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Study on Properties of Concrete Using Steel Fibers in M40 Grade Concrete

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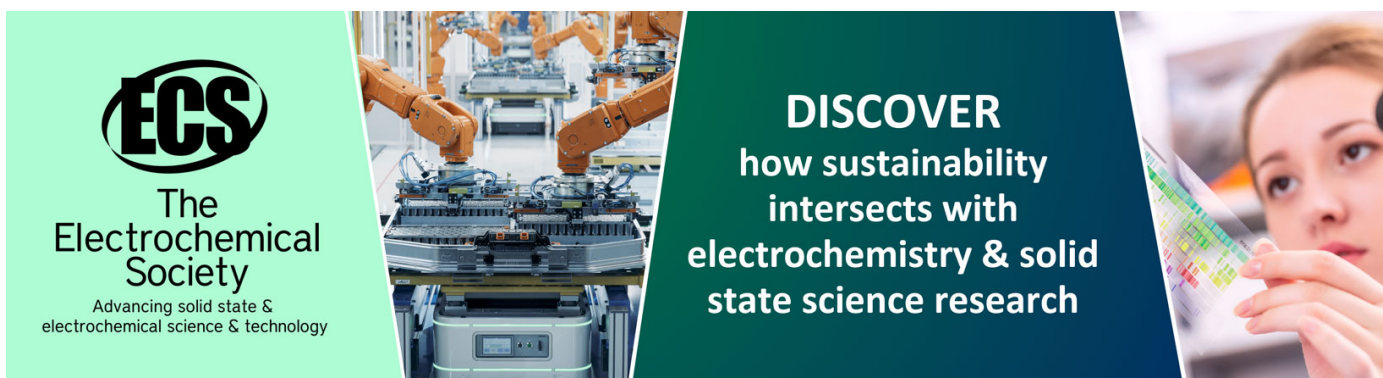
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Retraction: Study on Properties of Concrete Using Steel Fibers in M40 Grade Concrete (*IOP Conf. Ser.: Mater. Sci. Eng.* **1145 012080)**

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[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:[2107.06751v1](#)

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Study on Properties of Concrete Using Steel Fibers in M40 Grade Concrete

S Dhivya¹, P Manikandan¹, J Devaraja¹, M Dhivyalakshmi¹, R Akashkumar¹ and A R Ajithkumar¹

¹ Department of Civil engineering, KPR Institute of Engineering and Technology, dhivya.s@kpriet.ac.in, manikandan.p@kpriet.ac.in

Abstract. Concrete is a mixture of various components which possess strength, durability and also the aesthetic appearance. This study deals with the strengthening properties of Concrete by adding of steel fibers. This paper investigates about steel fibers that can be effectively used in concrete as a addition to concrete. This experimental study on various proportion steel fibers in addition to concrete. These steel fibers have a good tensile property strengthen the concrete which is weak in tension. The different percentages of fibers are 0.10, 0.30, 0.60, 0.90 and 1. The result shows that 1 percentage of fibers in Concrete attains a very high strength when compare to the conventional M 40 Grade Concrete. Further studies show that 1% of steel fiber plays a best role in addition with Concrete which is economically considerable and improves the tensile nature of the concrete.

Keywords: Steel fiber, M-40 Grade, Strength properties of Concrete

1. Introduction

Failures occur in concrete due to the property of weak in tensile strength. These failures create a very high loss economically [1]. We know concrete plays a important role in each of the construction activities that are carried out today. Different types of concrete mixtures are prepared with various available materials that are available as waste as well as economical. SF is a combination of steel fibers, cement, potable water, fine and coarse aggregate. The steel fibers are available at low cost with good quality which inhibits the strength properties of the concrete [2]. Fibers are classified as natural and artificial fiber. The steel fiber comes under artificial fibers. These fibers have different character such as fiber materials, geometrical shape, and distribution of fibers, orientation of fibers and its densities. It is used in Concrete in order to reduce cracks developed due to shrinkage.

Concrete is a cement based matrix combination which is reinforced with different percentages of fibers [3]. Using the fibers in Concrete varies from 1-2% based on geometry of achieving the strength and to increase its tensile. More research works are carried out in the SF with addition of fibres with different ratios. It enhances the post behavior of cracking with its ductile and absorption energy capacity [4-5]. Thus improving the above properties the strength characteristics of concrete were improved with good tensile strength. Thus addition of steel fibers in concrete in uniform order will attain more strength than the steel fibers added in random.



2. Materials Used

- Cement: Ordinary Portland cement (OPC-53grade).
- F. Aggregate: 4.60mm and standard sieve on 150 micron retaining
- Coarse aggregates: 20mm.
- Mixing water: Potable Water
- Steel Fiber – Hooked End Steel Fiber

3. Methodology

This experimental work is done as per the following figure 1 flowchart.

