EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 Volume 2 Number 9 (September-2014) pp. 175-180

www.ijcrar.com

Determination of compressive strength difference between conventional concrete and recycled aggregate concrete

Rahul Sikka[1] and Arvind Dewangan[2*]

[1]CTM (Civil Engineering), Department of Civil Engineering, HCTM Technical Campus, Kaithal, Haryana, India
[2]Department of Civil Engineering, HCTM Technical Campus, Ambala Road, Kaithal, Haryana, India
Corresponding author

KEYWORDS

Self-Compacting Concrete, Admixture, Superplasticiser, Fly

A B S T R A C T

Self-Compacting Concrete (SCC) is a highly flowable and non-segregating concrete and that does not require vibration when cast, yet it is capable of flowing through narrow openings or extremely congested reinforcement. SCC is also known as Self-Consolidating Concrete, Self-Levelling Concrete, and High-Fluidity Concrete. Development of Self- Compacting Concrete is a desirable achievement in the construction industry in order to overcome problems associated with cast-in-place concrete. This paper reveals that Self-Compacting Concrete is cast in such a manner that no additional inner or outer vibration is necessary for the compaction. It flows like "honey" and has a very smooth surface after placing. With regard to its composition, Self-Compacting Concrete consist of the same components as conventionally vibrated concrete, i.e. cement, aggregates and water, with the addition of chemical and mineral admixtures in different proportions. Usually, the chemical admixtures used are Superplasticiser and viscosity-modifying agents, which change the rheological properties of concrete. Mineral admixtures are used as an extra fine material, and in some cases, they replace cement.

Introduction

Self-Compacting Concrete (SCC) is a highly flowable and non-segregating concrete and that does not require vibration when cast, yet it is capable of flowing through narrow openings or extremely congested reinforcement. SCC is also known as Self-Consolidating Concrete, Self-Levelling Concrete, and High-Fluidity Concrete.

Development of Self- Compacting Concrete is a desirable achievement in the construction industry in order to overcome problems associated with cast-in-place concrete.

Self-Compacting Concrete is cast in such a manner that no additional inner or outer

vibration is necessary for the compaction. It flows like "honey" and has a very smooth surface after placing. With regard to its composition, Self-Compacting Concrete consist of the same components as conventionally vibrated concrete, i.e. cement, aggregates and water, with the addition of chemical and mineral admixtures in different proportions. Usually, the chemical admixtures used are Superplasticiser and viscosity-modifying agents, which change the rheological properties of concrete. Mineral admixtures are used as an extra fine material, and in some cases, they replace cement.

Development of SCC

The motive for development of Self-Compacting Concrete was the social problem on durability of concrete structure s that arose around 1983 in Japan. Due to a gradual reduction in the number of skilled workers in the Japan's construction industry, a similar reduction in the quality of construction work took place. As a result of this fact, one solution for the achievement of durable concrete structures independent of the quality of construction work was the use of, which could be compacted into every corner of a formwork, purely by means of its own weight.

Basic Principles for SCC

With regard to its composition, Self-Compacting Concrete consist of the same components as conventionally vibrated normal concrete, which are cement, aggregates, water, additives and admixtures. However, the high amount of Superplasticiser for reduction of the liquid limit and for better workability, the high powder content as "Lubricant" for the coarse aggregates, as well as the use of viscosity agents to increase the viscosity of the concrete have to be taken in to account. In principal, the properties of the fresh and hardened SCC, which depend on the mix design, should not be different from NC(Normal Concrete). Self-Compacting Concrete should have a Slump Flow(SF) of approximate SF > 65 cm after lifting the flow cone.

The objectives of the research are:

- To study the fresh properties of SCC mixes.
- To investigate the effect of replacement of cement with fly ash in varying percentages (20%-40%), on compressive strength at moist curing of 7,28,56 days.
- To examine the effect of water-powder ratio on properties of SCC mixes.
- To study the effect of chemical admixtures on SCC mixes

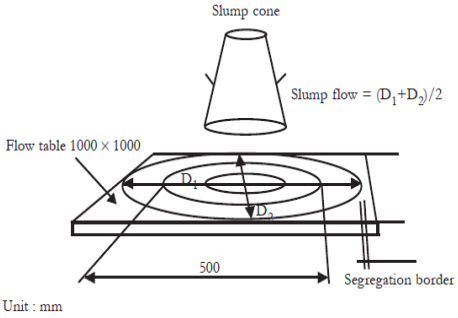
Experimental

1. **Mixing:** The mixing of concrete is done to have a homogeneous mixture of all ingredients in concrete. The hand mixing is done for the ingredients. Batching of concrete is done by weight.
2. **Casting of specimens:** The moulds for cubes are cleaned thoroughly. The inner surface of the moulds is coated with a thin layer of oil to avoid adhesion of concrete with the walls of mould. The mould are filled with SCC mixture and finished the surface with trowel. Vibration is done for compaction and cubes are removed from the moulds after 24 hrs.
3. **Curing:** The specimens were kept in a clean water tank just after removal from the mould and kept continuously moist till the time of testing.

