Int. J. Chem. Sci.: 14(S1), 2016, 359-366
ISSN 0972-768X
www.sadgurupublications.com

STUDY ON SILICA FUME REPLACED CONCRETE WITH SUPER PLASTICIZER

R. M. MADHANASREE[*,a], A. JOE PAULSON[b] and R. ANGELINE PRABHAVATHY[c]

[a]M. Tech. Student, Civil Department, Hindustan University, CHENNAI (T.N.) INDIA
[b]Assistant Professor, Department of Civil Engineering, Karunya University, COIMBATORE (T.N.) INDIA
[c]Professor, Civil Department, Hindustan University, CHENNAI (T.N.) INDIA

ABSTRACT

This paper presents an experimental study on the properties of silica fume replaced concrete and its nature as fresh and hardened concrete. The strength parameters of concrete made with partial replacement of cement by silica fume using super plasticizer is investigated. Properties of hardened concrete like ultimate compressive 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 use of silica fume as a pozzolana as it has increased worldwide attention over the recent years. When properly used it in certain percent, it can enhance various properties of concrete both in the fresh as well as in hardened states like cohesiveness, strength, permeability and durability. The silica-fume concrete included 0%, 12.5%, 13% and 13.5% silica as equal replacement of ordinary Portland cement of 53 Grade on the strength of M30, M35 & M40 grades. The ca/fa ratio adopted was 2.17.Extensive experimental investigation was carried out for various percentages of silica fume. 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 plasticizer is optimum.

Key words: Silica fume, Super plasticizer.

INTRODUCTION

General

Silica fume is a by- product in the production of silicon alloys such as ferro-chromium, ferro-manganese, calcium silicon etc., which also creates environmental pollution and health hazard. Silica fume is known to improve both the mechanical

---

*Author for correspondence; E-mail: madhanasreer@yahoo.com

characteristics and durability of concrete. Many modern concrete mixes are modified with the addition of admixtures, which improve the microstructure as well as decrease the calcium hydroxide concentration through a pozzolanic reaction. The subsequent modification of the microstructure of cement composites improves the mechanical properties, durability and increases the service-life properties.

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 slump greater 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 is to compare the strength parameters of silica fume replaced concrete and find the optimum percentage of replacement.

Literature review

Perumal et al (2004) has studied the effects of partial replacement of cement with silica fume on the strength and durability characteristics of high performance concrete. Cement replacement level of 10% with SF in M60, M70 and M110 grades of HPC mixes is found to be the optimum level to obtain higher values of compressive strength, split tensile strength, flexural strength and elastic modulus and lower values of porosity at the age of 28 days. Behnood et al. (2007) conducted experiment on the effects of silica fume addition on the properties of High performance concrete when exposed to different temperatures. The effect of different amounts of silica fume (SF) and water to cement ratios (w/c) on the compressive strength of high-strength concrete after exposure to high temperatures were determined. The strength loss for concrete specimens containing 6% and 10% Silica Fume at 600 C were 6.7% and 14.1% lower than those of the ordinary concrete. The dosage of Silica Fume had no significant effect on the compressive strength at 100 and 200 C, whereas the amount of Silica Fumes had considerable influences on the compressive strength at higher temperatures. Reddy et al. (2009) carried out a study on the influence of micro silica on the properties of ordinary Portland cement and Portland slag cement with and without super plasticizers. Out of all the various combinations of both ordinary Portland cement and Portland slag cement with partial replacement by micro silica with super plasticizer and without super plasticizer the best one was OPC with 10% micro silica and super plasticizer. It provided resistance to acid attack, alkaline attack and sulphate attack. In addition to an increase in the compressive strength as the age prolongs up to one year duration also. Katkhuda et al. (2009) determined the isolated effect of silica fume on tensile, compressive and flexure strengths on high strength lightweight concrete by replacing cement with different percentages of silica fume at different constant water-binder ratio keeping other mix design variables constant. The silica fume was replaced by 0%, 5%, 10%, 15%, 20% and 25% for water binder ratios 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. Hoe et al (2010), studied the rational mix design approach for high strength concrete using sand with very high fineness modulus and silica fumes as mix proportioning began with replacement of 12% of the total binder content with silica fume. Cubes were casted till a compressive strength of more than 65 mpa was achieved. Coarse aggregate with fineness modulus of 3.98 increased the compressive strength of the concrete in large extent and the high compressive strength of concrete 70.6 MPa.

