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RESEARCH ARTICLE

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A STUDY ON THE EFFECT OF SILICA FUME AND FLY ASH ON STEEL SLAG CONCRETE BY OBSERVING THE DURABILITY, CAPILLARITY AND PERMEABILITY PROPERTIES

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ABSTRACT

The fast growth in instralisation has resulted in tons of byproduct or waste materials, can be used as secondary cementatious materials such as fly ash, silica fume, ground granulated blast furnace slag, steel slag etc. By the use of these byproducts not only helps to use these waste materials but also improves the properties of concrete in fresh and hydrated states. Slag cement and fly ash are the two most common secondary cementatious materials used in concrete. Most concrete produced in nowadays includes one or multiple of these materials. That's why their properties are usually compared to each other by mix designers needed to optimize concrete mixtures. The present work a number of tests were carried out to make comparative studies of mechanical properties of concrete mixes prepared by using ultra tech brand Portland cement , Fly ash in 10%, 20% and 30% proportions of replacement, silica fume in 10%, 20% and 30% of replacement and also 10%, 20% and 30% addition of steel slag as a compound mixes. The fine aggregate used is natural sand belongs to zone II as per IS 383-1982.The coarse aggregate used is of 20 mm size. The ingredients are mixed in 1: 1.274: 2.99 proportions. The properties studied for 90 days of durability, capillarity and permeability.

Key words: Concrete, Fly ash, Blast furnace slag, Silica fume

INTRODUCTION

Because of recent strict environmental pollution controls and regulations have produced an increase in the industrial wastes and sub graded byproducts which can be used as secondary cementatious materials such as fly ash, silica fume, ground granulated blast furnace slag etc. The use of these secondary cementatious materials in concrete constructions not only prevents these materials to control the pollution but also to improve the properties of concrete in fresh and hydrated states.

The secondary cementatious materials can be divided in two categories based on their type of reaction with cement. They are the hydraulic and pozzolanic. Hydraulic materials react directly with water and to form cementitious compound like GGBS. Pozzolanic materials do not have any cementitious property but when used in cement or lime react with calcium hydroxide to form products producing cementitious prosperities.

Ground granulated blast furnace Slag:

Ground granulated blast furnace slag (GGBS or GGBFS) is gained by quenching molten iron slag, a by-product of iron and steel making from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

Material	Specific gravity	Water absorption in %
Steel slag	3.34	1.12%

Fly ash:

Fly ash is one of the wastes generated in the combustion of coal. Fly ash is generally collected from the chimneys of coal fired power plants, and is one of two types of ash that jointly are known as coal ash; the other, bottom ash, is collected from the bottom of coal furnaces.

Materials	Specific gravity
Silica fume	2.268

Silica Fume:

Silica fume is a byproduct in the reduction of high purity quartz with coke in electric arc furnaces in the production of silicon and ferrosilicon alloys. Silica fume contains fine particles with a surface area on the order of 215,280 ft^2/lb (20,000 m^2/kg) when measured by nitrogen adsorption techniques, with particles approximately one hundredth the size of the average cement Because of its extreme fineness and high silica content, silica fume is a very effective pozzolanic material particle.

Silica fume	ASTM-C-1240	Actual Analysis
SiO_2	85% min	86.7%
LOI	6 % Max	2.5%
Moisture	3%	0.7%
Pozz Activity Index	105% min	129%
Sp Surface Area	>15 m^2/gm	22 m^2/gm
Bulk Density	550 to 700	600
+45	10% max	0.7%

Tests to be conducted:

Durability Test:

For each set 3 were casted and tested for 90 days for determining the compressive strength for the optimum proportions of fly ash, silica fume replacements and steel slag additions while cured in acidic and base water.

Capillarity Test:

Two cube specimens were cast for concrete cube to determine capillary absorption coefficients after 28 days curing. This test is conducted to check the capillary absorption of different binder mix mortar matrices which indirectly measure the durability of the different concrete matrices.

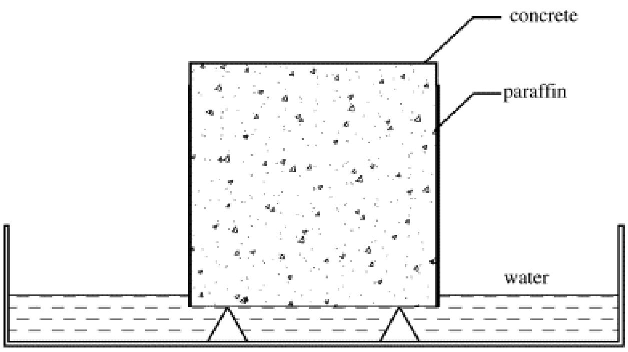

Fig: Capillary absorption test in progress

The capillary absorption coefficient (k) was calculated by using formula:

$$k=Q/A^* \text{ sqrt } (t)$$

where Q is amount of water absorbed

A is cross sectional area in contact with water

t is timeD = Breadth of Prism

Permeability test:

This test covers the laboratory determination of the D'Arcy coefficient of water permeability of hardened concrete specimens using a Concrete Permeameter. The samples are either cored from existing concrete structures or taken from moulded cylindrical specimens.

