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A REVIEW ON Study on Steel Fiber Reinforced Fly Ash Concrete

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Abstract—*Fibres are generally used as resistance of cracking and strengthening of concrete. In this project, I am going to carry out test on steel fibre reinforced concrete to check the influence of fibres on flexural strength of concrete. According to various research papers, it has been found that steel fibres give the maximum strength in comparison to glass and polypropylene fibres.The present study focus on the systematic design methodology for producing a self-compacting concrete (SFRSCC) consisting of steel fibre reinforcements. It is intended to achieve a self-consolidating concrete which can yield dual benefit of self-consolidating properties as well as toughness of the composite. Experimental modelling consisted of designing the mortar phase using manufactured sand (M-sand) as fine aggregate using systematic mix design methodology based on particle packing concept. Optimisation of aggregates was arrived based on packing density concept by conducting slump cone studies.*

Keywords- Steel fibers, Fly ash, Concrete, Flexure, Compression.

I. INTRODUCTION

Recently, the application of composite materials has been growing rapidly. It is difficult to find a field of technical activity or objects produced for everyday life where composites are not used. Fiber reinforced cement matrices, which contain concretes and mortars reinforced with short fibers, are perhaps the most important group of modern materials applied since 1940.s in various fields from building constructions up to concrete layers on runways and highways. The mechanism of reinforcement of concrete by fibers includes distributing short fibers regularly in the concrete matrix. This network of fibers opposes, depending on its density, to the widening of the crack and acts as crack arrestors by producing a pinching force which tends to make its propagation slower. It also causes transfer of stress across cracked sections allowing the affected parts of the composite to retain some post-crack strength to withstand deformations much greater than what can be sustained by the matrix alone.

Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle fracture of the concrete. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to the concrete would act as crack arrester and would substantially improve its Compressive and flexural strength properties. This type of concrete is known as fiber reinforced concrete.The crimped flat steel fibers were used in this study. The sizes (Length/aspect ratio) of the steel fibers are of 30mm/ 60.

II. LITERATURE REVIEW:

A. **Mohammad Adnan Farooq, Dr Mohammad Shafi Mir,** ***Department of Civil Engineering, N.I.T Srinagar, J&K, India, Associate Professor, Department of Civil Engineering, N.I.T Srinagar, J&K, India,*** **"Laboratory Characterisation of Steel Fiber Reinforced Concrete"[1]**

1.Workability

The compaction factor with fibers of aspect ratio 63 decreased from 0.78 to 0.52 for 0.5% and 3% fiber content respectively. The slump also decreased from 18 cm to 5 cm for 0.5% and 3.0% fiber content respectively. The compaction factor for 1% fiber content decreased from 0.79 to 0.62 with steel fiber of type 43 and 100 aspect ratio respectively. The slump for 1% fiber content decreased from 19 cm to 12 cm with steel fiber of type 43 and 100 aspect ratio respectively. The values for compaction factor and slump corresponding to varying fiber content are shown in Table I. Figure 1 and Figure 2 show the variation of compaction factor and slump with change in fiber content. The values for compaction factor and slump for 1% fiber content with steel fiber of varying aspect ratio are shown in Table II. Figure 3 and Figure 4 show a decrease in values of compaction factor and slump with increase in aspect ratios.

TABLE I
COMPACTION FACTOR AND SLUMP FOR VARYING FIBER CONTENT FOR ASPECT RATIO 63

Fiber Content(%age)	Compaction Factor	Slump(cm)
0.5	0.78	18
1.0	0.73	15
1.5	0.68	13
2.0	0.6	12
2.5	0.58	9
3.0	0.52	5

TABLE II
COMPACTION FACTOR AND SLUMP FOR VARYING ASPECT RATIO FOR FIBER CONTENT 1.0%

Aspect Ratio(l/d)	Compaction Factor	Slump(cm)
43	0.79	19
56	0.75	17
63	0.73	15
100	0.62	12

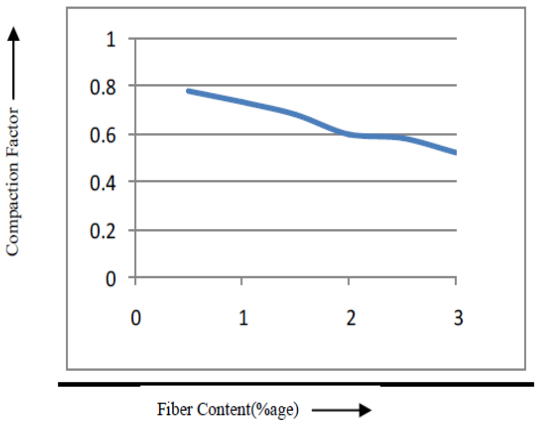

Figure 1:Compaction factor at different Fiber Contents (L/D=63)

