

# Strength and Durability Study on Concrete Incorporating with Pozzolanic Admixtures

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**ABSTRACT:** In this study, effects of mineral admixtures on the water permeability and compressive strength of concretes containing silica fume (SF) were experimentally investigated. The main parameter investigated in this study is M20 grade concrete with partial replacement of cement by silica fume. They were incorporated into concrete at the levels of 0%, 5%, 10%, 15% and 20%. This paper presents a detailed experimental study on compressive strength, split tensile strength and flexural strength at an age of 7 and 28 days. Test results indicate that use of silica fume in concrete has improved the performance of concrete in strength at a particular percentage replacement. Although the highest compressive strengths of concretes observed was 15% silica fume mix for ordinary Portland cement and were reduced as the increase in the replacement ratios.

**KEYWORDS:** Silica fume, flyash Strength, Durability.

## I. INTRODUCTION

Concrete is composed of an inert matrix of sand, gravel, crushed rock, or other aggregates held together by a harden paste of hydraulic cement and water. The thoroughly mixed ingredients, when properly proportioned, make a plastic mass which can be cast or molded into a predetermined size and shape. Upon hydration of the cement by water, concrete becomes stone, like In strength and hardness with utility for many purposes. Aggregates occupy about three-fourth of the space within a given mass of concrete and the is occupied by hydrated water –cement paste and air voids. The production of Ordinary Portland Cement (OPC), the main ingredient in normal concrete unfortunately, emits vast amounts of carbon dioxide gas into the atmosphere which has major contributions to greenhouse effect and thereby causing global warming; hence it is obvious to use either alternate or other materials as part replacement (1). Mineral admixture are widely used in concrete for various reasons especially for reducing the amount of cement required for making concrete which shows to a reduction in construction cost. Moreover most pozzolanic materials are byproduct materials. The use of these materials shows the reduction in waste, freeing up valuable land, save in energy consumption to produce cement and save the environment. Durability of Portland cement concrete is defined as its ability to resist weathering action, chemical attack, abrasion, fire or another process of deterioration. In other words, cement concrete will be termed durable, when it keeps its form and shape within the allowable limits to different environmental conditions. Durability of concrete has been a major concern of civil engineering professionals (2).

The subsequent modification of the microstructure of cement composites improves the mechanical properties, durability and increases the service-life properties. When fine pozzolana particles are dissipated in the paste, they generate a large number of nucleation sites for the precipitation of the hydration products. Therefore, this mechanism makes paste more homogeneous. This is due to the reaction between the amorphous silica of the pozzolanic and calcium hydroxide, produced during the cement hydration reactions (3).

## II. MATERIALS AND MIX PROPORTIONING

**CEMENT:** Cement is the important binding material for the production of concrete. For using cement in important and major works it is incumbent on the part of the user to test the cement to confirm the requirements of the Indian standard

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specifications with respect to its physical and chemical properties. In our project we used ordinary Portland cement 53 grade conforming to IS 8112:1989. The tests conducted on cement are tabulated in Table No.1

S.No	Property	Value
1	Normal consistence	33%
2	Initial setting time (min)	65
3	Final setting time (min)	250
4	Specific gravity	3.15
5	Fineness of cement	1.1

**Table 1 Physical Properties of Cement**

S.No	Physical properties	Result
1.	Specific gravity	2.12
2.	Physical form	Powder
3.	Size (Micron)	0.1
4.	Color	Dark grey

**Table 2: Properties of fly ash**

**FLY ASH:** Fly ash for this study is taken from Mettur Thermal Power Plant mettur. A class ‘f’ fly ash obtained from thermal power plant. A class ‘f’ fly ash obtained from thermal power plant. The properties of fly ash are shown in Table 2.

## SILICA FUME

Silica fume used was conforming to ASTM- C(1240-2000) and was supplied by “ELKEM INDUSTRIES” was named Elkem – micro silica 920 D. The Silica fume is used as a partial replacement of cement. The properties of silica fume are shown in Table 3.

S.No	Physical properties	Result
1.	Specific Gravity	2.2
2.	Bulk Density	576 (Kg/m <sup>3</sup> )
3.	Size , (Micron)	0.1
4.	Surface Area , (m <sup>2</sup> /kg)	20,000

**Table 3: Properties of silica fume**

S.no	Property	value
1	Specific gravity	2.65
2	Fineness modulus	2.80
3	Uniformity coefficient	3.33
4	Coefficient of curvature	0.906

**Table 4 Physical properties of fine aggregate**

## FINE AGGREGATE

Fine aggregate shall consist of natural sand or manufactured sand. Fine aggregates should be selected so as to reduce the water demand hence rounded particles are thus preferred to crush rock fines where possible. The finest fractions of fine aggregate are helpful to prevent segregation. For the fine aggregate river and conforming to IS 383-1970 was used. The properties of fine aggregate are shown in Table 4.

## COARSE AGGREGATE

Crushed stone coarse aggregate conforming to IS 383-1970 was used. The properties of fine aggregate are shown in Table 5.

