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Experimental Study Utilization Of Steel Fibres In Concrete Reinforcement

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Abstract: Concrete is a material that is widely utilized in the Construction industry due to its excellent workability and capacity to be moulded into any shape. Fibers are typically utilized to reinforce concrete and prevent it from cracking. The purpose of this research is to investigate the compressive and flexural strengths of steel fiber reinforced concrete (SFRC), which contains fibers in varying proportions from 0.5 to 3% of the concrete grade M-40. Steel fibers were employed with an aspect ratio of 50. There were 168 samples analysed in total during the study. Above is a trial mix with different proportions compared to a regular concrete mix. The following construction projects now utilize steel fiber reinforced concrete: runway pavement, bridging decks, machine foundations, blast-resistant structures, piles, pipes, sea-protective structures, hip-hulls, and storage tanks.

***Index Terms* -** Steel fiber reinforced concrete, Compressive Strength, Crack resisting, flexural strength

I. Introduction

Fibre reinforced concrete is a relatively new construction material developed through extensive research and development work during the last two decades. It has been proved as a reliable construction material having superior performance characteristics compared to the conventional concrete. Incorporation of Fibres in concrete has been found to improve several of its properties, cracking resistance, ductility and fatigue resistance, impact and wear resistance. Fibre reinforced concrete has found interesting new applications in the past two decades due to its inherent superiority over normal plain and reinforced concrete in the following properties: higher flexural strength, better tensile strength and modulus of rupture, higher shear strength, higher shock resistance, better ductility and fatigue resistance, crack resistance and failure toughness.

FRC is now increasingly used in structures such as airport pavement, bridged decks, machine foundations, blast resistant structures, piles, pipes, sea protective structure, hip-hulls and storage tanks. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cementitious material, aggregate and water and by adding some special ingredients. Hence concrete is very well suited for a wide range of applications. However, concrete has some deficiencies as listed below, Low tensile strength, Low post cracking capacity, Brittleness and low ductility, Limited fatigue life, not capable of accommodating large deformations. For long term, strength and toughness and high stress resistance, steel Fibre reinforced

Concrete (SFRC) is increasingly being used in structures such as flooring, housing, precast, tunnelling, heavy duty pavement and mining.

In the hardened state, when Fibres are properly bonded, they interact with the matrix at the level of micro-cracks and effectively bridge these cracks thereby providing stress transfer media that delays their coalescence and unstable growth. If the Fibre volume fraction is sufficiently high, this may result in an increase in the tensile strength of the matrix. Indeed, for some high-volume fraction Fibre composite, a notable increase in the tensile/flexural strength over and above the plain matrix has been reported. Once the tensile capacity of the composite is reached, and coalescence and conversion of micro-cracks to macro-cracks has occurred, Fibres, depending on their length and bonding characteristics continue to restrain crack opening and crack growth by effectively bridging across macro-cracks. This post peak macro-crack bridging is the primary reinforcement mechanisms in majority of commercial Fibre reinforced concrete composites.

Steel Fibre

The use of fibers as reinforcing materials dates back a long way. In order to create SFRC products, steel fibers are added to concrete mixes in a mixer, and the resulting green concrete is then poured into molds. The fibers' diameters and lengths range from 0.25 mm to 1.00 mm and 12 mm to 60 mm, respectively, and their fiber concentration varies between 0.3 and 3 percent by volume of concrete. how well-suited the previously published relationship between compressive strength and Normal concrete's tensile and flexural strengths in comparison to steel This experimental study included cement, sand, coarse aggregate, water, and steel. Fiber-reinforced concrete was assessed, and the mechanical properties of steel-reinforced concrete were examined.

TYPES OF FIBRE USED IN REINFORCED CONCRETE (FRC)

They are classified as;

a) Steel fibre reinforced concrete

b) Glass fibre reinforced concrete

c) Polymer fibre reinforced concrete

d) Natural fibre reinforced concrete

e) Synthetic fibre reinforced concrete

This study aims to envisage the use of Steel Fiber reinforcement in cement concrete, which consists of various percentages of Steel Fiber. Control mix, used as a reference while other samples contain different ratios of Steel Fiber in cement concrete. Decision analysis reveals that the characteristics of Steel Fiber used are improve the Compressive strength as well as the flexural strength of the concert. Steel fibers are those consisting of cement concrete mix and steel as fibers. This mix, have large number of volume fractions, geometries, orientations and material properties. Steel fiber increases properties like ductility, energy absorption, shear resistance and stiffness. The steel fibers can be straight, crimped, twisted, hooked, ringed and paddled end. Diameter can range from 0.5 to 1 mm

II. RESEARCH METHODOLOGY

The plan and procedure used to perform the study are divided into four major segments viz.

