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EXPERIMENTAL STUDY ON COMPRESIVE STRENGTH OF SELF COMPACTING CONCRETE

K. UMA SHANKAR, S. PRADEEP KUMAR & K. ARUN PRAKASH

Assistant Professor, Department of Civil Engineering, Knowledge Institute of Technology, Salem, Tamil Nadu, India

ABSTRACT

Self-Compacting Concrete (SCC) is a high performance concrete, it is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. Self Compacting Concrete has excellent high resistance to segregation and fluidity ensures a high level of homogeneity, minimal concrete voids and uniform concrete strength, providing the potential for a superior level of finish and durability to the structure. This project presents an experimental investigation of SCC properties workability for fresh state and mechanical properties of hardened SCC like compressive strength and impact strength. Fly ash is used as mineral admixture to replace 20% by weight of cement. Super plasticizer (Glenium B233) is used 0.5% to 1% of weight of cement. Viscosity Modifying Agent (Glenium Stream 2) is used 0.25% to 0.5% of weight of cement. Chemical admixtures confirming to the requirement of IS: 9103-1979. The trial mix design of SCC is focused on ability to flow under its own weight without vibration, flow through heavily congested reinforcement under its own weight, and retain homogeneity without segregation. Compressive strength for 7 days, 14 days, 28 days are determined. Impact strength test is to be conducted for SCC by ACI 544.2R-89 drop-weight method is adopted to test the specimens.

KEYWORDS: Self Compacting Concrete, Fly Ash, Super Plasticizer, Viscosity Modifying Agent

INTRODUCTION

Self-Compacting Concrete was first introduced in the late 1980’s by Japanese researchers, is highly workable concrete that can flow under its own weight through congested reinforcement section without segregation and bleeding. Such concrete should have low yield value to ensure high flow ability, a moderate viscosity to resist segregation and bleeding, and must maintain its homogeneity during transportation, and placing to ensure adequate structural performance and long term durability. It has three essential fresh concrete properties filling ability, passing ability and segregation resistance. SCC can save labour, eliminate consolidation noise and lead to innovative construction methods.

Advantages of SCC

Advantages of SCC over Normal Concrete are as follows:

- Faster construction
- Reduction in site man power
- Better surface finishes
- Easier placing
- Reduced noise levels in work site
- Economical construction and

- Improved filling capacity through highly congested reinforcement.

Fresh Properties of SCC

Filling Ability: The property of Self-Compacting Concrete to fill all corners of a formwork under its own weight (without vibration)

Passing Ability: The property of Self-Compacting Concrete to flow through reinforcing bars without segregation or blocking.

Resistance to Segregation: The property of Self-Compacting Concrete to flow without segregation of the aggregates and to remain homogenous during transportation, placing and after placement.

MATERIALS

Cement

The Ordinary Portland Cement of 43 grade conforming to IS: 8112 - 1989 was used for the present experimental study. Specific gravity of cement is 3.15 and fineness modulus cement is 1.75.

Fine Aggregate

Natural river sand with fraction passing through 4.75mm sieve and on 150µm sieve was used and tested as per IS: 2386 - 1983. Specific gravity of fine aggregate is 2.60, Fineness modulus of fine aggregate is 2.85 and bulk density of fine aggregate is 1488 kg/m^3

Coarse Aggregate

Crushed granite coarse aggregate of size 12.5mm was used and tested as per IS 2386-1983. Specific gravity coarse aggregate is 2.66 and bulk density of coarse aggregate is 1540 kg/m^3

Water

Portable water confirming to the requirements of IS: 456-2000 is used for mixing of SCC and curing the specimens as well.

Mineral Admixtures

In this project fly ash is used as mineral admixture. Fly ash from Mettur thermal power plant was collected from various hoppers. Fly ash consists of fine, powdery particles that are predominantly spherical in shape, either solid hollow and mostly glassy in nature. Fly ash is used @ 20% by weight of cement as replacement. Specific gravity of fly ash is 2.10.

Chemical Admixtures

Super plasticizer (Glenium B233) was used @ 0.5% of weight of cement for SCC1, SCC2, SCC3, SCC4, and super plasticizer was used @ 1% of weight of cement for SCC5, SCC6 and SCC7. Viscosity Modifying Agent (Glenium Stream 2) was used @ 0.25% of cement weight for SCC1, SCC2, SCC3, SCC4, and Viscosity Modifying Agent was used @ 1% of weight of cement for SCC5, SCC6 and SCC7

Mix Proportion

Class F fly ash (MTPS) is used as a mineral admixture is used @ 20% by weight cement replacement. Super plasticizer (Glenium B233) was used @ 0.5% to 1% by weight of cement and Viscosity Modifying Agent (Glenium Stream 2) was used @ 0.25% to 0.5% by weight of cement.

