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Study of Work Ability Durability and Strength of Concrete Using Silica Fume

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Abstract: ***In this present study use silica fume as a admixture in the concrete. Several researches have towards investigation the hardened property of concrete when added Silica Fume. In this present study to investigate the workability, durability and strength of concrete with partial replacement of cement by silica fume. The percentages are used 0%, 5%, 10%, 15%, 20% and specimen carried out at 7, 14 and 28 days of M30 Grade concrete with a fixed water cement ration 0.45. For workability properties (slump test, Vee Bee test) were carried out at 0%, 5%, 10%, 15%, 20%, durability properties (water absorption, sulphate attack) were carried out at 7, 28 days and hardened properties (compressive strength, flexural strength) were carried out at 7, 14, 28 days. Based on experimental investigation the concrete mix were found with increase in the content of silica fume as observed from the reduction in the slump values of concrete mix and increment of time in seconds were found in vee-bee test, durability were found decrease compressive strength of sulphate attack and strength (compressive strength and flexural strength) were found increase from 0% to 5% to 10% to 15% and both are decrease on 20% addition of silica fume. In this study use silica fume of size 1-150 nm improve the compressive strength of concrete. The test conducted on it shows a considerable increase in early-age parameters of workability, durability and strength of concrete using silica fumes. The strength increase was observed with the increase in the percentage of silica fume and decrease of strength at a particular percentage.***

Keywords: Silica fume, workability, durability, compressive strength, flexural strength

1. Introduction

Concrete is the construction material used many types of structure of commercial and industrial buildings. In the production of concrete OPC (Cement) is one of the main ingredients and of present as well as future. The wide use of concrete in structures, from buildings to factories, from bridges to airports, makes it one of the most investigated material. Out of the various materials used in the production of concrete, cement plays a major role due its size and adhesive property. So, to produce concrete with improved properties, the mechanism of cement hydration has to be studied properly and better substitutes to it have to be suggested.

2. Experimental Investigations

2.1 Material

2.1.1 Cement

Ordinary Portland Cement was classified into three grade namely 33, 43, 53 grade depending upon the strength of the cement at 28 days tested as per IS 4031-1988 part-4 Ordinary Portland Cement (Shree Cement) of 43 grade used for preparing concrete specimens.

Table 1: Properties of Ordinary Portland cement

S.No.	Property	Result
1	Normal consistency	34%
2	Initial setting time(min.)	32
3	Final setting time(min.)	408
4	Specific gravity	3.12
5	Fineness modolus	6.2%

2.1.2 Fine Aggregate

Fine aggregate is that aggregate which passed through the 4.75 mm sieve. Fine aggregate property is maintain to produce the maximum size of aggregate b/w 4.75mm,2.36mm, 1.18mm, 600 micron, 300 micron,150 micron, 75 micron, Pan .

Table 2: Properties of Fine Aggregate

S.No.	Property	Result
1	Specific gravity	2.67
2	Total water absorption (%)	2.15
3	Fineness modulus	3.227
4	Grading zone	II

2.1.3 Coarse Aggregate

Coarse aggregate is that aggregate which retained on 4.74 mm sieve. Coarse Aggregate, it is crushing to maintain the produce of maximum size of aggregate 20mm, 16mm, 12.5mm, 10mm, 4.75mm, Pan . It should be hard, strong, dense, durable and clean. It should be conform from IS code 2838 part1.

Table 3: Properties of Coarse Aggregate

S.No.	Property	Result
1	Specific gravity	2.72
2	Total water absorption (%)	1.12%
3	Fineness modulus	7.54
4	Impact value	12.3%
5	Crushing value	23.87%
6	Zone	II

2.1.4 Silica Fume

Silica Fume supplied through Delkem Industries Surajpur Industrial Area Greater Noida UP. Its batch no. is SY-210 a partial replacement of cement.

Table 4: Chemical composition of Silica Fumes

S. No.	Chemical	% of composition
1	SiO_2	99.88
2	Al_2O_3	0.043
3	Fe_2O_3	0.048
4	TiO_2	0.001

2.1.5 Water

Tab water used in experiment of both mixing and curing. Properties are assumed to same as normal water. Specific gravity of water taken as 1.00. Water has two functions in a concrete mix. Firstly it reacts chemically with the cement to from the cement paste in which the inert aggregates are held

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in suspension until the cement paste has hardened.

