# EFFECT AND OPTIMISATION OF MICRO SILICA ON HIGH GRADE STRENGTH OF CONCRETE

**Yasir Karim*, Megha Cheema[1], Neha Agarwal[2], Pooja Gothwal[3], Nirjhar Joshi[4], Manish Kumar Verma[5]**

*Assistant Professor, *Department of Civil Engineering, KIET Group of Institutions, (INDIA)*

[1,2,3,4,5] *UG Students, Department of Civil Engineering, KIET Group of Institutions, (INDIA)*

## ABSTRACT

*Concrete is one of the most important engineering material and the addition of some other materials may change the properties of concrete. With increase in trend towards the wider use of concrete for prestressed concrete and high rise buildings there is a growing demand of concrete with higher compressive strength. Mineral additions which are also known as mineral admixtures have been used with cements for many years. There are two types of materials crystalline and non-crystalline. Micro silica or silica fume is very fine non crystalline material. Silica fume is produced in electric arc furnace as a by-product of the production of elemental silicones or alloys containing silicon. It is usually a grey colored powder somewhat similar to Portland or some fly ashes silica fume is generally categorized as a supplementary cementitious material. Silica fume or micro silica was initially vied as cement replacement material and in some area it is usually used as replaced by much smaller quantity of silica fume micro silica may be used as pozzolanic admixtures. Admixture is defined as a material other than cement water and aggregate that is used as ingredient of concrete and is added to the batch immediately before or during mixing. Pozzolanic admixtures are siliceous or aluminous material which is themselves possess little or no cementitious value but will in finely divided form and in the presence of water chemically react with calcium hydroxide liberated on hydration at ordinary temperature to form compounds possessing cementitious properties. In our experiment we are going to use micro silica as an artificial pozzolans. We are going to add 0%, 5%, 10%, 15% by weight of cement in concrete.*

***Keywords: Cementitious, Concrete, Crystalline, Micro silica, Pozzolanic admixtures, Strength***

## 1. INTRODUCTION

Concrete is a most widely used building material which is a mixture of cement, sand, coarse aggregate and water. It can be used for construction of multistory buildings, dams, road pavement, tanks, offshore structures, canal lining. The process of selecting suitable ingredients of concrete and determining their relative amount with the objective of producing a concrete of the required strength durability and workability as economically as possible is termed the concrete mix design. Nowadays engineers and scientists are trying to increase the strength of concrete by adding the some other cheap and waste material as a partial replacement of cement or as a admixture fly ash, micro silica, steel slag etc. are the few examples of these types of materials. These materials are generally by-products from other industries for example fly ash is a waste product from power plants and silica fume is a by-product resulting from reduction of high purity quartz with coal or coke and wood chips in an electric arc furnace during production of silicon metal or ferrosilicon alloys. Nowadays whole world is facing a major problem of environmental pollution these materials fly ash micro silica, steel slag may become a major pollution material. Micro Silica is one of the materials used to reduce the amount of cement in concrete because of the expenses of cement but since the price of this material has increased in most of the countries it is not economical to apply it as a supersede of cement. Silica is more usual these days as an additional material to obtain special properties of concrete. Micro silica is one of the most active materials among all pozzolanic materials. We can reach to pozzolanic properties sooner in Micro silica than other pozzolanic

materials. According to its shape and size, microsilica can be used as an active fillet material in concrete. Because of high degree of pozzolanic activation, micro silica can convert useless crystallic Hydroxide Calcium to gel. It means that Micro silica combines with calcium hydroxide and converts it to stable calcium Silicate combinations. The concrete mixtures with microsilis have great adhesion, the reason is increasing the contact points of the solid particles and therefore they can be used in pumping. If microsilis is used as an additional material, it does not have harmful effect on the short term strength of concrete meanwhile it has a great effect in increasing the curing of concrete during 3- 28 days. The aim of this research is finding the optimized amount of Micro Silica in concrete.

## 2. LITERATURE REVIEW

### 2.1 EFFECTS OF SILICA FUME ON PROPERTIES OF HIGH STRENGTH CONCRETE

BY Er Aamir Ahad, Er.Kshipra Kapoor

**2.1.1 MATERIAL USED**: Cement of ultra tech of 43 grade has been used with normal consistency 33%, specific gravity 9.9, fineness of cement 5%and specific area 3250cm2/gm. Fine aggregate of grading zone 2 has been used with specific gravity 2.67, fineness modulus 3.20 Coarse aggregate of size 10 and 20 mm was used with specific gravity 1.22-1.225, chloride content is nill.