FRESH PROPERTIES OF SCC

Slump Flow Test

The slump flow test is done to assess the horizontal flow of concrete in the absence of obstructions. It is a most commonly used test and gives good assessment of filling ability. It can be used at site. The test also indicates the resistance to segregation. It range is in between 650mm and 800mm.

Figure 1: Slump Flow Test

L-Box Test

L-box aims at investigating the passing ability of SCC. It measures the reached height of fresh SCC after passing through the specified gaps of steel bars and flowing within a defined flow distance. With this reached height, the passing or blocking behaviour of SCC can be estimated.

Figure 2: L-Box Test

V-Funnel Test

The V-funnel flow time is the period a defined volume of SCC needs to pass a narrow opening and gives an indication of the filling ability of SCC provided that blocking and segregation do not take place. The flow time of the V-funnel test is to some degree related to the plastic viscosity.

Figure 3: V-Funnel Test

U-Box Test

U-Box test apparatus consists of vessel that is divided by a middle wall into two compartments. Especially fluidity of SCC is measured by using this test. It range is in between (h2 – h1) = 0 and 30mm.

Figure 4: U-Box Test

RESULTS AND DISCUSSIONS

The mix proportion are given for various trial mixes in table 1

Table 1: The Typical Proportion of the Mix

Mix	Cement	Fly ash	FA	CA	W/P Ratio
SCC1	0.80	0.20	1.01	0.87	0.38
SCC2	0.80	0.20	1.07	0.80	0.36
SCC3	0.80	0.20	1.07	0.73	0.34
SCC4	0.80	0.20	0.78	0.67	0.32
SCC5	0.80	0.20	0.48	0.42	0.30
SCC6	0.80	0.20	0.46	0.42	0.29
SCC7	0.80	0.20	0.43	0.39	0.28

Filling ability, passing ability, resistance to segregation properties of the SCC has been studied on the results are shown in table 2

Table 2: Acceptance Criteria of SCC

Mix	Slump Flow Test (mm)	L-Box (H2/H1)	V-Funnel (Sec)	U-Box (mm)
SCC1	720	0.92	8	18
SCC2	710	0.89	8	18
SCC3	703	0.88	9	19
SCC4	687	0.86	9	21
SCC5	703	0.84	8	21
SCC6	690	0.83	9	22
SCC7	672	0.83	10	23

The results of filling ability, passing ability, resistance to segregation properties of various SCC trial mixes are shown in figure 5, figure 6, figure 7, and figure 8.

