International Journal For Technological Research In Engineering
Volume 5, Issue 10, June-2018 ISSN (Online): 2347 - 4718

BEHAVIOUR OF SILICA FUMES ON REINFORCED CONCRETE COLUMNS

Iyellapogu Amar Prasad[1], Ch.Venkata Ramana[2], K.Hajarath[3]
[1]M.Tech Student, [2]Associate Professor,
[1,2]Department of Civil Engineering Rise Krishna Sai Prakasam Group of Institutions Ongole
[3]Assistant Professor Anurag group of Institutions Department of Civil Engineering Venkatapur Hyderabad

Abstract: The purpose of this experimental investigation is to study the behaviour of short columns produced from Silica fume concrete (SFC). In this investigation SFC was manufactured by usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixtures such as Silica Fume (SF) at various replacement levels. When coarse aggregate and fine aggregate ratio (ca/fa ratio) of the mix is varied and various percentage replacement of cement with silica fumes in the concrete. The percentage of silica fume varied are0%, 11%,13%,15%, and 17% as equal replacement of ordinary Portland cement. The water binder ratio (w/b) adopted is 0.42 and 0.50. The ca / fa ratios range from 1.50 to 1.75. After demoulding, the concrete specimens from each mix will be moist cured in water for 28 days. The compressive and tensile strength will be determined after each curing period. Five mixes M1 to M5 are cast with 0%, 11%, 13, 15%, and 17% replacement of SF to study the mechanical properties such as compressive strength of concrete at 28 days. Totally 5 columns were cast for mixes M1 to M5. The column specimens were tested in 500kN loading frame at 28 days.
Keywords: silica fume, replacement of cement, w/c ratio, column failure pattern

I. INTRODUCTION

Silica fume (SF) is a by-product derived from production of elemental silicon or alloys containing silicon and consists of a non-crystalline silica dust formed during oxidation of SiO vapor, which is primarily collected in bag house filters of electric arc furnaces. Silica fume consists of the fine particles with specific surface about six times of cement because its particles are very finer than cement particles. Hence, it has been found that when silica fume mixes with concrete the minute pore spaces decreases. Silica fume is pozzolanic, because it is reactive, like volcanic ash. Its effects are relate to the strength, modulus, ductility, sound absorption, vibration damping capacity, abrasion resistance, air void content, bonding strength With reinforcing steel, shrinkage, permeability, chemical attack resistance, alkali-silica reactivity reduction, creep rate, corrosion resistance of embedded steel reinforcement. In this investigation concrete is manufactured by usual ingredients cement; fine aggregate, coarse aggregate, water and mineral admixtures such as Silica fumes (SF) at various replacement levels. The study is to investigate the effects of binder systems containing different levels of silica fumes on time-dependent behavior of reinforced concrete columns. The total strain of concrete columns decreases at higher silica fumes replacement levels.

Silica fume concrete (SFC) is used for concrete mixtures, which possess workability, strength, and high modulus of elasticity, high density, high dimensional stability, 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. Also the presence of this admixture has been shown effective in increasing the electrical resistivity and the durability of concrete exposed to aggressive conditions like chloride containing environments. The Silica fume can produce both chemical and physical effects, which cause meaningful changes in the microstructure of concrete, diminishing its permeability and improving its strength. It has been shown that the physical effect of Silica fume, at 7 days, has an influence on compressive strength. At 28days, both chemical and physical effects are significant. One of the most important characteristics of Silica fume in this application is its small particle size, which is much smaller than anhydrous cement particles, with sizes of approximately 0.1–0.5 μ m and specific surface area of approximately 20000 m²-kg. Strength concrete refers to concrete that has a uniaxial compressive strength greater than the normal strength concrete obtained in a particular region. Strength concrete means good abrasion, impact and cavitations resistance. Using strength concrete in structures today would result in economic advantages. A scanning electron microscope (SEM) analysis of 16 years old concrete with addition of Silica fume shows that the microstructure of this material is more homogeneous and dense than the concrete without Silica fume. The high porosity of the matrix of the concrete without addition of Silica fume explains its lower strength and higher permeability to chloride ions. The study is to investigate the effects of binder systems containing different levels of silica fumes on time-dependent behavior of reinforced concrete columns. The total strain of concrete columns decreases at higher silica fumes replacement levels. Percentages of silica fumes that replace cement in this research are: 0%, 11%, 13%, 15%, and 17%. The water binder ratio (w/b) adopted is 0.42 and 0.50.Material like cement, fine aggregate, coarse aggregate, water and mineral admixtures such as Silica fumes (SF) will be tested in the laboratory and Concrete Mix Proportioned using IS 10262:2009.Cubes casted in laboratory at different proportions and then Testing done. And the columns are casted and tested.

A.Scope
Silica fume improves the properties of fresh and hardened concrete and fresh concrete made with silica fume is more cohesive and also Silica fume reduces segregation and bleeding. Lack of bleeding allows a more efficient finishing process and also Silica fume improves the durability of concrete.

B.Objectives
The main objective of the present investigation is to study the behaviour of reinforced concrete columns (replacement of cement with silica fume). Silica fume used as a partial replacement of cement is used to achieve require workability and to find out the ultimate load carrying capacity of short columns for the axial compression. To determine properties such as Stiffness and Compressive strength indices for silica fume concrete short columns. carry axial load deformation characteristics and evaluation of ductility parameters of Short column.

