International Journal of Modern Trends in Engineering and Research
www.ijmter.com
e-ISSN No.:2349-9745, Date: 2-4 July, 2015

Behaviour of Hybrid Fiber Reinforced Concrete Deep Beamsin Flexure & Shear

Prof. Sangita V Pawar[1], Prof. Pravin B. Shinde[2], Prof.V. P. Kulkarni[3]
[1,2]Department of Civil, Sanghavi College of Engineering, Nashik, India
[3]Department of Civil, Amrutvahini College of Engineering, Sangamner, Ahemadnagar, India
sangita.pawar23@gmail.com shindepravin448@gmail.com royalvpk@gmail.com

Abstract-Concrete is most widely used construction material in the world. The addition of fibers into concrete mass can dramatically increase the compressive strength, tensile strength, flexural strength, shear strength and impact strength of concrete.Hybrid Fiber Reinforced Concrete (HyFRC) is formed from a combination of different types of fibres, which differ in material properties, remain bonded together when added in concrete and retain their identities and properties. The combining of fibers often called as hybridization.
In this paper the strength of concrete cubes, cylinders and beams cast using M 30 grade concrete and reinforced with flat crimped steel and polypropylene fibres are presented. This paper addresses the flexure and shear behavior of hybrid fibre reinforced concrete deep beams. The shear span to depth ratio of the beams used in this investigation was maintained as 1.66.
The characteristic strength of concrete considered as f_{ck}30 MPa.The specimens incorporated steel and polypropylene fibres in the mix proportions of 0-0%,0-100 %, 25-75%, 50-50%, 75-25%, 100-0% by volume at a total volume fraction of 1.0%.
Keywords-Deep Beam; Polypropylene Fibre; Flat Crimped Steel Fibre; Split Tensile Strength; Flexural Strength; Shear Strength

"I. INTRODUCTION"

Cement mortar and concrete made with Portland cement is a kind of most commonly used construction material in the world. These materials have inherently brittle nature and have some dramatic disadvantages such as poor deformability and weak crack resistance in the practical usage. Also their tensile strength and flexural strength is relatively low compared to their compressive strength.In order to improve the mechanical properties of concrete it is good to mix cement with fibre which have good tensile strength. Concrete is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. The hybrid combination of metallic and non-metallic fibres can offer potential advantages in improving concrete properties as well as reducing the overall cost of concrete production.

"II. LITERATURE REVIEW"

M.V. Krishna Rao [10] Presented the behavior of deep beams is different from that of shallow beams in which the bending stress distribution is linear across the depth and the shear failure is ductile. He also addresses the flexure and shear behaviour of polypropylene fibre reinforced fly ash concrete (PFRFAC) deep beams.The variables of study include the Characteristic strength of concrete, fck (15.0 MPa, 20.0 MPa, and 25.0 MPa) and polypropylene fibre content (0%, 0.5% and 1%). The test results indicate that compressive strength of concrete increases with the increasing percentage of fibre. There has been a significant increase in flexural and shear strengths of PFRFAC.

This paper addresses the flexure and shear behavior of hybrid fibre reinforced concrete deep beam in which effective span to depth ratio was maintained as 1.66.The load deflection response of the beams with varying fibre content is investigated. Also mechanical properties of HyFRC were calculated i.e compressive strength and split tensile strength for different fibre proportions. The variables considered in this study include fibre content (steel and polypropylene %) i.e 0-0%, 0-100%, 25-75%, 50-50%, 75-25%, 100-0%.

