International Journal on Applications in Civil and Environmental Engineering
Volume 4: Issue 2 : May 2018, pp 23 – 29 www.aetsjournal.com *ISSN (Online) : 2395 - 3837*

EXPERIMENTAL INVESTIGATION ON SELF COMPACTION CONCRETE USING EXFOLIATED VERMICULITE AND MICRO SILICA FUME

S.SATHISH KUMAR , P.GOPALSAMY

***Abstract*—** Construction of durable concrete structures requires skilled labour for placing and compacting concrete. Self-compacting concrete achieve this by its unique fresh state properties. In the plastic state, it flows under its own weight and homogeneity while completely filling any frame work and passing around congested reinforcement. In the hardened state, it equal or excels standard concrete with respect to strength and durability. In order to explore the possibility of utilizing the exfoliated vermiculite and micro silica fume as partially replacement to fine aggregate and cement, an experimental investigation has been carried out. The percentages of exfoliated vermiculite added by weight to replace fine aggregate by weight were 0, 10%, 20% and 30%, and micro silica fume added by weight to replace cement by weight were 0, 5%, 10% and 15%. Specimens were to be cast M30 grade of concrete and fresh characteristics were evaluated based on its passing ability, flow ability, viscosity, and segregation resistance using J-ring, slump flow, V funnel, L-box, U-box tests. Test on compressive, split tensile, flexural strength and Deflection behavior of the specimen were also been studied.

Keywords -- Exfoliated Vermiculite, Micro Silica Fume, super plasticizer, Compressive Strength, Split Tensile Strength, Flexural Strength, Deflection Behavior.

I. INTRODUCTION

The development of new technology in the material science is progressive rapidly. In last three decades, a lot of research of carried out through out globe to improve the performance of concrete in terms of strength and durability qualities. Consequently concrete has no longer remain a construction material consisting of cement, aggregate and water only, but has becomes an engineered custom tailored material with several new constituents to meet the specific needs of construction industry. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability. In recent years, a lot research was carried out throughout the world to improve the performance of concrete in terms of its most important properties, i.e, strength and durability. Concrete technology has undergone from macro to micro level study in the enhancement of strength and durability properties from 1980's onwards. Till 1980 the research study was focused only to flow ability of concrete, so as to enhance the strength however strength durability didn't draw lot of attention of the concrete technologists. This type of study has resulted in the development of self compacting concrete (SCC), a much needed revolution in concrete industry. Self compacting concrete is highly engineered concrete with much higher fluidity without segregation and is capable of filling every corner of form work under its self weight only (Okamura 1987). Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties.

This concrete was first developed in Japan in late 80's to combat the deterioration of concrete quality due to lack of skilled labors, along with problems at the corners regarding the homogeneity and compaction of cast in place concrete mainly with intricate structures so as to improve durability concrete and structures. After the development of SCC in Japan 1988, Whole Europe started working on this unique noise free revolution in the field of construction industry. The last half of decade 1981 – 2000 has remained very active in the field of research in SCC in Europe. That is why, Europe has gone ahead of USA in publishing specification and guidelines for self compacting concrete (EFNARC 2002). Now, all over the world, a lot of research is going on, so as to optimize the fluidity of concrete with its strength and durability properties without a drastical increase in the cost. The first North American conference on designed and use of self – consolidation concrete was organized in November 2002. At present many researches are working in numerous universities and government R&D organization due to benefits of the use of this concrete. A very limited work is reported from India, Where the future for concrete is very bright due to scarcity of skilled manpower non-mechanization of construction industry, abundant availability of construction materials available at very low cost. Therefore, it can be said that SCC is still quite unknown to many researches, builders ready mix concrete produces academia etc.

Self compacting concrete is basically a concrete which is capable of flowing in to the formwork, without segregation, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other energy during placing. There is no standard SCC. Therefore each

S.Sathish kumar , Post Graduate Student, M.A.M.College Of Engineering And Technology, Trichirappalli . (Email ID : Smjsathish93@Gmail.Com)
P.Gopalsamy , Asst Professor, Dept Of Civil Engineering,M.A.M.College Of Engineering And Technology, Trichirappalli

SCC has to be designed for the particular structure to be constructed. However working on the parameters which affect the basic properties of SCC Such plastic viscosity, deformability, flow ability and resistance to segregation, SCC may be proportioned for almost any type concrete structure.

