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Effect on Steel Fiber Reinforced Concrete with Silica Fume for High Grade

C.G. Konapure, V.S Dasari
Assistant Professor, Department of Civil Engg, Solapur University, Solapur-413006
P.G.Student, Department of Civil Engg, Solapur University, Solapur-413006

Abstract*— This experimental study deals with M50 grade of concrete having mix proportion 1:1.97:2.75 with w/c ratio 0.41 to study the properties of concrete like compressive strength and flexural strength. The concrete containing steel fiber of 1% volume fraction of hook end with 71 aspect ratio. silica fume used as a replacement of cement of about 5% by weight and also superplastisizer are added as per requirement for achieving desired workability of concrete. A relationship between workability, compressive strength and flexural tensile strength represented mathematically and graphically. In the present investigation, the combined effects of steel fiber and silica fume on concrete properties were experimentally assessed with control specimen.

***Index Terms*—Concrete, steel fiber, silica fume, super plasticizer, workability, strength.**

I. INTRODUCTION

The structural properties of fiber reinforced concrete are well known. In the present study, an effort is made to combine the structural properties of steel fiber reinforcement with those of cement concrete with silica fume and super plasticizer. This study will enhance for a designer to combine the advantages of steel fiber and silica fume like increased strength, increased workability, reduced voids etc with those of fiber reinforcement. The contents of each section may be provided to understand easily about the paper.

II. SPECIFICATION OF MATERIALS

A. Cement

Ordinary Portland Cement (OPC) of 43 Grade is used for this experimental work. All properties of cement are tested according to I.S. 12269: 1987. The specific gravity of cement is 3.15.

B. Silica Fume (SiF)

Silica Fume is available in dry powder form and procured from Oriental Trexim Pvt. Ltd., Navi Mumbai. It is usually gray color powder; Silica fume under the product name "Grade 92 D" is available in 25kg bags.

C. Steel Fiber (S.F.)

In this Experiment Hook ended Steel Fiber type HK0750 is used having aspect ratio 71. It is obtained from Precision Drawell Pvt. Ltd., Nagpur. The length of dividing fiber is 50mm and diameter of fiber is 0.7mm.

D. Fine Aggregate

The sand used for this experimental work was locally procured and passing through 4.75mm sieve with specific gravity 2.80. The properties of Fine Aggregate are tested as per I.S. 383: 1970.

E. Coarse Aggregate

Crushed aggregate of maximum size 20mm & minimum 10mm are used in the present study. Its specific gravity is 2.85. The properties of Fine Aggregate are tested as per I.S. 383: 1970.

F. Water

Ordinary clean potable water is used for both mixing & curing.

G. Chemical Admixture (C.A.)

Chemical admixture super plasticizer Pidicrete CF 21 is used for experimental work for M50 Grade of concrete.

III. METHODOLOGY

A. Materials and Mixing Procedure

1. Batching: - The batching of concrete was carried out by weight. All the required materials for preparing the concrete were weighed with an accuracy of 0.5 grams as per the required proportions.

2. Mixing: - On the watertight platform, the concrete mixture was prepared by hand mixing. The cement and silica fume were thoroughly mixed in the dry state, and the sand was added to the mixture. The mixture was again thoroughly mixed and placed over the coarse aggregate. In case of fiber reinforced concrete, steel fibers were evenly sprinkled during mixing. Then water was added carefully with chemical admixture during mixing. Mixing was carried out until a workable mixture was obtained.

Fig.1:- Dry Mixing

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Fig .2:- Wet Mixing

3. Casting: - The concrete moulds were filled in three layers. In each of the layer, the concrete cubes will be compacted 25 times respectively. Vibration was given to the cube moulds using table vibrator. Vibrations were continued for one minute to ensure uniform compaction. The specimen were demoulded after 24 hours of casting and placed in a curing tank for 7 & 28 days.

B. Mix Design

The mix proportion was calculated for characteristic compressive strength of 50 N/mm^2. The proportions for normal mix of grade M50 are 1:1.97:2.75 with water cement ratio 0.41. The method used for mix design is the Indian Standard Method.

C. Slump cone test & Compaction factor test

Workability is carried out by conducting slump test and compaction factor test as per I.S. 1199-1959 on ordinary concrete and fiber reinforced concrete.

D. Compressive strength test

The compressive strength is taken as maximum compressive load resisted by per unit area. For compressive strength test, cube specimens of dimensions 150 mm x 150 mm x150 mm were cast for M50 grade of concrete. The concrete cube moulds were lubricated with oil before the mixed concrete was placed inside it. After curing, as per I.S.516-1959 all cubes were tested on Compression Testing Machine. The failure load was noted. In each category, three cubes were tested and their average value is reported. The compressive strength was calculated as follows, Compressive strength (MPa) = Failure load / cross sectional area.

E. Flexural strength test

Flexural strength test was conducted on beam specimens under two point loading as per I.S.516-1959, over an effective span of 600 mm divide into three equal parts. The average ultimate flexural tensile stress was determined from the failure flexural loads. For flexural strength test beam specimens of dimension 150 mmx150 mm x150 mm were cast. The beam specimens were tested after 28 days curing. The load is normally increased and at cracking of beam specimen, failure load is noted. The flexural strength was calculated as follows.

Flexural strength (MPa) = (P x L) / (b x d2)

Where, P = Failure load, L = Centre to centre distance between the support = 600 mm, b = width of Specimen=150 mm, d = depth of specimen= 150 mm.

IV. EXPERIMENTAL RESULTS

1 Fresh Concrete Properties

The fresh concrete properties slump, compaction factor & Density are shown in Table No.1.

