Review the Study of Silica Fume Performance on New and Hardened Concrete Structures

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Abstract. This paper introduces a review on the use of Silica Fume (SF) as a mineral compound in concrete. Different results from several studies are shown here, with particular emphasis on new materials and wood materials when combined with Silica Fume (Micro-silica or Nano-silica). The results showed significant improvements in concrete production areas when SF was installed. The review also revealed a brief overview of SF percentage conversion in the event of standard concrete and high strength. The declining operating condition (downtime) is identified.

Where there is an increase in SF percentage conversion. It can be concluded that the optimal percentage for SF conversion lies in the range of 8-10% mainly by compression force. However, the mixing variation increases to 12-15% if you are strong and flexible concrete strength. Studies also show the effect of silk smoke on the stability parameters such as water absorption, penetration, sulfate attacks, and chloride attacks.

Keywords: Silica fume; Workability; Split tensile strength; Compressive strength; Flexure strength

1. Introduction

1.1 Background

The Silica Fume layer has high-performance pozzolanic properties while being used in concrete due to its fine particles, high surface area, and high SiO2 content. Silica fumes are heavily fined for segregation. silica obtained as a product from the industry. It is used as a composite compound and has significant effects on the structure of the emerging material.

Silica fume, also known as micro silica is an amorphous (non-crystalline) silicon polymorph

dioxide. It is an ultrafine powder collected as a product from the production of silicon and ferrosilicon alloy. It is ideal for particles of less than 1 micron and an average diameter of about 0.1 microns, about a hundred times greater than the average cement particles. Its behavior is related to the high content of amorphous silica (> 90%). Reduction of high purity quartz to silicon at temperatures up to 2,000ºC produces SiO2 vapor, which binds and thickens low temperature to small particles containing non-crystalline silica

Silica Fume was first discovered in Norway (Oslo) in 1947, during a series of extracts from fossil fuels. Most of the smoke contained a very fine powder of a high percentage of silicon dioxide. Since the 1970s, gas filtration has begun on a large scale and, in 1976, the first standard NS 3050 was introduced using silk smoke in cement produced by the factory Newman and Choo (2003). It is a high-quality material used in the cement and concrete industry. It has been reported that when an estimated fume rate of 8-10% silica by cement is applied to concrete, its effect is between particles of 50,000 to 100,000 microspheres; that is, concrete mixes will be larger and cohesive due to fine particles of silica flame (Thomas et al. 2012).

Silica Fume can be used as an additional reinforcement material to increase strength and durability associated with AASHTO M 307 or ASTM C 1240. According to the Florida Department of Transport (2004), the rate of silk cement replacement should be between 7% and 9% in the bulk of cement materials (Bhanja and Sengupta 2005). Nowadays, the use of high-performance concrete is in high demand in the construction industry. To improve strength and durability, the use of silica fume as cement replacement was found to be a suitable compound. The mechanical properties especially the compressive strength of the concrete have been investigated to obtain a large volume of silica flame retardant. Various investigators have come up with a very large number.

1.2 Production and form of silica fume

Silica fume (SF) is a product of the melting process in the silicon and ferrosilicon industry. The reduction of high purity quartz to silicon at temperatures up to 2,000ºC produces SiO2 vapors, which combine and thicken at low temperatures into smaller particles containing non-crystalline silica. Products made of silicon metal products and ferrosilicon alloys with a silicon content of 75% or more contain 85-95% non-crystalline silica. The product of ferrosilicon alloy with 50% silicon has a very low silica content and is less pozzolanic. Therefore, the SiO2 content of silica flame is related to the type of metal produced. Salume fume is also known as micro silica, condense silica fume, volatized silica, or silica dust. The American Center for Concrete (ACI) defines silk smoke as "the finest non-crystalline silica produced in electric arc furnaces as a product of the production of elemental silicon or alloys containing silicon". It is usually a gray powder, almost identical to Portland cement or some other flying ash. It can exhibit both pozzolanic and medicinal properties. Silica fume has been seen as a pozzolanic compound that is effective in improving mechanical properties on a large scale. The physical composition of silica fume Diameter is about 0.1 micron to 0.2 microns; Above 30,000 m^2 / kg and dimensions vary from 150 to 700 kg / m^3. Figure 1 shows a schematic diagram for the production of silk smoke. The silica fume is collected in very large filters in the baghouse and makes it available for use in concrete (Siddique and Khan 2011).

