International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 4, July-Aug-2020, ISSN (Online): 2395-566X

Evaluation of Physical and Chemical Properties Concrete Incorporating Silica Fume and Nano-Sio2

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Abstract **- Silica fume concrete (SFC) is used for concrete mixtures, which possess workability, strength, high density, low permeability and resistance to chemical attack. The addition of Silica fume (SF) has proved to improve both the compressive strength and durability of concrete. From the earlier research, they found the optimum percentage of silica fumes to replace cement is 13% which used in this work. Silica fume is one of the by-products of silicon metal (or) it also knows as silicon alloy metal factories. The silica fume was considered as the waste industrial materials. Silica fume is also called as the condensed silica fume, micro silica and Volatilized silica. Due to its very active and high pozzolanic property it became the most valuable by-product among the pozzolanic materials. It is used in the concrete to improve its properties and it also increases the compressive strength. The color of silica fume is either premium white (or) premium grey. Silica fume (SF) is generated by the silicon metal or by ferrosilicon that which producing by industry. The compressive strength of each concrete decreases water–cement material ratio increases.**

Keywords- **Silica fume, cement, Composite, physical properties, chemical properties, concrete properties.**

I.INTRODUCTION

Silica fume improves the long-term corrosion resistance and alkali silica expansion, but also increases the carbonation of depth. The silica fumes also significantly and increases the no evaporable water content of the paste and later ages due to its pozzolanic activity. The results that which indicate the optimum percentage of silica fume replacement are not constant at all the water–cement ratios but are dependent up on the water content of the mix. Silica fume has been recognized as the one of The most effective supplementary cementations materials (SCMs) that which contributes to the concrete durability that which improvement through pozzolanic reactions.

SF is one of the very fine amorphous silica powders at which produced in electric arc furnaces as the by-product of the manufacture that which alloys the silicon or elemental silicon. Silica fume is normally utilized (or) used as the substitute for cement and concrete. The basis of 28-days of curing and testing strength results of modified strength of water-cementations material and the relationships ratio have been proposed for the concrete containing cement and the supplementary cementations material in silica fume are consider.

Abrams' law mainly known as Abrams' water- cements ratio law. This law mainly deals with the strength of concrete mix and is inversely related between the mass ration of water and to cement. In the history of concrete technology in 1918 the Abrams law is the water-cement ratio law and it is the strength of concrete. The originally formulated of Abrams' law in which that conventional concrete containing cement

II. SILICA FUME SOURCE

It is very fine no crystalline silica manufactured by electric arc furnaces as a by-product of the production of metallic silicon or ferrosilicon alloys. The raw materials are coal, quartz, and woodchips [9]. The smoke that produced from furnace operation is stored and sold as silica fume rather than being land filled. As the silica fume powder particles are hundred times finer than ordinary Portland cement, there might be problems arise when deals with silica fume, such as dispensing consideration, transportation, and storage that must be taken into account.

To overcome some of these difficulties, the material is commercially divided in various forms. The difference between these forms is the size of the particle which do not significantly affect the chemical make-up or reaction of material. This difference has effect on the different purposes of use. Thus, careful consideration is needed when choosing the type of silica fume for specific application.

Table 1: Chemical composition of all three materials used

Chemical Composition	Portland Cement	Silica Fume	Fly Ash
CaO	62.8	0.58	6.95
SiO_2	21.5	92.48	46.87
Al_2O_3	6.02	0.64	26.54
Fe_2O_3	3.42	1.56	11.32
MgO	0.89	0.39	2.18
Na_2O	0.08	0.45	1.08
SO_3	3.41	0.16	1.79
K_2O	0.64	0.89	3.05
Loss on Ignition (%)	1.24	2.85	0.22

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III. LITERATURE REVIEW

Xie, J., Zhang et al (2018) presented the effect of metakaolin (as a partial replacement of portlandpozzolona cement (PPC)) on strength of steel fibre reinforced concrete. An experimental investigation was carried out to evaluate the compressive and split tensile strength of steel fibre reinforced concrete made using PPC and 1% of steel fibre. The PPC replacement (with metakaolin) level varied between 10-16% by weight of cement at an interval of 1%. M-25 referral mix at 0.46 water cement ratio was used. The cube specimen and cylinder specimen were cast and tested for determination of compressive and split tensile strength of concrete at different replacement levels. It was observed that at 12% replacement level, compressive and split tensile strength increased substantially as compared to the referral concrete

Barton, I., Matejec et al (2018) Silica fume and Metakaolin are used as partial replacement of cement, and steel fibres of aspect ratio 50 are used at 2% of total volume of concrete to investigate the strength of concrete. The properties of partially replaced cement are studied based on workability and compressive strength of concrete.

G. Nithyambigai at al (2016) reviewed on various types of pozzolonic materials viz.fly ash, silica fume, metakaolin, blast furnace slag etc. are available which has cementeous properties. Blending these materials with ordinary portland cement can improve the cementing and mechanical properties of cement. These days use of metakaolin is tremendously gaining popularity in partial replacement of cement due to its fineness in improving various strengths and parameters of mortars and concrete.

