ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

A Study on Fly Ash Addition on Properties of High Strength Concrete

Hari Devender Anchoori
Chartered Structural Engineer
7-8-57, Hanmakonda, Warangal, Telangana State, India.

Abstract

Today concrete is most widely used construction material because of ease of construction and its properties like compressive strength, flexural strength, and durability. It is difficult to point out another material of construction which is as versatile as concrete. It is so closely associated now with every human activity that it touches every human being in his day to day living. It is well known that plain concrete is very good in resisting compressive forces but found to be weak against tensile forces. It has the qualities of flexibility and ability to redistribute stresses, but possesses a low specific modulus, limited ductility and little resistance to cracking. There are so many new types of admixtures have been developed in recent years to improve the strength and workability properties of concrete. The use of pozzolonic materials is as old as that the art of concrete construction which changes functional needs of a structure. This interest arises due to the collection of these materials from various countries and to strict the enforcement of pollution control and to stop dispersing this hazardous pozzolonic material in to the atmosphere. Pozzolonic materials by and large can be used to replace a part of cement in all construction works. In this class of materials silica fume is one, which can replace cement up to 20 %. 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 M70 grade of concrete, with maintaining the water cement ratio 0.286, using Fly ash in different percentage 0%, 5%, 10%, 15% and 20 %to the weight of cement.

Key Words- ***High strength concrete, Water cement ratio, Fly ash***

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[6] 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[4] 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[2] are

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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 economic 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 M70, at 28 days characteristic strength with different replacement levels of cement with fly ash are considered.

2. Experimental Programme

Sixteen specimens of concrete[1] were casted and tested in Laboratory. Fly ash is used in concrete in different percentage i.e., 0%, 5%, 10%, 15% and 20% to the weight of cement and study the 7 days and 28 days compressive strength, splitting tensile and flexural strength[7] of concrete. The details are listed in the Table 1 below:

S. No.	Specimen	Size	Numbers
1	Cube	150 x 150 x 150 mm	30
2	Cylinder	150 mm Dia and 300 mm Length	15
3	Beam	150 x 150 x 800 mm	15

Table no.1: Details of test specimen

2.1 Test Materials

2.1.1 Cement

Ordinary Portland cement (53 grade) whose Fineness – 350 m^2/kg ,Specific gravity- 3.11 Initial setting time - 85 min, Final setting time – 185 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 2.64, Water absorption 0.58% and Fineness Modulus 2.48 was used.

2.1.3 Coarse Aggregate

The coarse aggregate[2] 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 2.66, Water absorption 0.402% and Fineness Modulus 4.05 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 ConplastSP430(G) was used for enhancing workability and supplied as a brown liquid instantly dispersible in water. ConplastSP430(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 of cement.

2.1.6 Flyash

Fly ash is a by-product of Thermal Power Plants

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

Fly ash (By weight of Cement)	Fly ash Weight (kg)	Cement (kg)	Water (Litres)	Cement+ Fly ash (kg)	Sand (kg)	Coarse Aggregate (kg)	Super Plasticizer (By weight of cement)
0	0	600	171.66	600	521	1095	1.5%
5	30	570	171.66	600	521	1095	1.5%
10	60	540	171.66	600	521	1095	1.5%
15	90	510	171.66	600	521	1095	1.5%
20	120	480	171.66	600	521	1095	1.5%
Mix Proportions			0.286	1	0.868	1.825	1.5 %

Table 2: Mix Proportions of Concrete

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3. Test Results

3.1 Workability

Workability of fresh concrete determined by usingslump test given below.

Specimen Designation	Percentage of Fly ash Used	Slump (mm)
Mixture 0	0	41
Mixture 5	5	36
Mixture 10	10	33
Mixture 15	15	30
Mixture 20	20	29

Table no.3: Workability of Concrete.

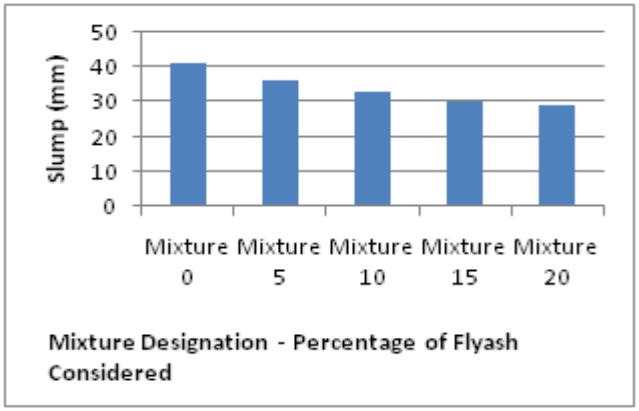

Figure 1: Envelope for Slump (mm)

3.2 Compressive Strength

The test was carried out compressive strength ofM70 grade of concrete. The compressive strength ofHigh-strength concrete with OPC[8] and Fly ash concrete at the age of 28 days is presented in Table 4.

