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Experimental Study on Fiber Reinforced Self Compacting Concrete

L. Arun Raja[1], Dr. M. Shahul Hameed[2]
[1]*Assistant Professor, Department of Civil Engineering, P.S.R. Engineering College, Sivakasi, TamilNadu, India.*
[2] *Dean (Research) & Professor, Department of Civil Engineering, P.S.R. Engineering College, Sivakasi, TamilNadu, India.*

Abstract: ***Self-Compacting Concrete (SCC) is one of the most important developments in the building industry. It provides solution to the problems occurring in normal concrete such as inadequate compaction which affects the strength and durability of structures. This project is taken up with the objective to evaluate the performance of self compacting concrete for M25 grade using Recron fibers and by adding suitable superplasticizer and Viscosity Modifying Agent (VMA). Basic tests for fine aggregate, coarse aggregate, cement, freshly prepared SCC tests such as slump flow test , J-ring , V-funnel, U-box tests were done and checked against the specifications given by EFNARC guidelines. Then mechanical properties such as compressive strength, tensile strength and impact strength were studied and the results were compared with normal SCC mix.***
Keywords: SCC, Recron fibers, Super plasticizer, VMA, EFNARC guidelines.

I. INTRODUCTION

Self compacting concrete (SCC) is a recently developed concept in which the ingredients of the concrete mix are proportioned in such a way that the concrete is compacted by its own weight without any vibration effort assuring complete filling of formwork even when access is hindered by narrow gaps between reinforcing bar. The term self-compacting concrete describes a property of fresh concrete that can be achieved in a variety of ways with different concrete constituent materials. It is used to facilitate and ensure proper filling and good structural performance of restricted areas and heavily reinforced structural members.SCC was developed in Japan in the late 1980 to be mainly used for congested reinforced structures in seismic region .Recently this concrete has gained wide use in many countries for different applications and structural configuration.SCC can also provide a better working environment by eliminating the vibration noise. One of significant limitations in the ready adoption of SCC also called self consolidating concrete .India is in lack of availability of appropriate mixture proportioning method. The principle and method of mixture proportioning of SCC as developed by different investigators.

II. STUDY ON MATERIAL

A. Cement

OPC 53 grade with brand name Ultra Tech is utilized for all SCC mixes. Specific gravity is 3.14, fineness and consistency are 3.45% and 32% respectively. The initial setting time was 30 minutes.

B. Fine Aggregate

These are passing through IS sieve 4.75mm were used. The specific gravity is 2.65, fineness modulus is 4.4 having a bulk density of 1790 kg/m^3.

C. Coarse Aggregate

The coarse aggregate was sieved through 12.5mm sieve. Coarse aggregate with specific gravity of 2.68, fineness modulus of 8.3 and having a bulk density of 1652 kg/m^3.

D. Recron Fibers

Recron 3s are Engineered Micro-fibers with a unique “Triangular” cross section, used for Secondary Reinforcement of Concrete. These fibers with cut length of 12mm, effective diameter of 0.04mm and aspect ratio of 300 are used.

E. Super Plasticizer

Ceraplast-300 is a high grade super plasticizer based on Nathphthalene. It reduces water-cement ratio while optimizing cement content to cost savings. It provides considerably high early strength by improving eater tightness , thereby improving concrete properties with improved durability and lower permeability.

F. Viscosity Modifying Agent

The sequence of addition of VMA and super plasticizer into the concrete mixture is important. If VMA is added before the super plasticizer, it swells in water and it becomes difficult to produce flowing concrete.VMA should be added after the super plasticizer has come into contact with the cement particles to avoid this swells in concrete. In this project, we use Ceraplast WU as an viscosity modifying agent.

III. EXPERIMENTAL INVESTIGATION

A. Mix Design

The mix design of self-compacting concrete is a trial and error method. Many references available for mix proportioning of SCC. Here we use mix proportioning based on previous investigation strength data using Japanese method and also based EFNARC guidelines. In our investigation we incorporate the procedures of EFNARC guidelines. These guidelines gives the range for coarse aggregate and fine aggregate content based on the limit the approximate mix design for M25 grade of concrete is obtained.

Cement (kg)	F.A (kg)	C.A (kg)	Water (lit)
503.97	898.29	809.36	178.4
1	1.78	1.61	0.4

Table – 1 Mix proportions

B. Workability Test on Fresh SCC

1) *Slump flow test:* The slump flow test aims at investigating the filling ability of SCC. This is a simple rapid test procedure. The slump flow test gives a good assessment of filling ability.

