AN EXPERIMENTAL STUDY ON SELF COMPACTING CONCRETE BY USING SILICA FUME AS PARTIAL REPLACEMENT OF CEMENT

S.S.Janagan[1], V.Harikrishnan[2], M.Gnanaprakash[3], M.Karthikeyan[4], P.Mithunraj[5]
[1]Assistant Professor, Faculty of Civil Engineering, Gnanamani College of Technology , Pachal, Namakkal, Tamilnadu.Mail : janagansiddan@gmail.com
[2,3,4,5]Bachelor of Civil Engineering, Gnanamani College of Technology , Pachal, Namakkal, Tamilnadu.

Abstract
Self-compacting concrete is a concrete which gets compacted under its self-weight. SCC is defined as the concrete which can placed and compacted into every corner of formwork, no need for vibrators to compact the concrete. SCC can save up to 50% in labour cost due to 80% faster pouring and reduced wear and tear on formwork. The experiments were carried out by replacing cement with different percentage of silica fume at a single constant water cementitious (W/C) ratio for 0.45 workability tests such as slump flow, V-funnel, L-box, U-box are carried out to determine optimum parameters for the self-compatibility of mixtures. For harden test on compressive strength, split tensile strength, flexural strength and modulus of elasticity of specimens are carried out. The result obtained from these tests are compared with conventional concrete of M_{30} grade of concrete specimens. Hence the use of silica fume leads to reduction in cement quantity for construction purpose and its use should be promoted for better performance as well as for environmental sustainability.
Keywords: self compacting concrete, Silica fume, Compressive strength, Split tensile strength, Flexural strength.

1. INTRODUCTION

In last three decades, a lot of research was carried out throughout globe to improve the performance of concrete in terms of strength and durability qualities. Consequently concrete has no longer remained a construction material consisting of cement, aggregates and water only but he has becomes an engineered customs tailored material with several new constituents to meet the special needs of construction industry. The growing use of concrete is special architectural configurations and closely spaced reinforcing bars made it very important to produce concrete that ensure proper filling ability, good structural performance and adequate durability.

Till 1980 the research study was focused only flow ability of concrete, so as to enhance the strength however durability did not draw lot of attention of concrete technologies. This type of study has resulted in the development of self compacting concrete (SCC), a much needed revolution in concrete industry. Self compacting concrete with much higher fluidity without segregation and is capable of filling every corner of form work under its self-weight only (okamura 1997). Thus SCC eliminates the need of vibration either external or internal for the compaction of the concrete without compromising its engineering properties. SCC has been described as “the most revolutionary developments in concrete construction for several decades”. Originally developed in japan to offset a growing shortage of skilled labour. The advantages of SCC are faster construction, improved durability, easier placing, better surface finish, thinner noise level, reduction in site manpower and safe working environment.

SCC achieves by its unique fresh state properties. In the plastic state it flows under its own weight and maintain homogeneity will completely filling any form work any passing around congested reinforcement. The workability if SCC is the important parameter and it's characterized by filling ability, passing ability, and segregation resistance.

1.1 OBJECTIVE

1 .To reduce the Co_2 emission by adding Silica fume and coarse aggregates inSCC.

2. No bleed water or aggregates segregation, placed beingeasier.

3. According, the aim of this work is to determine the strength at various percentage of silica fume (0%, 5%, 10%, 15%, and 20%) levels for making M_{30} grade high strengthconcrete.

1.2 SCOPE

1. The scope of the study is restricted to the following aspects. The workability, compressive strength, split tensile strength of silica fume in SCC of different mix proportions with constant w/c ratio have been investigated.
2. SCC can save up to 50% in labourcost**.**

1.3 WORKABILITY PROPERTIES OF SCC

S .No	METHODS	PROPERTIES
1.	Slump flow	Filling ability
2.	V-Funnel	Filling ability
3.	L-Box	Passing ability
4.	U- Box	Passing ability

1.4 METHODOLOGY

- Literature Collection And Study
- Material Collection And Study
- Test On Material Study & Properties
- Mix Design M-30 Grade Of Concrete
- Testing Of Fresh Concrete
- Casting Of Specimens
- Curing Of Specimens
- Testing The Mechanical Properties Of The Concrete
- Result And Discussions
- Conclusion

2. MATERIAL PROPERTIES

2.1 MATERIAL UESD

- Cement (OPC 53)
- Coarse Aggregate
- Fine Aggregate
- Silica fume
- Mixing of water
- Super plasticizers

2.1.1 Cement

Cement is an important binding material for the production of concrete. In our project we had used ordinary Portland cement 53 grade confirming IS 12269-2013.

