EFFECT OF SILICA FUME ON PROPERTIES OF CONCRETE

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Abstract: *The effect of silica fume in concrete improves both the mechanical and durability characteristics of the concrete. The project aims to show the effect of silica fume on properties of concrete. The presence of silica fume as addition by weight at 0.5% (control mix), 1.0%, 1.5%, with and without superplasticizer are studied. It emphasized the effect of silica fume on workability level and its maintenance of fresh concrete; strength development, strength optimization and elastic modulus of hardened concrete; and chemical and mechanical durability of mortar. The chemical and physical properties of silica fume shows that it is most reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable.*

Key Words: Silica fume, Concrete, Pozzolan, durability.

1. INTRODUCTION

Silica fume, also known as micro silica is an amorphous (non-crystalline) polymorph of silicon dioxide. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production. It is extremely fine with particles size less than 1 micron and with an average diameter of about 0.1 microns, about 100 times smaller than average cement particles. Its behaviour is related to the high content of amorphous silica (>90%). The reduction of high- purity quartz to silicon at temperatures up to 2,000°C produces SiO_2 vapours, which oxidizes and condense in the low temperature zone to tiny particles consisting of non-crystalline silica.

During the last three decades, great strides have been taken in improving the performance of concrete as a construction material. Particularly Silica Fume (SF) and fly ash individually or in combination are indispensable in production of high strength concrete for practical application. The use of silica fume as a pozzolana has increased worldwide attention over the recent years because when properly used it as certain percent, it can enhance various properties of concrete both in the fresh as well as in hardened states like cohesiveness, strength, permeability and durability. Silica fume concrete may be appropriate in places where high abrasion resistance and low permeability are of utmost importance or where very high cohesive mixes are requiredto avoid segregation and bleeding.

Strength is the ability of concrete to last a long time without any deterioration. Concretes are subjected to weathering actions, chemical attack, abrasion etc. so the concrete must be able to resist them. The design service of most buildings vary from 25 to 30 years and some even last for over 50 to 100 years. Thus the strength is of prime importance in the life and use of concrete.

2. METHODOLOGY

- The study aims to investigate the strength related properties of concrete of M20 grade made using copper slag and addition of SILICA FUME.
- The proportions of ingredients of the control concrete of grade M20 had to be determined by mix design as per IS code.
- The specimens were casted by varying the volume fraction of silica fume from 0 to1.5%. Then the specimens were cured for 7 days and 28 days.
- The various tests such as compression test, split tensile test, and flexural tests were carried out on the specimens and analysed

3. PROPERTIES OF SILICA FUME

- Workability
- Bleeding and segregation
- Time of set
- Plastic Shrinkage
- Drying shrinkage
- Creep
- Strength charecteristic
- Permeability
- Abrasion resistance

4. APPLICATION OF SILICA FUME

- Very low permeability to chloride and water intrusion
- Extremely high electrical resistivity (20 to 100 times greater than ordinary concrete)
- Increased abrasion and impact resistance on decks, floors, overlays and vertical structures
- Superior resistance to chemical attack from chlorides, acids, nitrates and sulfates
- Compressive strengths up to 140 Mpa
- High modulus of elasticity exceeding 40,000 Mpa
- High flexural strengths up to 14 MPa
- High early strengths for fast-track construction projects and precast applications.

5. MATERIALS USED

- Cement
- Water
- Fine aggregate
- Coarse aggregate
- SILICA FUME 0.5%,1%,1.5%.

6. COMPRESSION TEST

The test is carried out using 150mm concrete cubes on a Universal testing machine or compressive testing machine.

Procedure for Compressive strength of concrete or Cube test :-

1. Place the prepared concrete mix in the steel cube mould for casting.
2. Once it sets, After 24 hours remove the concrete cube from the mould.
3. Keep the test specimens submerged underwater for stipulated time.
4. As mentioned the specimen must be kept in water for 7 or 14 or 28 days and for every 7 days the water is changed.
5. Ensure that concrete specimen must be well dried before placing it on the UTM.
6. Weight of samples is noted in order to proceed with testing and it must not be less than 8.1Kg.
7. Testing specimens are placed in the space between bearing surfaces.
8. Care must be taken to prevent the existence of any loose material or grit on the metal plates of machine or specimen block.
9. The concrete cubes are placed on bearing plate and aligned properly with the center of thrust in the testing machine plates.
10. The loading must be applied axially on specimen without any shock and increased

    at the rate of 140kg/sq cm/min. till the specimen collapse.
11. Due to the constant application of load, the specimen starts cracking at a point & final breakdown of the specimen must be noted.