1. Material and there testing
2. Design of the Concrete Mix
3. Checking the properties of the Mix Concrete M40 grade
4. Testing of the Cube and Beam for there Compressive & Flexural Strength

III. EXPERIMENTAL RESULT AND DISCUSSION

Sieve Analysis 20 mm Aggregate

Sieve Size mm	Sample 1 (S1)	Sample 2 (S2)	Sample 3 (S3)	Sample 4 (S4)	Sample 5 (S5)	Average
40	100	100	100	100	100	100
20	93.31	92.74	94.07	92.91	96.37	93.88
10	10.55	9.85	11.41	10.47	10.32	10.52
4.75	1.98	2.00	2.51	1.74	2.02	2.05

Sieve Analysis 10 mm Aggregate

Sieve Size mm	Sample 1 (S1)	Sample 2 (S2)	Sample 3 (S3)	Sample 4 (S4)	Sample 5 (S5)	Average
12.5	100	100	100	100	100	100
10	91.32	88.12	87.14	87.63	91.41	89.12
4.75	7.03	8.14	9.05	6.39	7.79	7.68
2.36	2.02	1.80	1.96	2.00	2.07	1.97

Sieve Analysis Sand Aggregate

Sieve Size mm	Sample 1 (S1)	Sample 2 (S2)	Sample 3 (S3)	Sample 4 (S4)	Sample 5 (S5)	Average
10	100	100	100	100	100	100
4.75	98.60	99.56	99.85	99.25	99.49	99.35
2.36	90.20	88.69	90.0	88.90	88.46	89.25
1.18	74.58	78.69	74.85	78.10	79.83	77.21
0.600	50.47	49.74	51.15	53.20	51.69	51.25
0.300	11.60	12.20	13.20	12.40	14.00	12.68
0.150	5.30	6.05	5.40	5.40	5.20	5.47

Other Parameter of the Course and fine aggregate

S.no	Property	Test	Result	Method of Test
1.	Particle shape	Combined flakiness and Elongation index	27.44	IS:2386 Part I
2.	Aggregate Strength	Los Angeles Abrasion value or Aggregate Impact Value	23.90 % 18.68%	IS:2386 Part IV
3.	Water Absorption	10 mm 20mm Sand	0.65% 0.70% 1.25%	IS:2386 Part III
4.	Specific Gravity	10 mm 20mm Sand	2.623 2.625 2.615	IS:2386 Part III

Testing of the Cement for following physical properties

S.No.	Physical Properties of Cement (OPC 43) Grade	Results	Requirement of as per IS 269
1	Fineness	95.33	90 Min.
2	Consistency %	29.5	
3	Initial Setting time Final Setting time	40 370	30 Min. 600 Max.
4	Compressive Strength at 28 days N/mm^2	45.1	43Min
5	Specific Gravity	3.12	3.10-3.15

Testing of the Steel Fiber for following physical properties

S.No.	Physical Properties of Steel Fiber	Results
1	Length (mm)	50
2	Diameter (mm)	1
3	Aspect Ratio (L/D)	50

