International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Experimental Study on Behavior of Fiber Reinforced Concrete Slab Resting on Ground

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Accepted 15 May 2016, Available online 18 May 2016, **Vol.6, No.3 (June 2016)**

Abstract

The concrete pavements in India are subjected to repetitive axle loads of commercial vehicles ranging from 20kN to as high as 200kN. This continuous repetitive axle loads causes various flexural and fatigue damages. The performance of a pavement or overlay depends on the engineering properties of the materials used in construction. The use of fiber reinforcement is grabbing more attention in concrete pavements. The concept of fiber reinforcement is as old as the use of brittle materials such as clay bricks or concrete. Concrete fiber composites technology has grown over last three decades in to a mature industry. Since the pioneering research on steel fiber reinforced concrete conducted in United States in 1960's there has been substantial research and development throughout the world. Thereafter, various sorts of fiber materials have been investigated ever since and are utilized for different applications. An extensive experimental investigation is done in aim of studying the structural behavior of slabs resting on the ground which is made up of using steel fiber reinforced concrete (SFRC) is presented in this paper. Several slabs reinforced with different volume fractions (0-1%) of steel fibers are tested under a point load at the center of slab and cyclic load test is done. Our experimental result show that steel fibers significantly enhances the load carrying capacity under fatigue loadings up to an endurance limit of 1, 00,000 load cycles.

Keywords: *Fatigue; pavement; reinforced concrete; slabs on ground and steel fibers*

1. Introduction

For the past several years, it has been observed that rapid and continuous deterioration of conventional concrete pavements are occurring due to heavy traffic over it. At this stage, it is important to improve the performance of the material to be used so that an economical structure is obtained with safety and serviceability. This can be achieved by introducing steel fibers in the conventional concrete pavements. The fiber reinforced concrete is a composite material made with Portland cement, aggregate and incorporating discrete discontinuous fibers. The plain, unreinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. The role of randomly distributed discontinuous fiber is to bridge across the cracks that develop provides some post-cracking 'ductility'. The idea that concrete can be strengthened by fiber inclusion was first put forward by forter in 1910, but little progress was made in its development till 1963, when Roumaldi and Bastone[1] carried out extensive laboratory investigation and published their classical papers on subject. Since then there has been a great wave of interest in and application of SFRC in many parts of the world.

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2. Literature Review

Regarding to A.R.Khaloo[2], in slab application, it is recommend using the steel fiber volumetric percentage in range 1-2% because it can provide the higher energy absorption. With respect to fiber geometry, the length, diameter and aspect ratio is important for the performance of steel fiber reinforced concrete. For example the aspect ratio increase, the ductility increases as long as fiber can be properly mix with the concrete (A.R.Khaloo. *et al*, 2004). Generally, concrete is strong in compression and weak in tension. Referring to Johan Magnusson, Plain concrete is characterized by a relatively low tensile strength and brittle tensile failure. In structural application, the concrete will provide the reinforcing bars to carry the tensile forces once the concrete has cracked so that it remains largely in compression under load. In addition, the tensile failure strain of the reinforced concrete is significantly lower than the yield strain of the steel reinforced and the concrete crack before any significant load is transferred to the steel (John Magnusson. *et al*, 2004). The main objective of this study is to find out effect of change of percentage of fiber in concrete mix and find out thickness reduction of concrete slab on ground with respect to load he carried out many experiments and presented the use of steel fiber in many effective ways improving the strength and an improvement in fatigue life of pavement finally it is discussed to evaluate the use of SFRC for road pavements and compared its performance to plain concrete under traffic loading and concluded that the SFRC ground slabs are remarkably better than those of conventional concrete ground slabs (Ravindra. V.Solanki. *et al*, 2006). In industry application, the steel reinforced are needed to carry the tension forces in the concrete. Regarding to that, to develop the new application of reinforced concrete, additional fiber in the concrete are needed for improvement the mechanical properties of structural concrete. According to M.Behloul, fiber reinforced concrete is one of these new materials opening new ways for concrete structure. By adding fiber to concrete, it is improve the mechanical resistance an d ductility. Besides that, it's also reduced the plastic shrinkage; improve the resistance to abrasion, fire, impact, etc. In addition, the effect of the fibers lays more in the nature of energy absorption and crack control than in an increased the load transfer capacity (M.Behloul. et al. 2008). The most significant influence of the incorporation of steel fiber in concrete to improve the properties result in SFRC being a feasible material for concrete road pavements and evaluated the use of SFRC for road pavements and compared its performance to plain concrete under traffic loading. The influence of SFRC properties on performance and design aspects of concrete roads are discussed (W.A.Elsaigh &J.M.Robbert 2009). experimentally verified the adequacy of comparative design for slabs on ground subjected to static loadings .full scale plain concrete on SFRC slabs on ground were designed ,static load was applied at the center of slab. The validity of the aim with regard to traffic loading will be evaluated, using the results of trial road experiment. at lastly it is concluded that the performance of the thinner SFRC slabs on ground is found comparable to thicker plain concrete ,accordingly 25% of thickness reduction is possible by incorporating 30kg/m3 of steel fiber. (Elsaigh & robbert)