1.3 Physical features of silica fume

The material of fume silk depends on the type of production and the process used for its production. The powder form is 100 times smaller in particle size than in Portland cement. Silica Fume can be obtained in three forms namely, powder, condensed, and slurry. The color of the SF varies with a light black or white light due to a different production process and is influenced by some of the parameters such as chip shape. furnace temperature, the ratio of the wood to the charcoal used, the temperature finished, and the type of metal produced. Table 1 shows a brief description of the SF properties adopted by several authors.

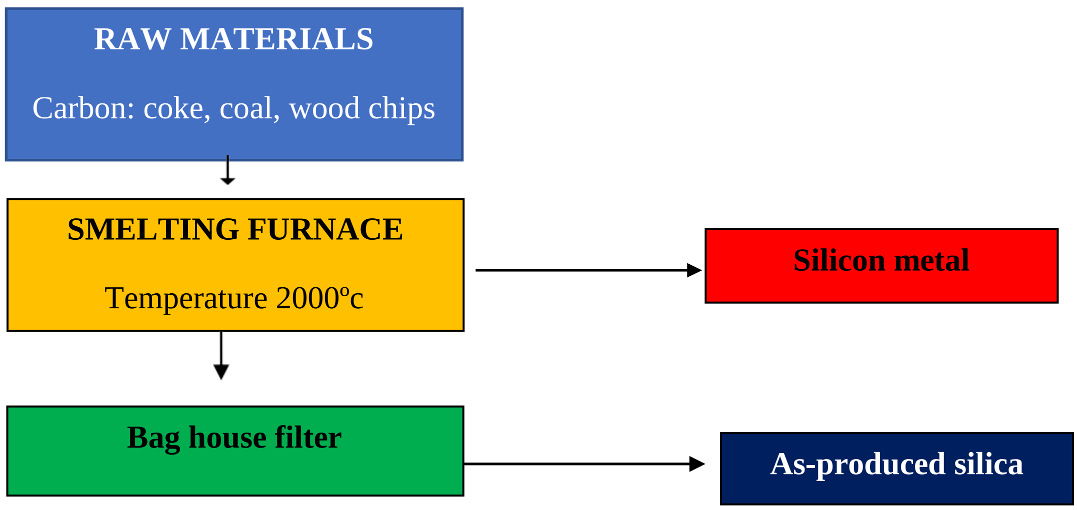

Fig. 1 Schematic diagram of silica fume production (Siddique and Khan 2011)

Table 1 Typical physical properties of silica fume

Authors \ Properties	Particle size	Bulk density (kg/m^3)	Specific gravity	Surface area (BET) (m^2/kg)
Toutanji and Bayasi (1999)	0.14 mm	225	2.3	20,000
Kumar *et al*. (2014)	-	240	2.34	20,000
Detwiler and Mehta (1989)	0.1μ	-	2.2	20,000
Mohyiddeen and Maya (2015)	1μ	576	2.2	20,000

1.4 The chemical properties of silica fume

Silica fume is produced during the high reduction of quartz temperature in an arc electric furnace where the main product is silicon or ferrosilicon. Due to the large amount of electricity required, these fumes are available in well-supplied power countries including Scandinavia, Europe, Canada, the USA, South Africa, and Australia. The chemical process is complex and depends on the production temperature. SiC was formed, initially playing important central roles. At temperatures> 1520 ° C, the reaction follows as ($SiO2 + 3C = SiC + 2CO$) but at temperatures> 1800 ° C, the reaction mode changes as ($3SiO3 + 2SiC = Si + 4SiO + 2CO$). The unstable gas is dispersed in the furnace where it reacts with oxygen to provide silicon dioxide such as ($4SiO + 2O2 = 4SiO2$). Below table 2 shows the variations in the chemical composition of several SFs accepted by several authors.

1.5 Variety of assessments accepted by several authors

Past investigators have developed cement replacement test settings for silica fume with a different replacement rate. In this paper, the parametric variations detected by different researchers for carrying out their experiments to ascertain the properties of concrete by the addition of SF have also been included. Table 3 shows a brief description of the experimental variations adopted by several authors:

Table 2 Chemical composition of silica fume samples

Authors \ Oxides	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	MgO (%)	K_2O (%)	Na_2O (%)	SO_3 (%)	LOI (%)
Sandvik and Gjorv (1992)	92.1	0.5	1.4	0.5	0.3	0.7	0.3	-	2.8
Hooton and Titherington (2004)	96.65	0.23	0.07	0.31	0.04	0.56	0.15	0.17	2.27
Fuat *et al*. (2008)	81.35	4.48	1.42	0.80	1.47	-	-	1.34	3.4
Detwiler and Mehta (1989)	96.0	0.1	0.6	0.1	0.2	0.4	0.1	-	1.7
Kumar *et al*. (2014)	90-96	0.5-3.0	0.2-0.8	0.1-0.5	0.5-1.5	0.04-0.1	0.2-0.7	0.1-2.5	0.7-2.5
Koksal *et al*. (2015)	85.35	1.42	2.39	0.80	1.47	-	-	1.34	3.4
Turkel and Altuntas (2009)	92.26	0.89	1.97	0.49	0.96	1.31	0.42	0.33	2.05
Khan *et al*. (2014)	91.4	0.09	0.04	0.93	0.78	2.41	0.39	0.01	2.0
Behnood and Ziari (2008)	91.7	1	0.9	1.68	1.8	-	0.10	0.87	2

Khater (2013)	94.92	0,02	1.28	0.03	0.01	0.15	0.28		0.02	3.28

Table 3 Experimental variations adopted by several authors

Authors	Material used	Superplasticizers type	Replacement level	w/c ratios	Concrete grade
Ajileye (2012)	OPC by QNCC, silica fume		0, 5, 10, 15, 20 25%	0.38	M30
Amudhavalli and Mathew (2012)	OPC 53 grade, silica fume (grade 920D)	CONPLAST-SP 430	0, 5, 10, 15, 20%	0.36	M35
Amarkhail (2015)	OPC, silica fume		0, 5, 10,15%	0.3	M40
Rathore and Walia (2016)	OPC 43 grade, silica fume	Shaliplast SP-431	0, 2.5, 5. 7.5, 10%	-	M55 & M60
Singh *et al.* (2016)	OPC 43, silica fume	-	0, 5, 10, 15%	-	M30
Sundararaman and Azhagarsamy (2015)	OPC 53, rice husk ash & silica fume	-	0, 5, 10, 15, 20, 25%	0.40	M20
Pradhan and Dutta (2013)	OPC 43, silica fume (grade 920D)	CONPLAST- SP 430	0, 5, 10, 15, 20%	0.50	-
Roy and Sil (2012)	OPC 53, silica fume (grade 920D)	-	0, 2.5, 5, 7.5, 10%	0.45	M20
Kumar *et al.* (2014)	OPC 53, fly ash grade C, silica fume	CONPLAST- SP 430	0, 10, 20, 30%	0.33, 0.34, 0.35, 0.36	M60
Mohyiddeen and Maya (2015)	Portland Pozzolana cement, silica fume	CONPLAST- SP 430	0, 4, 8, 12%	0.45	M30

different researchers for carrying out their experiment to ascertain the properties of concrete by the addition of SF have also been included. Table 3 shows a brief description of the experimental variations adopted by several authors:

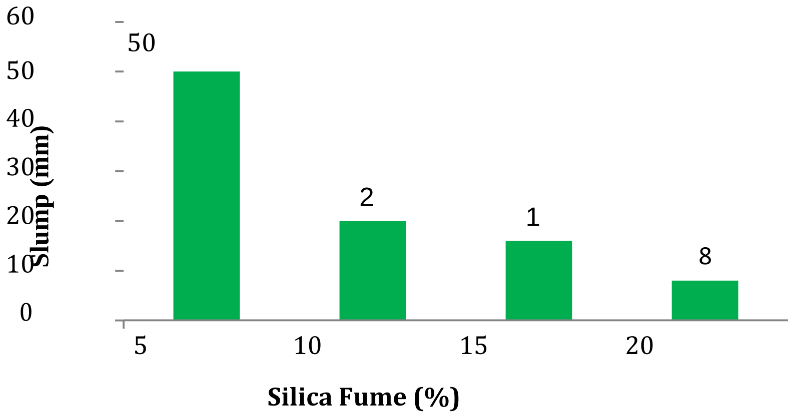

Fig. 2 Slump values for different replacement levels of silica fume (Amarkhail 2011)

2. Features of Fresh concrete

2.1 Effect of silica fume on workability of concrete

Another study was conducted to test the properties of new concrete with a different degree of silica flame retardant. This new concrete property has been tested by several authors and some of the findings are described here in this study. Kadri and Dual (1998) identified an increasing tendency to operate within a range of 5–6% when cement was replaced by a 10% silica fume component and Khayat et al. (1997) found a decrease in loss of 15 to 20 mm when cement was replaced by 7.5% silica fume.

