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Effect of Different Types of Steel Fibers on Strength Parameters of Self Compacting Concrete

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ABSTRACT*:* This research is based on investigating the effect of different types of steel fibers on strength parameters of self compacting concrete for M-40 grade of concrete using fibers like straight fiber, crimped fiber and hooked fiber. mix proportion of concrete was 1:1.79:2.54 and maintaining water cement ratio =0.35 in order to study the compressive strength, Split tensile strength, flexural strength, of steel fibre reinforced concrete (SFRC) containing fibers of 1%, 2% and 3% by volume of cement. Result data clearly shows that in 28 days there is increase of strength in Compressive strength, Flexural strength and Split Tensile strength upto 3% of addition of steel fiber for M-40 Grade of Concrete.

KEYWORDS: Different types of steel fibers proportions, M40 grade concrete, Mechanical properties of concrete.

I.INTRODUCTION

Self-compacting concrete has been depicted "the most progressive improvement in concrete development for a very long while". Initially created in Japan to balance a developing deficiency of talented work, it has proved to be beneficial from the following points. Speedier development, Reduction in site labor, Better surface , Easier putting, Improved durability, Greater flexibility in outline, Thinner concrete sections, Reduced noise level, Safer working environment.

Self Compacting Concrete (SCC) can flow under its own weight and totally fill the casing, even within the sight of congested reinforcement, with no compaction, while keeping up homogeneity of the Concrete. Compaction is hard to be done in conditions where there are dense reinforcement and large placing area. Utilization of SCC will defeat the troublesome throwing conditions and diminish labor required. The addition fibres in concrete enhance the tensile strength, flexural strength, impact strength, toughness, drying shrinkage, and failure pattern of the concrete. Including fibres enhances the mechanical qualities and additionally the ductility of SCC as a similar way simply like vibrated concrete. As a result of the predominant execution of SCC in its new state,insertion of fibres will prompt a more uniform scattering of fibres which is exceptionally basic for the execution of any fibre reinforced

II. RELATED WORK

Ganeshan.N et al [1] Studied the impact of steel fibres on the strength and behaviour of FRSCC structural elements subjected to flexure.. Twenty prisms were casted for this study, out of which two were plain SCC bars without fibres.

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The factors in this review were perspective proportion (15.25 and 35) and rate of volume part (0, 0.25, 0.5 and 0.75) of fibres. In light of the Experimental examination they watched that the primary split load and the post splitting conduct were found to have enhanced because of the expansion of fibres. A negligible change in the ultimate strength was observed. The addition of fibres had enhanced the ductility significantly.The ideal volume portion of fibres was observed to be 0.5 percent

Ali R. Khaloo1 et al [2] Investigated on the effect of length and volumetric rate of steel fibres on energy absorption of concrete slabs with different concrete strengths by testing 28 small steel fiber reinforced concrete (SFRC) slabs under flexure. Test occurs demonstrate that generally longer fiber and higher fiber content give higher energy absorption The outcomes are contrasted and a hypothetical forecast in view of arbitrary dispersion of fibres. The theoretical method resulted in higher energy absorption than that obtained in experiment.A design method according to allowable deflection is proposed for SFRC slabs inside the scope of fiber volumetric rates utilized as a part of the review. The method predicts resisting moment–deflection curve satisfactorily..

Osman Gencel et al [3] Studied composites of SCC with steel fibres for further property enhancement. Water/cement ratio and cement, fly ash and super plasticizer contents were kept constant at 0.40, 400, 120 and 6 kg/m3,respectively. The fibre amounts were 15, 30, 45 and 60 kg/m3. Comparing with plain concrete, adding steel fibres at 15, 30, 45 and 60 kg/m3 can increase the compressive strength by 3.2% and decrease by 3.4%, 2.0% and 1.0%, respectively. When compared with plain concrete, splitting tensile strength of fibre-reinforced concrete increases by 18.6%, 23.3%, 14.0% and 21.0% respectively. When compared with plain concrete, the flexural strength of fibre-reinforced concrete is higher by 13.1%, 24.2%, 40.6% and 51.7% respectively.

