EXPERIMENTAL INVESTIGATION OF EFFECT OF SAND FINES ON PROPERTIES OF SELF COMPACTING CONCRETE

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Abstract: It is proven that fines are important constituent to produce self compacting concrete (SCC). Comparing to conventional concrete more fines are added in SCC. Cement, fly ash and any filler material finer than 125 micron are considered as powder or fines. Amount of fines affects the fresh and hardened properties of the self compacting concrete. Fine aggregate used in the production of concrete also has some fines in it. In this paper effect of sand fines on fresh and hardened properties are investigated and presented. SCC mix were prepared by varying sand fines content from 6.9% in sand to 0 % and all other mix constituent were kept constant. Fresh properties like slump flow, T_{500} time and hardened properties like compressive strength were found.

***Index Terms* – Self compacting concrete, Sand fines, slump flow, compressive strength.**

I. INTRODUCTION

Self compacting concrete is becoming popular day by day due to its ease of use, less voids due to self compactibility and many other advantages. But at the same time SCC is very sensitive to variation of its mix constituent. As shown in figure powder content is more in SCC comparing to conventional concrete. Any particles finer than 125 micron are considered in powder. This fine material affects the flowability, segregation resistance and strength of the concrete. In this paper effect of finer particles present in fine aggregate on properties of SCC is investigated.

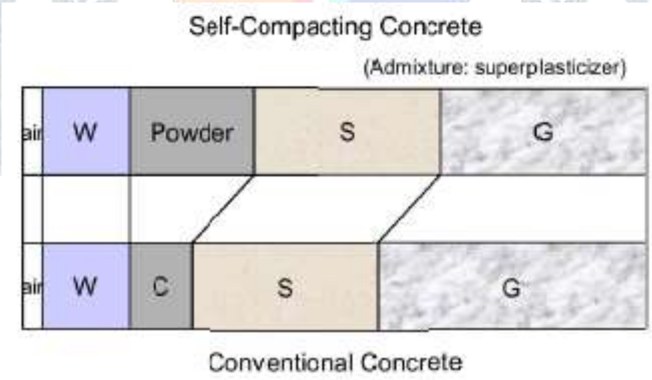

Figure 1. Comparison of material proportion for SCC and Conventional concrete (Okamura[1])

II. LITERATURE REVIEW

1. EFNARC Guidelines- European Approach

Self compacting concrete consists of almost same constituent materials as conventional concrete, which are cement, aggregates, water and with the addition of super- plasticizer and mineral admixtures (fly ash, Micro silica fume, GGBS, lime stone powder etc.) in different proportions. Usually, the chemical admixtures used are high-range water reducers (HRWR) and viscosity-modifying agents (VMA), which change the properties of concrete.

- Mineral admixtures are used as an extra fine material, besides cement, and in some cases, they replace cement.
- High volume of super-plasticizer is used for better workability
- The high powder content is used as “lubricant” for the coarse aggregates to flow.
- viscosity-agents to increase the viscosity of the concrete and segregation resistance

Table-1 Requirements of SCC mix in Fresh State as per EFNARC guideline

	Classes	Range (mm)	Application	Purpose	Remarks
Slump Flow	SF-1	550-650	Unreinorced	To check segregation, filling ability, viscosity	If paste extend several millimetres from the C.A. and if C.A. segregated at central area
	SF-2	660-750	Normal		
	SF-3	760-850	Very Congested Stru.		
T 500 time	VS-1	<=2	Good Filling,Surace finish	Viscosity	Prone to bleeding and seggregation
	VS-2	>2	High segregation Resistance		Lake in Surface finish
V Funnel	VF-1	<=8	Same as T500	Viscosity	Same as T500
	VF-2	9 to 25			
L-Box	PA-1	>=0.80 with 2 rebars	Housing/Vertical Structures (Gap 80 mm to 100 mm)	Passing Ability-Flow without blocking	No need when gap is more than 100 mm
	PA-2	>=0.80 with 3 rebars	Civil Engineering Stru. (Gap 60 mm to 80 mm)		
Sieve Segregation Test	SR-1	<=20%	For thin slabs & Vertical Application	Segregation resistance for higher slump flow	Flow Distance<5m Confinement Gap >80mm
	SR-2	<=15%	Tall Vertical Application		Flow Distance>5m Confinement Gap <80mm

