

Strength and Durability Properties of Concrete using Fly Ash and Silica Fumes

Er. Shivam Singh P¹
¹Assistant Professor,
Department of Civil Engineering,
Allenhurst Institute of Technology,
Kanpur

Er. Syed Mohd. Ashraf Husain P²
²Assistant Professor,
Department of Civil Engineering,
Allenhurst Institute of Technology,
Kanpur

Er. Praneet Madhav P³
³Assistant Professor,
Department of Civil Engineering,
Allenhurst Institute of Technology,
Kanpur

Abstract— This study is mainly focused on the durability and strength characteristics of different concrete mix with partial replacement of cement by fly ash (FA) and silica fume (SF). Firstly the cement was replaced with FA (20% & 30%) in which 30% FA replacement performed well then the cement content was further replaced with SF (10% & 15%) in which further replacement with 15 % of silica fumes performed well. Water cement ratio was kept constant for all mixtures. And further replacement is done by RCA (Recycled coarse aggregate) with the natural aggregate to make the system more eco friendly and cheap.

Keywords—Fly Ash, Silica Fumes, Durability and Strength.

I. INTRODUCTION

In construction work, concrete is the main ingredient due to its application in the present world. Its property like more strength, durability and affordability increases its field of application. Ability of structural material to hold out its design life without any deterioration for designed service condition is known as durability. The problems related to durability of materials starts when it deteriorates at early stage. The deteriorations of material do not contain issues related to safety. This will lead toward the structure damage which may pose great threat to structure.

Many researches has been carried out to find the replacement material for cement from last few years to improve the Durability and strength properties which can be beneficial for mass concrete. No. of researches had been done on the application of VA, FA, blast-furnace slag, rice husk ash, silica fume. VA and FA are pozzolanic materials because during cement hydration they react with lime. In pozzolanic materials silica reacts with lime and changes into cementitious materials. We are going to use fly ash and silica fume in this study. "High-performance concrete is defined as a concrete meeting special combinations of performance and requirements that cannot always be achieved by using conventional constituents and normal mixing, placing, and curing practice."

II. EXPERIMENTAL STUDY

2.1 Materials

Coarse aggregate, natural sand, fly ash, silica fume and 43 grades ordinary Portland cement were used as the main ingredient. The sand and coarse aggregate used for locally available in the market. The fly ash replacement was 20 % and 30 % in which 30 % fly ash replacement performed well so it is further replaced with 10 % and 15 % of silica fumes and finally aggregates were also replaced by recycled coarse aggregate. Fly ash is finely divided residue resulting from the combustion of powdered coal and transported by flue gases and collected by electrostatic precipitation. Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys.. The silica fume is collected from MOTIVE ASSOCIATES, Kolkata.

2.2 Methods

The materials were collected and mix design was done for M30 grade concrete.

Different types of mix were obtained by replacing the constituent material of concrete. In which cement is replaced by fly ash and silica fumes and natural aggregate were replaced by recycled coarse aggregate.

Types	Constituent materials and percentage replacement
S1	Normal M30 grade concrete
S2	Cement replacement by 20% of FA
S3	Cement replacement by 30 % of FA
S4	Cement replacement by 30 % of FA and 10 % of SF
S5	Cement replacement by 30 % of FA and 15 % of SF
S6	Cement replacement same as S ₅ and aggregate replacement by 40 % of RCA

Table-1 Different types of mix

III. RESULTS

Based on the laboratory test it has been observed that strength of concrete is increasing with addition of admixtures. The various tests that are conducted to test the strength and durability characteristics and their results correlate with the study and derive positive result and improvement.

