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EXPERIMENTAL INVESTIGATION ON HIGH STRENGTH FIBER REINFORCED CONCRETE WITH SILICA FUME

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Concrete is the most important building material in all countries because of its ability to cast in to any form and shape. The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cemetitious material, aggregate and water and by adding some special ingredients. The presence of micro cracks in the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibres in the mixture. The aim of this project is to find out the flexural behavior of high strength fiber reinforced concrete with silica fume. Mixes are prepared for M30 grade concrete. The different proportions of fibers added are 0.5%, 1%, 1.5% . The silica fume is replaced by 10% by the volume of cement in every mix. For compression test, the cubes of (150mm×150mm×150mm), for split tensile test cylinders (150mm diameter and 300mm length) and for flexural strengthtest.thebeamsof(1000mmx250mm×150mm)specimen are used. All the specimens were water cured for 28 days and tested subsequently. For the experimental study the compressive strength and flexural strength of concrete at 28 days will be find out

Keywords : silica fume, Micro cracks

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STEEL FIBER

Steel fibers are filaments of wire, deformed and cut to lengths, for reinforcement of concrete, mortar and other composite materials. The crack-arrest and crack-control mechanism of SFSCC results in the improvement of all properties associated with cracking, such as strength, ductility, energy absorption, and the resistance to impact, fatigue and thermal loading. The crack controlling property of fibers has three major effects on the behavior of concrete composite.

Steel fibers up to 5 per cent by volume are found to increase crack resistance (at first crack) of concrete up to 2.5 times the strength of unreinforced material, the compressive strength increases slightly. Split tensile strength as well as direct tensile strength are also increased by about 2.5 and 1.5 times, respectively. Young's Modulus of concrete may be doubled by adding about 2% percent of steel fibers by volume. The ductility increases enormously. In this project steel fibers are used with an aspect ratio of 50 and having hooked end. The fibers are conformed to ASTM A820.Shaktiman MSH 10050 type fibers are used here. The properties of fibers are given below based on manufacture's catalogue. Table 4.1 shows the properties of steel fiber.

Properties of Steel Fiber

Diameter	1mm
Fiber length	50mm
Tensile strength	1100 N/mm^2
Water absorption	Nil
Alkali resistance	High
Corrosion resistance	High

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APPLICATION OF STEEL FIBER IN CONCRETE

It is necessary to develop the concrete of special properties. Portland Pozzolona cement concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro-cracks are inherently present in the concrete and its poor tensile strength is due to propagation of such micro-cracks, leading to brittle failure of concrete. Development of such type of concrete that has to meet special requirements.

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ADVANTAGES OF STEEL FIBER REINFORCED CONCRETE

The main advantages of using the Steel fiber in concrete are

- Economical
- Controls cracking
- Increases flexibility
- Safe and easy to use
- Reduces water permeability
- Protection against early age crack formation
- Ductility and stiffness
- Energy absorption
- Shear resistance
- Microsilica or silica fumed is the most commonly used mineral admixture in high strength concrete. it has become the chosen favorites for high strength concrete and is a good pozzolana can be used in a big way, adding to the concrete mix will dramatically enhance the workability, strength & impermeability of concrete mixes while making the concrete durable to chemical attacks, abrasion & reinforcement corrosion, increasing the comprehensive strength.
- There is a growing demand in the production of concrete mixes, high performance concrete, and high strength, low permeability concrete for use in bridges, marine environment and nuclear plants ctc.

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Silica Fume

- The properties of silica fume are given below based on manufacture's catalogue. Table 4.2 shows the properties of silica fume.

Composition of Silica fume

Name of chemical	compositions
SiO2	99.5%
Al2O3	0.08%
TiO2	0.04%
CaO	0.01%
MgO	0.01%
L.O.I.	0.28%
ALKALIES	0.29%

APPLICATION OF SILICA FUME IN CONCRETE

Silica fume also known as micro silica is a byproduct of the reduction of high-purity quartz with coal in electric furnaces in the production of silicon and ferrosilicon alloys. Because of its extreme fineness and high silica content, Silica Fume is a highly effective pozzolanic material. Silica Fume is used in concrete to improve its properties like compressive strength, bond strength, and abrasion resistance; reduces permeability; and therefore helps in protecting reinforcing steel from corrosion.