D. K. K. Priyanka A at al (2013) conducted on concrete specimens using various replacements of silica fume and metakaolin; mechanical tests such as compressive, tensile and flexural strength tests, durability tests like rapid chloride permeability test, immersion test in acid solution, repeated freezing and thawing test and accelerated carbonation test. Strength tests revealed that the most appropriate strength was obtained for a substitution rate of metakaolin to binder ranging between 10% and 15%. It was observed that the resistance to chloride ion penetration reduced significantly as the proportion of silicafume and metakaolin binders increased. The filler effect resulting from the fine powder of both binders was seen to ameliorate substantially the resistance to chemical attacks in comparison with ordinary concrete. Durability tests also verified that concrete using metakaolin bore most of the mechanical and durability characteristics exhibited by concrete using silica fume. The tests implemented in this study confirmed that metakaolin constitutes a promising material as a substitute for the cost prohibitive silica fume.

Shashikant Dewangan at al (2016) carried out experiment on M 50 grade of concrete in this concrete cement was replaced by metakolin in various percentages such as 5%, 10%, 15%, 20%, 25% concrete specimens containing metakaolin were studied for their compressive strength.

R.M.Karthikeyan et al (2017) obtain high durability and high strength concrete by replacing cement with 40% & 50% of fly ash and 10% of Silica fume & Metakaolin. As Per ACI method the various mix designs are prepared for various proportions. Respective tests are conducted. Based on the results, 50% replacement of fly ash and 10% of silica fume with cement gave better compressive strength.

Tejas P. Pawar et al (2017) investigate effect of silica fume & fiber orientation of sisal fiber on performance of concrete, which ultimately solve the problems of waste disposal & reduces global warming. Here in the experiment an attempt has been made to increase the strength of concrete by replacing cement partially with silica fume and sisal fibers at varying percentage in a design mix of M30 and M40.

IV. OBJECTIVE OF STUDY

- To study the physical and chemical properties of silicafume and Metakaolin
- The mix design for M-60 grade of concrete
- To investigate the effect of replacing cement by silicafume and Metakaolin to compare the effect of presence of the replacement material on the strength of specimens to the conventional specimens.

V. METHODOLOGY

1. Materials

- Cement
- Fine aggregate
- Coarse aggregate
- Water
- Silica fume

2. Properties of Silica Fume

2.1. Physical Properties

- More than 95% of the Silica fume (SF) particles are finer than 1mm.
- Silica fume was used initially for cement replacement, along with the water-reducing admixtures
- Silica fume is affected by the carbon content and several aspects having to do with the manufacturing process, such as the use of wood chips versus coal, wood chip composition, furnace temperature, furnace

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exhaust temperature, and the kind of product (metal alloy) being produced.

2.2. Chemical Composition

- The amorphous silicon dioxide has a very high content in silica fume and a very fine spherical particles are consists. Iron, magnesium and alkali oxides are considered as small amounts.
- Silica fume is not a crystalline material will not dissolve in concrete, which must occur before the material can react. Don't forget that there is a crystalline material in concrete that is chemically similar to silica fume. That material is sand, while sand is essentially silicon dioxide (SiO2), it does not react because of its crystalline nature.
- The silica fume based upon the metal being produced in the smelter from which is the fume was recovered. Usually these materials have no impact on the performance of silica fume in concrete.

2.3. The Advantages of Using Silica Fume Are As Follows

- Early compressive strength is high
- Tensile, flexural strength and modulus of elasticity are high
- Toughness increases
- Bond strength is high
- Durability enhanced
- Permeability to chloride and water intrusion is very low.
- Abrasion resistance increases.
- Electrical resistivity is high and permeability is low.

2.4. The Applications Of Silica Fume Are

- Repair products silica fume is used in a variety of cementations
- Silica fume is used for high-way bridges, parking deck, marine structures and bridge deck overlays containing High performance concrete (HPC)
- Silica fume for greater design flexibility enhanced with High-strength concrete
- The usage in rock stabilization, mine tunnel linings and rehabilitation of deteriorating bridge and marine columns and piles are concrete by silica-fume

2.5. Effect on Mechanical Properties

With the addition of silica fume, the slump loss with time is proportionally increased in concrete mix. Due to the high surface area of silica fume particles in the concrete mix, workability and consistency of concrete decrease [9]. These are restraints against the suitable utilisation of silica fume concrete. However, the consistency of silica fume mortar is significantly increased by either using silane treated silica fume, i.e., silica fume which has been coated by a silane coupling agent prior to incorporation in the mix, or utilising silane as an additional admixture [10].

VI. CONCLUSION

It is investigated from the experimental study that the Silica fume and Fly ash is a better replacement for cement. The strength obtained by using both these materials is higher than the traditional cement concrete. The application of silica fume in concrete mixture has significantly increased and enhanced the properties of the concrete whether it is in wet stage or in harden condition. The overall effects of silica fume on the concrete properties.

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