

To Study Physical Properties of Self Compacting Concrete

Devvratvedanand Kumar¹, Brijesh Lopes², Kunal Mhatre³, Rohit Nityanand⁴,
Shreeshail Heggond⁵

^{1,2,3,4}(UG Students), ⁵Associate Professor,
Department of Civil Engineering St John College of Engineering and Management, palghar

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Abstract – Concrete is one of the versatile construction materials which are used worldwide. Self-compacting Concrete is a type of concrete which is capable of flowing into the form work uniformly under its own weight, without segregation and bleeding, better finishes, easier placement, thinner concrete sections, no vibration, safer working environment without any application of vibration. Due to many advantages like faster construction, reduction in site for thinner concrete sections, improved durability, concrete. This study mainly focuses on the self-compacting concrete which is prepared by partially replacing cement with industrial by-products. To understand the behavior of the self-compacting concrete, the fresh properties along with the durability characteristics have been discussed.

I- INTRODUCTION

Self-compacting concrete (SCC), also known as self-consolidating concrete, is one of the most widely used concrete types, mainly because of its self-compacting characteristics and strength. SCC is a highly flowable, non-segregating, special concrete type that can settle into formworks, and encapsulates, heavily reinforced, narrow and deep sections by means of its own weight. Unlike conventional concrete, SCC does not require compaction using external force from mechanical equipment such as immersion vibrators. In addition to these attractive benefits, as a high-performance concrete SCC maintains all of concrete's common mechanical and durability characteristics. SCC was developed in Japan in 1980s in order to achieve high-performance durable concrete

structures, and with advancements in concrete technology its use has become widespread all over the world (Ozawa et al., 1989; Okamura and Ouchi, 2003). The advantages of SCC in its fresh and hardened states include economic efficiency (i.e. it shortens the construction time as well as it reducing the labour and equipment required), improvement in working and living environment (i.e. it may consume high amount of industrial by-products, it reduces construction noise and health hazards) and enhancement in automation of the construction process (Ozawa et al., 1995; Bartos and Cechura, 2001). Generally, SCC is used for constructing reinforced concrete elements with closely arranged reinforcement sections, construction elements with limited compaction possibilities, filigree construction elements, exposed concrete parts where high surface quality is required, texture surfaced concrete construction elements, and reinforced concrete parts in environmentally noise sensitive sites.

Compared with ordinary concrete, SCC includes large amounts of binder, superplasticizer, and/or viscosity modifying admixtures (VMA). The supplemented binder content is associated with SCMs such as fly ash (FA), ground-granulated blast furnace slag (GGBFS), silica fume (SF), metakaolin (MK), rice husk ash (RHA), etc. The incorporation of SCMs into cement or concrete mixes provides many benefits to fresh and hardened concrete, such as improvement in workability and ultimate strength values. It also reduces the construction cost. SCC with high-volume SCMs is defined by the replacement of large amount of SCMs with cement in SCC mixes.

II- MATERIALS

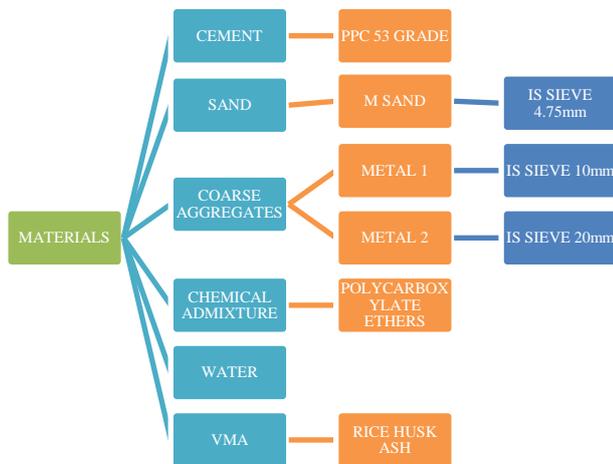


Fig.1- Materials used

Cement -

Ultra-tech PPC 53 grade used in this work and properties of material is mentioned in table 1.

