Partial Replacement of Cement in Concrete with Fly Ash and Micro Silica

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Abstract

Rapid growth of construction activities leads to active shortage of conventional construction materials due to various reasons. Concrete is mostly used construction material. Cement, fine aggregate and coarse aggregate are the constituents of the concrete. Researches were searching for cheaper & eco-friendly materials as a replacement of cement in concrete. Because the manufacture of cement leads to the pollution in large amounts (CO2 emissions are 0.8-1.3 ton/ton2 & SO2 emission is also very high). It was found that industrial waste such as micro silica and fly ash can be used as partial substitute for cement.

Keywords — *Compressive strength, Split tensile strength*

I. INTRODUCTION

The word concrete comes from Latin word "concretus" meaning compact or condensed. Concrete is a composite material composed of gravels or crushed stones (coarse aggregate), sand (fine aggregate) and hydrated cement (binder).For concrete to be good concrete it has to be satisfying in its hardened state and in its fresh state while being transported from the mixer and placed in the formwork. The requirements in the fresh state are that the consistence of the mix is such that the concrete can be compacted and also that the mix is cohesive enough to be transported and placed without segregation.

As far as the hardened state is considered, the requirement is a satisfactory compressive strength. Concrete achieves its strength after 28days of placing the concrete.

II. SILICA FUME

Silica fume is also known as micro silica, condensed silica fume, volatized silica or silica dust. It can be used in concrete and refractory materials. Microsilica, when used in concrete, it can improve concrete's properties such as compressive strength, bond strength and abrasion resistance, reduces permeability It is usually a grey coloured powder, somewhat similar to Portland cement or some fly ashes. It can exhibit both pozzolanic and cementations properties.

A. Sources and characteristics of silica fume

Silica fume is an artificial pozzolanic material, produced by the reduction of high quality quartz with coal in an electric arc furnace in the manufacture of silicon or ferro silicon alloy. Silica fume is, when collected, an fine powder having the following basic
properties:

- It has at least 85% SiO2
- Particle size between 0.1 and 0.2 micron
- Minimum specific surface of 15000m2/kg
- Spherical particle shape

III. FLY ASH

Fly ash is a fine powder byproduct from industrial plants using pulverized coal or lignite as fuel .It is the most widely used pozzolona siliceous or aluminosiliceous in nature in a finely divided form .They are spherical shaped "balls'' finer than cement particles

A. Sources of fly ash

Fly ash is powder recovered from the gases of coal fired electricity production Inexpensive replacement of Portland Cement Improves strength, segregation and ease of pumping the concrete

IV. OBJECTIVE OF THE STUDY

The aim of this study to make the High Performance Concrete by replacing cement with a waste material but super pozzolanic silica fume, fly ash. And to study the strength and workability of silica fume and fly ash concrete, through an experimental investigation

V. SCOPE OF WORK

The scope of the study is restricted to the following aspects.

1.The workability , compressive strength, split tensile strength of silica fume and fly ash concrete of different ratio, different mix proportions with constant water cement ratio's have been investigated.

2. High-performance concrete of grades M-25 the replacement levels of cement by silica fume and fly ash are selected as 0%, 6%, 8%, 10%, 12% & 14% for standard sizes cubes for testing.

VI. MATERIALS USED

A. *Cement:*

Ordinary Portland cement is used in the project work, as it is readily available in local market. The cement used in the project has specific gravity was 3.15.

B. *Coarse Aggregate:*

Crushed angular coarse aggregate were used. The specific gravity was 2.60. The coarse aggregate used in the project work are 20 mm down grade.

C. *Fine Aggregate:*

River white sand was used as fine aggregate. The specific gravity was 2.40. The fine aggregate used in the project work is 4.75 mm down grade

D. *Silica fume:*

Silica fume is also known as micro silica, condensed silica fume, volatized silica or silica dust. It is usually a grey coloured powder, somewhat similar to Portland cement or some fly ashes. It can exhibit both pozzolanic and cementations properties.

E. *Fly Ash:*

Fly ash is powder recovered from the gases of coal fired electricity production Inexpensive

VII. USES OF SILICA FUME

The appropriate use of SF in concrete can give a range of benefits in design, construction and performance of many types of concrete structure – including high-rise buildings, industrial floors, civil engineering and marine structures. It can be used for precast and inside concrete. SF has specific benefits during construction, including: •Increased cohesiveness of the fresh concrete, High early strength (in excess of 25 N/mm2 at24 hours). The dense. Lower permeability and improved durability, Greater resistance to abrasion and impact than conventional concretes of similar strength grade .SF can be used as an ingredient in high performance concretes containing micro-fibers to combat explosive spalling during exposure to fire, Environmental benefits (due to reduced cement contents and improved service life).SF is ideally suited to the most demanding applications, such as concrete slipways, dam spillways and hard standings, where chloride, chemical or abrasion resistance are required.

VIII. EFFECT OF SILICA FUME ON IMPORTANT PROPERTIES OF CONCRETE

The addition of Silica Fume to cement has been found to enhance cement properties:

•The addition of Silica Fume speeds up setting time, although the water requirement is greater than for OPC.