C.Literature Review
Safwan Khedr (1989)
The author has investigated the characteristics of silica fumes concrete. Proper introduction of silica fumes in concrete improves both the mechanical and durability characteristics of the concrete. The paper presents on results of research effort conducted at the American University in Cairo using Egyptian silica fumes in concrete. The program investigated various characteristics of silica-fumes concrete. The experimental program comprised six levels of silica-fumes contents (as partial replacement of cement by weight) at 0% (control mix), 5%, 10%, 15%, 20%, and 25%, with and without super plasticizer. It also included two mixes with 15% silica fumes added to cement in normal concrete. It was found that there was an optimal value of silica-fumes content at which concrete strength improved significantly. Due to the slow development of pozzolanic effect, there was a drop in early strength up to seven days and late significant gains up to 56 days upon introducing silica fumes to concrete. Elastic modulus, toughness, and steel-concrete bond increased at the optimum silica-fumes content in concrete. Results indicated general superior performance of silica-fumes concrete. Compressive strength of silica-fumes concrete is significantly improved up to 56 days.

Arnon Bentur (1989)
The author has carried out research on curing effects, strength and physical properties of high strength silica fume concrete. The physical properties of high strength silica fume concretes and their sensitivity to curing procedures are evaluated and compared with reference Portland cement concretes. The effects of poor curing procedures on the strength, and the skin properties, were found to be equally detrimental in the reference and in the silica fume concretes. The result presence of SF in a marked increase in strength, especially at 28 days, but also at 1day.The effects of poor curing procedures on the strength and skin properties of concretes were found to be equally detrimental in the reference and in the silica fume concretes.

Aitcin et al (1990)
The authors have presented on Long-Term compressive strength of silica-fume concrete Moreover, the compressive strength results obtained on concrete cores taken after a 4-year period from an experimental column built with a very high-strength concrete also confirmed that there was no tendency for strength loss in silica-fume concretes. From the results obtained on the seven field concretes under study, it is evident that silica-fume concrete exposed for 4-6 years to severe environmental conditions behaved as satisfactorily as the corresponding concrete without silica fume. No strength losses were noticed as in the case of a very high-strength concrete (85.4 MPa at 28 days) cast 4 years ago. It is interesting to note that, after 4 - 6 years of field exposure, these field concretes exhibit very low chloride-ion permeability, almost in the range of latex-modified concrete, or polymer-impregnated concrete.

Wolsiefer et al (1991)
The authors have investigated the Silica Fume Concrete solution to steel reinforcement corrosion in concrete .The paper discusses the utilization of silica fume concrete admixture to prevent reinforcing steel corrosion. Permeability, corrosion, electrical resistivity tests were conducted on 12% silica fume in reinforced concrete. Test results showed that silica fume admixture prevents salt induced corrosion of steel rebar. The extremely low chloride permeability and the very high electrical resistivity characteristics of silica fume concretes are extremely important factors in the prevention of micro and macro corrosion cells in steel reinforced concrete structures.

Roland Bleszynski (2002)
The author has carried out investigation on the durability of Ternary blend concrete with Silica Fume and Blast-Furnace slag. It is a Laboratory and outdoor exposure site studies. The paper describes project in detail and presents field observations and laboratory findings up to 2 years. Significant expansion due to alkali-silica reaction has occurred in the concrete made with high-alkali. The results of laboratory scaling tests indicated that the concretes produced with blended cement had inferior performance compared with plain Portland cement concrete, especially at higher levels of slag. The incorporation of blast-furnace slag into SF concrete reduces the water demand.

Dotto (2004)
The author has investigation on influence of silica fume addition on concretes physical properties and corrosion behaviour of reinforcement bars.The addition of silica fume (SF) in concretes improves their performance in resisting concrete reinforcement corrosion. With the purpose of evaluating the effect of different SF additions (0%, 6% and 12%). Concretes with different water–binder ratio (cement+SF) 0.50, 0.65 and 0.80 were used. The results have allowed showing that there are significant improvements of the concrete properties with the SF addition, suggesting its use in aggressive environments. This addition of SF can be effectively used in protecting steel

reinforcement against corrosion. The time to corrosion onset of reinforcement steel in concrete contaminated by chloride is greater in Silica Fume containing concretes than in plain concrete specimens. This time seems to be more dependent on the physical characteristics (porosity, resistivity, addition) than on the chemistry of the concrete pore solution.

Bhikshma et al (2009)
The authors have carried out an experimental investigation on properties of high strength silica fume concrete. The mechanical properties of high-strength concrete of grades M40 and M50, at 28 days characteristic strength with different replacement levels of cement with silica fume or micro silica of grade 920-D. Standard cubes (150mm x 150mm x 150mm), standard cylinders (150mm diameter x 300mm height) and standard prisms (100mm x 100mm x500mm) were considered in the investigation. In all 144 specimens were cast with and without silica fume. The mechanical properties viz., compressive strength, flexural strength and splitting tensile strength, and stress-strain characteristics of high strength concrete with various replacement of silica fume viz., 3%, 6%, 9%, 12% and 15%, has been considered. The use of waste material like silica fume improved the mechanical properties of high strength concrete which is otherwise hazardous to the environment and thus may be used as a partial replacement of cement. It is observed that the compressive strength, splitting tensile strength and flexural strength of M40 grade concrete is increased by 16.37%, 36.06% and 16.40% respectively, and for M50 grade concrete 20.20%, 20.63% and 15.61% respectively over controlled concrete. The maximum replacement level of silica fume is 12% for M40 and M50 grades of concrete.