"III. SELECTION OF INGREDIENTS AND MATERIALS"

3.1Material Properties

3.1.1 Cement

After reviewing all requirements 53 grade Ultra tech ordinary Portland cement is used throughout experiment. Cement is tested in laboratories and test results are as follows:

Table 3.1 Cement properties

Sr No	Description of Test	Results
1.	Fineness of cement (residue on IS sieve No.90 micron)	3 %
2.	Specific Gravity	3.15
3.	standard consistency of cement	29%
4.	Setting time of cement a) Initial setting time b) Final setting time	 100 minute 293 minute
5.	Soundness test of cement (with Le-Chatelier'smould)	1.7 mm
6.	Compressive strength of cement a) 3 days b) 7 days	 25.98 N/mm^2 37.1 N/mm^2

3.1.2 Fine Aggregate (Sand)

River sand of PravaraRiver is used as a fine aggregate. Table 3.2 shows the test results of coarse aggregate.

Table: 3.2 Physical Properties of Fine Aggregates (Sand)

Sr. No	Property	Results
1	Particle Shape, Size	Round 4.75 mm down
2	Fineness Modulus	3.17
3	Silt Content	2 %
4	Specific Gravity	2.65
5	Bulk Density	1793 kg/m^3
6	Surface Moisture	Nil
7	Water absorption	1 %

Table 3.3 Physical Properties of coarse Aggregate

Sr No	Property	Results
1	Particle Shape, Size	Angular, 20mm, 10mm down
2	Fineness Modulus of 20 mm aggregates	7.4
3	Specific Gravity	2.68
4	Water Absorption	0.6%
5	Bulk density of 20mm aggregates	1603 kg/m^3
6	Surface moisture	Nil

3.1.3 Coarse Aggregate

Locally available crushed stone aggregates with size 5mm to 12.5 mm and of maximum size 20 mm are used. Table 3.3 showsthe test results of coarse aggregate.

3.2 Physical Properties of Flat Crimped Steel Fibers

Material Purchase: M&J International E, Hatkesh industrial Estate, Mira Bhayander Road, Mira Road (East) Mumbai.

Table 3.4 Physical properties of steel fibers (Supplied by manufacture)

Sr. No.	Property	Values
1.	Diameter	0.55 mm
2.	Length of fiber	25mm to 50mm
3.	Width	2 to 2.5 mm
4.	Average aspect ratio	40 to 90
5.	Deformation	Continuously deformed circular segment
6.	Tensile Strength	400 to 600Mpa
7.	Specific Gravity	7.8
8.	Bond Factor	1

Table 3.5 Physical Properties of polypropylene fibers

Sr. No	Properties	Remark
1	Length	12 mm
2	Construction	Fibrillated
3	Melting Point	165^0 C
4	Absorption	Nil
5	Elongation	15%

3.3 Properties of Polypropylene Fibers

The material recruitment is done from "Dolphin Floats" situated at Bhosari M.I.D.C. Pune.It is used at 0.9 kg per m^3 of concrete (minimum).Table 3.5 Shows Physical Properties of polypropylene fibers.

"IV.RESULT AND DISCUSSION"

In present study cube compression test, split tensile test, flexure and shear test on beams on plain and varying hybridization ratio of steel and polypropylene fibres reinforced concrete at 1% fibre volume fraction by volume of concrete are carried out.The experimental results and discussion for various test results are described below:

4.1Test result Flexural strength

In flexure test, all beams are tested under two-point loading in universal testing machine of 100 tonnecapacity.

Table 4.1 Test Result for flexure

% of fiber (St-Pol)	Beam No	Load at 1st crack W_w(kN)	Ultimate Load W(kN)	Avg. Ultimate Load W (kN)	P=W+2.25(kN)	BM_E (atcentre) kN.m	F_b=Flexure strength= PL/bd^2 N/mm^2
0-0	B_1	196	495	491.5	493.75	82.57	9.143
	B_1	187	488				
0-100	B_2	200	511	518	520.25	86.98	9.63
	B_2	210	525				
25-75	B_3	225	541	533	535.25	89.48	9.9120
	B_3	231	534				
50-50	B_4	239	554	556	558.25	93.32	10.33

	B_4	242	558				
75-25	B_5	281	590	594	596.25	99.65	11.04
	B_5	278	598				
100-0	B_6	256	569	570	572.25	95.65	10.59
	B_6	268	571				

4.2 Test result for shear

In shear test, all beams are tested under two-point loading in universal testing machine of 100 tonne capacity.