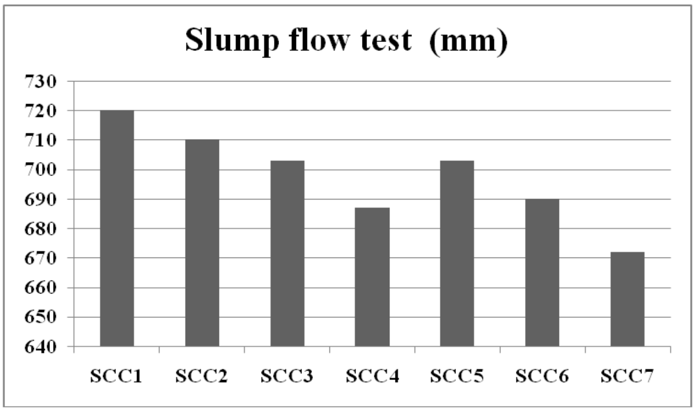

Figure 5: Slump Flow Test Results

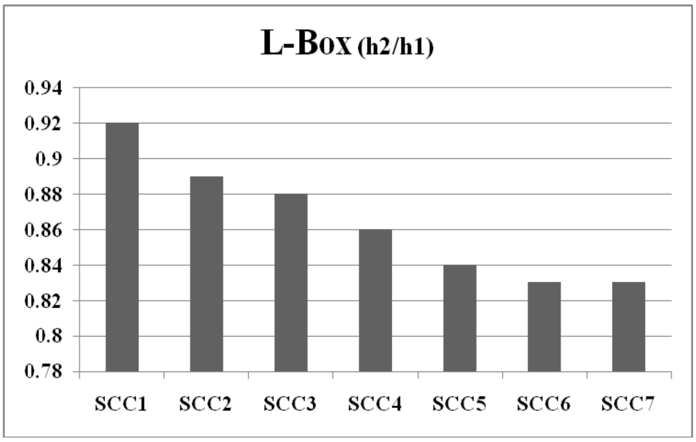

Figure 6: L-Box Test Results

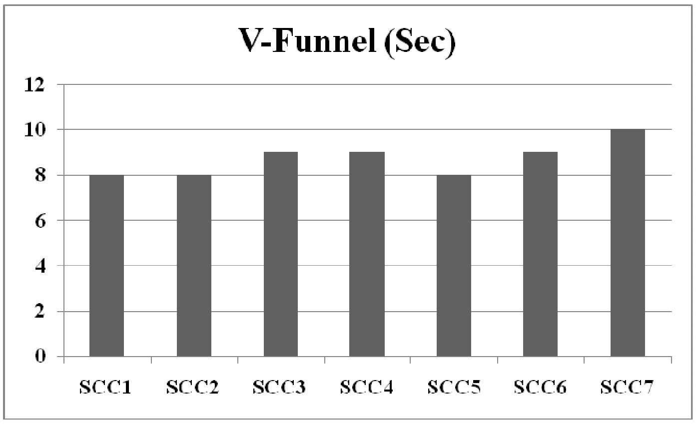

Figure 7: V-Funnel Test Result

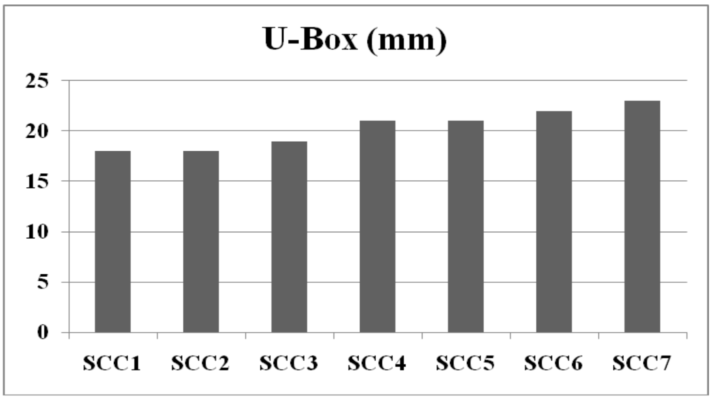

Figure 8: U-Box Test Result

Casting and Testing

Cubes of size 150 x 150 x 150mm were casted to determine the compressive strength of concrete. After specified duration these specimens were tested in the compression testing machine and the results are shown in table 3

Table 3: Compressive Strength of Concrete Cubes

Mix	Compressive Strength of Cubes in N/mm^2		
	7 Days	14 Days	28 Days
SCC1	31.50	36.70	44.00
SCC2	35.30	41.50	48.60
SCC3	38.00	46.50	53.50
SCC4	42.35	49.50	57.60
SCC5	46.80	55.20	61.30
SCC6	49.30	59.80	66.00
SCC7	52.00	61.00	71.00

DISCUSSIONS

Table 2 shows the acceptance criteria of various SCC trial mixes. Replacement level of SCC3 mix gives better acceptance criteria for sufficient compressive strength at 28 days.

