International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 03, March-2019

EXPERIMENTAL STUDIES ON THE PROPERTIES OF FIBER REINFORCED SELF COMPACTING CONCRETE

D. Vijayalakshmi[1], K. Madhavilatha[2]

[1]PG.Student, Department of Civil Engineering & GPREC,
[2]Assistant Professor, Department of Civil Engineering & GPREC,

ABSTRACT: Self-Compacting Concrete (SCC) is a concrete that has a high flowing ability with no segregation. . Self-Compacting Concrete added with glass fibers create Glass Fiber Reinforced Self-Compacting Concrete (GFRSCC). Self-Compacting Concrete added with Steel Fibers create Steel Fiber Reinforced Self Compacting Concrete (SFRSCC). The present work deals with the workability and strength studies on Glass Fiber Reinforced Self Compacting Concrete and Steel Fiber Reinforced Self Compacting Concrete of grade M30 with GGBS. The mix proportions for Self-Compacting Concrete were arrived at by performing mix design and then fine-tuning using EFNARC guidelines. In the past, several studies have been carried out on the SCC with addition of fibers. In this study, addition of four different volume fractions of glass fibers and steel fibers viz. 0.2%, 0.4%, 0.6% on a M30 grade SCC was investigated. For testing the properties of SCC and Glass Fiber Reinforced SCC (GFRSCC) in fresh state, Slump-flow, L-box and V-funnel and U-box tests were conducted. Whereas for testing the properties in hardened state, Compressive Strength, Split Tensile Strength, Flexural Strengths and durability tests were planned to be carried out for 7days and 28days. In this paper, the results obtained on the fresh and hardened properties of SCC with and without fibers are presented.

Key words: Self Compacting Concrete (SCC), Steel fibers, Glass fibers, Super Plasticizer (SP), Viscosity Modifying Agent (VMA).

1. INTRODUCTION

In the recent days due to rapid industrialization and urbanization tall, robust and smart structures are quite common. Hence researchers are developing new materials which are durable and strong enough to resist the applied loads. Many structures are being designed with congested reinforcement making the placement of concrete a highly difficult task. In such situation Self Compacting Concrete (SCC) offers a good solution. SCC is relatively a brittle material and addition of fibers improves its ductility and other engineering properties. Fiber Reinforced Concrete (FRC) is relatively a new construction material developed through extensive research and development work during the last two decades. It has already found a wide range of practical applications and proved to be reliable construction material having superior performance characteristics compared to conventional concrete. Incorporation of fibers in concrete has found to improve several properties like tensile strength, cracking resistance, impact & wear resistance and ductility & fatigue resistance. Further development in the field of FRC was due to the intr. The alkali resistant glass fiber, which is developed, recently has overcome this defect and can be effectively used in concrete. In this paper the fresh and hardened properties of SCC with and without glass fibers and steel fibers are investigated, and the results obtained are presented and discussed. Based on the investigations carried out, the conclusions arrived at are given.

2. MATERIALS AND METHODOLY

2.1Materials:

2.1.1 Cement: Ordinary Portland cement (OPC) of 53 grade, ultra tech brand has been used which satisfies all the physical properties as per IS 4031. It has a specific gravity of 3.13, fineness of 98%, and consistency of 32%.

2.1.2 Ground granulated blast furnace slag (GGBS): GGBS is a by result of iron and steel making. For the present work GGBS was obtained from JSW cements ltd. Steel: steel of Fe500 grade was used.

