A Literature Review study on Compressive and Tensile Strength of Steel Fibre Reinforced Concrete

Vinod H. Kashid[1] Vivek V. Mane[2] Nikhilesh M. Soundattikar[3]

[1]*U.G.Student, Department of civil Engineering, Bharati vidyapeeth's college of engineering, Kolhapur, India*

[2]*Assistant professor, Department of civil Engineering, Bharati vidyapeeth's college of engineering, Kolhapur, India*

[3]*Assistant professor, Department of civil Engineering, Bharati vidyapeeth's college of engineering, Kolhapur, India*

ABSTRACT

This paper presents a review of the various mechanical properties like compressive and tensile strength of steel fibre reinforced concrete. Fibres are used as cracking resistance and strengthening of concrete. According to various research papers it has been found that steel fibre carry considerable strength more than normal concrete. In this paper, some research shows compressive and tensile strength are increase linearly but also some research shows that the compressive and tensile strength increase non-linearly with increasing of steel fibre. In another one research, shows that such mentioned mechanical strength of concrete increases up to a certain volume fraction in fibre and get reduces after increasing the fibre volume fraction in the concrete.

Keywords*: steel fibre, SFRC, aspect ratio, fibre volume fraction, strengths.*

INTRODUCTION

As we know the concrete is a quasi brittle material. So it is obviously strong in compression but weak in tension. To overcome such brittleness there is interruption of conventional reinforcement in the concrete. By considered such mechanism we only counter balance the compression load by concrete and tension load by steel reinforcement. However we cannot overcome the inherent weakness of plain concrete in post cracking stage. It has been recognised that the addition of closely spaced and uniformly dispersed fibres to concrete would act as crack arresters and also would improve its various mechanical properties like compressive, split tensile and flexural strength etc.

REVIEW STUDY

D.B.Mohite and S.B.Shinde[1] presents, the study of compression strength on concrete mix of M70 grade, without steel fibre & with steel fibres. The steel fibres of hooked ended, flat and waved shape having aspect ratio of 50. The fibre volume fraction has been varied from 0.5% to 4% with an interval of 0.5% by weight of cement. Compression test carried on 150mm size cube specimens. Table no. 1 to 3 shows the results of compressive strength of steel fibre reinforced concrete compared with normal concrete for 7 and 28 days curing respectively. But in actual practice 28 days test result are more preferably used rather than 7 days test.

Fibre Content	Compressive Strength (MPa)		Compressive Strength %	
(Vf) %	7 days	28 days	7 days	28 days
0	50.35	76.3	-	-
0.5	52.14	79	3.5	3.53
1	53.23	80.86	5.71	5.97
1.5	54.02	81.26	7.28	6.5
2	54.68	82	8.59	7.47
2.5	54.86	82.93	8.95	8.68
3	57.09	85.5	13.38	12.05
3.5	57.83	86.63	14.85	13.53
4	58.34	87.4	15.86	14.54

Table no.1. Compressive strength of SFRC, MPa. (Waving Shape Fibre)

Fibre Content	Compressive Strength (MPa)		Compressive Strength %	
(Vf) %	7 days	28 days	7 days	28 days
0	50.35	76.3	-	-
0.5	50.82	76.8	0.9	0.65
1	51.81	77.5	2.89	1.57
1.5	53.13	79.5	5.52	4.19
2	54.12	81	7.48	6.15
2.5	57.09	84.5	13.38	10.74
3	57.55	86.2	14.29	12.87
3.5	58.08	87.2	15.35	14.28
4	58.67	88.3	16.52	15.72

Table no.2: Compressive strength of SFRC, MPa. (Flat Shaped Fibre)

For waving shape fibre, the maximum compressive strength increased at 4.0% of fibre content is 14.54 % at 28 days.For flat shaped fibre, the maximum compressive strength increase at 4.0% of fibre content is 15.72 % at 28 days.

