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Studies on Effect of Silica Fume on Workability and Strength of Concrete

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ABSTRACT

Silica fume is an industrial by product during the production of silicon metal or silicon alloys. Silica fume is known to improve the mechanical characteristics of concrete. The principle physical effect of silica fume in concrete is that of filler, because of its fineness can fit into space between cement grains in the same way that sand fills between particles of coarse aggregates and cement grains fill the space between sand grains. As for chemical reaction of silica fume, because of high surface area and high content of amorphous silica in silica fume, this highly active pozzolans reacts more quickly than ordinary pozzolans. The use of silica fume in concrete has engineering potential and economic advantage. This paper presents the optimal percentage of silica fume from the results of an experimental investigations carried out to for sustainable and economical production of concrete. It is observed that the optimum dose of silica fume is 15% (by weight), when used as part replacement of OPC. The silica fume inclusion decreases the workability and increases the strength of concrete considerably.

Keywords: Silica fume; pozzolan; compressive strength; OPC.

1. INTRODUCTION

Concrete is second most consumed as structure material which is a blend of cement, sand, coarse total and water. It is being utilized for the development of structures and growth of construction industry. The technique for choosing fitting elements of cement and deciding their relative sum with the aim of delivering a solid of the essential quality sturdiness and functionality as effectively as conceivable is named the solid blend structure. The compressive quality of solidifying concrete is generally viewed as a record of its additional properties relies on a ton of variables for example worth and measure of concrete water and totals bunching and blending putting compaction and restoring. The expense of cement arranged by the expense of materials plant and work the variety in the expense of material start from the data that the bond is various occasions exorbitant than the totals along these lines the expectation is to create a blend as plausible from the down to earth perspective the rich blends may prompt high shrinkage and split in the auxiliary cement and to advancement of high warmth of hydration is mass solid which may cause splitting. The authentic expense of cement is identified with the expense of materials fundamental to create a base mean quality considered trademark quality that is indicated by the planner of the structures. This relies upon the quality control measures yet there is no uncertainty that quality control adds to the expense of cement. The dimension of value control is regularly a modest participation and relies upon the size and sort of occupation these days architects and researchers are endeavoring to upgrade the quality of cement by including a few other financially and squander material as an incomplete substitute of concrete or as an admixture fly fiery remains, silica smolder, steel slag, and so forth are the couple of instances of these kinds of materials. These materials are by and large side-effect from further ventures, for instance, fly fiery debris is a waste item from power plants and silica smolder is a side-effect coming about because of an abatement of high immaculateness quartz by coal or coke and wood contributes an electric curve heater amid the generation of silicon metal or ferrosilicon composites. Be that as it may, these days silica smolder is utilized in vast sum since it upgrades the property of cement. The utilization of smaller scale silica as a pozzolana material has upgraded as of late in light of the fact that when blended in distinct extents it improves the properties of both crisp and hard solid like solidness, quality, penetrability and compressive quality, flexural quality and rigidity.

Literature Review

Prof. Vishal S. Ghutke, Prof. Pranita S.Bhandari [1] conducted a research on influence of silica fume on concrete by replacing 5%,10%,15%,20%of cement with silica fume and compared the strength of the concrete with the control concrete. The cement of grade 53was considered for the study. The water cement ratio of 0.5and 0.6 were examined. The results taken from testing the concrete on 3, 7 and 28days and the values were compared. From the research it is studied that the optimum value of compressive strength can be achieved in 10% replacement of silica fume.

Hon. FICT, Dip M [2] conducted a research on effect of silica fume on the properties of concrete. The research focuses on the effects of silica fume on main properties of concrete in the fresh and hardened state. As per BS EN 13263 the percentage addition of Silica fume for concrete should be <8% and should not exceed more than 12.5%. From the addition of silica fume, high early compressive strength (in excess of 25N/mm^2 at 24 hours) is been achieved. Cement content are generally > 400 kg/m^3 and w/c in the range 0.30 to 0.40 are reported. The splitting tensile strength reported as a percentage of compressive strength of 10% silica fume concrete (w/c = 0.35) ranged from 8.5% to 8.9% at ages of 28 to 182 days, whereas similar concrete without silica fume ranged from 9.4% to 10.7%. Rather than the compressive and tensile strength addition between 10% to 15% addition of silica fume the concrete works great for protection to embedded steel (chlorides), protection to embedded steel (carbonation), sulfate resistance, resistance to acids,etc and much more.

`Vikas Srivastava et all [3] proposed a research on effect of silica fume. The research shows that the addition of silica fume reduces workability. However, in some cases it improves the workability. Silica fume inclusion increases the compressive strength of concrete significantly (6-57%). The increase depends upon the replacement level. The tensile and flexural strength of silica fume concrete is almost similar to the referral concrete. The addition of silica fume improves the bond strength of concrete. The modulus of elasticity of silica fume concrete is almost similar to the referral concrete.

