Study the Effect of Addition of Silica Fume on Properties of High Strength Concrete

Mr. Sabale V. D.[1], Miss. Borgave M. D.[2], Mr. Shinde S. D.[3]

Student M.E. Structures, Govt. college of Engineering, Karad,[1]
Student M.E. Structures Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon[2] ,
Student M.E. Construction management, Dr. J.J.Magdum college of engineering Jaysingpur[3],Maharashtra-India.

Abstract

The use of high strength concrete in major constructions has become obligatory,whose mechanical properties are still at a research phase.In this paper the attempt has been made to study the properties of high strength concrete by adding silica fume in different percentage to the weight of cement. The properties include 7 days and 28 days compressive strength, splitting tensile strength and flexural strength of concrete. For this purpose, the experiment has been carried out on M60 grade of concrete,with maintaining the water cement ratio 0.3,using silica fume in different percentage 0%, 5%, 10%, 15% to the weight of cement.

Key Words- *High strength concrete, Silica fume, Water cement ratio*

1. Introduction

Concrete is considered as durable and strong material. Reinforced concrete is one of the most popular materials used for construction around the world. Reinforced concrete is exposed to deterioration in some regions especially in coastal regions. There for researchers around the world are directing their efforts towards developing a new material to overcome this problem. Invention of large construction plants and equipment's around the world added to the increased use of material. This scenario led to the use of additive materials to improve the quality of concrete. As an outcome of the experiments and researches cement based concrete which meets special performance with respect to workability, strength and durability.

Use of high strength concrete in construction sector, has increased due to its improved mechanical properties compared to ordinary concrete. High-strength concrete refers to concrete that has a uniaxial compressive strength greater than the normal strength concrete obtained in a particular region. This definition does not include a numerical value for compressive strength indicating a transfer from a normal strength concrete to high strength concrete. In 1950's, concrete with a compressive strength of M35 MPa was considered as high strength concrete. In the 1990's concrete with a Compressive strength greater than 110MPa was used in developed countries. However this numerical value (110MPa) could be considerably lower depending on the characteristics of the local materials used for these concrete products. Report of ACI committee 363 in 1979 defined high-strength concrete as having compressive strength more than 41.37 MPa (6000 Psi).

Now a days high strength and high performance concrete are being widely used all over the world. Most applications of high strength concrete have been in high rise buildings, long span bridges and in some special applications in structures. In developed countries, using high strength concrete in structures today would result in both technical and economical advantage. In high strength concrete, it is necessary to reduce the water/cement ratio and which in general increases the cement content. To overcome low workability problem, different kinds of pozzolanic mineral admixtures (fly ash, rice husk ash, metakaoline, etc. and chemical admixtures are used to achieve the required workability. In the present experimental investigation, the mechanical properties of high-strength concrete of grades M60, at 28 days characteristic strength with different replacement levels of cement with silica fume are considered.

2. Experimental Programme

Sixteen specimens of concrete were casted and tested in Laboratory. Silica fume is used in concrete in different percentage i.e, 0%, 5%, 10%, 15% to the weight of cement and study the 7 days and 28 days compressive strength, splitting tensile and flexural

strength of concrete. The details are listed in the Table 1 below:

Sr.no.	Specimen	Size	No.
1	Cube	150mm	08
2	Cylinder	Diameter- 150mm, Length- 300mm.	04
3	Beam	150X150X700mm	04

Table no.1: Details of test specimen

2.1 Test Materials

2.1.1 Cement

Ordinary Portland cement (53 grade) whose Fineness – 340 m^2/kg ,Specific gravity- 3.1 Initial setting time - 90 min, Final setting time – 190 min. was used.

2.1.2 Fine aggregate

In this study used sand of Zone-II, known from the sieve analysis using different sieve sizes (10mm, 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ) adopting IS 383:1963. Whose Specific Gravity is 2.65, Water absorption 0.6% and Fineness Modulus 2.47 was used.

2.1.3 Coarse Aggregate

The coarse aggregate used here with having maximum size is 12.5mm. We used the IS 383:1970 to find out the proportion of mix of coarse aggregate. Whose Specific Gravity is 2.65, Water absorption 0.4% and Fineness Modulus 4.01 was used.

2.1.4 Water

Portable water free from any harmful amounts of oils, alkalis, sugars, salts and organic materials was used for proportioning and curing of concrete.

2.1.5 Super plastisizer

In the present experimental investigations superplasticizer Conplast SP430(G) was used for enhancing workability and supplied as a brown liquid instantly dispersible in water. Conplast SP430(G) has been specially formulated to give high water reductions upto 25% without loss of workability or to produce high quality concrete of reduced permeability. The properties were Specific gravity 1.20 to 1.22 at 300C, Chloride content Nil. as per IS:9103-1999 and BS:5075, Air entrainment Approx. 1% additional air over control. The optimum dosage is best determined by site trials with the concrete mix, the rate of addition is generally in the range of 0.6 - 1.5 liters /100 kg cement.

2.1.6 Silica fume

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys.

2.2 Mix Design

The high strength concrete mix design was done DOE method. The following mix proportion was arrived as shown in Table 2

Water (lit)	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Silica fume (By Wt. of Cement)	Super Plasticizer (By wt. of Cement)
179.88	600	551	1133	0%, 5%, 10%, 15%	1.5%
0.3	1	0.918	1.88		

Table no.2: Mix Proportion of Concrete

3. Test Results

3.1 Workability

Workability of fresh concrete determined by using slump test given below.