Wen-Cheng Liao et al [4] Several SELF-CONSOLIDATING HIGH PERFORMANCE FIBER REINFORCED CONCRETE (SCHPFRC) blends taken from past reviews were adjusted utilizing the accessible available local materials, prompting suggested blends with compressive qualities running from 35 to 65 MPa. These mixtures contain coarse aggregates totals having a 12 mm most extreme size and 30 mm long steel fibers in volume parts of 1.5% and 2%. The SCHPFC have compressive qualities going from around 35 to 65 MPa and a tensile strengths extending from 3.5 to 6.5 MPa. They also showed strain-hardening response in tension, accompanied by multiple cracking. The peak strain capacity after first cracking in tension ranged from 0.25 % to 0.45%.

Abhishek Sachdeva and Pankaj Singhal [5] concentrated the effect of strands steel fiber in "self-compacting concrete" (SCC) with variety from 0.35%, 0.70% and 1% by density of cement and furthermore varied viscosity changing agent (VMA) from 0.1 to 0.2% by density of cement.The capacity of stream was measured with slump flow test.V-pipe test and L-Box test. They utilized flyash in steelfiber "self-compacting concrete" (SF-SCC) It was seen that compressive strength if there ought to develop an occasion of 0.35% steel fiber mix was greater than that of SCC and 0.70% steel fiber mix at any day was greater than that of 0.35% blend and compressive quality of 1% steel fiber is greater than that of 0.35% and 0.70% blend.So it is discovered that with the expansion in SF compressive quality additionally expanded

III.PROPOSED METHODOLOGY AND DISCUSSION

The present research aims at studying the effect of straight fiber, crimped fiber and hooked fiber on strength parameters of self compacting concrete for M-40 grade of concrete having a mix proportion of 1:1.79:2.54 and maintaining water cement ratio =0.35.The mix design was carried out using IS:10262-2009 and modified Nansu Method was also implemented.Cubes,Cylinders and Prisms were casted and tested at 7 and 28 days in order to study the compressive strength, Split tensile strength, flexural strength, of steel fibre reinforced concrete (SFRC) containing this fibers at a varying percentage of 1%, 2% and 3% by volume of cement.

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MATERIALS USED:

The various materials used in the preparation of Self Compacting concrete are as follows.
1. Cement.
2. Coarse aggregate.
3. Fine aggregate.
4. Steel Fibres(Straight, Crimped, Hooked)
5. Super plasticizer.
6. Water.

PROPERTIES OF MATERIALS

3.1 Cement

The most common cement currently used in construction is 53 grade Ordinary Portland cement.

Table I:Typical properties of OPC of grade 53

SL.NO.	Properties of cement		Values	IS:12269-1987
1	'Standard consistency'		27%	28%
2	'Fineness %' (retained on 90µ sieve)		3%	≤10%
3	Soundness(by Le Chatelier)		3mm	(≤10mm)
4	'Initial setting time(min)'		62	(≥30min)
5	Finally setting time(min)		370	(≤600min)
6	"Specific gravity"		3.15	-------
7	Compressive strength	(7 days)	45	(≤37 $N/mm^{2)}$
		(28 days)	65	(≤53 $N/mm^{2)}$

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3.2 Coarse aggregate

Coarse aggregate crushed granite of 20 mm maximum size and retained on IS 4.75 sieve has been used as coarse aggregate

Table II:Typical properties of Coarse Aggregate

SL.NO	Properties of coarse aggregate	Value's
1	Surface texture	(Crystalline)
2	Particle Shape	(Angular)
3	Specific gravity	(2.73)%
4	Water absorption	(0.24%)
5	Bulk density	(1.62)

3.3 Fine aggregate

In the investigation fine aggregate is manufactured sand obtained from local quarry is used, as per IS: 383-1997

