Performance of Self-compacting Concrete Using Self-curing Agents

S.Prema

Department of Civil Engineering,
Nandha College of Technology,
Erode 638 052, India.
prema.s@nandhatech.org

N.Saravanababu,

Department of Civil Engineering,
Nandha Engineering College
Erode 638 052, India.
babu023501@gmail.com

R.Pradheepa

Department of Civil Engineering,
Nandha Engineering College,
Erode 638 052, India.
pradhe2602@gmail.com

Abstract

In this study, the strength parameters of M30 grade of self-compacting concrete, self-curing concrete, Self-compacting Self-curing concrete are compared with conventional concrete. Mechanical properties self-compacting concrete, self-curing concrete, self-compacting self-curing concrete and conventional concrete such as compressive strength and split tensile strength are conducted. Self-compacted concrete describes concrete with the ability to compact itself only by means of its own weight without the requirement of vibration. It fills all recesses reinforcement spaces and voids even in highly reinforced concrete members. Self-compacted concrete with self-curing agents has also been studied and Self compacting agents are also used. In these study Conplast sp-430 chemical admixture used for self-compacting concrete. The self-curing agents used in this study is Polyethylene Glycols (PEGs). The hardened properties of M30 grade of conventional concrete will be found by casting and testing of cubes, cylinders and beams of various proportions. The varying parameters is i.e., fly ash, the percentage variation of fly ash is 10%, 20%, and 30%. The percentage of self-curing agent in Self – compacting concrete is constant i.e., (0.9%). It is taken from literature, results will be good for 0.9% of Self-curing concrete (PEG 600) and self-compacting concrete (Conplast sp-430). The objective of this study is to compare the mechanical properties of Self-compacting concrete, self-curing concrete and Self-compacting Self-curing concrete with conventional properties.

Key words: Self-compacting concrete, self-curing agents, self-compacting self-curing concrete, fly ash, conplast sp-430 and Polyethylene Glycols (PEGs).

I. INTRODUCTION

1.1 Self-compacting concrete

The self-compacting concrete (SCC) is the advanced innovating category of high performance concrete, characterized by its ability to spread and self-consolidation in the formwork exhibiting any significant separation of constituents. Elimination of vibration for compacting concrete during placing with the use of Self Compacting Concrete leads to substantial advantages related to better homogeneity, enhancement- of working-environment and improvement in the productivity by increasing the speed of construction [1].The replacement of cementitious material like fly ash has increased the paste content and enhances the fresh and strength properties. The use of self-compacting concrete (SCC) is spreading worldwide because of its very attractive properties in the fresh state as well as after hardening [2]. The use of SCC will lead to a more industrialized production, reduce the technical costs of in situ concrete constructions, improve the quality, durability and reliability of concrete structures and eliminate some of the potential for human error [3]. It will replace manual compaction of fresh concrete with a modern semi-automatic placing technology and in that way improve health and safety on and around the construction site. However, this type of concrete needs a more advanced mix design than traditional vibrated concrete and a more careful quality assurance with more testing and checking, at least in the beginning, when using SCC [4]. Self-Compacted Concrete (SCC) is highly workable concrete with high strength and high performance that can flow under its own weight through restricted sections without segregation and bleeding [5].

1.2 Self-curing concrete

Curing of concrete is for maintaining satisfactory moisture content in concrete during its early stages in order to develop the desired properties. However, good curing is not always essential and often neglected in many cases. The concept of self-curing agents is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete. It was found that water soluble alcohols can be used as self-curing agents in concrete. The use of self-curing admixtures is very important from the point of view that water resources are getting valuable every day (i.e. each $1m^3$ of concrete requires about $3m^3$ of water for construction most of which is for curing). The benefit of self-curing admixtures is more significant in desert areas (e.g. Rajasthan) where water is not adequately available.

II. OBJECTIVES

The objective of this study includes the following
1. To study the mechanical properties of self-compacting concrete, self-curing concrete by conducting hardened test.
2. To study the mechanical properties of self-compacting self -curing concrete by conducting the hardened test.
3. To compare these three types of concrete with the convectional concrete.
curing concrete and admixture was increased 8.9% and 12.03% with comparing conventional concrete.