Table No.1:- Result of Slump, Compaction Factor & Density of Fresh Concrete

Mix Type (S.F. % , SiF % & C.A)	Slump Value (mm)	Compaction Factor	Density (kg/m3)
S0 (1.0% , 00% & 1.0%)	25	0.741	2702.22
S1 (1.0% , 05% & 0.5%)	15	0.778	2693.33
S2 (1.0% , 05% & 1.0%)	20	0.698	2705.18
S3 (1.0% , 05% & 1.5%)	30	0.690	2708.15
S4 (1.0% , 10% & 1.5%)	25	0.767	2637.03
S5 (1.0% , 15% & 1.5%)	20	0.775	2613.33

2 Hardened Concrete Properties

The hardened concrete specimen properties are checked by compressive strength& Flexural strength.

2.1 Compressive Strength

The compressive strength of cube specimen is checked after 7 & 28 days in compressive testing machine. The result of compressive strength is shown in Table no.2 and Fig.No.3.

Table No.2:- Result of Compressive Strength at 7 Day & 28 Day

Mix Type (S.F. % , SiF % & C.A)	Compressive Strength(N/mm2)	
	7 Days	28 Days
S0 (1.0% , 00% & 1.0%)	36.72	53.52
S1 (1.0% , 05% & 0.5%)	34.30	47.86
S2 (1.0% , 05% & 1.0%)	36.30	49.75
S3 (1.0% , 05% & 1.5%)	36.88	52.82
S4 (1.0% , 10% & 1.5%)	37.59	56.78
S5 (1.0% , 15% & 1.5%)	38.55	58.30

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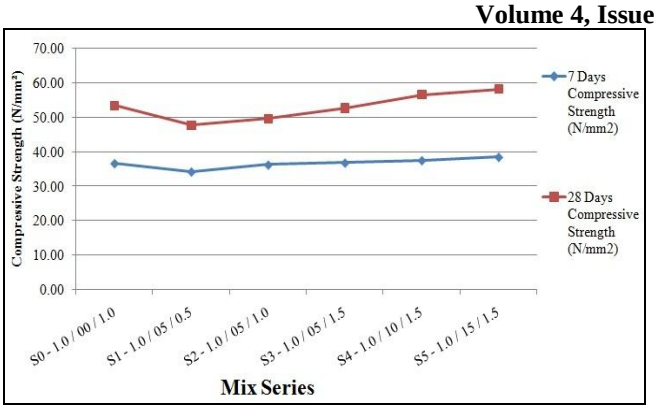

Fig.3:- Type of Mix vs. Compressive Strength at 7 Day & 28 Day.

2.2 Flexural Strength

The Flexural test of beam specimen is checked after 28days. The result of flexural strength is shown in Table No.3 and Fig. No.4.

Table No.3:- Result of Flexural Strength at 28 Day

Mix Type (S.F. % , SiF % & C.A)	Flexural Strength (N/mm2)
S0 (1.0% , 00% & 1.0%)	5.20
S1 (1.0% , 05% & 0.5%)	5.48
S2 (1.0% , 05% & 1.0%)	5.76
S3 (1.0% , 05% & 1.5%)	5.81
S4 (1.0% , 10% & 1.5%)	5.91
S5 (1.0% , 15% & 1.5%)	6.15

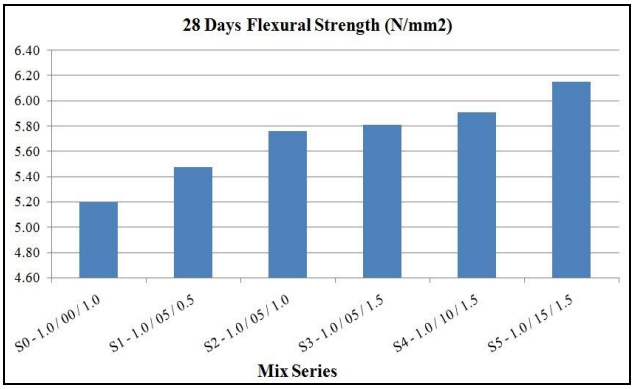

Fig 4:- Type of Mix vs. Flexural Strength at 28 Day

V. CONCLUSION

The following conclusions could be drawn from the present investigation.

1. As silica fume content increases the unit weight of concrete decreases.
2. For same % of addition of steel fiber, 15% silica fume gives lower density with 1.5% of chemical admixture.
3. Compaction factor of concrete increases with increase in silica fume content.
4. For high grade steel fiber reinforced concrete with silica fume must require more than 1.5% of chemical admixture to achieve homogeneous and workable mix.
5. Increment of silica fume content up to 15% given good result in terms of compressive strength and flexural strength.
6. The mix series S5 ((1.0%, 15% & 1.5%) gives high compressive strength and flexural strength.

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AUTHOR BIOGRAPHY

Prof. Konapur C.G has obtained his Bachelor of Engineering from Shivaji University,Kolhapur,India; M.E in Structural Engineering From Shivaji University,Kolhapur,India. Prof.Konapur C.G is currently working as Assistant Professor in Civil Engineering Department, Walchand Institute of Technology, Solapur with additional charge of P.G. co-ordinator and in charge of concrete technology laboratory. He has 10 years of teaching experience in the field of civil engineering. He has

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presented and participated in various conferences of national and international importance. His area of research interest is concrete technology in which he has guided several M.E thesis. He has published 7 papers in national and international journal.

Mr. V.S.Dasari has obtained his Bachelor of Engineering from Dr.Babasaheb Ambedker Marathwada University, Aurangabad, India. He is currently pursuing M.E (Final year) Structural Engineering from Walchand Institute of Technology, Solapur.