•At 15% replacement of Silica Fume cement has improved compressive strength due to its higher percentage of silica.

•More recent studies have shown Silica fume has uses in the manufacture of concrete for the marine environment. Replacing 15% Portland cement with Silica fume can improve resistance to chloride penetration.

•Several studies have combined fly ash and Silica Fume in various proportions. In general, concrete made with Portland cement containing both Silica Fume and fly ash has a higher compressive strength than concrete made with Portland cement containing either Silica Fume or fly ash on their own.

IX. USES OF FLY ASH

Fly ash is used as a supplementary cementitious material (SCM) in the production of portland cement concrete. When used in portland cement improve properties of the hardened concrete. SCM's include both pozzolans and hydraulic materials.

X. EFFECT OF FLY ASH ON IMPORTANT PROPERTIES OF CONCRETE

The addition of fly ash to cement has been found to enhance cement properties:

1) Normal consistency increases with increase in the grade of cement and fly ash content.
3) Workability increases in fly ash concrete
4) As the fly ash contents increases in all grades of OPC there is reduction in the strength of concrete..
5) In all grades OPC, fly ash concrete is more durable as compared to OPC concrete and fly ash up to 40% replacement increase with grade of cement.
6) Shrinkage of fly ash concrete is similar to the pure cement concrete in all grades of OPC.

XI. TEST METHODS

A. *Workability*:

The workability tests were performed using standard sizes of Slump Moulds

1) Slump Test

B. *Compressive Strength:*

The Steel mould of size 150 x 150 x 150 mm is well tighten and oiled thoroughly. then tested in 7, 28 days.

C. *Split Tensile Strength:*

The cylindrical specimen for routine testing and comparison of results, unless otherwise specified the specimens shall be cylinder 150 mm in diameter and 300 mm long.

XII. MIX PROPORTIONS OF SILICA FUME AND FLYASH

Mix	Silica Fume and fly ash%
M1	0
M2	6
M3	8
M4	10
M5	12
M6	14

Table 1 Mix Proportions

In every mix proportions of silica fume and fly ash concrete there is 70% of fly ash and 30% of micro silica

XIII.RESULTS AND DISCUSSIONS

A. Workability

The workability of M-25 grades of concrete with various proportions of silica fume and fly ash was estimated in terms of Slump test

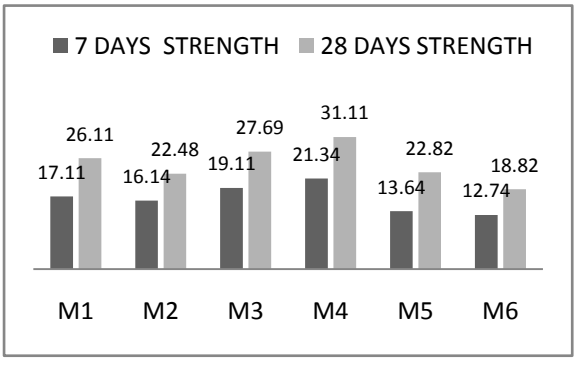
1) Slump Test:

The Slump test was conducted as per IS: 1199-1999. The results of Slump test M-25 grades of concrete outcomes that there is a slump loss for every increase in silica fume and fly ash when compared with conventional concrete.

B. Compressive Strength Test:

The Compressive Strength test was conducted as IS: 516-1979.. The results of Compressive Strength tests conducted on different grades of concrete without and with are tabulated below

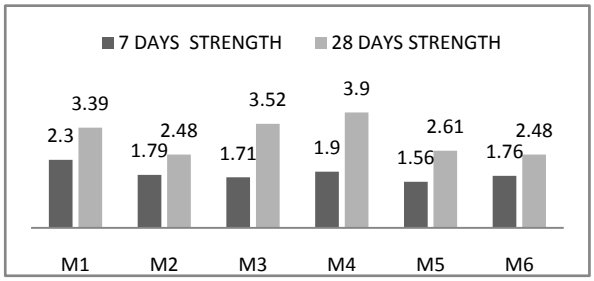
Variation of Compressive Strength of Fly Ash and Silica Fume Concrete in N/Mm2



C. Split Tensile Test:

The Split Tensile Strength test was conducted as per IS 5816-1999. The results of Split Tensile Strength tests conducted on different grades of concrete are tabulated below

Variation of Split Tensile Strength of Fly Ash And Silica Fume Concrete in N/Mm2



XIV. CONCLUSION

- The compressive strength of silica fume and fly ash concrete is found to be more than that of conventional concrete for a mix of 90% cement and 10% SF & FA and 92% of cement and 8% of SF & FA.
- The Split Tensile strength of silica fume and fly ash concrete is found to be more than that of conventional concrete for a mix of 90% cement and 10% SF & FA.
- The Silica Fume occupies more volume than cement same weight. So the total volume of the SF concrete increases for a particular weight as compared to conventional concrete.
- When the percentage of the silica fume is increased, the workability of the mix becomes very poor as compared to the conventional concrete.
- Silica Fume and Fly ash can be added to concrete by 8% & 10% as the strength was increasing than conventional concrete.

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