A literature review on study of silica fume as a partial replacement material of cement in concrete

Priyanka lohiya

Department of Civil Engineering

Galgotias University, Greater Noida ,Uttar Pradesh, India

Dr. Suprakash Biswas

Department of Civil Engineering

Galgotias University, Greater Noida ,Uttar Pradesh, India

Abstract: High-performance concrete with strength and stability can be defined as largely concrete, which is different from concrete obtained by conventional methods. The use of nanotechnology in concrete brings fresh material to its efficiency efforts. The very small size of the nanomaterial can effect the properties of the concrete by changing the microstructure. These tests have significantly improved front pressure strength and the overall concrete pressure strength. As the silica percentage increases, the strength increases. Concrete is present and future material.

Key Words: High-Performance Concrete, Silica Fume, Partial Substitution In Concrete For Conventional Materials.

I. INTRODUCTION

1.1 High performance concrete

High-performance béton is a mix of concrete that is stronger and longer than normal béton. This cement contains one or more cement ingredients such as fly-shell, silica particles, or soil-melting slag. High-performance concrete is defined as "concrete which fulfills the particular requirement for consistency and homogeneity, which cannot always be accomplished by the use of conventional materials, standard combination processes and typical healing practices." This is due to its freshness, mouldability and durability. In the last decade, concrete technology has progressed tremendously. Betons are not only a material made up of gravel, aggregates, liquids and blends, but a product with several different components. Today, concrete can cope with all unique demands under various conditions of exposure. With contemporary design, many additional properties in terms of building speed, workability features, early strength improvements, excellent resilience, tolerance to violent media and long service life are expected from concrete. High-level concrete (HPC), especially among fast-developing countries such as India, will soon be attracted by the mainstream industry. For High Performance Concrete (HPC) no specific definitions exist and for various organizations and experts, the concept of high-performance concrete is different. American concrete is a push that meets unique consistent, consistent criteria, not always met using conventional products, common mixing methodologies, and typical healing methods. The American Concrete Institute defines high-performance concrete.

1.2 Silica Fume

The American Concrete Institute , defines silica fume "as a by-product of the manufacturing of elementary, silicone or silicone-containing alloys" as "extremely thin some, crystalline silica produated in electric arc furnaces." Typically it is a gray rock, a little like asphalt in Portland or fly ash. The figure demonstrates a typical silica fumes as they emerge from a furnace.

Figure 1**:** Silica Fume

Other names are frequently referred to as silica fume. This is the name of some other silica fumes

- Smoking condensed silica
- Micro-silk.
- Silica volatilized

1.3 ChemicalPropertiesof silica fume

Table shows the primary chemical Silica fume properties. A discussion of each of these properties is provided below. The crystalline substance is insoluble in concrete, but must be dissolved before its reaction.

1.4Physical Properties of silica fume

The main physical properties of silica fume are indicated in this table. A discussion of each of these properties is provided below.

1.4.1Particlesize

Silica fumes are extremely small, with over 95% less than 1μm of particle size. For the physical and chemical contribution of silica fumes to concrete, the particle dimensions are significant.

1.4.2Bulkdensity

This is yet another unit weight term. The bulk smoke density of the formed silica fume is determined by the metal produced in the oven and the use of the oven. As the bulk density of the fume as generated is generally very small, transportation for long distances is not very economical.

1.4.3Specificgravity

This is yet another unit weight term. The bulk smoke density of the formed silica fume is determined by the metal produced in the oven and the use of the oven. As the bulk density of the fume as generated is generally very small, transportation for long distances is not very economical.

1.4.4Specificsurface

This represents the entire surface of a given material mass. The surface area is very big since the particles of silica smoke are very small. As particles decline, we know the market for sand increases; the same is true for silica fume. This is why it is critical to use silica fume with a water-reducing mixture. The exact surface of the silica fume shall be measured using a special process called BET or nitrogen adsorption process. Determination of measurable surface area on the basis of seven measurement or air permeability measurements indicates that the fume of silica is smaller.

