EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT BY SILICA FUME

K.Maheswari[1],

[1] *Lecturer, Civil engineering, Lakshmi Ammal polytechnic college, Tamilnadu, India*

ABSTRACT

Today, we need to look at a way to reduce the cost of building materials; particularly cement is currently so high that only rich people and governments can afford construction. Studies have been carried out to investigate the possibility of utilizing a board range of materials as partial replacement materials for cement in the production of concrete.This study investigated the strength & properties of silica fume concrete. Silica fume is very fine non crystalline material. Silica fume is generally categorized as a(One type of mineral admixtures) supplementary cementitious material. Silica fumes are generated by industries, which causes environmental as well as health problems due to dumping and disposal. Proper introduction of silica fume in concrete improves both the mechanical and durability characteristics of the concrete. Silica fume was initially view as cement replacement material and can be used as pozzolanic admixtures (mineral admixture). We are partially replacing cement with silica fume by adding 0%, 5%, 10%, 15%,20% by weight of cement in concrete and comparing the compressive strength of normal concrete with silica fume replaced concrete. This study has shown that between 5 to 10% replacement level of cement by silica fume in concrete will develop strength sufficient for construction purposes.

Keyword: -*Silica fume1, Concrete2, Admixture3, and Mineral Admixtures4 etc….*

1.INTRODUCTION

Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material from Industries has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste. These industrial wastes are dumped in the nearby land and the natural fertility of the soil is spoiled. hence it is obvious to use either alternate or other materials as part replacement. Some alternate or supplementary pozzolanic materials like fly ash , silica fume, rice husk ash, ground granulated blast furnace slag and high reactive metakaolin can be used for cement as partial replacement in concrete and should leads to global sustainable development and lowest possible environment impact and energy saving. The advantage like high strength , durability and reduction in cement production are obtained due to the incorporation of silica fume in concrete and the optimum percentage replacement of silica fume ranging from 10 to 20% to obtain maximum strength of concrete.

Silica fume is also known as micro silica or condensed silica fume, is used as an artificial pozzlanic admixture. It is a material resulting from reduction of quartz with coal in an electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Chemical composition of silica fume Contains more than 95 percent silicon dioxide Other constituents are carbon, Sulphur and oxides of aluminum, iron, calcium, magnesium, sodium and potassium. The physical composition of silica fume Oversize - % retained on 45 µm sieve (wet sieved) is 1.10% , (specific gravity) 2.26%,Bulk Density is 187.91 kg/m³ ,Specific Surface Area is 22.21 m²/kg.

2. REVIEWS OF ARTICLES

1. Pradhan and Dutta (2013) investigated the effects of silica fume on conventional concrete. The optimum compressive strength was obtained at 20% cement replacement by silica fume at 24 hours, 7 and 28 days. Higher compressive strength resembles that the concrete incorporated with silica fume was high strength concrete.

2. Ajileye (2012) Cement replacement up to 10% with silica fume leads to increase in compressive strength for M30 grade of concrete. From 15% there is a decrease in compressive strength for 3, 7, 14 and 28 days curing period. Compressive strength of M30 grade of concrete was increased from 16.15% to 29.24% and decrease from 23.98% to 20.22%.

3.Amudhavalli & Mathew (2012) studied the effect of silica fume on the strength and durability characteristics of concrete . The main parameter investigated in this study is M35 grade concrete with partial replacement of cement by silica fume by 0, 5, 10, 15 and by 20%. A detailed study in compressive strength, split tensile strength, flexural strength at age of 7 & 28 day was carried out. Results shows that silica fume in concrete has improved the performance of concrete in strength as well as in durability aspect.

3. EXPERIMENTAL WORK

In the first phase, the preliminary tests were conducted for various materials. The cubes, cylinders and beams were cast for this M25 grade concrete. The 7&28 days compressive strength, split tensile and flexural strength test for cubes, cylinders and beams were found using this M25 grade concrete.

4. MATERIALS USED

Materials used in this project such as cement, fine aggregate, coarse aggregate, and water are as per the specifications of IS codes.

4.1 Cement

Cement is considered as the best binding material and is being commonly used as a binding material in the construction of various engineering structures these days. Portland cement is referred as ordinary Portland cement is the most important type of cement and is a fine powder produced by grinding Portland cement clinker. Concrete is made by Portland cement, water and aggregates. Cement constitutes about 20 % of the total volume of concrete. Portland cement is hydraulic cement that hardens in water to form a water-resistant compound. The hydration products act as binder to hold the aggregates together to form concrete. The name Portland cement comes from the fact that the colour and quality of the resulting concrete are similar to Portland stone, a kind of limestone found in England. Although all materials that go into concrete mix are essential, cement is very often the most important because it is usually the delicate link in the chain. It constitutes only about 20 percent of the total volume of concrete mix; it is the active portion of binding medium and is the only scientifically controlled ingredient of concrete. Portland cement referred as (Ordinary Portland Cement) is the most important type of cement and is a fine powder produced by grinding Portland cement clinker. The OPC is classified into three grades, namely 33 Grade, 43 Grade, 53 Grade depending upon the strength of 28 days. The cement as determined from various tests conforming to Indian Standard IS: 8112:1989 are listed in Table 1.

