INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 3)
Available online at: www.ijariit.com

Fresh and hardened state properties of fiber reinforced self compacting concrete

Dade Thejaswini
thejaswinidade@gmail.com
JNTUH College of Engineering, Hyderabad, Telangana

Annam Jagadeesh
jagadeeshannam3837@gmail.com
JNTUH College of Engineering, Hyderabad, Telangana

Mandru Sanjay
sanjaymandru77@gmail.com
JNTUH College of Engineering, Hyderabad, Telangana

ABSTRACT

Even though concrete has achieved considerable progress in material science and construction technology, still it is having its own limitations, viz concrete cannot flow past obstructions into nooks and crannies. Thorough compaction is required to get enough strength and durability of concrete. Self-compacting concrete is a highly flow able, non-segregating concrete that can be spread into place, fill the formwork and hold to the reinforcement without any mechanical compaction. Compared to ordinary concrete self-compacting concrete increases the workability and durability. Fibres may be used to enhance the properties of self-compacting concrete such as flexural strength and tensile strength of concrete. Fibres such as glass, polymer, steel, synthetic, natural etc… are used in Fibre-reinforced self- compacting concrete. Steel fibres are used to enhance mechanical characteristics such as flexural strength and toughness. Polymer fibres may be used to reduce segregation and plastic shrinkage or to increase fire resistance. Advantages of Fibre-reinforced self-compacting concrete are an increase in durability, arrest the cracks, increase in energy absorption, reduces sudden failures etc… Various fresh property tests conducted for self-compacting concrete are V-funnel, U-funnel, and L-box and flow test (as per EFNARC guidelines). Hardened state tests are compressive strength, split tensile strength and flexural strength.

Keywords*— Workability, Durability, Fibers, V-funnel, U-funnel, L-box*

1. INTRODUCTION

“Fibre Reinforced Self-Compacted Concrete” (FRSCC) is produced from cement, various sizes of aggregates, which incorporate with fibres dispersed randomly. Several properties such as toughness, increase resistance to fatigue, impact and blast loading, reduce spelling of the reinforcement cover and improve abrasion resistance and flexural and shear strength is increased with the incorporation of adequate amount of fibers in the concrete matrix. The fiber type, configuration, aspect ratio and volume fraction and other mixture parameters influence the mechanical and durability characteristics. Incorporation of glass fibers increases the strength of the concrete and decreases its unit weight.

1.1 Concrete

Concrete is composed of aggregate bonded together with a fluid cement that hardens over time. Most concretes used are lime based concretes such as Portland cement concrete or concretes made with other hydraulic cement.

When aggregate is mixed together with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and molded into shape. The cement reacts chemically with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has manyuses. To improve the physical properties of the wet mix or the finished material several additives are often used such as pozzolonas or super plasticizers. Concrete is embedded with reinforced bars to increase the tensile strength and yield strength.

1.2 Self compacting concrete

The Self -Compacting Concrete is an innovative concrete which consolidates on its own weight and does not require vibration for placing. Even in the presence of congested reinforcement, it is able to flow under its own weight, completely filling formwork and achieving full compaction. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete. As industrial wastes are used and concreting is noise-free it is eco-friendly. As no vibration are required it reduces equipment cost. It reduced manpower Shortened construction time (Eg-Against 15 hrs. for normal concreting, 11 hrs. for a sec).

1.3 Fiber Reinforced Self Compacting Concrete

Fiber-Reinforced Concrete (FRC) contains fibers of numerous shapes and dimensions created from steel, synthetics, glass, and natural materials may be used in cement based composite material.

The capability of the fibers to transfer tensile stresses across a cracked section, potentially resulting in a decrease in crack depth is because of high ductility. Based on the number of fibers added and to their physical qualities (e.g. surface roughness and chemical stability) and mechanical qualities (e.g. tensile strength) the extent from the crack-depth reduced Plain concrete has two major inadequacies a minimal tensile strength and occasional strain at fracture. The tensile strength of concrete is extremely low because plain concrete normally consists of numerous micro-cracks it's the rapid propagation of those micro-cracks under applied stress that's responsible for that low tensile strength from the material. These inadequacies have brought to considerable research targeted at developing new methods for modifying the brittle qualities of concrete.

