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"EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE USING SILICA FUME"

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Abstract: - The waste materials which can be used as additional cementitious material like fly ash, micro silica, blast furnace, metakaolin, steel slag etc. From all these waste material the most successful cementitious material is silica fume. To decrease the amount of cement in concrete supplementary material are used. For this investigation micro silica is replaced by 0%, 5%, 7.5%, 10%, 12.5%, 15% & 20% by the weight of cement. Water binder ratio is taken 0.45 for M-35 grade of concrete. From this reserach the results showed that compressive strength, bending strength, split tensile strength at 12.5 percent replacement of silica fume replaced with cement is optimum after that strength were decreased.

Keywords: *Silica Fume, water cement ratio, compressive strength, flexural strength, tensile strength*

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I INTRODUCTION

Concrete is a most commonly used building material which is a mixture of cement, sand, coarse aggregate and water. It is used for construction of multi-storey buildings, dams, road pavement, tanks, offshore structures, canal lining. The method of selecting appropriate ingredients of concrete and determining their relative amount with the intention of producing a concrete of the necessary strength durability and workability as efficiently as possible is termed the concrete mix design. The compressive strength of harden concrete is commonly considered to be an index of its extra properties depends upon a lot of factors e.g. worth and amount of cement water and aggregates batching and mixing placing compaction and curing. The cost of concrete prepared by the cost of materials plant and labour the variation in the cost of material begin from the information that the cement is numerous times costly than the aggregates thus the intent is to produce a mix as feasible from the practical point of view the rich mixes may lead to high shrinkage and crack in the structural concrete and to development of high heat of hydration is mass concrete which may cause cracking. The genuine cost of concrete is related to cost of materials essential for produce a minimum mean strength called characteristic strength that is specific by designer of the structures. This depends on the quality control measures but there is no doubt that quality control add to the cost of concrete. The level of quality control is often an inexpensive cooperation and depends on the size and type of job nowadays engineers and scientists are trying to enhance the strength of concrete by adding the several other economical and waste material as a partial substitute of cement or as a admixture fly ash, silica fume, steel slag etc are the few examples of these types of materials. These materials are generally by-product from further industries for example fly ash is a waste product from power plants and silica fume is a by-product resulting from decrease of high purity quartz by coal or coke and wood chips in an electric arc furnace during production of silicon metal or ferrosilicon alloys. But nowadays silica fume is used in large amount because it enhances the property of concrete. The use of micro silica as a pozzolana material has enhanced in recent years because when mixed in definite proportions it improves the properties of both fresh and hard concrete like durability, strength, permeability and compressive strength, flexural strength and tensile strength.

II MATERIAL USED

2.1 Cement: ordinary Portland Cement (OPC) is used in this research work.

2.2 Sand: Sand is the main component grading zone-II of IS: 383-1978 was used with specific gravity of 2.62 and water absorption of 1.8% at 24 hours

2.3 Natural aggregate: Mechanically crushed stone of 20mm maximum size, satisfying to IS: 383-1978 was used. The specific gravity was found to be 2.62 and 2.64 and water absorption is 0.16% and 0.18% at 24 hours of 20mm aggregates respectively.

2.4 Silica Fume (Micro Silica): Micro silica is a result se of high-purity quartz with coke in stimulating arc furnaces in the

manufacture of silicon and ferrosilicon alloys: Chemical Composition of micro silica is as follows

Table 1: Chemical composition of micro silica

Properties	Observed value
Silica oxide	91%-97%
Aluminium tri oxide	0.7 -3.1%
Ferrous Oxide	0.4-0.9%
Magnesium Oxide	0.5-1.2%
Calcium oxide	0.2-0.7%
Potassium Oxide	0.4-0.8%
Calcium	0.6-1.5%
Loss on Ignition	Maximum 1.6%

III. EXPERIMENTAL WORK AND TEST

3.1 Slump Cone Test: The slump test result is a measure of the behavior of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete which then gives an idea about the workability condition of concrete mix.

3.2 Compressive Strength Test: The mould is prepared for cubes used in the compression test having a size of 150cmx150cmx150cm. After preparing cubes rest on the compression testing machine and load is applied. After applying load the value noted from the dial gauge. Compressive strength determine at 7 & 28 days.