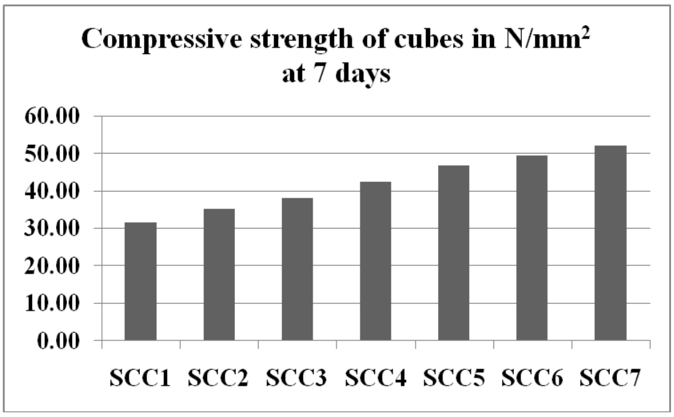

Figure 9: Compressive Strength of Cube at 7 Days

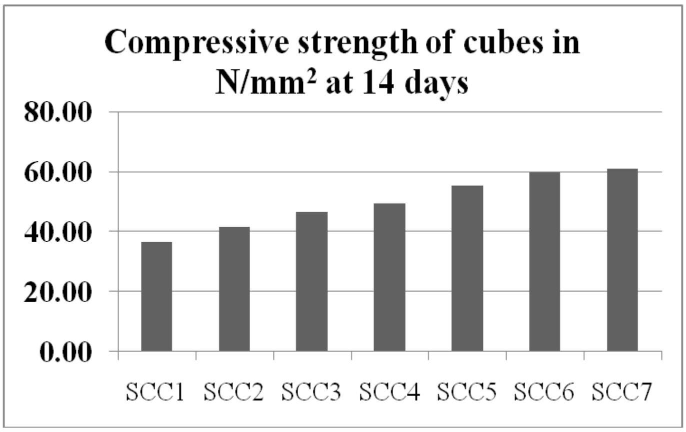

Figure 10: Compressive Strength of Cube at 14 Days

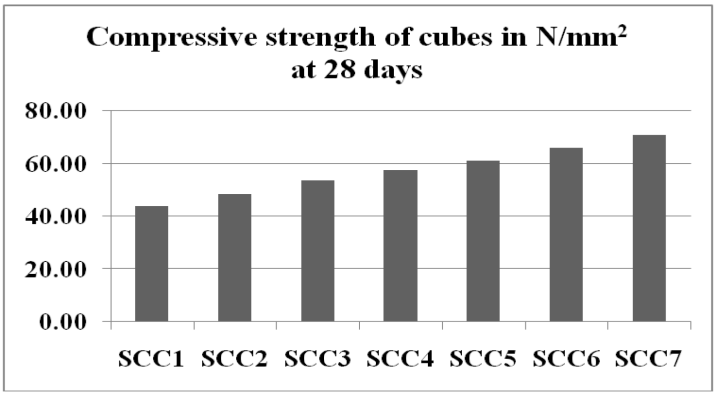

Figure 11: Compressive Strength of Cube at 28 Days

Test Procedure for Impact Strength

150mm dia and 63mm height specimens were casted and tested as per ACI 544.2R-89 procedure. After 28 days curing of all specimens were subjected to impact loading by means of drop- weight hammer principle. The impact strength of SCC is measured in terms of energy absorbed in Nm.

Figure 12: Drop-Weight Hammer Test Setup

150mm dia and 63mm height specimens supported in all the sides and held firmly to the floor. A steel hammer weighing 6kg is allowed to fall from a constant height of 2m through the guide at the center of the slab till the formation of first crack at the bottom of the specimen. The number of blows required to cause the first crack is noted Then the process is continued till the crack propagated further and appeared at the top surface of the specimen and corresponding number of blows is noted The impact energy absorbed in joules is calculated using the relation (n x W x h x 9.81) Where n- number of blows, W- weight in kg (6kg), h- drop height in metres (2m).

CONCLUSIONS

- Proportion where determined for various trial mixes.
- Flow ability, filling ability, passing ability, resistance to segregation test where conducted to satisfy to acceptance criteria.
- Compressive strength at age of 7 days, 14 days, 28 days where determined for all trial mixes.
- It is concluded that SCC3 mix gives sufficient compressive strength conforming acceptance criteria.

SUGGESTIONS

Test for Impact strength to be determined.

REFERENCES

1. Hajime Okamura and Masahiro Ouchi (2003) “Self-Compacting Concrete”, Journal of Advanced Concrete Technology, Japan Concrete Institute, Vol. 1, pp. 5-15.
2. Paratibha Aggarwal, Rafat Siddique, Yogesh Aggarwal, Surinder M Gupta. “Self-Compacting Concrete Procedure for Mix Design” Leonardo Electronic Journal of Practices and Technologies, Issue 12, January-June 2008 pp. 15-24.
3. Dinakar, K. G. Babu, Manu Santhanam “ Durability properties of high volume fly ash self compacting concretes” July 2008, www.elsevier.com/locate/cemconcomp.
4. Miao Liu “Self Compacting Concrete with different levels of pulverized fuel ash” Construction and Building Materials 24 (2010) pp 1245-1252.
5. M.S.Ravikumar, C.Selvamony, S.U.Kannan, S.Basil Gnanappa “Behaviour of Self Cmpacted Self Curing kiln ash concrete with various admixtures” Vol 4,No 8,October 2009.
6. Wen-Chen Jau, Ching-Ting Yang “Development of a modified concrete rheometer to measure the rheological behavior of conventional and Self-Consolidating Concretes”, Cement and Concrete Composites 32 (2010) pp 450-460.
7. “Specification and Guidelines for Self Compacting Concrete”, by EFNARC 2002.
8. Jaganathan “Impact study on ferrocement slabs Reinforced with Polymer mesh” International Journal of applied engineering Research vol-3 number 12(2008)
9. S.Subramanian and Chattopadhyay, “Experiments for Mix proportioning of self compacting concrete”, Indian concrete journal, vol 78, January 2002, pp 13-20.
10. Jagadish Vengala Sudarsan, M.S., and Ranganath, R.V. (2003), “Experimental study for obtaining self-compacting concrete”, Indian Concrete Journal, August, pp. 1261- 1266.