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Effect of Silica Fume on Strength Characteristic of Fly Ash Concrete

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ABSTRACT

Industrial byproducts such as Silica Fume (S.F) and flyash (F.A) can be utilized to enhance the strength and water permeability characteristic of Concrete. The utilization of these industrial by products is becoming popular throughout the world because of the minimization of their potential hazardous effects on environment. This paper investigates the effect of Flyash & Silica fume as a partial replacement of Ordinary Portland cement on Compressive Strength of Concrete. It has been found that addition of 10% silica fume improves the 7days compressive strength by 10.4%.The 28 days compressive strength was also increased by 22.7%.

I. INTRODUCTION

Cement is becoming a scarce resource all over the world because of its increasing demands day by day. The construction activities have increased in almost all the developing countries of the world. There always has been great effort in improving the quality and standards of the properties of concrete as a construction material. Traditionally fly ash and silica fume or the combination of both is added to concrete as a pozzolana material to enhance the properties of concrete. The use of silica fume as a pozzolana material has increased in recent years because when mixed in certain proportions it enhances the properties of both fresh and hard concrete like durability, strength, permeability and compressive strength, flexural strength and tensile strength. Silica fume is a very fine non crystalline material produced in electric arc furnace as a by-product of silicon or alloy factories containing silica. Silica fume has been known to us with different names such as micro silica, silica dust, and condensed silica fume. Silica fume has a property that it behaves as a pozzolana as well as cementious material. When the fine pozzolana silica fume particles are added to the paste, a heat of hydration is observed resulting in the formation of pozzolanic material and calcium hydroxide. Due to large surface area silica fume gets densed packed in the paste of cement and aggregate reducing the wall effect in the transition zone between the paste and aggregate. Concrete having optimum percentage of siica fume shows increase in strength and durability of concrete. Silica fume (SF) is a by product of the smelting process in the silicon and ferrosilicon industry. The

reduction of high-purity quartz to silicon at temperatures up to 2,000˚_C produces SiO_2 vapours, which oxidizes and condense in the low temperature zone to tiny particles consisting of non-crystalline silica. By-products of the production of silicon metal and the ferrosilicon alloys having silicon contents of 75% or more contain 85–95% non-crystalline silica. The by-product of the production of ferrosilicon alloy having 50% silicon has much lower silica content and is less pozzolanic.

Silica fume is also known as micro silica, condensed silica fume, volatilized silica or silica dust. Silica fume has been recognized as a pozzolanic admixture that is effective in enhancing the mechanical properties to a great extent. By using silica fume along with super plasticizers, it is relatively easier to obtain compressive strengths of order of 100–150 MPa in laboratory. Addition of silica fume to concrete improves the durability of concrete through reduction in the permeability, refined pore structure, leading to a reduction in the diffusion of harmful ions, reduces calcium hydroxide content which results in a higher resistance to sulfate attack. Improvement in durability will also improve the ability of silica fume concrete in protecting the embedded steel from corrosion. Silica fume particles are extremely small, with more than 95% of the particles finer than 1µm.This paper envisages the effect of silica fume on the strength of Fly Ash Concrete.

II. Research Significance

Research reports on effect of mineral admixture on the fresh and long term properties of high performance concrete are many, however literature on the bond behaviour of concrete containing pozzolans such as silica fume is scarce. From the environmental and sustainability point of view, there is a growing need to use supplementary cementitions material such as silica fume in RCC construction in India / worldwide. The structural behaviour of reinforced concrete is affected by several variables such as quality of raw materials, geometry of rebar, method of casting and compaction. The lack of sufficient information on the bond behaviour of concrete with supplementary cementitious materials necessitated the present study. This study attempets to evaluate the effect of silica fume and Flyash on the strength characteristics of concrete. Experimental studies will be conducted on different concrete made of OPC with 0%, 5%, 10% & 15% silica fume, for compression strength. Silica fume will be used as partial replacement material. Improve strength of concrete at all ages at optimum cement replacement levels. The strength development of concretes with silica fume differently depending on the content of silica fume and on the curing condition, as well as binder characteristics. Reduction heat of hydration, and also reduced water permeability of concrete. Improved sulphate resistance of concrete

III. Objectives:

The objectives of the study are summarized below:

(a) To study the compressive strength of concrete by placing 30% of cement weight by fly ash and then adding Silica fume in ratio of 0%, 5%, 10%,15%, by weight of cementitious material.

(b) To study the variation of strength at different ages of Concrete.