The conclusions were made from other literature survey and it is recommended using the steel fibers volumetric percentage in range 1 to 2%. The SFRC ground slabs are remarkably better than those of conventional concrete ground slabs. The SFRC increases the impact resistance, resistance to abrasion, crack control and load transfer capacity. The SFRC improves the durability of the concrete behavior. There is an increase in compressive strength varying from 3% to 26% on addition of steel fibers in concrete. The addition of the fiber does not significantly increase the compressive strength of concrete but does increase the compressive strain at ultimate load. The performance of the thinner SFRC slab on ground is found comparable to thicker plain concrete; accordingly 25% of thickness reduction is possible by incorporating 1 to 2% of steel fiber.

The main objective of this experimental investigation is to study the performance of non-fibrous and steel fiber reinforced concrete slabs under flexural fatigue loading by adding 1% volume fraction of steel fibers.

3. Experimental Investigation

Experimental work is done in two stages. In the first stage the basic tests were carried out to check the physical properties of materials used and the properties of concrete in fresh state like compaction factor test, density determination of concrete and in the second stage, testing of hardened concrete is done. The cube compressive strength, flexural strength of prisms and slabs, and flexural fatigue strength test or repeated load test of slabs is carried out.

The experimental investigation includes casting, curing and testing of 20 cubes, 10 prisms and 30slabs. The 20 cubes are classified into 4 sets each containing 5 specimens, the first 10 cubes for non-fibrous concrete, the second set for fibrous concrete. The prism specimens are classified into 2 sets each containing 5 specimens. The first set consists of 5 non-fibrous prisms. The other set consists of steel fiber reinforced concrete prisms. The total numbers of slabs casted are 30. They are classified into 6 sets each containing 5 specimens, the first 15 slabs for non-fibrous concrete, the other 15 for fibrous concrete.

3.1 Materials used

The materials used in this investigation are cement, fine aggregate, coarse aggregate, water, super plasticizer and Shaktiman steel fibers. Ordinary Portland cement (OPC 43 grade) of BIRLA SHAKTI group from a single batch was used throughout the course of the investigation. The properties of Cement and the test results carried out in the laboratory are shown in table-1. Fine Aggregate used is locally available river sand belonging to zone II is used for the project work. The sieve analysis data and physical properties of fine aggregates used are shown in table 3.1 & 3.2 Coarse Aggregate used in this investigation, crushed basalt stones of size 12mm down is used. The sieve analysis data and physical properties of coarse aggregate of 12 mm are shown in table 3.3 & 3.4. Potable water is used in the present investigation for both casting and curing of specimens. Super plasticizer used is the High range water-reducing admixture (HRWA) from Fosroc Chemicals India Limited; Bangalore of type Conplast SP-420 has been used in this work. The addition of super plasticizer to steel fiber reinforced concrete helps in improving workability for higher fiber volume mixes. Conplast - SP420, a concrete Super plasticizer based on Sulphonated Naphthalene Polymer is used as a water-reducing admixture and to improve the workability of steel fiber reinforced concrete. Conplast SP-420 has been specially formulated to give high water reduction up to 25% without loss of workability or to produce high quality concrete of reduced permeability. Refer table 4.

The physical properties of Conplast SP-420 as per Fosroc Chemicals Ltd. Are as under:
Specific gravity: 1.220 to 1.225
Chloride appearance: Nil as per IS 456
Appearance: Brown liquid
Air entrainment: Approx 1%
Compatibility: Can be used with all types of cements except high alumina cement.