Table 5: Property of tab water

S.No.	Properties of Tab Water	Result
1	PH	8.1
2	Suspended solids, mg/l	NIL
3	Dissolved solids, mg/l	288

2.2 Mix Proportion

Mix design of concrete designed in this experiment as per the Indian standard 10262:2009 and 456:2000. Sample was prepared for mix design of M30 grade of concrete. Mix proportions of concrete (Kg/m3) shown in below table.

Table 6: Property of tab water

S. No.	Material	Quantity (Kg/m^3)
1	Cement OPC	437.8
2	Fine Aggregate	673.97
3	Coarse Aggregate	1147.923
4	Water	197

2.3 Experimental Procedure

Specimen of standard cubes (150mm×150mm×150mm) and beams (100mm×100mm×500mm) were used for finding the compressive strength and flexural strength of concrete. There are three specimens were tested for 7days, 14days and 28 days for each proportions of silica fume replacement.

There are totally 36 cubes were casted for investigation the compressive strength and water absorption, 24 cubes were casted for sulphate attack test and 36 beams casted for investigation the flexural strength.

Cement was filled in cubes and beams width each layers and compactions by vibrator. Specimens were demolded after 24 hours and cured in water for 7 days, 14 days and 28 days and then tested for water absorption, sulphate attack and strength.

3. Test Result and Discussion

The result of water absorption sulphate attack and strength of hardened concrete to partial replacement of silica fume are discussed below.

3.1 Workability Test

3.1.1 Slump Test

The internal dimensions of the mould are bottom diameter 200 mm, top diameter 100 mm, and height 300 mm. The mould id filled in with fresh concrete in five layers, each approximately one quarter of the height land tamped with twenty five stokes of the rounded end of the tamping rod. The mould is removed by raising it slowly and carefully in a vertical direction. This allows the concrete to subside and the slump is measured immediately by determining the deference between the height of the mould and that of the height. There are three types of slump.

Table 7: Result of Slump Test Result

S.No.	Mix	Silica Fume (%)	Slump Test Result (mm)
1	M0	0	91
2	M1	5	63
3	M2	10	47
4	M3	15	30
5	M4	20	25

3.1.2 Vee Bee Test

The test measures the relative effort required to change a mass of concrete from the definite shape to another by mean of vibration. The amount of effort called remolding effort is taken as time in seconds required computing the change. The time required for compute remolding in seconds is considered as a measure of work ability and is expressed as number of Vee - Bee seconds.

Table 8: Result of Vee Bee Test

S.No.	Mix	Silica Fume (%)	Vee Bee Result (Sec.)
1	M0	0	17.20
2	M1	5	18.36
3	M2	10	18.52
4	M3	15	22.12
5	M4	20	24.58

3.2 Durability Test

3.2.1 Water Absorption Test

Water absorption values determined from the experimental results are given table 9. Each values representing the data set was calculated by the three specimens on 7 days and three specimens on 28 days. The result was given the below table.

Table 9: Result of Water Absorption

Mix	% of silica fume used	7 Days		Water Absorbed (%)	28 Days		Water Absorbed (%)
		Weight of dry sample (Kg)	Weight of wet sample (Kg)		Weight of dry sample (Kg)	Weight of wet sample (Kg)	
M0	0%	8.02	8.101	1.0	8.02	8.286	3.21
M1	5%	8.24	8.29	0.60	8.24	8.360	3.82
M2	10%	8.213	8.302	1.08	8.213	8.419	4.12
M3	15%	8.07	8.182	1.38	8.07	8.308	4.20
M4	20%	7.98	8.12	1.75	7.98	8.33	4.38