Hooton (2009)
The author has investigation on influence of silica fume on chloride resistance of concrete the purpose of the study was to study the influence of silica fume on strength development and chloride penetration resistance of concrete using a variety of test procedures and examine whether silica fume could reduce the need for steam curing. In this a series of concrete slabs were cast with 0, 7, and 12% by mass silica fume replacement of cement at W/CM = 0.35, 0.40, and 0.45. After either moist or steam curing, a variety of chloride resistance tests were performed. Results indicate that the use of properly dispersed silica fume results in far more dramatic reduction in chloride penetration, by all test methods, than doe's reduction in W/CM from 0.45 to 0.35. In general, the AASHTO T277 rapid index test provides a good indication of the reduction in chloride diffusion coefficients.7% silica fume provides an improvement in chloride penetration resistance regardless of the test procedure used.

Katkhuda et al (2009)
The authors have investigated the influence of silica fume on high strength light weight concrete. It is to determine the isolated effect of silica fume on tensile, compressive and flexure strengths on high strength light weight concrete. The silica fume was replaced by 0%, 5%, 10%, 15%, 20% and 25% for a water-binder ratio's ranging from 0.26 to 0.42. For all mixes, split tensile, compressive and flexure strengths were determined at 28 days. Based on the results, a relationship between split tensile, compressive and flexure strengths of silica fume concrete was developed using statistical methods. The optimum silica fume (SF) replacement percentages for obtaining maximum 28 day compressive and flexure strengths of lightweight high strength concrete ranges from 15% to 25% depending on the w/c ratio of the mix. The optimum percentage of SF replacement increases with the increase of w/c ratio. The percentage is almost a unique for tensile strength where it is noted 15% for w/c 0.26 and 0.30, and 20% for w/c 0.34, 0.38 and 0.42.

Muthupriya et al (2011)
The authors have investigation on high performance reinforced concrete column with silica fumes and fly ash as admixtures. High performance concrete was manufactured by usual ingredients such as cement, fine aggregate, coarse aggregate, water and mineral admixtures such as Silica fumes (SF) and Fly ash at various replacement levels and the Super Plasticizer used was CERAPLAST-300. The water binder ratio (w/b) adopted is 0.30. Specimens such as cubes, cylinders and prism beams were cast and tested for various mixes viz. Seven mixes M1 to M7 are cast with 0%, 5%, 7.5% and 10% replacement of SF and another set of specimens with 0%, 5%, 7.5% and 10% replacement of SF along with 10% constant replacement of fly ash .Mechanical properties such as compressive strength, split tensile strength and flexural strength at different ages of concrete at different levels such as 3, 7, 28, 56 and 90 days. The result shows that the optimum replacement of silica fumes is 7.5%. If 10% of fly ash is added the optimum replacement of silica fumes is 5%. Totally 7 columns were cast for mixes M1 to M7. The column specimens were tested in 1000kN loading frame at 28 days. From this, Load-Mid height deflection (P-Δ) curves were drawn and compared. The same failed columns were rehabilitated with GFRP sheets with one or two layers and again tested in 1000kN loading frame. The results were then compared with the initial results.

Sunkurwar (2011)
The author has investigated on the flexural Strength behavior of high strength prestressed concrete beam by using silica fume. Mix design of M50 grade concrete is made of different groups such as, Mix design with OPC + Micro silica + Fly Ash. Apart from this 15 beams were casted, 12 beams with OPC + Fly Ash + Silica Fume and 3 beams with OPC. These beams were tested on UTM (universal testing machine) machine for flexural strength after 24 days.Six beams for one point loading and six beams for two points loading. The use of mineral admixtures or pozzolanic in ordinary Portland cement concrete enhances improvement in mechanical properties like early compressive strength, flexural strength, reduction in expansion due to alkali- aggregate reaction and improvement in durability properties like water permeability and gas permeability, reduction in plastic shrinkage, cracking and chemical attack etc.

Umesh (2011)
The author has investigated the behavior of Polymer modified silica fume Concrete under sustained elevated temperature. The effect of sustained elevated temperature on the residual strength characteristics of silica fumes concrete with varying percentages of polymer in it. The polymer modified silica fume concrete (PMSF concrete) is exposed to elevated temperatures like 700 degree Celsius and 800 degree Celsius. Residual strengths like compressive strength, tensile strength, flexural strength and impact strength are studied in this experimentation. Different percentages of polymer additions 0%, 1%,2%,3%,4%,5%,6%,7% and 8%.The findings of the experimental results indicate that PMSF concrete shows higher resistance to sustained elevated temperatures and can be recommended where concrete structures are exposed to elevated temperatures. Concrete cube specimen of dimensions 150mmX150mmX150mm were cast and tested for compressive strength as per IS: 516-1959. Addition of 3% polymer into silica fume concrete will yield a concrete which shows better resistance when subjected to a sustained elevated temperature of 700C. Addition of 3% polymer into silica fume concrete will yield a concrete which shows better resistance when subjected to a sustained elevated temperature of 800C. The PMSF concrete performs better when subjected to a temperature of 7000C than at 8000C thus the polymer modified silica fume concrete shows higher resistance to elevated temperature than the reference concrete and hence can be used where concrete is subjected to elevated temperatures.

Biswat (2011)
The author has investigated the effect of super plasticizer and silica fumes on properties of concrete. The use of silica fume in conjunction with super plasticizer has become the backbone of high strength and high performance concrete. The physical properties of PSC obtained from the experimental investigation. The water cement ratio for constant range of slump (80mm to 85mm) are 0.45, and 0.35 for control mix and control mix with super plasticizer respectively. It can also be seen that the compressive strength of concrete increases with a increase in the replacement percentage up to 20% of silica fume content then decreases for all days of curing. It can be observed that the compressive strength of cubes at 28 days curing for control mixture with super plasticizer (MCP) is 35.6 MPa and the strength increases by 6.23%, 12.0 %, 16.82%, 18.39% and 13.39% for MS5(5% silica fume replacement), MS10(10% silicafumere placement), MS15, MS20, and MS25 mixes respectively, in comparison with the control mixture with super plasticizer(MCP). The increase in strength from 28 to 56 days was 4% to 9%. The water cement ratio reduces by 23% in concrete by using super plasticizer (1% by weight of cement) for a constant range of slump 80mm to 85mm. The flexural strength of concrete is increased by use of silica fume up to 15% replacement of cement.