Table 1: Properties Cement

Sl. No.	Properties	Result
1.	Specify Gravity	2.9
2.	Initial Setting time	35 min
3.	Final setting time	235 min
4.	Normal Consistency	34%
5.	Compressive strength in N/mm2 At 3 days At 7 days	 25.4 34.2

Table 3.1: Physical Properties of Fine Aggregate

Sl. No.	Properties	Result	As per confirming to IS
1	Specific	2.62	2.6 – 2.8
2	Fineness	2.92	2.8 – 3.2
3	Grading	Zone II	Zone II
4	Bulk Density	1605	1815 Kg/m3

Table 3.2: Sieve Analysis Data of Fine Aggregate

Sl. No.	IS Sieve Size	Cumulative % Passing	% passing by weight as per IS 383 – 1970 for zone II
1	4.75 mm	99.4	90 – 100
2	2.36 mm	87.4	75 – 100
3	1.18 mm	74.2	55 – 90
4	600 mic	38.4	35 – 39
5	300 mic	8.4	8 – 30
6	150 mic	0.2	0 – 10
7	Pan	0	-

Table 3.3: Physical properties of Coarse Aggregate

Sl. No.	Properties	Result	As per confirming to IS 383 – 1970
1	Specific Gravity	2.7	2.6 – 2.8
2	Fineness	6.65	6.5 – 8.5
3	Bulk Density	1550	1885 Kg/m3

Table 3.4: Sieve Analysis Data of Coarse Aggregate

Sl.No.	IS Sieve Size	Cumulative % Passing	% passing by weight as per IS 383 – 1970
1	40 mm	--	-
2	20 mm	100	100
3	12.5 mm	86.6	80 – 90
4	10 mm	61.8	40 – 85
5	4.75 mm	2.9	0 – 10
6	2.36 mm	0.1	-
7	Pan	0	-

3.1.1 Steel Fibers

The steel fibers used in this investigation are 'Shaktiman Crimped Round Steel Fibers' of diameter 0.55 mm and length 30 mm (Aspect ratio 54). A uniform volume fraction of steel fibers as 1.0% has been used in this investigation. The fibers are randomly oriented throughout the concrete as random orientation of steel fibers gives better results compared to that of parallel and perpendicular to applied load orientation of steel fibers10. As Shown in plate 2 and table 5

3.1.2 Mix Design

The prime requirement in SFRC is to have uniform distribution of steel fibers and to avoid balling or bunching of fibers. The high range water-reducing admixtures are used to improve the workability of SFRC. A particular fiber type, orientation and percentage of steel fibers also effects on the workability of SFRC mix. The factor which has a major effect on workability is the aspect ratio (l/d) of fibers. The workability decreases with increasing aspect ratio10. In practice it is very difficult to achieve a uniform mix if the aspect ratio is greater than about 100. The maximum size of coarse aggregate is the most important factor in SFRC mix. The strength decreases with increase in maximum size and proportion of coarse aggregate for SFRC17. The maximum size of coarse aggregate should preferably limited to12. In this dissertation work, the concrete mix is designed to achieve characteristic compressive strength of 40 N/mm2 after 28 days of curing.

3.1.3 Mix Proportions

The water-cement ratio decided as per the mix design was 0.4 for non-fibrous concrete. The make concrete workable at 0.4 water cement ratio, super plasticizer was used with 1% and 2% by weight of cement for non-fibrous and fibrous concrete respectively. Trial mixes were performed to decide the dosage of super plasticizer for SFRC. Refer table 3

3.1.4 Mixing method

The mixing procedure is same as for conventional concrete along with addition of steel fibers. After spreading all coarse aggregate, fine aggregate and cement a uniform mixing is done and then the steel fibers are added randomly with uniform distribution. After that water along with super plasticizers is added and final mixing is done for 8-10 minutes.