Fibre Content	Compressive Strength (MPa)		% increase in Compressive	
(Vf) %	7 days	28 days	7 days	28days
0	50.35	76.3	-	-
0.5	51.15	76.9	1.58	0.78
1	51.48	77.5	2.24	1.57
1.5	52.27	78.5	3.18	2.49
2	52.8	79	4.86	4.19
2.5	54.67	81.8	8.57	7.2
3	55.88	83.6	10.98	9.56
3.5	56.76	84.5	12.73	10.74
4	57.99	86	15.17	2.71

Table no.3: Compressive strength of SFRC, MPa. (Hooked Shaped Fibre)

For hooked shaped fibre, the maximum compressive strength increased at 3.5% of fibre content is 10.74 % at 28 days. The paper shows that the compressive strength increased continuously with increase volume fraction of fibre. The Flat Shaped Fibre which is having more surface area gives more percentage increases in compressive strength than others.

G. Velayutham and C.B. Cheah[2] carried out the test to check the mechanical properties like compressive strength and flexural strength. The compressive and flexural strength of steel fibre high strength concrete (SFHSC) arrived their maximum value of 70.7 MPa and 11.45 MPa respectively for 3% volume fraction of steel fibres. The properties of steel fibre high strength concrete (SFHSC) was checked on the 100mm size cube specimens for 7 days curing and 7 days + 24 hour hydrothermal curing. Table no.4 and 5 shows compressive strength of steel fibre high strength concrete (SFHSC) compared with normal strength concrete for normal and hydrothermal type curing.

Steel Fiber Volume (%)	Compressive strength (MPa)	Strength Effectiveness (%)	Flow test (mm)
0	45.2	0	150
0.5	51.3	13.5	147
1.0	56.9	25.9	150
1.5	59.8	32.3	155
2.0	61.7	36.5	145
3.0	70.7	56.4	150

Table no.4: Compressive strength of SFHSC and NSC (Normal Curing)

Steel Fiber Volume (%)	Compressive strength (MPa)	Strength Effectiveness (%)	Flow test (mm)
0	50.1	0	150
0.5	49.5	-1.2	147
1.0	53.9	7.6	150
1.5	55.4	10.6	155
2.0	58.9	17.6	145
3.0	64.1	27.9	150

Table no.5 Compressive strength of SFHSC and NSC (Hydrothermal Curing)

The compression strength increases up to 56.4% and 27.95% with normal strength concrete for normal and hydrothermal type curing. Table no. 6 and 7 shows flexural strength of steel fibre high strength concrete (SFHSC) compared with normal strength concrete for normal and hydrothermal type curing.

Steel Fiber Volume (%)	Flexural strength (MPa)	Strength Effectiveness (%)	Flow test (mm)
0	5.52	0	150
0.5	6.08	10.1	147
1.0	6.44	16.7	150
1.5	7.11	28.8	155
2.0	8.69	57.4	145
3.0	11.45	107.4	150

Table no.6. Flexural strength of SFHSC and NSC (Normal Curing)

Steel Fiber Volume (%)	Flexural strength (MPa)	Strength Effectiveness (%)	Flow test (mm)
0	6.55	0	150
0.5	4.55	-30.5	147
1.0	4.99	-23.8	150
1.5	5.12	-21.8	155
2.0	8.10	23.7	145
3.0	10.71	63.5	150

Table no.7. Flexural strength of SFHSC and NSC (Hydrothermal Curing)

The flexural strength increases up to 107.4%and 63.5% with normal strength concrete for normal and hydrothermal type curing. The results show that the value of both type of strengths gives more at 3% of volume of steel fibre.

A.M. Shende et al[3] presented the investigation on compressive strength, flexural strength and split tensile strength of steel fibre reinforced concrete. A relationship between aspect ratio vs. compressive, flexural and split tensile strength represented graphically. For compressive strength test, 150mm size cube specimens were cast

for concrete mix M40 grade. Superplastisizer was utilized in concrete mix. Fig. No.1 shows graphically representation of compressive strength result. For flexural strength test, 100mmX 100mmX 500mm size beam specimens were casted and flexural strengths were investigated. Fig. No. 2 shows graphically representation of flexural strength test results.

