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STUDY ON SILICA FUME REPLACED CONCRETE WITH SUPER PLASTICIZER

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ABSTRACT

This paper presents an experimental study on the nature of silica fume and its influences on the properties of fresh and hardened concrete. In the present study, an attempt has been made to investigate the strength parameters of concrete made with partial replacement of cement by silica fume using super plastisizer. Properties of hardened concrete via ultimate compressive strength, flexural strength and split tensile strength have been determined for different mix combinations of materials and these values are compared with the corresponding values of conventional concrete. The present investigation has been aimed at to bring awareness amongst the practicing Civil Engineers regarding advantages of this new concrete mixes.The silica-fume concrete included 0%, 12.5%, 13% and 13.5% silica as equal replacement of ordinary Portland cement on the strength of M20, M25 and M30 grades. The ca/fa ratio included is 2.17.Extensive experimental investigation was carried out for various percentages.After de-moulding, the concrete specimens from each mix were moist cured in water and the compressive and tensile strengths were determined at 7 and 28 days. From the test results, it was found that 13% silica fume replacement with super plastisizer is optimum.

Keywords: hardened concrete, silica, tensile strengths

1. INTRODUCTION

1.1 General

Silica fume is a by-product derived during the production of elemental silicon or an alloy containing silicon and it is very fine non-crystalline silica produced in electric arc furnaces. Silica fume is known to improve both the mechanical characteristics and durability of concrete.

The principal physical effect of silica fume in concrete is that of filler, which because of its fineness can fit into space between cement grains in the same way that sand fills the space 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 pozzolan reacts more quickly than ordinary pozzolans.

1.2 Advantages

Silica Fume has been used all over the world for many years in the area where high strength and durable concrete is required. Silica Fume improves the characteristics of both fresh and hard concrete. The material's potential use was known as early as the late 1940s. But it wasn't widely used until the development of powerful dispersants, or high-range water-reducing admixtures, or super plasticizers. Once these admixtures were available, using silica fume in concrete became possible.

Fresh concrete made with silica fume is more cohesive and therefore less prone to segregation than concrete without silica fume. To offset this increased cohesion when placing; silica fume concrete is typically placed at 40 to 55 mm greater slump than concrete without silica fume.

Due to the very high surface area of the silica fume and the usually very low water content of silica fume concrete, there will be very little bleeding of concrete. Once silica fume content of about 5% is reached, there will be no bleeding in most concretes. In addition to improved durability, the lack of bleeding allows a more efficient finishing process to be used with silica fume concrete.

The objectives of this paper are

- To compare the strength parameters of silica fume replaced concrete.
- To find the optimum percentage of replacement.

2. EXPERIMENTAL PROCEDURE

2.1 Materials

The proportioning of silica fume concrete consists of selection of suitable ingredients, cement, supplementary cementations materials, aggregates, and water and chemical admixtures. The mineral admixture that was used in this work was silica fume from ELKEM INDIA (P) LTD., Mumbai conforming to ASTM C-1240. The chemical admixture used for this work is CONPLASTSP 430, naphthalene based super plasticizer. Potable water was used for this work. The dosage of super-plasticizer adopted was 2.25% by weight of total cementations material. Locally available quarried and crushed blue granite stones conforming to graded aggregate of nominal size 12.5mm as per IS:383-1970 with specific gravity 2.82 and fineness modulus 6.73 as Coarse aggregates (CA) and Locally available river sand conforming to Grading zone II of IS: 383-1970 with specific gravity 2.75 and fineness modulus 2.73 as fine aggregates (FA) were used.

2.2. Experimental procedure

The dosages of silica fume were 0%, 12%, 12.5%, 13% and 13.5% of the total cementations materials. Each dosage was tested at w/cm ratios 0.42. It is reported that strength of both cement paste and concrete can be affected by the super-plasticizer. The dosage of super-plasticizer adopted was 2.5% by weight of total cementations materials for mixes.

In each module, the total weight of cementations materials were kept constant at 520 kg/cum. Total aggregate (coarse + fine) content was also kept constant at 1,813 kg / m3. The ca/fa ratios adopted for six modules were 2.174.