3.3 Flexural Strength Test: Designed for flexural strength test beam samples of dimension 100x100x500 mm were cast. The specimens were demoulded after 24 hours of molding and were transferred to curing tank where in they be permitted to cure for 28 days. These flexural strength samples were tested under a point loading as per I.S. 516-1959, over an effective span of 400 mm on Flexural testing machine. Load and resultant deflections were noted up to failure. In each classification two beams were tested and their average value is noted.

3.4 Split Tensile Strength: The mould is prepared for cylinder used in the tensile test having a size of 150cm diameter and 300m height. After preparing cylinder rest on the compression testing machine and load is applied. After applying load the value noted from the dial gauge. Tensile strength determine at 7 & 28 days

3.5 Durability Test Resistance against Acid Attack

For acid attack test concrete cube of size 150*150 *150 mm are prepared for different percentages of silica fume addition. The samples are cast and curing in the mould for 24 hours, after 24 hours, every sample are demoulded and kept in curing tank for 28 days. After 28-days all specimens are kept in environment for 2-days for constant weight, then, the specimens are weighing and immersed in 5% sulphuric acid (H2SO4) solution for 28-days. The pH value of the acidic medium was at 0.3.. After 28-days of immersing in acid solution, the specimens are taken out and were washed in consecutively water and kept in environment for 2-day for constant weight. Then the specimens are weighed and loss in weight and hence the percentage loss of weight was calculated

IV. TEST RESULTS

4.1 Workability As shown in below table 2 for different percentage of silica fume slump value were calculated..

Table 2: Workability Result

Batches	% Silica Fume	Slump (mm)
Mix-01	0	75
Mix-02	5	80
Mix-03	7.5	83
Mix-04	10	78
Mix-05	12.5	72
Mix-06	15	65
Mix-07	20	55

4.2 Compressive Strength; The below table shows the compressive strength for different percentage of micro silica which is vary from 0%-20%..

Table 3: Compressive Strength Result

Mix Design	% Silica fume	7 days Compressive Strength	28 days Compressive Strength
Mix-01	0	25.97	42.95
Mix-02	5	26.85	44.22
Mix-03	7.5	27.03	44.81
Mix-04	10	27.75	45.70
Mix-05	12.5	29.85	47.18
Mix-06	15	26.18	43.88
Mix-07	20	25.85	43.02

4.3 Flexural Strength The below table shows the Bending strength for different percentage of silica fume which is vary from 0%-20%.

Table 4: Flexural Strength Result

Mix Design	% Silica fume	7 days Flexural Strength	28 days Flexural Strength
Mix-01	0	3.42	5.26
Mix-02	5	3.65	5.41
Mix-03	7.5	3.85	5.61
Mix-04	10	4.02	5.75
Mix-05	12.5	4.45	6.10
Mix-06	15	3.98	5.69
Mix-07	20	3.25	5.30

4.4 Split Tensile Strength The below table shows the tensile strength for different percentage of micro silica which is vary from 0%-20%.

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Table 5: Tensile Strength Result

Mix Design	% Silica fume	7 days Split Tensile Strength	28 days Split Tensile Strength
Mix-01	0	2.29	4.48
Mix-02	5	2.46	4.70
Mix-03	7.5	2.69	5.10
Mix-04	10	2.87	5.26
Mix-05	12.5	3.33	5.64
Mix-06	15	2.48	4.60
Mix-07	20	2.23	4.18

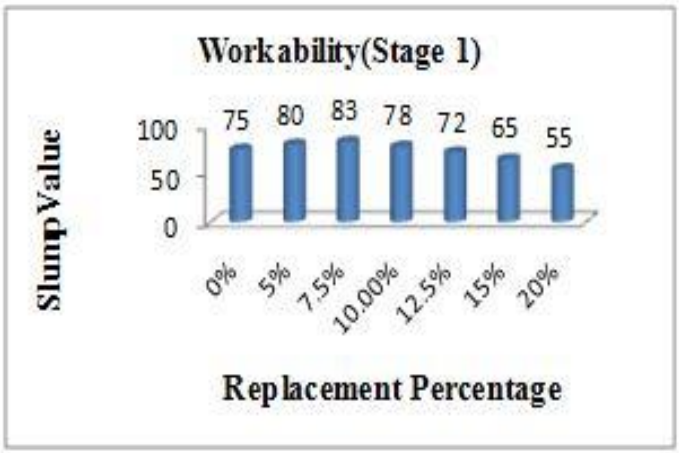
4.5 DURABILITY TEST: Cubes of sizes 150mm were cast and cured for 28 days. After 28 days curing cubes were taken out and allowed for drying for 24 hours and weights were taken. For acid attack 5% dilute hydrochloric acid is used. The cubes were to be immersed in acid solution for a period of 30 days. The concentration is to be maintained throughout this period. After 30 days the specimens were taken from acid solution. The surface of specimen was cleaned and weights were measured. The specimen was tested in the compression testing machine under a uniform rate of loading 140Kg/cm2 as per IS 516. The mass loss and strength of specimen due to acid attack was determined.

