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Evaluation of mechanical properties of concrete by using lathe steel fiber

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Abstract

Studying the characteristics of concrete when it incorporates steel fibers produced by various lathe operations is the primary goal of the current research project. We are aware that a significant amount of trash is produced in lathe shops in the form of steel fibers. If we manage these steel fibers and use them in the most cost-effective method, which is by incorporating them with concrete, it increases the quality of concrete while also lowering the cement content. It enhances the concrete's workability and mechanical qualities. In this present research work the steel fibers of diameter 0.6 mm and length 45mm was used with varying percentages of steel fibers of 0%,0.5 %, 1 % ,1.5 % ,2 % ,2.5 % by the weight of concrete of M20 grade with a cement to water ratio of 0.42. According to the analysis of the current study, these steel fibres incre ase the compressive and flexural split tensile strength. It was also observed that concrete's characteristics were i mproved byusing straight steel fibres. With the steel fibres we removed from the lathe, we discovered that 2% b y weight is the optimum dosage for producing the highest compressive strength of 15%, split strength of 30%, a nd flexural strength of 42%.

Keywords: Steel, concrete, fibers, compressive strength, properties.

Introduction

Concrete fibers is a composite material and has gain popularity from last so many years. If we look into history Thompson et al. (1997) used fibers and proved that the concrete has gained strength as compared to conventional concrete. He worked on SFRC and done so many researches on it. The study by Armelin et al. (1998) concluded that the pull out of individual fibers was related to overall toughness performance of SFRC under flexural loading and also depends upon variation of fiber density arrangement. Dattatreya et al. (2005) researched on the micro crack stress induced in dramix steel fiber reinforced concrete (DSFRC), by using UPV (ultrasonic Pulse velocity Technique). The study revealed that the FRC shows higher micro-crack initiation as compared to plain concrete. The test showed that 1% of volume fraction of Dramix Steel fibers increases the mechanical properties of concrete. Perumel (2015) proposed the linear relationship between flexural strength and splitting tensile strength and also the relationship of split tensile strength with compressive strength. Liao et al. (2022) concluded that on addition of fiber reinforced polymer sheets improves the structural strength and shows high strength towards load. Mohammadi et al. (2005) concluded that the variation in the distribution of fatigue life of SFRC was more as compared to plain concrete. Altun et al. (2006) investigated that the flexural toughness and the ultimate load of reinforced concrete beams which are manufactured by the application of steel fibers increases the structural strength as those members which are not induced by these kinds of steel fibers. Yang et al (2011) resulted that the bending behavior of ultra-high-performance concrete members was characterized by multi- micro cracking and localized macro cracking. Meda (2012) concluded the ductility improved by the introducing the fibers in concrete. Shende et al. (2013 also worked on the fiber Reinforced concrete by using different percentages of fiber 0,1 %,2% and 3% by volume for M40 grade of concrete and the Aspect ratio was found 50,60,67, taking different length of fibers. The result that they concluded was the flexural strength increases gradually up to 3 % of fiber content. Vasudev et al. (2013) used fibers with varying M30 concrete with varying percentages ranging from 0,0.25,0.75and1 % and concluded that the splitting tensile strength of concrete increases from 20 -22%. The authors have carried out flexural test using different types of fibers. Ms. K. Ramadevi et al. (2012) concluded that the replacement of fine aggregates with Pet bottles reduces the Sand Fraction. Sharma et al. (2016) worked on the concrete reinforced with waste steel. They investigate on the use of steel scraps as a steel fiber in rigid pavement and to scrutinize the physical and mechanical properties. They concluded that concrete reinforced with such materials improves its strength as compared to plain concrete.

Methodology

Materials used

The materials used in this kind experimental investigation are fine aggregates coarse aggregates and scrap steel fibers. These materials are enlisted below:

Cement: Ordinary Portland cement of 43 grade of Ultra tech has been used in this work for the experimental purposes as per IS 4031-1988.The various properties of cement are given in Table 5.

Fine Aggregates: The fine aggregates that were used were that type of sand which was locally available and before that, this sand was used it was firstly sieved in IS sieve 4.75mm and it was used for the preparation of steel fiber reinforced concrete. Total weight of sand was taken 1kg and time of sieving was 15 minutes. The properties of fine aggregates like Fineness Modulus ,Specific Gravity and water absorption are 3.49, 2.90 and 3.47% respectively.

Coarse Aggregates: The coarse aggregates which was selected for this experimental work was obtained from local quarry. The maximum size of these coarse aggregates was 20mm.The physical properties of coarse aggregates like fineness modulus and specific gravity are 2.3 and 3.10.

Steel Fibre: The fibers were collected from the scrap material generated from the lathe. The shape of fibers was straight and deformed and with diameter of 0.6 has been used in the experimental work for the preparation of fiber reinforced concrete. The length of fibers was selected 40mm and density 7850 and with tensile strength 500-300 N/mm^2.

Water: - Water which was selected for the mixing and curing in the experimental work was free from oils, acids, alkali's, salts and sugar. As per IS code 456-2000 potable water is generally considered for the concreting operations.

Testing Of Materials:

The main motive of this is to find the properties of different ingredients which we used for making different specimens for the experimental work . The data we collected for Cement, sand, aggregates and Steel Fibers showed that the right type of material has been used for making Steel fiber Reinforced concrete.

Test On Cement

The Cement which we selected for the experimental; work was OPC Ultratech of grade 43. The specifications as per IS: 8112-1989. it was in good condition. The Various test conducted on the cement and their values are shown in the Table 5.

Consistency of cement pastes:

Consistency tests for the cement paste with steel fibers were done by vicats apparatus to observe the changes in water in the pastes due to addition of steel fibers. Table 1 shows the normal consistency of the steel fibers with cement paste.