The mix details of all modules are given below in Table-1:

Table-1. Design mix details.

Grade	Mix No.	ca/fa	S.F. rep
M20, M25& M30	M-1	2.174	0%
	M-2		12%
	M-3		12.50%
	M-4		13%
	M-5		13.50%

3. TEST RESULTS

According to mix ratio in each mix 6 cubes and 3 cylinders were casted. 3 cubes were tested on 7th day, remaining 3 cubes on 28th day. Cylinders were tested to find the tensile and compressive strength. The test results are mentioned in Table-2.

Table-2. Compressive and split tensile test results.

Grade	S.F replacement	Cube compressive strength		Cylinder (28 days)	
		7 days	28 days	Comp. Strength	Tensile strength
M20	0.00%	16.48	31.12	26.17	2.82
	12.00%	16.96	31.76	26.42	2.87
	12.50%	17.4	32.18	27.41	2.92
	13.00%	18.24	33.41	28.3	3.12
	13.50%	17.64	32.58	27.6	3.06
M25	0.00%	17.02	34.28	29.03	3.21
	12.00%	17.39	34.74	29.37	3.27
	12.50%	17.84	35.51	29.67	3.34
	13.00%	18.84	36.28	31.27	3.61
	13.50%	18.12	35.71	30.17	3.47
M30	0.00%	17.09	39.29	33.03	3.97
	12.00%	17.31	40.11	33.69	4.12
	12.50%	17.82	40.65	34.28	4.29
	13.00%	18.59	41.88	35.5	4.56
	13.50%	18.12	41.44	35.05	4.36

4. RESULTS AND DISCUSSION

4.1 Cube compressive strength

Chart-1 shows the variation of average 7days cube compressive strength with respect to percentage replacement of cement with silica fume. Chart 2 shows the similar variations of 28 days. From these figures it can be seen that the average cube compressive strength is maximum when the silica fume replacement is 13%. Hence, it can be concluded that performance of silica fume concrete with regard to cube compressive strength is maximum at 13% replacement of cement with silica fume.

4.2 Cylinder compressive strength

Chart-3 shows the variation of average 28days cylinder compressive strength with respect to percentage replacement of cement with silica fume. From these figures it can be seen that the average cylinder compressive strength is maximum when the silica fume replacement is 13%. Hence, it can be concluded that performance of silica fume concrete with regard to

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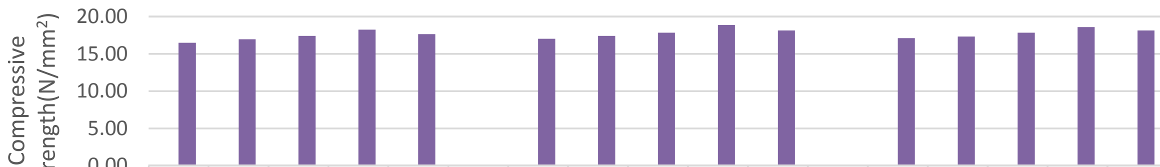
cylinder compressive strength is maximum at 13% replacement of cement with silica fume.

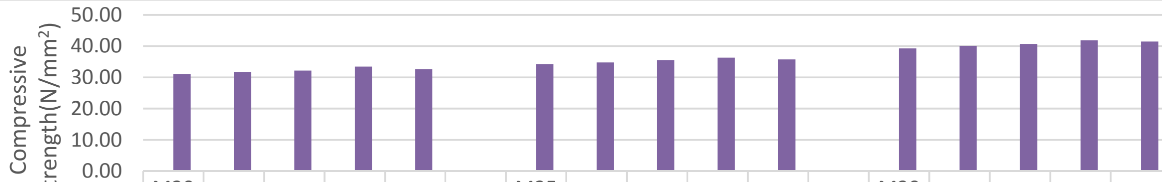
4.3 Tensile strength of cylinder

Chart-4 shows the variation of average 28days cylinder tensile strength with respect to percentage replacement of cement with silica fume. From these Figures it can be seen that the average cylinder tensile strength is maximum when the silica fume replacement is 13% of cement.