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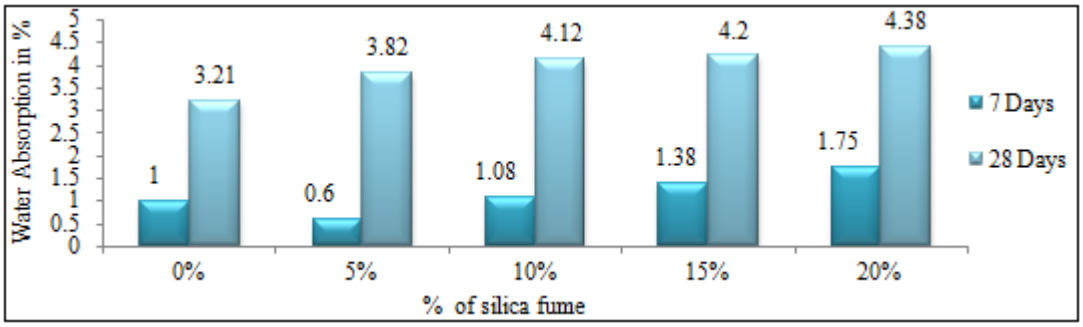

Figure 1: Effect of silica fume on water absorption on weight on cubes

3.2.2 Sulphate Attack Test

Sulphate Attack Test values determined from the experimental results are given table 10. Each values representing the data set was calculated by the three specimens on 7 days and three specimens on 28 days. In this test Magnesium Sulphate used in tab water.

Table 10: Result of Sulphate Attack

Mix	% of silica fume used	Compressive Strength N/mm^2	
		7 Days	28 Days
M0	0%	19.01	37.73
M1	5%	19.17	38.03
M2	10%	20.06	38.45
M3	15%	20.62	39.81
M4	20%	17.62	36.21

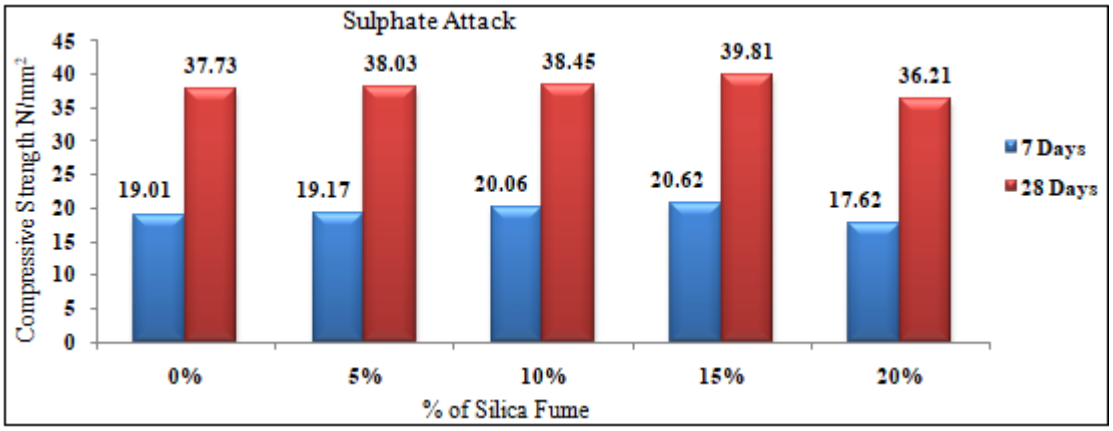

Figure 2: Effect of sulphate attack on compressive strength of cubes

3.3 Strength Test

Table 11: Result of Compressive and Flexural Strength

Mix	Compressive Strength N/mm^2			Flexural Strength N/mm^2		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
M0	19.08	26.99	38.19	3.84	4.78	5.82
M1	19.41	27.52	38.87	4.02	5.61	7.11
M2	20.25	27.62	39.80	4.98	6.35	9.05
M3	21.11	27.88	40.11	6.21	8.81	9.31
M4	19.35	25.21	38.94	5.48	7.51	8.31

3.3.1 Compressive Strength

Result of compressive strength of concrete given in table 11.Silica fume replaced with cement. Test was carried out to obtain compressive strength of concrete at the age of 7, 14 and 28 days. Cubes were tested using Compressive Strength Testing machine (CTM) capacity of 1000 KN. From the fig.3 maximum increase in compressive strength obtained as 21.11 N/mm^2, 27.88 N/mm^2 and 40.11N/mm^2 at 7, 14 and 28 days when silica fume was replaced by 15% of cement.