Table 6: Effect of Acid Attack on Weight and Compressive Strength of Cubes

S.No	Silica fume %	Loss in Weight (%) At 28 Days	Loss in Compressive strength (%) At 28 days
1.	0	5.2	12.01
2.	5	3.2	10.76
3.	7.5	2.83	7.81
4.	12.5	2.75	8.05
5.	15	2.65	8.29
6.	20	2.93	7.40
7.	25	2.25	7.95

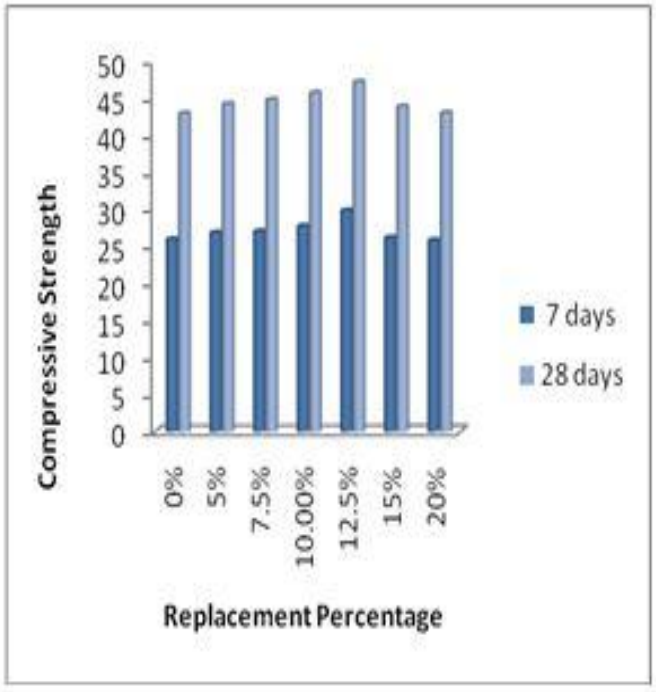
V. DISCUSSION ON TEST RESULTS

5.1 Workability: From the graph 1 the workability decreases after 7.5 percentage replacement of silica fume.



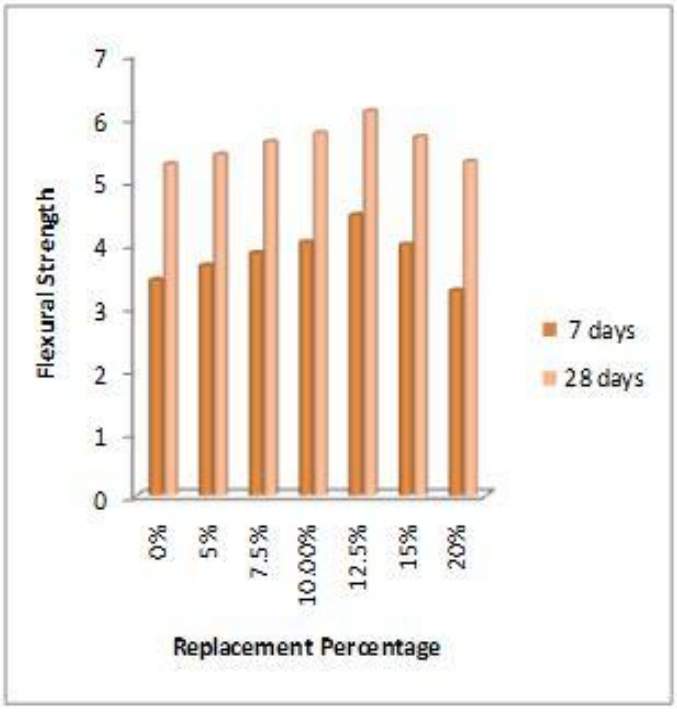
Graph 1: Slump Test for workability (mm)

5.2 Compressive Strength Test: From the graph 2 it is conclude that 7 & 28 days compressive strength 14.89% & 9.85% increases when percentage upto 12.5%. After that strength decreases when percentage of micro silica increases.