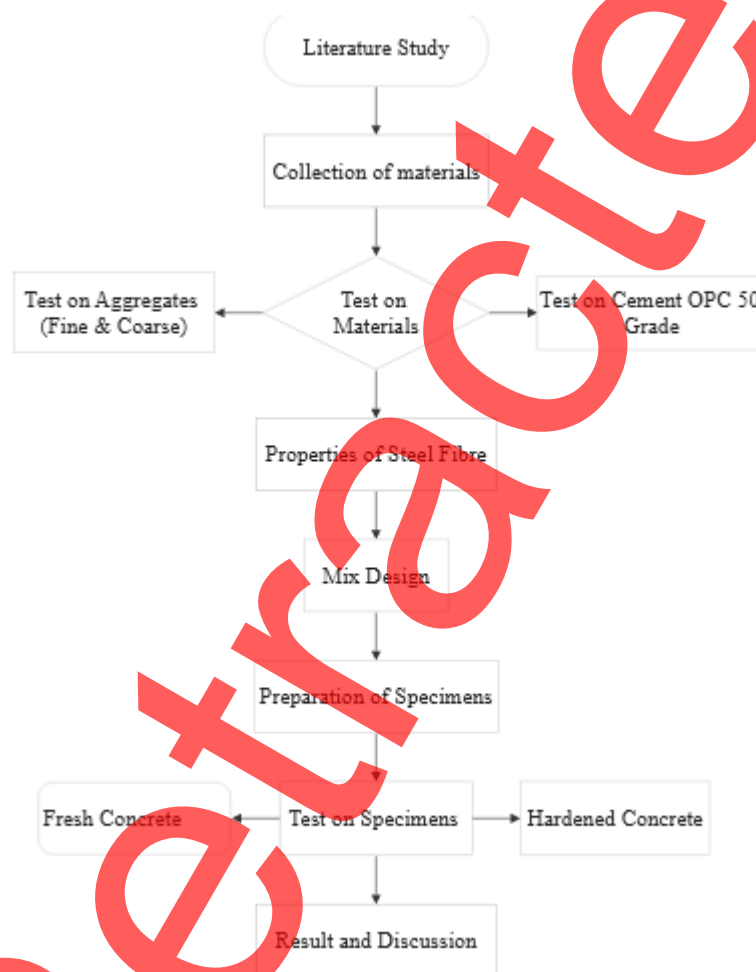


Figure 1. Flow chart of Methodology

4. Properties of Materials

Water used is normally distilled water is considerable for concreting. In the present study, potable water is used. The properties of the materials are tabulated in Table 1, 2, 3 and 4 below with the steel fiber image in figure 2.

Table 1. POC 53 Grade Cement Properties

<i>Test on Cement</i>	<i>Tested Data</i>	<i>Standard value</i>
Fineness	8%	<10%
Initial setting	45 minutes	30 minutes
Normal consistency	33 %	30%
Specific gravity	3.13	3.15

Table 2. Fine Aggregate Properties

Properties	Test value	Standard value
Type	Natural sand	Natural sand
Specific Gravity	2.60	2.3
Fineness Modulus	2.705	2.6-2.9

Table 3. Coarse Aggregate Properties

Properties	Test value	Standard value
Type	Crushed	Crushed
Specific gravity	2.83	2.5 – 2.8
Maximum size	20mm	20mm
Fineness modulus	3.33	2.9-3.5

Table 4. Steel Fiber Properties

Properties	Description
Cross section	Hooked end
Diameter (d)	1mm
Length(L)	50mm
Density	7800 kg/cu.m
Young modulus	2×10^5 Mpa

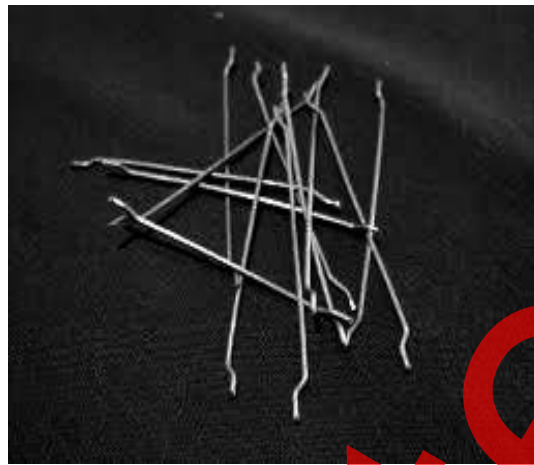


Figure 2. Hooked End Steel Fiber

5. Mix Design with Mix Proportions

As per code IS 10262-2009. Mix Design Process is made and the quantities are arrived for the specimens that are to be prepared for testing. Prepared specimens with different percentages of steel fiber and they are tabulated in Table 5-10.

