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Determination of high Strength Concrete with Steel Fibre & Silica Fume

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***Abstract**: In this experimental studies effect on the Properties of concrete by using Silica fume and steel fibre is investigated, the combined effect of silica fume and steel fibre to be determined. The purpose of this work is to obtain a more flexural strength of concrete produced by using both silica fume and steel fibre. Steel fibres with aspect ratio of 80 were used in the experiments. [1] Addition different percentage of steel fibre and different percentage silica fume by weight of cement content. The slump cone method is used to determine workability [2]. Compressive and Flexural strength test were made on hardened concrete specimens. Plain concrete pavements have low flexural strength and strain capacity;By using fibre structural characteristics are improved and also allows reduction of the thickness of the pavement layer. These better properties are considerable and controlled by characteristics of fibre and percentage. The major effect of fibre reinforcement is to delay and prevent from cracking of concrete. This is will reduces the thickness of pavement which is responsible for less maintenance and provides durability. Brittleness of concrete reduced by addition of steel fibre and Silica fume increases the density of concrete. Failure by using steel fibre and silica fume is ductile in nature and without steel fibre and silica fume brittle in nature [2].*

***Keywords**: Silica fume, cement, Composite, physical properties, concrete properties*

I. INTRODUCTION

Steel fibres used in concrete from 1990s.As per IRC:SP:46-1997 steel fibres have equivalent diameters based on cross-sectional area which is 0.15 mm to 2 mm and lengths from 7mm to 75 mm. Aspect ratios generally range from 20 to 100.(Aspect ratio is defined as the ratio between fibre length and its equivalent diameter, which is the diameter of a circle with an area equal to the cross-sectional area of the fibre)[4].Rigid pavements are so named because the pavement structure deflects very little under loading due to the high modulus of elasticity of their surface course. Concrete slabs provide the load carrying capacity of rigid pavement. Concrete slab spreads the load across a wide area which reduces the stress. Failure of conventional concrete is mainly due to the breakdown of the bond between cement paste and aggregate.

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Addition of steel fibre increases the flexural strength and tensile strength and silica fume increases the density of concrete which responsible for the increase in compressive strength of concrete [5].

Addition of fibre can improve ductility of concrete without decreasing compressive strength. Concrete ductility will affect the process of initial cracking until the concrete collapses due to impact. Certain types of fibres enhance the performance of the concrete. This research evaluates the compressive strength, flexural strength of the concrete which is essential in rigid pavement. It has been broadly used for overlay roads, airfield pavements and bridge decks[6].

Recently the use of Steel fibre and Silica fume in concrete in construction has been increased. The determination of properties of steel fibre and silica fume (or micro silica is very significant to enhance the properties of concrete. The quality of good and durable concrete depends on the properties of raw material in concrete also proper mix design, use of admixtures, proper mixing, placement, efficient curing. Steel fibre and Silica Fume is one of the good additional materials in concrete. Silica fume reduces bleeding on concrete by absorbing water in concrete[1].

II. OBJECTIVES

The proposed work has the objective of started below.

1. To find desirable Steel fibre Percentage on concrete
2. To determine the Compressive strength of concrete.
3. To determine the flexural strength of concrete.

In this section discussion about experimental work are carried out. The materials and their properties, mixture proportions have been described.

III. MATERIALS

A) Steel fibre:

Steel fibers are concrete reinforcing material which in combination with concrete provides certain advantages in comparison with traditional reinforcement. Aspect ratio maintain in this SFRC is 80. Steel fibre is in circular cross sectional shape. It is hooked end type steel fibre. Using steel fibre enhances the static flexural strength, fatigue resistance and shear strength. Properties such as torsional strength and toughness are also improves. Application of SFRC minimizes the crack width in concrete. Ductility and resistance to crack improves by SFRC. The uniform distribution of steel fibres in the concrete forms matrix nature. SFRC eliminates the wire mesh in shotcrete also provides easy handling.

FIG - STEEL FIBRE

Table: Physical and mechanical properties of steel fibre.