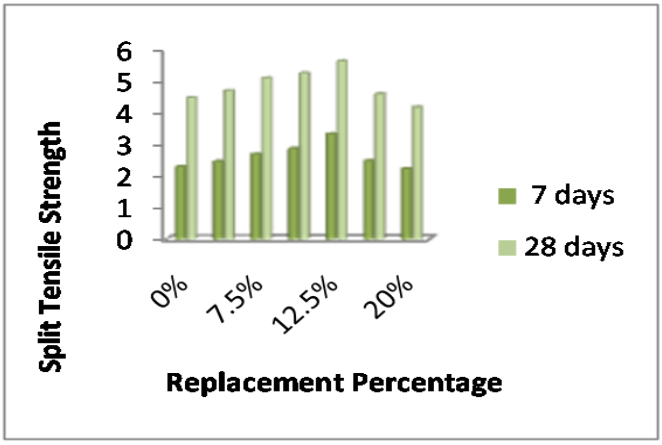
Graph: 2. Compressive Strength in N/mm2

5.3 Flexural Strength: It is conclude that 7 & 28 days bending strength 16.14% & 13.77% increases when percentage upto 12.5%. After that strength decreases when percentage of micro silica increases.



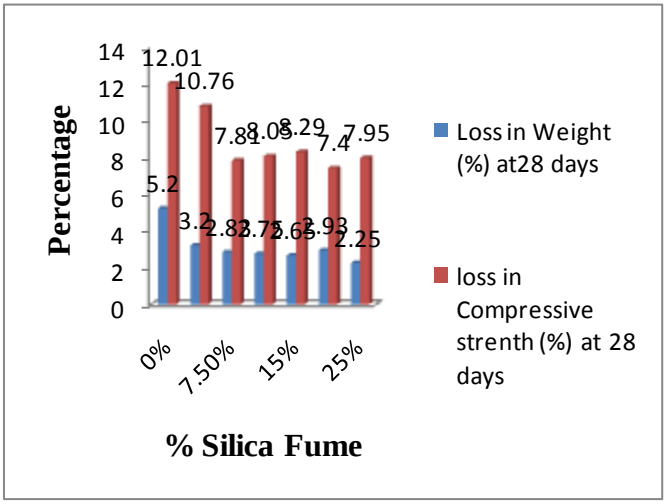
Graph:3 Flexural Strength in N/mm2

5.4 Split Tensile Strength: It is conclude that 7 & 28 days tensile strength 31.12% & 25.89% increases when percentage upto 12.5%. After that strength decreases when percentage of micro silica increases.



Graph 4: Split Tensile Strength in N/mm2

5.5 Durability Test: As shown in graph 5 the action of acids on concrete is the change of calcium compounds into calcium salts of the attacking acid. These reactions destroy the concrete structure. The percentage of loss in compressive strength was 12.01%, 10.76%, respectively. Thus replacement of silica fume is found to have increased the durability against acid attack.



Graph 5: Effect of acid attack on weight and compressive strength of cubes

VI. CONCLUSIONS:

From the above research work the conclusion are as follows:

1. Workability of concrete increases when percentage of silica fume upto 7.5 after that increase percentage of silica fume workability decreases.

2. Compressive strength 14.89% & 9.85% increases at 7 & 28 days when percentage upto 12.5%.

3. It is conclude that 7 & 28 days bending strength 16.14% & 13.77% increases when percentage upto 12.5%. After that strength decreases when percentage of micro silica increases

4. It is conclude that 7 & 28 days tensile strength 31.12% & 25.89% increases when percentage upto 12.5%. After that strength decreases when percentage of micro silica increases.

5. The percentage of loss in compressive strength was 12.01% at without replacement of cement by silica fume. Thus replacement of silica fume is found to have increased the durability against acid attack

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