Experimental Investigation on Mechanical Properties of HYBRID Fibre Reinforced Concrete

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Abstract— A concrete has strong in compression and weak in tension, impact and flexure. To overcome these properties we need to add some addition to concrete like fibres. Fibres are giving some additional tensile,flexure and impact strength to concrete. In this investigation we are adding synthetic and metallic fibres like hybrid(steel+ polypropylene) with a fibre dosage of 0.5%, 1%, 1.5% were dispersed into the concrete of mix design M30 grade. The results are compared with conventional concrete and mono fiber so that here increasing the fibre dosage in concrete gradually increasing in compressive strength, split tensile strength flexure strength and impact resistance respectively for28 days curing period .so finally while using fibres in concrete we are going to transfer brittle failure to ductility property.

Key words: Fibre reinforced concrete, Steel fiber, polypropylene fiber, Compressive strength, Split tensile strength, Flexural strength

I. INTRODUCTION

Concrete is the most widely used construction material in this world. Generally concrete has low ductility, tensile and impact resistance on bridge decks, Aircrafts etc.,

Concrete has little ability to resist tensile stresses and strains due to its brittle behavior. Fibers are randomly added to conventional to enhance its desired engineering properties. Hence hybrid fibers are added with concrete mix. Higher fiber dosage caused decrease in compressive strength. It was found that adding more fibre dosage beyond a limit would have adverse affect on strength parameters. Due to an increasing use of FRC (fibre-reinforced concrete) in construction like bridge decks and military industries against impact loads, these concretes are important role in human life. Sai abhinav et al.[1] concluded that increasing the fibre dosage there is increase in impact resistance of fibre reinforced concrete. G.Jagadeesh et al[2] investigate on polypropylene fibre reinforced concrete and finally concluded that while fibres increasing there increase in mechanical properties. Harika et al [3] investigate on Sisal fibre reinforced concrete and finally concluded that while fibres increasing there is decrease in compressive strength. The aspect ratio (L/d) and volume fraction (Vf) are important fibres parameters in FRC. When cracks are initiated in FRC, the fibres bear the applied loads, when the load increases the fibres tend to transmit the excess stresses to the matrix. Thus, fiber reinforced concretes are more ductile than other concretes.

It was reported that hybrid fibers were effective in improving mechanical properties of the concrete.. The main objective of this project is to study the mechanical properties of fiber reinforced concrete with mix proportion of fibers for M30 grade concrete and comparing with the conventional concrete and mono fiber concrete to know the optimum percentage of addition of fibres to concrete and finding maximum ratios.

II. EXPERIMENTAL STUDY

The experimental investigation was focused on the effect of various fiber dosages on mechanical properties of FRC. Mix proportion was designed using IS 10262-2009 and IS 456-2000 with mean target strength of 38.25 MPa (M30) for control mix.[4]

Ordinary Portland cement (type 1) was used in this study. A coarse aggregate with a maximum nominal size of 20 mm and a fine aggregate with a fineness modulus of 3.4 were used in the experiment. Hybrid fibers (steel+polypropylene) were used; their geometry and apparent shape are shown in Fig. 1 and their properties are listed in Table 1. Super plasticizer of SP-430 was used to adjust the workability of mixtures.

Fig. 1: Steel and Polypropylene fibres

Fibre	Diameter (μm)	Specific Gravity	Modulus of Elasticity (GPa)
Steel	5-500	7.84	200
Polypropylene	20-400	0.9-0.95	3.5-10

Table 1: Physical Properties of fibres

Crushed granite stones of size 20 mm and 10 mm were used as coarse aggregate and river sand was used as fine aggregate. The bulk specific gravity in oven dry condition and water absorption of the coarse aggregate 20 mm and 10mm were 2.58 and 0.3% respectively. The bulk specific gravity in oven dry condition and water absorption of the sand were 2.62 and 1% respectively.