Murali et al (2012)
The authors have carried out an experimental investigation on the utilization of Silica fumes to enhance the tensile strength of concrete. The compressive strength of concrete in which cement was partially replaced with silica fumes. The percentage replacement of silica fumes is 5, 10, and 12.5,15 respectively. The split tensile strength of concrete with zero percentage replacement of silica fumes was found to be 2.25N/mm^2. The increasing percentage of silica fumes up to 10% has significantly enhanced the split tensile strength of concrete by 15.11%. Beyond 10% the strength has been decreasing up to 10% replacement of cement by silica fumes, the tensile strength (28 days)of M20 grade concrete increases, and then, with higher percentage of replacement of cement by silica fumes strength decreases.

Erich D et al (2012)
The authors have investigated the Structure of Portland cement pastes blended with silica fume.The use of Sonicated silica fume, it is possible to reduce the required quantity of admixture in blended cements to achieve specified performance. Using densified silica fume as a supplementary cementations material in Portland cement-based systems promotes an increased compressive strength, along with reduced permeability, relative to materials based on Portland cement. Silica fume exhibits higher reactivity, associated with increased consumption of portlandite during curing, relative to pastes including densified silica fume. Sonicated silica fume exhibits higher reactivity, associated with increased consumption of portlandite during curing, relative to pastes including densified silica fume.

Parekhl and Modhera (2012)
The authors have carried out an experimental investigation on the percentage variation effect of silica fume and recycled aggregates on recycled aggregate concrete. It is well known fact that it is giving little lower strength than natural aggregate concrete. Though, if it is used up to 20% of replacement, than it can give almost similar strength to that of natural aggregate concrete. Hence it was necessary to improve strength of recycled aggregate concrete for higher recycled aggregate content. Silica fume was very popular material used for strength improvement. Hence popular mix of 1:1:2 was checked with different % of silica fume combination. 5%, 7% and 10% of silica fume were replaced with cement and 30%, 50% and 100% of recycled aggregates were replaced with natural aggregate and results were analyzed. Thus total nine trials were analyzed and conclusions were derived in detail. Water absorption of RCA was 5 to 9 times higher and specific gravity of is 15% to 20% lower than the NCA. Furthermore, RCA had 9 to 11% lower density. Attached cement mortar and voids in that are the basic reason behind such behavior. These aggregates are used without any type of treatment, i. e. without wash treatment. Water absorption, specific gravity and density will further improve, if one can use these aggregates by proper treatment. Elongation and flakiness index were observed little higher for RCA. 7% addition of silica fume to 100% RA concrete will give the same result as that of 100% NA concrete. 5% incorporation will not be sufficient for 100% RA replacement, while 10% silica fume is giving little higher result than required. Compressive, tensile and flexural tests

were carried out for all the materials.

Debabrata Pradhan (2013).
The author has investigated the influence of Silica Fume on normal concrete. The different mechanical properties like compressive strength, compacting factor, slump of concrete incorporating silica fume. Mix of concrete incorporating silica fume is cast to perform experiments. The silica fume was replaced by 0%, 5%, 10%, 15% and 20% for water-cementations materials (w/cm) ratio for 0.40. For all mixes compressive strengths were determined at 24 hours, 7 and 28 days for 100 mm and 150 mm cubes. Other properties like compacting factor and slump were also determined for five mixes of concrete. Experimental results at all ages and replacement levels compressive strengths of 100 mm cubes are higher than 150 mm cubes. It was observed that the maximum compressive strength is obtained at 20% silica fume replacement levels and thereafter compressive strength is decreased. Higher compressive strength at 28 days of about 67.7 MPa for 150 mm cube and 71.33 MPa for 100 mm cube are obtained at 20% cement replacement by silica fume. But in normal concrete without silica fume at 28 days compressive strength of about 49.48 MPa for 150 mm cube and 55.67 MPa for 100 mm cube are obtained. It is observed that 28 days compressive strength is increased by 36.82% for 150 mm cubes and by 28.13% for 100 mm cubes than control concrete i.e. without silica fume. For workability they are concentrated to keep compacting factor 0.814 for all mix irrespective of slump. The slump value ranges from 20 to 50 mm. The value of slump showed the mixes are cohesive in nature.

Faseyemi Victor (2012)
The author has investigated the Micro silica (Silica Fume) as Partial Cement Replacement in Concrete. Silica fume and cement were replaced with silica from 0 to 25% in steps of 5% by weight, mix proportioning was based on 1:2:4 mix ratio. Cubes (150 x 150 x 150 mm) were produced and cured in a curing tank for 3, 7, 14 and 28 days. The cubes were subjected to compressive strength tests after density determination at 3,7,14 and 28 days respectively. It was observed that the compressive strength of C30 grade of concrete is increased from 16.15% to 29.24% and decrease from 23.98% to 20.22%.The maximum replacement level of silica fume is 10% for C30 grade of concrete. Volume replacement methods are recommended to investigate the possibility of producing high strength concrete with micro silica. The maximum replacement level of silica fume is 10% for C30 grade of concrete. From 15% there is a decrease in compressive strength for 3, 7, 14 and 28 days curing period. It was observed that the compressive strength of C30 grade of concrete is increased from 16.15% to 29.24% and decrease from 23.98% to 20.22%. The maximum replacement level of silica fume is 10% for C30 grade of concrete.