3.1.5 Casting of Cube prism and slabs Specimens

The cube moulds are made up of cast iron and best quality water proof plywood was used for prism and slab moulds. The standard sizes of cube moulds of 150mm x 150mm x 150 mm, 75mm x 100mm x 500mm and 500mm x 500mm x 50mm were used for casting the concrete cubes prisms and slabs respectively. The moulds are cleaned and one coat of engine oil was applied on all the internal surfaces of moulds to avoid sticking of concrete to mould. All the moulds were filled in 3 layers. The height of each layer is 1/3rd height of the mould and for each layer 25 blows were given with the help of tamping rod uniformly. After filling and compacting the moulds, the top surfaces were made smooth and were allowed to set in mould for 24 hours.

3.1.6 Curing

The slabs, prism and cube specimens were allowed to set in mould for 24 hours, after 24 hours these specimens are demoulded and were kept under wet conditions by immersing them in water continuously for 28 days for curing.10 cubes (5 fibrous and 5 non-fibrous) were cured for 7 days.

4. Test on Fresh Concrete

4.1 Compaction Factor Test

The test is done as per IS 1199-1959 procedure and is calculated by using the formulae. Refer fig 3

The compaction factor=

$$\frac{Weight\ of\ partially\ compacted\ concrete}{weight\ of\ fully\ compacted\ concrete}$$

4.2 Determination of Density

The Density of concrete of was determined in fresh state. The cube mould was cleaned and the inside surface was oiled. The concrete was then filled into the mould in three layers by tamping each layer 25 times with standard 16 mm tamping rod. After filling the mould it was then weighted. Knowing the weight of empty mould and mould filled with concrete, the density of the concrete was calculated using the formula.

Density = $\frac{W_2 - W_1}{V}$

Where W1 = Weight of empty mould; W2 = Weight of empty mould + concrete; V = Volume of mould

5. Test on Hardened Concrete

5.1 Compressive strength test

The characteristic compressive strength of Cube specimens at 7 and 28 days of curing was determined. The cubes were tested in a compression testing machine of capacity 2000KN. The load is applied in such a way that, the two opposite side of the cubes are compressed (top and bottom surface). Calculation: The compressive strength was calculated by dividing the maximum applied load to specimen by cross sectional area of specimen and it is expressed in N/mm2. Shown in plate 5

Compressive strength = Maximum applied load/ cross sectional area of cube.

5.2 Flexural strength Test

The prism specimens of size 75mm x 100mm x 500mm were tested in Universal testing machine for flexural strength. Before placing the specimen in the testing machine, the bearing surfaces of the supporting and loading roller shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. The specimen was placed in the machine in such a manner that the load was applied to the uppermost surface as cast in the mould, along two lines 13.3 cm apart. The axis of the specimen was carefully aligned with the axis of the loading device. The load was increased until the specimen fails. The maximum load during test was recorded. Shown in plate 6

Calculation: The flexural strength was calculated by using the following formula as given in IS 516.

Flexural strength (Fb) = (P*l)/ (b*d2)

5.3 Static Load Test for Slabs

The loading frame is used to determine the ultimate load carrying capacity of the specimen. The capacity of the frame is 1000 kN. The slab was rested over a simple support of span 400 mm c/c. Hydraulic jack was used to apply the load. Several packing materials are used to pack the gap between top of hydraulic jack and loading frame. The magnitude of loading was observed in gauge of hydraulic jack as well as in proving ring. The rate of loading was kept to 24KN/min. After application of 4KN load, a gap of 15secs was given, so that the specimen can take load uniformly. The load was applied till the specimen failed. Shown in plate 7

5.4 Fatigue Test

The machine used for this test was repeated load test setup of capacity 2T, controlled by software developed by Spanktronics, Banglore. Fatigue load test setup consists of PC based data system, controller, repeated load test system and hydraulic system. Single point loading was used in the flexural fatigue strength test during the testing. The span of slabs from c/c of supports is 400mm. Half sine wave type of fatigue load is offered on the specimen. Rest period is taken as zero. As per the literature since concrete is insensitive to frequency of loading, hence for the purpose of expediency a frequency of 4 Hz is used. A varied stress ratio of 0.7, 0.8 and 0.9 is used for the test. During the testing minimum load is set at 10 Kg and amplitude is kept constant. The number of cycles is recorded through an automatic recorder. Number of cycles of loading is recorded till the specimen failed. Shown in plate 8

Table 4: Mix Proportions

Mix Proportion	Quantities in Kg/m3
Cement	465
Fine Aggregate	440.24
Coarse Aggregate	1278.6
Water	190.06