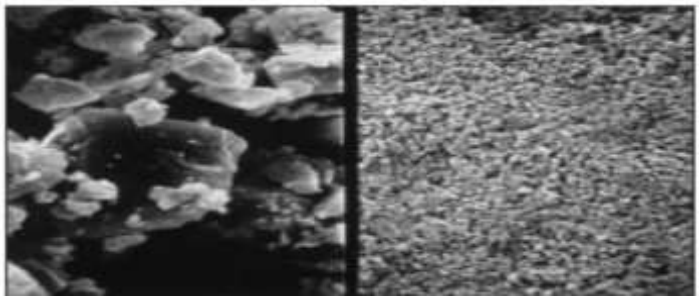

Figure 2: Photo Micrograph of Portland cement Grains and Silica Fume Particles

Form	Agglomerated
Particles Color/ Appearance	Grey
Specific Gravity	2.20
Size of particles	0.1 µ
Dosage	2 - 10 % by weight of cement
Chloride content	Nil

Figure 3: Physical Properties of Silica Fume

II. RESEARCH BACKGROUNDS

[1] Jayeshkumar, P., Zala, LB, Umrigar, FS, (2012), Partial cement substitution experiment in design of concrete mixed with fly ash. This research study discusses the viability of partial cement substitution by the thermal industry waste in concrete manufacturing. The usage of fly ash as an extra cementation ingredient in concrete formulations has been studied as an alternative to conventional concrete. Therefore, the range of fly ash used in concrete is 0% (without fly ash), the weight percentage of M-25 is 10% (weight), the weight percentage of M-40 is 20% (cement) and M-40 the weight percentage (cement) is 30%. Production of concrete mixtures, testing and comparison of compressive strength and cracking strength of conventional concrete.

[2] As partially substitute for asphalt, Mar Thong, C., (2012), Sawdust Ash (SDA). The study suggests the use of SDA in all cement grades to partially substitute cement up to a maximum of 10 percent by volume. Test findings reveal that, with the addition of SDA, the higher calcium level findings in higher expansion. Early intensity production was found to be approximately 50-60% of its 28-day strength.

[3] Embedded nanoparticles ZrO2, control of the mechanical properties in cemented composites Ali, N., Shadi, R., Shirint, R., (2010. In this study, a partial replacement of cement with Nano phase particles from ZrO2 was studied in order to detect the tense break and bending resistance along with the concrete setting time. Four different contents of 0.5%, 0.1 per cent, 1.5% and 2.0% by weight have been reported with ZrO2 nanoparticles with the average diameter of 15 nm.

[4] Mortar To Using Fly Ash, a partial replacement of cement (Moinul, I., Saiful, I., (2010)). The paper focused on the results of a research study to analyze the effect of fly ash on the hardness of mortar and on increased use of mortar of fly ash. Class F fly ash has been substituted with cement by six per cent by weight (10%, 20 %, 30%, 40 %, 50% and 60%). Also prepared as a mortar guide were Ordinary Portland Mortar (OPC).

[5] The hardness of Mortar and concrete made from the pozzolane, as a partial alternative to cement, is Hossain, M., Karim, M., Hasan, M., Hossain, M. K., (2016): a study. In current years researchers have been working to build more efficient cementing processes to mitigate harmful impacts on the atmosphere and disintegrate concrete frameworks associated with traditional Portland concrete (OPC). The most efforts to build organic binders have been done with pozzolanes including slag, fly ash (FA), ash of fuel palm-oil (POFA), methane kaolin (MK), silica fume (SF), RhA (rice husk ash).

[6] Escalante, G., Espinoza, P., Gorokhovsky, A. (2009), a comparative study of partial replacement of Portland cement and alkali-activated cement as a coarse blast furnace as concrete material The efficiency of cement to concrete is 230, 280 and 330 kg / m3 of coarse-grained slag 2900 cm2 / g. Second, the slag partly substituted Portland cement by 30 percent, 50% and 70%. The intensity declined as the quantity of slag increased;

[7] Maddalena, C., Massimiliano, F., Luca, B. (2013), Massimiliana, F., Maddalena, C., B. (2015). A hydraulic or pozzolanic waste content, used as partial substitute for a cement clinker, may lead to the hydration of the Cement paste and, after proper curing, can result in a beneficial pore structure refining [9]. Such mineral additions thereby inhibit the penetration of ionic species into the concrete and avoid the impact of embedded steel corrosion due to chlorides or concrete deterioration due to sulfate ions.

[8] Justice, J.M., Kennison, L.H., (2005), Analysis of the Two Metacaolins and Silica Fume Used as External Products in Cementation. At 8 percent, weight cement substitution measured the efficiency of two metakaolins as complementary cementation materials (SCMs). The surface areas of metakaolins differ (11.1 vs. 25.4 m2 / g). Without the use of SCM, the mixture control water / cerium ratio was controlled to 0.40, 0.30, and 0.60, and the efficacy of the meta-kaolin mixture was compared with the part using silicon fume instead of cement.

