EXPERIMENTAL STUDIES ON FIBRE REINFORCED SELF CONSOLODATING – SELF CURING CONCRETE

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***Abstract*— Self Consolidating Concrete (SCC) is generally defined as a concrete, which does not need compaction. It means SCC gets compacted without external efforts like vibration, damping etc., The use of SCC in actual construction is still less in India. Lack of awareness and technical data could be cited as the main reasons. For adoption of any new material or technology, it needs proven performance over traditional materials. At the same time, curing of concrete plays a major role in developing the concrete microstructure and pore structure, and hence improves its durability and performance. Curing is not always practical in many cases due to scarcity of quality water. Water resources are becoming valuable every day. Each one cubic metre of concrete requires approximately 3000 litres of water for construction. In this experimental investigation, an attempt has been made to develop the SCC with self curing property by using concure (self curing agent). It helps to increase the water retention capacity when it compares to the conventionally cured concrete. The concure is water based concrete curing compound complying with the internationally recognized ASTM C309-90 standard. In this work it has been planned to produce self Consolidating and self curing concrete with fibre. The chemical admixtures like Super Plasticizer (SP), Viscosity Modifying Agent (VMA), concure and mineral admixture like Silica Fume (SF) has been used. Various properties like workability, mechanical were studied and discussed. In this investigation workability tests for SCC were carried out as per European Federation of National Association Representing Concrete (EFNARC) guide line provisions. The cube has been cast for conventional and SCC for M40 grade of concrete. Then the cube has been tested for 28 days curing. The mix Tr9 produce better results among all the mix.**

***Keywords*— Self Consolidating Concrete, compressive strength, Super plasticiser, Viscosity Modifying Agent, workability, concure.**

I. INTRODUCTION

In recent years, SCC has gained wide use for placement in congested reinforced concrete structures with difficult casting conditions. For such applications, the fresh concrete must possess high fluidity and good cohesiveness [10]. Fibres are effective in increasing Compressive strength up to 1.0 percent fibre content, beyond which the increase is not much effective[9]. Fiber-reinforced concrete is becoming an increasingly popular construction material due to its improved mechanical properties over un reinforced concrete and its ability to enhance the mechanical performance of conventionally reinforced concrete [3].The current trend is incorporating self curing agents in Self Consolidating Concrete. There has been no significant improvement in the tensile strength properties. Incorporating fibres in concrete enhances both tensile and flexural properties. So, a study has been conducted on fibre reinforced Self Consolidating Self curing concrete.

A) Self Consolidating Concrete

Concrete is the most versatile construction material because it can be designed to withstand the harsh environments while taking on the most inspirational forms. Engineers are continually pushing the limits to improve its performance with the help of innovative chemical admixtures and supplementary cementitious materials. SCC is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement.

The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete. SCC requires little vibration or compaction which has been used in Europe since the early 1970s but it was not developed until the late 1980's in Japan. In Europe, it was probably first used in civil works for transportation networks in Sweden in the mid 1990's. The multi-national industry lead project "SCC" 1997-2000 and since then SCC has found increasing use in all European countries.

Self- Consolidating Concrete offers a rapid rate of concrete placement, with faster construction time and ease of flow around congested reinforcement. The fluidity and segregation resistance of SCC 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. SCC is often produced with low water-cement ratio providing the potential for high early strength, earlier demoulding and faster use of elements and structures.

The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. The improved construction practice and

performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction.

The main reasons for the employment of Self-Consolidating Concrete can be summarized as follows:

- Faster construction.
- Assuring compaction in the structure - especially in confined zones where vibrating the concrete is difficult.
- Reduced noise levels, absence of vibration.

B) Self Curing Agent

Concure is also known as concure WB (White). It is water based concrete curing compound based on a low viscosity wax emulsion and supplied as a white emulsion which forms a clear film on drying. It complies with the internationally recognized ASTM C309-90 standard was employed. The surface of the concrete was thoroughly moistened before the application of the compound to prevent its absorption into the concrete. Then the compound was uniformly applied to the surface of the samples, ensuring complete coverage, with a brush after its removal from the mould. Control of moisture loss improves surface quality, reducing permeability, producing a hard wearing, dust free surface and minimizing potential for surface cracking and shrinkage.

The main reasons for the employment of self-curing concrete can be summarized as follow:

- Improved curing of concrete enhances cement hydration and provides a more durable concrete.

C) Objectives

The following are the objective of this work.

- To study the workability and compressive strength of SCC.
- To study workability and mechanical properties of fibre reinforced Self Consolidating - Self Curing Concrete.
- To study the strength properties of fibre reinforced Self Consolidating Self Curing Concrete (SC-SCC).