His discovery was largely sponsored by Yogendra et al. (1987) which in his research also proved a declining trend in performance when the rate of silica flame transfer was increased. In addition researchers such as Ramakrishnan and Srinivasan (1982), Nader (2007), Srivastava (2012) conducted a study of cement mortar replacement and reported that the performance of new concrete decreases with increasing percentages of silica fume and other rare cases improve usability with Mohyiddeen and Maya (2015). an increasing tendency to work on concrete when the percentage of copper slag increases and the performance of concrete decreases as the percentage of silica fume increases. It can be concluded that the decrease in silica fume activity is due to the high surface area of the silica fume and the increase in the working of copper slag is due to the low water absorption.

Amarkhail (2015) found that the performance of the new concrete was low due to the low water content/cement (w / c = 0.3). He noted that up to 10% of cement can be replaced by silica fume without damaging the performance of the concrete. Figure 2 shows the difference in slump values and the statistical percentage of SF.

Wong and Razak (2005) studied the new composite concrete structures by adopting three different w / c ratings of 0.27, 0.30, and 0.33. For each w / c ratio, cement is replaced with 0, 5, 10 and 15% silica flame. Table 3 shows the Slump variation with varying degrees of change in a particular w / c ratio. It is concluded in the study that the large variability in usability in all mixtures is due to the standard plasticizer used for compounds with the same w / c ratio.

Table 3 Slump values for different w/c ratios and silica fume replacement Wong and Razak (2005)

Mixture	W/C ratios	Slump (mm)	W/C ratio	Slump (mm)	W/C ratio	Slump (mm)
Control	0.27	165	0.30	225	0.33	240
SF 5%		100		215		180
SF10%		50		117		100
SF 15%		35		30		35

3. Features of reinforced concrete

3.1 Effect of silica fume on compressive strength

Numerous studies have been performed to improve the compression strength of concrete by different percentages of silica flame variability. Perumal and Sundararajan (2004) examined the effect of silk smoke on high-performance concrete or high-strength concrete and tested the concrete marks of M60, M70, and M110 mixing a

d investigated the achievement of high levels of cement silica replacement. The compressive strength of these concrete distances has been preferred for 28 days and the optimal return value of the silica flame was found to be 10%. In addition, Hanumesh et al. (2015) investigated the mechanical properties of silica smoke incorporators as partial replacement of cement (5, 10, 15, and 20%) for a distance of M 20 of concrete. The result shows that the extremely dense strength of concrete is obtained from 10% of the

silica fume combinations which can be described as a large volume. However, a declining trend in compression strength is observed when the replacement rate exceeds 10%. From 10% there is a decrease in pressure. On the other hand, Katkhuda et al. (2009) investigated the effect of the addition of silica fume on high-strength light concrete. They replaced the silica fume with 5, 10, 15, 20, and 25% with a w / c ratio ranging from 0.26 to
0.42. They reported high compression strengths of various w / c ratios such as 0.26, 0.30 & 0.34, 0.38 and 0.42 61.75 N / mm2 at 15% SF instead and 56.23 & 52 N / mm2 at 20% SF and 46.15 and 40.95 N / mm2 in 25% SF are included respectively. In addition to this, Ismeik (2009) has made an impact of mineral bonding on high-strength concrete plant structures made of locally available materials. Accepted different SF replacement rates such as 5, 7.5, 10, 12.5, and 15% for three different values w / c (0.30, 0.35 & 0.40). He noted that the maximum amount of compressive strength was obtained as 50 N / mm2 in 28 days when the total silica flame change was 10% at 0.30 w / c ratio while the minimum compressive strength was obtained as 37 N / mm2 at 0.40 w /. c average. Similarly, Amudhavalli and Matthew (2012) also investigated the effect of silica smoke on concrete strength by a w / c ratio of 0.36 and the rate of silica flame retardation taken as 5, 10, 15, and 20%.

The maximum compression strength for 7 days and 28 days is 38.3 & 47.3 Mpa respectively and the correct concentration of silica fume rate was observed at 15%.

Kumar and Dhaka (2016) worked to replace cement with silica and its effects on M35 concrete mixing structures at different levels of silica fume by 5, 9, 12, and 15% by weight of cement. The absolute percentage change of SF was found to be 12% when the maximum compressive strength was obtained. The maximum force for 7 days and 28 days was obtained as 30.95 N / mm2 & 46.14 N / mm2 respectively. In addition, Ajileye (2012) also investigated the effect of SF on concrete structures by accepting 5, 10, 15, 20, and 25% switching rates for 0.38 w / c of M30 mixtures. It also showed an increasing tendency for compressive strength up to 10% of SF variance. On the other hand, a clear statement reported by ACI Committee 226 (1987) that a significant contribution of silk smoke to the development of concrete at normal therapeutic temperatures occurs in approximately 3 to 28 days. It is also reported that mixing seems to work better than pozzolan than fly ash. In addition, several studies have been conducted to evaluate the effect of SF in mixing concrete materials by Mohyiddeen and Maya (2015), Menon et al. (2013), and Mazloom et al. (2004). Figure 3 shows the combined effect of different researchers on the compressive strength of the concrete at a different level of SF variation for 7 days and 28 days oftreatment.

