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Alccofine and steel in self-compacting concrete

Mrs Khating A. A[1]. , Mr. Supekar G. S.[2] Mr. Mehetre S. M.[3]

[1]*Civil Engineering, Samarth Engineering, Belhe.*
[2] *Civil Engineering Jaihind Polytechnic, Kuran.*
[3]*Civil Engineering JCOE, Kuran.*

Abstract - *Self-compacting concrete (SCC) is considered as a concrete which can be placed and compacted under its self weight with little or no vibration effort and which is at the same time cohesive enough to be handled without segregation or bleeding. It is used to facilitate and ensure proper filling and good structural performance of restricted areas and heavily reinforced structural members. SCC was developed in Japan in the late 1980s to be mainly used for highly congested reinforced structures in seismic regions. Recently, this concrete has gained wide use in many countries for different applications and structural configurations. SCC can also provide a better working environment by eliminating the vibration noise. There are many advantages of using SCC, especially when the material cost is minimized. These include:*

1.Reducing the construction time and labor cost;
2.Eliminating the need for vibration;
3.Reducing the noise pollution;
4.Improving the filling capacity of highly congested structural members.
5.Facilitating constructability and ensuring good structural performance.

Keywords- *Alccofine, self-compacting concrete, steel fibre*

I. INTRODUCTION

ASFSCC offers several economic and technical benefits; the use of steel fibres extends its possibilities. Steel fibres acts as a bridge to retard their cracks propagation, and improve several characteristics and properties of the concrete. Fibres are known to significantly affect the workability of concrete. Therefore, an investigation was performed to compare the properties of plain normal compacting concrete (NCC) and SCC with steel fibre and alccofine. Fly ash has high pozzolanic reactivity and low price as compared to silica fume and fly ash as it is a manufactured product. It reduces free drying shrinkage and restrains the shrinkage cracking width. It also helps in enhancing the compressive strength and durability of SCC.

II. OBJECTIVES

1. To study the strength properties of ASFSCC composite with various % of alccofine and constant % of steel fiber such as Compressive Strength, Split Tensile Strength and Flexural Strength.
2. To investigate the properties of ASFSCC composite with various % of alccofine and constant % of steel fiber such as Workability.
3. To compare the properties of ASFSCC with different % of alccofine for constant % of Steel fiber.

III. MIX DESIGN FOR SELF COMPACTING CONCRETE

Initially Mix design for M30 grade concrete was done by using IS-10262 method of Mix design. This mix is then further modified for relative proportions of fine and coarse aggregates with addition of filler materials like as Fly ash and super plasticizer to make it SCC. For Mix design of SCC guidelines given by “Rational SCC Mix Design Method” developed by Okamura and Ozawa were followed. Those guidelines are as follows:

Table 1:- Guidelines for Mix Design of SCC as per Rational SCC Mix Design Method

Constituent	Typical range by Mass (kg/m^3)	Typical range by volume (liters/m^3)
Powder	380-600	
Paste		300-380
Water	150-210	150-210
Coarse Aggregate	750-1000	270-360
Fine Aggregate (Sand)	Contents balance the volume of the other constituents, typically 48-55% of total aggregate weight.	
Water/Powder ratio by Vol.		0.85-1.10

The mix Design is based on approach Outlined below:

1) Determination of desired air content.
2) Determination of Coarse aggregate content
3) Determination of sand content
4) Determination of optimum water: powder ratio and super plasticizer dose.
5) Finally the concrete properties are assessed by standard tests.

Mix design selection and adjustment can be made according to the procedure shown in Fig. 2.15.

