Effect of Natural Admixture on Compressive Strength of Silica Fume Blended Concrete

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Abstract— A durable concrete is one that has ability to withstand the damaging effect of the environment and of its service conditions without undue deterioration and excessive maintenance over the design life of a structure. The used of high performance concrete is an alternative in producing high-strength concrete, durable and construction friendly. In the present investigation, experimental results on compressive strength and UPV of concrete made with various mixture proportions i.e., silica fume (0%-20%) and egg (0%-0.35%) have been presented. The increasing trend in compressive strength and UPV values observed from 0% egg dosage to 0.35% egg dosage at all curing periods. At 0.5% egg dosage the compressive strength and UPV values have decreased at all ages. Similar trend has been observed for the other silica fume proportions i.e. from 10% to 15%. At 20% silica fume dosage, all the values have decreased when compared to the 15% silica fume dosage mixes. From the results it is observed that 0.35% egg dosage and 15% silica fume dosage can be taken as optimum dosages.

Key words: opc cement, Silica fume, natural egg, compressive strength ultrasonic plus velocity test

I. Introduction

While greatly varying from architectural masterpieces to the simplest of utilities. It is the most widely Concrete is the mostly used material in various types of construction, from the flooring of a hut to a multi storied high rise structure from pathway to an airport runway, from an underground tunnel and deep sea platform to high-rise chimneys and TV Towers. In the last millennium concrete has demanding requirements both in terms of technical performance and economy used construction materials. It is difficult to point out another material of construction which is as versatile as concrete.

Cement concrete is one of the seemingly simple but actually complex materials. The properties of concrete mainly depend on the constituents used in concrete making. The main important material used in making concrete are cement, sand, crushed stone and water. Even though the manufacturer guarantees the quality of cement it is difficult to produce a fault proof concrete. It is because of the fact that the building material is concrete and not only cement. The properties of sand, crushed stone and water, if not used as specified, cause considerable trouble in concrete. In addition to these, workmanship, quality control and methods of placing also play the leading role on the properties of concrete.

II. Literature & review

In this chapter, a brief review of literature on influence of mineral admixtures on the strength and durability aspects such as saturated water absorption, sorptivity, corrosion resistance and acid resistance of high performance concrete is reported and discussed.

In the present study, the mineral admixtures such as Silica Fume are used for producing HSC. Silica fume is a by-product of the fabrication of silicon metal, ferrosilicon alloys and other silicon alloys. Since, the particles of silica fume are very small, they can enter the space between the cement particles and thus improve packing. The literatures regarding the influences of these mineral admixtures on the properties of concrete in the fresh and hardened stage are discussed.

A. *Effect of Admixtures on High Performance Concrete*

High compressive strength is generally the first property associated with silica fume concrete. **Yogendran et al (1987), Hooton (1993) and Sabir (1995)** reiterated that the strength development in concrete with condensed silica fume is higher in the range of 12-28%. Cong and Darwin (1992) reported that lower compressive strengths were achieved at the age of 3 days while higher strengths at 7 and 28 days with silica fume mortars.

III. Investigations

This study involves the details of development of the process of making low calcium Silica fume based hardened concrete. The physical and chemical properties of Silic fume, aggregate, water and egg used in the investigation were analyzed based on standard experimental procedures laid down in *IS*, *ASTM* and *BS* codes. The experiments conducted on coarse aggregate are specific gravity and water absorption, Bulk density & Sieve analysis by using respective codes [4-9]. The experiments conducted on fine aggregates are specific gravity, moisture content, sieve analysis and bulking of fine aggregate using volume method. The tests conducted on geo polymer concrete are Compressive strength [10-12], are as per the respective *IS*, *BS* and *ASTM* codes.

A. *Materials used*

1) *Cement*

Cement is a material, generally in powder form, which can be made into a paste usually by the addition of water and, natural egg, will set into a solid mass. Numerous organic compounds used for adhering, or fastening materials, are called cements, but these are classified as adhesives, and the term cement alone means a construction material. The most widely used of the construction cements is Portland cement. It is a pure white colour powder obtained by finely grinding the clinker made by strongly heating an intimate mixture of calcareous and argillaceous minerals

2) *Fine aggregate*

Fine aggregate / sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles, but is distinct from clays which contain organic materials. Sands that have been sorted out and separated from the organic material by the action of currents of water or by winds across arid lands are generally quite uniform in size of grains.