Specimen Designation	Percentage of Fly ash Used	Cube Compressive Strength (N/mm²)	
		7 Days	28 Days
Mixture 0	0	23.23	62.62
Mixture 5	5	42.91	69.61
Mixture 10	10	46.82	74.15
Mixture 15	15	36.85	66.77
Mixture 20	20	32.38	61.25

Table 4: Compressive Strength of Concrete

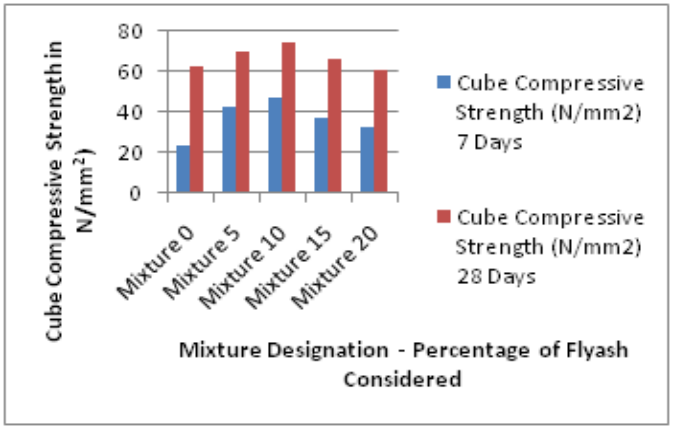

Figure 2: Envelope for Compressive Strength

3.3 Splitting Tensile Strength

The test was carried out according to IS 5816- 1999to obtain the splitting tensile strength of M70 gradeconcrete[5]. The test results of both the mixes werepresented in the Table 5.

Specimen Designation	Percentage of Fly ash Used	Split Tensile Strength (N/mm²)
Mixture 0	0	3.53
Mixture 5	5	4.29
Mixture 10	10	4.67
Mixture 15	15	4.01
Mixture 20	20	3.75

Table 5: Split Tensile Strength Results

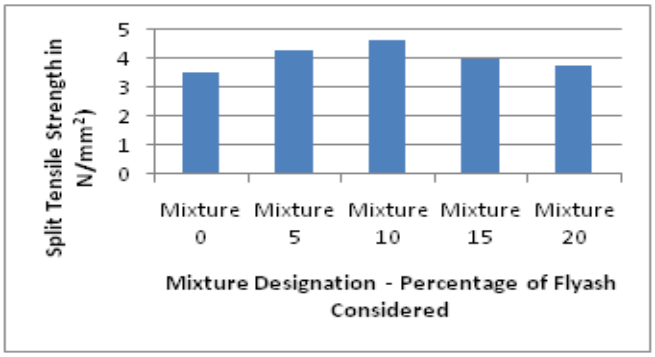

Figure 3: Envelope for Split Tensile Strength

3.4 Flexural Strength

The test was carried out on beam specimen, the testresults of both the mixes were presented in the Table 6.

Specimen Designation	Percentage of Fly ash Used	Flexural Strength (N/mm²)
Mixture 0	0	10.11
Mixture 5	5	16.12
Mixture 10	10	16.33
Mixture 15	15	14.63
Mixture 20	20	13.52

Table 6: Flexural Strength Results

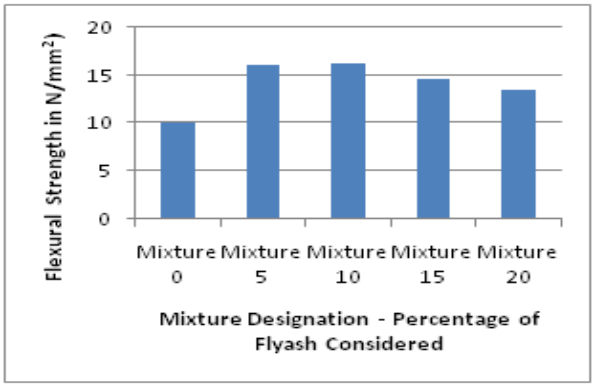

Figure 4: Envelope for Flexural Strength

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4. Conclusion

With the experimental studies conducted on Highstrength concrete the following conclusions can bedrawn:

1. Replacement of cement up to 10% with Fly ash leads to increase in compressivestrength, splitting tensile strength and flexuralstrength of concrete.
2. Beyond 10% there is a decrease incompressive strength, tensile strength andflexural strength for 28 days curing period.
3. There is a decrease in workability as thereplacement level increases, and hence waterConsumption will be more for higherreplacements.
4. Use of Fly ashgives significant result onproperties of concrete as compared to normalconcrete.

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