EXPERIMENTAL

Materials

The chemical admixture used for this work is CONPLAST SP 430, which is a naphthalene based super plasticizer. Potable water was used in this work. The dosage of super-plasticizer adopted was 2.25% by weight of total cementitious material. Locally available quarried and crushed blue granite stones conforming to graded aggregate of nominal size 12.5 mm 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.

Experimental procedure

The dosages of silica fume were 0%, 12%, 12.5%, 13% and 13.5% of the total cementitious materials. Each dosage was tested at w/cm ratios 0.42.

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

Table 1: Design mix details

Grade	Mix No.	ca/fa	S.F.
M30, M35 & M40	M-1	2.174	0%
	M-2		12%
	M-3		12.50%
	M-4		13%
	M-5		13.50%

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	Compressive strength	Tensile strength
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

Cont…

Grade	S. F. Replacement	Cube compressive strength		Cylinder 28 days	
		7 Days	28 Days	Compressive strength	Tensile strength
M35	0.00%	17.45	44.71	37.76	4.16
	12.00%	17.72	45.28	38.43	4.28
	12.50%	18.29	46.09	39.07	4.35
	13.00%	19.05	47.51	40.32	4.72
	13.50%	18.71	46.77	39.17	4.5
M40	0.00%	18.25	50.61	42.53	4.48
	12.00%	18.72	51.31	43.02	4.7
	12.50%	19.32	51.81	43.18	4.81
	13.00%	20.09	53.07	44.48	4.94
	13.50%	19.61	52.15	43.21	4.87

RESULTS AND DISCUSSION

Cube compressive strength

Fig. 1 and 2 show the variation of averagecube compressive strength with respect to percentage replacement of cement with silica fume. Fig. 1 on 7 days and Fig. 2 on 28 days, respectively. The average cube compressive strength was maximum when the silica fume replacement was 13%. Hence, it was concluded that the performance of silica fume concrete with regard to cube compressive strength was maximum at 13% replacement of cement with silica fume.

Fig. 1: 7 Days cube compressive strength (N/mm^2)

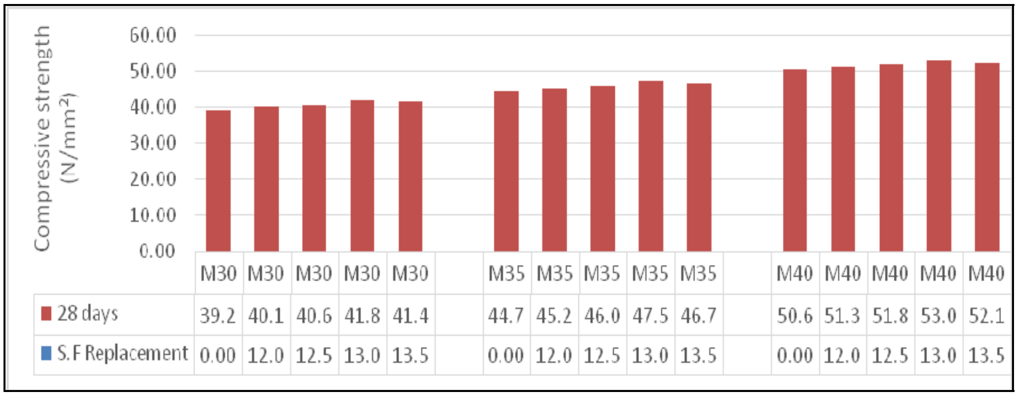

Fig. 2: 28 Days cube compressive strength (N/mm^2)

Cylinder compressive strength

Fig. 3 shows the variation of average 28 days cylinder compressive strength with respect to percentage replacement of cement with silica fume. The average cylinder compressive strength was maximum when the silica fume replacement was 13%. Hence, it was concluded that the performance of silica fume concrete with regard to cylinder compressive strength was maximum at 13% replacement of cement with silica fume.