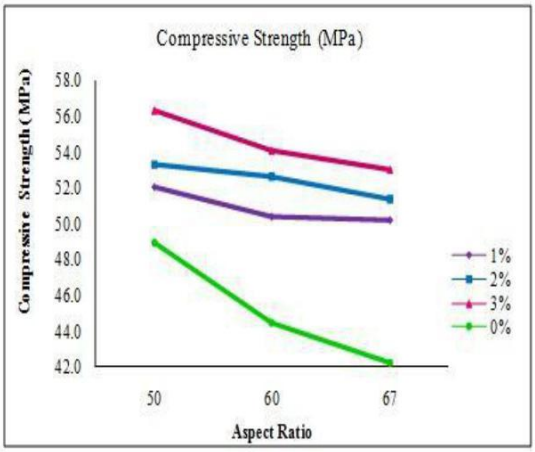

Fig. No.1 Percentage increase in 28 Days Compressive Strength For M-40 Grade Concrete

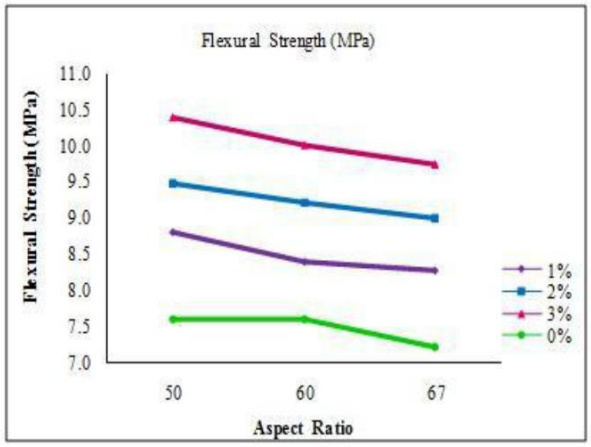

Fig. No.2 Percentage increase in 28 Days Flexural Strength For M-40 Grade Concrete

For split tensile strength test, 150mm dia. and 300mm length cylinders were casted and split tensile strength carried out. Fig. No.3 shows graphically representation of result of split tensile strength.

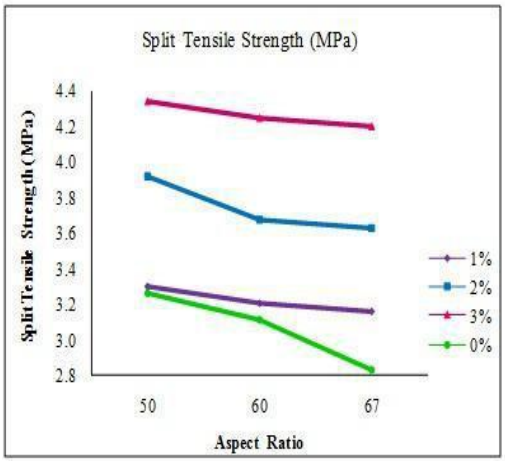

Fig. No.3 Percentage increase in 28 Days Split tensile Strength For M-40 Grade Concrete

The compressive strength increases from 11 to 24% with addition of steel fibres. The flexural strength increases from 12 to 49% with addition of steel fibres. The split tensile strength increases from 3 to 41% with addition of steel fibres. The effective volume fraction of steel fibre was observed at 3% steel fibre volume. The good co-relation to increase in compressive, flexure and split tensile strength was observed in the aspect ratio of 50 rather than 60 and 67.

Waqas Arshad et al[4] presented in the paper, that steel fibre were added in varying in percentage i.e. 0.1%, 0.5% and 1% compared with normal concrete (0% fibre). Concrete mix of M20 was used. Compressive and

tensile strength investigated of all varying samples and compared with normal concrete. Steel fibres were used in varying percentage by the weight cement used. In the compressive strength test, 150mm diameter with 300mm depth cylinders were casted and test was conducted. The fig. No.4 shows graphically representation of average compression strength. In tensile strength test, five specimen beams having size 150mmx150mmx750mm were casted and test was carried on UTM after 28 days curing. The fig. No.5 shows graphically representation of average tensile strength.