To establish an appropriate mixer proposion for a SCC the performance requirements must be defined taking into account the structural conditions such as shape, dimensions, reinforcement density and construction conditions. The construction conditions include methods of transporting, placing, finishing and curing. The specific requirement of SCC is its capacity for self-compaction, without vibration, in the fresh state. Other performance such as strength and durability should be established as for normal concrete.

II. SELF COMPACTION CONCRETE

A) Definition

The concrete that is capable of self consolidation and occupying all the formwork without any vibration is termed as self – compaction concrete. The guiding principle behind the self – compaction is that "the sedimentation velocity of a particle is inversely proportional to the viscosity of the floating medium in which the particle exists.

B) Ingredients of SCC

The constituent materials used for the production of scc are discussed as follows

1) CEMENT

Ordinary Portland cement (53 grade) cement conforming to IS 8112 was used. The various laboratory tests were conducted on cement to determine standard consistency, initial and final setting time as per IS 403 I and IS 269 – 1967. The results are tabulated in table 1 the result conforms to the IS recommendations.

TABLE - 1 PROPERTIES OF CEMENT

S.NO	Test conducted	Result
1	Normal consistency	32%
2	Initial setting time	35 mins
3	Final setting time	540 mins
4	Specific gravity of cement	3.14

2) FINE AGGREGATE

The sand used for experimental program was locally procured and conforming to zone II. The sand was first sieved through 4.75 mm to remove and particles greater than 4.75 mm. the fine aggregates were tested as per Indian standard specification IS:383 – 1970. Properties of the fine aggregate used in the experimental work are tabulated in table 2.

TABLE - 2 PROPERTIES OF FINE AGGREGATE

S.NO	Test conducted	Result
1	Specific gravity	2.57
2	Fineness modulus	2.90

3) COARSE AGGREGATE

The shape and particle size distribution of the aggregate is very important as it affects the packing and voids content. The moisture content, water absorption, grading and variations in fine content of all aggregates should be closely and continuously monitored and must be taken in to account in order to produce SCC of constant quality. Coarse aggregate used in this study had a maximum size of 12.5 mm. Properties of the coarse aggregateused in the experimental work are tabulated in table 3,

TABLE - 3 PROPERTIES OF COARSE AGGREGATE

S.NO	Test conducted	Result
1	Specific gravity	2.70
2	Fineness modules	7

4) WATER

Mixing water quality is required in accordance with the quality standards of drinking water, use for PH>4 clean water.

5) SUPER PLASTICIZER

Chemical admixtures are important in the self- compacting concrete mix, as the w/c ratio is greatly reduced. Therefore high range water reducers are to be used to obtain the required workability. In the present investigation, poly corboxylate ether. This super plasticizer colour was brown liquid.

6) VMA

Master glenium sky 8233, viscosity modifying admixture(VMA) specially developed for producing concrete with enhanced viscosity and controlled rheological properties. It increases resistance to segregation and exhibits superior stability and controlls bleeding.

7) EXFOLIATED VERMICULITE

Vermiculite is a hydrous phyllosilicate mineral. It undergoes significant expansion when heated. Vermiculite is chosen to replace fine aggregate in concrete because of its specific properties such as it is lighter in weight, improved workability, improve fire resistance, improved resistance to cracking and shrinkage and mainly inert chemical nature. The specific gravity of vermiculite is 2.5.

Figure 1 Exfoliated Vermiculite

8) MICRO SILICA FUME

Micro silica fume imparts very good improvement to rheological. Mechanical and chemical properties. It improves the durability of the concrete and thus reduces segregation and bleeding. Silica fume of specific gravity 2.34 was used in this study. Silica fume contains more than 90% silicon dioxide.