S.No	Test for Cement	Value obtained
1.	Normal consistency	28%
2.	Specific gravity	3.117
3.	Initial setting time	30 minutes
4.	Final setting time	230 minutes

2.1.2 Coarse Aggregate

As per IS 383:1970 the 20mm used. The shape of coarse aggregate is angular, water absorption is 1.0%. Specific gravity of nominal size of aggregate is 2.52

S.No	Test for coarse aggregates	Value obtained
1.	Specific gravity	2.52
2.	Water absorption	0.7%
3.	Impact value	10%

2.1.3 Fine Aggregate

As per IS 383:1970 fine aggregate properties were tested. Water absorption is 0.38%, Specific gravity of fine aggregate is 2.51

S.No	Test for fine aggregates	Value obtained
1.	Fineness modulus	2.39
2.	Specific gravity	2.51
3.	Water absorption	0.38%

2.1.4 Silica fume

Silica fume is a waste by product of the production of silicon and silicon alloys. Silica fume is available in different forms, of which the most commonly used in densified form.

S.No	Test for Silica fume	Value obtained
1.	Specific gravity	2.52
2.	Fineness modulus	0.7%

2.1.5 Water

According to IS 3025, water to be used for mixing and curing should be free from injurious or deleterious materials. Portable Water is generally considered satisfactory. In the present investigation, available water within the campus is used for both mixing and curing purposes**.**

3. MIX DESIGN

3.1Concrete mix proportion

The mixes were designated in accordance with IS 10262-2009 mix design method. Based on the results, the mix proportions M30 was designed. Concrete mix with w/c ratio of 0.45 was prepared. The details of mix proportions for $1m^3$ of concrete are given in Table below

Mix proportions for M30 Grade of Concrete (Kg/m^3)

Grade	Cement	FA	CA	Water
Mix 30	425.73	830.27	867.59	191.6
	1	1.95	2.03	0.45

4. CASTING OF SPECIMENS

a) Cubes (150x150x150mm)
b) Cylinders (150mm diameter, 300mm height)
c) Prism (500,100 and 100mm)

5. TESTING OF SPECIMENS

5.1 Fresh concrete test

a. Slump flow test
b. L- box test
c. U- box test
d. V- Funnel test

5.1.1 Slump flow test

Sl.No	Sample	Slump flow
1.	SCC+ 0% of silica fume	Collapse
2.	SCC+ 5% of silica fume	Collapse
3.	SCC+ 10% of silica fume	Collapse
4.	SCC+ 15% of silica fume	Collapse
5.	SCC+ 20% of silica fume	Collapse

5.1.2 L- box test

Sl. No	Sample	Height Difference(mm)
1.	SCC + 0% of silica fume	0.9
2.	SCC+ 5% of silica fume	0.95
3.	SCC+ 10 % of silica fume	0.85
4.	SCC+ 15% of silica fume	0.95
5.	SCC+ 20% of silica fume	0.75

5.1.3 U- box test

Sl. No	Sample	Height Difference (mm)
1.	SCC+ 0% of silica fume	0.53
2.	SCC+ 5% of Silica fume	0.57
3.	SCC+ 10% of silica fume	0.55
4.	SCC+ 15% of silica fume	0.63
5.	SCC+ 20% of silica fume	0.6

5.1.4 V- Funnel test

SI.NO	SAMPLE	FLOW TIME (SEC)
1	SCC+ 0 % of silica fume	6
2	SCC+ 5 % of silica fume	6.5
3	SCC+ 10 % of silica fume	7
4	SCC+ 15 % of silica fume	6.5
5	SCC+ 20 % of silica fume	8