Mohammad et al (2012)
The authors have studied characterization of silica fume and its effects on concrete properties. The effects of silica fume on the concrete properties such as strength, modulus, ductility, permeability, chemical attack resistance, corrosion, freeze-thaw durability, creep rate. The study of silica fume source, physical properties of silica fume, chemical properties. 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 are Tensile strength, Compressive strength, Permeability, Freeze-thaw durability, Vibration damping capacity, Corrosion resistance of reinforcement steel, Permeability etc. 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.

Indrajit Patel et al (2013)
The authors have studied the effect of Partial Replacement of Cement with Silica Fume and Cellulose fiber on Workability and Compressive Strength of High Performance Concrete. High performance concrete is widely used in construction due its high strength, high workability, and high durability. Further investigations are also made to observe effect of inclusion of cellulose fiber on the properties of fresh and harden concrete. The experimental study of compacting factor and compressive strength through standard hpc test practice lay down by Bureau of Indian Standards, (BIS) and also describes the test results of different ingredients. The present investigation is to investigate the workability, mechanical properties for hpc mixes of grade M25 by replacing 0, 7, 9, and 12 percentage of the mass of cement with Silica Fume and 0.5, 1 percentage of Cellulose fiber and using a super plasticizer. Also, an attempt is made to find the optimum cement replacement level by SF and CF for better strength of HPC. Compaction factor decreases when the percentage of cellulose fiber increases with silica fume. The values of compacting factor are within range of 0.86 to 0.95 which meets the requirement of BIS-456.7% replacement of silica fume and 0.5% of cellulose fiber gives an optimum compressive strength. Beyond 7% silica fume and 0.5% cellulose fiber compressive strength decreases.

Mix Design for M25 Grade Concrete for W/C ratio 0.42
Mix design on recommended guide lines is a process of assessing the optimum combination of ingredients initially and final mix proportion is obtained only on the basis of further trial mixes. To arrive at a concrete mix design M_{25} concrete is carried as per IS code.

Mix Design Details (W/C -0.42)

Water	Cement	Fine aggregate	Coarse Aggregate
197.00	469.04	669.04	1106.54
0.42	1.00	1.42	2.35

Mix Design Details(W/C-0.5)

Water	Cement	Fine aggregate	Coarse aggregate
197	394	710.7	1123.92
0.50	1	1.80	2.85

Methodology
Step 1: Preparatory Modules
a) Collection of materials
b) Mix design for the work –M25 grade concrete.
Step 2: Work Planned
a) Silica fume replacement 0%, 11%, 13%, 15%, and 17%
b) Coarse and fine aggregate ratios = 1.60
c) Water - cement ratio = 0.42 & 0.50
Step 3: Cubes and testing
a) 30 cubes are casted for every mix
b) Compressive testing are done at 28 - 3 samples each.
Step 4: column
Columns are casted for M25 grade of 0%, 11%, 13%, 15% and 17% silica fume replacement.

3.3 Design of Column

Step -1: Dimensions
Size of column = 150 x 150
Cover = 25mm
Span (L) = 700mm
Factored load on column, P_u = 350 KN

Step – 2: Size of column and check e_{min}

$$\frac{D}{20} = \frac{150}{20} = 7.5$$

(3.2)

$$e_{min} = \frac{L}{500} + \frac{300}{30}$$ (IS 456-2000 CL.25.4)

$$= \frac{700}{500} + \frac{150}{30}$$

$$= 6.40 < 7.5$$

e_{min} less than $\frac{D}{20}$ is assumed in the formula. Hence short column for axial load can be used.

Step – 3: Calculation of slenderness

$l_{ex} = 1.0L$ (3.3)
= 700mm (IS 456 CL.25.1.2)

$$\frac{lex}{b} = \frac{700}{150} = 4.66 < 12$$

Hence, short column.

Step – 4: Find the area of steel and check percentage
(a) By formula

$$P_u = 0.4\, f_{ck}\, A_c + 0.67 f_y\, A_s$$ (IS456 CL39.3)

$$350*10^3 = 0.4 * 25\,(150^2 - As) + 0.67*415*As$$

$$As = 466.33\ mm^2$$

Therefore Percentage P = As/b^2 (4.3)

$$= \frac{466.33}{150x150} x100$$

= 2.0%

This more than 0.8% and less than 6% (IS456 CL39.3)
Hence, ok

By SP 16 TABLES
A_g = 225cm^2
P = 350 KN
Percentage P =2.0% (SP-16 Chart 25)
As = 2.0 *150*150/ 100
= 450 mm^2
Use 4 bars of – 12mm diameter each

Area As $= 4 * \frac{\pi}{4} * 12^2$
= 452.38 mm^2

Step – 5: Detail the longitudinal steel
Use cover = 20 mm (IS456 Cl 26.4.2.3)

Steel spacing $= \left(\frac{150-25-25-12}{2}\right)$
= 49mm

Therefore clear spacing between bars = 49 - $\emptyset$
= 49 -12
= 37< 300 (IS456 CL 26.5.3.1)

Step – 6: Design transverse steel
Diameter of links not less than 25/4 or 6mm
Use 8mm
Spacing least off
a) Dimensions of column = 150mm
b) 16 times of $\emptyset$ of long steel = 16*12 = 192mm
c) 300mm Adopt 150mm (IS456 CL26.5.3.2C)
Use Fe 415 steel for ties
Provide 8mm $\emptyset$ @ 135mm C/C