B. Course Aggregate

Coarse aggregate are the crushed stone is used for making concrete. The commercial stone is quarried, crushed, and graded. Much of the crushed stone used is granite, limestone, and trap rock. The last is a term used to designate basalt, gabbro, diorite, and other dark-coloured, fine-grained igneous rocks. Graded crushed stone usually consists of only one kind of rock and is broken with sharp edges. The sizes are from 0.25 to 2.5 in (0.64 to 6.35 cm), although larger sizes may be used for massive concrete aggregate. Machine crushed granite broken stone angular in shape was used as coarse aggregate. The maximum size of coarse aggregate was 20 mm and10 mm specific gravity of 2.78.

1) Natural Admixture Egg

Grill hen egg was utilized as Natural admixture, egg white and yellow yolk was thoroughly blended and added to concrete. The Natural admixture was supplanted to water at different substitution levels 0%, 0.15%, 0.25%, 0.35% and 0.50%.

2) Silica Fume

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 pozzolanic & can be used in a big way, Adding to the concrete mix will dramatically enhance the workability, strength & in-permeability 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 etc.

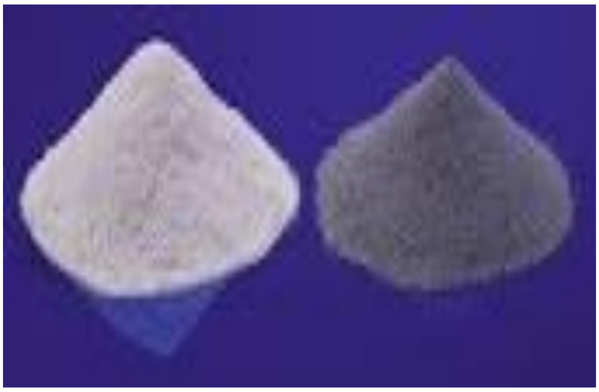

Fig. 1: Silica fume- Pure white color 2. Pure grey

C. Methodology

In the course of investigation, traditional fine mixture for the study of varied properties, completely different specimens are solid and tested. The physical and chemical properties of silica, water and egg used in the investigation were analyzed based on standard experimental procedures laid down in *IS ASTM* and *BS* codes. The tests conducted on fresh concrete are Compressive strength, as per the respective *IS*, *BS* and *ASTM* codes [10-16].

1) Compressive Strength Test

The compression check is dispensed on specimens like cuboidal or cylindrical in form generally prisms are used. The tip components of beam area unit left intact when failure in the square cross section of the beam this a part of the beam may well be well accustomed determine the compressive strength. The compressive strength of concrete is that the most vital and helpful property of Concrete. The compression check was dispensed mistreatment 2000 KN compression testing machine.

The compressive strength of plain concrete and with addition of Silica Fume, with egg was conducted on the cubical specimens for all the mixes after 3 and 7 days of curing as per code. Various cubes with C100% SF0%, C90% SF10%, C87.5% SF12.5%, C85% SF15%, C80% SF20% were casted and tested for compressive strength at 3 days and 7 days respectively.

Fig. 2: Testing of cubes for compressive strength

The compressive strength (f'_c) of the specimen was calculated by dividing the maximum load applied to the specimen by the cross-sectional area of the specimen as given below.

$$f'_c = P/A$$

Where, f'_c = Compressive strength of the concrete (in N/mm^2)
P = Maximum load applied to the specimen (in Newton)
A = Cross-sectional area of the specimen (in mm^2)

D. Ultrasonic plus velocity test

This test is done to assess the quality of concrete by ultrasonic pulse velocity method as per IS: 13311 (Part 1) – 1992. The method consists of measuring the time of travel of an ultrasonic pulse passing through the concrete being tested. Comparatively higher velocity is obtained when concrete is good in terms of density, uniformity, homogeneity

Average compressive strength results were evaluated for 28 days, 56 days and 112 days of concrete cubes with C100% SF0%, C90% SF10%, C87.5% SF12.5%, C85% SF15%, C80% SF20% additions respectively. The UPV test for 28, 56 days was also conducted.

Pulse velocity (km/s)	Concrete quality
Above 4.5	Excellent
3.5-4.5	Good
3.0-3.5	Medium
Below 3.0	Doubtful

Table 1: Interpretation of UPV Results

Fig. 3: ul*tra*sonic plus velocity test.

IV. RESULTS AND DISCUSSIONS

Tests were conducted on compressive strength of concrete specimens. Standard procedures were adopted for testing. The results of the experimental investigations are presented and discussed herein. The compressive strength results are given in Table 4.1.