SCC requirements are specific to site condition. If reinforcement is little or no, no need of passing ability

Salient Point of Mix Design

1. Water/powder ratio by volume of 0.85 to 1.1 by Volume
2. Total powder content - 160 to 240 litres (380-600 kg) per cubic meter.
3. Total Paste Content- 300 to 380 litre
4. Coarse aggregate content normally 27 to 36 per cent by volume of the mix.(750-1000 kg)
5. Water Content 150-210 litre/m3
6. The sand content 48-55 % of total aggregate weight.

III. EXPERIMENTAL INVESTIGATION

MATERIAL PROPERTIES

In present study material used are 20 mm coarse aggregate, fine aggregate, PCE based super plasticizer Master Glenium Sky BASF 8549. All imported properties of these materials are found and presented.

Table-2 Specific gravity and Water Absorption of materials used

Material	Specific Gravity	Water Absorption
Cement (PPC)	2.9	-----
Coarse Aggregate (20 mm)	2.86	1.11
Fine Aggregate	2.57	1.89
Master Glenium Sky 8549	1.1	-----

Table-3 Sieve Analysis of Fine Aggregate

Sr. No.	I.S. Seive Size	RETAINED			% ge Passing	Required % age Passing for Zone-II as per IS-383	Required % age Passing for Zone-III as per IS-383
		Weight	% ge retained	Cum % ge retained			
1	10	0	0	0.00	100	100	100
2	4.75	21	2.1	2.10	97.9	90 to100	90 to100
3	2.36	73	7.3	9.40	90.6	75 to 100	85 to 100
4	1.18	168	16.8	26.20	73.80	55 to 90	55 to 90
5	0.6	82.0	8.2	34.40	65.6	**35 to 59**	**60 to 79**
6	0.3	351	35.1	69.50	30.5	8 to 30	12 to 40
7	0.15	236	23.6	93.10	6.9	0 to 10	0 to 10
8	0.075	69.0	6.9	100.00	0	0 to 3	0 to 3
9	Pan	0	0	100.00			

Table 4 shows the mix proportion taken in this study. Total 10 mixes are prepared keeping aggregate volume constant to check the effect of aggregate. At first four mixes were prepared by varying sand proportion in total aggregate and after that six mixes were prepared by varying sand fines. Slump flow, T500 time and V funnel test were carried out for fresh concrete and compressive strength test carried out for hardened concrete.

Table-4 Proportions finalized for SCC mix per cubic meter of concrete:

	Water	Cement	Admixture-Super Plasticizer (SP)	sand	10 mm	20 mm	Marble Dust
Volume (ltr)	200	137.93	2.91	639.16			
Kg	200	400	3.2	1107	0	596.08	0
	FIX			VARYING			

Table 5: Design Mix using Maximum Size of aggregate 20 mm

Mix Designation	Combination of Aggregate		20 mm	10 mm	Sand	Marble Dust	Cement	water	SP
	FA	20 mm							
Mix 1	65:35		596.08	0.00	1107.00	0.00	400.00	200.00	3.200
Mix 2	60:40		684.83	0.00	1027.25	0.00	400.00	200.00	3.200
Mix 3	55:45		774.53	0.00	946.65	0.00	400.00	200.00	3.200
Mix 4	52:48		828.81	0.00	897.87	0.00	400.00	200.00	3.200

In above mix it is observed that the combination in which sand proportion is more exhibits the lesser strength. After close analysis it was found that fines content in sand used in this mix is about 6.9 %. For combination of 65% sand with 35% of 20 mm aggregate, sand fines is 76.38 kg/m3, which comes 4.49% of total aggregate.. Maximum strength in design mix with MSA 20 mm was found for the aggregate combination of 52% sand and 48% coarse aggregate i.e for Mix-4,in which sand fines content was 3.59% of total aggregate i.e. 61.95 kg per cubic meter of concrete. Now to check effect of sand fines, sand fines in aggregate combination of 60%:40 % and 55%:45% (FA to 20 mm CA) reduced from 61.95 kg/m3 to 0 kg/m3. Actually in 60:40 and 55:45 combination sand fines are 70.88 kg/m3 and 65.32 kg/m3 respectively.