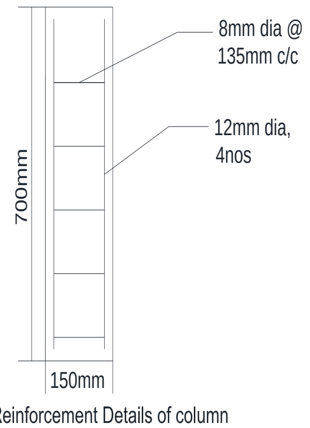


FIG . Reinforcement details of column

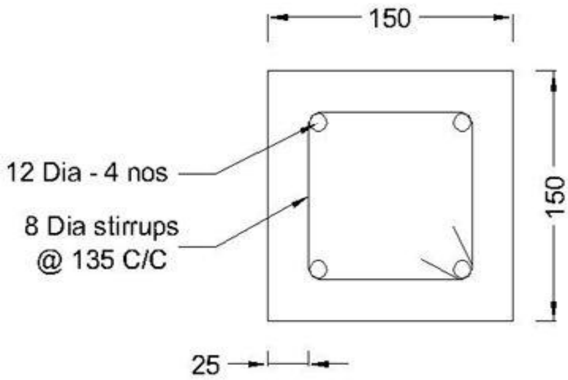


FIG CROSS SECTION OF COLUMN

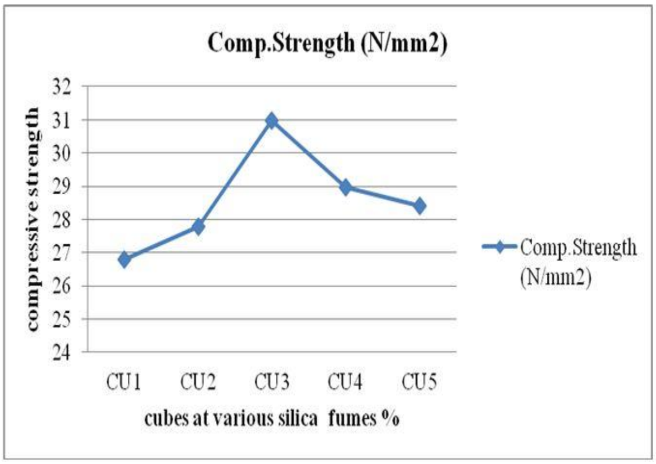
Table No: Details of the columns tested

SPECIMEN NO	W/C RATIO	% OF SILICA FUME	LENGTH (L) Mm	BREDTH (B) Mm
C1	0.42	0	700	150
C2		11	700	150
C3		13	700	150
C4		15	700	150
C5		17	700	150
C6	0.50	0	700	150
C7		11	700	150
C8		13	700	150
C9		15	700	150
C10		17	700	150

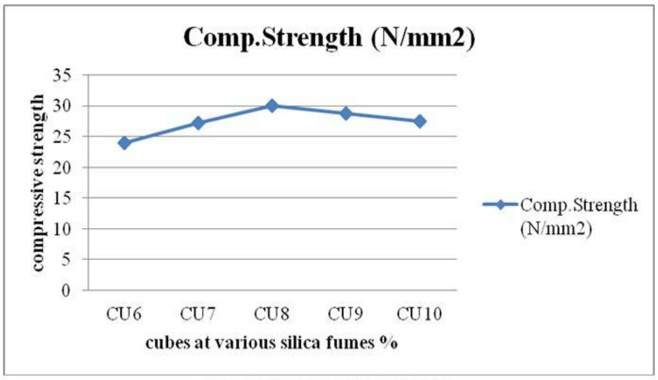
In the table details of column casted at various silica fumes replacement percentages (0, 11%, 13% 15%, 17 %.) at 0.42and .50 water cement ratios with column size (150*150*700), have been showed.

Compressive Strength Result for Cubes- w/c 0.42

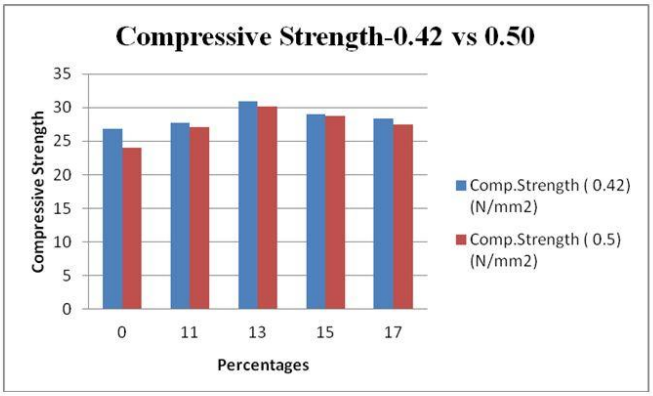
W/C Ratio	Specimen Name	% of Silica Fume	Load (KN)	Comp.Strength (N/mm^2)
0.42	CU1	0	603.40	26.80
	CU2	11	625.30	27.79
	CU3	13	697.03	30.97
	CU4	15	652.20	28.98
	CU5	17	639.10	28.40