Water

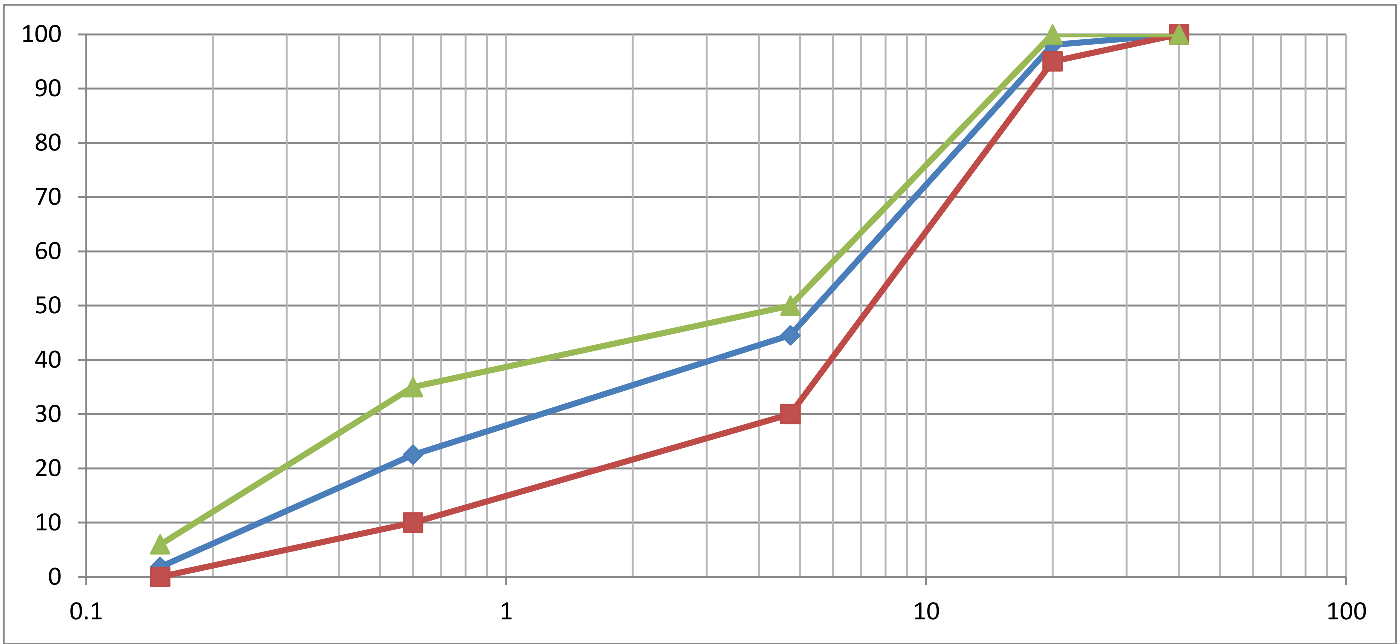
The water used for mixing and curing needs to be clean and free of any organic components, oils, acids, alkalis, salts, sugar, or other chemicals that could harm steel or concrete. When there is uncertainty about the strength development, testing for the concrete's compressive strength and cement's first setting time should be conducted using the same water to determine whether or not it is suitable for use in the manufacturing of concrete.

III. Design Mix of M 40 Concrete

The **Job Mix Formula (JMF)** is an essential part of Concrete mix design. Mix execution is significantly impacted by degree. Embracing the idea that the degree producing the greatest extreme thickness is the optimal one could seem reasonable.

All in Aggregate Gradation

IS sieve sizes mm	% Passing		% passing of different fractions			Sp. Limits	
	I	II	I	II	Combined		
	Coarse Agg.	Fine Agg.	58.7	41.3	100		
			Coarse Agg.	Fine Agg.	Combined	Lower	Upper
40	100.00	100	58.7	41.3	**100**	100	100
20	96.70	100	56.74	41.32	**98.06**	95	100
4.75	5.90	99.39	3.46	41.07	**44.53**	30	50
0.6	0.00	54.46	0.00	22.50	**22.50**	10	35
0.15	0.00	4.44	0.00	1.83	**1.83**	0	6



MIX PROPORTION OF CONCRETE (M40)

S.NO	W/C Ratio	Weight of Cement (KG)	Weight of Sand (KG)	Weight of 10 mm (KG)	Weight of 20 mm (KG)	Weight of Water (KG)	Weight of Admixture (KG)	Slump After 2.0 Hr. (mm)
1	0.34	423	766	546	546	144	2.75	110

Cube and beam Compressive and Flexural Strength at 7 days and 28 days

S. No	Compressive Strength 7 days (N/mm2)	Flexural Strength 7 days (N/mm2)	Compressive Strength 28 days (N/mm2)	Flexural Strength 28 days (N/mm2)
1	42.37	3.40	54.20	4.65

Objective of Work:

M40 concrete trials have been made with different proportion of Steel fiber.