A. General Effect of Silica Fume

With 0% silica fume and 0% egg, the basic M25 concrete has given the design strength of 15.87MPa at 3 days and 24.85 MPa at 7 days. These values increased to 20.42 MPa and 26.49 MPa with the increase of egg dosage at 0.35% at 3 and 7 days respectively. At 0.5% egg dosage the compressive strength values have decreased at all ages. Similar trend has been observed for the other silica fume proportions i.e. from 10% to 15%. At 20% silica fume dosage, all the values have decreased when compared to the 15% silica fume dosage mixes. From the results it is observed that 0.35% egg dosage and 15% silica fume dosage can be taken as optimum dosages.

Mix content	% of egg addition	Avg. Compressive strength results(N/mm^2)			
		3days	7days	28 days	56 days
C100% SF0%	0%	15.87	24.85	28.79	31.09
	0.15%	14.02	17.73	29.38	31.31
	0.25%	18.38	25.02	30.87	34.58
	0.35%	20.42	26.49	31.03	35.87
	0.50%	17.75	19.27	32.31	38.36
Mix content	% of egg addition	Avg. Compressive strength results(N/mm^2)			
		3days	7days	28 days	33.20
C90% SF10%	0%	17.74	21.60	28.89	35.0
	0.15%	18.80	21.33	31.33	35.82
	0.25%	19.26	24.20	31.40	36.40
	0.35%	20.25	27.14	32.40	38.80
	0.50%	22.30	25.42	33.03	35.0
C87.5% SF12.5%	0%	19.26	23.13	32.48	37.07
	0.15%	20.02	26.07	33.23	37.79
	0.25%	22.15	29.20	34.51	39.49
	0.35%	23.98	28.04	35.80	40.56
	0.50%	22.80	27.87	36.98	36.78
C85% SF15%	0%	19.90	24.33	33.49	39.08
	0.15%	21.26	27.19	34.42	39.86
	0.25%	23.29	28.78	36.51	41.46
	0.35%	27.21	31.79	38.75	40.83
	0.50%	25.31	29.90	37. 15	36.2
C80% SF20%	0%	18.39	23.42	31.03	36.2
	0.15%	20.98	25.90	33.31	36.58
	0.25%	22.79	26.22	33. 51	38.15
	0.35%	24.80	27.35	34.78	39.25
	0.50%	23.12	26.98	33.89	37.58