Table 1: Normal consistency of steel fibers with cement paste

S.NO	CODE	CONSISTENCY%
1	OPC	31
2	MX(0.5)	32
3	MX(1)	33

4	MX(1.5)	33
5	MX(2)	34
6	MX(2.5)	34

Setting Time:

The setting time were conducted on the cement paste blended with fibers. The test results are shown in the below Table 2.

Table 2: Initial and final setting time of steel fibers with cement paste

S/NO	Code	Initial Setting Time (Minutes)	Final Setting Time (Minutes)
1	OPC	35	280
2	$MX_{(0.5)}$	85	248
3	$MX_{(1)}$	93	244
4	$MX_{(1.5)}$	94	249
5	$MX_{(2)}$	96	256
6	$MX_{(2.5)}$	100	249

Soundness

A cement paste should undergo large change in volume once it gets set., If the cement paste contains free lime, magnesia or calcium sulphate it may show expansion. Standard specifications for Portland cement specifies a maximum autoclave expansion of 0.80% for all Portland cement types. According to standard the expansion of Portland cement shall not exceed 10mm. During the experimental investigation the soundness produced by colliding paste were observed uniform and shows no marks of cracking. The soundness values are given in following Table 3.

Table 3: Soundness Values of Different Mix Proportions

S/NO	Code	Soundness (mm)
1	OPC	1 mm
2	$MX_{(0.5)}$	0.6 mm
3	$MX_{(1)}$	0.6 mm
4	$MX_{(1.5)}$	0.6 mm
5	$MX_{(2)}$	0.6 mm
6	$MX_{(2.5)}$	0.6 mm

Specific Gravity of Cement –

The ratio of the density of a substance to a density of a standard substance, usually water for a liquid or solid and air for gas. Specific gravity of cement is depending upon the particle size of cement as shown in Table 4. The various properties of cement are described in Table 5.

Table 4: Specific gravity of cement

Sr. No.	Material	Gm
1	Mass of empty bottle (W_1)	633
2	Mass of bottle with full of water (W_2)	1513
3	Mass of bottle with full of kerosene oil (W_3)	1335
4	Mass of bottle, kerosene oil and cement (W_4)	1379
5	Mass of cement (W_5)	60
6	Specific Gravity of cement	2.99

Calculations:

Specific Gravity (S.G.) = $W_5 (W_3 – W_1) / (W_5 + W_3 – W_4)(W_2 – W_1)$

= 60(1335– 633) / (60+1335–1379) (1513– 633)

= 42120/14080 = 2.99

Table 5: Properties of Cement

Sr. No.	Characteristics	erimental value	Specified value as per IS:8112-1989
1	onsistency of cement (%)	33%	---
2	Specific gravity	2.99	3.15
3	al setting time (minutes)	32	>30 As Per IS 4031-1968
4	l setting time (minutes)	300	<600 As per IS4031-1968
5	ressive strength (N/mm^2) 3 days 7 days 28days	 27.56 40.57 48.96	 >23 >33 >43
6	Soundness (mm)	0.6	10
7	Fineness of Cement	6%	10% As Per IS 269-1976.

Tests on Fine and Coarse Aggregates:

a. Fineness Modulus:

It is calculated by sieve analysis. The objective of calculating fineness modulus is to generally calculate fine aggregate rather than coarse aggregate .it is a numerical index of fineness, it gives the idea about the mean size of the particles present in the sample. The observed data is shown in Table 6 and 7.

Fineness Modulus = ∑ (Cumulative retained percentages) /100

Fineness Modulus of Fine Aggregates:

Total weight of sand taken= 1 kg and Time of sieving = 15 minutes

Table 6: Sieve Analysis of Fine Aggregate (as per IS: 383- 1970)

Sr. No.	IS Sieve Designation	Mass Retained on sieve (gm)	% age retained	Cumulative %age retained c.
1	4.75mm	0	0	0
2	2.36mm	30	3.0	3.0
3	1.18mm	19	1.9	4.9
4	600µ	15	1.5	6.4
5	300µ	432	43.2	49.6
6	150µ	372	37.2	86.8
7	75µ	118	11.8	98.6
8	Pan	14	1.4	100
∑ C				349.3

Calculations:

Fineness modulus of sand = ∑ C/100
Fineness modulus of sand= 349.64/100=3.493 say 3.4.

Fineness Modulus of Coarse Aggregates:

Total weight of coarse aggregate = 10 kg

Time of sieving = 15 minutes

Table 7: Sieve Analysis for Coarse Aggregate

Sr. No.	IS Sieve Designation	Mass Retained on sieve (gm)	Percentage (%) retained (gm)	Cumulative Percentage (%) retained (gm)
1	80mm	0	0	0
2	40mm	250	250	5
3	20mm	1750	2000	40
4	10mm	1600	3600	72
5	4.75mm	1400	5000	100
6	2.36mm	0	5000	100
7	1.18mm	0	5000	100
8	0.6mm	0	5000	100
9	0.3mm	0	5000	100
10	0.15mm	0	5000	100
∑C				717

Calculations:

Fineness Modulus of Coarse Aggregate = ∑C / 100

Fineness Modulus of Coarse Aggregate =717 /100 = 7.17

Fig. 3: Sieve Analysis

Specific Gravity of Fine Aggregates: The ratio of the density of a substance to a density of a standard substance, usually water for a liquid or solid and air for gas. Specific gravity of cement is depending upon the particle size of cement. The Gm is depicted in Table 8 and test is depicted in Figure 4.

Table 8: Specific gravity of fine aggregate

Sr No.	Determination	Gm
1	Mass of empty pycnometer (W_1)	627
2	Mass of pycnometer with sand (half of bottle) (W_2)	1385
3	Mass of pycnometer, sand and full of water (W_3)	2012
4	Mass of pycnometer with full of water (W_4)	1514.6
5	Specific Gravity of fine aggregate	2.9

Calculations:

Specific gravity = $[(W_2-W_1)] / [(W_2-W_1) - (W_3-W_4)]$

= [(1385 – 627)] / [(1385 -627) – (2012 – 1514.6)]
= 758 / (758 – 497.4)
= 2.90

Therefore, Specific Gravity of Fine Aggregate is equal to 2.90

Specific gravity of Coarse aggregates: This is shown in Table 9 and the apparatus used is shown in Figure 4.