Quantities for Cement = 636.00 kg/m³

F.A = 197.25 kg/m³

C.A = 1135.00 kg/m³

Content of Water = 6.57 Liters

Water-cement ratio = 0.42

Final mix proportion = 1: 1.34: 2.43

Table 5. Mix Proportion of SFRC (0% of fiber) in M40 Grade Concrete

Specimen	Quantity of materials			
	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (liters)
Conventional Concrete	636	1132	197	6.37
	1	1.3	2.52	0.4

Table 6. Mix Proportion of SFRC (0.1% of fiber) in M40 Grade Concrete

Specimen	Quantity of materials				
	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (liters)	Steel fiber (%)
Steel Fiber Concrete (SFRC)	636	1132	197	6.37	0.10
	1	1.3	2.52	0.4	

Table 7. Mix Proportion of SFRC (0.1% of fiber) in M40 Grade Concrete

Specimen	Quantity of materials				
	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (liters)	Steel fiber (%)
Steel Fiber Concrete (SFRC)	636	1132	197	6.37	0.30
	1	1.3	2.52	0.4	

Table 8. Mix Proportion of SFRC (0.6% of fiber) in M40 Grade Concrete

Specimen	Quantity of materials				
	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (liters)	Steel fiber (%)
Steel Fiber Concrete (SFRC)	636	1132	197	6.37	0.60
	1	1.3	2.52	0.4	

Table 9. Mix Proportion of SFRC (0.9% of fiber) in M40 Grade Concrete

Specimen	Quantity of materials				
	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (liters)	Steel fiber (%)
Steel Fiber Concrete (SFRC)	636	1132	197	6.37	0.90
	1	1.3	2.52	0.4	

Table 10. Mix Proportion of SFRC (1% of fiber) in M40 Grade Concrete

Specimen	Quantity of materials				
	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (liters)	Steel fiber (%)
Steel Fiber Concrete (SFRC)	636	1132	197	6.37	1
	1	1.3	2.52	0.4	

6. Experimental Work

Concrete specimens were casted in iron moulds. Inside the mould oil is applied for easy removal of specimens. The specimens casted with the arrived water cement ratio. Concrete must be done carefully to avoid balling, segregation and difficulty in mixing the materials using fibers.

A. Compressive strength of Cube specimens

Compression strength is determined by testing the concrete specimen under axial load of 500 tonnes loading capacity. The cube specimen with standard specimen is used for casting and testing. As the load is applied, at maximum loading the cube will attain crack. The compressive Strength is calculated from the below. Figure 3 shows the Test for Compressive Strength.

$$\text{Compressive strength} = \text{Load/Area N/mm}^2$$



Figure 3. Test for Compressive Strength

B. Tensile Strength of Concrete

The cylindrical specimen with dimensions of standard size is used and is kept in horizontal position for loading in CTM. As it attains the maximum load, the cylinder will attain the failure by forming cracks. The Split Tensile Strength is calculated from the below. Figure 3 shows the Test for Tensile Strength.

$$\text{Tensile strength} = 2P / 3.14 DL \text{ N/mm}^2$$



Figure 4. Test for Split Tensile Strength

C. Flexural Strength of Concrete

Flexural strength of specimens are done to determine its strength on flexure. The specimen is kept in the flexural testing equipment. When the load is provided in the specimens and it will attain the

failure at two points or one point at the loading. The flexural capacity is calculated from the below Figure 5. Figures 6-8 shows the comparison chart. Tables 11, 12 and 13 shows the Split Tensile Strength, comparison of split tensile strength and Flexure strength with different percentages of fibres volume.

$$\text{Flexural strength} = PL/bd^2 \text{ N/mm}^2$$



Figure 5. Test for Flexural Strength

7. Results and Discussions

A. Result of Compressive Test

Table 11. Compressive Strength of M 40 and SFRC with different proportions of Fibers

Specimen	No of specimens	Compressive Strength(N/mm ²)		
		7 Days (N/mm ²)	14 days (N/mm ²)	28 days(N/mm ²)
CC(M40)	3	20.08	30.52	43.22
SFRC (0.1%)	3	21.04	31.46	40.02
SFRC (0.3%)	3	21.35	30.54	40.78
SFRC (0.6%)	3	20.30	31.94	42.04
SFRC (0.9%)	3	23.42	32.44	43.03
SFRC (1%)	3	26.84	35.82	46.76