2. TYPES OF FIBERS

Fiber is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat. The fiber is often described by a convenient parameter called “aspect ratio”. The ratio of its length to its diameter is the aspect ratio of the fiber. Typical aspect ratio ranges from 30 to 150. The following are the different types of fibers:

- Steel Fibers
- Polypropylene Fibers
- Glass Fibers
- Natural Fibers.
- Carbon Fibers.
- Asbestos Fibers.

2.1 Steel Fibers

Toughness, ductility and flexural strength are enhanced by using steel fibers in concrete. Due to dispersed fibres cracks are arrested Major drawbacks are corrosion damage and increased density.

Fig. 1: Steel fibers

2.2 Polypropylene fibers

Even though polypropylene fibers have lower wear resistance but superior to polyamide fibers in elasticity and resilience. They possess good heat-insulating properties and is highly resistant to acids, alkalies, and organic solvents.

Fig. 2: Polypropylene fibers

2.3 Glass Fiber

Glass fibres are lightweight and extremely strong. Strength is 4 times more than that of steel. Breakage of fibres and surface degradation of glass by high alkalinity of hydrated cement paste are the two major problems But now alkali resistant AR-glass fibres are used. Resistance to impact and plastic shrinkage.

Fig. 3: Glass fibres

2.4 Natural fibers
The use of natural fiber like rice husk, coconut fiber, Banana fiber… etc.

Fig. 4: Natural fibers

2.5 Carbon fibres
They have a very high modulus of elasticity and flexural strength. Expansive. Strength and stiffness characteristics are superior to those of steel.

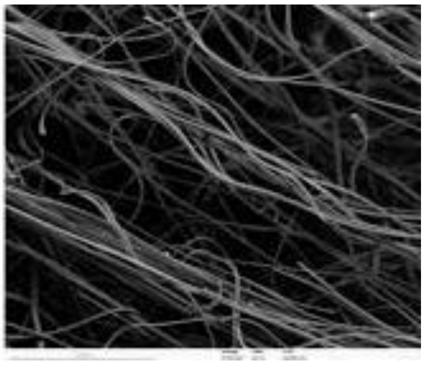

Fig. 5: Carbon fibers

3. OVERALL ADVANTAGES OF FIBRES
- Improved durability of the structure.
- Increased tensile and flexural strength.
- Higher resistance to later cracking.
- Reduced shrinkage of early age concrete.
- Increased fire resistance of concrete.
- Reduces the spalling of the reinforcement cover and improves abrasion resistance.
- Increase in energy absorption capacity.
- High potential to deal with the impact and impulsive or dynamic loads.

4. TEST METHODS
4.1 Requirements
The workability of SCC is higher than the highest class of consistence described within EN 206 and can be characterised by the following properties:
- Filling ability
- Passing ability
- Segregation Resistance.

A concrete mix can only be classified as Self-compacting concrete if the requirements for all three characteristics are fulfilled.