[9] Tailor, Yahya, Yahya, a. (2008), the impact on rheological properties, leakage and structural cement bonding strength. The use of SCMs in structural grooves shows that the demand for water in blends produced with Portland cement is increasing. Using binary and ternary cements, when used in well-scattered structures, results in greater fluidity, lower yield tension, higher plastic viscosity and improved tolerance to induced bleeding relative to comparison mixtures made of Portland cement.

[10] Ganesan, K., Raja gopal, K., than gavel, K., (2007), Bagasse ash assessment as additional cementation content. In this analysis, the effect of BA on the physical and mechanical properties of hardened concrete was recorded as a partial replacement for cement. The properties of the studied concrete include compressive power, resistance to tensile cracking, water absorption, permeability, chloride diffusion and resistance to chloride ions. Test results show that BA is an effective mineral mix with an optimal 20 per cent cement replacement ratio.

[11] Hanumesh, BM, Varun, B.K. (2015), "The mechanical properties of concrete vapor are used as a substitute for cement." The latest work has endeavored to use silica fume as an alternate source of cement and to evaluate the cement replacement limit for concrete grade M20. The main purpose of this research was to analyze in part as cement replacements the mechanical characteristics of M20 grade concrete control and silica fume concrete at different concentrations of silica fume (5, 10, 15 and 20 per cent).

[12] Sonali, K.G., Deotale, R.S., (2014): 'Supplementing Cement with a partly substituted GGBS & RHA and natural sand with coal quarries' In order to reduce the waste disposal problem, the concrete industry is continuously seeking additional cement material. The agricultural waste includes rice husk ash (RHA) and quarry sand (QS). A partial replacement of natural sander (NS) with quarry sand and a partial replacement of cement using GGBS and RHA could provide the economic solution for the problem. The study is done in three phases: the first mixture of M40 grade concrete, 15%, 45%, 75% by 90% and 100% by natural sandstone, which offers the optimal replacement percentage with maximum compression extreme activation.

2.1 Conclusion from literature Review

- The impact of concrete increases with the use of silica.
- Improved compressive strength improves workability of concrete by using silicon fume to improve workability.

III. SILICA FUME AS BYPRODUCT

Silica fume is a by-product of silicone or ferrosilicon alloy production. Beton is one of the most suitable solutions for silica fumes. This is made of a very volatile pozzolan with its chemical and physical properties. Silicium-containing concrete fumes can be very strong and long lasting. Silica fume is available from concrete admixture suppliers and is simply added during concrete manufacture if specified. The concrete contractor puts, finishes and heals silica-fumes concrete in particular. As this photograph shows, silicone metal and alloys are made in electric furnaces. Quartz, coal and wood chips are the raw materials. The smoke is collected and dispersed in silica fume, instead of being processed from the furnace cycle. Perhaps the most significant application is to combine concrete minerals in this material. The gases are primarily made up of the amorphous dioxide of silicium (SiO2). — Unbelievably small particle, around 1/100th of a standard cement particle size.

IV. PROPERTIES OF FRESH CONCRETE

The key and significant quality of fresh concrete is its versatility. The simplicity with which it can be compacted or worked is tangible working ability. The ability of a fresh (plastic) concrete mix to correctly and without the consistency of the concrete fill the form / mold with the necessary work is being performed. The Road Testing Laboratory, UK, which has extensive study in the fields of compactness and workability, has defined the workability as 'the property of concrete,' which defines the amount of inertial work required for complete compaction.' Another definition that has a broader significance is that it is defined as "easy to compact concrete by 100% with regard to the compactation and deposition mode." Concrete workability is a concept consisting of the following four partial concrete properties, namely mixed functionality, portability, mouldability and lightweight capability. Generally, machinability is the amount of work needed to compress concrete in a specific mold. The operability required for a particular mixture depends on the type of pressure used and the complex nature of the shield used in reinforced concrete. A functioning mix should not be separated. The functionality will depend on water content, aggregate, cement content and age and it can be modified, like super plasticizers, by adding chemical admixtures. Concrete workability is measured by:

(a) Slump testapparatus,

(b) Compaction factortest.