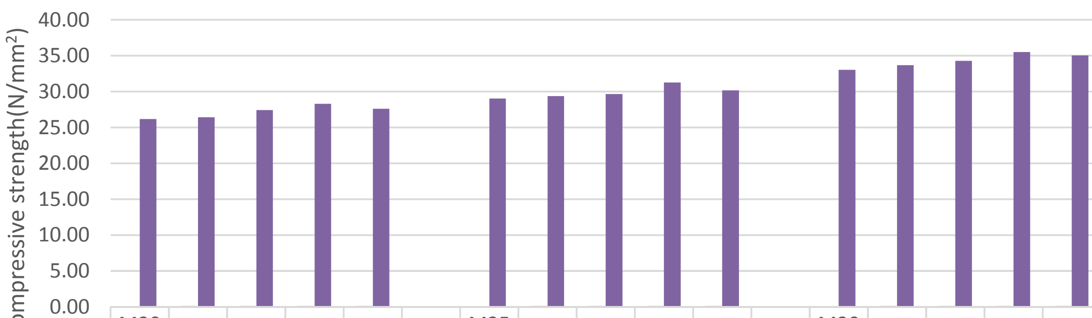
	M20						M25						M30				
S.F REPLA	0.00%	12.00	12.50	13.00	13.50		0.00%	12.00	12.50	13.00	13.50		0.00%	12.00	12.50	13.00	13.50
WITH S.P	16.48	16.96	17.4	18.24	17.64		17.02	17.39	17.84	18.84	18.12		17.09	17.31	17.82	18.59	18.12

Chart 1: 7 days Cube compressive strength



	M20						M25						M30				
S.F REPLA	0.00%	12.00	12.50	13.00	13.50		0.00%	12.00	12.50	13.00	13.50		0.00%	12.00	12.50	13.00	13.50
WITH S.P	31.12	31.76	32.18	33.41	32.58		34.28	34.74	35.51	36.28	35.71		39.29	40.11	40.65	41.88	41.44

Chart 2: 28 days Cube compressive strength



	M20						M25						M30				
S.F REPLA	0.00%	12.00	12.50	13.00	13.50		0.00%	12.00	12.50	13.00	13.50		0.00%	12.00	12.50	13.00	13.50
Comp. strength	26.17	26.42	27.41	28.3	27.6		29.03	29.37	29.67	31.27	30.17		33.03	33.69	34.28	35.5	35.05

Chart 3: 28 days Cylinder compressive strength

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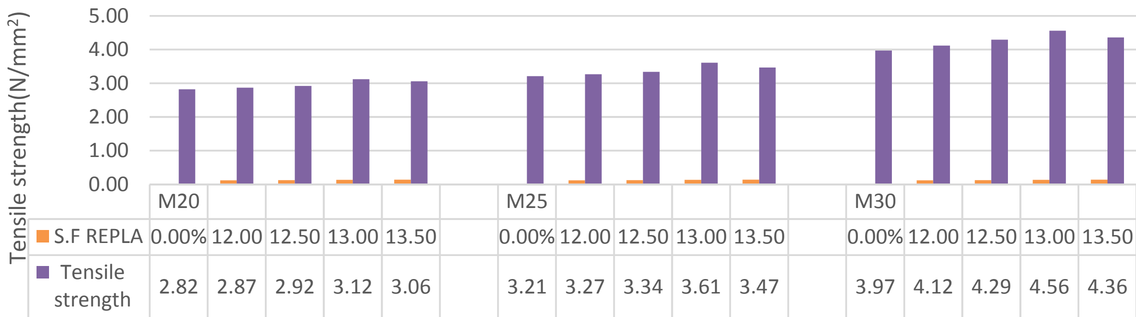

Chart 4 : 28 Days Cylinder tensile strength

5. CONCLUSION

It is concluded that the performance of silica fume concrete with respect to the cube and cylinder compressive strength is superior when the percentage replacement of cement with silica fume is 13%.

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