Experimental Investigation of Hybrid Fiber Reinforced Concrete

Vijay A. Netragaonkar[1] Prof. G. N. Shete[2]
[1]M. Tech Student [2]Assistant Professor
[1,2]Department Civil Engineering
[1,2]M. S. Bidve Engineering College, Latur-413512, Maharashtra, India

Abstract— Hybrid fiber reinforced concrete is defined as concrete that reinforced by two or more types of fibers. The aim of this study is to study the mechanical properties of hybrid fiber reinforced concrete. Where the fibers used were consists of nylon fiber and carbon fiber. For this purpose four mixes are done. One normal concrete mix and three hybrid fiber reinforced concrete mixes were prepared. The nylon fiber of various ratio are 0.25%, 0.5%, 0.75% and carbon fiber of various ratio are 0.1%, 0.2%, 0.3% are mixed on volume of concrete. The concrete mix design is used as per IS: 10262-2009 in M30 grade. Total percentage of Fiber are 0.35%, 0.7%, 1.05%. Slump test was carried out for each mix in the fresh state in order to determine the workability of the hybrid fiber reinforced concrete. From the slump test all specimens show low workability. 3.8% increase in the compressive strength of the Hybrid Fiber Reinforced Concrete (HYFRC), 1.6% increase in the tensile strength of the HYFRC, and 31% increase in flexural strength of HYFRC.

Keywords: Carbon fiber, Nylon Fiber, Workability, Compressive, Tensile, Flexural strength

I. INTRODUCTION

Fiber Reinforced Concrete is concrete containing fibrous material. The fiber can make the failure mode more ductile by increasing its tensile strength of concrete. It contains short distinct fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers each of having different properties. In addition, the character of fiber reinforced concrete changes with geometries, distribution, orientation, and densities. In a hybrid, two or more different types of fibers are rationally combined to produce a composite that derives benefits from each of the individual fibers and exhibits a synergistic response. The hybrid combination of metallic and non-metallic fibers improving concrete properties as well as reducing the overall cost of concrete production.

Addition of short fibres plays an important role in the improvement of mechanical properties of Concrete. It increases elastic modulus, decreases brittleness, controls cracks. its. Fibre require more energy absorption, resulting in a substantial increase in the toughness and fracture resistance of the materials to the cyclic and dynamic load.

A. Types of Fibre Reinforced Concrete

1) Steel Fibre Reinforced Concrete
2) Polypropylene Fibre Reinforced Concrete
3) Glass Fibre Reinforced Concrete
4) Carbon Fibre Reinforced Concrete
5) Nylon Fibre Reinforced Concrete

II. EXPERIMENTAL PROGRAM

Cement: Local available PPC is used.

Fine aggregate: Locally available with specific gravity 2.63, water absorption 2%

Coarse aggregate: Locally available, maximum size 20 mm, specific gravity 2.68

Water: Potable water was used for the experimentation.

Carbon Fiber: In this experiment chopped carbon fiber are used having size 12 mm.

Nylon Fiber: Nylon fiber of length 18 mm were used.

Different proportion of nylon and carbon fiber are shown below table:

Notation (%)	Nylon fiber by volume of Concrete (%)	Carbon fiber by volume of Concrete (%)
0	0	0
0.35	0.25	0.1
0.70	0.5	0.2
1.05	0.75	0.3

Table 1: Different proportion of fibers used:

Concrete for M30 grade were prepared as per IS 10262:2009 with w/c 0.4

Mix proportion for M30 grade concrete for tested material as follows:

Material	Quantity
Cement	479 Kg/m^3
Sand	655.60 Kg/m^3
Coarse Aggregates	1091.59 Kg/m^3
Water	191.58 Kg/m^3

Table 2: Concrete mix proportions.

III. WORKABILITY

The workability of M30 grade of concrete is measured by widely used empirical test i.e. slump test with w/c ratio 0.4 for addition of different percentage fiber.