III. MIX DESIGN

In this study, water cement ratio of 0.5 was adopted for M30 grade concrete and Sisal of 0.5%, 1%, 1.5% volume fractions were used.

Constituents	Content KG/ m^3 of concrete

Cement	394.32
Fine aggregate	623.45
Coarse aggregate	1097.81
Water content	197.16
Fibres	
0.5%	11.56
1%	23.12
1.5%	34.69
Super plasticizer	9.38

Table 2: Content of mix proportions used

IV. TEST METHOD

A. *Details of specimen preparation*

Cubes of size 150 mm were used to evaluate the compressive strength of HFRC. Cylinders of size 150 mm x 300 mm were used to determine the split tensile strength. Flexural strength of HFRC was evaluated using 100 mm x 100 mm x 500 mm beams. Steel moulds were used for casting the specimens. Concrete was poured in mould in 3 layers and each layer was vibrated for 15 sec after placing it on the vibrating table for proper compaction. Smooth surface was ensured by properly levelling the surface of the specimen. Specimens were removed from the moulds after 24 hrs of casting and immersed in clean water for 28 days. Specimens were prepared for fibre dosages of 0.50%, 1.00% and 1.50% of volume of concrete in addition to samples of control mix. Three specimens were prepared for each test and average value was obtained.

Fig. 2: Compressive strength

Fig. 3: split tensile strength

Fig. 4: Flexure set up

V. RESULTS & DISCUSSION

A. *Compressive strength:*

Compressive strength is the capacity of material to with stand loads tending to reduce size. The compressive strength of concrete cube of size (15cmx15cmx15cm) for dosage of fibre 0.5%,1%,1.5% is given by following table 2 for the curing period of 28 days.

Fibre dosage (%)	compressive strength SFRC 28 DAYS	compressive strength PPFRC 28 DAYS	compressive strength S+PPFRC 28 DAYS
PCC	40.62	40.62	40.62
0.50%	42.13	39.64	43.56
1.00%	43.71	40.73	45.87
1.50%	45.07	41.04	46.88

Table 3: Compressive strength of HFRC at 28 days curing

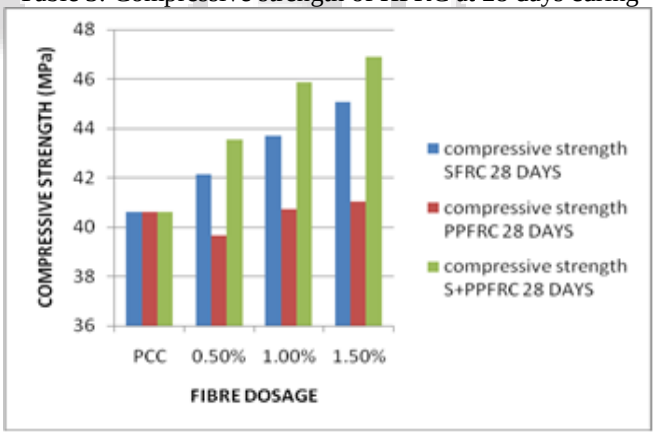

Fig. 5: Compressive strength of HFRC at 28 days curing

By observing the table readings we can say that, with the increase in dosage of fibre and with curing period of concrete the compressive strength of concrete cube gradually increasing. The compressive strength of concrete is increases with minimum percentage of dosage is 0.5%

B. *Split tensile strength:*

Fibre dosage (%)	Split tensile strength SFRC 28 DAYS	Split tensile strength PPFRC 28 DAYS	Split tensile strength S+PPFRC 28 DAYS
PCC	3.13	3.13	3.13
0.50%	3.32	3.12	3.45
1.00%	3.58	3.21	3.63