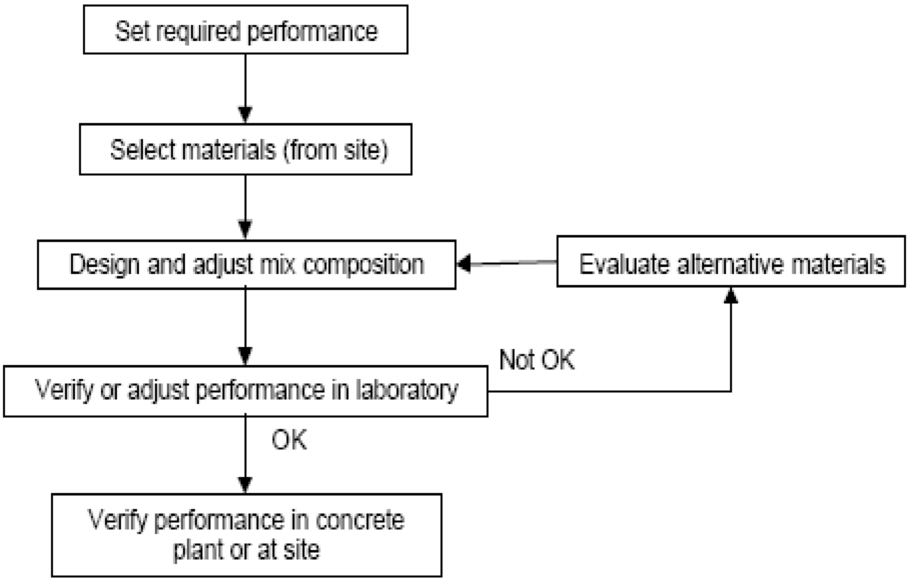


Fig1 Mix Design Procedure chart

1. Actual Mix Design

Selecting Vol. of water / Vol. of powder=0.9
Volume of Water=0.203m^3
Hence, Volume of cement= 0.203÷0.9
= 0.226 m^3
Wt. of cement= 0.226×31.5 (considering Sp.Gr. of Cement=3.15)
= 711.9 Kg.

2. Quantities for One Cubic Meter Concrete

1) Weight of Cement = 498.3 kg
2) Weight of Fly Ash = 213.6kg
3) Sand(Taking fine Aggregates 55% of total Aggregate Content) =
55⁄100× (569.29+1076.06)
= 904.94 kg.
4) Weight of coarse aggregate = 740.41 kg
5) Super plasticizer (1% bwc) = 4.983 kg
6) VMA (0.5% bwc) = 2.492 kg
***bwc**=by weight of cement

3. Proportion

Cement	Flyash	sand	Coarse aggregate	water
1	**0.3**	**1.814**	**1.48**	**0.408**

IV TEST RESULTS OF SELF COMPACTING CONCRETE:

Table 2: Slump Cone Test by Abrams Cone

Sr. No.	Alccofine(%)	Flyash (BWC)	Steel Fiber (%)	Slump Flow By Abrams Cone (mm)	
				Horizontal Slump (mm)	T_{50} -Time (Sec.)
1.	0	0.3	0	612.5	4
2.	5	0.3	1	590	3.5
3.	10	0.3	1	550	3
4.	15	0.3	1	540	2
5.	20	0.3	1	532	2.8
6.	25	0.3	1	505.8	3

Table 3: V-Funnel Test

Sr. No.	Alccofine (%)	Flyash (BWC)	Steel fibre (%)	V-Funnel Test
				Flow Time (Sec.)
1.	0	0.3	0	15
2.	5	0.3	1	70
3.	10	0.3	1	80
4.	15	0.3	1	95
5.	20	0.3	1	107
6.	25	0.3	1	121

Table 4: L-Box Test

Sr. No.	Alccofine (%)	Flyash (BWC)	Steel fibre (%)	L Box Test				
				T_{20} Time (Sec)	T_{40} Time (Sec)	H_1 (mm)	H_2 (mm)	H_1/H_2 Ratio
1.	0	0.3	0	5	10	5	3	1.66
2.	5	0.3	1	10	16	7	3	2.33
3.	10	0.3	1	25	36	6.2	2.1	2.95
4.	15	0.3	1	47	55	8	1.7	4.7
5.	20	0.3	1	51	58	8.7	1.3	6.69
6.	25	0.3	1	63	67	9.5	0.9	10.55