Values obtain for different percentage mix is as show in following table

% of Hybrid Fiber concrete		Slump Value (mm)
Nylon Fiber	Carbon Fiber	
0%	0%	100
0.25%	0.1%	97
0.50%	0.2%	94
0.75%	0.3%	89

Table 3: Slump values for different percentage of mix

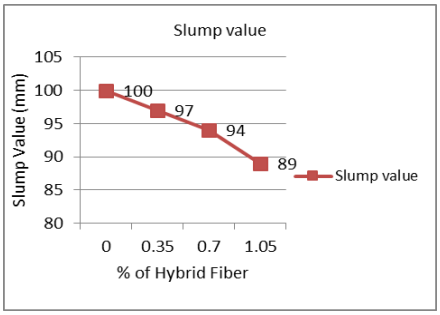

Fig. 1: Slump values for different percentage of mix

IV. EXPERIMENTAL METHODOLOGY

A. Compressive Strength Test:

Compressive strength test, cube specimens of dimension 150 x 150 x 150 mm were cast for M30 grade of concrete. The moulds were filled with 0%, 0.35%, 0.70%, 1.05% of fibers. Tamping was done while filling the cubes. The top surface of specimen was leveled and finished. After 24 hour the specimen were remolded and were transferred to curing tank wherein they were allowed to cure for 7 days and 28 days. After 7 and 24 days curing, these cube were tested on digital compression testing machine as per I.S. 516-1959. The failure load was noted. In each category, three cube were tested and their average value is reported. The compressive strength was calculated as follows:

Compressive strength (N/mm^2) = Failure load/ Cross sectional area.

B. Tensile Strength Test:

Knowledge of tensile strength of concrete is of great importance. Tensile strength determine by side splitting method. Splitting cube along its middle parallel to the edges by applying two opposite compressive forces along two opposite edges. Tensile strength is determine by $0.642P / S^2$.

P = Failure load

S^2 = Area of cube

C. Flexural Strength Test:

Flexural test on beams were carried out in universal testing machine of capacity 1000KN. Deflectometer were fixed to measure the deflection at salient points. The load acting at two points. The load was applied without shock and increased until failure occurs. The load-deformation pattern was plotted and maximum load applied to the specimens were recorded. The flexural strength 150 x 150 x 700 mm specimens were tested. The flexural strength of the specimens were calculated by the following equation:-

$$Fr = \frac{PL}{bd^2}$$

V. EXPERIMENTAL RESULTS

A. Compressive Strength

The result of compressive strength for M30 grade of concrete on cube specimen with 0% HFRC, 0.25N0.1C, 0.50N0.2C and 0.75N0.3C fibers are shown in table and graph below:

% NF	% CF	Compressive Strength (N/mm^2)	
		7 Days	28 Days
0%	0%	22.79	38.70
0.25%	0.1%	25.37	40.19
0.50%	0.2%	22.25	35.06
0.75%	0.3%	17.86	32.32

Table 4: Results of Compressive strength

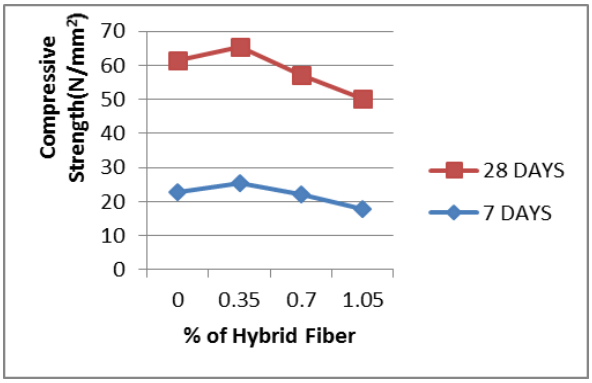

Fig. 2: Graphical result of Compression Test

B. Tensile Strength

The result of Tensile strength for M30 grade of concrete on cube specimen with 0% HFRC, 0.25N0.1C, 0.50N0.2C and 0.75N0.3C fibers are shown in table and graph below:

% NF	% CF	Tensile Strength (N/mm^2)	
		7 Days	28 Days
0%	0%	14.62	24.9
0.25%	0.1%	16.28	25.30
0.50%	0.2%	14.28	22.44
0.75%	0.3%	11.55	20.75

Table 5: Results of Tensile strength

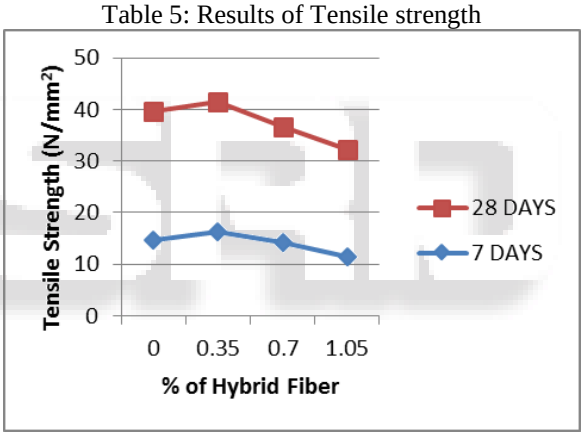

Fig. 3: Graphical result of Tensile Test

C. Flexural Strength

Testing of all beam specimens with two points loading for flexural strength. The results of flexural strength were plotted in below table for 28 days. Result indicate that if we increase percentage of hybrid give us good results and help to increase flexural strength of concrete.