Figure 2 Micro Silica Fume

9) MIX PROPORTION

Cement	=	372.53kg/m^3
Fine aggregate	=	763.36kg/m^3
Coarse aggregate	=	1189.08kg/m ^{3}
Water	=	152.6liter
Super plasticizer	=	1%
VMA	=	1.2%
Mix proportion	=	1:2.04:3.1

- poly corboxylate ether super plasticizer is used as admixture.
- Master glenium sky 8233is used for viscosity modifying Agent.
- Scc1: controlled concrete
- Scc2:5%SF+95%cement+10%EV+90%fa
- Scc3:10%SF+90%cement+20%EV+80%fa
- Scc4:15%SF+85%cement+30%EV+70%fa

III. TEST RESULT

A. Fresh state

Tested on fresh concrete were performed to study the workability of SCC with various proportions of exfoliated vermiculite and micro silica fume. The tests conducted are listed below.

- Slump flow test
- V- funnel test
- J- ring test
- L- box test
- U- box test

TABLE - 4 TEST RESULT ON FRESH CONCRETE

Identification	Tests on fresh concrete				
	Slump	J-ring	V-funnel	L-box	U-box
SCC1	710	9.8	8.9	0.89	22
SCC2	690	8.7	8.7	0.87	25
SCC3	685	9.2	8.6	0.85	26
SCC4	665	8.9	8.3	0.83	28

B. Harden state

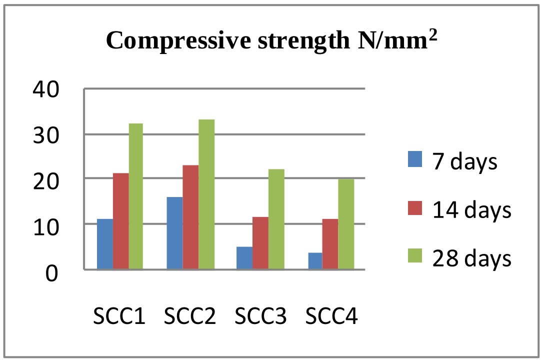
1) Compressive Strength:

Twelve standard cubes, every one for diverse percentages were tested to determine the 7-day,14-day and 28-day compressive strength and results are given in Table - 5 graphs below shows the variation of compressive strength with diverse replacement of exfoliated vermiculite and micro silica fume.

Figure 3 compressive test on cube

TABLE – 5 COMPRESSIVE STRENGTH OF CONCRETE CUBE (N/MM^2)

Cube	EV	SF	7Days	14days	28days
SCC1	0%	0%	11.5	21.33	32
SSC2	10%	5%	16.0	23.11	33
SCC3	20%	10%	5.3	11.55	22
SCC4	30%	15%	4.0	11.11	20



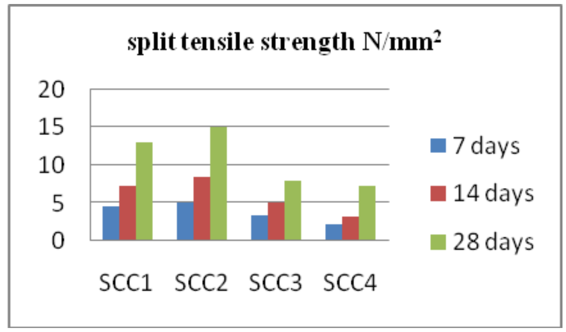
2) Split Tensile Strength:

Twelve standard cylinder, every one for diverse percentages were tested to determine the 7 - day, 14 - day and 28 - day compressive strength and result are given in Table -9 graphs below shows the variation of split tensile strength with diverse replacement of exfoliated vermiculite and micro silica fume.

