Research Paper Management

A State of Art- Self Compacting Concrete with Various Industrial Waste

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ABSTRACT

Self-compacting concrete (SCC) requires large amount of powder content and fine particles as compare to courser for its cohesiveness and ability to flow without bleeding and segregation. Also day by day, the amount of the industrial waste like fly ash, silica fume, quarry dust etc. as a waste material is significantly increasing all over the world. So literature study done on the influence of including various industrial wastes on the fresh properties and harden properties of self-compacting concrete. Studies include the fresh properties and harden properties like slump-flow test, L-box test V-funnel test, compressive strength, split tensile strength of SCC.

Keywords : Self Compacting Concrete, Fly ash, Silica fume

Introduction

Self-compacting concrete (SCC) is relatively new one which can be placed and compacted under its own weight with little or no vibration, but has gained popularity in last few decades because it leads to improve concrete quality, productivity and working conditions compared to normally vibrated concrete (NVC) [2]. SCC was originally developed at the University of Tokyo, Japan during the year 1986 by Prof. Okamura and his team to improve the quality of construction and also to overcome the problems of defective workmanship. A prototype of SCC for structural applications was first completed in 1988 and was named ''High Performance Concrete'', and later proposed as ''Self Compacting High Performance Concrete''. A committee was formed to study the properties of SCC, including a fundamental investigation on workability of concrete, which was carried out at the University of Tokyo, Japan [1].

SCC represents one of the most outstanding advancement in concrete technology during the last decade. Due to its specific properties, which are achieved by the excellent co-ordination of deformability and segregation resistance, SCC may contribute to a significant improvement in the quality of concrete structures and open up new fields for the application of concrete [1]. The introduction of SCC represents major technological advances, which leads to a better quality concrete and an efficient construction process. SCC allows the construction of more slender building elements and more complicated and interesting shapes. The production of SCC allows the pumping of concrete to a great height and the flow through congested reinforcing bars without the use of compaction other than the concrete self-weight. As a result, the use of SCC can lead to a reduction in construction time, labour cost and noise level on the construction site [5].

REVIEW OF VARIOUS LITERATURE PAPER AS PROPERTIES OF SELF COMPACTING CONCRETE

In general, it is difficult to compare the properties results of self compacting concrete of different published studies. This is due to the fact that in each study the factors that affect the fresh properties and harden properties of the composites are varied. Some of these factors include water to binder ratio, dosage of super plasticizer, and percentage of industrial waste utilization in the matrix characteristics. However, despite these factors, there are some common trends among the data obtained by previous investigators as may be seen in the literature review summary.

Binu Sukumar, K. Nagamani, R. Srinivasa Raghavan [1] studied the effect 0f high volume fly ash on the self compacting concrete in early ages of the SCC. In this study author taken OPC Cement of 53grades, fine aggregates of specific gravity 2.64, course aggregates of specific gravity 2.79, potable water, class F fly ash, quarry dust of specific gravity 3.64, PCE based super plasticizer, and VMA. This investigation is based on two different mix proportions for various grades of SCC. The mix proportions (A-series and B-series) for various rades of SCC (30–70 MPa) were determined. A-series is obtained by using fly ash alone as mineral admixture and B-series using quarry dust as inert filler along with fly ash and are tabulated in Table 3. AS30 stands for mix A for a grade of 30 MPa and BS30 stands for mix B for a grade of 30 MPa. Percentage of cement content varies from 25% to 89% of total powder, fly ash content varies from 52% to 8% of total powder and quarry dust (granite powder used as inert filler) varies from 22% to 3% of total powder for different grades of B-series from 30 to 70 MPa. For a grade of 30 MPa SCC (BS30), cement content is only 25% of total powder content and the rest 75% of the powder consist of fly ash and quarry dust. Whereas in AS30, cement content is 48% and the remaining 52% is occupied by fly ash alone. Poly carboxylic ether based super-plasticiser is used for the high workability and water retention. The dosage of super-plasticiser is optimised by conducting Marsh Cone test. Optimum dosage of super-plasticiser of 0.4–0.7 is used as percentage of binder for water/powder ratio of 0.34–0.31. VMAs are also used to enhance stability and viscosity and there by cohesiveness of the mix. Another mix proportions are arrived for the same grades from 30 to 70 MPa by using only fly ash as mineral admixture.

Table 1: Mix Proportion for various grade of SCC.

Mix ID		Fly ash (kg/	Quarry dust (kg/	FA (kg/ m^3)	CA (kg/	W/P ratio	SP% of	VMA% of binder
AS30	250	275	-	842	772	0.34	0.4	0.1
BS30	133	275	117	842	772	0.34	0.4	0.1
AS40	333	215	--	835	766	0.33	0.4	0.1

BS40	246	215	87	835	766	0.33	0.4	0.4
AS50	417	153	-	828	759	0.32	0.5	0.1
BS50	357	153	60	828	759	0.32	0.5	0.1
AS60	500	101	-	820	753	0.32	0.5	0.1
BS60	463	101	37	820	753	0.31	0.6	0.1
AS70	583	50	--	813	745	0.31	0.7	0.1
BS70	566	50	17	813	746	0.31	0.7	0.1

For this study different ingredients were batched by weight as per the mix proportions given in Table 1 and mixed well in a pan mixer of capacity 60 kg and the workability tests such as slump flow test, V-funnel test, and L-box test as per specifications were carried out to test the flowability, filling ability, passing ability and segregation resistance as per specifications. The workability test results (Table 2) are found to be within the prescribed limits as per specifications and satisfy all the required rheological characteristics of self compatibility.