7. SPLIT TENSILE TEST

Compression testing machine, two packing strips of plywood 30 cm long and 12 mm wide, moulds, tamping bar (steel bar of 16 mm diameter, 60 cm long), trowel, glass or metal plate

Preparation of Samples

1. The sample size is cylinder of diameter 15 cm and height of 30 cm. The mould used is metal with mean internal diameter of the mould is 15 cm ± 0.2 mm and the height is 30 +/- 0.1 cm. The mould should be coated with a thin film of mould oil before use to prevent adhesion of concrete.

2. Concrete is placed into the mould in layers of approximately 5 cm thickness. Each layer is compacted either by hand or by vibration. When compacting by hand, the tamping bar is utilized and the stroke of the bar shall be distributed in a uniform way. The number of strokes for each layer should not at least 30. The stroke should penetrate in to the underlying layer and the bottom layer should be rodded throughout its depth.

3. After compacting the top layer, the surface of the concrete should be finished level with the top of the mould, using a trowel and covered with a glass or metal plate to prevent evaporation of water.

4. Curing: The test specimen should be stored in a place at a temperature of 27 +/- 2 C for 24 hrs. After this period, specimens are removed from the moulds to be submerged in clean fresh water or saturated lime solution for the specified curing period (such as 7 or 28 days). The water or solution should be renewed every 7 days.

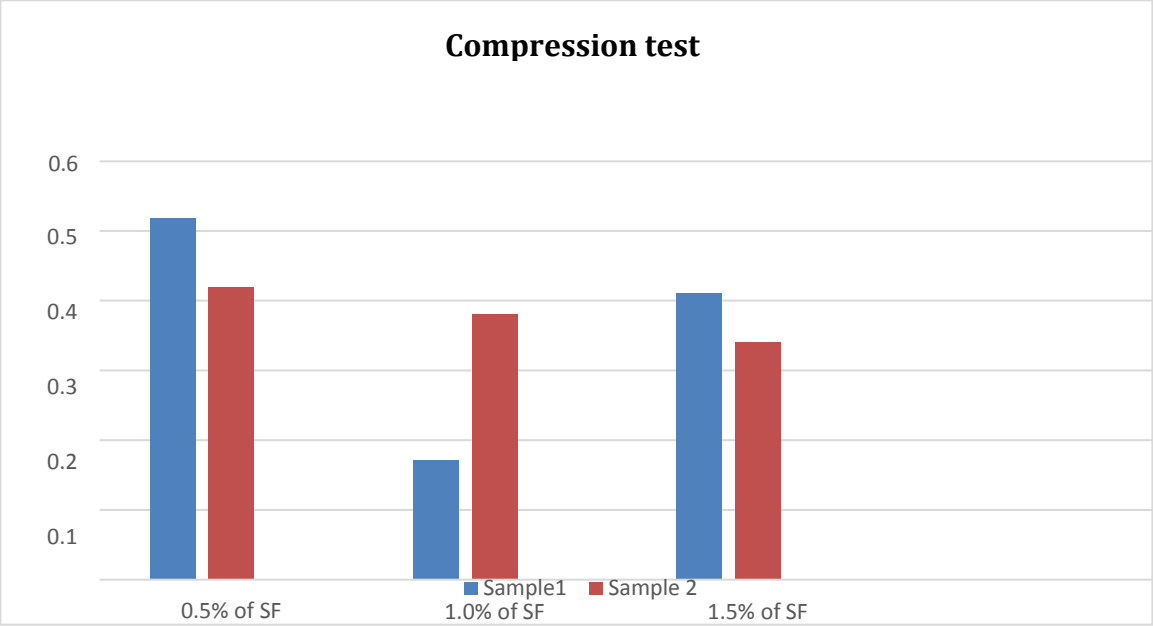
Procedure of Splitting Tensile Test:

1. After curing, wipe out water from the surface of specimen
2. Using a marker, draw diametrical lines on the two ends of the specimen to verify that they are on the same axial place.
3. Measure the dimensions of the specimen.
4. Keep the plywood strip on the lower plate and place the specimen.
5. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate.
6. Place the other plywood strip above the specimen and bring down the upper plate to touch the plywood strip.
7. Apply the load continuously without shock at a rate of approximately 14-21 kg/cm2/minute (Which corresponds to a total load of 9.9 ton/minute to 14.85 ton/minute)
8. Write the breaking load (P)

8. RESULT ANALYSIS

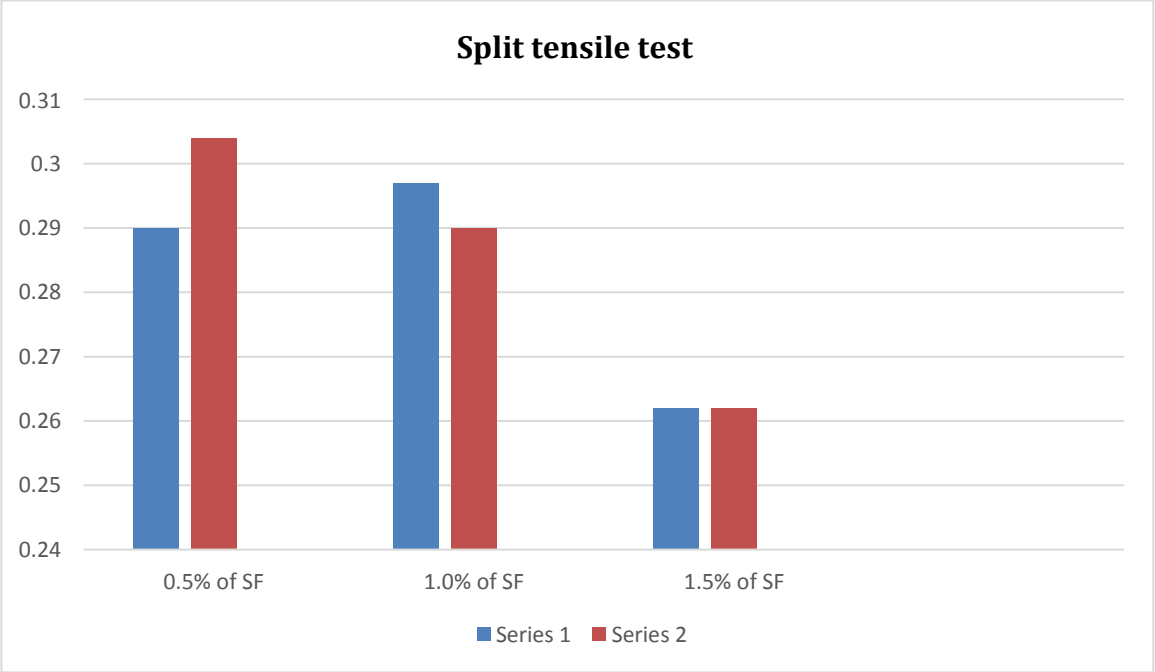
Compression test

S.no	Percentage of silica fume added	Sample 1 Compressive strength(N/cm2)	Sample 2 Compressive strength(N/cm2)
1	0.5%	0.518	0.419
2	1.0%	0.171	0.381
3	1.5%	0.411	0.340



Split tensile test

S.no	Percentage of silica fume added	Sample1 Tensile strength (N/cm2)	Sample2 Tensile Strength (N/cm2)
1	0.5%	0.290	0.304
2	1.0%	0.297	0.290
3	1.5%	0.262	0.262



9. CONCLUSIONS

- The strength and durability characteristics of concrete mixtures have been computed in the present work by replacing 0.5%, 1.0% and 1.5% silica fume with the cement.
- Compressive strength adding 0.5% silica fume in the mix, there is an increase in the strength of cube after 7 days as com pa red to concrete without replacement.
- And after 14 days and 28 days there is enormous increase in strength as compared to the control mix. By adding 1.0% silica fume, there is large amount of increase in strength after 7, 14 and 28 days respectively.
- The Compressive strength tends to increase with increase percentages of silica fume in the mix and decreases after 10% replacement.

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