Amudhavalli [4] studied the Effect of silica fume on the strength and durability characteristics of concrete. The main parameter investigated in this study is M35 grade concrete with partial replacement of cement by silica fume by 0, 5, 10,15and by 20%. A detailed experimental study in Compressive strength, split tensile strength, flexural strength at age of 7 and28 day was carried out. Results show that Silica fume in concrete has improved the performance of concrete in strength as well as in durability aspect.

Perumal [5] observe the effect of partial replacement of cement with silica fume on the strength and durability properties of high grade concrete. Strength and durability properties for M60, M70 and M110 grades of HPC trial mixes and to arrive at the maximum levels of replacement of cement with Silica fume, investigations were taken. The strength and durability characteristics of these mixes are compared with the mixes without SF. Compressive strengths of 60 N/mm^2, 70 N/mm^2 and 110 N/mm^2 at 28days were obtained by using 10 percent replacement of cement with SF. The results also show that the SF concretes possess superior durability properties.

MATERIALS AND METHODS

3.1 Cement

Ordinary Portland cement of 43 grade confirming to IS 4031-1988 was used in the present study. The various properties of cement are resulted as shown in Table below:

Table1. Properties of Cement

S.No.	Property	Result
1	Normal consistency	33 %
2	Initial setting time	42 min
3	Specific gravity	9.99
4	Fineness of cement	5 %
5	Specific area	3250cm^2/gm
6	Soundness of cement	1.00 mm

3.2 Fine Aggregate

M sand was used as fine aggregate of grading zone II. The properties of fine aggregate are shown in table below:

Table 2. Properties of Fine Aggregate

Sr. No	Property	Result
1.	Bulk Density	1625 kg/m^3
2.	Fineness modulus	3.80
3.	Specific gravity	2.67
4.	Water absorption	1.2

3.3 Coarse Aggregate

Coarse aggregate of size 20 mm of crushed stone locally available confirming to IS 383-1987 was used

Table 3. Properties of Coarse Aggregate

Sr. No	Property	Result
1.	Bulk Density	1525 kg/m^3
2.	Fineness modulus	3.67
3.	Specific gravity	2.89
4.	Water absorption	0.46 %

3.4 Water

The tap water used in this study was free of alkalis, acids, salts, organic materials & other impurities

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3.5 Silica Fume

Silica fume is an industrial by-product used in concrete mixes to replace cement. Surface area of silica fume is 20m^2/kg. The diameter of silica fume particle is about 0.1-0.2Ïm. The content of SiO_2 reaches up to 95% above.

2.6 Super Plasticizer

Super plasticizer- CONPLAST-SP 430 in the form of sulphonated Naphthalene polymers complies with IS: 9103-1999 and ASTM 494 type F was used to improve the workability of concrete.

CASTING OF SPECIMEN

The mould for casting the specimen of standard cubes of (150 mm x 150 mm x 150 mm) was used to determine the compressive strength. The specimens of standard cylinders of (300 mm x 100 mm) were used to determine split tensile strength. The specimens of standard prisms of (150mmx150mmx700mm) were used to determine the flexural strength. Total 36 Cubes, 36 cylinders & 36 prisms were casted for the strength parameters. The concrete was filled in three different layer and each layer was well compacted. The specimens were remolded after 24 hours cured in water for 7 & 28 days. Then it is been tested for its compressive, split tensile and flexural strength as per Indian standard.

RESULT AND DISCUSSIONS

Results of fresh and hardened concrete properties with partial replacement of Silica Fume were discussed in comparison with those of normal concrete:

3.1 slump test Result

The effect of silica fume addition to the concrete as cement replacement on workability characteristic is shown in Fig 3.1graphically. As the percentage of silica fume increases from 0% to 25% the slump decreases from 100 to 71mm. The reduction in slump is attributed to the particles size, surface area and size of silica fume particle which is very much lesser than cement particles and it requires more water than cement alone for a given slump. Figure 1 shows the slump test performed for the fresh concrete.