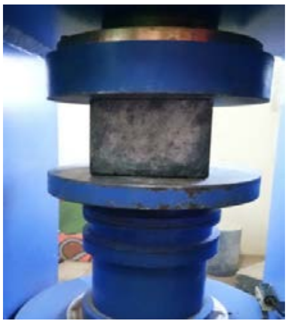
5.2 Hardened concrete test

a. Compressive strength test
b. Split tensile strength test
c. Flexural strength test

5.2.1 Compressive strength test

Compressive strength = (P/A) (N/mm^2)

Where,
P=Applied load (N)
A=Area of the specimen (mm^2)



5.2.2 Split tensile strength test

Split tensile strength test = (2xP)/ (πdl) (N/mm^2)

Where,
P=Applied load (N)
D=Diameter of the cylinder (mm)
L=Length of the cylinder (mm)

5.2.3 Flexural strength test

Flexural strength = (Pl/bd^2) (N/mm^2)
P= Applied load (N)
L= Length of the prism (mm)
d=Depth of the prism (mm)
b=Breadth of the prism (mm)

6. RESULTS AND DICUSSIONS

6.1 General

The result of the test that was carried out on trial mixes of M_{30} grade of concrete to evaluate their workability and strength properties are presented in this chapter. Trial mixes with varying percentages of silica fume added in concrete by (0%, 5%, 10%, 15%, and 20%) was studied. The properties of the concrete mixtures silica fumes in concrete are discussed in this chapter.

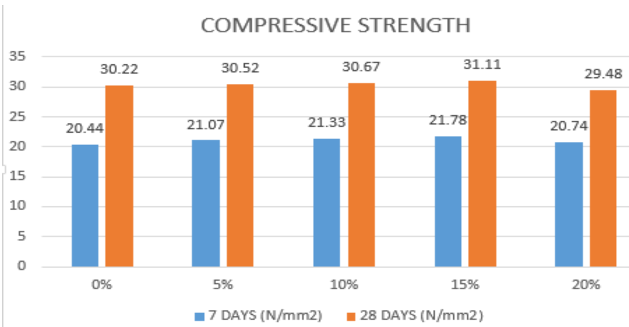
6.2 Strength properties of concrete

On hardened concrete strength properties such as compressive strength, split tensile strength and flexuralstrength were determined as per BIS specification.

6.2.1 Compressive Strength Analysis

The compressive strength tested on cube for different percentage of silica fume for M_{30} concrete for 7days and 28days having better result achieved, compared to conventional concrete high strength achieved in self compacting concrete. But strength was reduced at adding 20% of silica fume.

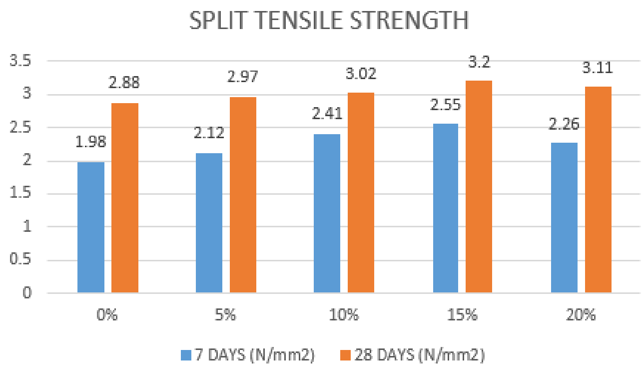
F_{ct} = P/A (N/mm^2)	PERCENTAGE OF CUBE				
	0%	**5%**	**10%**	**15%**	**20%**
7 Days (N/mm^2)	20.44	21.07	21.33	21.78	20.78
28 Days (N/mm^2)	30.22	30.52	30.67	31.11	29.48



6.2.2 Split tensile strength

The split tensile strength tested on cylinder for different percentage of silica fume for M_{30} concrete for 7days and 28days having better result achieved, compared to conventional concrete high strength achieved in self compacting concrete. But strength was reduced at adding 20% of silica fume.