Compressive Strength- w/c 0.42



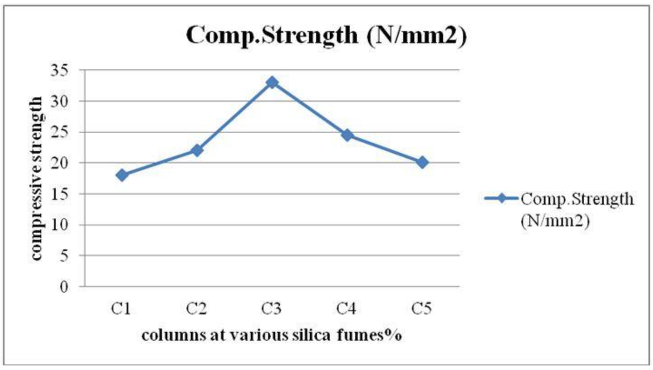
Compressive Strength- w/c 0.50



Comparison of Compressive Strength of 0.42 & 0.50 w/c

Compressive Strength Result for Column-w/c 0.42

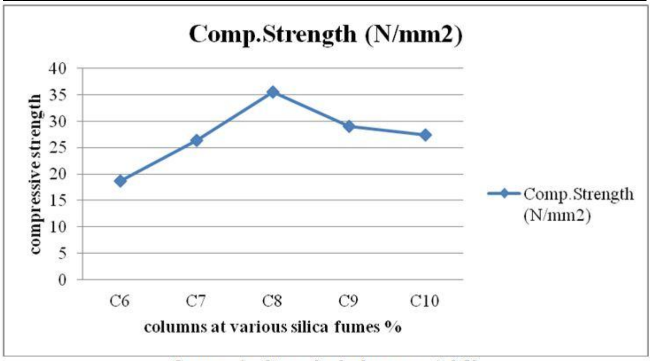
W/C Ratio	Specimen Name	% of Silica Fume	Load (KN)	Comp.Strength (N/mm^2)
0.42	C1	0	406.9	18.07
	C2	11	495.20	22.01
	C3	13	744.26	33.07
	C4	15	550.48	24.44
	C5	17	452.53	20.11



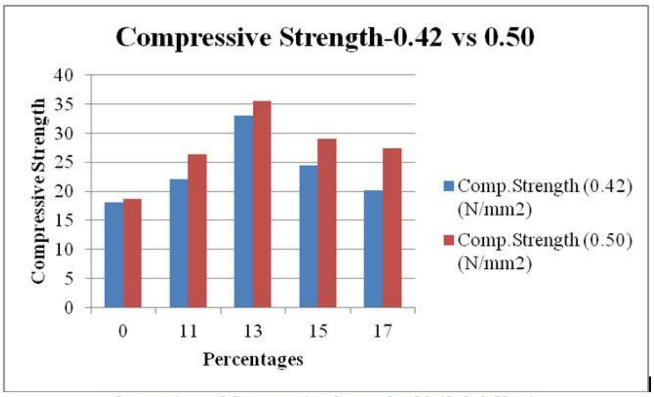
Compressive Strength for columns- w/c 0.42

Compressive Strength Result for Column-w/c 0.50

W/C Ratio	Specimen Name	% of Silica Fume	Load (Pu) (KN)	Comp.Strength (N/mm^2)
0.50	C6	0	418.74	18.61
	C7	11	592.57	26.33
	C8	13	799.19	35.52
	C9	15	653.95	29.06
	C10	17	615.95	27.37



Compressive Strength of columns - w/c 0.50



Comparison of Compressive Strength of 0.42 & 0.52 w/c

Failure Pattern

In the specimens with and without silica fume, failure was due to concrete compression at the column. Fig 5.5 shows the failure pattern of column due to compressive load.

Fig …Failure pattern of column due to compressive load

Strength Capacity of the Specimens

The trajectory of load Elongation of all the specimen with and without silica fume such as C1, C2, C3, C4, C5, C6, C7, C8, C9,and C10 respectively. The specimen without silica fume C1 failed at the load of 249KN at cross head travel at peak 11.310mm and C6 failed at load of 418.740 KN at cross head travel at peak 12.530mm. The other specimens with silica fume C2, C3, C4, C7, C8, C9 and C10 (tested at 28 days) in this C3 and C8 with 13% SF shows higher value of ultimate capacity of 33.078 and 35.520 N/mm^2 with elongation of 17.850mm and 11.370 mm respectively.The load elongation behavior of C1 column is shown in Fig 5.7.The load elongation behavior of C3 column is shown in Fig 5.8. The load elongation behavior of C6 column is shown in Fig 5.9. The load elongation behavior of C8 column is shown in Fig 5.10.From the load-elongation behavior it can be seen that the load carrying capacity of column with 13% replacement of cement with silica fume is more than that of the control beams but load carrying capacity reduces with the addition of silica fume.

Fig .. shows Load vs Elongation for 0% silica fume column of 0.42 water cement ratio

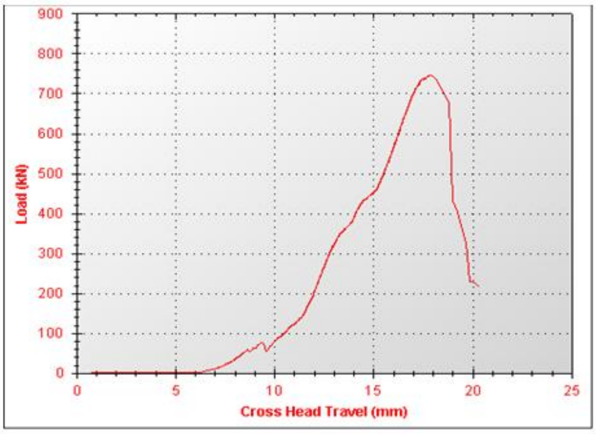


Fig .. shows Load vs Elongation for 13% silica fume column of 0.42 water cement ratio.