Table 5 U Box Test

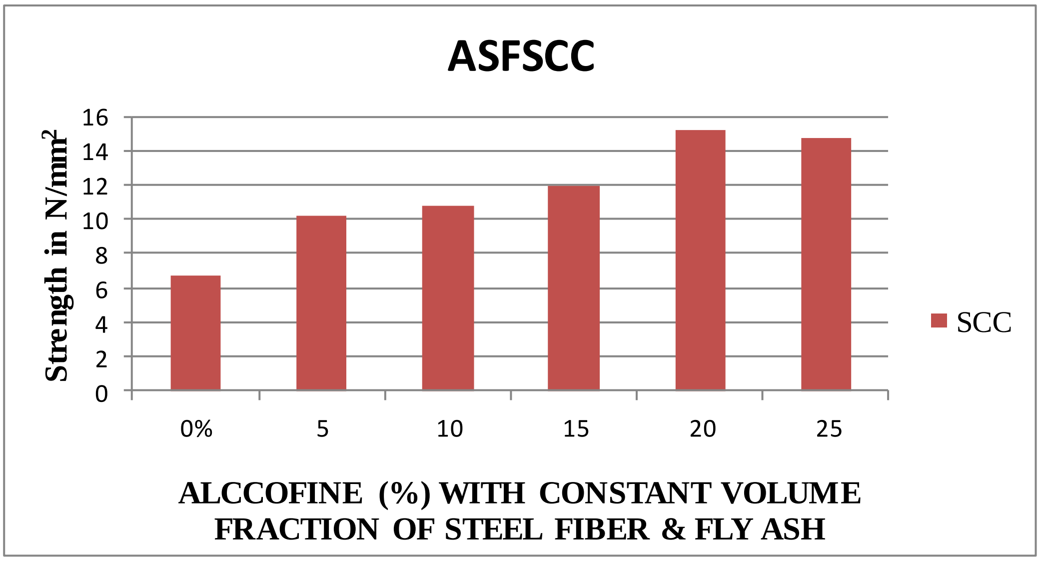
Sr. No.	Alccofine (%)	Flyash (BWC)	Steel fibre (%)	U Box Test		
				H_1 (mm)	H_2 (mm)	H_1-H_2 (mm)
1.	0	0.3	0	380	320	60
2.	5	0.3	1	390	310	80
3.	10	0.3	1	430	220	210
4.	15	0.3	1	580	120	360
5.	20	0.3	1	600	100	500
6.	25	0.3	1	650	50	600

Table 6 J Ring Test

Sr. No.	Alccofine (%)	Flyash (BWC)	Steel fibre (%)	J Ring Test		
				H_1 (mm)	H_2 (mm)	H_1-H_2 (mm)
1.	0	0.3	0	10	8	2
2.	5	0.3	1	13	6	7
3.	10	0.3	1	10	7	3
4.	15	0.3	1	12	6	6
5.	20	0.3	1	11	7	4
6.	25	0.3	1	10	6	4

Table 7 Compression Test of Cubes at the End of 3 Days

Sr. No.	Alccofine (%)	Steel fiber (%)	Fly ash (%)	Comp. Load (KN)	C/S Area (mm^2)	Comp. Strength (N/mm^2)	Avg. Comp. Strength (N/mm^2)
1.	0	0	0.3	150	22500	6.67	6.75
				145		6.44	
				161		7.15	
2.	5	1	0.3	227	22500	10.08	10.23
				219		9.73	
				229		10.17	
3.	10	1	0.3	242	22500	10.75	10.79
				239		10.62	
				248		11.02	
4.	15	1	0.3	264	22500	11.73	11.92
				253		11.24	
				288		12.80	
5.	20	1	0.3	327	22500	14.53	15.19
				334		14.84	
				365		16.22	
6.	25	1	0.3	333	22500	14.80	14.68
				342		15.20	
				316		14.04	



Graph 1: Comparative chart of compressive strength

Table 8: Compression Test of Cubes of SSC at the End of 7 Days

Sr. No.	Alccofine (%)	Steel fiber (%)	Fly ash (%)	Comp. Load (KN)	C/S Area (mm2)	Comp. Strength (N/ mm2)	Avg. Comp. Strength (N/ mm2)
1.	0	0	0.3	238	22500	10.57	10.86
				254		11.28	
				242		10.75	
2.	5	1	0.3	245	22500	10.88	10.84
				239		10.62	
				248		11.02	
3.	10	1	0.3	285	22500	12.62	12.39
				272		12.08	
				281		12.48	
4.	15	1	0.3	445	22500	19.75	19.45
				438		19.46	
				431		19.15	
5.	20	1	0.3	447	22500	19.86	20.18
				453		20.13	
				461		20.48	
6.	25	1	0.3	447	22500	19.86	19.97
				453		20.13	
				448		19.92	