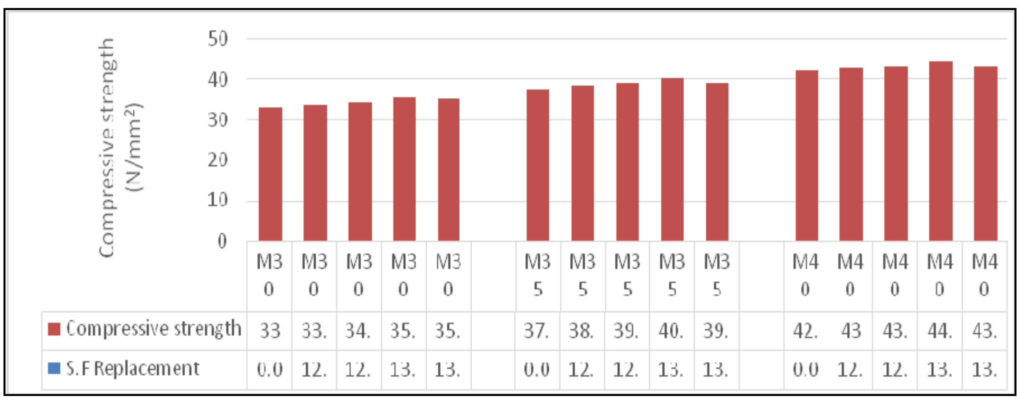

Fig. 3: 28 Days cylinder compressive strength (N/mm^2)

Tensile strength of cylinder

Fig. 4 shows the variation of average 28 days cylinder tensile strength with respect to percentage replacement of cement with silica fume. The average cylinder tensile strength is maximum when the silica fume replacement was 13% of cement.

Fig. 4: 28 Days tensile strength (N/mm2)

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%. The compressive strength attained in 7 days was 44.4% of its maximum strength attained in 28 days.

REFERENCES

1. A. Behnood and H. Ziari, Effects of Silica Fume Addition and Water to Cement Ratio on the Properties of High-Strength Concrete after Exposure to High Temperatures (2007).

2. A. Bashir et al., Study of Permeability and Compressive Strength of Silica Fume Concrete (2014).

3. N. K. Amudhavalli and J. Mathew, Effect of Silica Fume on Strength and Durability Parameters of Concrete (2012).

4. P. M. Anilkumar et al., Effects of Silica Fume and Fly Ash on Durability Characteristics of High Performance. Concrete (2014).

5. A. Chaipanich, Role of Silica Fume in Cement and Concrete Technology (2004).

6. S. Bhanja and B. Sengupta, Influence of Silica Fume on the Tensile Strength of Concrete (2004).

7. K. C. Biswal and S. C. Sadangi, Associate Professor, Department of Civil Engineering, National Institute of Technology, Rourkela, Orissa, India, Ex Post

Graduate Student, Department of Civil Engineering, NIT, Rourkela, Orissa, India. Effect of Superplasticizer and Silica Fume on Properties of Concrete (2011).

8. B. Damodhara Reddy, S. Aruna Jyothy and I. V. Ramana Reddy, Influence of Microsilica on the Properties of Ordinary Portland Cement and Portland Slag Cement with and Without Super Plasticizers (2009).
9. D. Pradhan et al., Studied the Influence of Silica Fume on Normal Concrete (2012).
10. D. K. S. Roy and A. Sil, Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete (2012).

Accepted : 04.05.2016