4.2 Tests conducted on SCC
4.2.1 Slump test by Abram's cone

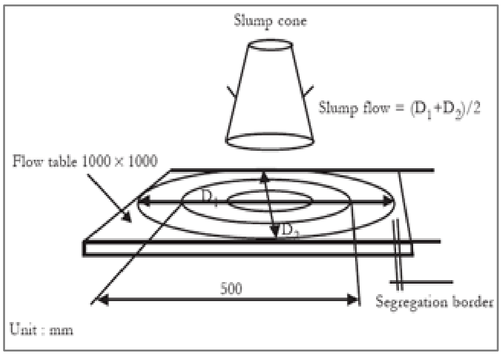

Fig. 6: Slump test by Abram's cone

4.2.2 U-box test

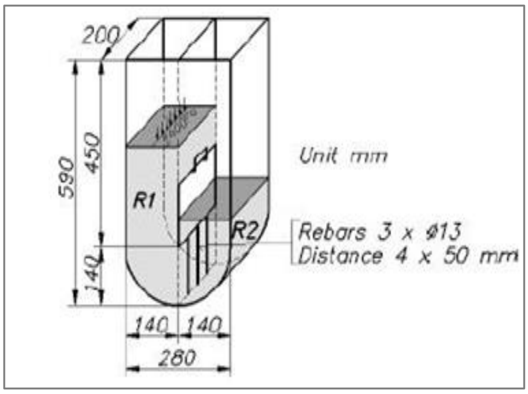

Fig. 7: U-box test

4.2.3 V-Funnel test

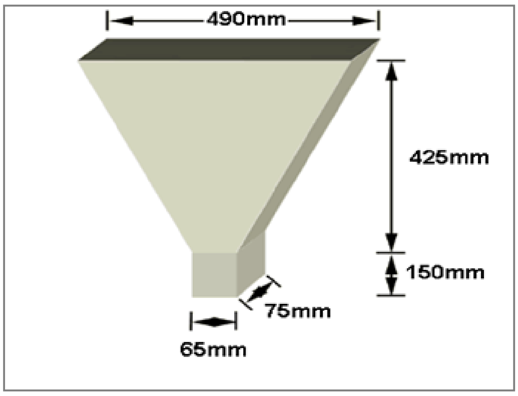

Fig. 8: V-Funnel test

4.2.4 L-Box test

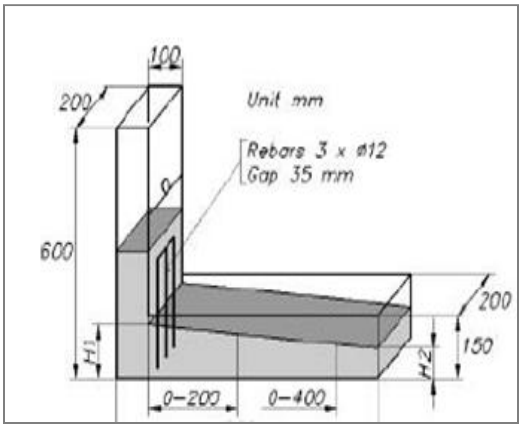

Fig. 9: L-Box test

Table 1: Acceptance criteria for SCC

S no.	Method	Unit	Property	The typical range of values	
				Minimum	Maximum
1.	Slump flow by Abrams cone.	mm	Filling ability	650	800
2.	T50cm Slump flow.	sec	Filling ability	2	5
3.	V-funnel	sec	Filling ability	6	12
4.	L-box	h2/h1	Passing ability	0.8	10.
5.	U-box	(h2-h2) mm	Passing ability	0	30

4.3 Hardened state tests: (IS 516-1959)

4.3.1 Compressive strength: Test for compressive strength is carried out either on a cube or cylinder Cube of 15cm*15cm*15cm is cast and cure it in water and respective 3,7,28 day's strength can be determined under CTM.

4.3.2 Split tensile strength test: It is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. The cylinder of 15cm dia and length of 30cm is cast and cure it for 28 days. Tensile strength is determined under CTM. The split is formed diagonally.

4.3.3 Flexure strength test: It is a measure of an unreinforced concrete beam or slab to resist failure in bending. Beam of size 10cm*10cm*50cm is arranged as shown in fig and flexure strength is determined.

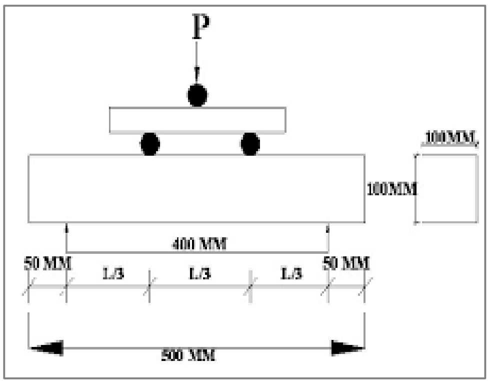

Fig. 10: Two-point loading setup in Exure test

5. RESULTS

Table 2: Mix proportions for M30 Grade FRSCC

S no.	Mix	Cement Kg/m3	F.A Kg/m3	C.A Kg/m3	Water Liters	S.P ml	Fibers %	
							Glass	Steel
1	TR1	600	751	789	175	5030	0	0
2	TR2	600	751	789	175	4600	0	0
3	TR3	600	751	789	175	4280	0	0
4	SCC	480	989	746	201	3360	0	0
5	FRSCC1	480	989	746	201	3360	0.05	0.05
6	FRSCC2	480	989	746	201	3360	0.1	0.1
7	FRSCC3	480	989	746	201	3360	0.2	0.2
8	FRSCC4	480	989	746	201	3360	0.3	0.3