ADVANTAGES OF SILICA FUME

The advantages of silica fume are listed below

- Increased cohesiveness of the fresh concrete, which can lead to improved handling characteristics.
- Curing can start earlier as there is no need to wait for bleed water to dissipate.
- Lower permeability and improved durability
- Greater resistance to abrasion and impact than conventional concretes of similar strength grade.
- Compressive strengths in are easily achieved. Higher flexural strength and modulus of elasticity than conventional concretes of equal compressive strength

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- Environmental benefits to reduced cement contents and improved service life.

SUPER PLASTICIZER

Super plasticizers are a water-reducing admixture that causes a significant increase in flow ability with little effect on viscosity. For example, the addition of 0.3 to 1.5 percent (by weight of cement) conventional super plasticizer to a concrete mix with 50-70 mm slump increases slump to 200-250 mm

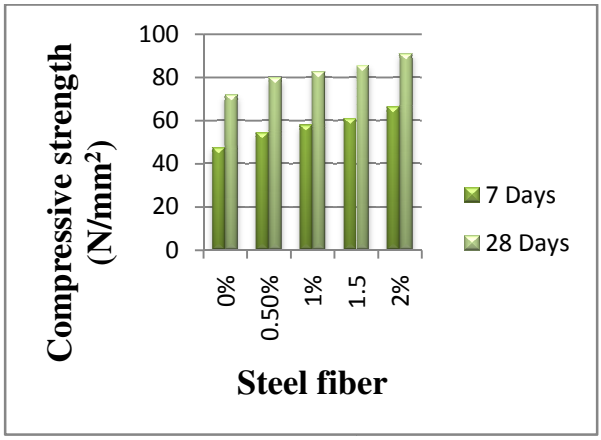
COMPRESSIVE STRENGTH

The compressive strength test for cubes was conducted in compression testing machine as per IS 516:1964. The cubes were tested in compressive testing machine at the rate of 140 kg/cm^2/min. and the ultimate loads were recorded

The average compressive strength, of the samples is taken as compressive strength of corresponding concrete grade. The test result for controlled mix is given below

Compressive strength

Sl.no	Percentage of fiber	Percentage of silica fume	7 days (N/mm^2)	28 days (N/mm^2)
1	0	0	47.3	71.70
2	0.5	8%	54.24	79.70
3	1	8%	57.8	81.37
4	1.5	8%	60.96	85.37
5	2	8%	65.27	89.45



Variation of compressive strength

SPLIT TENSILE STRENGTH

From table 8.2, it is observed that, average split-tensile strength at 28 days increased with increase in percentage of steel fiber up to 2%. The graphical representation of the variation of average

Sl.no	Percentage of fiber	Percentage of silica fume	Split tensile Strength (N/mm^2)
1	0	0	3.13
2	0.5	8%	3.30
3	1	8%	3.35
4	1.5	8%	3.41
5	2	8%	3.48

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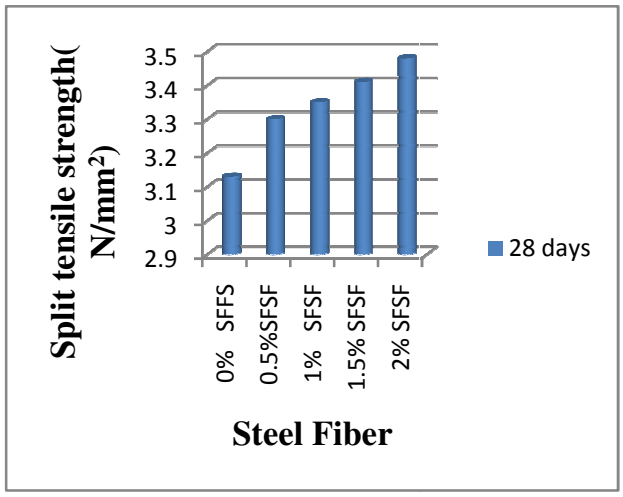
split-tensile strength at 28 days is shown in Figureure 8.3.