Table III:Typical properties of Fine Aggregate

SL.NO.	Properties of fine aggregate	Value
1	Surface Texture	(Crystalline)
2	Specific gravity	2.71
3	Water absorption	3.8%
4	Grading Zone	(Zone II)
5	Fineness Modulus	(2.68)

3.4 Steel Fibres:

a)Straight Steel Fibres: These Steel fibers are nothing but the pieces of steel wire from 0.3 to 1.1 mm in dia and these are having length 50 mm. These steel fiber are used in three-dimensional reinforcement of concrete and replaces steel mesh.

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Figure 1: Straight Steel Fibres

b)Crimped Steel Fiber: Crimped Steel Fiber is used as a piece of either dry or wet process shotcreting to enhance Flexibility, quality and impact resistance.

Figure 2:Crimped Steel Fibre

c)Hooked Steel Fiber: Hooked Steel Fiber can be used with any concrete mix and high concrete density is less mandatory then for undulated or for flat-end fibers. Load transfer in the crack is very good with this fiber shape.

Figure 3:Hooked Steel Fiber

3.5 Super Plasticizer:

The purpose of SP is to improve the workability of fresh concrete. **AUROMIX 400 INBNG1,** a super plasticizer manufactured by **FOSROC c**onstructive solutions, was used in the present work.

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Table IV: Typical Properties of Auro-mix 400 Super Plasticizer

PROPERTIES	RESULT
Appearance	Light Yellow colored liquid”
PH	Min 6
Volume mass @ 20◦C	(1.09)Kg Per Liter
Chloride Content	Nil
Alkali content	< 1.5 g Na_2o Proportionate liter of admixture

3.6 WATER: Potable water free from impurities and deleterious material was used for mixing and curing in this study.

IV. EXPERIMENTAL RESULTS

4.1 COMPRESSIVE STRENGTH (IS 516-1959)

Cubes of size (150 x 150 x 150mm) were casted and tested for determining compressive strength at 7 and 28 days The concrete cubes were cured at ambient temperature.

AVG 7 Days Compressive Strength (N/mm^2)at 0% Fiber Content =21.4 N/mm^2

AVG 28 Days Compressive Strength (N/mm^2) at 0% Fiber Content =40.3 N/mm^2

Table V: Average Compressive Strength in N/mm^2 at 7 and 28 Days for different fibers at varying percentages

Type of Steel Fiber	Fiber Content in %	AVG 7 Days Compressive Strength N/mm^2	AVG 28 Days Compressive Strength N/mm^2
Straight Fiber	1%	22	40.5
	2%	25	42
	3%	24	41.5
Crimped Fiber	1%	22.5	42.5
	2%	25.5	44.25
	3%	23.5	42.5
Hooked Fiber	1%	23.25	44
	2%	26	48
	3%	24.5	44.5

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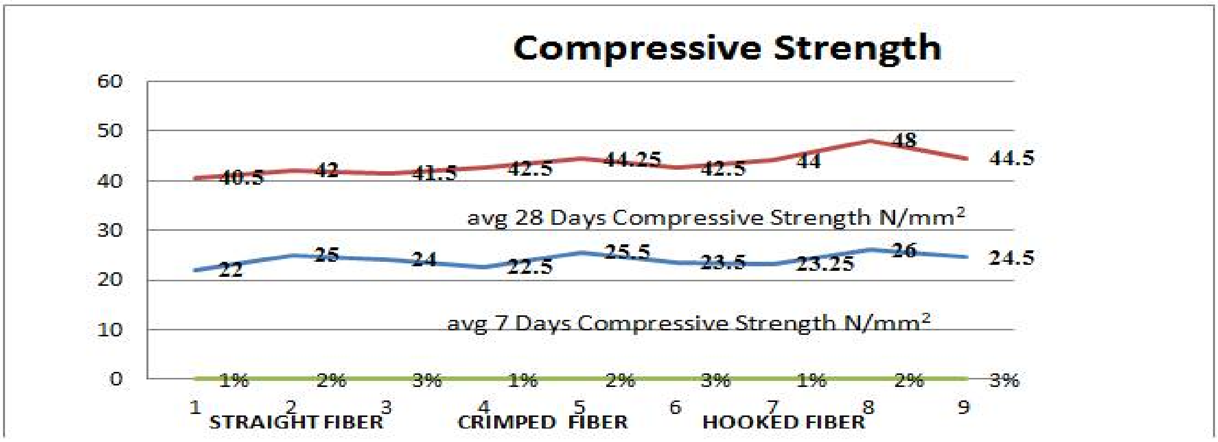