Table 5: Super plasticizer

Type of concrete	Quantities in Kg/m3
1.0% by Weight of cement	4.565
2.0% by Weight of cement	9.30

Table 6: Fibers

Type of concrete	Quantities in Kg/m3
1.0% by Weight of concrete	23.74

Plate 1: Typical SFRC Mix

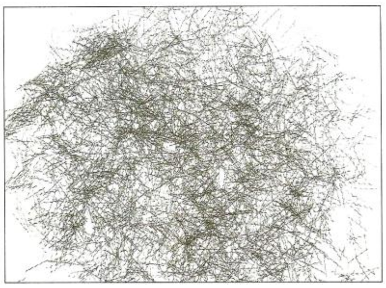

Plate 2: Shaktiman Steel Fiber

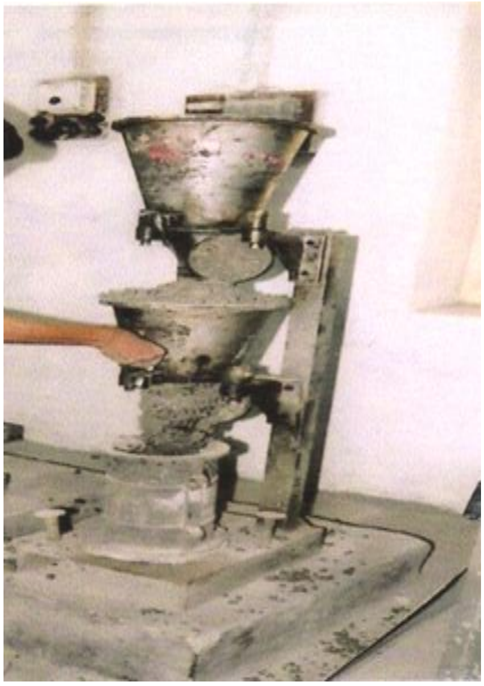

Plate 3: Compaction factor test

Plate 4: Casting of cubes

Plate 5: Test set up for Cube Compressive Strength

Plate 6: Test setup for Flexural strength Of Prisms

Plate 7: Test setup for Static Point Load of Slabs

Plate 8: Test setup for Flexural Fatigue Strength

The Shaktiman steel fibers of diameter 0.55 mm and length 30 mm (aspect ratio 54) are used in this investigation. The characteristics of steel fibers are shown in section 1.3. The concrete mix is prepared using Ordinary Portland Cement with locally available fine aggregate, coarse aggregate, potable water and superplasticizer. For the fatigue test, a total number of 20 slabs (500 mm x 500 mm x 50 mm) are casted for M 40 grade of concrete with water cement ratio 0.4

6. Results & Discussion

In the experimental work the observations were recorded for compressive, flexural and fatigue strength. Compaction factor and density values of fresh concrete were also recorded.

Compressive Strength of Cubes

Table 7.1: Compressive Strength of Cubes of NF 0% Steel fibers

Cubes	Load (kN)	Compressive strength (N/mm^2)	Avg. Compressive Strength (N/mm^2)
(7 days) 1	882.92	39.24	40.79
2	981	43.6	
3	784.88	34.8	
4	1010.43	44.9	
5	931.95	41.42	
(28 days) 1	1108.5	49.26	44.56
2	990.8	44.03	
3	951.6	42.30	
4	1030.1	45.78	
5	931.95	41.42	

Table 7.1.1: Compressive Strength of Cubes of SF 1.0% Steel fibers

Cubes	Load (kN)	Compressive strength (N/mm^2)	Avg. Compressive Strength(N/mm^2)
(7 days) 1	981	46.21	43.38
2	1010.43	44.9	
3	765.18	34	
4	1010.43	44.9	
5	931.95	41.42	
(28 days) 1	1128.15	50.14	48.124
2	1177.2	52.32	
3	981	43.60	
4	1079.1	47.96	
5	1049.67	46.65	

Table 7.2.1: (Flexural strength of prisms after 28 days)