Table 1- Cement Physical Properties

Properties of Cement	Experimental values obtained
Initial Setting Time (min)	40
Final Setting Time (min)	340
Normal Consistency (%)	26.35
Specific Gravity	3.157
Fineness	7
Cement Compressive strength at 28 th day	53.8(N/mm ²)

Fine Aggregates –

In this work, crushed stone sand i.e. M-sand belongs to Zone II. Laboratory test results are mentioned in table 2.

Table 2- M-Sand Physical Properties

Properties of M-sand	Experimental Value Obtained
Specific Gravity	2.76
Bulk Density	1717kg/m ³
Fineness modulus	2.71
Water Absorption	1.6 %

Coarse Aggregates-

Here there are two type of aggregates are used.

- 1) Metal 1: In which they are angular in shape and 10mm IS sieve down size.
- 2) Metal 2: In which they are angular in shape and 20mm IS sieve down size.

Physical properties of coarse aggregates are mentioned in table 3.

Table 3- Coarse Aggregates physical properties

Properties of Coarse Aggregates	Experimental Values Obtained
Specific Gravity	2.88
Impact Value	18.6 %
Los Angeles abrasion value	25.46 %
Combined Index	27.52 %
Water absorption	0.5 %
Fineness Modulus	7.46

Super plasticizer-

Chemical namely Polycarboxylate ethers was used. Properties of Polycarboxylate ether is mentioned in table 4.

Table 4- Properties of Polycarboxylate ethers.

Items	Specification (FXP 50 %)
Visual Appearance	Pale Brown Viscous liquid
(23°C) Density	1.10±0.02
PH (23°C) Acidity	5.0± 0.5
(%) Solid Content	40.0±2.0
(0°C,24 hours) Stability	No Crystallization
Solid Content (wt. %)	50±2
Appearance	Brown Viscous Clear liquid

Water-

Water must be free from all chemical and physical impurities as such that it deemed to be a drinking water. The pH value of water used in this work is 6.5.

viscosity modifying admixtures-

Rice husk ash of 10% Cementitious material was used.

III- MIX PROPORTION

Two conventional and three SCC mixes with chemical replacement is prepared and examined to determine the properties of self- compacting concrete. Table 5 and 6 represents the Mix Proportion of conventional concrete and self-compacting concrete mixtures.

Table 5- Mix Proportions for Conventional Concrete

	Conventional Concrete Trail 1	Conventional Concrete Trail 2
Cement	472.90 kg/m ³	655 kg/m ³
Fine Aggregates	743.66 kg/m ³	549.83 kg/m ³
Coarse Aggregates	1010.25 kg/m ³	1104 kg/m ³
Water	189.162 kg/m ³	203 kg/m ³
Chemical	-	-
Rice Husk Ash	-	-

Table 6- Mix Proportions for SCC

Materials	SCC 1% PCE	SCC 0.75% PCE	SCC 0.5% PCE
Cement	452.25 kg/m ³	495.324 kg/m ³	542.7kg/m ³
Fine Aggregates	1085.86 kg/m ³	997.488 kg/m ³	951.98 kg/m ³
Coarse Aggregates	888.43 kg/m ³	851.60 kg/m ³	812.76 kg/m ³
Water	140.7 kg/m ³	154.1 kg/m ³	168.84 kg/m ³
Chemical	5.02 kg/m ³	4.128 kg/m ³	3.0115 kg/m ³
Rice Husk Ash	50.25 kg/m ³	55.036 kg/m ³	60.3 kg/m ³

Rice husk ash is used as a viscosity modifying agent.

Ratio of coarse and fine aggregates is taken as, 55% of fine aggregates and 45 % of coarse aggregates of total aggregates respectively.

Ratio of coarse aggregates is taken as 60 % of 10mm and 40 % of 20mm of total coarse aggregate respectively.

Water is reduced by 33% because of use of PCE.