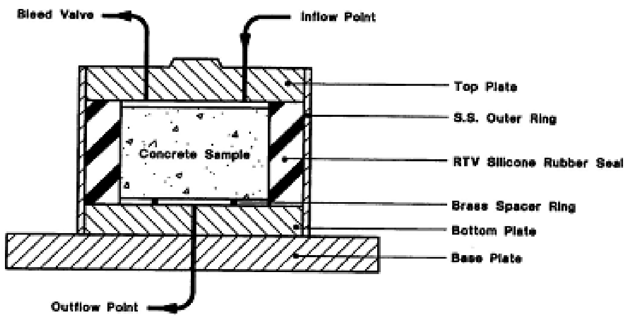

Fig: Showing Permeability apparatus

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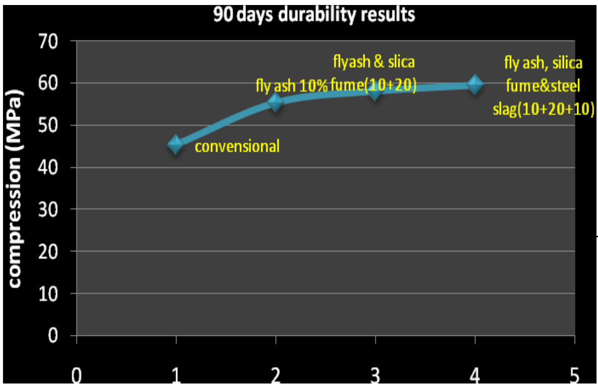
After testing the specimens the results are as follows:

Durability of concrete with different proportions of admixtures

No. Of.curing days → / *Mix types ↓*	**90 Days (MPa)**
1	45.33
2	55.37
3	57.77
4	59.55

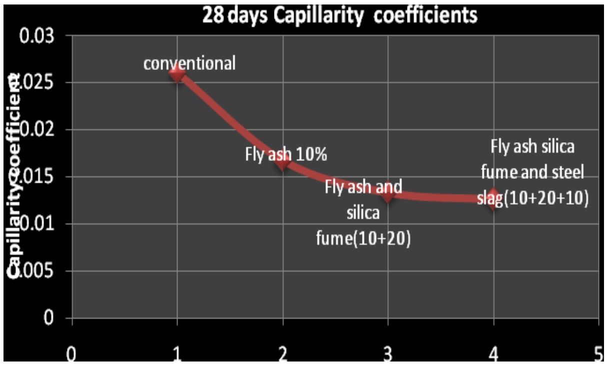
Where
1=Conventional mix concrete.
2=10% Fly ash replaced concrete.
3=10% FA and 20% SF replace concrete.
4=10%FA+20% SF replaced and 10% steel slag added concrete.



Capillarity of concrete with different proportions of admixtures

No. Of.curing days → / *Mix types ↓*	**28 Days capillarity coefficient results**
1	0.02667
2	0.0167
3	0.0133
4	0.0126

Where
1=Conventional mix concrete.
2=10% Fly ash replaced concrete.
3=10% FA and 20% SF replace concrete.
4=10%FA+20% SF replaced and 10% steel slag added concrete.



Permeability of concrete with different proportions of admixtures

Pressure difference (Pa)	**1**	**2**	**3**	**4**
5	1.39E-14	1.20E-14	1.01E-14	8.00E-15
10	7.47E-15	7.01E-15	6.89E-15	6.50E-15
15	3.25E-15	2.95E-15	2.65E-15	2.54E-15

Where
1=Conventional mix concrete.
2=10% Fly ash replaced concrete.
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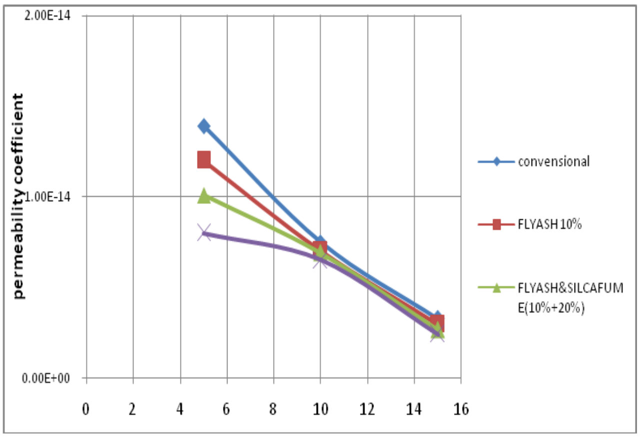

CONCLUSIONS

Based on the experimental investigations on the "engineering properties of concrete" such as durability, capillarity and permeability. And considering the "environmental aspects" the following observations are made regarding of fly ash silica fume replaced and steel slag added concrete for compression members, tension members and flexural members.

1. By doing this project we are reduced the cement content by 30% than conventional concrete
2. In compression members the incremental change in the strength was observed in durability aspect and it is more than 1.311 times than conventional concrete.
3. In the capillarity aspect we observed the decremental change which is 0.5 times the conventional concrete.
4. In permeability aspect we observed the decrementalchange, which is 0.65 times the actual conventional concrete.

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