5.1 Compressive Strength

Table 3: Compressive strength values

Mix	28days Strength n/mm2	% Increase In Strength
SCC	41.84	-
FRSCC1	49.8	19.02
FRSCC2	53.8	28.58
FRSCC3	56.5	35.03
FRSCC4	57.8	38.14

Table 4: Comparison of the test result

Mix	Compressive Strength Test		
	Cube Size	Strength (7 Days)	Strength (28 Days)
SCC	100x100	36	41.84
FRSCC1	100x100	36.2	49.8
FRSCC2	100x100	39.6	53.8
FRSCC3	100x100	41.9	56.5
FRSCC4	100x100	42.2	57.8

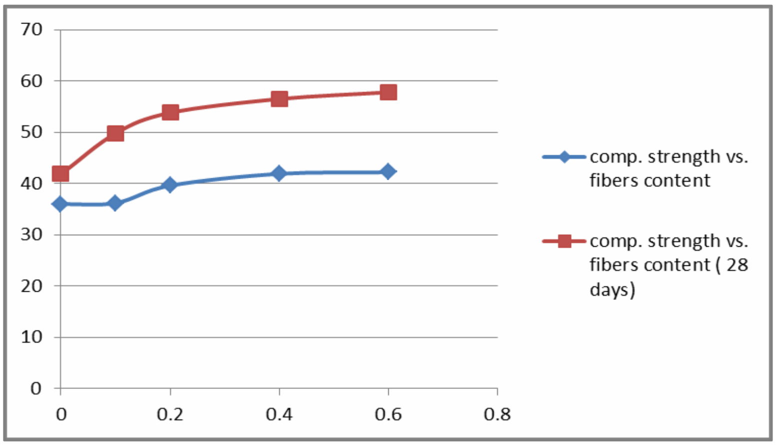

Fig. 11: Comp. strength (vs) fibers

The increase in compressive strength for 0.1%,0.2%,0.4% and 0.6% of quantity of fibers are 19.02%,28.58%,35.03% and 38.14% respectively when compared to SCC without fibers.

5.2 Split tensile strength

Table 5: Split tensile strength values

Mix	Tensile strength	
	Cylinder size (mmxmm)	28days strength (n/mm2)
FRSCC1(0.1)	100x200	6.127
FRSCC2(0.2)	100x200	6.31
FRSCC3(0.4)	100x200	6.49
FRSCC4(0.6)	100x200	6.56

Table 6: Comparison of the test result

Mix	28 Days Strength (n/mm2)	% Increase in Strength
SCC	4.3	-
FRSCC1	6.127	42.48
FRSCC2	6.31	46.74
FRSCC3	6.49	50.93

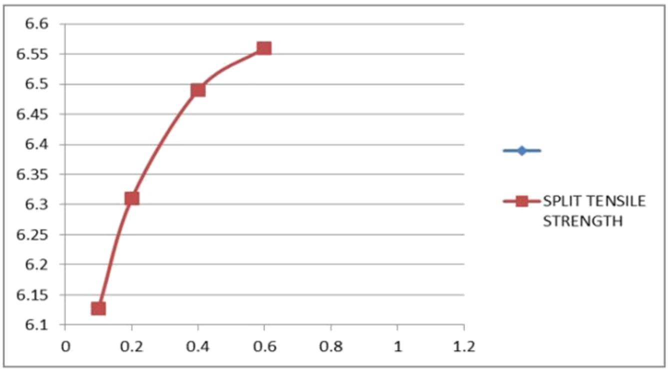

Fig. 12: Split tensile strength vs. fibers content

The increase in tensile strength for 0.1%,0.2%,0.4% and 0.6% of quantity of fibers are 42.48%,46.74%,50.93% and 52.55% respectively when compared to SCC without fibers.The optimum split tensile strength was obtained at 0.2% fibers by volume of concrete,which is 6.31N/mm2.