Table 9: Specific gravity of coarse aggregate

Sr No.	Determination	Gm
1	Mass of empty pycnometer (W_1)	627
2	Mass of pycnometer with coarse aggregate (W_2)	1523
3	Mass of pycnometer, coarse aggregate and full of water (W_3)	2122
4	Mass of pycnometer with full of water (W_4)	1514.5
5	Specific Gravity of coarse aggregate	3.10

Calculations:

Specific gravity = $[(W_2-W_1)]/ [(W_2-W_1) - (W_3-W_4)]$

= (1523 -627)/ [(1523 -627) – (2122 – 1514.5)]

= 896/ 896-607.5 = 3.10

Fig.4: Specific Gravity Test (Fine and coarse aggregates).

Moisture Content of Fine aggregates: It is described in Table 10.

Table 10: Moisture content of fine aggregates

Sr No.	Determination	Gm
1	Mass of moist sample (W)	1000
2	Mass of pycnometer or full of water (W_a)	1514.6
3	Mass of container, aggregate and water (W_b)	2147.8
4	Mass of displaced water ($W + W_a – W_b$)	366.8
5	Specific Gravity of aggregate, saturated surface dry density	2.9
6	Surface Moisture (w%)	3.47%

Calculations:

Moisture Content = $[(W + W_a – W_b) – (W/G)]/[W – (W + W_a – W_b)]$ *100

= [366.8 – (1000/2.9)] / [1000 – 366.8] *100

= 3.47 %

Therefore, Moisture Content of fine aggregate is equal to 3.47%

Fibers:

Scrap steel of 0.5 mm diameter has been used in the preparation of SFRC. The fiber of 40mm in length has been used giving optimum aspect ratio of 80 The properties of fibers are given in Table 11.

Table 11: Properties of fibers used

SR.NO	Tensile Strength	Young's modulus	Specific Gravity	Length of Fiber	Diameter of Fiber	Aspect Ratio
1	360 Mpa	2.05×10^4Mpa	7.8	45mm	0.6 mm	75

Mix Design

The basic objective of concrete mix design is to enable a concrete technologist to design a concrete mix for a suitable strength. It is the method of choosing the ingredients of concrete and to determining their relative proportions in order to make the concrete economically efficient.

Mix Design by Indian Standard Method (IS 10262) Data

The following basic data required to be specified for a design of concrete mix.

- Characteristics strength of concrete at 28 days (f_{ck}) = 20N/mm^2
- Maximum size of crushed aggregate = 20mm
- Degree of workability (Compacting Factor) = 0.90
- Value of Statistical Coefficient (K) = 1.65
- Value of Standard Deviation (S) = 5.00

Test data of materials

- Cement used = OPC 43 grade
- Specific Gravity of Cement = 2.99
- Specific Gravity of coarse aggregates(20mm) = 3.10
- Specific Gravity of fine aggregates = 2.90

Target strength for mix design

- $F_t = f_{ck} + k \times S$
- K= 1.65, S= 5.00, f_{ck} = 20N/mm^2
- F_t = 28.25N/mm^2

Selection of water cement ratio

- Maximum water cement ratio specified for durability = 0.45 (Refer IS: 456-2000 Table 5)
- Therefore, the water/cement ratio adopted = 0.43

Selection of water content:

Water content = 186 kg/m^3

Cement content = 186/0.43 = 432.55kg/m^3.

Table 12: Mix Design Proportion of Standard (M 20) Grade Concrete

Mix designation	**Water**	**Cement**	**Fine aggregate**	**Coarse aggregate**
MX0	186 kg/m^3	435 kg/m^3	717.83kg/m^3	1306.55 kg/m^3
	.42	1	1.65	3

So, the Mix Proportions for M_{20} worked out to be **0.42:1:1.65:3** **Calculations for Volumes**

Volume of cube = 15 x 15 x 15 =3375cm^3

Volume of cylinder = π x 7.5^2 x 30 =5301.44 cm^3 Volume of Beam Mould=15 x15 x70=15750 cm^3 Total volume = 24426.44

Add 10% extra volume = 26869.084 cm^3

Volume of concrete = (1 / 2.99) + (1.61/ 2.90) + (2.99/ 23.10) + (0.42 / 1) = 2.26m^3

Table 13: Steel Fibre Based Concrete Mix

Mix Designation	Percentage of steel Fiber (%)	eight of Steel fiber (Kg)	Aspect Ratio	Water (Kg)	ment Kg	Coarse aggregates (Kg)	Fine aggregates (Kg)
MX_0	0	0	0	15	35.52kg	110.17	56.28
MX_1	0.5	1.123	75	15	35.34kg	109.62	55.99
MX_2	1	2.246	75	15	34.99kg	108.52	55.7
MX_3	1.5	3.369	75	15	34.47kg	107.44	55.41
MX_4	2	4.492	75	15	33.79kg	105.38	55.12

MX_5	2.5	5.615	75	15	32.90kg	103.75	54.83

Casting Of Specimen

For Compressive Strength

The mould of size 150 mm x150 mm x150 mm were and specimens of concrete filled in this mould. To find the Compressive strength of SFRC. The cube were casted (30 cubes) and the cement quantity, fine aggregates, Coarse aggregates, scrap steel fibers and water for each batch were weighted to 1kg. Sand and steel fibers is added and mixed to each other in dry form ,water is added to it for mixing .Then the concrete is poured into mould. Before putting the concrete into the mould. The moulds are cleaned and oiled then concrete are poured into it

,after pouring the concrete proper date and batch no is written at the top of specimen .These moulds are then placed into water tank for curing as shown in Figure 5. After that tests are conducted after 7 days and 28 days at CTM (compression Testing Machine).