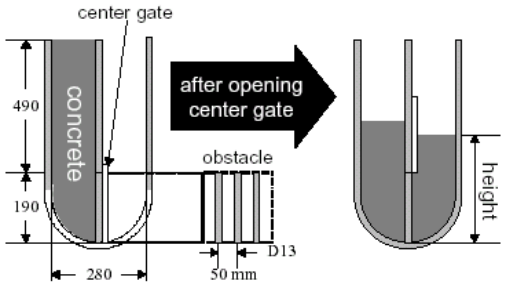
4. **Test Methods:** Fresh concrete is tested as:-

Filling Ability:

(a) **Slump Flow Test**



U-Box Test



Methodology of Concrete Mix Design: ACI Method of SCC Mix Design

In this method, concrete is first designed by the ACI method of mix design(which usually gives a larger amount of fines when compared with the IS method of mix design). Initially a mix was made with a w/c ratio of 0.5 to get a desired slump flow of around 160 mm to 180 mm.

To proceed towards SSC, Coarse aggregates are then replaced with a fine powder (fly ash), by weight starting from a value of 15%, 10%, 15%, etc, until a slump flow of (500 mm – 700 mm) is achieved by Slump Flow Test. Each trial should satisfy flow test, passing ability test and filling ability test.

Typical Range of SCC Mix Composition

Constituent	Typical Range by Mass (kg/m^3)	Typical Range by Volume(litres/m^3)
Powder	380-600	
Paste		300-380
Water	150-210	150-210
Coarse Aggregate	750-1000	270-360
Fine Aggregate	Content balances the volume of the other constitutions, typically 48-55% of total aggregate weight.	
Water/Powder ratio by Volume		0.85-1.10

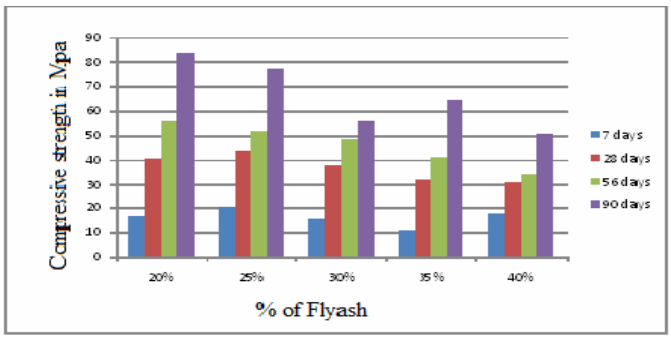


Fig.1 Variation in compressive strength with increase in fly ash content for FAR mixes

Physical Properties of fly Ash

Sr. No.	Physical Properties	Test Results
1	Colour	Grey(Blackish)
2	Specific Gravity	2.13
3	Lime Reactivity-average Compressive Strength after 28 days of mixture 'A'.	 4.90 MPa

Table.3.3 Chemical properties of Fly Ash

Sr. No	Constituent Determined	Percentage By weight
1	Loss on Ignition	4.17
2	Silica(SiO2)	58.55
3	Iron Oxide (FeO3)	3.44
4	Alumina (Al2O3)	28.20
5	Calcium Oxide (CaO)	2.23
6	Magnesium Oxide (MgO)	0.32
7	Total Sulphur (SO3)	0.07
8	Insoluble Residue	----
9	Alkalies (a) Sodium Oxide (Na2O) (b) Potassium Oxide (K2O)	0.58 1.26

The properties of fly ash conform to IS 3812-1981.

Superplasticiser

Superplasticiser of the make **"SIKA VISCOCRETE-10(H1)"** is used as chemical admixture for the concrete. Specification are shown in following table :

Specifications of the Superplasticiser

Basis	**Aqueous Solution of Modified Polycarboxylate**
Appearance	Brown Liquid
Density	Approx. 1.10
P_H	Approx. 5.0

Hardened concrete is tested as

Compressive strength: Compressive test is carried on 150mmX150mmX150mm cubes with compression testing machine of 2000 KN capacity.