1.50%	4.13	3.31	4.27

Table 4: Split tensile strength of HFRC at 28 days curing

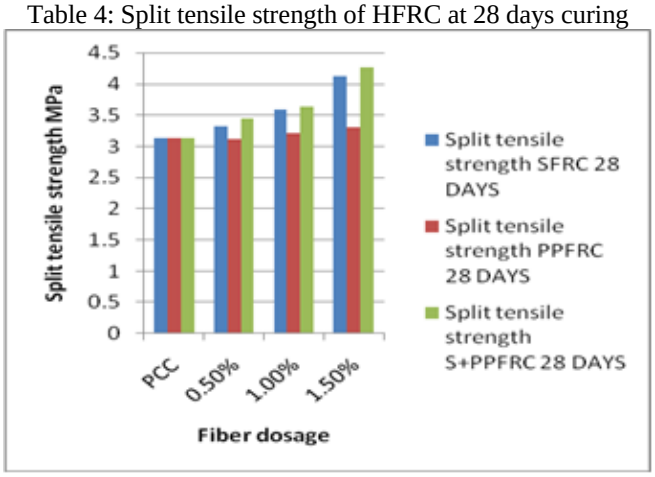

Fig. 6. Split tensile strength of HFRC at 28 days curing

From the table observation we can say that with increase of fibre dosage and curing period fibre reinforced concrete the split tensile strength of fibre reinforced concrete increased. The maximum split tensile strength of fibre reinforced concrete is 4.27 N/mm^{2}and is occurred at 1.5% dosage of fibre at a curing period of 28 days. The graphical representation of split tensile strength of HFRC and various dosage of fibre content is given in fig4 for curing period 28 days.

C. Flexural strength:

Tensile strength of fibre reinforced concrete is estimated by using flexural strength of fibre reinforced concrete. It calculates an unreinforced concrete beam or slab to resist failure occurred under bending.

Fibre dosage (%)	Flexure strength SFRC 28 DAYS	flexure strength PPFRC 28 DAYS	flexure strength S+PPFRC 28 DAYS
PCC	4.38	4.38	4.38
0.50%	4.67	4.4	4.73
1.00%	4.98	4.6	5.07
1.50%	5.68	4.79	5.77

Table 5: Flexural strength of PFRC at 28 days curing

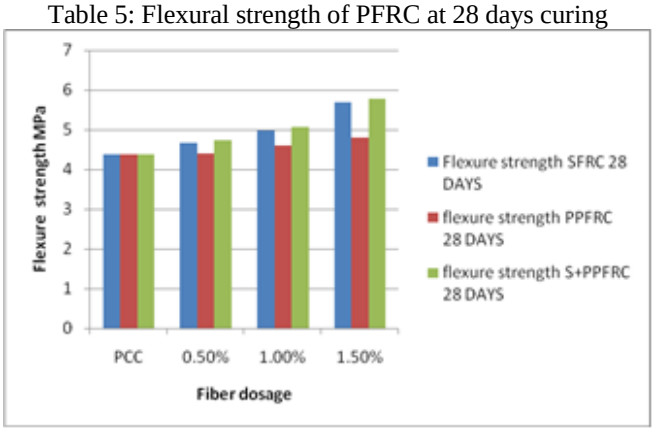

Fig. 7: Flexure strength of HFRC at 28 days curing

From the table observation we can say that with increase of fibre content and curing period of HFRC the flexural strength of HFRC increased. The maximum Flexural strength of HFRC is 5.77N/mm2 and occurred at fibre dosage 1.5% and for a curing period of curing period of 28 days. The graphical representation of flexural strength of HFRC and various dosage of fibre content is given in fig 7 for curing period 28 days.

VI. Conclusions

Based on the results of this experimental investigation, the following conclusions can be drawn:

1) Hybrid fibers were been effective in improving compressive strength, split tensile strength and flexural strength of the concrete compared to PCC.
2) Compressive strength of concrete increased with increase in fiber dosage of 0.50%.
3) Split tensile strength of concrete slightly increased with increase in fiber dosage and the maximum Flexural& split tensile strength attained for a fiber dosage of 1.50%
4) Flexural strength having more increment when compared to split tensile strength and compressive strength.

References

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