Fig. 5: Casting of Cubes

For Flexural Strength

The flexural Strength test was conducted on beams as per IS code 516-1959. The Surface supported with rollers was cleaned and then the specimen was put under the contact with rollers .the load was applied in the specimen in such a manner and load was applied in such a manner without causing jerks and continuously at the rate such that extreme fiber stress increased approximately 7.5 kg /sq/min .The load is applied until the specimen shows the sign of failure. In this way, flexural strength is calculated

Flexural Strength (Mpa) = PXL /b x d^2

P= Failure Load, L = centre to centre distance =640mm, b= 150mm, d =150mm

Fig. 6: Casting of Beam

For Tensile Strength

In this test concrete concrete cylinders of 150mm diameter and length of 300 is taken and specimens are casted (Figure 7). After that proper curing is done .This test is conducted as per IS Code 516-1999.

The specimen is demoulded and Placed under Compression Testing Machine. The load is applied gradually at the constant rate of 2.4N/mm^2/min .And the specimen shows the failure Split tensile Strength (N/mm^2) = 2P/Π l d

Fig. 7: Casting of Cylinder

Testing Of Specimen

The following tests have been carried on various specimens:

- Compressive strength test
- Split tensile strength test
- Flexure Strength test

Compressive Strength Test

In this test we take specimen from the curing tank after the time period of 7 and 28 days (Figure 8) and in this way, we calculated the compressive strength after 7 and 28 days. Specimens were tested on 200 tons capacity of UTM. The cubes were placed properly. The load is applied gradually at the constant rate 14 N/mm^2. Unit of f failure of specimen takes place. This test was performed as per IS code 516-1959.The compressive strength is calculated as Load/Area, Graph is shown in Figure 13.

Fig. 8: Concrete specimen on Compressive Strength Testing Machine

Split Tensile Strength Test

The Split tensile test was conducted according to IS code 516-1999The specimens were casted in cylinders and proper curing was done. After that these specimens were taken out from water and were tested under split tensile testing machine of 100 tonnes bearing capacity (Figure 9). The load was applied gradually at the rate of 2.4N/mm^2/minute until the failure takes place in the specimen Split Tensile strength (MPa) = 2P / π DL, Where, P = failure load, D = diameter of cylinder = 150 mm, L = length of cylinder = 300 mm.

Fig. 9: Test Set up for Split Tensile Strength

Flexure Strength Test

The Flexure strength of specimen was analysed as per Is code 516-1959. The surface of the machine was cleaned and oiled. After that, the specimen is put on the surface with contact to rollers. The axis of the specimen was carefully aligned with the axis of loading device. The load of 7 Kg/sq cm/min. The load is applied gradually to the specimen until the specimen show the signs of failure (Figure 10). The Flexural Strength is given by

Flexural strength (MPa) = (P x L) / (b x d^2),

Where, P = Failure load, L = Centre to center distance between the support = 640 mm, b = width of specimen=150 mm, d = depth of specimen= 150 mm.

Fig. 10: Test Set Up for Flexure Strength Test

Results

The experimental investigations on steel fiber collected from lathe and reinforced with concrete was conducted at varying percentages of fiber content. The results of compression, tension and flexural strength are given in the Tables which are calculated from the experimental work.

Compressive Strength

The compressive strength was conducted on the specimens as per Is code 516-1959. The compressive strength which is calculated in the case of plain concrete and SFRC given in Tables 13 and 14, shows compressive strength after 7 and 28 days. The compressive strength of concrete mix with 2 % fibre content was 21.99Mpa after 7 days and 36.21Mpa after 28 days. the strength at the % of 0%,0.5%, 1%,1.5%,2%,2.5% and after 7 days are 15.18, 8.88, 19.25, 19.36, 21.99, 16.11 respectively and the strength at the % of 0%, 0.5%,1%,1.5%,2%,2.5%, after 28 days are 29.25,31.99,33.77,33.84,36.21,32.73 respectively. The fibres increase the toughness and compressive strength. It has been found that the compressive strength of SFRC-based specimens increased by 15% with 2% steel fibre weight (Figure 11 and 12).

Table 13: Compressive Strength after 7 Days

Mix Designation	ercentage of Steel Fibre	ompressive Load(KN)	ompressive Strength (N/mm^2)	Average Compressive strength (N/mm^2)
MX0	0	340 355 330	15.11 15.77 14.66	15.18
MX1	0.5	410 415 450	18.22 18.44 20	18.88
MX2	1	415 430 455	18.44	19.25
MX3	1.5	441 443 430	19.60 19.40 19.10	19.36