2.2 Aggregates:

2.2.1 Coarse Aggregates: In this work C.A is used which were downgraded of 20mm nominal size and angular shape brought from local crushing units. Physical properties of coarse aggregate are shown below table.
Table 1 shows the properties of coarse aggregates

Table 1 Properties of coarse aggregates

Property	Result
Bulk density	1580KN/m^3
Specific gravity	2.80
Water absorption	0.5%
Crushing value	13.4%
Impact value	13.20%

2.2.2 Fine Aggregates: In this work F.A is used which was downgraded of 4.75mm nominal size. It is collected from the bed of Tungabhadra River. Physical properties of F.A are shown below.
Table 2 shows the properties of fine aggregates

Table2. Properties of fine aggregates

Property	Result
Bulk density	1674KN/m^3
Specific gravity	2.62
Fineness modulus	3.2%
Zone	2

2.3 Chemical Admixture: Super plasticizer is the main use of water reducing agent and improves workability factors. Poly Carboxylite ether based (Glenium B-233) S.P is used in this present study. Physical properties are shown below.

2.3.1Super Plasticizer: Poly carboxylic ether based SP (Glenium B233) was used to improve the workability of concrete.

2.3.2 Viscosity modifying agent (VMA): VMA based on cellulose ether was used only for SCC to modify its flow properties. B. Mix proportions: Table 1 shows the mix proportions of plane SCC of M30 grade as per Nansu method
Table 5 shows the workability properties of SCC (M30) grade

Tabl 3. Workability properties of SCC

Tests	Obtained values	Acceptance criteria based on EFNARC guidelines
Slump (mm)	570	550 – 650
V-funnel (seconds)	18	>10& < 27
L-box	0.88	0.85 – 1
U- box (mm)	0	0 – 3


Fig.1 V FUNNEL TEST


Fig2 SLUMP FLOW TEST

Fig.3 L- BOX TEST

Fig.4 U-BOX TEST

2.3.3. **SLUMP FLOW TEST**: It is the most commonly used test and gives a good assessment of filling ability. As per EFNARC guide, the range is from 650mm to550 mm.

2.4. V-FUNNEL TEST: The test measures flow ability and segregation resistance of concrete. At first, the test assembly is set firmly on the ground and the inside surfaces are moistened. .

2.4.1 L-BOX TEST: The test assesses the flow of the concrete and also the extent to which it is subjected to blocking by reinforcement. The apparatus consist of rectangular section box in the shape of an L.

2.4.2 U-BOX TEST: Sometimes the apparatus is called a 'box-shaped' test. The test is used to measure the filling ability of self compacting concrete. The apparatus consists of a vessel that is divided by a middle wall compartments.

3 EXPERIMENTAL DETAILS:

The specimen were then taken off from water after curing, wiped with clean dry cloth and kept ready for compression test, split tensile test and flexural test. The testing for hardened concrete properties were conducted as per IS: 516 code.
Table 6 shows the mix proportions for SCC using fibers

Table 4 Mix proportions for SCC with and without fibers

Mixes	**M-1**	**M-2**	**M-3**	**M-4**	**M-5**	**M-6**	**M-7**
Designation	SCC	SCCG0.2	SCCG0.4	SCCG0.6	SCCS0.2	SCCS0.4	SCCS0.6
Cement	216	216	216	216	216	216	216
GGBS	144	144	144	144	144	144	144
F.A.	815	815	815	815	815	815	815
C.A.	1145	1145	1145	1145	1145	1145	1145
Water	156	156	156	156	156	156	156
S.P.	5.4	5.4	5.4	5.4	5.4	5.4	5.4
G.F	-	1.2	1.65	1.96	-	-	-
S.F	-	-	-	-	2.6	3.2	3.6

Name of the fiber	**% of fiber**	**Tests**	**Obtained values**
Steel	0.2%	Slump flow test	620
		V-funnel	10
		L-box	0.92
		U-box	2
	0.4%	Slump flow test	600
		V-funnel	12
		L-box	0.95
		U-box	1
	0.6%	Slump flow test	595
		V-funnel	14
		L-box	0.93
		U-box	3