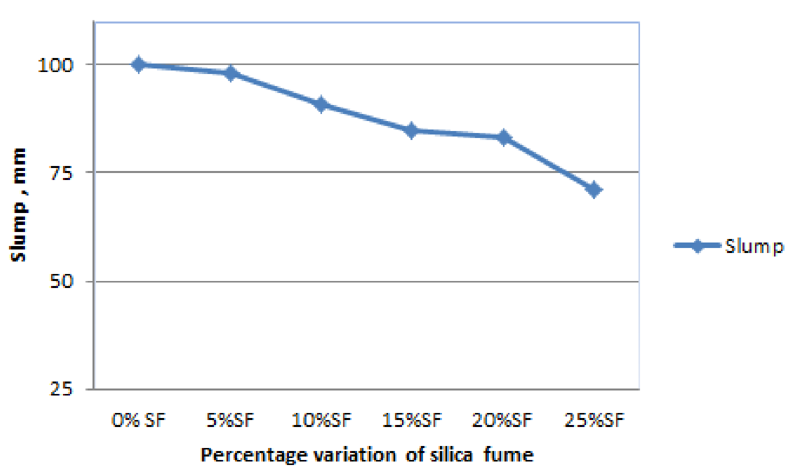

Fig.1 Results of Slump test

3.2 Compressive Strength Result

The test was carried out conforming to IS 516-1959 to obtain compressive strength at the age of 7 and 28 days. The cubes were tested using Compression Testing Machine (CTM). The results are shown in table 7.

Table 4. Compressive strength of concrete

Concrete Mix	Compressive strength (mpa)	
	7 Days	28 Days
0% SF	14.25	23.5
5%SF	18.12	27.92
10%SF	22.35	29.67
15%SF	26.28	31.54
20%SF	23.56	28.51
25%SF	21.48	26.48

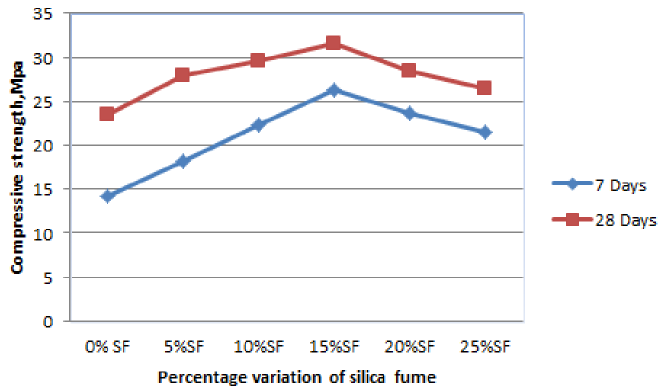

Fig. 2 Results of Compressive strength test

3.2 SPLIT TENSILE STRENGTH TEST

The test was carried out conforming to IS 516-1959 to obtain Split Tensile Strength of Concrete strength at the age of 7 and 28 days.

Table 5. Split Tensile strength of concrete

Concrete Mix	Split Tensile strength (mpa)	
	7 Days	28 Days
0% SF	2.76	3.11
5%SF	2.98	3.65
10%SF	3.12	4.21
15%SF	3.26	3.82
20%SF	3.01	3.62
25%SF	2.86	3.52

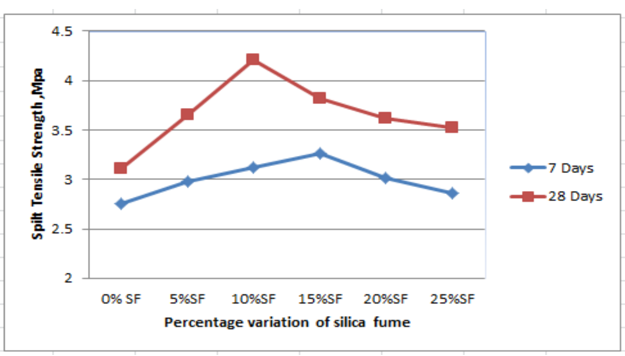

Fig: 3 Results of Split Tensile strength test

The cylinders were tested using Compression testing machine (CTM) of capacity 1000 KN. The results are shown in table 5.

3.3 Flexural Strength Test

The test was carried out conforming to IS 516-1959 to obtain Flexural Strength of Concrete strength at the age of 7 and 28 days. The beams were tested using Flexural Testing machine (FTM) of capacity 1000 KN. The results are shown in table 6.

Table 6: Flexural strength of concrete

Concrete Mix	Flexural strength (mpa)	
	7 Days	28 Days
0% SF	3.21	3.89
5%SF	3.45	3.97
10%SF	3.89	4.12
15%SF	3.91	4.01
20%SF	3.51	3.91
25%SF	3.37	3.82

