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DURABILITY STUDY ON BLENDED CEMENT CONCRETE WITH FLY ASH SILICA

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ABSTRACT

Durability of concrete is defined as its ability to resist weathering action, chemical attack, abrasion or any other process of detorioration. It also includes the effects of quality and serviceability of concrete when exposed to sulphate and chloride attacks. It is the material of choice where strength, durability, impermeability, fire resistance and abrasion resistance are required. The main aim of the present study is to determine the compressive strength, split tensile strength, flexural strength of concrete mix of M30 grade, with partial replacement of cement with SILICA FUME and FLY-ASH.

This study is mainly confined to evaluation of changes in compressive strength, split tensile strength, flexural strength and weight reduction in six different mixes of M30 Grade namely conventional aggregate concrete (CAC), concrete is made by replacing 15% of cement by Fly Ash and 5% Silica Fume(FSAC1),concrete is made by replacing 15% of cement by Silica Fume and 5% of Fly Ash(FSAC2), concrete is made by replacing 10% of cement by Fly Ash and 10%Silica Fume (FSAC3),concrete is made by replacing of cement by 12% Fly Ash and 8% of Silica Fume (FSAC4), concrete is made by replacing of cement by 8% Fly Ash and 12% of Silica Fume(FSAC5).

The effect of 5% of H_2SO_4 on these concrete mixes are determined by immersing these cubes for 7days, 28days and in above solutions and the respective changes in both compressive strength, split tensile strength, flexural strength and weight reduction had observed and up to a major extent we can conclude concretes made by that Fly Ash and Silica Fume had good strength and durable properties compared to conventional aggregate in severe Environment.

Keywords*: Conventional Aggregate Concrete, Fly Ash, Silica Fume*

I. INTRODUCTION

Concrete is the most widely used man-made construction material in the world. It is obtained by mixing of fine aggregates, coarse aggregates and cement with water and sometimes admixtures in required proportions. Fresh concrete or plastic concrete is freshly mixed material which can be molded into any shape hardens into a rock-like mass known as concrete. The hardening is because of chemical reaction between water and cement, which continues for long period leading to stronger with age. The utility and elegance as well as the durability of concrete structures, built during the first half of the last century with ordinary Portland cement (OPC) and plain round bars of mild steel, the easy availability of the constituent materials (whatever may be their qualities) of concrete and the knowledge that virtually any combination of the constituents leads to a mass of concrete have bred contempt. Strength was emphasized without a thought on the durability of structures. As a consequence of the liberties taken, the durability of concrete and concrete structures is on a southward journey; a journey that seems to have gained momentum on its path to self– destruction. This is particularly true of concrete structures which were constructed since 1970 or thereabout by which time the following developments are came subsequently.

The Ordinary Portland Cement (OPC) is one of the main ingredients used for the production of concrete and has no alternative in the civil construction industry. Unfortunately, in the production of cement involves emission of large amounts of carbon-dioxide gas into the atmosphere, a major contribution for green house effect and the global warming. Hence it is inevitable either to search for another material or partly replace it by some other materials to save our environment. The search for any such cementitious material, which can be used as an alternative or as a supplementary for cement should lead to global sustainable development and lowest possible environmental impact.

By performing experimental studies it is found that some materials like Fly ash, Ground Granulated Blast furnace Slag (GGBS), Rice husk ash, High Reactive Met kaolin, and Silica fume are some of the pozzolanic materials which having the similar properties of cement can be used in concrete as partial replacement of cement. A number of studies are going on in India as well as abroad to study the impact of use of these pozzolanic materials as cement replacements and the results are encouraging. The strength, durability, workability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and other controls during placing and curing.

1.1 Advantages of Blended Concrete

The Engineering benefits likely to be derived from the use of mineral admixtures (blended cements and cement mineral admixtures can be used interchanging) in concrete are improved resistance to thermal cracking because of lower heat of hydration, enhancement of ultimate strength, reduction in permeability due to pore refinement, and a better durability to chemical attacks such as chloride, sulphate water, soil and alkali-aggregate expansion.

The beneficial effect of various cementitious materials are so significant that their use in reinforced concrete liable to corrosion in hot climates (which is the condition prevailing in entire India during most part of the year), is virtually necessary. Portland cement alone should not be used in future marine structures and in coastal areas i.e. within 1 Km of coast line.