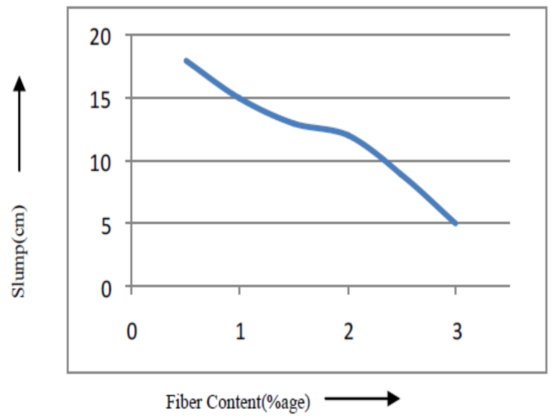

Figure 2:Slump at different Fiber Contents (L/D=63)

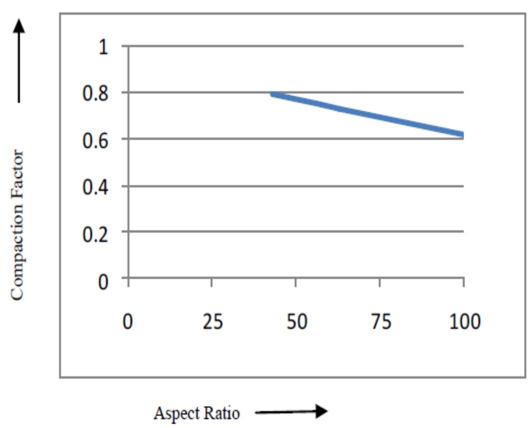

Figure 3: Compaction Factor of SFRC with fiber of different aspect ratio's for 1% Fiber Content

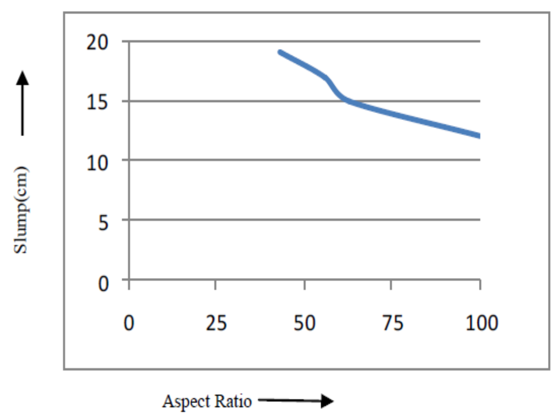

Figure 4: Slump of SFRC with fiber of different aspect ratio's for 1% Fiber Content

2. Compressive Strength

The compressive strength increases from 32.17 MPa with 0% fiber content to a maximum of 41.55 MPa with 1.0% fiber content and then again starts decreasing with an increase in fiber content. The compressive strength values obtained after 7, 14 and 28 days of curing at various fiber contents are shown in Table III and the variation is presented in Figure 5.The compressive strength values obtained with fibers of type 43 and 100 aspect ratios for 1% fiber content are 42.56 MPa and 40.6 MPa respectively. The compressive strength values obtained after 7, 14 and 28 days curing with fibers of type 43, 56, 63 and 100 aspect ratios are shown in Table IV and the variation is presented in Figure 6.

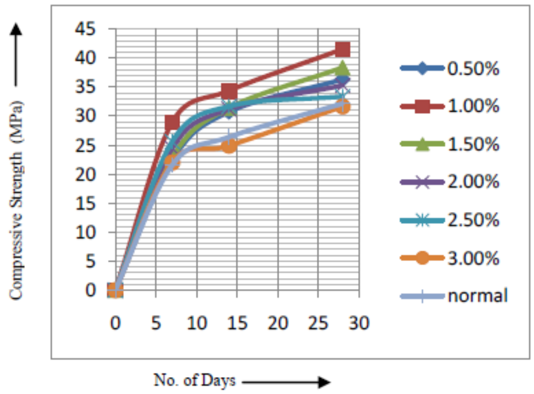

Figure 5: Variation of compressive strength with time for steel fibers (L/D=63) of different volume fractions

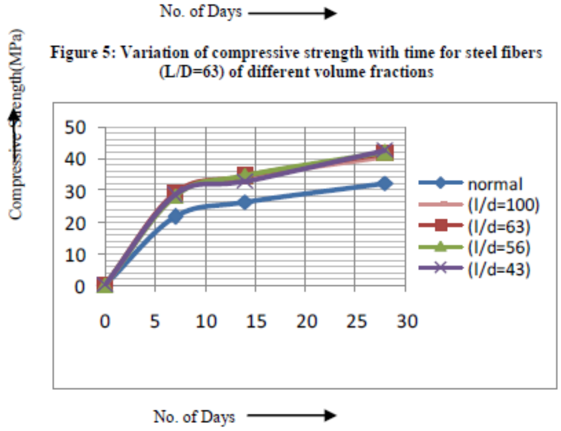

Figure 6: Variation of compressive strength with time for steel fibers (1%) of different aspect ratios.