Specimen No.	Load (t)	Flexural strength (N/mm^2)	Average flexural strength (N/mm^2)
NF-I			
1	0.70	3.65	3.44
2	0.60	3.20	
3	0.60	3.20	
4	0.70	3.65	
5	0.67	3.50	
SF-1%			5.52
1	1.0	5.232	
2	1.0	5.232	
3	1.0	5.232	
4	1.05	5.493	
5	1.225	6.41	

Table 7.3.1: Static point load capacity of slabs Static point load after 28 days of Non-Fibrous

Specimen No.	Load (t)	Load (KN)	Average Load (KN)
1	3.8637	37.9	30.15
2	2.4787	24.32	
3	3.2736	32.11	
4	3.2736	32.11	
5	2.4787	24.32	

Table 7.3.2: Fibrous

Specimen No.	Load (t)	Load (KN)	Average Load
1	3.0698	30.11	33.48
2	3.1769	31.16	
3	3.709	36.01	
4	4.369	42.86	
5	2.7796	27.26	

Table 7.4.1: Fatigue Test: Non-Fibrous slabs

SI. No	Stress Ratio	Load Applied	No of cycles for failure	Average No. of Cycles for failure
1	0.4	1200	18	18
2		1200	8	
3		1200	16	
4		1200	25	
5		1200	7	
6	0.35	1100	57	78
7		1100	29	
8		1100	7	
9		1100	13	
10		1100	22	
11	0.3	1000	169	183
12		1000	18	
13		1000	178	
14		1000	180	
15		1000	188	

Table 7.4.2: Fatigue Test: Fibrous slabs

SI. No	Stress Ratio	Load Applied	No of cycles for failure	Average No. of Cycles for failure
1	0.45	1300	100021*1*	100020*
2		1300	100014*	
3		1300	100009*	
4		1300	100034*	
5		1300	100023*	

*Slabs did not failed up to an endurance limit

6.1 Properties of Fresh Concrete

In fresh state, workability measurements using compaction factor test and density values were recorded. The compaction factor and density values are tabulated in table 7.5 From the results it can be seen that workability is maintained by increasing the dosage of super plasticizer and the dosage is increased with the increase in volume fraction of fibers.

6.2 Compressive Strength

The cube specimens are tested for compressive strength. The result at the age of 7 days and 28 days are obtained for both non-fibrous and steel fiber reinforced concrete is presented in table 7.1& 7.6. The variation of compressive strength v/s volume fraction of fibers is shown in figures 1 & 2. The increase in compressive strength of 10.14% was observed for fibrous when compared with non-fibrous concrete at age of 7 days, which again increased to 11.12% for age of 28 days.

6.3 Flexural Strength

The prism specimens were tested for flexural strength in Universal testing machine. The average value of flexural strength at 28 days obtained for both non-fibrous and steel fiber reinforced concrete are presented in table 7.2 & 7.7. The variation of flexural strength v/s volume fraction of fibers is shown in fig 3 & 4. The maximum flexural strength attained for fibrous concrete was 5.52MPa. The percentage increased by 60.46% when compared to that of non-fibrous concrete.

6.4 Static Point Load Test

The Slabs were tested for point load carrying capacity under static conditions in loading frame. The average value of point loads at 28 days obtained for both non-fibrous and steel fiber reinforced concrete are presented in table 7.3.1, 7.3.2 & 7.8. The variation of flexural strength v/s volume fraction of fibers is shown in fig 5. The maximum point load carried by fibrous slab with fibrous concrete was 33.48KN and that carried by non-fibrous slab was 30.15KN.

6.5 Flexural Fatigue Strength

The slab specimens are tested for flexural fatigue strength. The results at the age 28 days obtained for both non-fibrous and fibrous concrete for varying stress ratios. The mode of failure of the non-fibrous slabs under flexural fatigue load was same as under the static flexural load (sudden failure). There were no initial cracks observed before the failure. Failure of SFRC slabs was not observed as the endurance limit was 100000 cycles and results are presented in table 7.4.1, 7.4.2, 7.9 & 7.10

Table 7.5: Density in (KN/m^3) and Compaction Factor of Concrete

Specimen type	Density (KN/m^3)*	Compaction Factor
N.F	25.05	0.93
Vf– 1.0%	26.72	0.94

*Average of three specimens is taken

Table 7.6 Compressive strength of cubes in N/mm^2

Specimen type	Compressive* strength after 7 days curing	Compressive* strength after 28 days curing
N.F	40.79	44.56
Vf– 1.0%	43.38	48.12