MX4	2	505 510 470	22.44 22.66 20.88	21.99
MX5	2.5	370 362 355	16.44 16.10 15.80	16.11

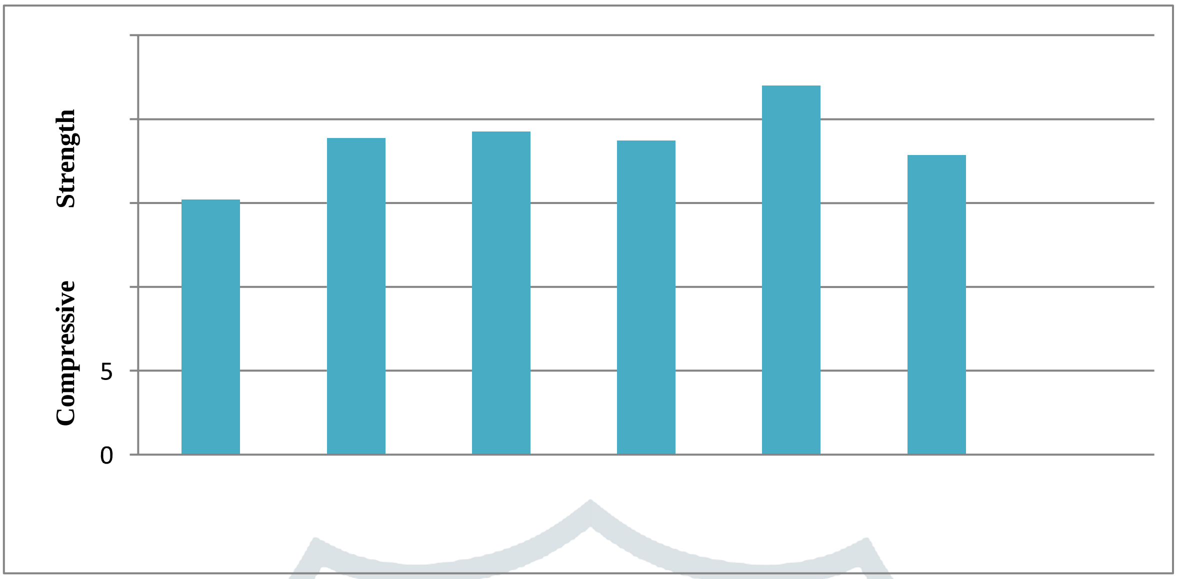

Fig. 11: Compressive Strength After 7 Days

Table 14: Compressive strength After 28 Days

Mix Designation	ercentage of Steel Fibre	ompressive Load (KN)	ompressive Strength (N/mm^2)	Average Compressive strength (N/mm^2)
MX0	0	650 655 670	28.88 29.11 29.77	29.25
MX1	0.5	710 720 730	31.55 32 32.44	31.99
MX2	1	780 785	34.66 34.88	33.77
MX3	1.5	740 770	32.88 34.22	33.84
		870	38.66	

MX4	2	705 645	31.33 28.66	36.21
MX5	2.5	700 775 735	31.11 34.44 32.66	32.73

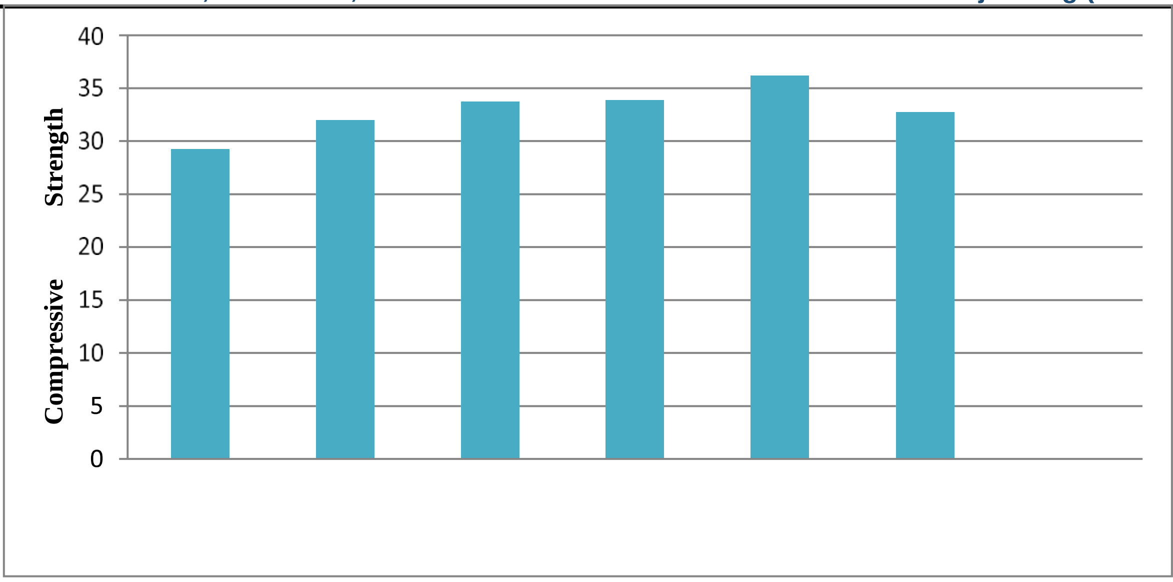

Fig. 12: Compressive Strength After 28 Days

It is clearly seen from the Tables that the addition of scrap steel fibers generated from lathe increases the compressive strength .it is concluded that the scrap steel fibers of lathe improves the properties of M20 concrete

Flexure Strength

The Test specimens of 150 X 150 X 700 mm of plain mortar and SFRC has been investigated. The effective length of the beam was taken 640mm and the flexural strength were calculated after 7 and 28 days respectively and is shown in Table 15 and 16. The flexural strength has been calculated as 1.39,1.46,1.77,1.89,2.1,1.79, after 7 days at the percentage of 0%,0.5%,1%,1.5%,2%,2.5, respectively and the flexure strength after 28 days at the percentage of fibre as 0%,0.55,1%,1.5%,2%,2.5%, are 2.19,2.98,3.31,3.25,3.53,3.04s respectively (Figure 20 and 21). The flexural strength increases more at the fibre content of 2 % and data are clearly shown in Table 15 and 16 plotted in graph/ Figure 13 and 14. It has been seen that the plain concrete specimens get broken into two parts as we applied the load while in the case of SFRC beams micro-cracks are developed and not broken into two parts. It means that the ductility of concrete is increased.