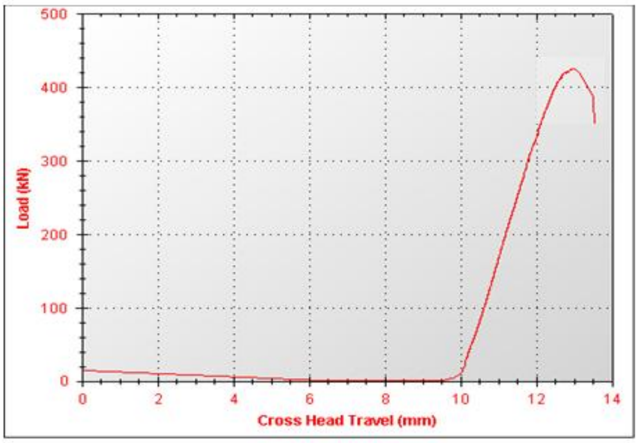


Fig … shows Load vs Elongation 0% silica fume column of 0.50 water cement ratio.

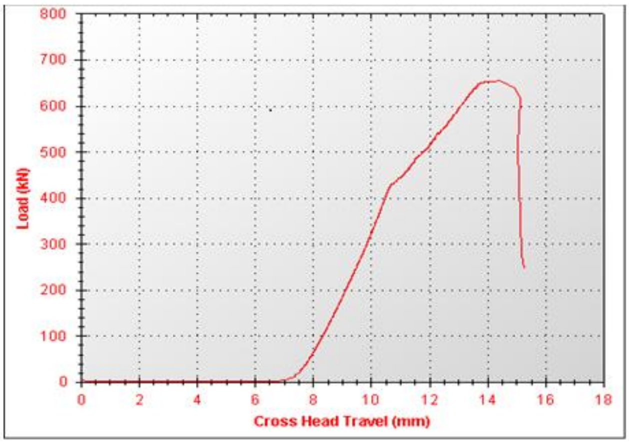


Fig ..shows Load vs Elongation for 13% silica fume column of 0.50 water cement ratio.

II. CONCLUSIONS

- The strength of silica fume concrete increased as the days of curing increased.
- The concrete mix using 13% replacement of cement with silica fume has higher compressive strength when compared to other concrete mixes with and without silica fume at 28 days.
- The maximum strength of 13% silica fume replacement for 0.42 water cement ratio was obtained on 28th day which was recorded as 30.97 N/mm2.
- The load carrying capacity of columns with 13% replacement of cement with silica fume is 22 to 25% more than that of the control columns.
- The short column with 13% (C3 and C6) SF shows higher value of ultimate capacity which is 22% higher than the control column (SC) and also it shows the ductile behavior.

REFERENCES

[1] Muthupriya, P., Subramanian, K., Vishnu ram, B.G. (2011). "Experimental investigation on high performance reinforced concrete column with silica fume and fly ash as admixtures."Asian journal of civil engineering. pp 597-618.

[2] Ram Kumar, V.R., Muraliand, G., and Partheeban, A. (2012). Utilisation of silica fumes to enhance the tensile strength of concrete. International Journal of Emerging trends in Engineering and Development.pp 607-609.

[3] Safwan, A., Khedr, Mohamed nagib Abou-Zeid. (1994). "Characteristic of silica-fume concrete."ASCE. vol.6, pp 357-375.

[4] Arnon Bentur and Ariel Goldman (1989). "curing effects, strength and physical properties of high strength silica fume concretes." Journal of Materials in Civil Engineering., vol.1, pp146-58.

[5] Erich, D., Rodriguez, Susan, A., Bernal, John, L., Provis, Jordi Paya, Jose, M., Monzo, and Borrachero, M.V., (2012). "Structure of Portland Cement Pastes Blended with Sonicated Silica Fume. "Journal of materials in civil engineering ASCE.pp 1295-1304.

[6] Dotto, J.M.R., deAbreu, A.G., DalMolin, D.C.C., Meuller, I.L.(2004). "Influence of silica fumes addition on concretes physical properties and on corrosion behaviour of reinforcement bars". Cement & Concrete Composites. pp 31-39.

[7] Roland Bleszynski, R., Doug Hooton, Michael, D.A., Thomas, and Chris, A., Rogers. (2002). "Durability of ternary blend concrete with silica fume and blast-furnace slag: laboratory and outdoor exposure site studies."ACI materials journal. Pp 499-508.

[8] Wolsiefer, J.T. (1991). "Silica fumes concrete a solution to steel reinforcement corrosion in concrete". Aci international conference on durability of concrete. pp 1-39.

[9] Sunkurwar, R.R. (2011). "Flexural Strength Behaviour of High Strength Prestressed Concrete Beam by Using Silica Fume". International Journal of Earth Sciences and Engineering1ISSN".pp 1047-1050.

[10] Pradhan, D.(2013). "Influence of Silica Fume on Normal Concrete".Int. Journal of Engineering

Research and Application. Pp 79-82.

[11] Bhikshma, V., Nitturkar, K., and Venkatesham, Y. (2009). “Investigations on mechanical properties of high strength silica fume concrete”. Asian journal of civil engineering.pp 335-346.

[12] Parekhl, D.N., and Modhera, C.D. (2012). “Percentage variation effect of silica fume and recycled aggregates on recycled aggregate”.IJAERS.pp76-80.

[13] Hooton, R.D., Pun, P., Fidjestol, P., Kojundic, T. (2001). “Influence of silica fume on chloride resistance of concrete”, University of Toronto.pp1-11.

[14] Rodríguez, E.D., Susan, A., Bernal, John, L., Provis, Jordi Paya.(2012). “Structure of Portland cement pastes blended with Sonicated silica fume”. ASCE.pp1295-1304.

[15] Ajileye, F.A.(2012). “Investigations on micro silica (silica fume) as partial cement replacement in concrete”. Global Journal of researches in engineering Civil and Structural engineering.