Table 4.2 Test results for shear

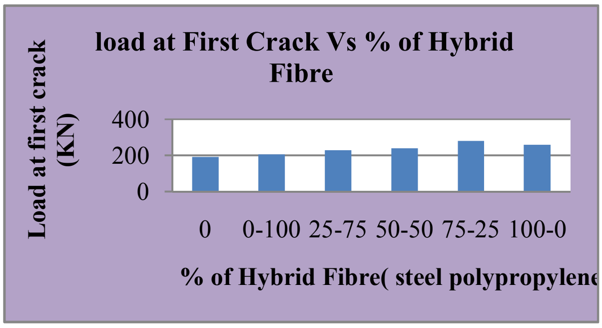
% of fiber (St-Pol)	Beam No	Load at 1st crack W_w(kN)	Ultimate Load W(kN)	Avg. Ultimate Load W (kN)	P=W+2.25 (kN)	SF_A kN	Shear strength N/mm^2
0-0	B_1	230	544	547.5	549.75	276	3.066
	B_1	245	551				
0-100	B_2	261	563	567	569.25	285.75	3.166
	B_2	265	571				
25-75	B_3	273	578	584.5	589.75	294.5	3.2722
	B_3	278	591				
50-50	B_4	285	598	600	602.25	302.25	3.358
	B_4	298	602				
75-25	B_5	329	646	642.5	644.75	323.5	3.59
	B_5	335	639				
100-0	B_6	315	613	610.5	612.75	307.5	3.4166
	B_6	319	608				

"V.GRAPHICAL REPRESENTATION"

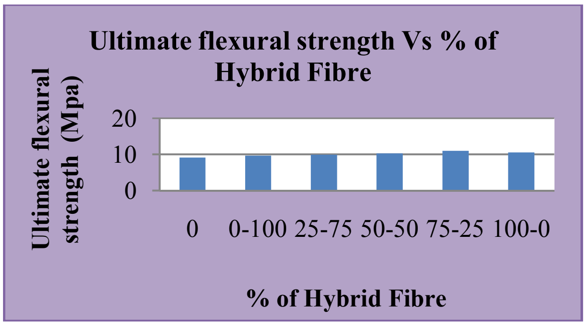
5.1 Flexure strength

5.1.1 Load at first crack in flexure

The variation in load at first crack with percentage of hybrid fibre is shown in graph 5.1.



Graph 5.1 Variation of load @ first crack in flexure With percentage of hybrid fibre(steel-polypropylene)



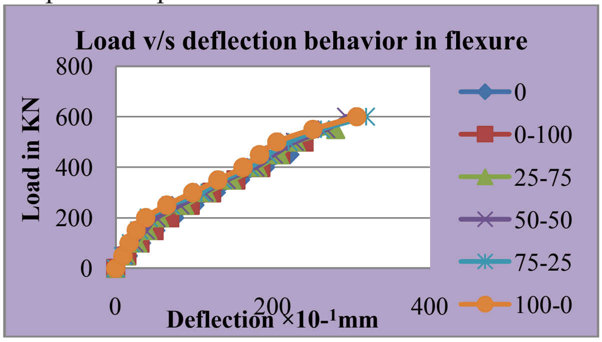
Graph 5.2 Variation of flexural strength with percentage of hybrid fibre(steel- Polypropylene)

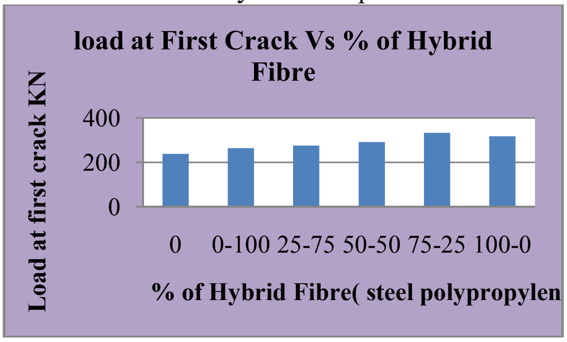
5.1.2 Ultimate flexural strength

Graph 5.2 depicts the variation of ultimate flexural strength with percentage of hybrid fibrecontent.