TABLE III
RESULTS OF STRENGTH PROPERTIES OF SFRC FOR VARYING VOLUME FRACTION WITH 63 ASPECT RATIO

Fiber Content(%age)	Compressive Strength (MPa)			Split Tensile Strength (MPa)			Flexural Strength (Mpa)		
	7 Day	14 Day	28 Day	7 Day	14 Day	28 Day	7 Day	14 Day	28 Day
0	21.55	26.4	32.17	1.71	2.15	2.73	3.03	4.05	4.7
0.5	22.4	30.75	36.33	2.085	2.59	3.33	3.655	4.5	5.53
1.0	28.94	34.38	41.55	3.05	3.77	4.5	5.04	5.85	7.395
1.5	22.9	31.42	38.4	2.1	2.99	3.51	5.53	6.82	8.4
2.0	24.43	31.21	35.31	2.015	2.53	3.225	5.83	7.4	8.94
2.5	25.6	31.71	33.37	1.87	2.31	2.875	5.5	7.145	9.085
3.0	22	24.9	31.66	1.985	2.245	2.815	5.435	6.99	8.985

3. Split Tensile Strength

The split tensile strength increases from 2.73 MPa with 0% fiber content to a maximum of 4.5 MPa with 1.0% fibe content and then again decreases with an increase in fiber content. The split tensile strength values after 7, 14 and 28 days curing at various fiber contents are shown in Table III and the variation is presented in Figure 7.The split tensile strength values obtained with fiber type 43 and 100 aspect ratios for 1% fiber content are 4.72 MPa and 4.4 MPa respectively. The split tensile strength values after 7, 14 and 28 days curing with fiber type of 43, 56, 63 and 100 aspect ratios are shown in Table IV and the variation is presented in Figure 8.

TABLE IV
RESULTS OF STRENGTH VALUES OF SFRC FOR VARYING ASPECT RATIOS WITH 1% FIBER CONTENT

Aspect Ratio(l/d)	Compressive Strength (MPa)			Split Tensile Strength (MPa)			Flexural Strength (Mpa)		
	7 Day	14 Day	28 Day	7 Day	14 Day	28 Day	7 Day	14 Day	28 Day
-	21.55	26.4	32.17	1.71	2.15	2.73	3.03	4.05	4.7
43	28.57	32.8	42.56	3.335	3.89	4.72	4.22	5.7	7.21
56	28.4	34.7	41.9	2.94	3.56	4.58	4.34	5.85	7.395
63	28.94	34.38	41.55	3.05	3.77	4.5	5.04	6.07	7.58
100	29.1	34.1	40.6	3.2	3.81	4.4	5.2	6.32	7.71

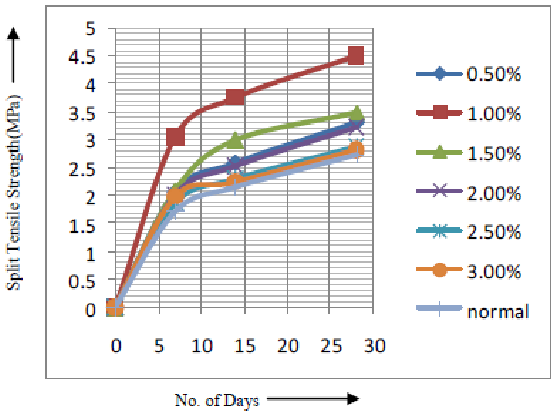

Figure 7: Variation of split tensile strength with time for steel fibers (L/D=63) of different volume fractions

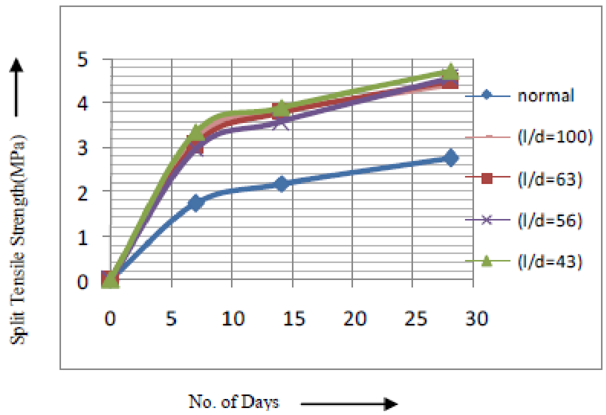

Figure 8: Variation of split tensile strength with time for steel fibers (1%) of different aspect ratios.