3.1 Compressive strength of concrete

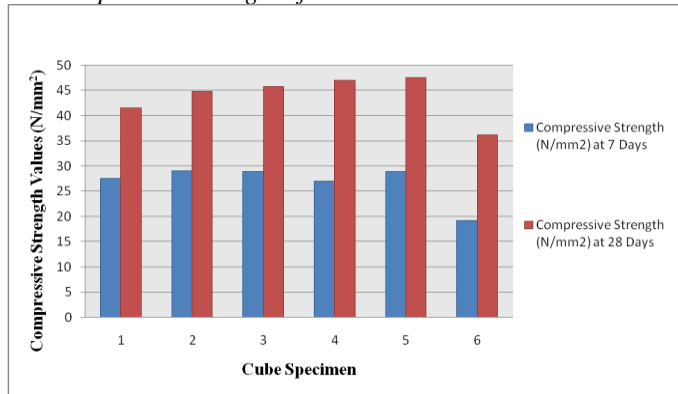


Figure 1-Compressive strength of different types of mix

3.2 Flexural strength of beam

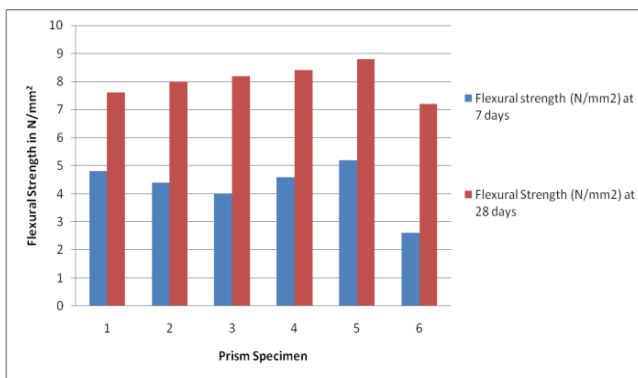


Figure 2- Flexural strength of different types of mix

3.3 Split tensile strength of cylinders

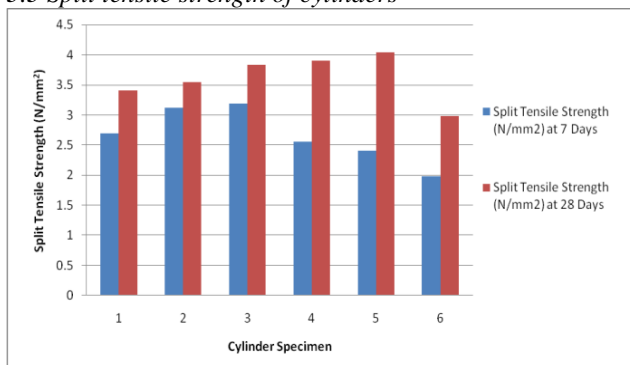


Figure 3- Split tensile strength of different types of mix

3.4 Durability characteristics

3.4.1 Sulphate attack test

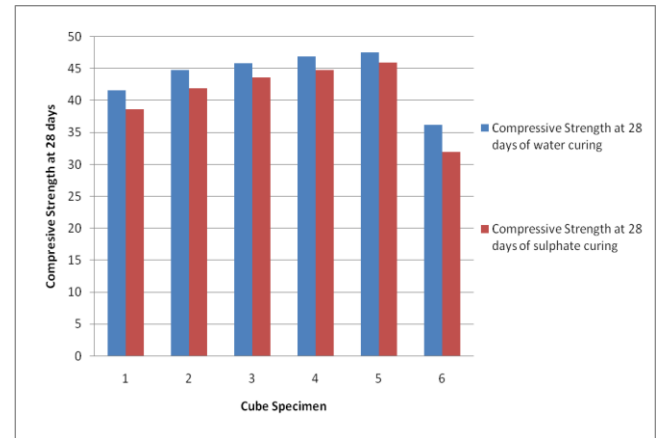


Figure 4- Comparison of compressive strength of Cubes in different curing

3.4.2 Water absorption test

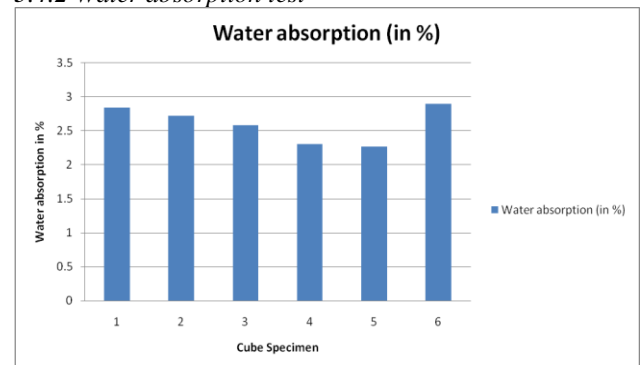


Figure 5- Water absorption of different types of mix

IV. CONCLUSIONS

In the present study an effort is taken to check the combined effect of fly ash and silica fume on the durability and strength properties of concrete. On the basis of test the following conclusion can be made –

- With increase in fly ash content compressive strength increases, but combined effect of fly ash and silica fume gives better performance.
- Concrete with 30% fly ash+ 15% silica fumes performed well in split tensile and flexural strength test.
- Combined effect of fly ash and silica fumes has also increased the durability properties by decreasing the water absorption and increasing the resistance against sulphate attack.
- Replacement of aggregate with recycled coarse aggregate along with cement replacement with fly ash and silica fume have not shown better performance as compared to the normal concrete but it is good enough to work and can be used in small construction works like road kerbs, pavement etc.
- Compressive strength, split tensile strength and flexural strength of concrete with 30 % fly ash + 15 % silica fume has increased to 14 %, 18 % and 15 % respectively as compared to normal concrete.

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