EFFECT OF PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME ON COMPRESSIVE STRENGTH OF CONCRETE

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ABSTRACT

High Strength and high performance concrete are made by replacing normal concrete partially with silica fume. Silica fume is non-toxic and non-metallic waste of industries. It is suitable for concrete mix and improves the compressive strength of concrete. The main objective of this paper is to determine the optimum replacement percentage which can enhance the compressive strength, slump of concrete with silica fume. It is found that when cement is replaced by silica fume compressive strength increases up to certain percentage. The cement replacement level by silica fume was 0%,10%and 20% for a constant water-cement ratio of 0.5and 150mmX150mmX150mm cubes were used to determine the compressive strength at the age levels of 24 hours,7 days and 28 days.

Keywords: Silica fume, high strength concrete, optimum, slump test/cm ratio, strength

1. INTRODUCTION

Silica fume is a byproduct obtained during the production of elemental silicon or an alloy containing silicon and it is very fine non-crystalline silica produced in electric arc furnaces. Silica fume is also known as microsilica,Condensed silica fume, volatized silica or silica dust. It is usually a grey colored powder, somewhat similar to Portland cement or some fly ashes. It exhibit both Pozzolanic and cementations properties. The incorporation of silica fume in concrete improves the different mechanical properties like concrete strength, modulus of elasticity, durability, corrosion protection, chemical and abrasion resistance. Addition of silica fume to concrete improves the durability of concrete and also in protecting the embedded steel from corrosion. Silica fume is byproduct and it is the most beneficial use in concrete because of its chemical and physical properties, it is a very reactive Pozzolona. In this paper the advantages of using silica fume in concrete in partial replacement of cement are found. Benefit of silica fume has been discussed by replacing cement with silica fume at varying percentage and the strength parameters were compared with conventional concrete.

2. EXPERIMENTAL INVESTIGATION

A. MATERIALS

- **CEMENT**

The cement used is OPC of ACC brand of 43 grade according to BIS specification (IS 8112-1989) on compressive strength levels.

- **FINE AGGREGATES**

Locally available river sand as per IS: 383-1970 is used

- **COARSE AGGREGATES**

Crushed aggregates used according to IS: 383-1970.The size, Specific gravity and fineness modulus of coarse aggregates are 12.5mm, 3.01&5.23

- **SILICA FUME**

Silica fume is supplied from “Shri Krishna Enterprises” Delhi. The silica fume is used as a partial replacement of cement.The chemical composition of silica fume is

Table No 1 CHEMICAL ANALYSIS OF SILICA FUME

S.No	CHEMICAL ANALYSIS	ANALYSIS
1	SO_2	94%
2	SO_3	0.16%
3	CL	0.10%
4	TOTAL ALKALI	0.64%
5	MOISTURE CONTENT	0.14%
6	LOSS OF IGNITION	1.88%
7	PH	7.45%

PHYSICAL COMPOSITION OF SILICA FUME

Diameter is about 0.1 micron to0.2 micron
Surface area about 30000^2 m/kg
Density varies from 150 to 700 kg/m^3

- **MIX PROPORTIONING**

M20 grade of concrete and water-cement ratio 0.5 is used for this study. Three type of concrete mix are prepared. The first (type) was conventional concrete (0% silica fume),the second one (type) was OPC with 10% replacement of silica fume and the third is (type) OPC with 20% replacement of silica fume all with W/C ratio 0.5

- **WORKABILITY OF CONCRETE**

Workability is defined as the property of freshly mixed concrete or mortar which determines the homogeneity with which it can be mixed, placed, consolidated and finished. In general terms, workability represents the amount of work which is to be done to compact the concrete in a given mould. In this study workability was measured by conducting slump cone test.

Table No 2 SLUMP CONE TEST VALUE

Percentage replaced by silica fume	W/C ratio=0.5
0	65mm
10	44mm
20	21mm

- **EXPERIMENTAL PROCEDURE**

The specimen of standard cube of (150mmX150mmX150mm) was used to determine the compressive strength of concrete .Three specimen were tested for 24 hours,7daysand 28 days with each proportion of silica fume replacement. The W/C ratio adopted was 0.5 the concrete was filled in different layers and each layer was compacted. The specimen was removed from mould after 24 hours, cured with clean water and then tested for compressive strength as per Indian Standard. The temperature of the cured water and test room was 27 ± 2ºC.

3. TEST RESULTS AND DISCUSSIONS

Table No 3 Compressive Strength of Cube

4. CONCLUSION

The optimum compressive strength is obtained at 20% cement replacement by a Silica Fume at all age levels (i.e. 24 hours,7 & 28 days) from the result it is concluded that the silica fume is a better replacement of cement. The rate of strength gain with silica fume in concrete is high.

1. Increase in W/C ratio decreases strength of concrete.

2. Workability of concrete decreases with increase with percentage of silica fume.

3. Compressive strength decreases when the cement replacement is above 20 %of silica fume.

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Table No 3 COMPRESSIVE STRENGTH OF CUBE

W/C ratio	**% of Silica Fume**	**Compressive Strength (MPa)**			**Slump (mm)**
0.5		24 hours	7 days	28 days	
	0	14.02	16.1	26.06	65mm
	10	14.08	16.94	27.98	44mm
	20	16.49	18.08	32.29	21mm