Table 5 Test results for different percentages of fibers

3.1.RESULTS AND DISCUSSIONS

Table 6 shows the Workability properties for 7 and 28days

Table 6Workability Properties of SCC and fibers

Percentage of fibers	**Compressive strength**		**Split tensile strength**		**Flexural strength**	
	@ 7 days	**@ 28 days**	**@ 7 days**	**@ 28 days**	**@ 7 days**	**@ 28 days**
M-1	34.56	43.67	3.8	4.3	1.8	2.9
M-2	33.82	44.02	2.5	3.6	2.3	3.0
M-3	33.96	48.45	2.5	4.1	2.9	3.8
M-4	35.45	46.06	3.4	4.2	3.2	4.0
M-5	38.92	49.04	2.7	3.8	2.9	3.4
M-6	46.96	51.04	3.9	4.4	3.6	3.9
M-7	52.79	56.34	4.2	4.6	4.2	4.8

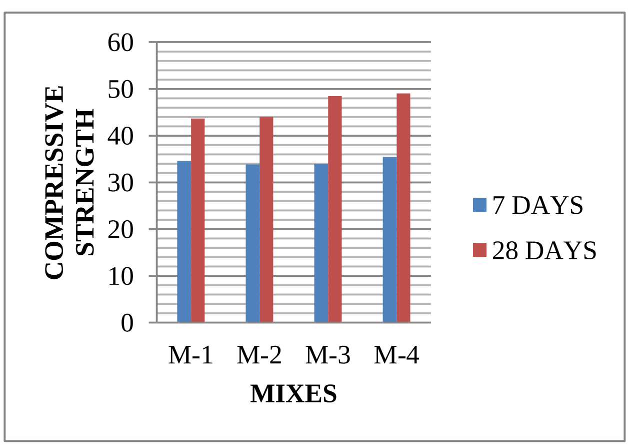


Fig5 compressive strength plane SCC and glass fibers

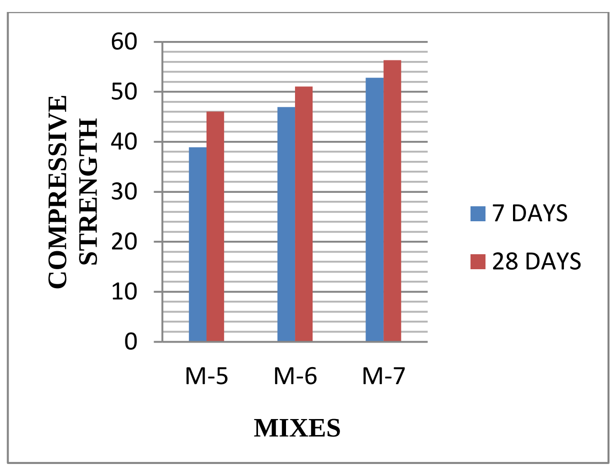


Fig 6 compressive strength for steel fibers

International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Volume 5, Issue 03, March-2019, e-ISSN: 2455-2585, Impact Factor: 5.22 (SJIF-2017)