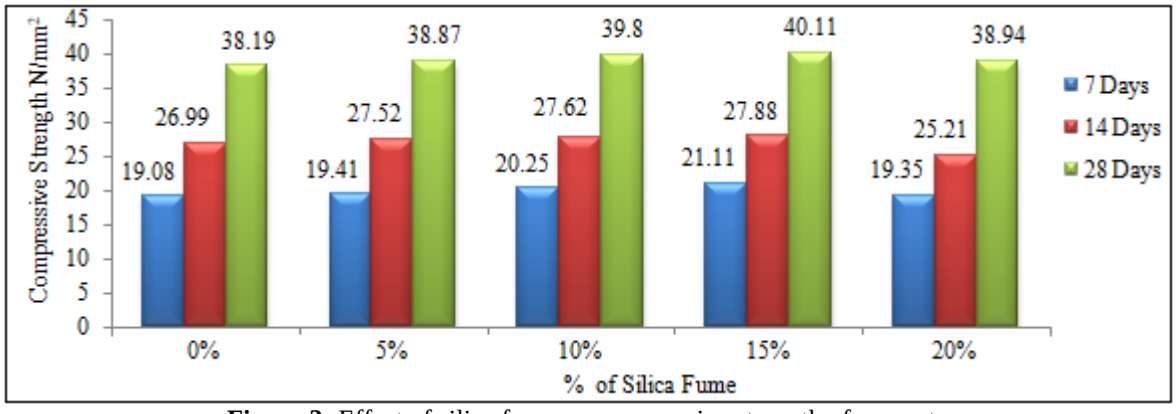

Figure 3: Effect of silica fume on compressive strength of concrete

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3.3.2 Flexural Strength

Result of flexural strength of concrete. Silica fume replaced presented in above table 12. Test was carried out to obtain flexural strength of concrete at the age of 7,14 and 28 days. Beams were tested using Flexural Strength Testing machine (FTM) capacity 1000 KN. From the fig.4 maximum increase in flexural strength is obtain as 6.21N/mm2, 8.8 N/mm2 and 19.31N/mm2 at 7, 14 and 28 days when silica fume was replaced by 15% of cement.

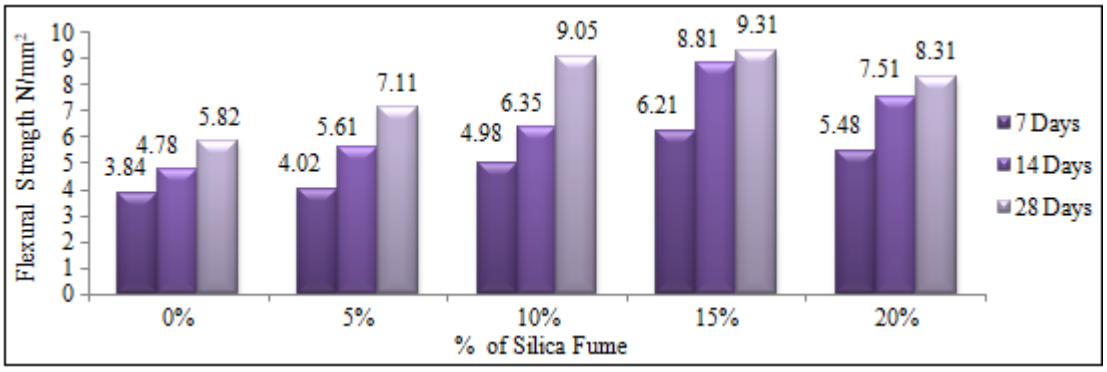

Figure 4: Effect of silica fume on flexural strength of concrete

4. Conclusion

Based on scope of material, techniques, procedure and another parameter associated this work following conclusions are recommended can be stated. The conclusions drawn are

1) Increase the consistency with content of silica fume from 0 to 1.5% in the mixes.
2) Observed the initial and final setting time of cement.
3) The best result for the water absorption was observed at the different percentage (0%, 5%, 10%, 15%, 20%) of silica fume respectively.
4) The trends observed for sulphate attack resistance decrease the compressive strength with the use of Magnesium Sulphate for the mixes of different percentage (0%, 5%, 10%, 15%, 20%) respectively.
5) Increase the compressive strength at early different ages in all the mixes with increase the silica fume from 0%, 5%, 10%, 15% but compressive strength decrease on 20% addition of silica fume.
6) Inclusion of silica fume increase the flexural strength with 0%, 5%, 10%, 15% increase the percentage of silica fume but decrease on 20% addition of silica fume

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