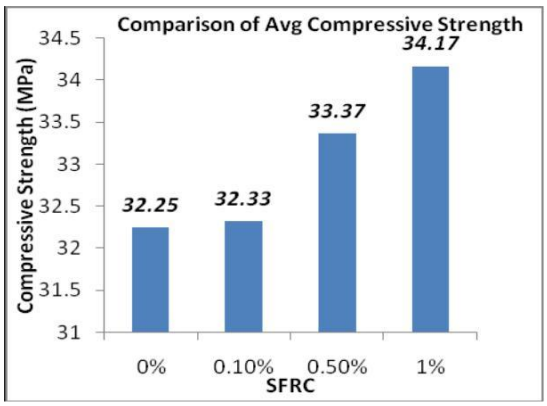

Fig. No.4 Average compression strength

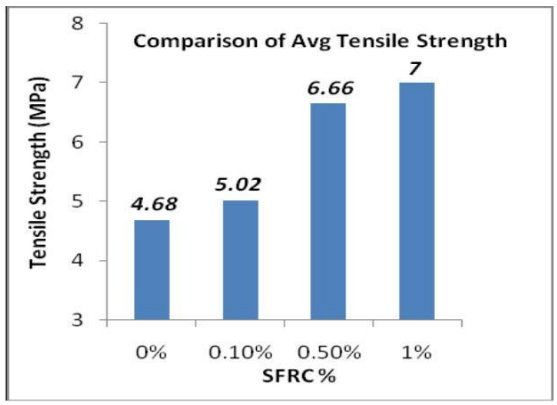

Fig. No. 5 Average tensile Strength

The compression strength increased from 2% to 6% with the addition of steel fibre and also tensile strength of beams increased from 7% to 49% with addition of steel fibre. Similar behaviour was observed in case of Tensile strength, samples without fibres were splited into two portions but beams having steel fibres remain intact due to strong interlocking force between steel fibres and concrete matrix.

S. A. Mahadik et al[5] presented the effect of steel fibre on the strength properties of concrete for M40 grade have been investigated. There two tests were carried out. First consists of 15 no.s concrete beam specimens were casted and tested with different percentage of steel fibre for flexural strength test and second consists of 15 no.s concrete cube specimens were casted and tested with different percentage of steel fibre for compression strength of concrete. The steel fibre volume fraction was 0% to 1%by volume of concrete with an interval of 0.25%. In this investigation, maximum percentage increase in flexural strength can be obtained for beams with 0.75% steel fibre were 43.29% but decrease in flexural strength at 1% steel fibre were 34.19%. Also maximum percentage increase in compressive strength can be obtained for cubes with steel fibre 0% to 0.75% steel fibre were 24.15% but decrease in compression strength at 1% steel fibre were 10.19%. Such result shows in fig. No.6 and 7.

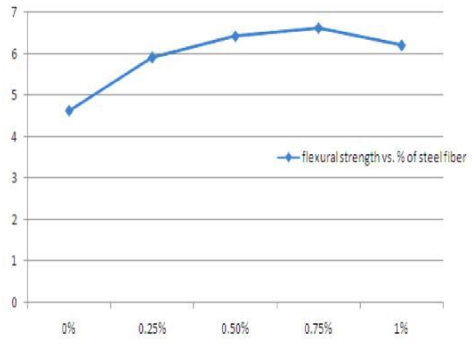

Fig. No. 6 Flexural strength vs. Percentage steel fibre content

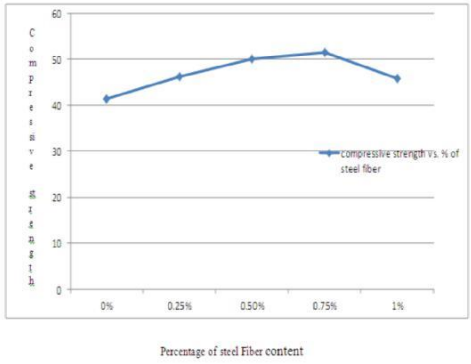

Fig. No.7 Compressive strength vs. Percentage steel fibre content

Thus it was recommended to use steel fibre 0.75% by volume of concrete to get the maximum benefit in improving flexural and compressive strength.