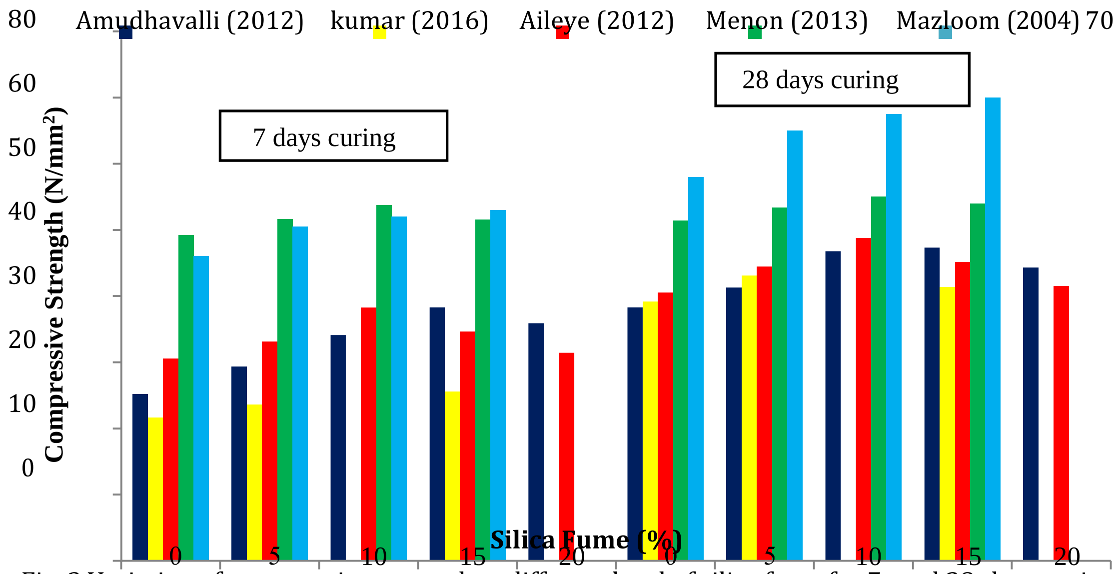

Fig. 3 Variation of compressive strength at different level of silica fume for 7- and 28-days curing

3.2 Effect of silica fume on split tensile strength

Numerous studies have been conducted to evaluate the effectiveness of concrete in terms of strength divided by percentage variations in silica fume conversion. Hanumesh et al. (2015) identified concrete

machine structures by incorporating Silica Fume as cement substitutes (5, 10, 15, and 20%). They confirmed the increasing tendency for the separated strength of the metal by the use of silica flame up to 10% of the cement mortar overhead when the solid strength was reduced. The appropriate percentage of silica cement substitution was found to be 10% in the M20 range of concrete. However, Sasikumar and Tamilvanan (2016) conducted experimental studies by accepting the SF variation rate of up to 50% in the M 30-degree range of concrete. They found the right percentage of silica smoke at 25% to get the maximum separation power for 7 and 28 days of treatment. In addition, Katkhuda et al. (2009) investigated the effect of silica fume on high- strength concrete by incorporating 5, 10, 15, 20, and 25% SF with w / c ratios varying from 0.26 to
0.42. They reported that a large percentage would be 15%with ratings of 0.26 and 0.30 w / c where the correct accuracy of 20% is found in the 0.34, 0.38, and 0.42 w / c ratios.

Menon et al. (2013) investigated the effect of silica fume on new and complex structures of fly ash-based self-compacting concrete geopolymer concrete (SCGC). They focused on concrete mixes with a water content of water-to-geopolymer solid (W / Gs) of 0.33 in size and a total binder content of 400 kg / m3. The heavy particles of fume fighters that replaced the fly ash in this study were 5, 10, and 15%. They obtained a maximum separation power of 4.40 & 4.67 N / mm2 in 7 and 28 days of treatment respectively at a maximum rate of 10% silica fume conversion. Numerous studies have been conducted by Amudhavalli and Matthew (2012) and Kumar and Dhaka (2016) to evaluate the effect of SF substitution on power separation by using different parameters in their experimental studies such as w / c ratios, treatment years, percentage of SF variation and different concrete marks. Figure 4 shows the combined results of the various investigators on the strength of the concrete at a different level of SF transition for 7 days and 28 years of treatment.