At present in India ordinary Portland cement is considered as the 'best', if not the sole, cementitious material in the concrete. The other materials, primarily fly ash and silica fume are viewed as replacements or substitutes for cement, whereas these cementitious materials are today concrete ingredients in their own right.

- Improved concrete workability
- Lower risk of thermal cracking
- Improved concrete durability and long-term strength
- Reduced overall concrete cost.

1.2 Scope of study

The objective of the present study is to investigate the workability, strength and Durability behaviours for M30 grade concrete by replacing 20% of cement with fly ash and silica fume.

To investigate different basic properties of concrete such as compressive strength and splitting strength and flexural strength and comparing the results of different proportional.

First an attempt is made to find strength of concrete by replacing cement with Silica Fume and Fly Ash in minor quantity and curing in water.

Later doing the same but by curing in water along with 5% of acid.
With the above two attempts we can study the comparison of normal curing and acidic curing when replaced with Silica Fume and Fly Ash.

II. LITERATURE REVIEW

Gopalam M and Haque M (1987) The Paper "effect of curing regime on the properties of fly ash concrete" published in the American concrete Institute journal reported on the effect of compressive strength and flexural strength of normal and fly ash concrete, cured in water and in uncontrolled environment. It was found that the curing conditions influenced the compressive strength significantly. The 91 days air cured concrete strength was less than the 7 days for cured concrete strength. Poor curing is concluded to be more detrimental to the compressive strength development of fly ash concrete as compared to normal concrete.

Yogendran et al. (1987) made an attempt to modify the properties of concrete with respect to its strength and other properties by using silica fume and chemical admixtures. Silica fume in high–strength concrete at a constant water binder ratio(w/c) of 0.34 and replacement percentages of 0 to 25, with varying dosages of HRWRA The maximu28 day compressive strength was obtained at 15% replacement level.

Nicholas j.Carolina and,R clinofton (1991) in their paper "HPC Research needs to Enhance its Use" in concrete International , list out the exploitable attributes of HPC, which can be grouped into three general categories, Properties and enhanced durability properties, They are Adhesion to Hardened concrete, Abrasion Resistance, Corrosion Protection, Chemical Resistance, Durability Energy Absorption, early Strength, high Elastic module, high compressive Strength , high modulus of rupture, high tensile strength and high Strength/Density ratio, high workability and Cohesiveness, low permeability, resistance to wash out, Volume Stability.

2.1 Critical Observations from the Literature:
Only one pozzolanic materials combination is used with Ordinary Portland cement i.e., binary blended cements only.

- Micro Silica incorporation in concrete results in significant improvements in the workability of concrete, along with the compressive strength.
- The maximum percentage of synthetic fiber to be used in concrete along with silica fume to get good outcome.
- A typical 1000 mega watt station using coal of calorific value 3500 kilo cal. Per kg. and ash content of 4 to 4.5 per cent would need about 500 acres for disposal of fly ash during its useful operation of 30 years.

III. MATERIALS AND PROPERTIES

3.1 Cement
Cement is a material that has cohesive and adhesive properties in the presence of water. Such cements are called hydraulic cements. These consist primarily of silicates and aluminates of lime obtained from limestone and clay. There are different types of cement; out of that I have used ordinary Portland cement (OPC) of 53 grade from Ultratech Company for this present study.

Figure1: Cement

Table -1: Physical Properties of Ordinary Portland cement

Fineness	$340 m^2/kg$
Specific gravity	3.02
Initial setting time (min)	98
Final setting time(min)	219

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3.2 Aggregates

Types of Aggregates:

1. Fine aggregate
2. Course aggregate

Table -2: Properties of Fineness aggregate

Properties	Results Obtained
Specific gravity	2.60
Water absorption	0.8%
Fineness modulus	2.75

Table -3: Properties of Coarse aggregate

Properties	Results Obtained
Specific gravity	2.59
Water absorption	0.4%
Fineness modulus	4.01

3.3 Admixtures

Admixtures are usually in two types of admixtures available in the market.

Mineral admixtures

- Fly ash
- Silica fume
- Met kaolin
- Rice husk ash
- Ground granulated blast furnace slag

Chemical admixtures

- Super plasticizers
- Water reducing admixtures
- Retarding admixtures
- Strength increasing admixtures

3.4 Silica Fume

Silica fume is a by-product of producing silicon metal or Ferro silicon alloy in smelters using electric arc furnaces. These metals are in many industrial applications include aluminum and steel production , computer chip fabrication, and production of silicones, which are widely used in lubricants and sealants. While these are very valuable materials, the byproduct silica fume is of more importance to the concrete industry replacement of Portland cement due to its versatile properties. The availability of high range water reducing admixtures (super plasticizers) has opened up new ideas for the use of micro silica as part of the cementing material in concrete to produce very high strength cement (>100 MPa).