IV- RESULT AND DISCUSSION

In this study, fresh, hardened properties and durability of self-compacting concrete were investigated by using waste materials (Rice Husk Ash). The investigations were carried out according to appropriate criteria given by European standards. In the present study, such properties of self-compacting concrete produced with fly ash were investigated based on fresh concrete tests, specifically workability, strength and durability tests.

Fresh Properties

Slump Flow Test

The slump value plays a major role in SCC. By the value of slump, it is possible to know the effectiveness of flow in SCC; i.e., flowability of SCC under congested reinforcements can be studied at site through this test. The slump values also determine the durability of the mix, segregation and bleeding in the mix. The minimum value of slump is to be 650mm and the maximum value 800 mm for a fresh SCC. The slump values for different mixes are shown in table.7 and fig.2

Table 7- Slump Flow test

Mix Proportions (%)	Slump Flow
SCC 1 % PCE	760mm
SCC 0.75 % PCE	705mm
SCC 0.5 % PCE	676mm

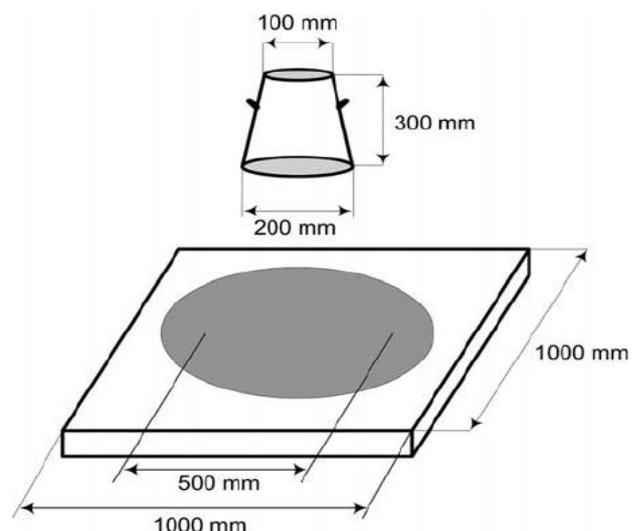


Fig 2- Apparatus of slump cone test

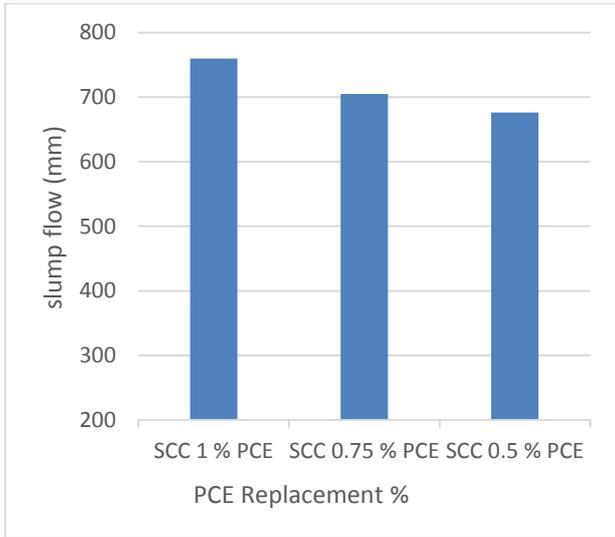


Fig 3- Slump flow test with PCE

L- Box Test

The ratio of is used to indicate the value of the result of L-box. The minimum value of can be 0.8 and the maximum value 1.0.