Table -1: Properties of OPC 43 grade concrete

S.no	Characteristics	Values
1.	Specific gravity	3.15
2.	consistency(%)	33
3.	Initial setting time	45(Minutes)
4.	Final setting time	430(Minutes)

4.2 Fine Aggregate

Aggregate which passed through 4.75 mm IS Sieve and retained on 75 micron (0.075mm) IS Sieve is termed as fine aggregate. Fine aggregate is added to concrete to assist workability and to bring uniformity in mixture. Usually, the natural river sand is used as fine aggregate. Ordinary river sand conforming IS 383-1970 was used

Table -2: Properties of Fine Aggregate

S.no	Characteristics	Values
1.	Specific gravity	2.5
2.	Bulk density(kg/m3)	1.3
3.	Fineness modulus	3
4.	Water absorption	1%

4.3 Coarse Aggregate

The coarse aggregate for the works should be river gravel or crushed stone. Angular shape aggregate of size is 20 mm and below. The aggregate which passes through 75 mm sieve and retain on 4.75 mm are known as coarse aggregate. It should be hard, strong, dense, durable, clean, and free from clay or foamy admixtures or quarry refuse or vegetable matter. The pieces of aggregates should be cubical, or rounded shaped and should have granular or crystalline or smooth (but not glossy) non- powdery surfaces. Aggregates should be properly screened and was if necessary Clean before use.Coarse aggregates containing flat, elongated or flaky pieces or mica should be selected.

Table -3: Properties of Coarse Aggregate

S.no	Characteristics	Values
1.	Shape	Angular
2.	Water absorption	2%
3.	Size	20mm
4.	Specific gravity	2.74

4.4 Water

Generally, water that is suitable for drinking is satisfactory for use in concrete. The potable water is generally considered satisfactory for use in concrete. The water should conform to IS 456-2000 standards

5.TEST ON FRESH CONCRETE

Fresh concrete is a freshly mixed material which can be mould into any shape. Workability of concrete is determined for fresh concrete.

Table -4: Workability of fresh concrete

S.no	Characteristics	Values
1.	Slump value	40-100
2.	Compaction factor	0.92

6. RESULTS AND ANAYSIS

Table -5: Hardened Concrete Test for 7 days

	0% of Silica fume	5% of Silica fume	10% of silica fume	15% of silica fume	20% of silica fume
Compressive Strength (N/mm2)	14.25	18.33	24.12	26.30	24
Split tensile Strength (N/mm2)	2.5	2.75	3.32	3.5	3
Flexural Strength(N/mm2)	3	3.42	3.75	3.85	3.52

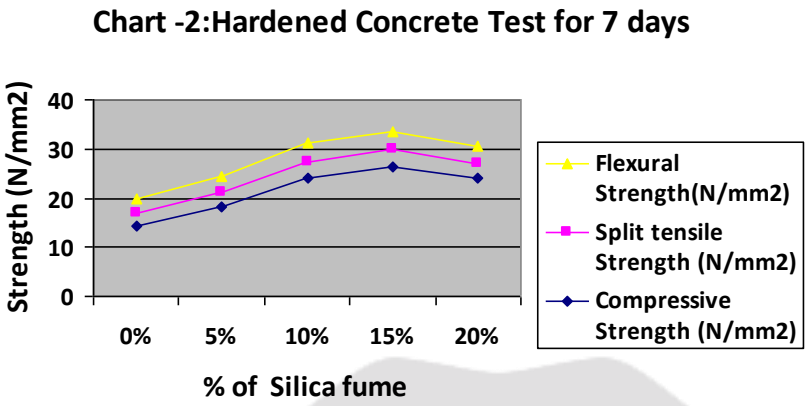
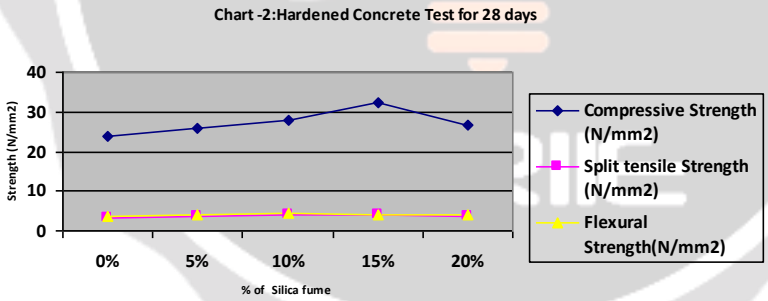


Table -6: Hardened Concrete Test for 28 days

	0% of Silica fume	5% of Silica fume	10% of silica fume	15% of silica fume	20% of silica fume
Compressive Strength (N/mm2)	24	26	27.92	32.5	26.5
Split tensile Strength (N/mm2)	3.25	3.5	4.03	3.95	3.45
Flexural Strength(N/mm2)	3.67	3.98	4.25	4.02	3.87



7. CONCLUSIONS

Based on the experimental investigation carried out on concrete by using various percentages of silica fumes.Concrete mixtures with different proportions of silica fume ranging from 0%, 5%, 10%, 15% and 20% for each three numbers of cube, cylinder and prism casted. The replacement of cement with silica fume 5% to 15 % leads to increase in compressive strength whereas the percentage 20% leads replacement of to decrease in compressive strength. The optimum percentage of silica fume is found to be 15% whereas beyond that the strength is reduced. The addition of silica fume reduces workability.

1 . Compressive strength was increased in silica fume 15% at 7 days and 28days.

2. Split tensile strength was increased in silica fume 15% at 7 days and 28 days.

3. Flexural strength was increased in silica fume 15% at 7 days and 28 days.

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