Sr. No.	Properties	Result
1	Diameter	0.62 mm
2	Specific Gravity	7.95
3	Length	48 mm
4	Aspect ratio	80
5	Tensile strength	370 MPa
6	Modulus of Elasticity	2 X 105MPa
7	Modulus of Rigidity	0.769 X 105Mpa
8.	Coefficient of thermal expansion	12 X 10-6 / 0C

B) Silica fume

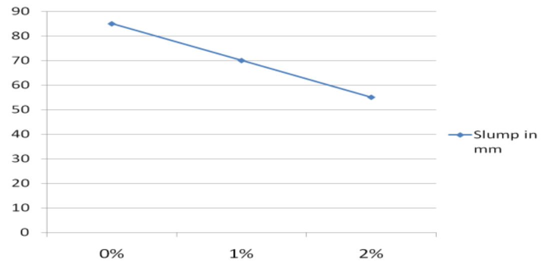
Silica fume is a by-product of silicon metal or ferrosilicon alloys. Silica fume has been considered as a pozzolanicadmixture that is improves the mechanical properties of concrete. Chemical and physical properties of silica fume gives better performance, Silica fume consists primarily of amorphous (non-crystalline) silicon dioxide ($SiO2$).Silica fume fills the voids in concrete which responsible to improves the latter's durability by reducing permeability of concrete. The addition of silica fume to concrete improves the latter's durability by reducing permeability. Sulphate attack can be reduced by the diffusion of harmful ions and the calcium hydroxide content. [7].

FIG – MICRO SILICA

IV. CONCRETE TESTING

Table: Test results of slump cone test

% of steel fibre	0 %	1 %	2 %
Slump in mm	85	70	55



Graph: Graph showing test results of slump cone test

Graph represents that as percentage of steel fibre increases Workability will be decreases Compressive strength test of concrete can be conducted by using Compression Testing Machine

Compressive Strength (N/mm2) = $\frac{P}{a}$

Here, p = load at failure (N)

a= cross sectional area (mm^2)

Flexural strength test of concrete can be conducted by using centre point loading method as per following formula.

Flexural Strength (N/mm^2) = $\frac{P\,l}{b\times d^2}$

Here, p = load at failure (N)

l = length of beam specimen (mm)

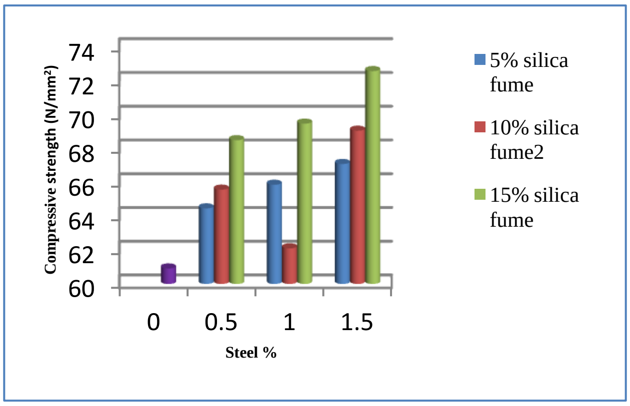
b = breadth of beam specimen (mm)

d = depth of beam specimen (mm)

Table: 28 days compressive strength for randomly mixed steel fibres

% Steel fibre	Aspect ratio	Position of fibres	% of silica fume	Load (KN)	Compressive strength (N/mm^2)	Avg. compressive strength (N/mm^2)
0.0	80	Randomly mixed		1308	58.11	60.64
				1434	63.73	
				1352	60.08	
0.5			5	1418	63.02	64.56
				1484	65.96	
				1456	64.71	
			10	1445	64.23	67.12
				1506	66.99	
				1568	69.58	
			15	1525	67.75	68.53
				1560	69.30	
				1542	68.53	
1.0			5	1445	64.26	65.62
				1519	67.51	
				1465	65.11	
			10	1360	60.44	62.01
				1435	63.77	
				1391	61.82	
			15	1460	64.93	68.71
				1656	73.57	
				1522	67.64	
1.5			5	1428	63.46	67.17
				1595	70.88	
			10	1506	66.93	69.63