The passing ability of the concrete is tested and concludes that with increase in chemical admixture (PCE) the passing ability increases. In this mix, 1% replacement by polycarboxylate ether behaves better in passing ability of concrete. The passing ability of L-Box test is shown is table.8

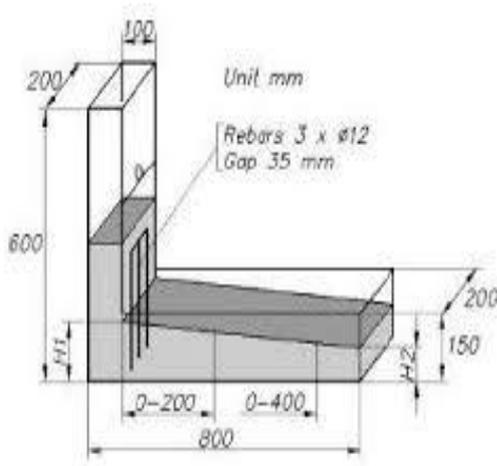


Fig 4 - Apparatus of L-Box test

Table 8- L-Box Test

Mix Proportion (%)	h2/h1
SCC 1 % PCE	0.91
SCC 0.75 % PCE	0.818
SCC 0.5 % PCE	0.724

Mechanical Properties

Compressive strength can be determined by the compression test. Here the cube of 150 mm³ dimension is casted for testing, the mean average strength value for the three cube (3, 7, 28 days) specimens are considered. The compressive strength results are mentioned in the table.9 and fig.5

The strength attainment of SCC 1% PCE, SCC 0.75% PCE, and SCC 0.5% PCE, was 58.75%, 57.27%, and 54.33% respectively on 3 days, 69.38%, 75.72%, and 71.19% on 14 days and 121.16%, 125.33%, and 117.58% on 28 days.

When compared with the conventional concrete increasing amounts of chemical admixtures generally increase the strength.

In this mix, 0.75 % replacement by polycarboxylate ether behaves better in respect to mechanical properties of concrete.

Table.9- Compressive Strength

Sample	Compressive strength (N/mm ²)	Compressive strength (N/mm ²)	Compressive strength (N/mm ²)
	3 days	7 days	28 days
Conventional Trail 1	12.93	18.12	36.46
Conventional Trail 2	26.86	39.39	60.28
SCC 1% PCE	32.31	38.71	66.64
SCC 0.75% PCE	31.49	41.65	68.93
SCC 0.5% PCE	29.88	39.16	64.67

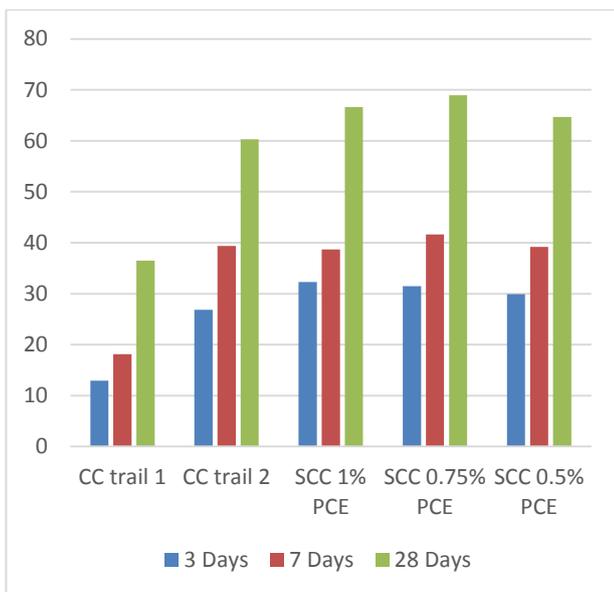


Fig.5- Comparison of CC and SCC

V- CONCLUSION

- In present scenario there is a greater need for self-compacting concrete due to sickness of member & architectural requirement, also to improve durability of the structure.
- Use of 0.75 % of polycarboxylate ether (of Cementitious material) gives better result.
- Now the world is going to facing greater need of high performance concrete, durability point of view and SCC where the conventional way of compacting may not be always useful under different site condition.so instead of going for the conventional let us mix the concrete compacting on its own which is called as self-compacting concrete.
- Use of rice husk ash (wastage material) reduce 10% cement content in concrete.
- At same grade of concrete, we find SCC with certain change as decrease of 10% of final cost (electricity cost, labour cost, reduction in cement due to use of rice husk ash).

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