Table 6: Design Mix to check Effect of Sand Fines

Mix Designation	Combination of Aggregate		20 mm	10 mm	Sand (>150 micron)	Sand (<150 micron)	Cement	water	SP
	FA	20 mm							
Mix 5	60:40		684.83	0.00	965.30	61.95	400.00	200.00	3.200
Mix 6	60:40		684.83	0.00	997.25	30	400.00	200.00	3.200
Mix 7	60:40		684.83	0.00	1027.25	0	400.00	200.00	3.200
Mix 8	55:45		774.53	0.00	884.70	61.95	400.00	200.00	3.200
Mix 9	55:45		774.53	0.00	916.65	30	400.00	200.00	3.200
Mix 10	55:45		774.53	0.00	946.65	0	400.00	200.00	3.200

Figure 2: Fines sieved from sand

IV. RESULTS AND DISCUSSION

Table 7: Compressive strength and fresh properties of design mix with MSA 20 mm

Mix Designation	Combination of Aggregate		Slump Flow (mm)	T500 (Sec)	V Funnel (Sec)	Compressive Strength		Remarks/ Observation
	FA	20 mm				7 Days	28 Days	
Mix 1	65:35		730	2.36	4.8	22.07	34.82	
Mix 2	60:40		680	2.57	4.4	22.2	35.52	
Mix 3	55:45		640	3.12	2.4	23.46	39.92	
Mix 4	52:48		650	3	1.66	26.9	41.37	Bleeding

MIX-1

Mix-2

MIX-3

MIX-4

Figure 3: Slump flow for Mix 1, 2, 3 and 4

It can be seen that, Mix-1, Mix-2 and Mix-3, fine aggregate percentage in total aggregate is 65%, 60% and 55% respectively. Slump flow is decreasing as sand percentage is decreased and strength is increased as sand percentage is decreased even if all other materials are in same amount in the mix.

Table 8: Compressive strength and fresh properties of design mix varying the sand fines

Mix Designation	Combination of Aggregate		Slump Flow (mm)	T500 (Sec)	V Funnel (Sec)	Compressive Strength		Remarks/ Observation
	FA	20 mm				7 Days	28 Days	
Mix 15	60:40		680	1.59	7.77	21.3	39.36	
Mix 16	60:40		700	1.72	6.5	23.29	39.19	
Mix 17	60:40		675	1.36	4.8	23.99	41.49	
Mix 18	55:45		675	1.57	8.4	17.6	39.84	Bleeding
Mix 19	55:45		700	1.51	7.5	19.14	40.02	Bleeding
Mix 20	55:45		700	1.34	6.99	23.7	41.81	Bleeding

Mix-4 **Mix-5** **Mix-6**

Figure 3: Slump flow for Mix 4, 5 and 6

Mix-7 **Mix-8** **Mix-9**

Figure 4: Slump flow for Mix 7, 8 and 9

Discussion of Result: It was found that if sand fines are decreased the strength of mix is increased but chance of bleeding increases. In above mix strength was almost becomes equal to that with the maximum strength achieved in Mix 3, without much compromising to slump flow.

IV. CONCLUSION

1. Strength of SCC mix is affected by the amount of sand fines present in mix. Strength is increased as sand fine is decreased.
2. Sand used in present study has around 6.9 % particles finer than the 150 micron sieve. Sand fines shall be under 4% for SCC mix with 20 MSA.
3. It can be concluded that for lower grade of concrete in which Cementitious material is less effect of sand fines is considerable.
4. Fines are necessary for viscosity improvement and to stop bleeding, but sand fines present in mix decreases the strength.

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