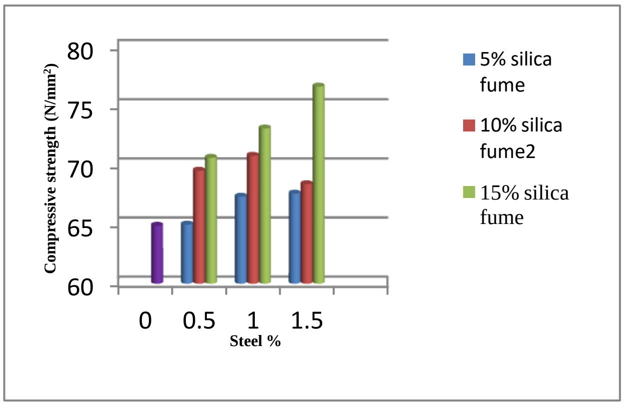
				1592	70.75	
				1603	71.23	
			15	1667	74.08	72.73
				1601	71.15	
				1642	72.97	



Graph: Graph showing variation in 28 days compressive strength for randomly mixed steel fibre and silica fume

Table: 28 days compressive strength for 2/3 rd position mixed steel fibre

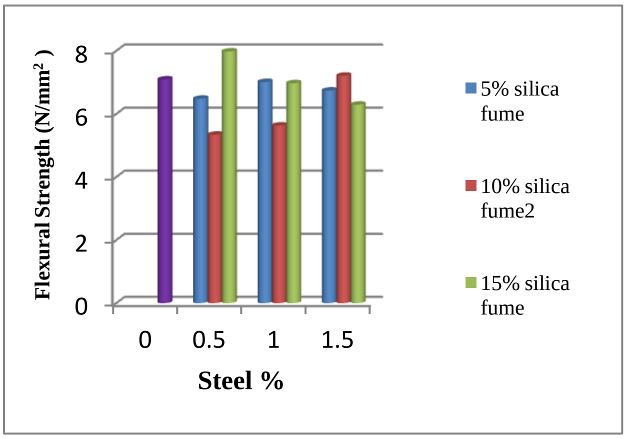
%Steelfibre	Aspect ratio	Position of fibres	% of silica fume	Load (KN)	Compressive strength (N/mm²)	Avg. compressive strength (N/mm²)
0.0	80	2/3 rd position		1423	63.24	64.67
				1498	66.57	
				1445	64.22	
0.5			5	1426	63.37	64.79
				1499	66.62	
				1449	64.4	
			10	1532	68.08	69.38
				1598	71.02	
				1554	69.06	
			15	1591	70.71	70.33
				1588	70.57	
				1569	69.73	
1.0			5	1503	66.80	67.45
				1528	67.91	
				1522	67.64	
			10	1669	74.17	71.23
				1518	67.46	
				1622	72.08	
			15	1750	77.77	72.89
				1541	68.48	
				1630	72.44	
1.5			5	1511	67.15	67.56
				1532	68.08	
				1518	67.46	
			10	1534	68.17	68.42
				1545	68.66	
				1540	68.44	
			15	1712	76.08	76.73
				1738	77.24	
				1730	76.88	



Graph: Graph showing variation in 28 days compressive strength for 2/3rd position of steel fibre and silica fume

Table: Flexural strength test results:

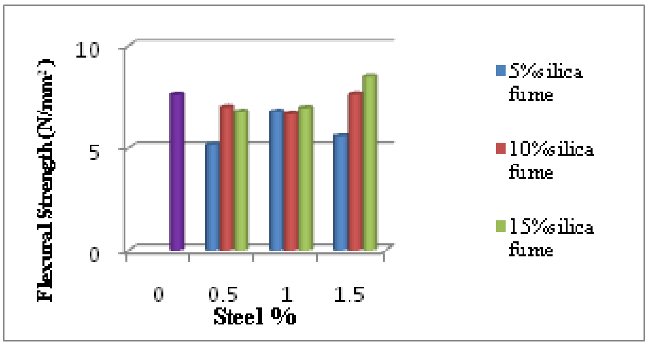
% steel fibre	% of Silica fume	Aspect ratio	Position of fibres	Load (KN)	Displacement at failure (mm)	Flexural strength (N/mm²)	Average flexural strength (N/mm²)
0.0		80	Randomly mixed	36.4	0.9	6.47	7.09
				39.1	1.2	6.95	
				37.9	1.0	7.86	
0.5	5			24.8	1.8	5.14	6.48
				37.78	1.3	7.83	
				31.3	1.4	6.49	
	10			20.24	1.1	4.19	5.34
				31.78	1.9	6.59	
				25.27	1.3	5.24	
	15			30.03	0.6	6.23	7.98
				47.00	1.2	9.74	
				38.49	0.8	7.98	
1	5			28.59	2.6	5.93	7.01
				39.37	3.2	8.16	
				33.57	3.0	6.96	
	10			23.14	1.5	4.8	5.63
				30.85	2.1	6.4	
				27.48	1.8	5.69	
	15			35.12	2.8	7.28	6.97
				32.12	3.1	6.66	
				33.64	2.9	6.97	
1.5	5			32.46	1.9	6.73	6.74
				31.38	2.5	6.50	
				33.78	1.6	7.00	
	10			33.26	3.1	6.9	7.21
				36.16	4.0	7.5	
				34.98	3.4	7.25	
	15			28.49	3.4	5.91	6.29
				32.44	2.8	6.73	
				30.12	3.0	6.24	



Graph: Graph showing variation in 28 days flexural strength for randomly mixed steel fibre and silica fume

Table: Result showing variation in 28 days Flexural strength for 2/3rd position of steel fibre:

steel fibre	% of Silica fume	Aspect ratio	Position of fibres	Load (KN)	Displacement at failure (mm)	Flexural strength (N/mm^2)	Average flexural strength (N/mm^2)
0.0		80	2/3 rd position	38.71	0.8	6.88	7.61
				43.02	1.1	7.64	
				40.12	0.9	8.32	
0.5	5			21.67	2.6	3.85	5.18
				33.43	3.2	5.94	
				27.84	3.0	5.77	
	10			33.49	3.7	5.95	7.00
				41.10	3.4	7.3	
				37.48	3.6	7.77	
	15			37.48	3.2	6.66	6.77
				36.12	3.9	6.42	
				34.87	4.0	7.23	
1	5			36.84	3.8	6.54	6.68
				35.25	4.7	6.26	
				34.98	4.8	7.25	
	10			37.19	4.3	6.61	6.96
				37.32	3.6	6.63	
				36.96	4.4	7.66	
	15			34.62	2.9	6.15	6.58
				35.72	3.2	6.35	
				34.94	3.0	7.24	
1.5	5			34.33	2.4	6.10	6.84
				38.91	3.3	6.91	
				36.24	2.8	7.51	
	10			42.12	4.1	7.48	7.63
				39.12	4.3	6.95	
				40.86	4.2	8.47	
	15			45.02	4.9	8.00	8.5
				46.88	6.2	8.33	
				45.49	5.0	9.43	



Graph: Graph showing variation in 28 days Flexural strength for 2/3rd position of steel fibre and silica fume

V. Conclusion

a) More flexural and compressive strength observed in 80 Aspect Ratio as compared to plain concrete.
b) As percentage of fibre and silica fume increases flexural strength also increases.
c) Concrete of Randomly mixed steel fibre gives less strength than 2/3rd placed steel fibres.
d) Failure is brittle in nature without fibre and with fibre failure is ductile.
e) It is observed that workability of concrete decreases as % of steel fibre increases.
f) Use of micro silica increases the density of concrete and superplasticizer enhances good finishing of concrete.
g) As percentage of steel fiber increases cracks develop in concrete decreases upto 15%

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