Figure 4 split tensile test on cylinder

TABLE – 6 SPLIT TENSILE STRENGTH OF CONCRETE (N/MM^2)

Cube	EV	SF	7Days	14days	28days
SCC1	0%	0%	4.52	7.35	13
SSC2	10%	5%	5.09	8.48	15
SCC3	20%	10%	3.39	5	8
SCC4	30%	15%	2.26	3.3	7.3



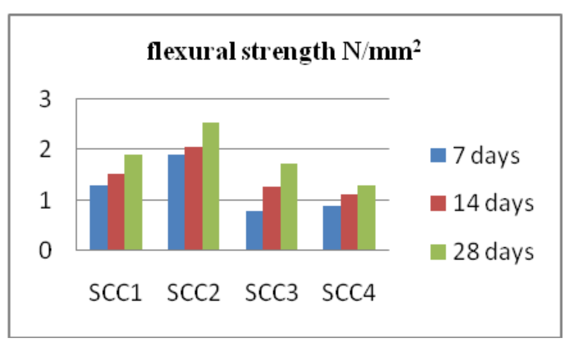
3) Flexural Strength:

Twelve standard prism, every one for diverse percentages were tested to determine the 7 - day, 14 - day and 28 - day flexural strength and result are given in Table - 7 graphs below shows the variation of flexural strength with diverse replacement of exfoliated vermiculite and micro silica fume.

Figure 5 flexural test on prism

TABLE – 7 FLEXURAL STRENGTH OF CONCRETE PRISM (N/MM^2)

Cube	EV	SF	7Days	14days	28days
SCC1	0%	0%	1.3	1.53	1.9
SSC2	10%	5%	1.9	2.06	2.55
SCC3	20%	10%	0.8	1.28	1.74
SCC4	30%	15%	0,9	1.12	1.3



4) Deflection Behaviour

In order to study the performance of the beam with partial replacement of cement by silica fume, the experimental is to be carried out as below the tables 11,12,13,14. The aim of this study is to study the flexural behaviour of the beams.

Dimensions of Beam and reinforcement details

Length = 1m - 2nos of 8 mm dia@bottom Rft,
Breath = 0.15m - 2Nos of 8 mm dia @ top Rft,
Depth = 0.15m - 6 mm Stirrups @ 100 mm c/c.
No of beams = 4

Figure 6deflection test on beam

TABLE 8 EXPERIMENTAL FOR SCC1 SPECIMEN

Load	Deflection L/2(mm)	Remarks
0	0	
2.28	0.13	
4.06	0.29	
6.44	0.58	
8.09	0.89	
10.04	1.31	
12.17	1.69	
14.04	2.22	
16	2.53	Initial crack
18.02	2.87	
20.67	3.22	
22.14	3.27	
24.50	4.39	
26.53	5.12	
28.08	6.09	
30.02	6.92	
32.27	7.92	
34.09	8.88	
36.09	10.12	
38.49	11.78	
40.59	12.32	
42.18	13.77	
44.03	16.91	Failure
43.02	18.45	

TABLE 9 EXPERIMENTAL FOR SCC2 SPECIMEN

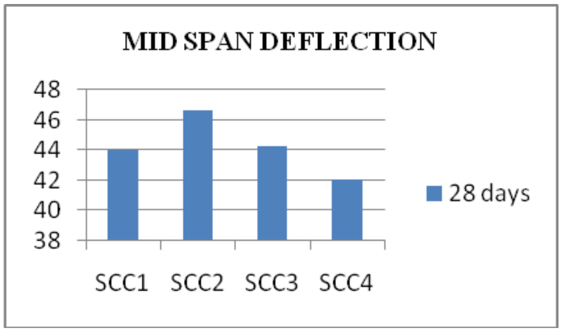
Load	Deflection L/2	Remarks
0	0	
2.04	0.14	
4.56	0.39	
6.37	0.87	
8.36	1.23	
10.56	1.65	
12.34	1.81	
15	2.47	Initial crack
16.07	2.79	
18.67	3.13	
20.56	3.54	
22.14	3.97	
24.86	4.36	
26.11	4.75	
28.35	5.06	
30.31	5.73	
32.47	6.49	
34.09	7.45	
36.87	8.29	
38.48	9.17	
40.67	10.93	
42.38	12.44	
44.54	14.22	
46.67	16.74	Failure
42.11	20.74	