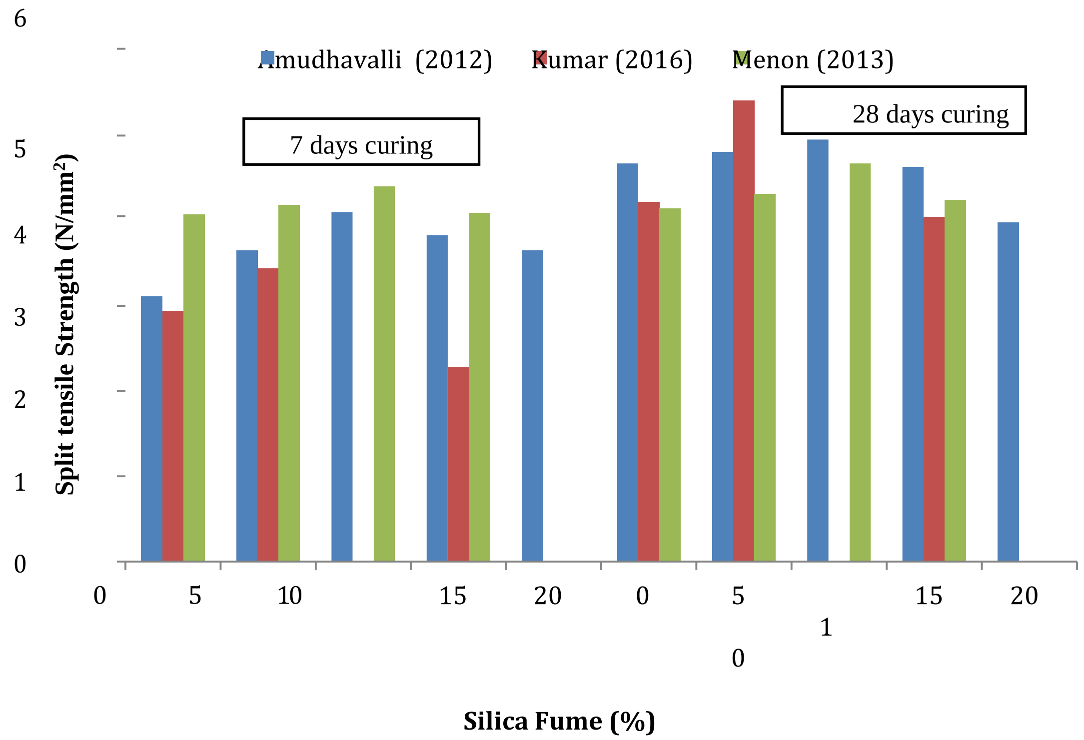

Fig. 4 Variation of split tensile strength at different level of silica fume for 7- and 28-days curing

3.3 Effect of silica fume on flexure strength

Previous studies show a clear limitation of the silica fume volume in improving the flexibility of concrete. Other findings on improving flexure strength have been demonstrated in this study to substantiate the above statement.

Katkhuda et al. (2009) replaced SF by 5, 10, 15, 20, and 25% with a w / c ratio that varied from 0.26 to 0.42 28 days of treatment. A large percentage of high flexural strength was found to be 15% w / c 0.26, 20% w

/ c 0.30 & 0.34 and 25% w / c 0.38 & 0.42. Similarly, Ismeik (2009) also investigated the effect of SF mineral admixtures (in variations of 5, 7.5, 10, 12.5, and 15%) on high-strength concrete plant structures of different w / c concentrations (0.30, 0.35 & 0.40). We found the maximum flexural strength to be 10 N / mm2 at 28 days when the total silica flame change was 15% by 0.30 w / c ratio and the minimum flexural strength was obtained as 6.6 N / mm2 at 0.40 w / c average. He also concluded that flexure strength tends to increase by decreasing w / c ratios for each percentage of silica flame variability.

Amudhavalli and Matthew (2012), Amarkhail (2015) received similar differences in SF replacement level i.e., 5, 10, 15, 20% for 7 and 28 days of treatment time at different w / c intervals as 0.36 and 0.30 respectively. Both have experienced a 15% increase in the positive change of Silica Fume.

On the other hand, Roy and Sil (2012) studied the effect of cement replacement of solid concrete and found that the flexibility increased by about 39% and 21% in that of conventional concrete when 10% cement was replaced by SF.

Similarly, Kumar and Dhaka (2016) also investigated the conversion of cement by silica by 5, 9, 12 and 15% by weight of cement for 7 and 28 days are here. The maximum flexural strength was obtained at 12% instead of the silica flame.