Test Results of Cement Sample

S. No.	Characters	Experimental Value	Limits As per IS:8112-1989
1	Consistency of Cement	26.5	-----
2	Specific Gravity	3.24	3.15 g/cc
3	Initial Setting Time	83 min	>30 min.
4	Final Setting Time	313 min	<600 min.
5	Fineness of Cement	5%	10%
6	Soundness of Cement	10mm	< 10 mm
7	Compressive Strength		
I.	3 days	23.54 MPa	< 23 MPa
II.	7 days	33.57 MPa	< 33 MPa
	28 days	43.60 MPa	< 43 Mpa

Compressive Strength Results of SCC Mixes at the age of 7, 28, 56 and 90 days

Mix No.		SCC1	SCC2	SCC3	SCC4	SCC5
Date of Casting		22/01/14	23/01/14	26/01/14	27/01/14	28/01/14
Cement	**Kg/m^3**	486.0	486.0	486.0	486.0	486.0
Fly Ash	**Kg/m^3**	134.19	134.19	134.19	134.19	134.19
Compressive Strength	**7 days**	17.0	17.0	16.13	16.15	12.21
	28 days	25.26	26.90	27.57	31.54	29.21
	56 days	35.32	43.60	43.60	57.12	41.86
	90 days	50.14	52.32	48.39	66.27	49.27

Result and Discussion

Self-Compacting Concrete with a similar water cement or cement binder ratio will usually have a slightly higher strength compared with traditional vibrated concrete, due to the lack of vibration giving an improved interface between the aggregate and hardened paste. A number of concrete properties may be related to the concrete compressive strength, the only concrete engineering property that is routinely specified and tested.

Compressive strength tests were carried on 150mmX150mmX150mm cubes with compression testing machine of 2000KN capacity. The specimens after removel from the curing tank was cleaned and properly dried. The surface of the testing machine was cleaned. The cube was then placed with the cast faces in the contact with the plates of the testing machine. The load on the cube was applied at a constant rate of stress. Because of non-linearity of the stress-strain

relation of the concrete at the higher stresses, the rate of increses in the strain must be increased progressively as failure approaches i.e. the speed of movement of the head of the testing machine has to be increased. This can be done only with a hydraulic operated machine. The compressive strength was found after 7, 28, 56, and 90 days in order to compare the strength of different concrete mixes.

It is observed that, the variation in compressive strength at 7 days and 28 days is less but there is significant difference at 56 days and 90 days for different SCC mixes. At 20% replacement of cement with the fly ash, 90 days compressive strength is 83.71 Mpa, where as it is 50.58 Mpa for 40% replacement. By increasing the percentage replacement of cement with fly ash, the compressive strength of SCC mixes is decreased. It is preferable to use up to 30 % replacement for good compressive strength. For medium strength Self-Compacting Concrete with 35% to 40% replacement can be used satisfactorily. SCC1, SCC2, SCC3, SCC4, SCC5, FAR1, FAR2, FAR5, FAR6, FAR7 mixes, in this study had given good results with the incorporation of fly ash. The result shows that using sequential procedure developed in this study, SCC could be achieved successfully.

Acknowledgment

Authors express sincere thanks to Director-HCTM Technical Campus Kaithal, and The Head, Civil Engineering Department, HCTM Technical Campus, Kaithal, Haryana, India for facilities in lab and encouragement.

References

(1) Ozawa,K., Maekawa,K. and Okamura, H., "Development of the High Performance concrete," Proceeding of JSI, 1989, Vol. 11, No 1, pp. 699-704

(2) S. Subramanian and D. chattopadhyay., "Experiments for Mix Proportioning of Self-Compacting Concrete," The Indian Concrete Journal, August 2002, pp. 13-20

(3) Jagdish Vengala , M.S. Sudarshan and R.V. Ranganath., "Experimental study for Obtaining Self-Compacting Concrete," The Indian Concrete Journal,August2003, pp. 1261-1266

(4) Mohammed Lachemi, khandakar M.A. Hossain, Vasilos Lambros, and Bouzoubaa., "Development Of Cost-Effective Self Consolidating Concrete incorporating fly ash, Slag cement, or Viscosity-Modifying Admixtures," ACI Material Journal , September-October 2003, pp. 419-425

(5) IS: 516-1959, "Indian Standard Code of Practice Methods of Test for Strength of Concrete," Bureau of Indian Standards, New delhi, India.

(6) IS: 1199-1959, "Indian Standard Methods of Sampling and Analysis of Concrete, " Bureau of Indian Standard, New Delhi, India.

(7) IS: 383-1970, "Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete", Bureau of Indian Standard, New Delhi, India.

(8) IS: 8112-1989, "Specification for 43 grade Portland Cement," Bureau of Indian Standard, New Delhi, India.

(9) Mustafa Sahmaran, I. Ozgur Yaman., "Hybrid Fiber Reinforced Self-Compacting Concrete with a High Volume Coarse Fly Ash," Construction and Building Materials (June 2005)pp. 1-7.

(10) P.L. Domone., "Self-Compacting Concrete: An Analysis of 11 years of Case Studies," Cement and Concrete Composites, October 2005, pp. 1-12.