Fig-1. Slump flow test

2) *J-ring test:* J-ring consists of a ring of 500mm diameter with vertical bars attached to it. In this test, the time taken to reach 500mm and the height difference between the concrete inside the bars and outside the bars was measured.

Fig-2. J-ring test

3) *V-funnel test and V-funnel at T_5 Minutes:* Segregation resistance is the resistance of the components of SCC to migration or separation. This can be done by V-funnel.

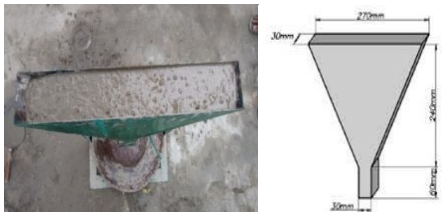

Fig-3. V-funnel test

4) L-box Test: Passing ability is required to guarantee a homogenous distribution of the components of SCC in the vicinity of obstacles. This can be tested by L-box. The vertical section of the apparatus was filled with the concrete sample. After 1 minute, the sliding gate was lifted and the concrete was allowed to flow out into the horizontal section. The time taken for the concrete to reach the 200mm and 400mm marks was noted.

C. Workability test results for SCC

Table-2 Workability test results

S.No	SCC type	Slump Flow mm	J-ring		V-funnel		L-box		
			T_{500} sec	h1~h2 mm	T(0) sec	T(5) sec	T_{200} sec	T_{400} sec	h2/h1
1	SCC -C	700	1	3	8	10	0.9	1	1.9
2	$RFSCC_1$	670	1.21	5	8.6	11.2	0.89	1.1	2.1
3	$RFSCC_2$	655	1.3	5.6	9.15	11.65	0.86	1.25	2.2
4	$RFSCC_3$	630	1.8	6.1	10	12.58	0.81	1.32	2.39
5	EFNARC limits	600 to 800	<2	<10	8 to 12	<T+3	>=0.8	1±0.5	2±0.5

D. Compressive Strength Results

Table-3 Compression test results

S.No	Type	Compressive strength		Remarks
		7 DAYS MPa	28 DAYS MPa	
1	SCC - C	29	36	Conventional self- compacting concrete
2	$RFSCC_1$	31.5	37.5	SCC with addition of 0.1% recron fibers
3	$RFSCC_2$	32.2	38	SCC with addition of 0.2% recron fibers
4	$RFSCC_3$	32.7	40	SCC with addition of 0.3% recron fibers

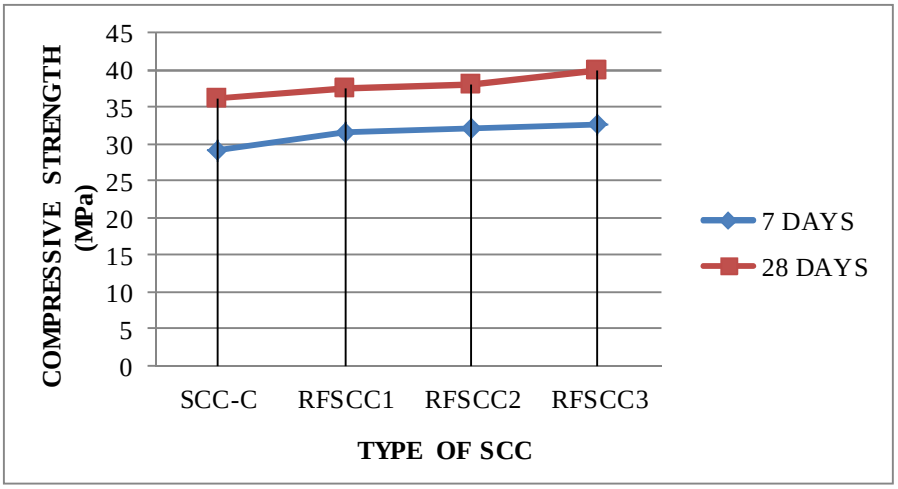

Chart 1- Comparison of compressive strength with addition of fibers in SCC

E. Split Tensile strength Results

S.No	Type	Split tensile strength		Remarks
		7 DAYS MPa	28 DAYS MPa	
1	SCC - C	2.618	3.52	Conventional self- compacting concrete
2	$RFSCC_1$	2.724	3.6	SCC with addition of 0.1% recron fibers
3	$RFSCC_2$	3	3.73	SCC with addition of 0.2% recron fibers
4	$RFSCC_3$	3.2	3.9	SCC with addition of 0.3% recron fibers