In addition, Mohyiddeen and Maya (2015) also work with the effect of silk smoke on concrete containing copper slag as a good M30 grade concrete mixer with a silica variant of silica fume of 4, 8, and 12% and a good composite mixed with slag copper at 20, 40 and 60%. They tested the flexural strength for various concrete mixes for 28 days and found a maximum amount of flexural strength such as 7.5 N / mm2 at the appropriate conversion rate of 8% fumed silica and 40% copper slag. In addition to this, Menon et al. (2013) investigated the impact of silk smoke on new and complex fly ash-based self-compacting geopolymer concrete (SCGC).

They found an increase in flexural strength up to 4.29 and 4.56 N / mm2 at 7 and 28 days respectively with a 10% rate of silk smoke conversion as a positive percentage. Figure 5 shows the combined effect of the various investigators with the flexible strength of the concrete at a different level of SF variation for 7 days and 28 years of treatment.

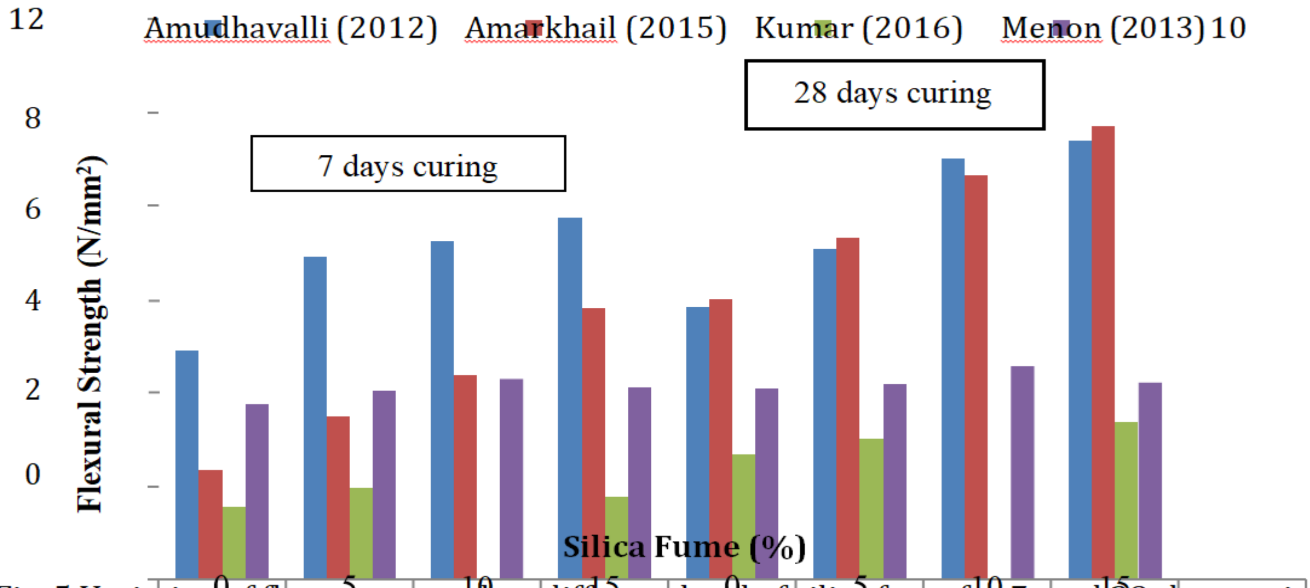

Fig. 5 Variation of flexure strength at different level of silica fume for 7- and 28-days curing

3.4 Effect of silica fume on durability parameters

Separate research has been done to test the strength of concrete when combined with Silica Fume. This section looks at the overall results of the research findings with the parameters of the strength of Silica Fume concrete. In a similar line, authors such as Ramakrishnan and Srinivasan (1982), Song et al. (2010) reported the importance of Silica Fume concrete mixing about its absorption efficiency found below that of ordinary concrete (e.g., OPC). This has shown that silica fume concrete decreases with a slope which makes concrete difficult to penetrate as by inserting silk thread with cement, it creates a small concrete block formation. It has also been found that the penetration of concrete has been significantly reduced as the rate of silica flame retard ability exceeds 8 to 12%.

However, if this input is more than 12%, the penetration capacity is very good and, in some cases, increases the water level and the binding. They also saw a reduction in penetration with an increase in the quality of Silica Fume. Similarly, Diaz and Delvasta (2005) and Shekarchi et al. (2009) reported that the incorporation of silica fume improves the absorption of water from cement structures in Portland due to the reduction of incoming spaces.