III. MATERIALS

3.1 *Cement*

Ordinary Portland cement was chosen so that the influence of Tuticorin thermal power plant fly ash could be studied without any other intervention. The 53 grade ordinary portland cement was chosen because of its greater fineness which would have effective hydration and also secondary hydration. The physical properties of cement which was used for the experimental investigation are given in Table 1

Table 1. Testing of Cement

S No	DESCRIPTION	RESULT
1	Specific gravity	3.12
2	Fineness by sieve analysis	4%
3	Consistency	34%

3.2 *Fly ash*

Fly ash was collected from Mettur thermal power plant at Mettur near Salem. Fly ash has been collected using electrostatic precipitator in the plant was taken directly from hopper in dry state. It has been categorized as class F-fly ash. It is usually produced by burning anthracite or bituminous coal. In the sum of the percentage of the three principle constitutes i.e. Sio_2, Al_2o_3, & Fe_2o_3 is equal to greater than 70%, so the fly ash is termed as class F.

3.3 *Fine aggregates*

Natural sands, crushed and rounded sands, and manufactured sands are suitable for SCC. River sand of specific gravity 2.613 and conforming to zone II of IS 363 was used for the present study.

Table 2. Testing of Fine Aggregate

S No	DESCRIPTION	RESULT
1	Specific gravity	2.613
2	Water Absorption	1.0%
3	Fineness modulus	2.72
4	Moisture content	2%

3.4 *Coarse aggregate*

The shape and particle size distribution of the aggregate is very important as it affects the packing and voids content. The moisture content, water absorption, grading and variations in fines content of all aggregates should be closely and continuously monitored and must be taken into account in order to produce SCC of constant quality. Coarse aggregate used in this study had a maximum size of 12mm. Specific gravity of coarse aggregate used was 2.625.

Table 3. Testing of Coarse-Aggregate

S No	DESCRIPTION	RESULT
1	Specific gravity	2.625
2	Water Absorption	0.5%
3	Fineness modulus	6.15

3.5 *Water*

Ordinary potable water available in the laboratory was used.

3.6 *Chemical admixtures*

Super plasticizers or high range water reducing admixtures are an essential component of SCC. Conplast SP 430 was used as super plasticizer and polyethylene glycol 600 was used as self-curing admixture.

IV. MIX PROPORTION OF SCC

The selection of suitable ingredients of concrete and the determination of their relative proportions were done with an aim to produce concrete of required strength and durability as economical as possible. Based on the properties of cement, fine aggregate, coarse aggregate and water, the mix proportion was calculated by adopting IS 10262 – 2009. Our design was based on EFNARC specifications.

Table 4. Selected Mix Design for M30 Grade

Cement kg	F.A Kg	C.A Kg	Water lit	SP%	PEG %
500	903	835	187	0.9	0.9

Table 5. Re-placement percentage

Percentage (%)	10%	20%	30%
Cement kg	450	400	350
Fly ash kg	50	100	150

V. EXPERIMENTAL PROGRAM

5.1 *Fresh Properties of Self compacted concrete*

Test on fresh concrete where performed to study the workability of SCC and SCSCC with various percentage of fly ash.

The tests conducted are listed below:

- Slump Flow Test
- V-Funnel
- L-Box Test

Fig.1 a) Slump test

Fig.1 b) V-Funnel test

Table 6. Fresh Concrete Result for Self-Compacting Concrete Mix

IDENTIFICATION	PERCENTAGE OF FLY ASH	SLUMP FLOW (mm)	V-FUNNEL (Sec)	L-BOX (H2/H1)
SCC MIX 1	0	660	11	0.89
SCC MIX 2	10	690	13	0.85
SCC MIX 3	20	670	09	0.87
SCC MIX 4	30	700	12	0.83

Table 7. Fresh Concrete Result for Self Compacting self-curing Concrete Mix

IDENTIFICATION	PERCENTAGE OF FLY ASH	SLUMP FLOW (mm)	V-FUNNEL (Sec)	L-BOX (H2/H1)
SCSCC MIX 1	0	670	11	0.85
SCSCC MIX 2	10	680	10	0.84
SCSCC MIX 3	20	670	13	0.88
SCSCC MIX 4	30	690	12	0.83

5.2 *Harden test Result for 7 & 28 days*

The cube & cylinders were casted and they were subjected to curing for 7 & 28days.

The size of cube is 150mm x 150mm x 150mm & the size of cylinder is 150mm x 300mm. They were subjected to compression test and split tensile test after 7 & 28days respectively.