% NF	% CF	Flexural Strength (N/mm^2) 28 Days
0%	0%	6.28
0.25%	0.1%	8.25
0.50%	0.2%	7.88
0.75%	0.3%	4.31

Table 6: Results of Flexural strength

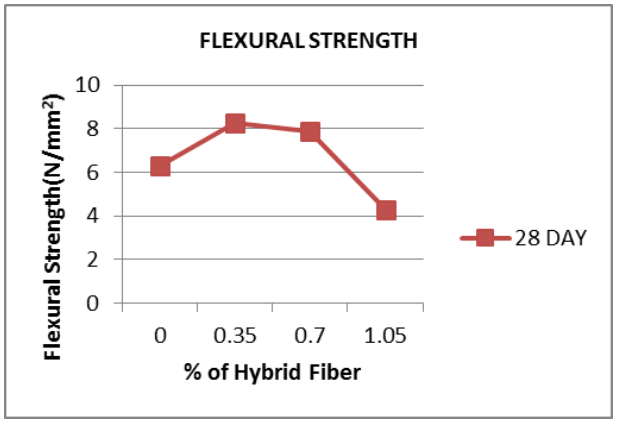

Fig. 4: Graphical result of Flexural Strength

VI. CONCLUSION

Based on results and observation made in experimental research study. The following conclusions are drawn.

It is observe that with increase in percentage of Nylon Fiber and Carbon Fiber workability decreases.

The crack formation is very small in fiber specimen compare to the non fiber specimen.

3.8% increment in the compressive strength of concrete by addition of 0.25% nylon fiber and 0.1% carbon fiber with respect to volume in concrete as compare to conventional concrete by using aggregate cement ratio (A/C) is 3.6 and water cement ratio (W/C) is 0.4.

31% increment in the flexural strength is found by addition of 0.25% nylon fiber and 0.1% carbon fiber in concrete as compare to conventional concrete by using aggregate cement ratio (A/C) is 3.6 and water cement ratio (W/C) is 0.4

1.6% increment in the Tensile strength of concrete by addition of 0.25% nylon fiber and 0.1% carbon fiber with respect to volume in concrete as compare to conventional concrete by using aggregate cement ratio (A/C) is 3.6 and water cement ratio (W/C) is 0.4.

REFERENCES

[1] E. Mello, C. Ribellato, E. Mohamedelhassan "Improving Concrete Properties With Fibers Addition" International Journal of Civil and Environmental Engineering | Vol. 8, No.3, 2014

[2] S. M. Kinayekar, Dr. V. D. Gundakalle, Kishor Kulkarni "The Effect of Addition of Carbon Fiber on Mechanical properties of High Strength Concrete" International Journal of Innovative Reasearch in Science, Engineering and Technology. ISSN:2319-8753

[3] J. Saxena and A. Saxena "Enhancement the Strength of Conventional Concrete by using Nylon Fiber" International Journal Of Engineering And Science Vol.5, Issue 2 (February 2015), pp 56-59, ISSN (e): 2278-4721, ISSN (p):2319-6483

[4] Anirudha Swami, Shishr Gupta "Use of Nylon Fiber in Concrete" IJSRD – International Journal for Scientific Research & Development | Vol. 4, Issue 05, 2016 | ISSN (online): 2321-0613

[5] E. Siva Subramanian, V.R. Vaishnave, V.T.S. Vignesh "Experimental Investigation of Concrete Composite Using Nylon Fiber" International Jouranl of Engineering Science & Research Technology ISSN: 2277-9655 Impact Factor: 4.116 December, 2016

[6] K.Manikandan, A.Arun kumar, M.Deepak kumar, V.Manikandan, K.Satish kumar "Experimental Investigation On Nylon Fiber Reinforced Concrete" International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 03 | Mar – 2017 e-ISSN: 2395-0056 p-ISSN: 2395-0072

[7] S. M. Deore, J. S. Bodke, R. V. Aware, C. V. Ahire, P. M. Kamble, Prof. A. R. Pendhari "Addition of carbon fiber in concrete with partial replacement of Sand by Waste Foundry Sand." e-ISSN:2395-005| p-ISSN: 2395-0072.