1. Blending the different proportion of steel fiber as tabulated below: -

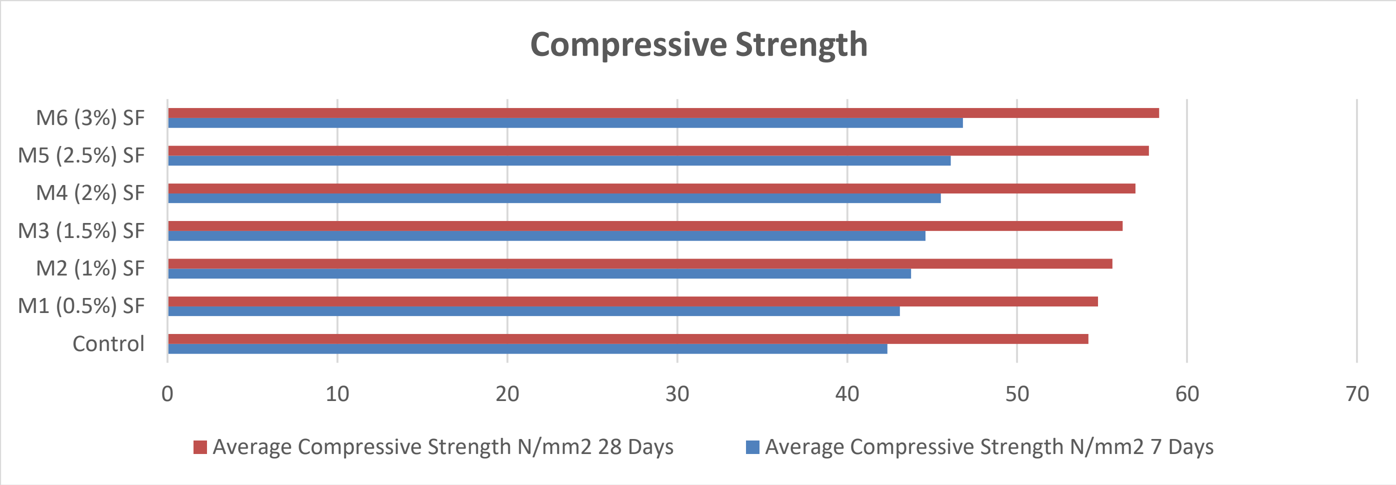
S. No.	Mix ID	Material Percentage
1	SAMPLE 1 (S1)	0.5% of steel fiber
2	SAMPLE 2 (S2)	1.0% of steel fiber
3	SAMPLE 3 (S3)	1.5% of steel fiber
4	SAMPLE 4 (S4)	2.0% of steel fiber
5	SAMPLE 5 (S5)	2.5% of steel fiber
6	SAMPLE 6 (S6)	3.0% of steel fiber

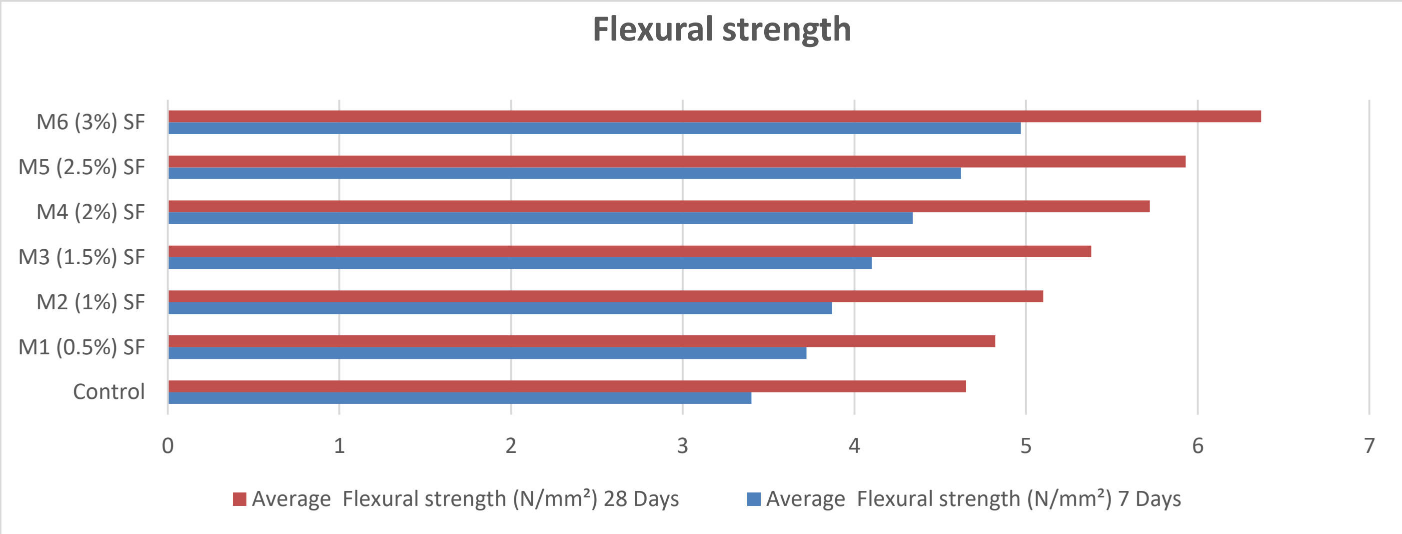
Compressive Strength and Flexural strength Test result addition of Steel Fiber