4. Flexural Strength

The flexural strength increased from 4.7 MPa for 0% fiber content to a maximum 9.085 MPa for 2.5% fiber content and then started decreasing. The flexural strengths for various fiber contents after 7, 14 and 28 days are shown in Table III and graphically represented by Figure 9. The flexural strength also increased with an increase in aspect ratio unlike from compressive and split tensile strength. The flexural strength increased from 7.21 MPa to 7.71 MPa for 43 and 100 aspect ratio respectively. Table IV shows the flexural strengths for 43, 56, 63 and 100 aspect ratio fibers after 7, 14 and 28 days. The increasing flexural strength with an increase in aspect ratio is represented by Figure 10.

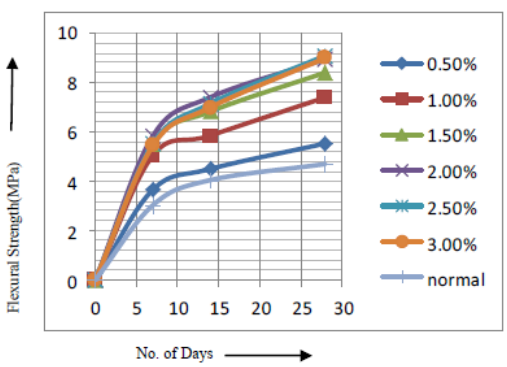

Figure 9: Variation of flexural strength with time for steel fibers (L/D=63) of different volume fractions

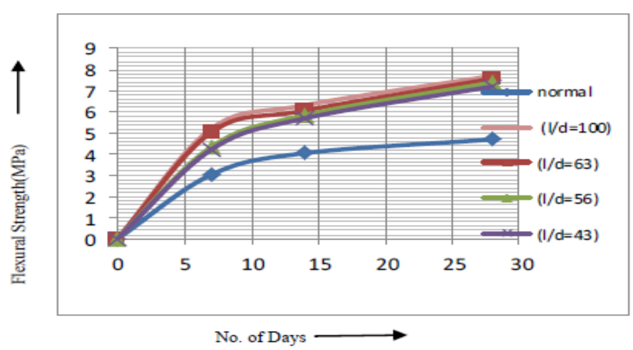

Figure 10: Variation of flexural strength with time for steel fibers (1%) of different aspect ratios.

B. Divyeshkumar D. Paradava, Prof. Jayeshkumar,Pitroda,Student of final year M.E. C. E. & M., B.V.M. Engineering College, VallabhVidyanagar, Assistant Professor & Research Scholar, Civil Engineering Department, B.V.M. Engineering College, VallabhVidyanagar– Gujarat – India, "Utilization Of Artificial Fibres In Construction Industry: A Critical Literature Review"[2]

Steel fibres are short, discrete lengths of steel with an aspect ratio from about 20 to 100, and with anyof several cross sections. Some steel fibres have hooked ends to improve resistance to pull out froma cement-based matrix. Varies type of steel fibre like Hooker end steel fibre, Round steel fibre and flat crimped steel fibre photo show in Fig 3, 4 and 5.

TABLE: 3
PROPERTIES OF STEEL FIBRE

Properties	Value
Relative density	7.80
Diameter, µm (0.001 in.)	100-1000
Tensile strength, MPa	500-2600
Modulus of elasticity, MPa	210,000
Strain at failure, %	0.5-3.5

AREA OF APPLICATION OF STEELFIBRE:

Fig.2: Application of steel fibre

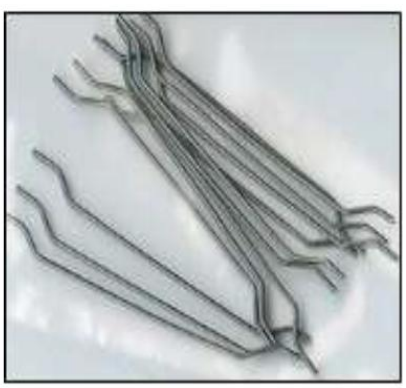

Fig: 3 Hooked end steel fibre

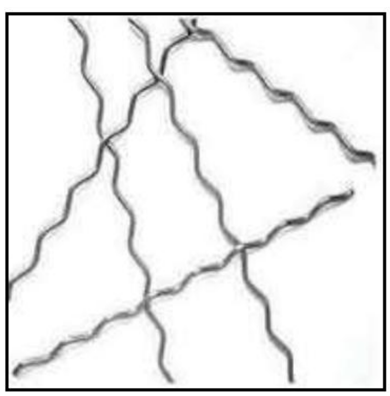

Fig: 4 Round steel fibre

Fig: 5 Flat crimped steel fibre

C. **Vasudev R, Dr. B G Vishnuram,International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May-2013 "Studies on Steel Fibre Reinforced Concrete – A Sustainable Approach"[7]**

1. Fiber Properties

The fibre strength, stiffness, and the ability of the fibres to bond with the concrete are important fibre reinforcement properties. Bond is dependent on the aspect ratio of the fibre. Steel fibres have a relatively high strength and modulus of elasticity. They are protected from corrosion by the alkaline environment of the cementitious matrix, and their bond to the matrix can be enhanced by mechanical anchorage or surface roughness. Long term loading does not adversely influence the mechanical properties of steel fibres. In particular environments such as high temperature refractory applications, the use of stainless steel fibres may be required.

2. Manufactured Steel Fibres& Turn Steel Fibres

Round, straight steel fibres are produced by cutting or chopping wire, typically wire having a diameter between 0.25 to 1.00 mm. Flat, straight steel fibres having typical cross sections ranging from 0.15 to 0.64 mm thickness by 0.25 to 2.03 mm width are produced by shearing sheet or flattening wire. Crimped and deformed steel fibres have been produced with both full-length crimping, or bent or enlarged at the ends only. Some fibres have been deformed by bending or flattening to increase mechanical bonding. Some fibres have been collated into bundles to facilitate handling and mixing. During mixing, the bundles separate into individual fibres.

3. CASTING AND TESTING

The concrete mix adopted was M20 and M30 concrete with varying percentage of fibres ranging from 0, 0.25, 0.5, 0.75 & 1%. Even though the mix design need not be done for the basic mixes of M20 it was verified by designing it as per the quality of the material and other conditions. The M30 concrete mix design was carried out by incorporating the fly ash (along with cement) as the cementitious material which was generally adopted by many RMC plants widely.

Table 3.1 Mix proportion of M20

Free Water	Cement	FA	CA
191.5	383kg	572.1kg	1161.6kg

Table 3.2 Mix proportion of M30

Free Water	Cement & FA	FA	CA
163	300kg+100kg	622 kg	1227 kg

4. Overview of Tests

Table 3.3 Compressive strength of M20 grade concrete cubes

Fibre content (%)	7th Day		28th Day	
	Mean Load (kN)	Compressive strength (N/mm²)	Mean Load (kN)	Compressive strength (N/mm²)
0%	510.6	22.69	581.48	25.84
0.25%	458.8	20.39	463.14	20.58
0.5%	490.5	21.80	558.98	24.84
0.75%	482.6	21.45	556.16	24.71

Table 3.4 Compressive strength of M30 grade concrete cubes

Fibre content (%)	7th Day		28th Day	
	Mean Load (kN)	Compressive strength (N/mm²)	Mean Load (kN)	Compressive strength (N/mm²)
0%	694.58	30.87	885.68	39.36
0.25%	641.92	28.5	794.2	35.29
0.5%	669.68	29.76	845.3	37.57
0.75%	655.18	29.12	824.98	36.67

III. CONCLUSION

1. The workability of fresh concrete was found to decrease with an increase in the fiber content. There was also a decrease in the workability with the increase in the aspect ratio.
2. There is less variation (with time) in the strength (compressive, split tensile and flexural) of SFRC as compared to normal concrete.
3. The addition of steel fibres in the amount ofcombined with admixture type superplasticizer, gave higher strength, both flexuraland compressive, at all ages. Better effectswere observed in flexural strength tests but thecompressive strengths were significantlyincreased.
4. The addition of steel fibers at 1.0% by volume causes a significant enhancement in early as well as long term compressive strength of concrete. The maximum improvement in 28-days strength was observed to be 29.15%. Hence 1% fiber content is optimum fiber content for 63 aspect ratio fiber from compressive strength point of view.
5. The addition of steel fibers at 1% by volume causes a considerable improvement in early as well as long term split tensile strength of concrete. The maximum improvement in 28-days strength was observed to be 64.83%. Hence 1% fiber content is optimum fiber content for 63 aspect ratio fiber from split tensile strength point of view.

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