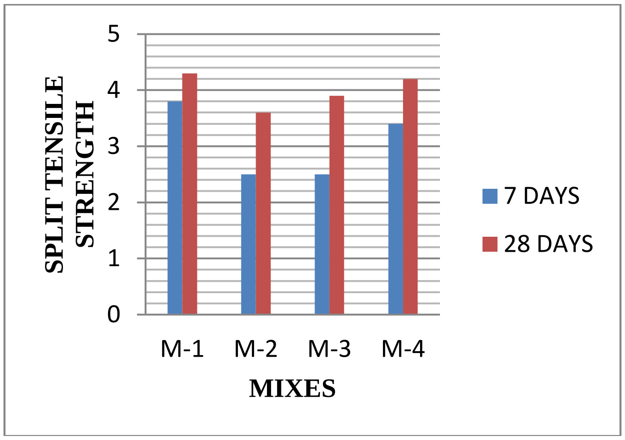


Fig 7 split tensile strength for SCC and glass fibers

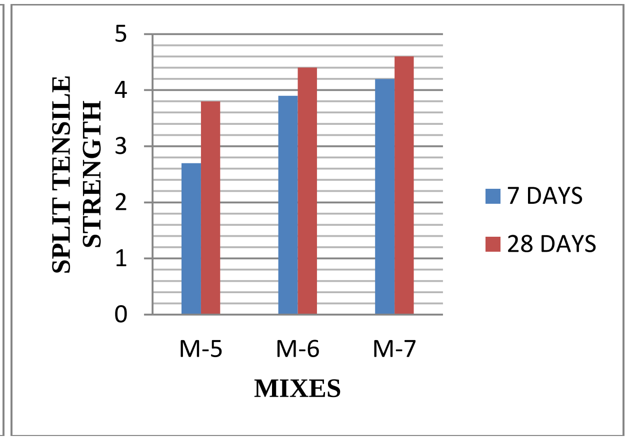


Fig 8 split tensile strength for steel fibers

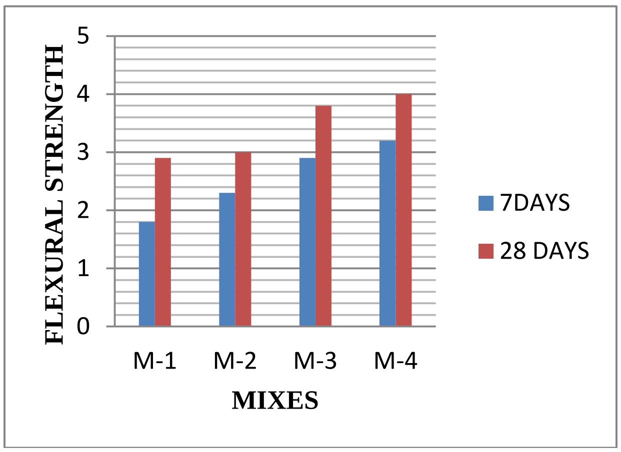


Fig 9 flexural strength of plane SCC and glass fibers

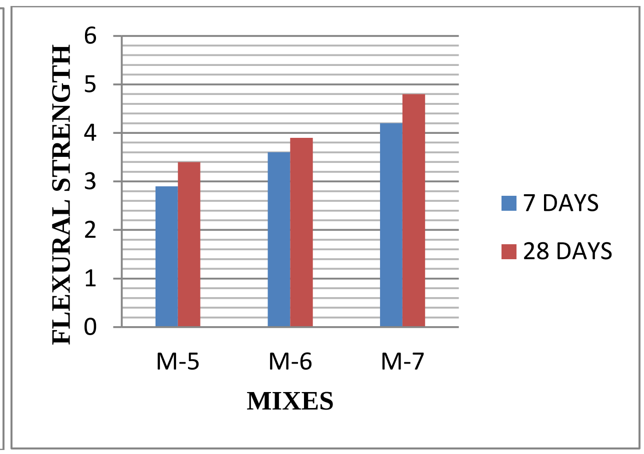


Fig 10 flexural strength for steel fibers

4. Durability properties of SCC with and without fibers:

4.1.1 Impact Test:

The energy absorption capacity of each specimen used in this test is calculated by using equation.