5.1.3 Load deflection behavior in flexure

Graph 5.3 depicts the variation of deflection with load in flexure of HyFRC deep beams.





Graph5.3 Loadv/s deflection behaviors in flexure

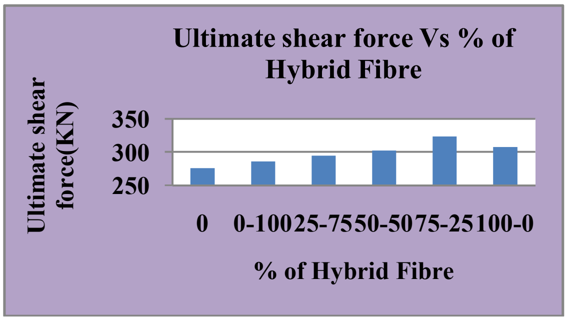
Graph 5.4 Variation of load @ first crack in shear With percentage of hybrid fibre(steel-Polypropylene)

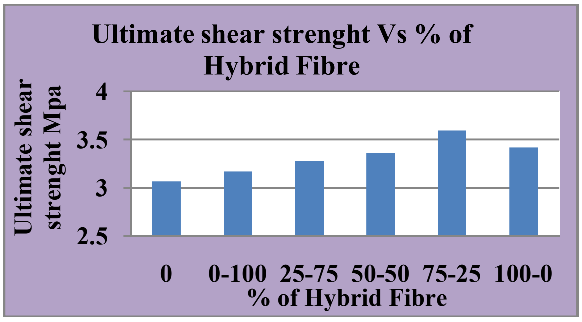
5.1.4 Load at first crack in shear

The variation in load at first crack with percentage of hybrid fibre is shown in graph 5.4.

5.1.5 Ultimate shear force

Graph 5.5 depicts the variation of ultimate shear force with percentage of hybrid fibre





Graph 5.5 Variation of Ultimate shear force With percentage of hybrid fibre (Steel-polypropylene)

Graph 5.6 Variation of shear strength with percentage of hybrid fibre (Steel-polypropylene

5.1.6 Ultimate shear strength strength

Graph 5.6 depicts the variation of ultimate shear strength with percentage of hybrid fibrecontent.

"VI. CONCLUSIONS"

Based on results of experimental investigations conducted on HyFRCcubes, cylinders and beams the following conclusions are drawn:

1) Compressive strength of HyFRC after 28 days for 75-25% (steel-polypropylene) hybridization ratio is maximum.It is increased by 19.95% with respect to normal concrete (i.e. Hybridization ratio 0-0%). At 28 days Compressive strength of SFRC (i.e. Hybridization ratio 100-0 %) is increased by 6.61% with respect to normal concrete & compressive strength of PPFRC (i.e. Hybridization ratio 0-100 %) increased by 6.21% with respect to normal concrete.

2) Split Tensile Strength of HyFRC Concrete for 28 Days Increases with Increasing Contribution of Steel Fiber in hybridization ratio. Split tensile strength of SFRC (i.e. Hybridization ratio 100-0%) is maximum. split tensile strength of SFRC (i.e. Hybridization ratio 100-0%) increases 41.61% & Split tensile strength of PPFRC (i.e. Hybridization ratio 0-100%) increases 6.35% with respect to normal concrete respectively.