It is known that the coefficient of capillary absorption is reduced by the insertion of a pozzolanic material into the cementitious matrix.

The effect is most evident in the case of silica fume. It is also reported that the addition of silica fume has delayed the action of the chloride ion causing the deterioration of the protective film around the metal-reinforced steel deposits in the mud. Shekarchi et al. (2009) concluded that the incorporation of 7.5% silica flame led to a significant reduction in chloride dispersion in concrete. However, an increase in silica vapor content from 7.5 to 12.5%, showed a small impact on the penetration reduction.

In the same book, Gjorve (1995) reported that condensed silk thread significantly increased resistance to chloride infiltration. Altering up to 9% of the silica fume in high concrete can reduce chloride variability by about five. He concluded that if well-distributed silica vapor was combined with low water content, it would appear that concrete structures with good performance could be constructed even in the presence of violent and hostile environments. Moreover, Khayat et al. (1997) reported that the rapid penetration of chloride ion concrete by silica-fumed concrete was four to five times lower than OPC transfer concrete. Similarly, Chung et al. (2010), Elahi et al. (2010) also calculated the increased performance of the combined concrete resistance in dealing with the diffusion of chloride ions due to the release of chloride ions from the C-SH layers and the better microstructure formation by the pozzolanic reaction. It has been reported by ACI Committee-234, (2000) that the use of silica fume will produce less resistant concrete, but concrete will be smaller in volume per unit. The committee also hopes that the low availability of silica fume concrete and the corresponding development of long-term durability will provide one of the most important developments in the concrete construction industry. On the other hand, Lee et al. (2005) observed the use of silica fume with a positive effect by controlling the energy loss of the OPC matrix due to its pozzolanic reaction and subsequent reduction of calcium hydroxide, when employed in the sodium sulfate environment. The silica fume matrix does not easily allow the saturation and diffusion of sulfate ions from the sodium sulfate solution.

4. Conclusions

According to the review, it is clear that a combination of admixtures such as Silica Fume has efficient mixing materials to provide good quality concrete. A common standard finish can be drawn from new reinforced concrete structures.

A. Silica Fume is considered to be the most efficient pozzolanic tool that provides extended concrete mixing due to its high modulus that produces the required amount of water to maintain the required performance. However, the need for water can be removed by using a plasticizer. The performance of concrete with Silica Fume depends largely on the particle size, surface area, particle composition, and degree of replacement. In general, it is small in particle size and raises the area of mineral mixing, and increases the water requirements of the concrete. The performance of the new concrete is reduced by an increase in the percentage of silica flame.

III. The compression strength of the concrete increases with an increase in the conversion rate of the Silica Fume at a rate of 8-12% below with no significant change in compression strength. Instead, a decrease in the influence of the compression force is expected if the replacement level exceeds 12%. Also, it is found that the compressive strength decreases with the increase of the w/c rate followed by an increase in Silica Fume substitution.

IV. The strength divided by the strength of the concrete indicates an increasing trend up to a limit of 10-15%. It can be said that the strength of the solid separation decreased with the increase of the w / c ratio followed by an increase in Silica Fume exchange. However, the same trend is observed in the event of volatility in the conversion range of 10-15%.

Boundaries of V. Sturities such as water absorption, energy penetration, sulfate attack, and resistance to chloride infiltration are higher in the case of concrete combined with silica fume compared to conventional OPC concrete.

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References

1) ACI 226 (1987), "Silica Fume in Concrete", ACI Mater. UJ., 158-166.

2) ACI 234R-96 (2000), "Guide to the Use of Silica Fume Concrete", Manual of Concrete Practice, American Concrete Institute, 1-51.

3) Ajileye, F.V. (2012), "Investigations on micro-silica (fumed silica) as a partial cement installation in concrete", Global J. Res. Eng. Community Building. Eng., 12 (1), 17-23.

4) Amarkhail, N. (2015), "Effect of silica fume on high-strength concrete structures", Int. J. Technology. Res. Appl., 32, 13-19.

5) Amudhavall, N.K., and Matthew, J. (2012), "Effect of silica fume on the strength and strength limits of concrete", Int. J. Eng. Science. Emerg. Technol., 3 (1), 28-35.

6) Anilkumar, P.M., Raghavendra, M. and Sudhakumar, J. (2014), "Effects of Silica fume and fly ash with high durability of high-performance concrete", Int. J. Emerg. Technol. Adv. Eng., 4 (10), 298-303.

7) Behnood, A. and Ziari, H. (2008), "Effects of the addition of silica fume and water in the cement scale in areas of high-strength concrete after exposure to high temperatures", Cement Concrete Compos.