Table-4 Split tensile test results

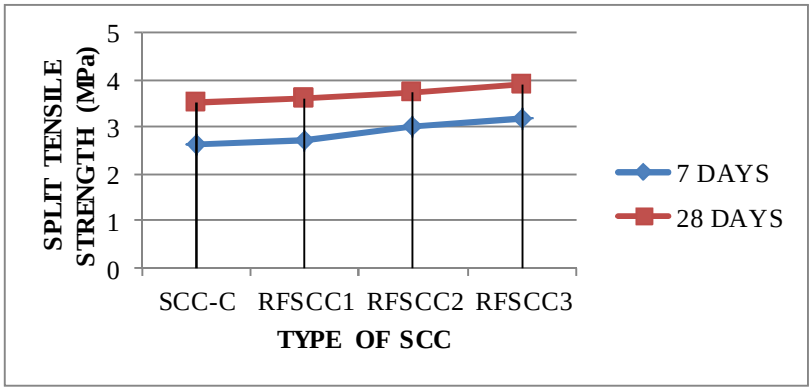

Chart 2 – Comparison of split tensile strength with addition of fibers in SCC

F. Impact Test Results

Table-5 Impact test results

S.No	Type	Age of Curing	No. of blows		Impact strength kn-m	
			First crack	Failure crack	First crack	Failure crack
1	SCC – C	7 days	54	56	1.141	1.183
		28 days	79	81	1.669	1.712
2	$RFSCC_1$	7 days	61	65	1.289	1.374
		28 days	81	83	1.712	1.754
3	$RFSCC_2$	7 days	67	72	1.416	1.521
		28 days	82	85	1.733	1.796
4	$RFSCC_3$	7 days	67	74	1.42	1.564
		28 days	84	87	1.755	1.838

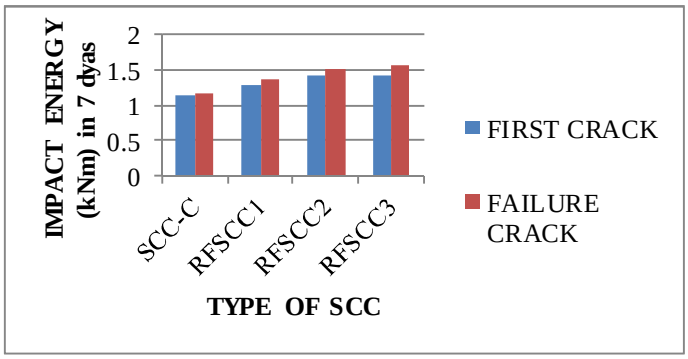

Chart 3- Comparison of Impact Energy in 7 days with the addition of fibers in SCC

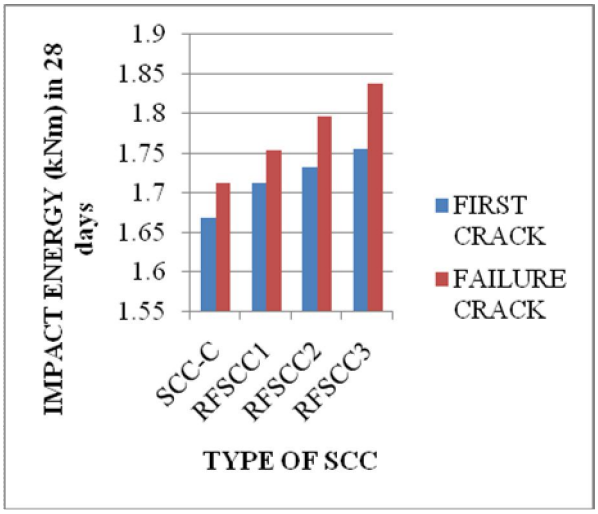

Chart 4 - Comparison of Impact Energy in 28 days with the addition of fibers in SCC

IV. RESULTS AND CONCLUSION

The basic properties of materials were tested and results tabulated. In this project the used two admixtures are super plasticizers and viscosity modifying agent. The fresh concrete tests were conducted to find out the workability. The fresh concrete tests like L-box, V-funnel, J-ring and slump flow tests were conducted and results were tabulated.