5.3 Flexural strength of concrete

Table 7: Flexural strength of concrete values

Mix	Flexural strength	
	Beam size	28days strength (n/mm2)
FRSCC1(0.1)s	100x100x500	10
FRSCC2(0.2)	100x100x500	12
FRSCC3(0.4)	100x100x500	13
FRSCC4(0.6)	100x100x500	13.1

Table 8: Comparison of the test result

Mix	28 Days Strength (n/mm2)	% Increase in Strength
SCC	7.2	-
FRSCC1	10	38.99
FRSCC2	12	66.67
FRSCC3	13	80.55
FRSCC4	13.1	81.95

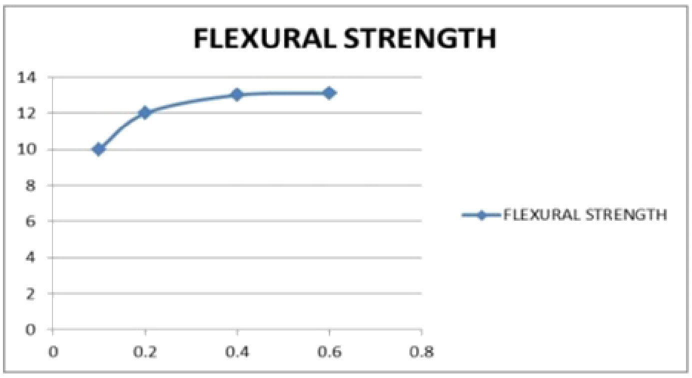

Fig. 13: Flexural strength vs. fibres content

The increase in Flexural strength for 0.1%,0.2%,0.4% and 0.6% of quantity of fibers are 38.99%,66.67%,80.55% and 81.95% respectively when compared to SCC without fibers. The optimum value of flexural strength is obtained at 0.2% fibers by volume of concrete, which is 12N/mm2.

6. INTERPRETATION OF RESULT

6.1 Fresh concrete

(a) FRSCC gives lower slump that means low workability, which creates a problem during placing of concrete.
(b) More plasticizer can be used to increase the workability but it increases the cost.
(c) After its addition its mixing becomes difficult, therefore it requires a high degree of supervision is required.
(d) It was observed that as the fiber content increases the slump flow values decreases.
(e) It was observed that as the fiber content increases the V funnel values decreases.
(f) It was observed that as the fiber content increases the L-Box values decreases

6.2 Hardened concrete

(a) Addition of fibers imparts higher comp n flexural strength, which is more suitable for RCC frame members such as columns (compress members) and beams (flexural members).
(b) The dispersed fiber imparts High tensile strength i.e, greater crack arresting property which can counteract the brittle failure.
(c) Addition of fiber should be specified range, High fiber content damages the properties. The fiber content should be between 0.2%-0.4percent.
(d) The greater compressive, tensile and flexural strength is achieved by the addition of admixtures like super plasticizer which increases the cost of construction.
(e) Alkali resistant glass fibers are added to SCC in volume fractions of 0.1%, 0.2%, 0.4% and 0.6% (by volume of concrete) FRSCC-1, FRSCC- 2, FRSCC-3 and FRSCC-4 respectively.
(f) The optimum fiber content was obtained at FRSCC-2(0.2% fibers)
(g) Different mechanical properties were compared for all the mixes.

7. SUMMARY

Studies were carried out on Fibered Reinforced Self Compacting concrete. The parameters studied include compressive strength, flexural strength, and tensile strength, and workability, % of fibers by volume of concrete. The results show that the mechanical properties of the concrete are optimum at 0.2% of glass and steel fibers in equal proportions by volume of concrete.

8. REFERENCES

[1] Chirag Pawar, Palak Sharma, Abhyuday Titiksh,' Gradation of Aggregates and its Effects on Properties of Concrete
[2] S. Gruewald, J.C Walraven Self Compactig Fiber Reinforced Concrete Research page, Delft University of Technology, Faculty of Civil Engineering and Geosciences.
[3] Groth, P., Nemegeer D., The use of steel fiber in SSC, in A. Skarendahl, O. Petersson, (Eds.), self-compacting Concrete, RILEM Symposium Stockholm, RILEM Publication, Cachan, 1999,pp.497-507
[4] BOOK: Concrete Technology Author A.M Neville and J.J Brooks.
[5] BOOK: Concrete Technology Theory and Practice Author M.S Shetty