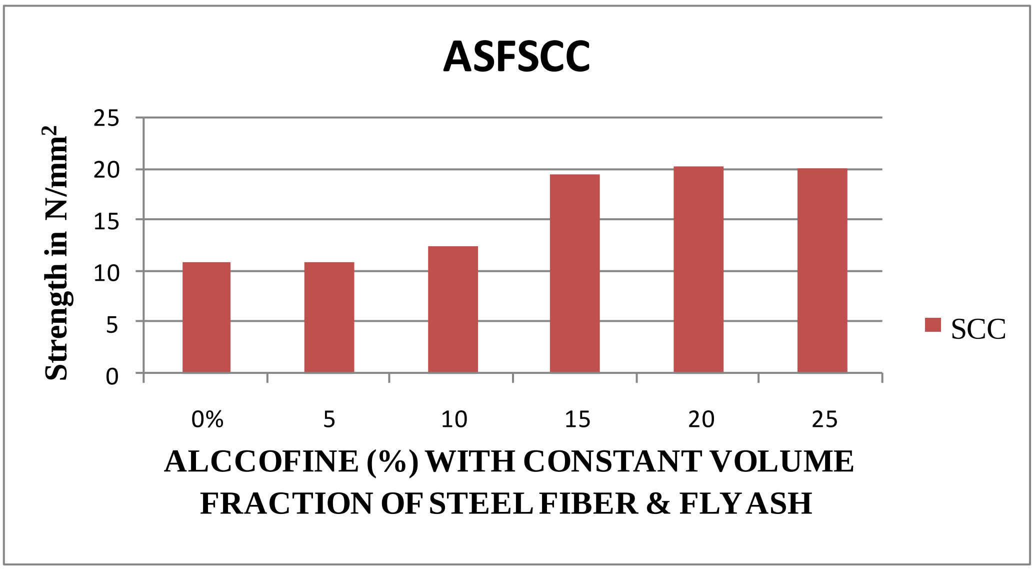


Table 9 Compression Test of Cubes of SCC at the End of 28 Days

Sr. No.	Alccofine (%)	Steel Fiber(%)	Flyash (Bwc)	Comp. Load (KN)	C/S Area (mm2)	Comp. Strength (N/ mm2)	Avg. Comp. Strength (N/ mm2)
1.	0	0	0.3	415	22500	18.44	19.37
				458		20.35	
				435		19.33	
2.	5	1	0.3	569	22500	25.28	25.61
				572		25.42	
				588		26.13	
3.	10	1	0.3	621	22500	27.60	27.35
				614		27.88	
				598		26.57	
4.	15	1	0.3	700	22500	31.10	30.88
				695		30.88S	
				690		30.66	
5.	20	1	0.3	498	22500	22.13	23.34
				543		24.13	
				535		23.77	
6.	25	1	0.3	453	22500	20.13	20.05
				434		19.28	
				467		20.75	

Table 10: Split Tensile Strength on Cylinder of SCC at the End of 28 Days

Sr. No.	Alccofine (%)	Steel Fiber (%)	Flyash (Bwc)	Load (N)	Split Tensile Strength (N/ mm^2)	Avg.Split Tensile Strength0.4 $\sqrt{fck}$ (N/ mm^2)
1.	0	0	0.3	131	1.85	1.94
				145	2.02	
				138	1.95	
2.	5	1	0.3	158	2.23	2.31
				164	2.32	
				166	2.38	
3.	10	1	0.3	170	2.40	2.40
				171	2.42	
				168	2.37	
4.	15	1	0.3	174	2.46	2.50
				181	2.56	
				176	2.49	
5.	20	1	0.3	122	1.72	1.61
				112	1.58	
				109	1.54	
6.	25	1	0.3	98	1.38	1.45
				107	1.51	
				105	1.48	