The casted cube, cylinder and discs were tested and the mechanical properties were found out, such as compressive strength, spilt tensile strength and impact strength on various self compacting concrete mixes with Recron fibers (0.1%. 0.2% & 0.3%) at 7 and 28days. The test results were compared by using chart.

In this work, the test results show that compressive strength increased slightly and split tensile strength shows a gradual increase when compared to compressive strength with the addition of fibers. The impact strength showed a great increase in 28 days than 7 days. Further addition in fiber content may result in improve the mechanical properties. Recron3S are mostly used in conventional concrete. These fibers are nowadays used in self compacting which is now proved to be enhancing the properties of SCC.

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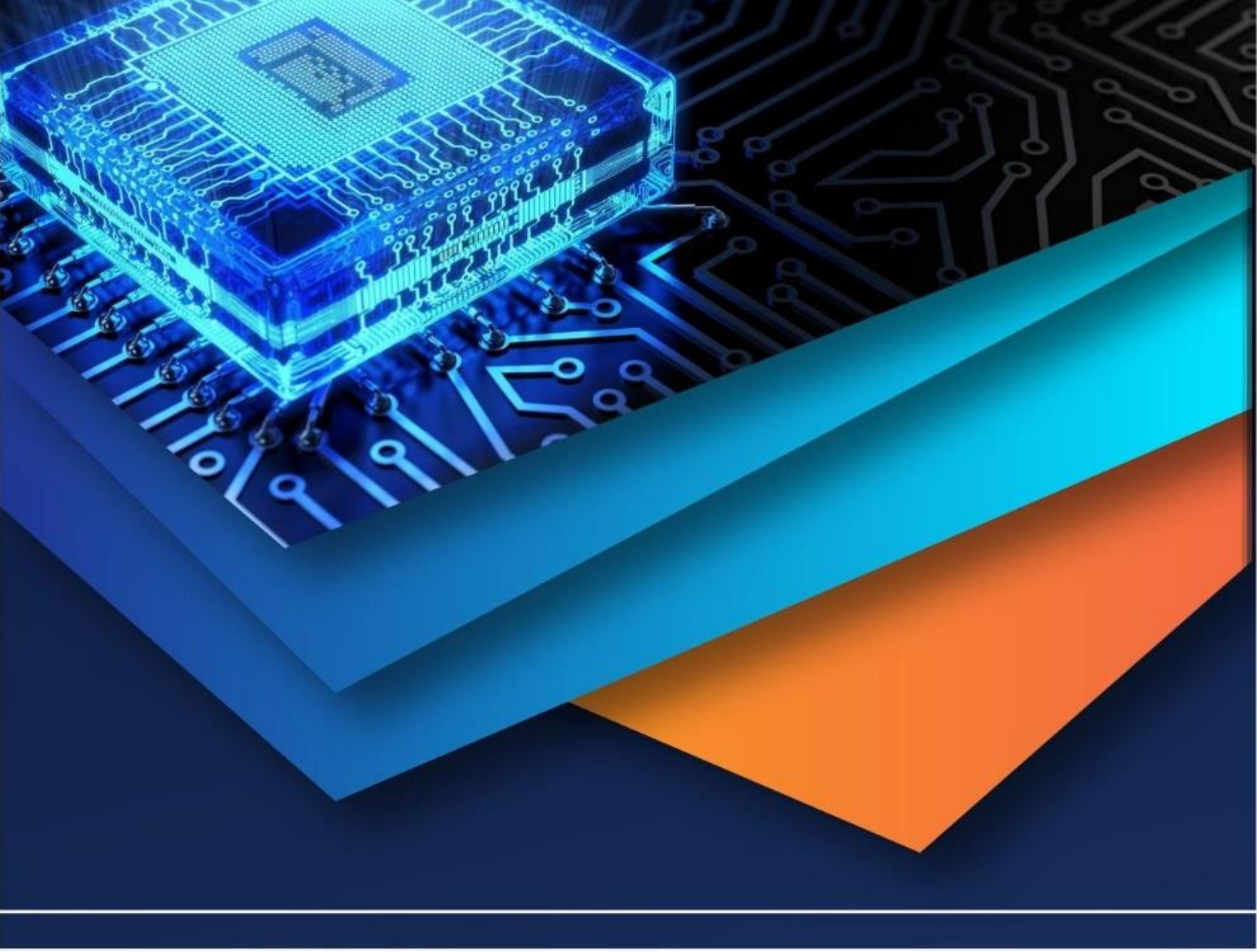

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