$$\text{Impact energy, } U = \left(\frac{nmv^2}{2}\right)$$

Substituting the relevant values in equation

$$457 = \left(\frac{9810t2}{2}\right)$$

t = 0.3052 s and V= 9810 x 0.3052 = 2994.01mm/s

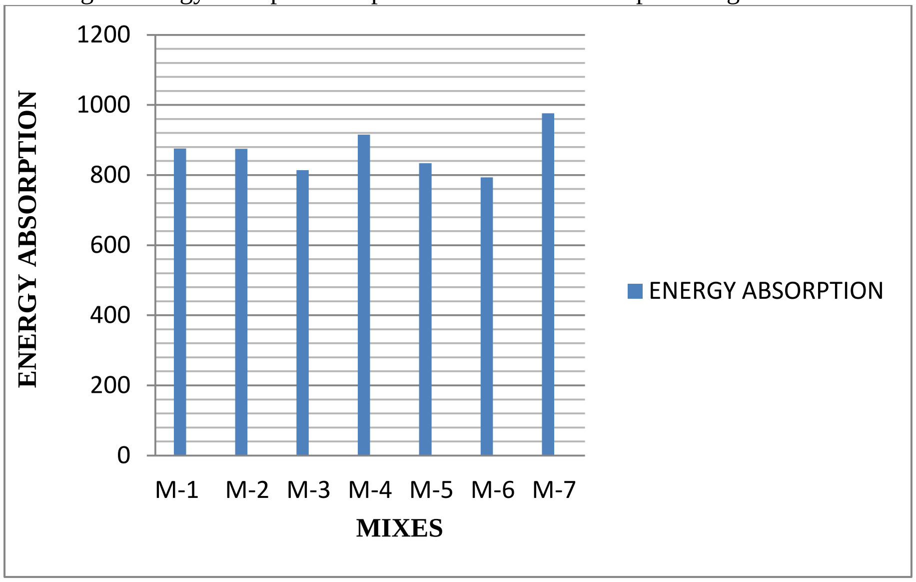
U = 44.3x2994.01x9810 =20.345 KN/mm.

Table 7 shows the test results of impact test

Table7 Test results of impact test for plane SCC and different percentages of fibers

Mixes	**First crack (N1)**	**Failure crack (N2)**	**Energy absorption (U)**
M-1	25	39	875.43
M-2	34	43	874.83
M-3	32	40	813.8
M-4	32	45	915.52
M-5	33	41	834.14
M-6	26	39	793.45
M-7	37	48	9765.56

Fig 11 energy absorprion for plane SCC and different percentages of fibers



4.1.2Water absorption and volume of voids:

This test is done to find the percentage water absorption and density of voids. It is calculated by thes equation.

Absorption after immersion, % = B-A/(A*100)

Volume of voids, % = C-A/(C-D)*100

Table 8shows the water absorption and percentage of voids for plane SCC with and without glass and steel fibers

Table 8 .Water absorption and Percentage of voids

Mixes	**Percentage of absorption**	**Percentage of voids**
M-1	3.36	7.51
M-2	4.22	7.28
M-3	2.87	7.02
M-4	2.98	7.34
M-5	3.48	6.06
M-6	3.03	7.54
M-7	3.34	8.08