IV. RESULT & DISCUSSION

The experimental program was designed to investigate silica fume and fly ash as partial replacement in concrete. The replacement levels of cement by silica fume and fly ash are selected as (0%, 5%, 8%, 10%, 12%, and15%) and (0%, 5%, 8%, 10%, 12%, and15%) by weight of cement for standard size of cubes. The specimen of standard cube (150mmx150mm x 150mm), cylinders (150mm diameter 300height), and prism (100 x 100 x 400mm) was casted for compression, split tensile strength and flexure test.

4.1 Compressive Strength of Concrete

Table -4: Compressive strength results for Normal Water curing.

MIX	7 DAYS STRENGTH Mpa	28 DAYS STRENGTH Mpa
CAC	26.31	40.473
FSAC1	23.689	36.44
FSAC2	24.705	38.00
FSAC3	25.86	39.79
FSAC4	21.509	33.088
FSAC5	22.526	34.652

FSAC1 = 15% FA & 5% SF
FSAC2 = 5% FA &15% SF
FSAC3 = 10% FA & 10% SF
FSAC4 = 12% FA & 8% SF
FSAC5 = 8% FA & 12% SF

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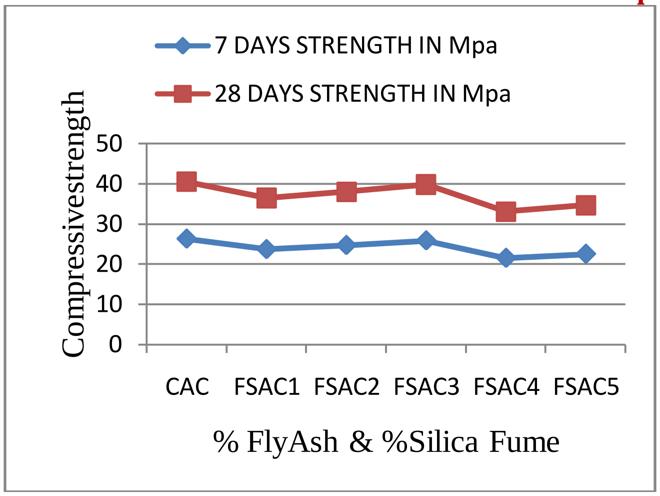

Chart -1: Compressive strength for Normal water curing result

Table -5: Compressive strength results for durability

	7 DAYS STRENGTH Mpa	28 DAYS STRENGTH Mpa
CAC	24.852	38.23
FSAC1	24.561	37.78
FSAC2	21.80	33.74
FSAC3	24.852	38.23
FSAC4	20.49	31.523
FSAC5	21.50	33.08

For Durability purpose 5% of H_2SO_4 can be added in water for curing

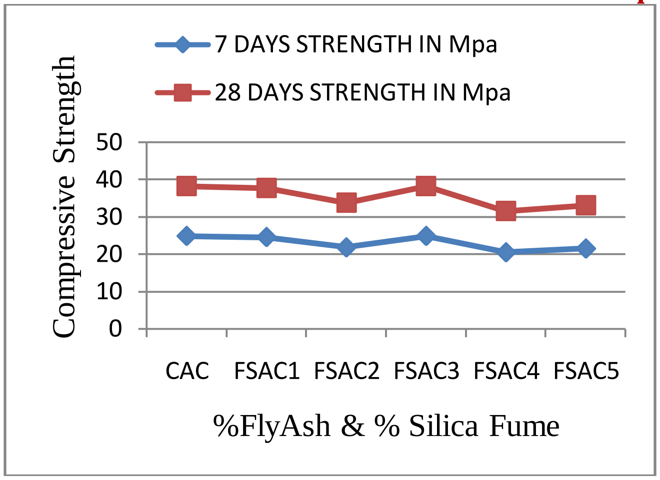

Chart -2: Compressive strength results for durability

4.2 Split Tensile Strength of Concrete

Table -6: Split tensile strength result for normal curing of water

MIX	7 DAYS STRENGTH Mpa	28 DAYS STRENGTH Mpa
CAC	2.88	4.44
FSAC1	2.609	3.79
FSAC2	2.47	4.40
FSAC3	2.67	4.115
FSAC4	2.17	3.34
FSAC5	2.72	4.186