*Average of five specimens is taken

Table 7.7 Flexural strength of prisms in N/mm^2

Specimen type	Flexural * strength after 28 days curing
N.F	3.44
Vf– 1.0%	5.52

*Average of five specimens is taken

Table 7.8 Static Load Carrying Capacity of Slabs in KN

Specimen type	Static Load Carrying Capacity Of Slabs after 28 days curing
N.F	30.15
Vf– 1.0%	33.48

*Average of five specimens is taken

Table7.9 Flexural Fatigue Test: non-Fibrous slabs

SI. No	Stress Ratio	Load Applied	Average No. of Cycles for failure
1	0.4	1200	18
2	0.35	1100	78
3	0.3	1000	183

*Average of five specimens is taken

Table 7.10 Flexural Fatigue Test: Fibrous slabs

<table>
<tr><th>SI. No</th><th>Stress Ratio</th><th>Load Applied</th><th colspan="2">Average No. of Cycles for failure</th></tr>
<tr><td>1</td><td colspan="2">0.45</td><td>1300</td><td>100020*</td></tr>
</table>

*Slabs did not failed up to an endurance limit.

*Average of five specimens is taken

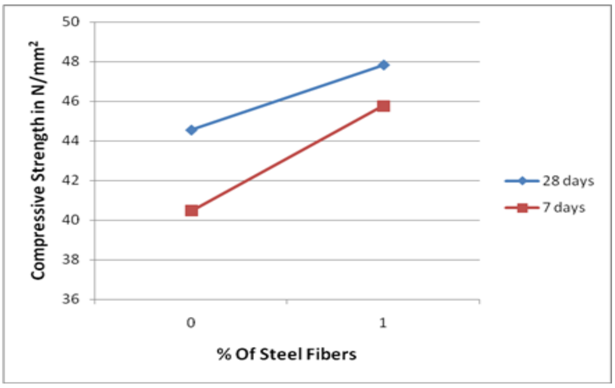

Fig.1: Compressive Strength V/s volume fraction of fibers

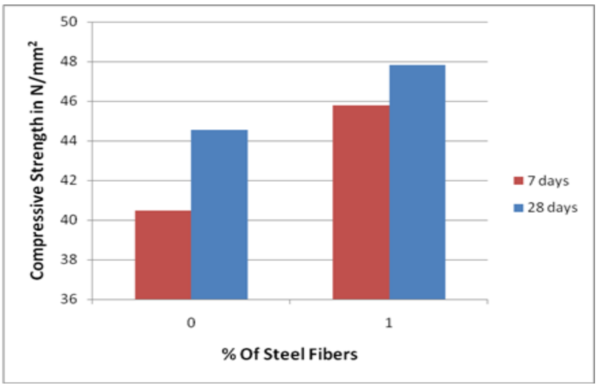

Fig. 2: Relative increase in compressive Strength V/s volume fraction of fibers

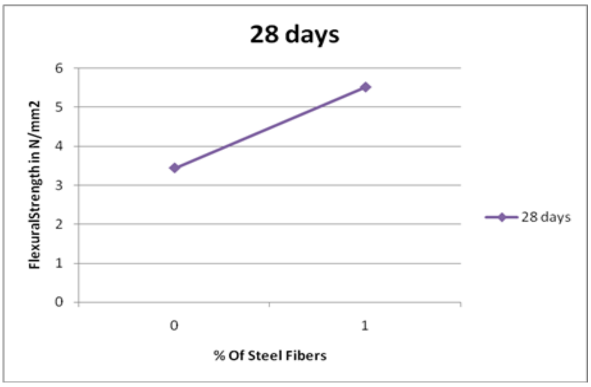

Fig. 3: Flexural strength V/s Volume fraction of fibers

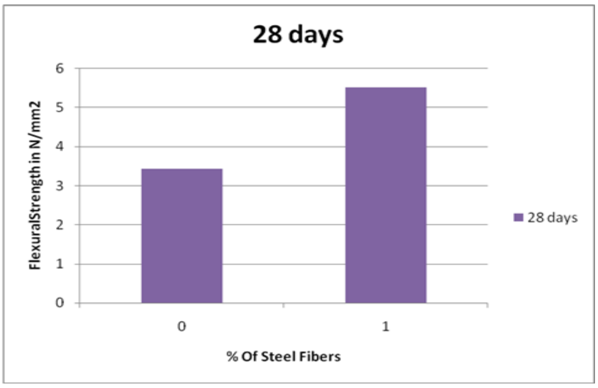

Fig. 4: Relative increase in Flexural strength V/s Volume fraction of fibers

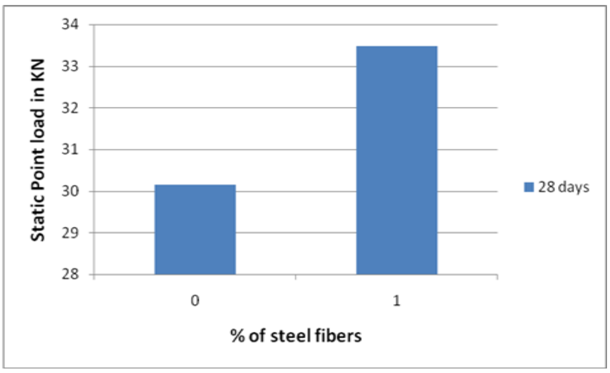

Fig.5: Static Point Load V/s volume fraction of fibers

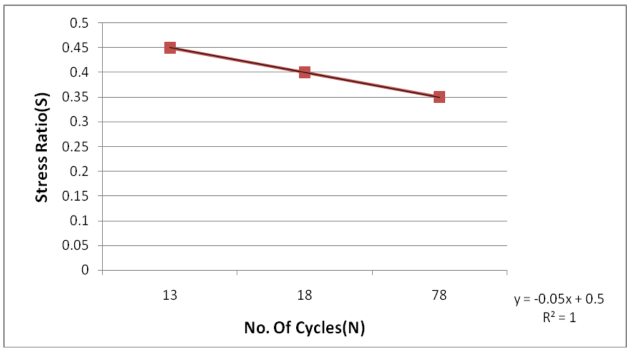

Fig.6: Relative increase in Static Point Load V/s Volume fraction of fibers