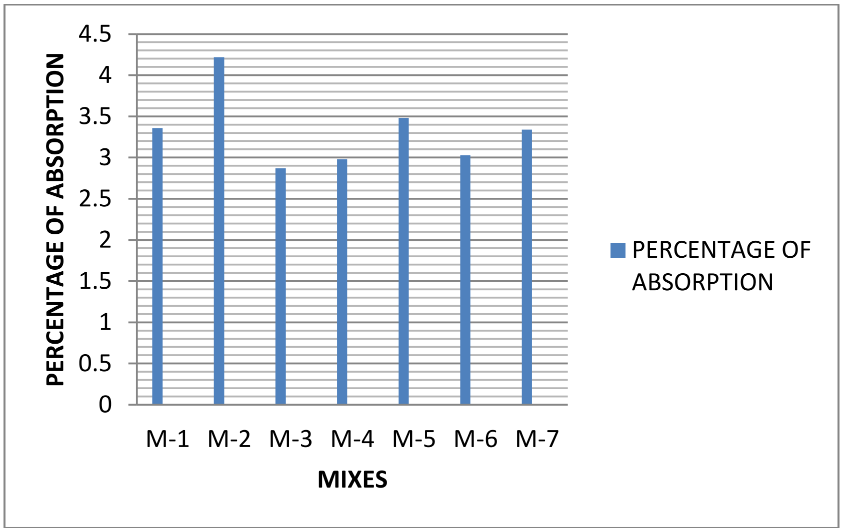


Fig 12 shows the percentage of absorption for different percentages of fibers

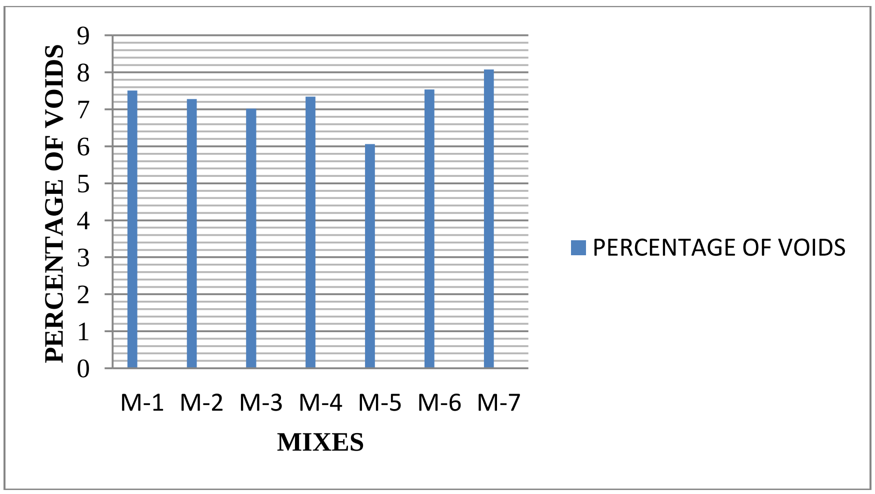


Fig 13 percentage of voids for plane SCC and fibers

4.2 Rapid Chloride Permeability Test (RCPT):

It is a standard test method to determine electrical conductance of concrete to provide a rapid indication of its resistance to the penetration of chloride ions. This test method covers the laboratory evaluation of materials and electrical conductance of concrete samples.

$$Q = 900(I0 + 2(I30 + I60 + I90 + \text{------} + I300) + I360)$$

Charge passed (coulombs)	Chloride ion penetrability
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very low
<100	Negligible

Table 9 Chloride ion penetrability based on charge passed

CONCLUSIONS

The following conclusions are drawn based on the experimental investigation:

- The maximum compressive strength for steel at M-4(0.6%) and glass fibers is found to be achieved at M-6 (0.6%).
- The optimum point for split tensile strength is for steel fibers at M-6(0.6%) for glass fibers at M-4(0.6%).
- The maximum point for glass fibers for tensile strength is at M-4 at (0.6%) for glass fibers atM-4(0.6%).
- The glass fibers did not satisfy the slump, L-box, U-box values of EFNARC guidelines due to the low dosage of fiber addition .and also due to high dispersing nature of glass fibers.

REFERENCES

1) Ardra Mohan, K.M. Mini, " Strength and durability studies of SCC incorporating silica fume and ultra fine GGBS", Construction and Building Materials, 2018. 2
2) S.S. Vivek, G. Dhinakaran, "Fresh and hardened properties of binary blend high strength self compacting concrete", Engineering Science and Technology an International Journal, 2017.
3) M.Adams Joe, A.Maria Rajesh, "Study on the Effect of GGBS & M Sand in Self Compacting Concrete", The International Journal Of Engineering And Science (IJES) Volume 4 2015. 5.
4) T.A. Soylev, T Ozturan, *Durability, physical and mechanical properties of fiber-reinforced concretes at low-volume fraction* in Elsevier Journal of Construction and Building Materials 73 September (2014), 67-75.
5) Aref Sadeghi Nik, Omid Lotfi Omran, *Estimation of compressive strength of self-compacted concrete with fibers consisting nano-SiO2 using ultrasonic pulse velocity* in Elsevier Journal of Construction and Building Materials 44 April (2013), 654-662.