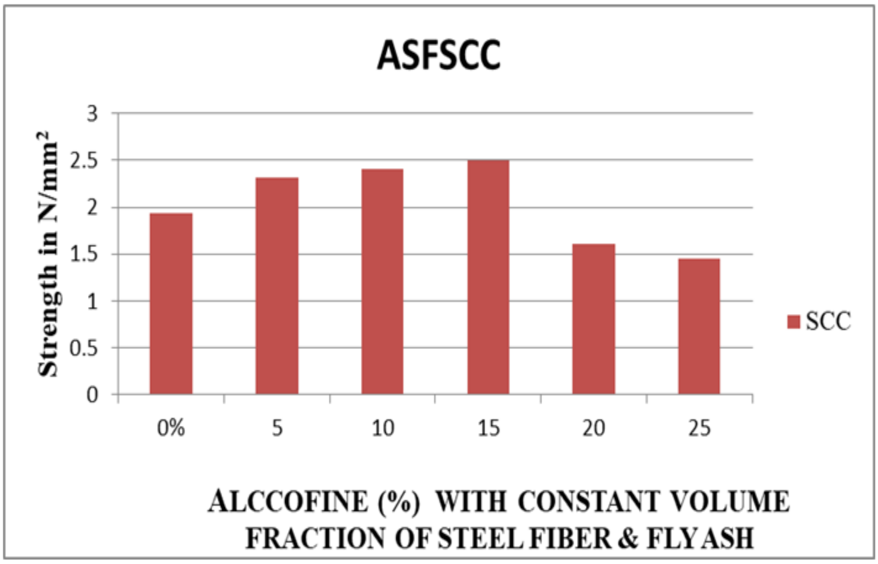
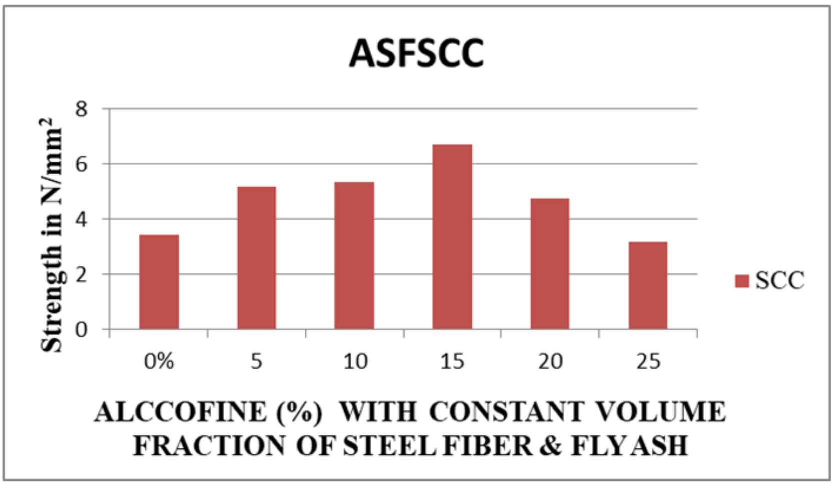


Table 11: Flexural Strength on SSC at the End of 28 Days

Sr. No.	Alccofine (%)	Steel fibre(%)	Flyash (Bwc)	Applied Load At Failure (KN)	Flexural Strength (N/ mm^2)	Avg. Flexural Strength, $0.7\sqrt{fck}$ (N/ mm^2)
1.	0	0	0.3	15	3.11	3.45
				18	3.73	
				17	3.52	
2.	5	1	0.3	22	4.56	5.18
				25	5.18	
				28	5.80	
3.	10	1	0.3	30	6.22	5.36
				23	4.68	
				25	5.18	
4.	15	1	0.3	32	6.63	6.7
				37	7.67	
				28	5.80	
5.	20	1	0.3	22	4.56	4.73
				25	5.18	
				21	4.45	
6.	25	1	0.3	14	2.90	3.17
				17	3.52	
				15	3.11	



VI. CONCLUSION

The present investigation has shown that it is possible to design alccofine and steel fibre in self-compacting concrete incorporating fly ash. The SCCs have a slump flow in the range of 505.5-612.5 mm, a flow time ranging from 2 to 4 s, V-funnel flow in the ranging from 15 to 121 sec ,a L-Box ratio ranging from 1.66 to 10.55, U box test value ranging from 60 to 600mm and a J-Ring test value ranging from 2 to 6mm. It was observed that it is possible to achieve self compaction with different percentage of alccofine and constant volume fraction steel fiber i.e. 1% inclusion.

Although results obtained from all of the mixes satisfy the lower suggested by EFNARC, all mixes had good flow ability and possessed self-compaction characteristics.

The SCC developed compressive strengths ranging from 6.75 to 14.68Mpa at the end of 3 days, from 10.84 to 14.68Mpaat the end of 7 days and from 19.37 to 30.88Mpa, at the end of 28 days.

The SCC developed split tensile strengths ranging from1.61 to2.50Mpa at the end of 28 days.

The SCC developed flexural strengths ranging from 3.45 to 6.7Mpa at the end of 28 days.

The strength of SCC is increase up to 15%, beyond 15% of alccofine the strength get reduced. Addition of superplastisizer in SCC to maintain flow ability gives proper compaction of concrete which enhance all properties of SCC. Also the addition of fly ash in SCC improves microstructure of concrete that also helpful to enhance all mechanical properties with the durability of concrete.

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