IV. Materials & Methodology Used

Cement: Ordinary Portland Cement (OPC) conforming to IS 8112-1989 was used for this study, The OPC" BIRLA" of 43 grade has been used.

Fine Aggregate: River Sand conforming to zone-II of IS 383-1970 has been used.

Coarse Aggregate: Two fractions of coarse aggregate having nominal maximum as 20mm & 10mm were used in this study.

The following laboratory tests were performed on aggregates as per relevant IS code and mix design of M 30 grade of concrete containing fly Ash will be carried out. The laboratory test programme was proposed as under :

(A) Physical properties of coarse aggregates (20mm and 10mm size)

- Sieve Analysis And Fineness Modulus
- Specific Gravity
- Water Absorption

(B) Physical properties of fine aggregates

- Sieve analysis
- Specific gravity
- Water absorption

(C) Mix design (M 30 grade) as per IS 10262:2009

- Containing OPC and Fly ash.
- Addition of 0%, 5%, 10%, 15% of Silica fume of the weight of Cementitious materials in the FlyAsh Concrete.
- Study of Compressive Strength at 7 & 28 days

Table 1 : Chemical Properties of Silica Fume

S.No	Test Parameter	Test Value
1	Partical size	<1 µm
2	Bulk Density	130-430 kg/m^3
3	Slurry	1320-1440 kg/m^3
4	Specific Gravity	2.22
5	Surface Area	13,000-30,000 kg/ m^3

Table 2 : Chemical Properties of FlyAsh

S.No	Parameter Chemical properties)	Test Value	Requirement As per IS : 3812 (P:1):2003
1	Silicon Dioxide (Sio2) +Aluminium Oxide(Al2O3)+Iron Oxide(Fe2o3)in % by mass	71.47	70
2	Silicon Dioxide (Sio2)I% by mass, Min	64.27	35
3	Magnesium Oxide (Mgo)in % by mass, Max	1.41	5.0
4	Total Sulphur as Sulphur trioxide (So3) in % by mass, Max	1.21	3.0
5	Total Chloride in % mass	0.012	0.05
6	Loss Of Ignition In % By mass (Max.)	1.27	5

V. EXPERIMENTAL PROCEDURE

In this study M-30 GRADE of concrete was designed as per IS Code. In this study firstly we have replaced 30% of OPC with Fly ash and then later on keeping cementitious same. We are replacing 5%, 10%,15% of sand

with Silica fume by weight of Cementitious material.

For each replacement 4 sets of cubes were casted in each set 6 cubes were casted and later on the compressive strengths of cubes was to be checked at 7 & 28 days.

The Test result obtained are summarized in Table 3 shown below and the variation is shown in the figure 1.

VI. RESULTS

Table 3 : Results

Silica Fume Quantity	7 Days Strength (MPa)	28 Days Strength (MPa)
0%	27.96	39.67
5%	28.69	44.56
10%	30.89	48.69
15%	28.29	45.69

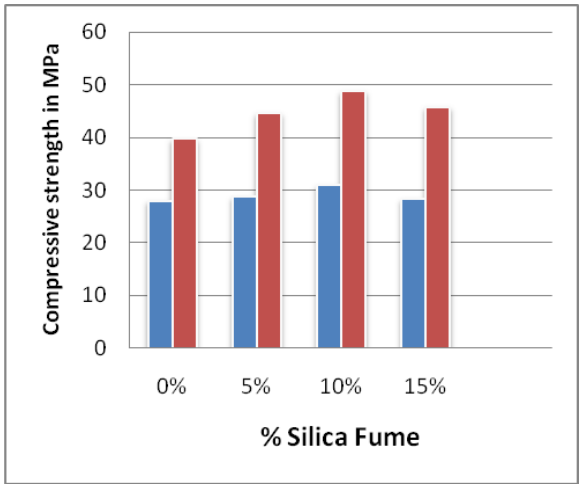

Figure 1

VI. CONCLUSION

On the basis of the results obtained in this study, the following conclusions have been drawn:

(a) The addition of Silica Fume improved the compressive strength of fly ash concrete.

(b) The optimum quantity of Silica fume was found as 10%,At this replacement the 7days compressive strength was increased by 10.4% and 28 days strength by 22.7%.The main reason for the increase in strength is due to pozzolanic reaction of silica Fume with $Ca(OH)_2$ produced from the hydration of portland cement. Further Silica fume has extremely fine particles due to this the surface area is more and it has higher SiO_2 Content. Therefore more reactive than Flyash. Hence it can be effectively used in Combination with flyash to achieve better results.

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