Table 15: Flexural Strength after 7 days

Mix Designation	Percentage of Steel Fibre	Load Taken(KN)	Flexural Strength (N/mm^2)	Average Strength (N/mm^2)
MX0	0	9.13 5.6 7.40	1.73 1.06 1.40	1.39
MX1	0.5	6.89 5.7 10.6	1.30 1.08 2.01	1.46
MX2	1	6.97 9.5 11.6	1.32 1.80 2.19	1.77
MX3	1.5	7.9 10.1 12.0	1.49 1.91 2.27	1.89
MX4	2	8.74 12.07 12.55	1.65 2.28 2.37	2.1
MX 5	2.5	11.03 9.51 7.9	2.09 1.80 1.49	1.79

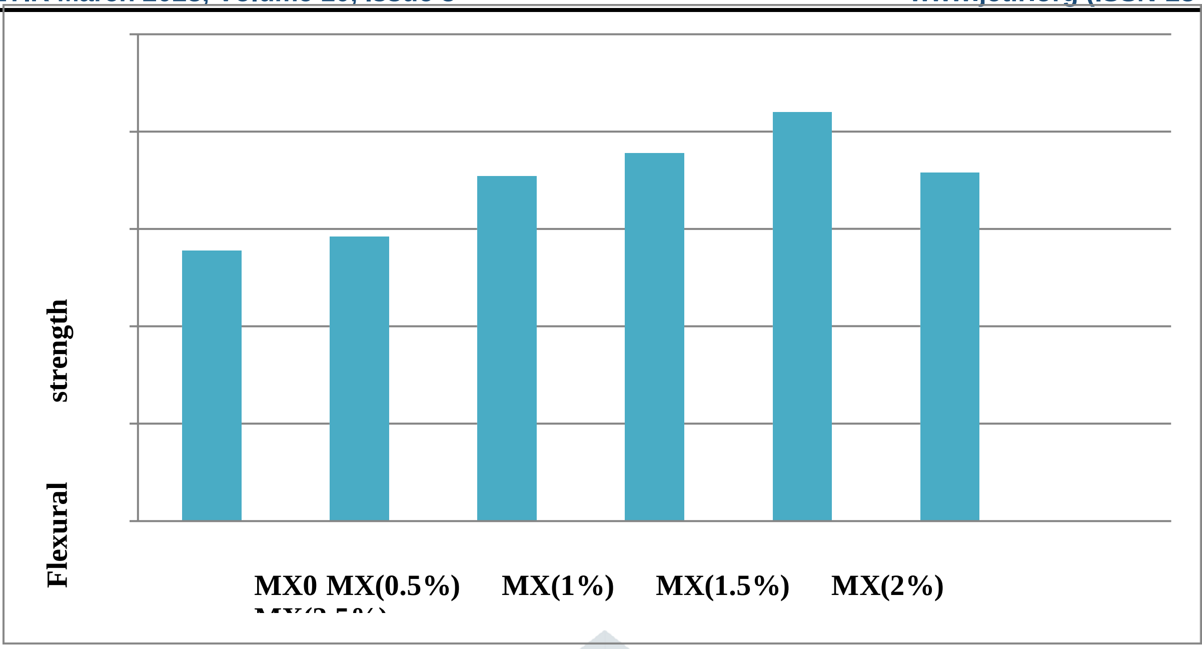

Fig. 13: Flexural strength after 7 days

Table 16: Flexure Strength after 28 Days

Mix Designation	**Percentage of Steel Fibre**	**Load Taken (KN)**	**Flexural Strength (N/mm^2)**	**Average Strength (N/mm^2)**
MX0	0	14.24 9.5 11	2.70 1.80 2.08	2.19
MX1	0.5	15.20 15 17	2.88 2.84 3.22	2.98
MX2	1	16.5 17 19	3.12 3.22 3.60	3.31
MX3	1.5	16 17 18.5	3.03 3.22 3.50	3.25

MX4	2	17 19 20	3.22 3.60 3.79	3.53
MX 5	2.5	16 15.24 17	3.03 2.88 3.22	3.04

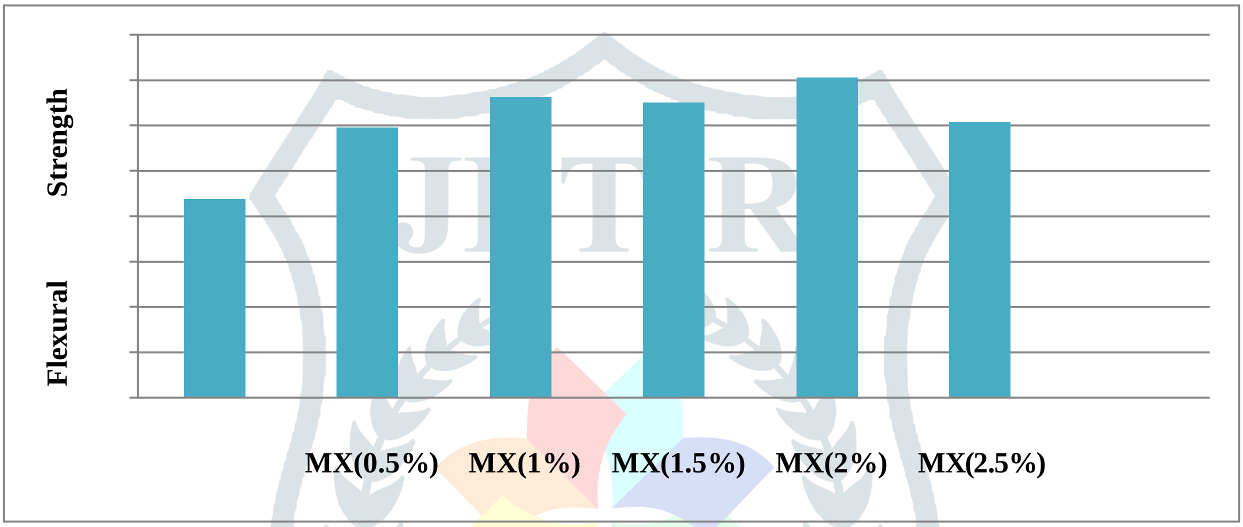

Fig. 14: Flexure Strength After 28 Days

Split Tensile Strength

In the split tensile strength specimens of size, 300 X 150 mm are taken under the compression testing machine of 100 tonnes capacity. The cylinders are placed in the horizontal position. The split strength of plain and SFRC concrete is calculated. The fibres are added to the concrete at varying percentages of 0.5 %,1 %,1.5%,2and,2.5%. The split tensile strength is calculated after 7 and 28 days as shown in Tables 17 and 18 respectively. The split strength after 28 days was calculated as 2.28Mpa, 2.52Mpa, 2.64Mpa, 2.94 Mpa, 3.11Mpa, 2.61Mpa and 2.52Mpa. It has been seen that the flexural strength increases by 1.10, 1.15, 1.28, 1.36, 1.11 and 1.14 (Figure 15 and 16). We found that the split tensile strength increases with the addition of steel fibres.