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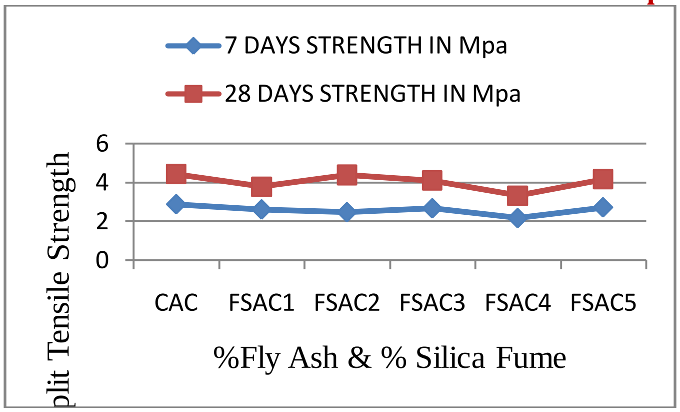

Chart -3: Split tensile strength result for Normal Curing of water

4.3 Flexural Strength of Concrete

Table -7: Flexural strength result for normal curing of water

	7 DAYS STRENGTH Mpa	28 DAYS STRENGTH Mpa
CAC	3.85	5.79
FSAC1	3.23	4.96
FSAC2	3.7	5.82
FSAC3	3.53	5.30
FSAC4	3.00	4.62
FSAC5	3.30	5.19

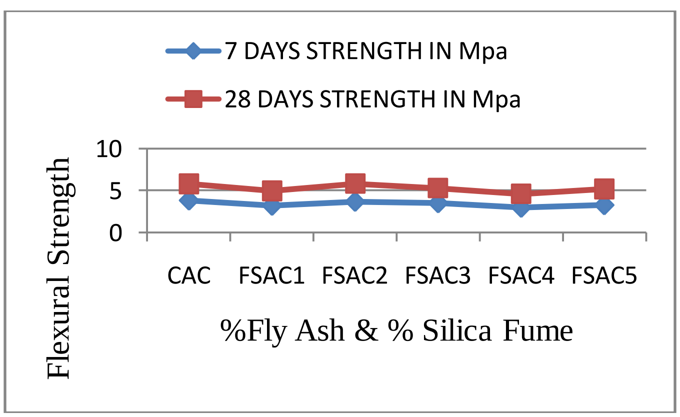

Chart -3: Flexural strength result for Normal Curing of water

V. CONCLUSION

Based on experimental studies the following conclusions are drawn.

1. Cement replacement by in combination of fly ash and adding silica fume leads to increase in compressive strength, split tensile strength and flexural strength up to 20 % replacement for M30 grades of concrete.
2. There is a decrease in workability as the replacement level increases, and hence water consumption will be more for higher replacements.
3. The Compressive strength value is reached by 10%Fly Ash and 10%Silica fume mix as compression with CAC.
4. Split tensile strength value is reached by 5%Fly Ash and 15%Silica Fume mix is replaced by cement by compression with CAC.
5. Flexural strength increased by 5%Fly Ash and 15%Silica Fume mix is replaced by cement by compression with CAC.
6. For durability purpose 5%of H2SO4 should be added in water curing so we can observed at all strengths the durability strength values can be decreased as comparative with normal curing strengths.
7. This study has shown that between 20% replacement levels, concrete will develop strength sufficient for construction purposes. Its use will lead to a reduction in cement quantity required for construction purposes and hence sustainability in the construction industry as well as aid economic construction .
8. It can also be observed that when silica fume is replaced highly in cement so that strength is highly as comparitative with Fly Ash.

VI. SCOPE FOR FURTHER STUDIES

The experimental work on pozzolanic materials along with ordinary Portland cement is still limited. But it has a great scope for further studies.
The following aspects are considered for future study and investigations.

1. Industrial wastes, such as silica fume, blast furnace slag, fly ash are being used as supplementary cement replacement materials and recently, agricultural wastes are also being used as pozzolanic materials in concrete.
2. To reduce the green gas emission and to safeguard the land.

It requires a proper mixing proportions for the development of high strength, high performance concrete which may not be possible manually. So it needs some global optimization technique to develop the desired results with greater accuracy and time saving..

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