Table 2: Compressive strength for 3, 7,28,56 days various % Silica Fume

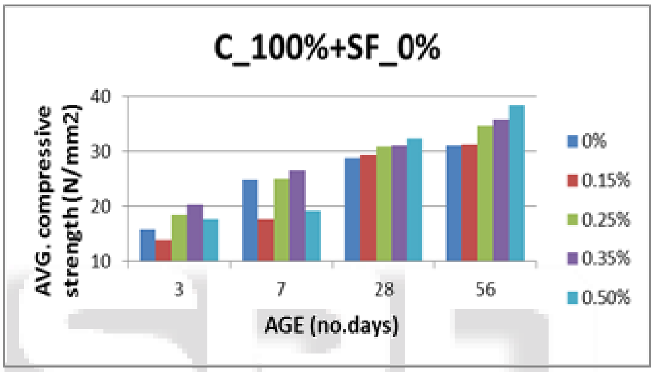

Fig. 4: Compressive Strength for C100% SF0%

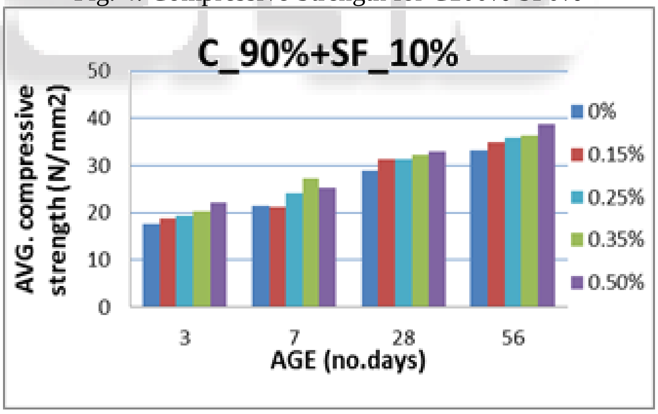

Fig. 5: Compressive Strength for C90% SF10%

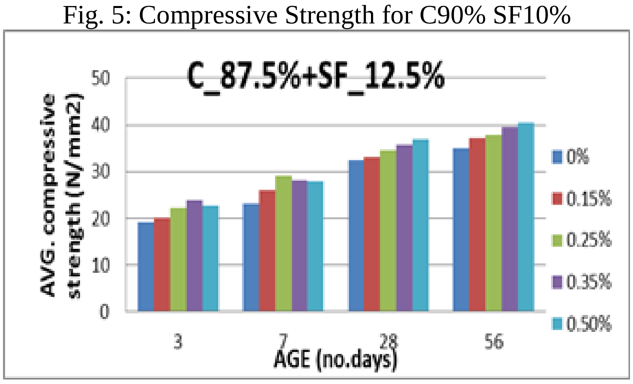

Fig. 6: Compressive Strength for C87.5% SF12.5%

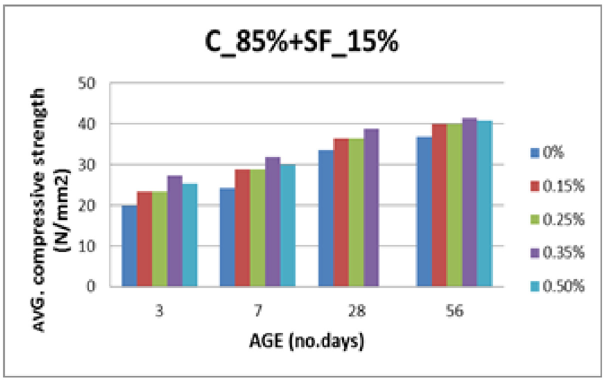

Fig. 6: Compressive Strength for C85% SF15%

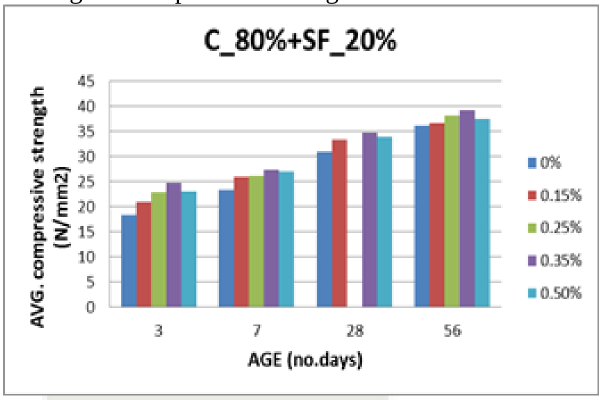

Fig. 7: Compressive Strength for C80% SF20%

B. Effect of Silica fume on UPV

The increasing trend in UPV values observed from 0% egg dosage to 0.35% egg dosage at all curing periods. At 0.5% egg dosage the UPV values have decreased at all ages. Similar trend has been observed for the other silica fume proportions i.e. from 10% to 15%. At 20% silica fume dosage, all the values have decreased when compared to the 15% silica fume dosage mixes. From the results it is observed that 0.35% egg dosage and 15% silica fume dosage. From the results it is observed that 0.35% egg dosage and 15% silica fume dosage can be taken as optimum dosages.

MIX CONTENT	% OF EGG ADDING	UPV RESULTS (M/S)	
		UPV	UPV
	0%	3378	4325
	0.15%	4121	4339
C100% SF0%	0.25%	4178	4491
	0.35%	4237	4559
	0.50%	4298	4630
	0%	4024	4425
	0.15%	4125	4505
C90% SF10%	0.25%	4360	4630
	0.35%	4425	4702
	0.50%	4491	4777
	0%	4134	4559
	0.15%	4237	4630
C87.5%	0.25%	4360	4691
SF12.5%	0.35%	4491	4717
	0.50%	4525	4777
	0%	4360	4612
	0.15%	4491	4812
C85% SF15%	0.25%	4559	4895
	0.35%	4702	4934
	0.50%	4630	4870
	0%	4360	4237
	0.15%	4425	4525
C80% SF20%	0.25%	4599	4630