Fig.2 a) Compressive strength test on cube

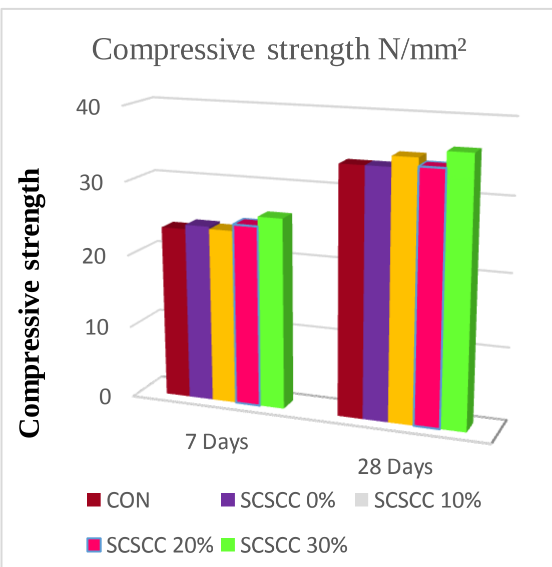
Fig.2 b) Split tensile strength test on cylinder

Table 8. Compressive strength test results

Compressive strength N/mm^2								
Days	**7 days**				**28 days**			
Conventional concrete	23.9				33.8			
Fly ash	0%	10%	20%	30%	0%	10%	20%	30%
Self-compacting concrete	24.3	24.8	26.3	26.9	33.3	34.9	36.2	36.9
Self-curing concrete	23.4	24.9	23.3	24.8	32.7	32.9	33.1	34.2
Self-compacting self-curing concrete	24.2	23.9	24.8	26.1	34.8	35.2	34.1	36.2

Table 9. Split tensile strength test results

Split tensile strength N/mm²								
Days	**7 days**				**28 days**			
Conventional concrete	2.3				3.2			
Fly ash	0%	10%	20%	30%	0%	10%	20%	30%
Self-compacting concrete	2.3	2.3	2.4	2.5	3.2	3.4	3.3	3.6
Self-curing concrete	2.3	2.1	2.2	2.4	3.3	3.0	3.2	3.4
Self-compacting self-curing concrete	2.4	2.2	2.2	2.5	3.3	3.2	3.4	3.5



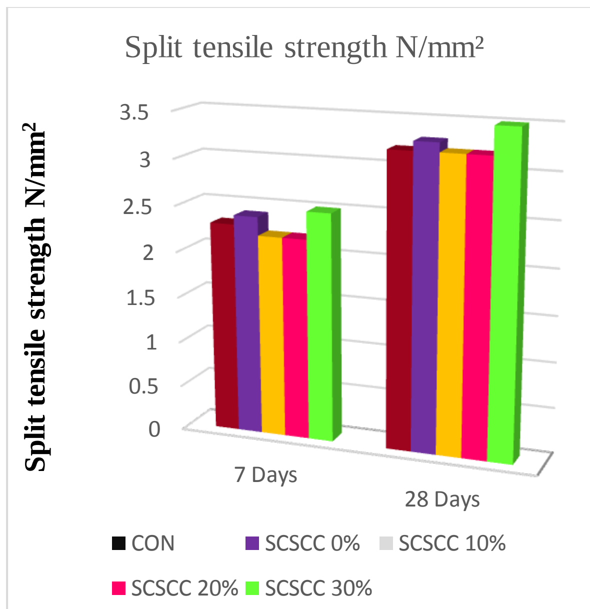


Fig.3 a) Comparison between conventional and self-compacting self-curing concrete for comp strength test

Fig.3 b) Comparison between conventional and self-compacting self-curing concrete for split tensile strength test

VI. DISCUSSION

The self-compatibility properties were tested in fresh state and its satisfied the self-compacting concrete criteria. The test results are summarized in table 8, table 9 graphically represented in graph 1, graph 2. It shows the comparative representation of all cubs and cylinders. The self-compacting concrete cubs and cylinder was good result with comparing conventional concrete. The compressive and split tensile strength of the self-compacting concrete, self-curing concrete and self-compacting self-curing concrete was increase with comparing conventional concrete. Self-compacting concrete was more strength then comparing conventional concrete. The self-curing concrete using polyethylene glycol 600 was lesser compressive and split tensile strength then comparing self-compacting concrete. The self-compacting self-curing concrete was shows batter result then self-compacting concrete and self-curing concrete. Particularly 30% of fly ash replacement in self-compacting self-curing concrete shows more strength then other replacement percentage of fly ash.

VII. CONCLUSION

From the experimental investigation the compressive and split tensile strength of the self-compacting concrete, self-curing concrete and self-compacting self-curing concrete was increase with comparing conventional concrete. The self-curing concrete using polyethylene glycol 300 was lesser compressive and split tensile strength then comparing self-compacting concrete. Self-compacting self-curing concrete was shows batter result then conventional concrete, self-compacting concrete and self-curing concrete. Self-compacting self-curing concrete is 30% of fly ash replacement shows more strength then other replacement percentage of fly ash.

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