Graph: 4.1 Compressive Strength at 7 and 28 days

4.2 Splitting Tensile Strength Test

Cylinders of size (150 x 300mm) were casted and tested for determining Splitting Tensile Strength at 7 and 28 days The concrete Cylinders were cured at ambient temperature.

AVG 7 Days split tensile Strength (N/mm^2) at 0% Fiber Content =1.95 N/mm^2

AVG 28 Days split tensile Strength (N/mm^2) at 0% Fiber Content =3.8 N/mm^2

Table VI: Average Split Tensile Strength in N/mm^2 at 7 and 28 Days for different fibers at varying percentages

Type of Steel Fiber	Fiber Content in %	AVG 7 Days split tensile Strength N/mm^2	AVG 28 Days split tensile Strength N/mm^2
Straight Fiber	1%	2	3.5
	2%	2.25	4.25
	3%	2	4
Crimped Fiber	1%	2.25	4
	2%	2.5	4.25
	3%	2	4
Hooked Fiber	1%	2.05	4
	2%	2.75	4.5
	3%	2.25	4.25

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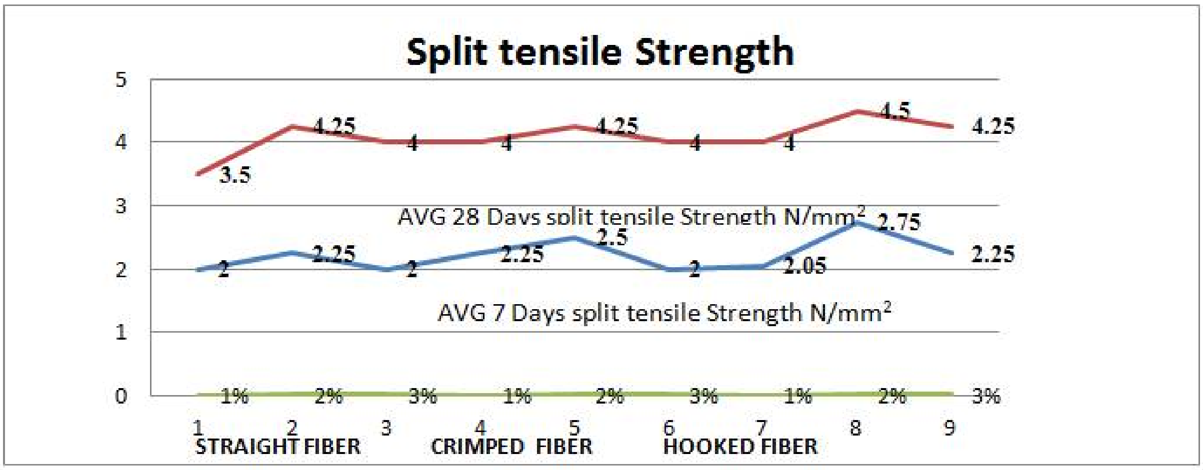

Graph: 4.1 Split Tensile Strength at 7 and 28 days

4.3 Flexural Strength Tests

Prisms of size (100 x100x500mm) were casted and tested for determining Flexural Strength at 7 and 28 days