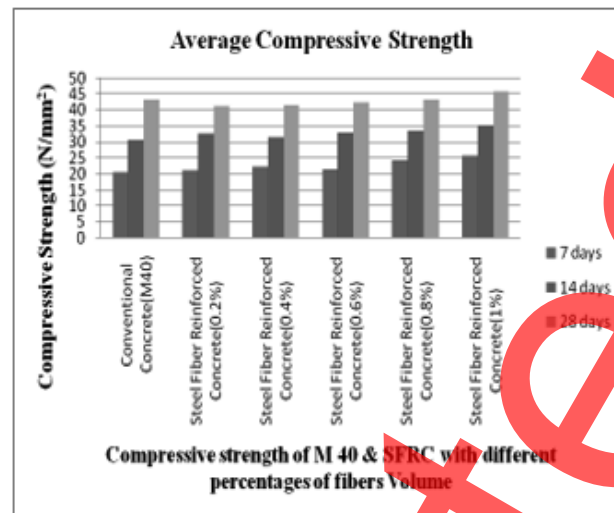


Figure 6. Comparison Chart of Compressive strength under various percentage of Steel Fiber

B. Result of Split Tensile Test

Table 12. Split Tensile Strength of M40 and SFRC in different proportions of fibers.

Specimen	No of specimens	Split strength (N/mm ²)		
		7 Days (N/mm ²)	14 days (N/mm ²)	28 days(N/mm ²)
CC(M40)	3	2.13	2.94	3.88
SFRC (0.1%)	3	2.34	3.26	3.97
SFRC (0.3%)	3	2.24	3.38	4.07
SFRC (0.6%)	3	2.41	3.33	4.38
SFRC (0.9%)	3	2.48	3.40	4.52
SFRC (1%)	3	2.55	3.45	4.69

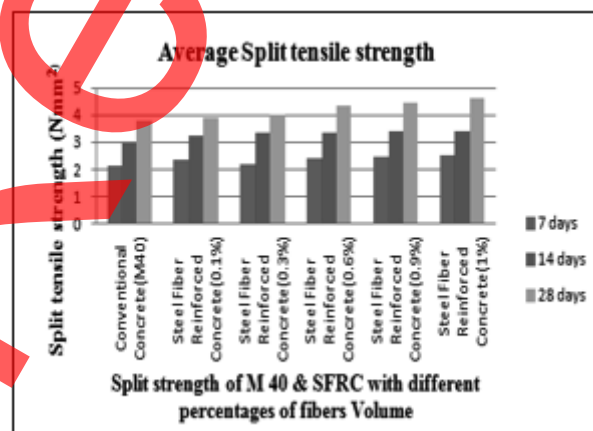


Figure 7. Comparison Chart of Split Tensile strength under various percentage of Steel Fiber

C. Result of Flexure Test

Table 13. Flexure strength with different percentages of fibers volume

Specimen	No of specimens	Flexural strength (N/mm ²)		
		7 Days (N/mm ²)	14 days (N/mm ²)	28 days (N/mm ²)
CC(M40)	3	2.14	6.07	8.02
SFRC (0.1%)	3	3.26	6.45	10.19
SFRC (0.3%)	3	3.43	6.56	11.47
SFRC (0.6%)	3	3.56	7.05	11.74
SFRC (0.9%)	3	3.72	7.37	12.67
SFRC (1%)	3	3.86	7.58	13.76

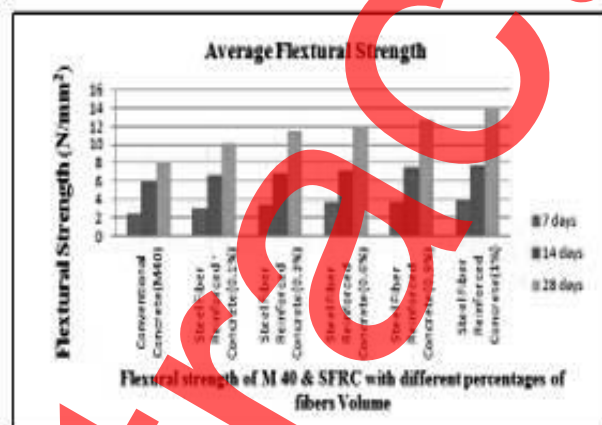


Figure 8. Comparison Chart of Flexural strength under various percentage of Steel Fiber

8. Conclusion

The strength properties of concrete were studied in this experimental work with the specimens of 0% and SF with (0.1%, 0.3%, 0.6%, 0.9% and 1%) in concrete and the results are obtained as follows:

- ❖ From the obtained result, compressive strength in addition of 1 % of steel fiber with Conventional Concrete increases 6.1 percentages in strength.
- ❖ From the obtained result, split tensile strength in addition of 1 % of steel fiber with Conventional Concrete increases 3.4 percentages in strength.
- ❖ From the obtained result, the flexural strength in addition of 1 % of steel fiber with Conventional Concrete increases 8.2 percentages in strength.

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