II. Experimental Work

A) Materials Used

1) *Cement:* Ordinary Portland Cement (53 grade) conforming to IS 8112 has been used in the study. The different laboratory tests were conducted on cement to determine standard consistency, initial and final setting time, and specific gravity. The results are tabulated in Table I. The results conform to IS recommendations.

TABLE I. PROPERTIES OF CEMENT

S. No.	Test conducted	Result
1	Standard consistency	32%
2	Initial setting time	150 minutes
3	Final setting time	330 minutes
4	Specific gravity	3.15

2) *Fine Aggregate:* River sand procured from a nearby source was used as fine aggregate in this study. The physical properties of fine aggregate such as specific gravity and fineness modulus were determined in accordance with IS: 2386-1963. The details are shown in Table II.

TABLE II. PROPERTIES OF FINE AGGREGATE

S. No.	Sand Type	Name of the Test	Zone II
1	River Sand	Specific gravity	2.74
2		Fineness modulus	2.67

3) *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 2.74.

4) *Water:* Potable water was used in the investigations for both mixing and curing purposes.

5) *Chemical admixtures:* Super plasticisers or high range water reducing admixtures are an essential component of SCC. The super plasticizer (Conplast SP 430) as a viscosity modifying agent (Gelenium stream 2) and self curing admixture (Concure) was used. Concure is water based concrete curing compound complying with the internationally recognized ASTM C309-90 standard was used in this investigation.

6) *Mineral admixtures:* Micro silica or Silica Fume (SF) improves the durability of the concrete by reinforcing the microstructure through filler effect and thus reduces segregation and bleeding. It also helps in achieving high early strength. Silica fume of specific gravity 2.34 was used in this study.

7) *Mix Proportioning:* The mix proportioning for M40 grade concrete used in the present work. It is designed as per EFNARC standards. The mix proportioning adopted was cement: sand: coarse aggregate/water-cement ratio respectively 1: 1.4: 1.15: 0.36.

B) Experimental Investigations

Tests on fresh concrete were performed to study the workability of SCC with various proportions of SP and VMA. The tests conducted are listed below:

1. Slump flow test
2. V- funnel flow test
3. U-tube test
4. L-box test

The acceptance criteria for the fresh properties of SCC are listed in Table III.

TABLE III. ACCEPTANCE CRITERIA FOR SCC.

S. No.	Method	Unit	Typical range of values	
			Minimum	Maximum
1	Slump - flow	mm	650	800
2	V- funnel	Sec	6	12
3	L - Box	(h_2/h_1)	0.8	1.0
4	U - Box	(h_2/h_1)	0	30

C) Mix Proportion of SCC

There is no standard method for SCC mix design and many academic institutions, admixture, ready-mixed, pre cast and contracting companies have developed their own mix proportioning methods. De Schutter method, based on EFNARC specifications, was adopted for mix design. Different mixes were prepared by varying the amount of coarse aggregate, fine aggregate, water powder ratio, super plasticisers and VMA. After several trials, SCC mix satisfying the test criteria was obtained. The details of the design mix are given in Table IV.

TABLE IV. MIX PROPORTION FOR SCC.

Particulars	Quantity (kg/m^3)
Cement	754.6
Fine aggregate	1061.83
Coarse aggregate	868.77
Water (lt/m^3)	275.40

D) Test Results

1) Result on fresh concrete

Notations:

RMX: 1: 1.4: 1.15: 0.36.

RMX: Reference Mix

Tr 1: NR + 0.6% SP* + 0.4% VMA* +10%SF *
Tr 2: NR + 0.8 % SP* + 0.4% VMA* +10%SF *
Tr 3: NR + 1.0 % SP* + 0.4% VMA* +10%SF *
Tr 4: NR + 0.6 % SP* + 0.6% VMA* +10%SF *
Tr 5: NR + 0.8 % SP* + 0.6% VMA* +10%SF *
Tr 6: NR + 1.0 % SP* + 0.6% VMA* +10%SF *
Tr 7: NR + 0.6 % SP* + 0.8% VMA* +10%SF *
Tr 8: NR + 0.8 % SP* + 0.8% VMA* +10%SF *
Tr 9: NR + 1.0 % SP* + 0.8% VMA* +10%SF *
Tr 10: NR + 0.6 % SP* + 1.0% VMA* +10%SF *
Tr 11: NR + 0.8 % SP* + 1.0% VMA* +10%SF *
Tr 12: NR + 1.0 % SP* + 1.0% VMA* +10%SF *

*** By weight of cement**

TABLE V. WORKABILITY TEST RESULTS.

