibre + nylon fibre).

3) Sorptivity of hybrid textile fibre reinforced concrete is much less as compared to the sorptivity of conventional concrete without fibres. The hybrid textile fibre reinforced concrete produced from the combination (steel fibre + polypropylene fibre) has exhibited least sorptivity as compared to that of (steel fibre + polyester fibre) and (steel fibre + nylonfibre).

4) Chloride resistance of hybrid textile fibre reinforced concrete is much higher as compared to conventional concrete without fibres. Also hybrid textile fibre reinforced concrete produce by the combination of fibres (steel fibre + polypropylene fibre) exhibits higher resistance to chloride attack ascomparedtothat of (steel fibre + polyester fibre) and (steel fibre + nylon fibre).

5) Finally it may be concluded that the hybrid textile fibre reinforced concrete produced with the combination of fibres such as (Steel fibre + Polypropylene fibre), (Steel fibre + Polyester fibre), (Steel fibre + Nylon fibre) may be used in the production of pre-cast structural elements.

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BIOGRAPHIES

Name: Gajanan Akkimaradi, M.Tech (Structural Engineering) student Department of Civil Engineering, Government Engineering College, Haveri, Karnataka, India

Name: Prof. Kashinath B. Rugi Department of Civil Engineering, Government Engineering College, Haveri, Karnataka, India

Name: Dr. K. B. Prakash, Principal, Government Engineering College, Haveri, Karnataka, India

Name: Dr. Jagadish G. Kori, Head of the Civil Engineering Department, Government Engineering College, Haveri, Karnataka, India