3) Flexural strength of HyFRC for 75-25% &100-0% after 28 days is nearly same. Flexural strength of HyFRC with75-25% hybridization ratio and SFRC i.e. hybridization ratio 100-0% is increases 20.78% &15.86% respectively than normal cement concrete. Flexural strength of PPFRC (i.e. Hybridization ratio 0-100%) increased by 5.36% with respect to plain reinforced concrete deep beams.

4) The Load at first crack for shear of HyFRC (75-25%) deep beams is maximum than plain reinforced concrete deep beam having steel and polypropylene fibre content (0-0%) and different hybrid fibre content.

5)The ultimate shear strength of hybrid fibre reinforced concrete deep beam having (75-25%)steel and polypropylene fibre is increased 17.09 % than plain reinforced concrete deep beams having steel and polypropylene fibre content (0-0%).

6) The Load at first crack for flexure of HyFRC (75-25%) deep beam is maximum than plain reinforced concrete deep beam having steel and polypropylene fibre content (0-0%) and different hybrid fibre content.

7) The ultimate flexural strength of hybrid fibre reinforced concrete deep beam having (75-25%)steel and polypropylene fibre is increased 20.74 % than plain reinforced concrete deep beam having steel and polypropylene fibre content (0-0%).

8) The failure of hybrid fibre reinforced concrete deep beams was observed to be more ductile and gradual in comparison to plain reinforced concrete deep beams.

REFERENCES

[1] Faisal FouadWafa, "Properties and Applications of Fiber Reinforced Concrete",Journal of Engineering Science, 1990, Vol. 2, pp. 49-6.

[2] Mohammad Abdul Rashid,AhsanulKabir, "Behavior of Reinforced concrete deep beams under uniform loading", Journal of civil engineering,the institution of engineering, Bangladesh,1996, Vol.CE.24, No.2,pp.155-169.

[3] V.P.V. Ramana, T. Kanta , S.E. Morton, P.K. Dutta, A. Mukherjee, Y.M. Desai, "Behavior Of CFRPC Strengthened Reinforced Concrete Beams With Varying Degrees Of Strengthening", 2000, No.31, pp. 461-470.

[4] Saeed Ahmed, Imran A Bukhari, JavedIqbalSiddiquiandShahzad Ali Qureshi, "A Study On Properties Of Polypropylene Fiberreinforced Concrete" 31st Conference On Our World In Concrete & Structures, August 2006, Singapore,pp.1-10.

[5]G.Jeenu, U.R.Reji, and V.Syam Prakash," Flexural Behavior OF Hybrid Fibre Reinforced Self Compacting Concrete" Proceedings ofthe International Conference onOur World in Concrete & Structures, 2007, Singapore.

[6] Thamer H. Hanna," Shear Behavior of Fibrous High Strength Concrete Deep Beams Under Uniformly Distributed Loading", Journal ofZankoySulaimani, November 2007, Vol. 10, No.1, Part (A), pp 43-51.

[7] Vengatachalapathy.V, Ilangovan.R, "Study on Steel Fibre Reinforced Concrete Deep Beams with and without Openings" International Journal of Civil and Structural Engineering, 2010, Vol. 1, No 3, pp.509-517.
[8] S.P. Singh, A.P. Singh and V. Bajaj, "Strength and Flexural Toughness of Concrete Reinforced with Steel-Polypropylene Hybrid Fibres", Asian Journal of Civil Engineering (Building and Housing), 2010, Vol. 11, No. 4, pp.495-507.
[9] P Sravana, P SrinivasaRao, And T SeshadriSekhar, "Flexural Behaviour Of Glass Fibre Reinforced Self Compacting Concrete Slabs" 35thconference On Our World In Concrete & Structures ,25 - 27 August 2010, Singapore.
[10] M.V. Krishna Rao, N.R. DakhshinaMurthy and V. Santhosh Kumar, "Behaviour of Polypropylene Fibre Reinforced Fly Ash Concrete Deep Beams in Flexure and Shear", Asian Journal of Civil Engineering (Building and Housing), 2011, Vol. 12, No. 2, pp. 143-154.