Split tensile strength



Variation of split tensile strength

MODULUS OF RUPTURE

it is observed that, average split-tensile strength at 28 days increased with increase in percentage of steel fiber up to 2%. The graphical representation of the variation of average split-tensile strength at 28 days is shown

Modulus of rupture

Sl.no	Percentage of fiber	Percentage of silica fume	Flexural Strength (N/mm^2)
1	0	0	5.92
2	0.5	8%	6.28
3	1	8%	6.35
4	1.5	8%	6.47

8.4 SULPHATE ATTACK ON CONCRETE

The percentage loss in weight and percentage loss in compressive strength after immersing the cubes in the solutions is shown

specimen	Percentage loss in weight		Percentage loss in compressive strength	
	28 days	56 days	28 days	56 days
CONTROL	1.2	2.32	5.6	9.53
SFSF	0.72	1.32	4.7	7.2

Sulphate attack

ACID RESISTANCE TESTS

The acid attack testing procedure was conducted by immersing concrete specimens in H_2SO_4 solution.

Acid Resistance HCl

Solution	Percentage loss in weight		Percentage loss in compressive strength	
	28 days	56 days	28 days	56 days
CONTROL	5.65	8.34	10.34	15.67
SFSF	3.74	5.93	7.68	11.3

Acid Resistance H_2SO_4

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Solution	Percentage loss in weight		Percentage loss in compressive strength	
	28 days	56 days	28 days	56 days
CONTROL	2.42	4.8	8.6	12.56
HCL	1.92	3.9	6.2	8.8

FLEXURAL STRENGTH

RCC beams were cast for controlled concrete and M60 grade concrete with 2% steel fiber and 8% silica fume.For M60 grade concrete conventional and SFRCSF RCC beams, the initial crack load was found as 120 KN and 180 KN respectively. The ultimate load was found as 190 KN and 220 KN respectively. The maximum deflection at L/2 was found as 12.3 mm for conventional RC beam and 11.9 for SFRCSF beam.

Load Vs deflection for M40 conventional and SFRCSF

Sl no	Load	Deflection	
		M60 conventional	M60 SFRCSF
1	10	0.60	0.4
2	20	1.1	0.67
3	30	1.6	0.98
4	40	2.4	1.2
5	50	3.2	1.67
6	60	4.14	1.98
7	70	5.2	2.38
8	80	6.48	2.96
9	90	7.34	3.43
10	100	8.7	4.13
11	110	10.26	4.89
12	120	12.3	5.5
13	130	-	6.23
14	140	-	6.98
15	150	-	7.6
16	160	-	8.6
17	170	-	9.8
18	180	-	11.9

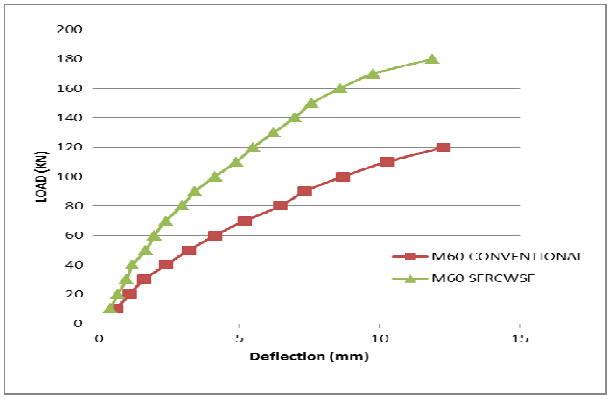

Figure 8.4 Load vs Deflection curve for M40 conventional and SFRCSF

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Compressive Strength Testing

Split Tensile Test

CONCLUSION

The strength of the concrete increases with the increases in the fiber content. The optimum fiber dosage is founded as 2% among various percentages in the project. For high strength concrete super plastizer is added to increase the slump value. The mechanical properties of concrete increases when the steel fiber and silica fume is added. The modulus of rupture improved more than that of compressive strength and split tensile strength. The ultimate load carrying capacity of RCC beam increases when the steel fiber and silica fume are added in the concrete. The silica fume in concrete gives good durability to the concrete.

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