CONLUSION

After studying above papers following conclusion has been drawn

1. Some give the increasing variation in mentioned mechanical strength of concrete with percent increase in steel fibre.
2. One of the research shows that there is increasing variation up to certain percentage of steel fibre and gets reducing after increasing percentage of steel fibre in the concrete.
3. Also the research shows that strong interlocking co-relation developed between concrete and steel fibre after the first cracks means increase in durability in post cracking zone.
4. There is need to prepare exact co-relation between volume of steel fibre with mentioned mechanical strength of concrete.

REFERENCES

[1] D.B.Mohite, S.B.Shinde "Experimental investigation on effect of different shaped steel fibers on compressive strength of high strength concrete" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)

[2] Velayutham, C.B. Cheah "effect of steel fibre on mechanical properties and durability of steel fibre high strength concrete (SFHSC-) subjected to normal and hydrothermal curing" MATEC Web of conference 10, 02004 (2004)

[3] A.M. Shende, A.M. Pande, M. Gulfam Pathan, " Experimental Study on Steel Fibre Reinforced Concrete for M-40 Grade" International Refereed Journal of Engineering and Science (IRJES)

[4] Waqas Arshad Tanoli, Amjad Naseer, Fazli Wahab, " Effect of Steel Fibres on Compressive and Tensile Strength of Concrete" International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 04, October 2014

[5] S. A. Mahadik, S. K. Kamane, A. C. Lande "Effect of Steel Fibers on Compressive and Flexural Strength of Concrete", International Journal of Advanced Structures and Geotechnical Engineering ISSN 2319-5347, Vol. 03, No. 04, October 2014

[6] P. N. Balaguru, and S. P. Shah, 1992, "Fiber Reinforced Cement Composites", McGraw-Hill: New York.

[7] J. J. Beaudoin, 1990, "Handbook of Fibre Reinforced Concrete" – Principles, Developments and Applications, Noyes Publications: New Jersey, USA.

[8] D. J. Hannant, 1978, "Fibre Cements and Fibre Concretes", John Wiley and Sons: New York, USA.

[9] G. R. Williamson, 1974, "The effect of steel fibres on compressive strength of concrete", ACI Special Publication. SP-44, 195-207.

[10] S. P. Shah and V. B. Rangan, 1971, “Fibre reinforced concrete properties”, ACI Journal. 68, 126- 135.
[11] Colin D. Johnston, “Fiber reinforced cements and concretes” Advances in concrete technology volume 3 –

[12] Perumalsamy N. Balaguru, Sarendra P. Shah, ‘‘Fibre reinforced cement composites’’, Mc Graw Hill International Editions 1992.
[13] Arnon Bentur & Sidney Mindess, ‘‘Fibre reinforced cementitious composites’’ Elsevier applied science

[14] Balendran RV, Zhou FP, Nadeem A, Leung AYT. “Influence of steel fibres on strength and ductility of normal and lightweight high strength concrete.” Build Environ 2002; 37(12):1361–7.
[15] K. Holschemacher, T. Mueller, Y. Ribakov, “Effect of steel fibres on mechanical properties of high-strength concrete.” ELSEVIERMaterials and Design 31 (2010) , 2604–2615
[16] Chang-Geun Cho , Yun-Yong Kim , Luciano Feo, David Hui. “Cyclic responses of reinforced concrete composite columns strengthened in the plastic hinge region by HPFRC mortar.” ELSEVIER Composite Structures 94 (2012) 2246–2253
[17] ASTM C-78-00 Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
[18] Ali A. Abbas, Sharifah M. Syed Mohsin, Demetrios M. Cotsovos. “Seismic response of steel fibre reinforced concrete beam–column joints.” ELSEVIER Engineering Structures 59 (2014) 261–283
[19] Milind V. Mohod, “Performance of Steel Fibre Reinforced Concrete.” IJCS ISSN: 2278-4721, Vol. 1,

[20] Ahsana Fathima K M & Shibi Varghese, “Behavioural Study of Steel Fibre and Polypropylene Fibre Reinforced Concrete.” Issn(E): 2321-8843; Issn(P): 2347-4599,Vol. 2, Issue 10, Oct2014, 17-24

Vijay Ram Ghorpade
Digitally signed by Vijay Ram Ghorpade
Date: 2023.04.19 10:33:12 +05'30'