Table 3: Compressive strength & UPV for 28, 56, 112 days various Silica Fume

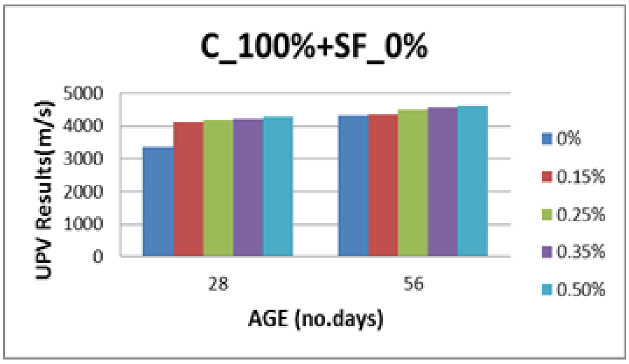

Fig. 8: UPV for C100% SF0%

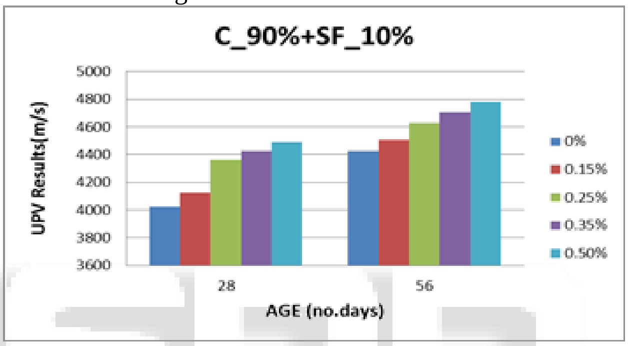

Fig. 9: UPV for C90% SF10%

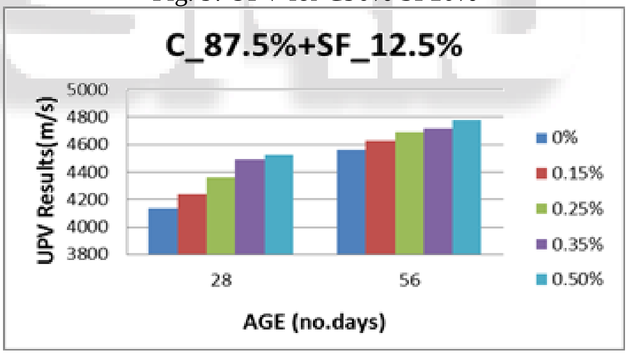

Fig. 10: UPV for C87.5% SF12.5%

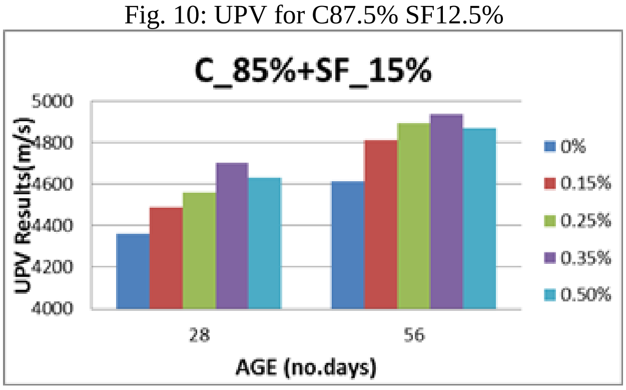

Fig. 11: UPV for C85% SF15%

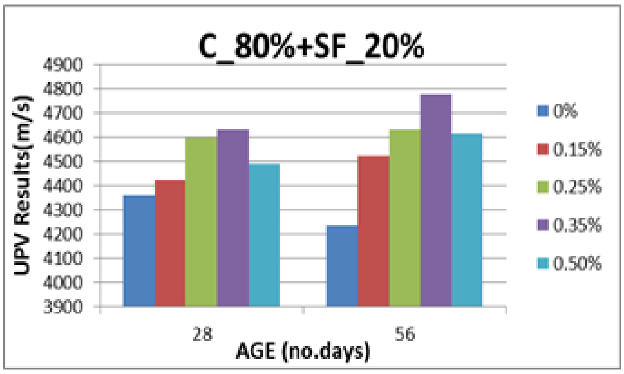

Fig. 12: UPV for C80% SF20%

Thus the graphs are plotted for the experiments conducted on Silica fume with addition of Egg for 3, 7, 28, 56 and 112 days respectively and the conclusions are derived.

V. CONCLUSIONS

Based on the present experimental investigation, the following conclusions are drawn.

1) The increasing trend in compressive strength and UPV values observed from 0% egg dosage to 0.35% egg dosage at all curing periods. At 0.5% egg dosage the compressive strength and UPV values have decreased at all ages.
2) Similar trend has been observed for the other silica fume proportions i.e. from 10% to 15%. At 20% silica fume dosage, all the values have decreased when compared to the 15% silica fume dosage mixes.
3) From the results it is observed that 0.35% egg dosage and 15% silica fume dosage can be taken as optimum dosages.

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