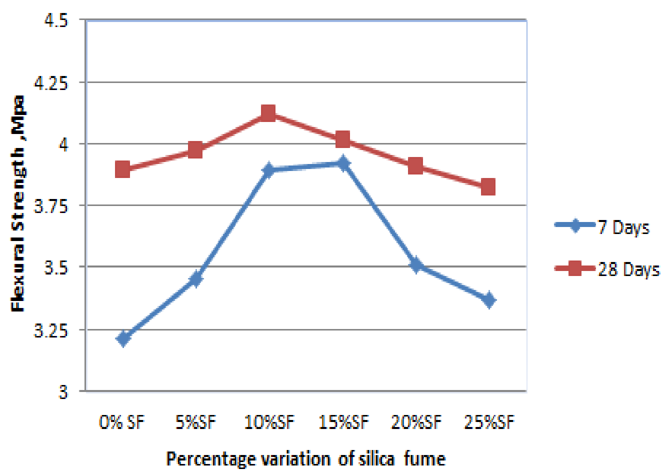

Fig: 4 Results of Flexural strength test

CONCLUSION

The replacement of cement with silica fume 5% to 25 % leads to increase in compressive strength whereas the percentage replacement of 20 to 25% leads to decrease in compressive strength. The optimum percentage of silica fume is found to be 15% whereas beyond that the strength is reduced. The addition of silica fume reduces workability. Silica fume having high fineness content leads to high normal consistency. The strength gain due to silica fume replacement in compressive strength is almost similar to that in split tensile strength due to addition of superplasticizer. Silica fume also decrease the voids in concrete. Addition of silica fume improves bond strength of concrete. Modulus of elasticity of silica fume concrete is similar to that of conventional concrete.

REFERENCES

1. Prof. Vishal S. Ghutke, Prof. Pranita S.Bhandari.Influence of silica fume on concrete.

2. Hon. FICT, Dip M, Chartered MCIM, DMS Consultant.The effect of silica fume on the properties of concrete as defined in concrete society report 74, cementations materials.
3. Vikas Srivastava, Alvin Harison, P. K. Mehta, Atul, Rakesh Kumar,Assistant Professor, Civil Engg. Department, SHIATS (Formerly AAI-DU) Effect of Silica Fume in concrete.
4. Amudhavalli, N. K. & Mathew, J. (2012). Effect of silica fume on strength and durability parameters of concrete. International Journal of Engineering Sciences & Emerging Technologies. 3 (1), 28-35
5. Perumal, K., Sundararajan, R. (2004). Effect of partial replacement of cement with silica fume on the strength and durability characteristics of High performance concrete. 29th Conference on OUR WORLD IN CONCRETE & STRUCTURES: 25 – 26 August 2004, Singapore.
6. Kumar, R. , Dhaka, J. (2016). Review paper on partial replacement of cement with silica fume and its effects on concrete properties. International Journal for Technological Research in Engineering. 4,(1).
7. Ghutke, V. S. & Bhandari, P.S. (2014). Influence of silica fume on concrete. IOSR Journal of Mechanical and Civil Engineering, 44-47.
8. Hanumesh B. M., Varun, B. K. & Harish B. A. (2015).The Mechanical Properties of Concrete Incorporating Silica Fume as Partial Replacement of Cement. International Journal of Emerging Technology and Advanced Engineering. 5 (9), 270.
9. Shanmugapriya , T.& Uma R. N.(2013) Experimental Investigation on Silica Fume as partial Replacement of Cement in High Performance Concrete, The International Journal of Engineering And Science (IJES) .2 (5), 40-45.
10. Kumar, A., Jain, S., Gupta, S., Sonaram&Merawat, S.(2015). A Research Paper on Partial Replacement of Cement in M-30 Concrete from Silica Fume and Fly Ash. SSRG International Journal of Civil Engineering,3(5), 40-45.
11. Jain, A. &Pawade, P. Y. (2015). Characteristics ofSilica Fume Concrete. International Journal of Computer Applications
12. Roy, D. K. (2012). Effect of Partial Replacement ofCement by Silica Fume on Hardened Concrete. International Journal of Emerging Technology and Advanced Engineering, 2(8), 472-475.
13. Amarkhail, N. (2015). Effects of silica fume on properties of high-strength concrete. International Journal of Technical Research and Applications, 13-19.
14. Sasikumar, A. (2016). Experimental Investigation onProperties of Silica Fumes as a Partial Replacement of Cement. International Journal of Innovative Researchin Science,, 5 (3), 4392-4395.
15. Ajileye, E.V. (2012). Investigations on Microsilica(Silica Fume) As Partial Cement Replacement in Concrete. Global Journal of Researches in Engineering Civil and Structural engineering 12 (1), 17-23.
16. Sharma, a. &Seema (2012). Effect of partialreplacement of cement with silica fume on compressive strength of concrete. International journal of research in technology and management, 1 (1), 34- 36
17. Pradhan, D & Dutta, D. (2013). Effects of SilicaFume in Conventional Concrete. International Journal of Engineering Research and Applications. 3(5).

Conflict of Interest

None of the authors have any conflicts of interest to declare.

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