S.NO	Property	Value
1.	Specific gravity	2.65
2.	Fineness modulus	6.19
3.	Uniformity coefficient	1.26
4.	Coefficient of curvature	1.13

**Table 5 Physical properties of coarse aggregate**

S.NO	Property	Value
1.	Solid content	42%
2.	Specific gravity	1.22

**Table 6 Physical properties of super plasticizer**

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## SUPER PLASTICIZER

The Sulphonated Naphthalene Formaldehyde based super plasticizer (Conplast Super Plasticizer – SP 430) used. Table properties of super plasticizer. The properties superplasticizer are shown in Table 5.

## MIX PROPORTIONING

Concrete mix design in this experiment was designed as per the guidelines specified in I.S. 10262-1982. But some restriction is imposed by restricting the amount of cementations material content is equal to 450 Kg/m<sup>3</sup>. The Table 7 shows mix proportion of concrete (Kg/m<sup>3</sup>):

Table 7 Mix proportioning

Mix proportions	Cement kg/m <sup>3</sup>	Fine Aggregate kg/m <sup>3</sup>	Coarse Aggregate kg/m <sup>3</sup>	Water kg/m <sup>3</sup>	Chemical Admixture kg/m <sup>3</sup>	Fly ash kg/m <sup>3</sup>	Silica fume kg/m <sup>3</sup>
Mix 1(0%)	270	869	1106	140	7.7	115	0
Mix 2(5%)	270	869	1106	140	7.7	109.25	5.75
Mix 3(10%)	270	869	1106	140	7.7	103.5	11.5
Mix 4(15%)	270	869	1106	140	7.7	97.75	17.25
Mix 5(20%)	270	869	1106	140	7.7	92	23

## III. TEST RESULTS AND DISCUSSIONS

### COMPRESSIVE STRENGTH TEST

Compressive strength test were carried out on 150 mm X 150 mm X 150 mm specimen for that three cube were prepared for each mix. Test was carried out as per IS: 14858:2000. Specimen shall be tested after 7, 14 and 28 days respectively. The results of compressive strength of the specimens were shown in figure 1.

### SPLIT TENSILE STRENGTH

A test for tensile strength in which a cylindrical specimen is loaded to failure in diametric compression applied along the entire length, method of determining the tensile strength of concrete using a cylinder which splits across the vertical diameter. Split tensile strength test were carried out on a cylindrical specimen 150 mm in dia and 150 mm long for three cylinders were prepared for each mix. Specimen shall be tested after 7 and 28 d respectively. The results of split tensile strength shown in figure 2

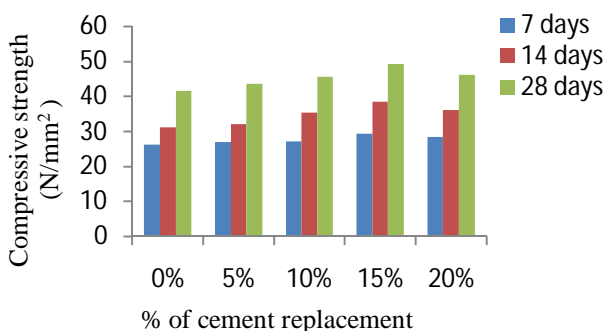


Figure 1 Compressive strength test result

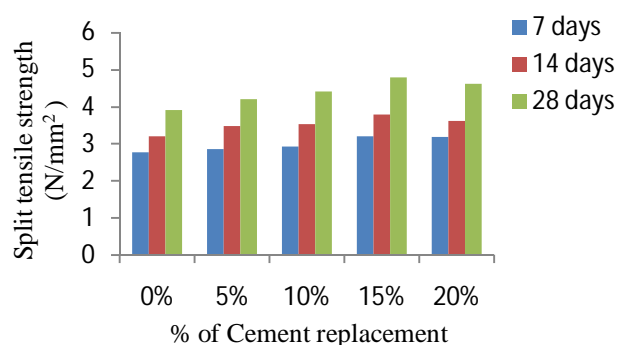


Figure 2 Split tensile strength test result

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## FLEXURAL STRENGTH TEST

A flexural strength of concrete in beam specimen is load to failure under two point loading. Flexural strength carried by the specimen sizes 100 mm x 100 mm X 500 mm long for three beams were prepared for each mix. Specimen shall be tested after 28 days respectively. The results of split tensile strength shown in figure 3