TABLE 10 EXPERIMENTAL FOR SCC3 SPECIMEN

Load	Deflection L/2	Remarks
0	0	
2.69	0.25	
4.89	0.42	
6.17	1.12	
8.67	1.27	
10.89	1.67	
12.23	1.98	
14.64	2.16	
17	2.69	Initial crack
18.33	2.97	
20.78	3.19	
22.39	4.41	
24.89	5.92	
26.48	6.17	
28.32	7.33	
30.35	8.65	
32.59	9.97	
34.76	10.36	
36.43	10.87	
38.56	11.53	
40.86	12.87	
42.58	13.27	
44.23	16.95	Failure
43.12	22.85	

TABLE 11 EXPERIMENTAL FOR SCC4 SPECIMEN

Load	Deflection L/2 (mm)	Remarks
0	0	
2.30	0.94	
4.14	0.89	
6.88	1.78	
8.43	1.54	
10.03	2.98	
12.12	2.23	
14	2.25	Initial crack
16.44	3.67	
18.45	4.41	
20.05	4.48	
22.08	5.77	
24.03	5.25	
26.17	6.32	
28.32	7.75	
30.58	9.29	
32.59	10.37	
34.02	11.02	
36.55	12.62	
38.26	15.21	
40.12	16.15	
42.11	22.15	Failure
40.09	26.94	



IV. CONCLUSION

From the experimental investigations In this project work experiments were carried out for the percentages of exfoliated vermiculite added by weight to replace fine aggregate by weight 0, 10%, 20% and 30%, and micro silica fume added by weight to replace cement by weight were 0, 5%, 10% and 15%in self compacting concrete.The addition of silica fume resulted in similar flow parameters in SCC as that of conventional self compacting concrete.It is more important and quality method.

The results of tests on its compressive strength, split tensile strength and flexural strength a test shows that the strength increased when the fine aggregate is replaced with 10% exfoliated vermiculite and cement is replaced with 5% micro silica fume. When exfoliated vermiculite and micro silica fume further added (or) increased in the concrete the strength found to decrease.

The behavior of deflection it is clearly from above the tables 11, 12, 13,14 that exfoliated vermiculite 10% and micro silica fume 5% (SCC2) have the highest load carrying capacity among the group. The other specimen performed in a poor manner with low load carrying capacity.

REFERENCES

[1] Chandra Sekar G[1], Hemanth Kumar Ch[2](2016),"Effect of fly ash on mechanical properties of light weight vermiculite concrete", international journal of innovative research in science

[2] Mr. M. Gunasekaran (2016),"Study on vermiculite in corporate in mortar", International Journal for Innovative Research in Science & Technology 2349-6010

[3] M.R.Divya, Prof.M.Rajalingam, Dr.Sunilaa George (2016), "A Study on concrete with replacement of fine aggregate by vermiculite", International Journal of New Technology and Research 2454-4116

[4] Praveen Kumar E[1], Manojkumar C[2] (2006), "Experimental study of vermiculite insulated samples with conventional samples in construction industry", International Journal of Research in Engineering and Technology 2319-1163

[5] A. V. V. Sairam[1], K. Sailaja[2] (2007),"An experimental study on strength properties of vermiculite concrete using fly ash as partially replacement of cement and silica fume as mineral admixtures", International Research Journal of Engineering and Technology

[6] Praveer Singh[1], Mohd. Afaque Khan[2] (2016),"The Effect on Concrete by Partial Replacement of Cement by silica fume", International Research Journal of Engineering and Technology

[7] Dilip Kumar Singha Roy[1], Amitava Sil[2] (2012)," Effect of Partial Replacement of Cement by Silica Fume on harden concrete", International Journal of Emerging Technology and Advanced Engineering

[8] Ashutosh Sharma, (2006)," Effect of partial replacement of cement with silica fume on compressive strength of concrete", international journal of research in technology and management
Prof. Vishal S. Ghutke[1](2011),"Influence of silica fume onConcrete", Journal of Mechanical and Civil Engineering

[9] Alaa M. Rashad (2016)," Vermiculite as a construction material"Construction and Building Materials 125 (2016) 53–62.