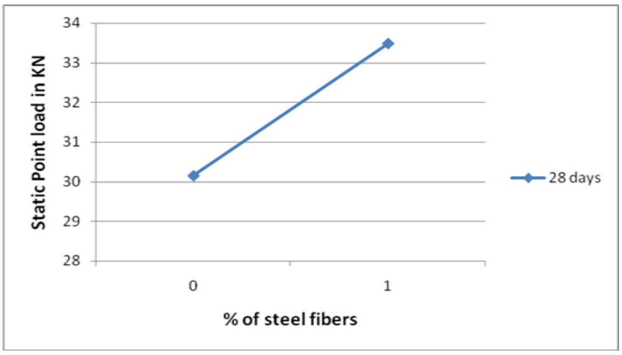

Fig.7: S-N Curve for Non-Fibrous Slabs

Conclusion

1) The addition of steel fibers has increased the density of concrete from 25.05kN/m3 for plain concrete to 26.72 kN/m3 for steel fiber reinforced concrete.
2) The increase in compressive strength of 10.14% was observed for fibrous concrete when compared with non-fibrous concrete at age of 7 days, which again increased to 11.12% for age of 28 days. The average flexural strength for 28 days attained was 5.52MPa for fibrous prism.
3) The increase in flexural strength of 60.46% is observed when compared to that of non-fibrous concrete. The average point load carried by fibrous slab was 33.48KN and that carried by non-fibrous slab was 30.15KN.
4) An increment of 11.05% was observed in fibrous slabs when compared to non-fibrous slabs.
5) The nature of failure in static flexural load was identical for both non-fibrous and fibrous specimens.
6) Mode of failure of non-fibrous specimens under static conditions was sudden. It is observed that the cracks in fibrous specimen did not propagate through the cross section of slabs.
7) Cracks were arrested due to steel fibers leading to more number of cracks. For non-fibrous slabs, under flexural test, the average no. of cycles for failure are 18, 78 and 183 for respective stress ratios of 0.40, 0.35 and 0.30. No failure of fibrous slabs was observed in flexural fatigue test up to an endurance limit of 1, 00,000 load cycles.

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