This self compacting concrete of different grade were filled in cubes and cylindrical specimens to find out the harden properties of the concrete such as compressive strength and split tensile strength of the concrete as shown in the table 3 and table 4 respectively.

Table 2: Workability test results.

Mix ID	W/P ratio	SP% of binder	Slump Flow (mm)	T50cm Time (s)	V-funnel flow at T_f (s)	**V funnel flow at Tmin (s)**	L-Box h_2/h_1
AS30	0.34	0.4	793	1.0	3	4	1.0
BS30	0.34	0.4	675	1.5	5	6	0.91
AS40	0.33	0.4	786	1.0	4	5	0.99
BS40	0.33	0.4	690	2.0	5	5	0.92
AS50	0.32	0.5	773	1.5	4	5	0.96
BS50	0.32	0.5	685	2.0	4	5	0.89
AS60	0.32	0.5	766	1.5	5	6	0.95
BS60	0.31	0.6	695	2.0	4	5	0.94
AS70	0.31	0.7	742	2.0	5	6	0.95
BS70	0.31	0.7	680	2.0	4	6	0.9

Table 3: Compressive Strength of SCC.
Table 4: Split Tensile Strength of SCC.

Mix ID	7 days	28 days
AS30	27.6	39.62
BS30	21.28	32.5
AS40	35.26	50.24
BS40	28.41	42.3
AS50	43.54	61.82
BS50	34.69	52.00
AS60	49.81	70.93
BS60	41.83	61.9
AS70	55.92	81.25
BS70	48.8	71.5

Mix ID	7 days	28 days
AS30	3.12	4.06
BS30	2.76	3.72
AS40	3.96	5.01
BS40	3.35	4.53
AS50	4.58	5.95
BS50	3.76	5.06
AS60	4.85	6.72
BS60	4.35	5.79
AS70	5.48	7.54
BS70	4.84	6.54

Halit Yazıcı [3], has replaced cement with a Class C fly ash (FA) in various proportions from 30% to 60%, and studied the mechanical properties. Also he carried out the similar test with the incorporation of 10% silica fume to the same mixture. A natural river sand and crushed limestone with a maximum size of 15 mm was used as fine and coarse aggregates, respectively. The specific gravity and water absorption properties of river sand and crushed limestone are 2.60, 1.63%, and 2.71, 0.39%, respectively. A new generation polycarboxylate based super plasticizer meeting standard specifications of ASTMC 494 Type F was used in this study. Preliminary test results showed that SP used in this study gave higher spread retention with FA blended cement comparing to the Portland cement SCC at 20°C.

In order to keep a constant water/binder ratio, super plasticizer has been used in different dosages. In mix design total cementitious content was kept constant at 600 kg/m^3, and the water/binder ratio at 0.28. In H series, cement was replaced at four proportions (30%, 40%, 50% and 60%) with FA. Cement also replaced with SF at constant ratio (10%) in HS series. Similar FA replacements were implemented in HS series (30%, 40%, 50% and 60%). The concrete mixtures were prepared in a horizontal axis mixer. In the fresh state, slump flow diameter, V-funnel and T50 times of the SCC mixes were measured according to the EFNARC Committee's suggestions and results are as shown in table 5.

Table 5 :Properties of Fresh Concrete

Series	FA	SF	Flow	T50	V-box
C	0	0	710	3.5	20
H30	30	0	785	3.5	18
H40	40	0	750	4.5	23
H50	50	0	800	5	42
H60	60	0	780	7.5	35
HS30	30	10	825	3.5	12
HS40	40	10	765	4	18
HS50	50	10	775	3.5	19
HS60	60	10	780	4	16

For the harden properties Cube specimens (71x71x71 mm) were used to determine the compressive strength of concrete. SCC H series and HS series Compressive strength vs fly ash content graph is as shown in fig 1 and fig 2 respectively.

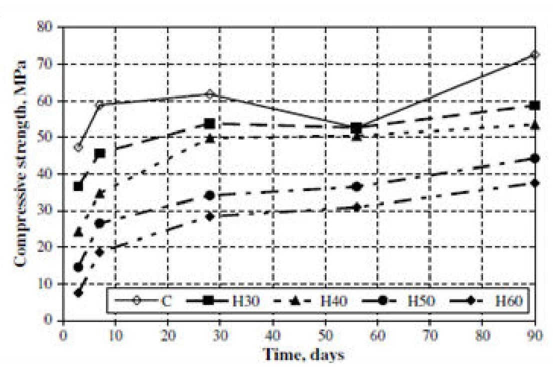

Fig 1. Relationship between FA content and compressive strength for H series.

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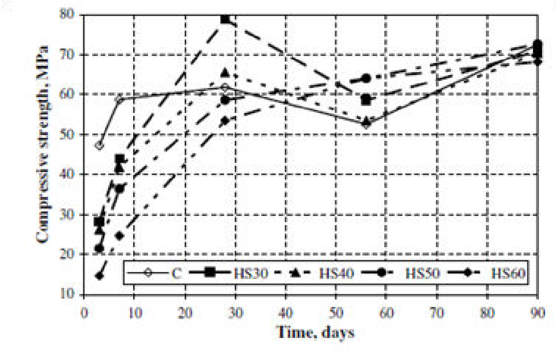

Fig 2. Relationship between FA content and compressive strength for HS series.

Conclusion

1. Addition of fly ash in self compacting concrete increases the workability of concrete, which results in the large slump flow as compare to no fly ash in self compacting concrete.
2. From the study it is found that as fly ash content increases in the concrete mix as a replacement of OPC cement it reduces the compressive strength and split tensile strength of self compacting concrete.
3. If silica fume is also added in the composition as a addition of fly ash then it gives more strength then the plain high volume fly ash SCC for the same fly ash content.

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