Table 17: Split Tensile Strength after 7 Days

Mix Designation	Percentage of Steel Fibre	Load Taken(KN)	Split Tensile Strength (N/mm^2)	Average Strength (N/mm^2)
MX0	0	100 90 110	1.414 1.273 1.556	1.41
MX1	0.5	115 110 120	1.626 1.556 1.697	1.62
MX2	1	127 123 130	1.796 1.740 1.839	1.79
MX3	1.5	125 124 134	1.768 1.754 1.895	1.80
MX4	2	130 125 135	1.839 1.768 1.909	1.83
MX 5	2.5	120 122 130	1.697 1.725 1.839	1.75

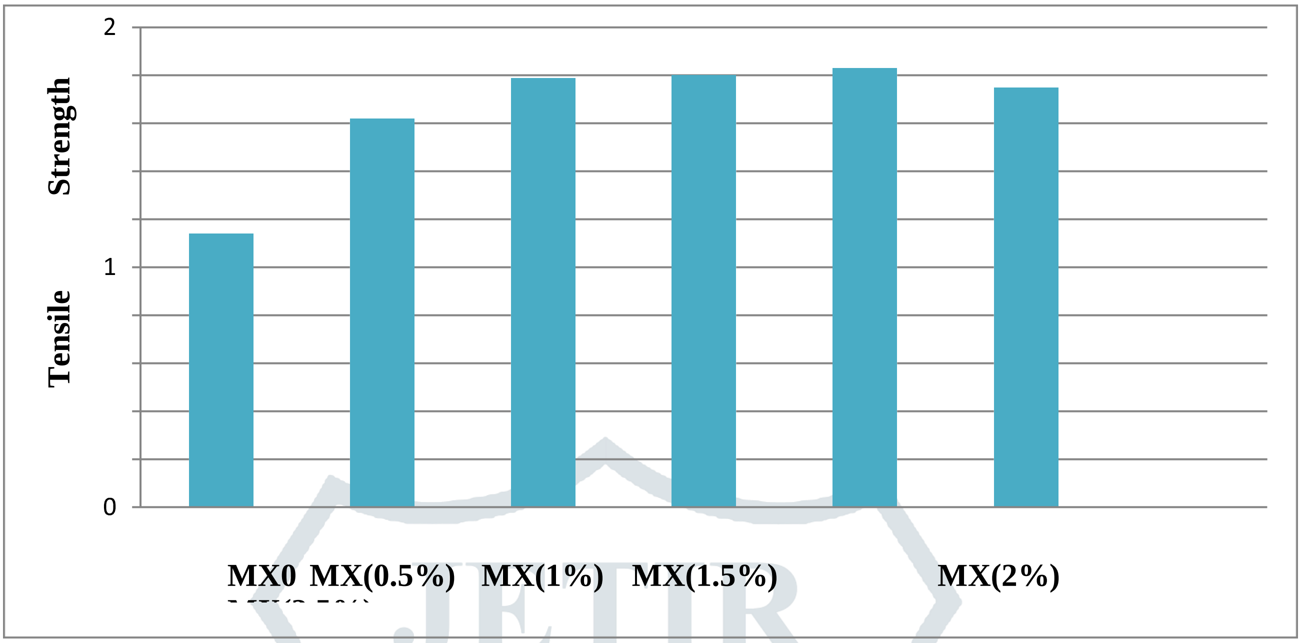

Fig. 15: Split Tensile Strength After 7 Days

Table 18: Split Tensile Strength after 28 Days

Mix Designation	Percentage of Steel Fibre	Load Taken(KN)	Split Tensile Strength (N/mm²)	Average Strength (N/mm²)
MX0	0	160 155 170	2.263 2.192 2.405	2.28
MX1	0.5	175 190 170	2.475 2.687 2.405	2.52
MX2	1	180 195 185	2.546 2.758 2.617	2.64
MX3	1.5	210 215 200	2.970 3.041 2.829	2.94