Silica fume in %	Slump (mm)
RS-0	42
RS-5	38
RS-10	34
RS-15	31

Table no.3: Workability of Concrete.

3.2 Compressive Strength

The test was carried out compressive strength of M60grade of concrete. The compressive strength of High-strength concrete with OPC and silica fume concrete at the age of 28 days is presented in Table

Silica fume (%)	Compressive Strength in N/mm^2	
	7 Days	28 Days
RS-0	19.87	53.67
RS-5	36.78	59.66
RS-10	40.12	63.56
RS-15	31.57	57.23

Table. No 4. compressive strength of concrete

3.3 Splitting Tensile Strength

The test was carried out according to IS 5816- 1999 to obtain the splitting tensile strength of M60 grade concrete. The test results of both the mixes were presented in the Table

Silica fume (%)	Splitting tensile strength (M60) in N/mm^2 28 Days
RS-0	3
RS-5	3.68
RS-10	4.0
RS-15	3.43

Table no5. 28 days splitting tensile strength of concrete.

3.4 Flexural Strength

The test was carried out on beam specimen, the test results of both the mixes were presented in the Table.

Silica fume (%)	Flexural strength (M60) in N/mm^2 28 Days
RS-0	8.660
RS-5	13.820
RS-10	14
RS-15	12.540

Table no. 6. 28 days flexural strength of concrete

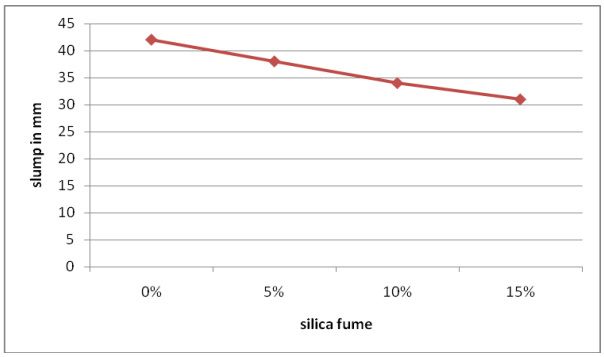

figure 1. Variation of workability

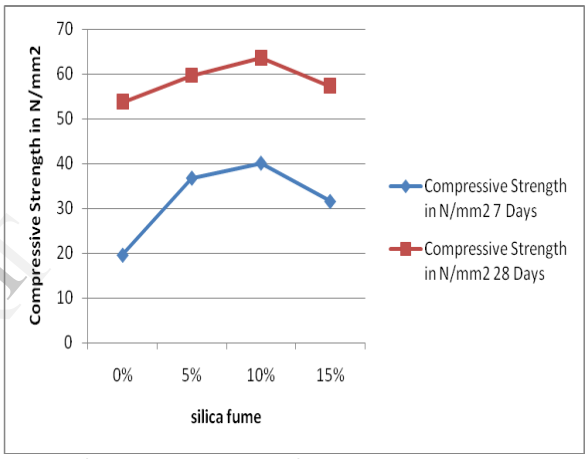

figure 2. variation of 7 days and 28 days compressive strength.

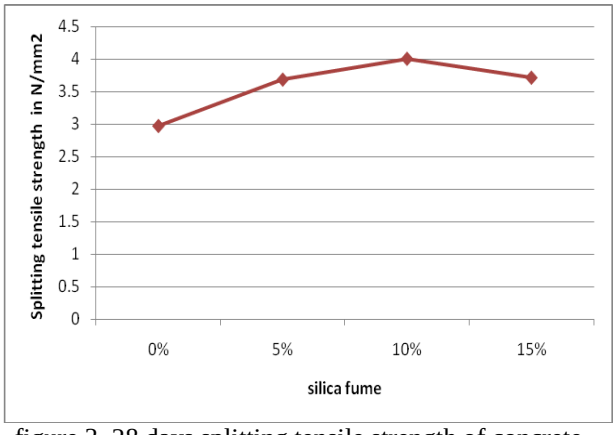

figure 3. 28 days splitting tensile strength of concrete.

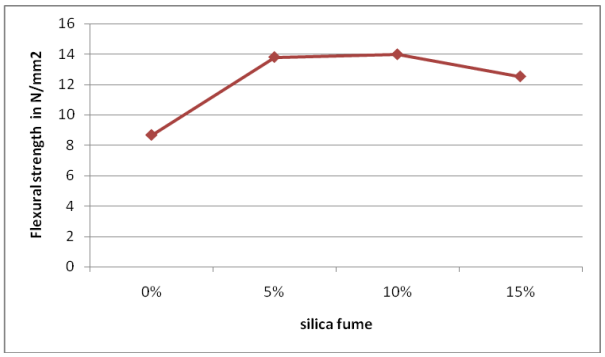

figure.4 variation of 28 days flexural strength.

4. Conclusion

With the experimental studies conducted on High strength concrete the following conclusions can be drawn:

1. Replacement of cement up to 10% with silica fume leads to increase in compressive strength, splitting tensile strength and flexural strength of concrete.
2. Beyond 10% there is a decrease in compressive strength, tensile strength and flexural strength for 28 days curing period.
3. There is a decrease in workability as the replacement level increases, and hence water Consumption will be more for higher replacements.
4. Use of silica fume gives significant result on properties of concrete as compared to normal concrete.

6. References

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