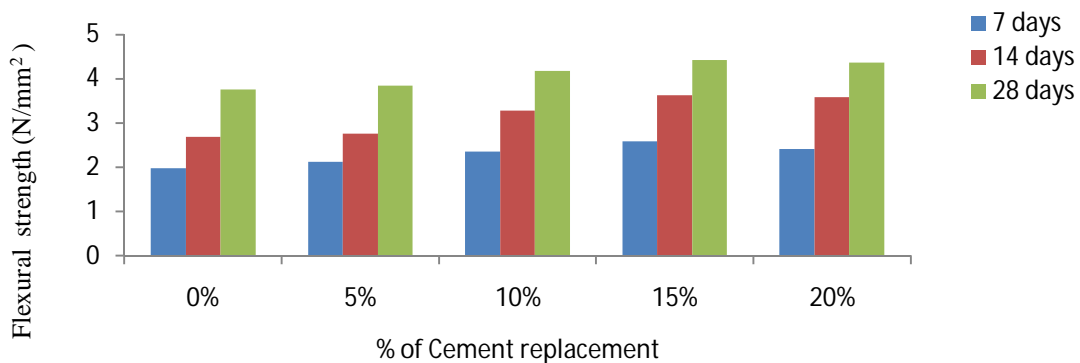


Figure 3 Spilt tensile strength test result

## DURABILITY TESTS

### Saturated Water Absorption:

Saturated water absorption (SWA) tests were carried out on 100mm cube specimen at the age of 28 and 90 days curing as per ASTM C 642. The specimens were weighed before drying. The drying was carried out in a hot air oven at a temperature of 105oC. The dried specimens were cooled at room temperature and immersed in water. The specimens were taken out at regular interval of time, surface dried using a clean cloth and weighed. This process was continued till the weights became constant. The difference between the measured water saturated mass and oven dried mass expressed as % of oven dry mass gives the SWA. The water absorption was calculated as % of water absorbed =  $(W_s - W_d) \times 100 / W_d$  Where,  $W_s$  = weight of specimen at fully saturated condition  $W_d$  = weight of oven dry specimen. The results of water absorption shown in Table 8

Table 8 Results of Saturated Water Absorption

S.No	Replacement %	Wet weight (kg)	Dry weight(kg)	Water Absorption (%)
1.	0%	2.520	2.432	3.62
2.	5%	2.535	2.457	3.17
3.	10%	2.543	2.480	2.54
4.	15%	2.598	2.564	1.32
5.	20%	2.572	2.512	2.38

### ACID RESISTANCE:

The acid resistance tests were carried out on 150 mm size cube specimens at the age of 28 days curing. The cube specimens were weighed and immersed in water diluted with one percent by weight of sulphuric acid for 45 days continuously. Then the specimens were taken out from the acid water and the surfaces of the cubes were cleaned. Next the weight and the compressive strengths of the specimens were found out and the average percentage of loss of weight and compressive strengths were calculated. The results of acid resistance shown in Table 9

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**Table 9 Results of Acid Resistance**

S.No	Replacement %	Dry weight (kg)	weight after immersed in acid (kg)	Weight loss (%)
1.	0%	2.522	2.429	3.83
2.	5%	2.536	2.449	3.55
3.	10%	2.549	2.465	3.41
4.	15%	2.553	2.478	3.01
5.	20%	2.568	2.488	3.21

**ALKALINITY MEASUREMENT:**

The trial mixes of HPC on cube specimens were tested for compressive strength after 28 days of water curing. The broken pieces of tested specimens were again broken into small pieces using hammer and ball mill and then powdered. Each of the powder samples (about 20 gram) was put into 100 ml of distilled water. The aqueous solution was allowed to stand for 72 hrs and more and was agitated often, to enable more of free lime of hydrated cement paste to get dissolved in water. The pH of the aqueous solution was measured by pH meter and also by putting the pieces of pH indicating papers into the solution. The color of the pH paper in the solution is matched with the standard color chart supplied by the manufacturer in order to get the pH of the solution. The results of acid resistance shown in Table 10

**Table 10 Results of Acid Resistance**

S.No	Replacement %	pH values (after 28 days)
1.	0%	13.45
2.	5%	13.30
3.	10%	13.19
4.	15%	13.26
5.	20%	13.22

**IV. CONCLUSION**

From the results it was identified that the replacement of silica fume up to 15% shows the best results on strength test and also on durability test.

**REFERENCES**

- [1] Gopalakrishnan, S., Annie Peter, J., and Rajamane, N.P., "Strength and durability characteristics of concretes containing high volumes of fly ash with and without processing", Proc. of International Conference on Recent Trends in Concrete Technology and Structures (INCONTEST 2003), Coimbatore, 10-12 Sept 2003, pp203-20
- [2] Gruber.K.A., Terry Ramlochan, Increasing Concrete durability with high reactivity metakoalin, Vol.23,December2001,pp.479-484.
- [3] PothaRaju M, JanakiRao A, "Effect of temperature on residual compressive strength of fly ash concrete," The Indian Concrete Journal, May 2001, pp.347-350.
- [4] Indian standard IS: 456-2000 Code of practice for plain and reinforced concrete (fourth edition), 2000
- [5] Indian Standard Code OF Practice "IS 10260:2009" Mix Proportion in Guidelines. First revision, New Delhi
- [6] Gambhir,M.L.,Concrete technology,Mc-GrawHill education(India), new delhi,3<sup>rd</sup> edition 2004.
- [7] ShettyM.S,"Concrete Technology – Theory and Practice", S.Chand and Company Ltd, New Delhi, 1986.