Trials	Slump flow mm	V-Funnel (Sec)	L-Box (h_2/h_1) mm	U-Box $(h_2 - h_1)$ mm
Tr 1	670	11	0.95	13.6
Tr 2	670	11	1.1	13.8
Tr 3	684	13	1.1	14.1
Tr 4	688	14	1.15	14.1
Tr 5	688	13	1.1	14.1
Tr 6	685	13	1.35	13.7
Tr 7	696	11	1.35	13.7
Tr 8	710	11	1.35	12.8
Tr 9	717	11	1.46	12.8
Tr 10	715	12	1.46	12.8
Tr 11	715	12	1.46	12.9
Tr 12	716	11	1.5	12.7

Fig 1 SCC Mixing In Mixer Machine

Fig 2 V – Funnel test

Fig 3 Slump flow test

Fig 4 U box test

2) Result on harden concrete :

Nine standard cubes each for various percentages were tested to determine the 7- days, 28- days, 56- days compressive strength and results are given in table-VI

TABLE VI. COMPRESSIVE STRENGTH OF CUBE (M40 – SCC).

Trials	7 Days (N/mm^2)	28 Days (N/mm^2)	56 Days (N/mm^2)
Tr 1	36.55	44.85	59.52
Tr 2	35.12	44.39	58.24
Tr 3	35.81	45.88	57.98
Tr 4	36.46	46.31	58.44
Tr 5	38.19	49.48	60.98
Tr 6	41.22	53.96	61.69
Tr 7	46.62	56.17	61.16
Tr 8	46.91	61.66	65.73
Tr 9	49.65	63.88	68.97
Tr 10	48.75	62.32	67.55
Tr 11	48.16	63.10	65.56
Tr 12	49.10	63.38	68.32

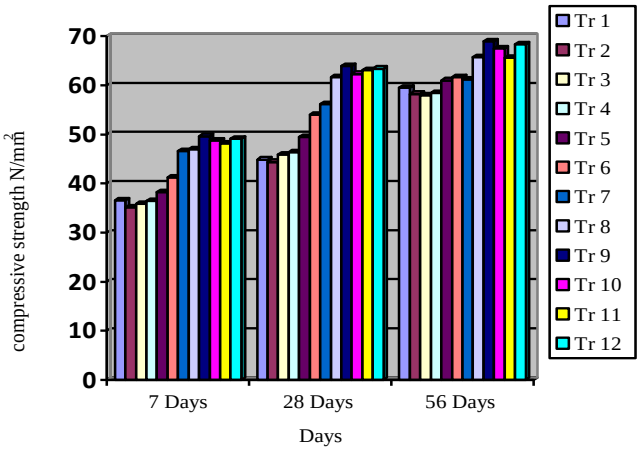

Fig 5 Cube Compressive Strength N/mm^2 (SCC)

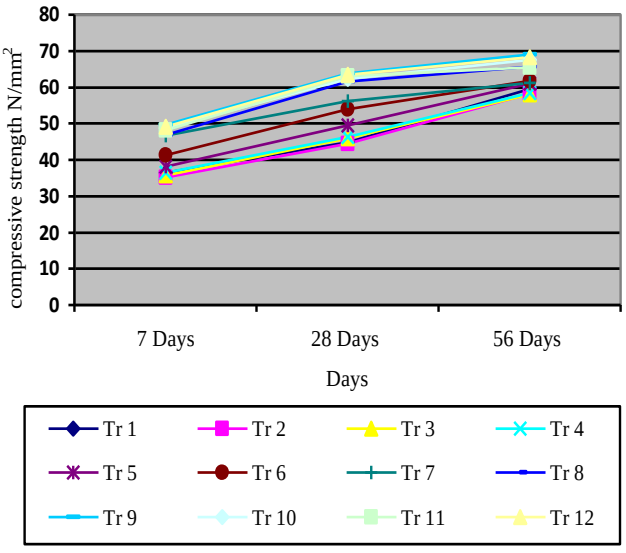

Fig 6 Cube Compressive Strength N/mm^2 (SCC)

Fig 7 Cube Casting

III. CONCLUSIONS

Based on the experimental investigation, the following conclusions are drawn:

- The fresh concrete test results are within the limits of SCC i.e., flow ability, passing ability and resistance against segregation.
- The compressive strength of Tr6, Tr7, Tr8, Tr9, Tr10, Tr11 and Tr12 is achieved grade of concrete with in 7- days.
- It is found that the ratio of gain in strength is early.

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