Slump test: a concrete slump test is an empirical test which measures fresh concrete functionality. In particular, the coherence of the concrete in this specific batch is calculated. This check is performed to verify the quality of newly constructed concrete. Coherence is a term closely associated with workability. It is a term which describes the condition of fresh concrete. The test is popular because the appliance is simple and easy to use. Sadly, the nature of the study also allows a broad variation in the manner the research is carried out. It is carried out in India according to the IS specification. The result of the stagnation test is to reduce the performance risk of the compact inverted concrete cone. The consistency or moisture of the concrete is measured.

Compaction factor check: Use a compaction factor test as per IS: 199-1959, fresh concrete pressure factor is used to evaluate the operability of fresh concrete. The device used is a factor-compacting device. Testing is carried out

- Sample of concrete is placed at the boundary in the top hopper.
- The trap door is opened so that the cement can be reached in the lower hopper.
- The lower hopper trap door is removed so that the concrete may spill through the container.
- Any concrete above the top point of the ring is then chopped off by means of flat scissors.
- Concrete measured in storage tanks. This is attributed to the weight of partially compacted concrete.
- A new concrete sample fills the container and vibrates to achieve maximum compaction. In the cylinder the concrete is weighed up again. The full compacted concrete weight is called that weight.

$$\text{Compacting factor} = \frac{\text{Weight of partially compacted concrete.}}{\text{Weight of fully compacted concrete}}$$

The higher the slump or compaction factor value, the more workable is the concrete grade and the easier.

V. CONCLUSION &FUTURE SCOPE

The review found that Silica Fume concrete exhibited less strength in its early stages, and that its strength improved. With the increase in replacements, the workability of Silica Fume concrete has decreased.If the concrete is to use Silica Fume it will prove cost-effective as it is free of usable waste.The use of Silica fume in concrete protects natural resources used in concrete production so that the building industry in concrete is sustainable.Some durability tests, such as water permeability, chlorides ion resistance, steel reinforcement corrosion, sulphate attack resistance to marine life, etc., with silica-fume, are required.The existence of alkalis that may adversely affect the relation between binder matrix and aggregate is suggested for a detailed chemical examination of the steel slag / Silica fume.

REFERENCE

[1] Jayeshkumar, P., Zala, L.B., Umrigar, F.S., (2012), experimental investigations on partial replacement of cement with fly ash in design mix concrete. International Journal of Advanced Engineering Technology E-ISSN 0976-3945.

[2] Marthong, C., (2012), Sawdust Ash (SDA) as Partial Replacement of Cement. International Journal of Engineering Research and Applications.

[3] Ali, N., Shadi, R., Shirint, R., (2010), Embedded ZrO2 nanoparticles mechanical properties monitoring in cementitious composites. Nazari, et al, ZrO2 nanoparticles in Concrete.

[4] Moinul, I., Saiful, I., (2010), Strength Behaviour of Mortar Using Fly Ash as Partial Replacement of Cement. Concrete Research Letters Vol. 1(3) 2010.

[5] Hossain, M., Karim, M. M., Hasan, M., Hossain, M. K., (2016), Durability of mortar and concrete made up of pozzolans as a partial replacement of cement: A review. Elsevier Ltd. All rights reserved.

[6] Escalante, G., Espinoza, P., Gorokhovsky, A., (2009), Coarse blast furnace slag as a cementitious material, comparative study as a partial replacement of Portland cement and as an alkali activated cement. Construction and Building Materials 23 (2009) 2511–2517.

[7] Maddalena, C., Massimiliano, F., Luca, B., (2013), Comparison of ground waste glass with other supplementary cementitious materials.

[8] Justice, J.M., Kennison, L.H., (2005), Comparison of Two Metakaolins and a Silica Fume Used as Supplementary Cementitious Materials. Article to be published in: Proc. Seventh International Symposium on Utilization of High-Strength/High.

[9] Khayat,, K.H., Yahia, A., (2008), Effect of Supplementary Cementitious Materials on Rheological Properties, Bleeding, and Strength of Structural Grout. Title no. 105-M66.

[10] Ganesan, K., Rajagopal, K., Thangavel, K., (2007), Evaluation of bagasse ash as supplementary cementitious material. Cement & Concrete Composites 29 (2007) 515–524.

[11] Hanumesh, B.M., Varun, B.K., (2015), The Mechanical Properties of Concrete Incorporating Silica Fume as Partial Replacement of Cement. ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 9, September 2015.

[12] Sonali, K.G., Deotale, R.S., (2014), "To Study the Partial Replacement of Cement by GGBS & RHA and Natural Sand by Quarry Sand In Concrete". IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).