Prisms AVG 7 Days flexural Strength (N/mm^2)at 0% Fiber Content =2.48 N/mm^2

AVG 28 Days flexural Strength (N/mm^2)at 0% Fiber Content =4.38 N/mm^2

Table VII: Average Flexural Strength in N/mm^2 at 7 and 28 Days for different fibers at varying percentages

Type of Steel Fiber	Fiber Content in %	AVG 7 Days Flexural Strength N/mm^2	AVG 28 Days Flexural Strength N/mm^2
Straight Fiber	1%	2.5	4.5
	2%	3	5
	3%	2.5	4.5
Crimped Fiber	1%	2.5	5.25
	2%	3.25	5.5
	3%	3	5
Hooked Fiber	1%	3	5.25
	2%	3.5	5.6
	3%	3.25	5.25

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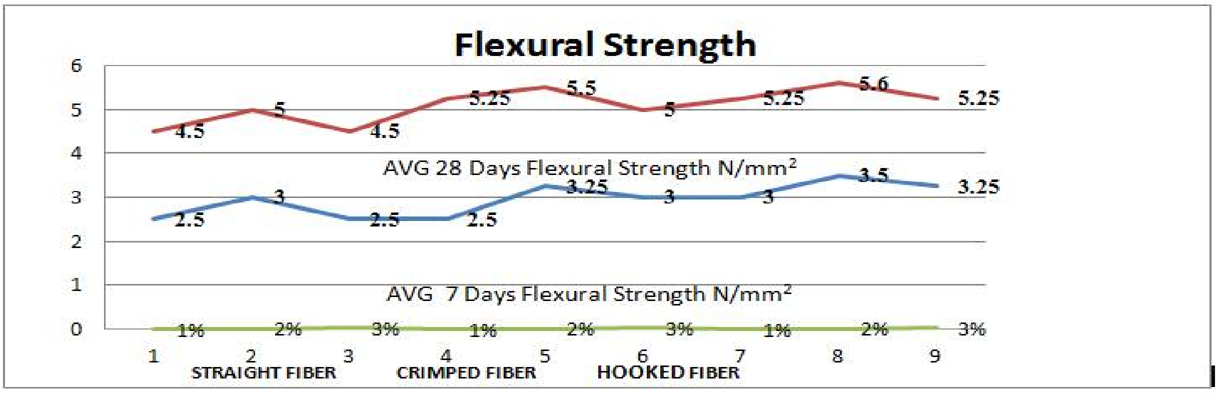

Graph: 4.3 Flexural Strength at 7 and 28 days

V.CONCLUSIONS

In this study, different types of steel fibers were used to produce fiber reinforced self-compacting concrete
A strict mixing procedure is followed in this study, in terms of time of mixing, addition of components, and sequence of material addition. In order to achieve high quality SCC and SFR-SCC mixes, it is essential to strictly follow the recommended mixing procedure. This procedure with the given mix proportions has led to an SCC mix that was able to flow and fill the molds without any need of vibration.The following conclusions were obtained from this study.

1)The 7 and 28 days compressive strength of self-compacting concrete with hooked steel fibres is maximum at a fibre percentage of 2%
2)The 7 and 28 days splitting tensile strength of self-compacting concrete with hooked steel fibres is maximum at a fibre percentage of 2%
3)The 7 and 28 days flexural strength of self-compacting concrete with hooked steel fibres is maximum at a fibre percentage of 2%
4)The variation of 28 days splitting tensile strength of self-compacting concrete with different type of steel fibre percentage is moderate.
5)Addition of fibres to self-compacting concrete increases the 28 days splitting tensile strength by 3.4% to 13.25%
6)Addition of fibres to self-compacting concrete increases the 28 days flexural strength by 3.1% to 10.93%.
7)It is observed that compressive strength increases from 11 to 24% with addition of steel fibres.
8)The optimum percentage of different type of steel fibre was found to be 2 percentage.
9)Hooked steel fibres at 2% addition to SCC was found to be the most efficient mix.

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