S. No	Mix ID	Compressive Strength 7 days (N/mm2)	Flexural Strength 7 days (N/mm2)	Compressive Strength 28 days (N/mm2)	Flexural Strength 28 days (N/mm2)
1	M1 (0.5%) SF	43.1	3.72	54.75	4.78
2	M2 (1%) SF	43.75	3.87	55.60	5.1
3	M3 (1.5%) SF	44.60	4.1	56.20	5.38
4	M4 (2%) SF	45.50	4.34	56.95	5.72
5	M5 (2.5%) SF	46.1	4.62	57.75	5.93
6	M6 (3%) SF	46.80	4.97	58.35	6.37

Comparative Results

S.no.	Mix	Average Compressive Strength N/mm^2		Average Flexural Strength N/mm^2	
		7 Days	28 Days	7 Days	28 Days
1	Control	42.37	54.20	3.40	4.53
2	M1 (0.5%) SF	43.10	54.75	3.72	4.78
3	M2 (1%) SF	43.75	55.60	3.87	5.1
4	M3 (1.5%) SF	44.60	56.20	4.1	5.38
5	M4 (2%) SF	45.50	56.95	4.34	5.72
6	M5 (2.5%) SF	46.1	57.75	4.62	5.93
7	M6 (3%) SF	46.8	58.35	4.97	6.37





The above graphical images represent that the use of steel fibers in concrete has given better results in terms of density, compressive strength and most importantly the flexural strength of concrete of while auditioned with steel fibers has better results which could result further research to use in the construction

IV. CONCLUSIONS

Based on the results addition of steel fiber following conclusion is given below: -

1. Using the specified ingredients and Steel fiber percentages—0.5, 1, 1.5, 2, 2.5 and 3 the concrete mix design was completed.
2. When Steel fiber is added to the Control mix at different percentages, it was found that the Compressive as well as the Flexural Strength both are increases as the steel Fiber increases.
3. When Steel fiber is added to the Control mix at different percentages, it was found that the density are increases as the steel Fiber increases the test findings show that a considerable increase in the amount of Steel fiber in the mixture results in a large surface area being reduce the air Voids.

According to the study, adding Steel fibers to Concrete has an impact on the mix's qualities, such as increasing Workability, Compressive strength, tensile strength, and Flexural Strength. The fibers may be able to prevent structural deterioration in the pavement, enhancing fatigue resistance and deformation resistance.

V. FUTURE SCOPE

The present work has wide scope for future research. Some of the research areas are as follows:

1. Investigation of reduction in cement content for different percentage addition of some other material in mix when permissible strength results are achieved and save cost of cement.
2. Investigation by use different aspect ratio different shape of the steel fibers.

3. Replacement of cement by other pozzolanic material such as glass powder, silica fumes, fly ash, stone dust etc. incorporated with different type of fiber.
4. Behaviour of mechanical and physical property by suitable other alternatives of sand and aggregate.
5. Behaviour under creep and shrinkage can be investigated.
6. Durability study must be carried out before adoption in field.

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