MX4	2	220 230 210	3.112 3.253 2.970	3.11
MX 5	2.5	176 194 184	2.489 2.744 2.405	2.55

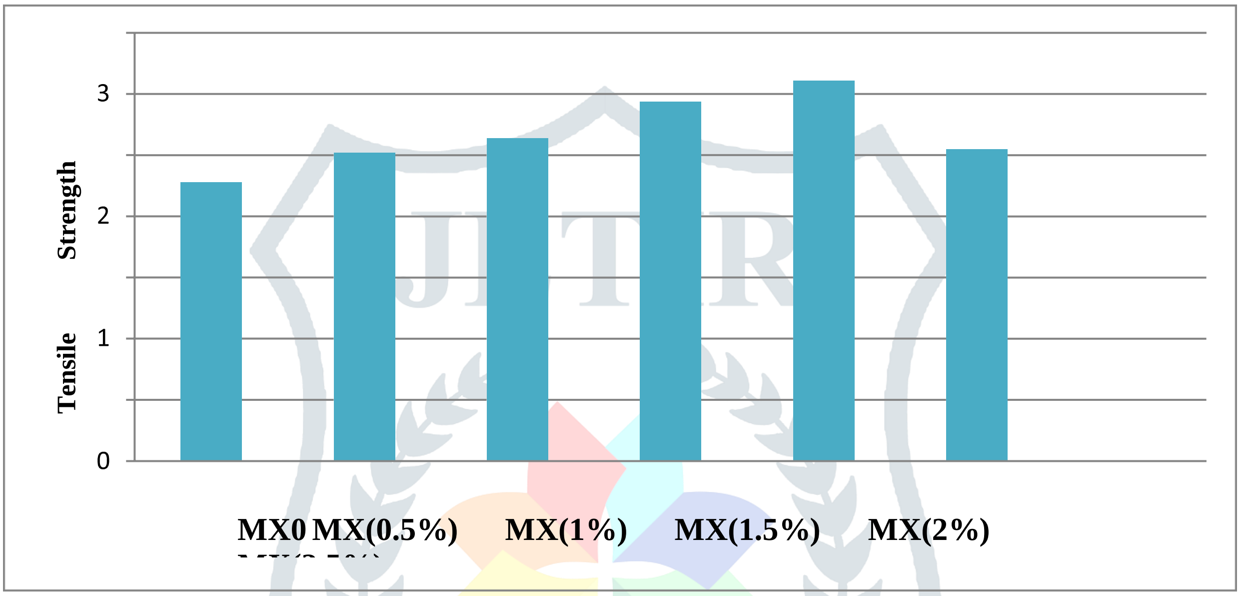

Fig. 16: Split Tensile Strength After 28 Day

Conclusions:

Steel Fiber Reinforced Concrete is a relatively new construction material and laboratory work and fieldwork have clearly shown that the SFRC contains high compressive, flexural and tensile strength. It can be widely used in places where ordinary concrete fails to work because of its higher strength and ductility.

From the Results of the experimental investigation, following are the conclusions:

- The experimental investigation shows the properties of M20 reinforced with scrap material (steel fibres) generated from lathe.
- The Experimental work also showed that the workability of SFRC gets reduced as we increased the fibre amount.
- It also shows that the compressive strength of SFRC gets increased up to 15% with 2% of steel fibres used as compared to plain concrete.
- It has been concluded that the use of fibre content of 2% by weight of concrete is the optimum dosage.
- The split tensile strength of steel fibre reinforced concrete gets increased up to 30% with 2 % as compared to plain concrete.
- It is observed that the compressive strength of steel fibre reinforced concrete gets increased up to 2 % dosage amount after that it starts decreasing.
- The reported work also showed them that the Flexural strength of steel fibre-reinforced concrete gets 42% as compared to plain concrete.
- The report of investigation showed that the compressive strength of steel fibre reinforced concrete gets increased up to 2 %, after that it starts decreasing.

Future Aspects

The present experimental investigation has been carried out to investigate the behavior of SFRC under tension, Flexure and compression. The optimum aspect ratio is 80 of fibres and experiments were carried out for the fibre content of 0%,0.5%,1%,1.5%,2%.2 .5% and3% .it has been observed the effect of fibre length, aspect ratio and the fibre content on the SFRC concrete. More than 3% of fibre content needs future investigation and other aspects like:

• The impact of fibre length variation on the SFRC's compressive, tensile, flexural, and other structural characteristics.

• The effect of a fiber's aspect ratio on SFRC behaviour.

• The structural behaviour of SFRC is affected by fibre contents ranging from 3 to 12%.

• Using fibre content to influence the ductility and toughness of SFRC.

• The impact of a change in the W/C ratio on how the SFRC behaves structurally.

• The ductility of concrete is increased by using steel tyre strips as reinforcement.

References

1. Thompson, N. G., & Lankard, D. R. (1997). Improved Concretes for Corrosion Resistance (No. FHWA-RD-96-207).
2. Armelin, H.S., Banthia, N. Development of a general model of aggregate rebound for dry-mix shotcrete (Part II). (1998) Mat. Struct. 31, 195–202. https://doi.org/10.1007/BF02480400.
3. Dattatreya, J. & Gopalakrishnan, S. (2005). A study of pore structure of concrete mixtures with binary and ternary blends. 32. 225-227.
4. Perumal, R. (2015). Correlation of compressive strength and other engineering properties of high-performance steel fiber–reinforced concrete. Journal of Materials in Civil Engineering, 27(1), 04014114.
5. Liao, J., Zeng, J. J., Bai, Y. L., & Zhang, L. (2022). Bond strength of GFRP bars to high strength and ultra-high strength fiber reinforced seawater sea-sand concrete (SSC). Composite Structures, 281, 115013.
6. Mohammadi, Y., & Kaushik, S. K. (2005). Flexural fatigue-life distributions of plain and fibrous concrete at various stress levels. Journal Of Materials in civil engineering, 17(6), 650-658.
7. Altun, F., Haktanir, T., & Ari, K. (2006). Experimental investigation of steel fiber reinforced concrete box beams under bending. Materials and structures, 39, 491-499.
8. Yang, J., Du, Q., & Bao, Y. (2011). Concrete with recycled concrete aggregate and crushed clay bricks. Construction and Building Materials, 25(4), 1935-1945.
9. Meda, A., Minelli, F., & Plizzari, G. A. (2012). Flexural behaviour of RC beams in fibre reinforced concrete. Composites Part B: Engineering, 43(8), 2930-2937.
10. Ms. K. Ramadevi, Ms R. Manju -Experimental Investigation on the Properties of Concrete With Plastic PET (Bottle) Fibres as Fine Aggregates (ISSN 2250-2459, Volume 2, Issue 6, June 2012).
11. Sharma, P., Sharma, A., Sharma, A., & Srivastava, P. (2016). Automobile waste and its management. Research Journal of Chemical and Environmental Sciences, 4(2), 1-7.