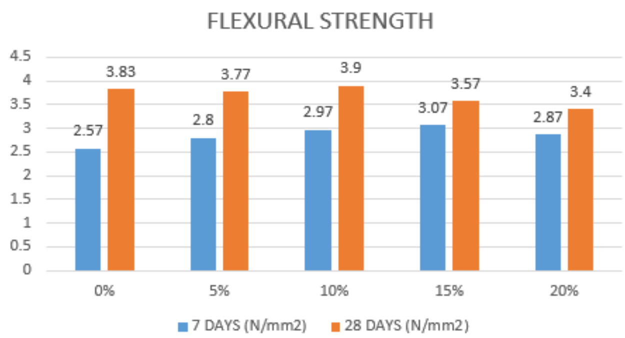
F_{ct} = $2P/\pi DL$ (N/mm^2)	PERCENTAGE OF CYLINDER				
	0%	**5%**	**10%**	**15%**	**20%**
7 Days (N/mm^2)	1.98	2.12	2.41	2.55	2.56
28 Days (N/mm^2)	2.88	2.97	3.11	3.2	3.39



6.2.3 Flexural strength test

The flexural strength tested on prism for different percentage of silica fume for M_{30} concrete for 7days and 28days having better result achieved, compared to conventional concrete high strength achieved in self compacting concrete. But strength was reduced at adding 15% and 20% of silica fume.

F_{ct} = PL/BD^2 (N/mm^2)	PERCENTAGE OF PRISM				
	0%	**5%**	**10%**	**15%**	**20%**
7 Days (N/mm^2)	2.57	2.8	2.97	3.07	3.4
28 Days (N/mm^2)	3.83	3.77	3.9	3.77	4.17



7.CONCLUSION

1. SCC with 5%, 10%, and 15% replacement of cement with silica fume showed good results in compression and tension, but

strength was decreased at 15% and 20% of silica fume in flexural zone.

2. Mix proportions, super plasticizers dosage and binder materials type used is responsible for variation in the concrete properties of flowing and self-compacting concretes.

3. Self compacting concrete with silica fume give better properties due to pozzolanic activity of the silica fume with higher reactivity related with the higher fineness.

4. However, on a more rational basis of total cost, including the labour charges, formwork and making good finished surfaces, SCC can more advantageous.

REFERENCES

1.Debabrata Pradhan and D. Dutta "Influence of silica fume.

2.G. Iyappan, k. Suganthi, R. Saleema begum and R. Dharamaraj "Experimental investigation of SCC using silica fume**".**

3. Luiz Roberto Prudencio, Jr.Alexantre Lima de oliveira, Fernanado pelisse and Philippe jean paul gleize "Use of porcelain polishing as a supplementary cimentitious material in self compacting concrete''.

4. Reze Bani Ardalan, Aires Joshaghani and R.Douglas Hooton "Workability retention and compressive strength of self compacting concrete incorporating pumice powder and silica fume".

5.Ram Kumar and Er.Jitender Dhaka"Review paper on paritial replacement of cement with silica fume and its effects on concrete properties".

6. Sheelan M.Hama and Nahla N.Hila"Fresh properties of scc with plastic state partial replacement of sand".

7. Vanab Naderi Zarnaghi, Ali Fouroghi Asl, Vahid Nourani and Hongyan Ma "On the pore structure of light weight scc containing silica fume".

8. Yimmy Fernado Siva, David A.Lange and Silvio Delvasto"Effect of incorporation of masonary residue on properties of self compacting cocnrete"

Author reference

1.Mr.S.S.JANAGAN ,Assistant Professor, Faculty of Civil Engineering, Gnanamani College of Technology , Pachal, Namakkal, Tamilnadu.Mail : janagansiddan@gmail.com

2.V.HARIKRISHNAN ,Bachelor of Engineering, Gnanamani College of Technology , Pachal, Namakkal, Tamilnadu.Mail :harikrishnancivil98@gmail.com

3.M.GNANAPRAKASH ,Bachelor of Engineering, Gnanamani College of Technology , Pachal, Namakkal, Tamilnadu. Mail :msgnanaprakash1105@gmail.com

4.M.KARTHIKEYAN , Bachelor of Engineering, Gnanamani College of Technology , Pachal, Namakkal, Tamilnadu.Mail : karthimadhew18297@gmail.com

5.P.MITHUNRAJ ,Bachelor of Engineering, Gnanamani College of Technology , Pachal, Namakkal, Tamilnadu.Mail : Mithunraj.yakvaj@gmail.com