**2.1.2 CASTING OF SPECIMEN**- To determine the compressive strength standard cube of (150*150*150mm), and to determine the split tensile strength, standard cylinders of 300*300mm used. And to determine the flexure strength, standard prism (150*150*700) mm was used.

**2.1.3 CONCLUSION-** The optimum replacement of cement with silica fume 5% to 20 % leads to increase in compressive strength whereas the percentage replacement of 25% leads to decrease in compressive strength. The addition of silica fume reduces workability. However, in some cases it improves the workability. Silica fume having high fineness leads to high normal consistency. The trend in the strength gain due to SF replacement in compressive strength is almost similar to that in split tensile strength for lightweight high strength concrete. Addition of silica fume in proper proportion improves durability attack by acidic waters and improving concrete conditions. Silica fume also decrease the voids in concrete. Addition of silica fume reduces capillary. Addition of silica fume improves bond strength of concrete. Modulus of elasticity of silica fume concrete is similar to that of conventional concrete.

### 2.2 OPTIMIZE PROPERTIES OF CONCRETE WITH SILICA FUME

BY: Patil Hiteshkumar Santosh, Prof (Dr) A.K. Dwivedi, Prof (Dr) A.M.Chatterjee

**2.2.1 MATERIAL USED-** 53 grad of OPC cement, Zone II sand, 20 mm downgraded aggregate, commercial Silica Fume Grade 920-D (specific surface = 21.4, bulk density = 620 Kg/m3) have been used for various composites. Designed Mix Proportion has been used as (normal concrete) 1: 2.14: 2.65 for M25 grade concrete with the following ingredients: a) Cement = 380.9 Kg/m3, b) Sand = 817.34 Kg/ m3 c) Well graded aggregate (20mm size) = 1012.032 Kg/m3 d) Coarse aggregate / Fine aggregate ratio was 1.23 and water cement ratio was 0.43 for all mixes.

**2.2.2 CONCLUSION-** With the experimental studies conducted on concrete with silica fume the following conclusions can be drawn:

- Compressive strength, split tensile strength & Flexural Strength are directly proportional to consider percentage replacement of cement by silica fume.
- Percentage change in compressive strength, split tensile strength & Flexural strength for 15% replacement of cement with silica fume gives optimum results.
- Workability is inversely proportional to the % of silica fume.
- The use of chemical admixture is necessary for increasing workability of concrete with silica fume.

 As the increase in w/c ratio with silica fume strength of concrete decreases.

### 2.3 INFLUENCE OF SILICA FUME ON THE TENSILE STRENGTH OF CONCRETE

BY: By: S. Bhanja, Sengupta

#### 2.3.1. MATERIAL USED

The constituent materials used in the program were tested to comply with the relevant Indian Standards. To assure uniformity of supply, the materials were subjected to periodical control tests. The cement used was Ordinary Portland Cement, having a 28-day compressive strength of 54 MPa. Silica fume containing 90.9% SiO2 and having a BET specific surface area of about 18,000 m2 /kg was used. Natural river sand having a fineness modulus of 2.5 was used. The specific gravity and water absorption values were obtained as 2.65% and 0.8%, respectively. Crushed, angular, graded coarse aggregates of nominal maximum size 12.5 mm were used in the investigation. The specific gravity and the water absorption of the aggregates were 2.85& and 0.9%, respectively. Potable water and a high dosage of high range water reducing admixtures [superplasticizer (SP)] were employed for the mixing.

#### 2.3.2 CONCLUSION

Extensive experimentation was carried out to determine the isolated effect of silica fume on the tensile strength of concrete at water – binder ratios ranging from 0.26 to 0.42 and cement replacements of 0% to 30%. The following conclusions can be derived from the present investigation: 1. The results of the present investigation indicate that, other mix design parameters remaining constant, silica fume incorporation in concrete results in significant improvements in the tensile strengths of concrete, along with the compressive strengths. 2. The optimum silica fume replacement percentages for tensile strengths have been found to be a function of w/ cm ratio of the mix. The optimum 28-day split tensile strength has been obtained in the range of 5– 10% silica fume replacement level, whereas the value for flexural strength ranged from 15% to 25%. 3. Both the split and flexural tensile strengths at 28 days follow almost the same trend as the 28-day compressive strength does. Increase in split tensile strength beyond 15% silica fume replacement is almost insignificant, whereas sizeable gains in flexural tensile strength have occurred even up to 25% replacements.

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