EXPERIMENTAL INVESTIGATION ON ARAMID FIBER REINFORCED SELF COMPACTING CONCRETE

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***Abstract*—Self-compacting concrete has an enhanced ability to flow. It is known to result in an increased segregation and bleeding potential. This paper discusses the results of an experimental investigation into the properties of self-compacting concrete mixes having 0.15% of aramid fiber and 1% dosage of high-performance superplasticizer melamine sulfonate and also to increase the tensile strength in concrete by using aramid fiber.The workability was assessed using three tests according to the specification of self compacted concrete (slump flow, L- box differential height and V-funnel tests).**

Keywords— Self compacting concrete, Aramid fiber, Superplasticizer.

I.INTRODUCTION

Self-compacting concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. Use of SCC can also help minimize hearing-related damages on the worksite that are induced by vibration of concrete. Another advantage of SCC is that the time required to place large sections is considerably reduced.

When the construction industry in Japan experienced a decline in the availability of skilled labour in the 1980s, a need was felt for a concrete that could overcome the problems of defective workmanship. This led to the development of self-compacting concrete, primarily through the work by Okamura[1]. A committee was formed to study the properties of self-compacting concrete, including a fundamental investigation on workability of concrete, which was carried out by Ozawa etal[2]at the University of Tokyo. The first usable version of self-compacting concrete was completed in 1988 and was named "High Performance Concrete", and later proposed as "Self Compacting High Performance Concrete".

Testing of concrete in its fresh state is a major focus of this study. SCC is defined by its behaviour when it is in the fresh state, and it is determined whether concrete meets certain requirements, while fluid is paramount in qualifying concrete as SCC or not. The slump flow, L-box and V-funnel are all used for all mixes of this study.

As the dosage of super plasticizer increases, the slump flow increases. This is expected because as the super plasticizer dosage increases the fluidity of the concrete also increases.

This type of concrete is ideal to be used in the following applications:

- Drilled Shafts Columns.
- Earth Retaining systems.
- Areas with high concentration of rebar and pipes.
- Improved constructability.
- Labour reduction.
- Bond to reinforcing steel.
- Improved structural Integrity.
- Accelerates project schedules.
- Reduces skilled labour.

1.1 FIBER

Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Fiber reinforced concrete is of different types and properties with many advantages. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete 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 aspect ratio of the fiber is the ratio of its length to its diameter. Typical aspect ratio ranges from 30 to 150.

The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibres) termed volume fraction typically ranges from 0.1 to 3%. Aspect ratio (L/D) is calculated by dividing fibre length (L) by its diameter (D).

TABLE 1.1 ASPECT RATIO OF THE FIBER

Type of Concrete	Aspect Ratio	Relative Strength	Relative Toughness
Plain concrete	0	1	1
With	25	1.5	2.0
Randomly	50	1.6	8.0
Dispersed Fibers	75	1.7	10.5

1.1.1 ARAMID FIBER

Aramid fiber is a great composite material. It has high tensile strength, higher resistance, less wear tear. It has also two types they are Para aramid and Meta aramid. This fiber is produced by chopping a bundle made of epoxy-impregnated, braided aramid filaments. Its appearance is similar to that of steel fiber but it gives high tensile strength compared to other.

Fig 1.1 Aramid Fiber

Aramid fibers are class of heat-resistant and strong synthetic fiber. They are used in reinforcement composites, aerospace and military applications, for ballistic-rated body aramic fabric and ballistic composites, in bicycle tires, and as an asbestos substitute. The name is a portmanteau of "aromatic polyamide".

II. LITERATURE REVIEW

1. Shailendra Kumar Bohidar et al., "**Study on Aramid Fiber and Comparison with other composite materials"** International Journal for Innovative Research in Science and Technology, Volume1, Issue 7 (2014).
2. AlokVerma et al., **"Use of Superplasticizer In Concrete and Their Compatibility With Cements"** International Journal of Civil Engineering and Technology, Volume 4,Issue 1 (2013).
3. Shahul Hameed, M., Saraswathy, V. and Sekar, A.S.S., **"Rapidchloride permeability test on self-compacting high performance green concrete",** e- journal of Non-Destructive Testing (e-JNDT), ISSN. No.1435-4934, Vol.15, No.1, 2010.

III. EXPERIMENTAL MATERIALS AND METHODOLOGY

3.1 METHODOLOGY

1. Collection of materials
2. Finding material properties
3. Casting
4. Curing
5. Compressive and Split tensile strength tests
6. Result and discussion
7. Conclusion.

3.2 MATERIAL USED

3.2.1 CEMENT

Ordinary Portland cement (43 grade) was used for casting all the specimens.

3.2.2 FINE AGGREGATE

Clean and Dry River sand available locally belongs to zone II is used. Sand passing through IS 4.75mm Sieve is used for casting all specimens.

3.2.3 COARSE AGGREGATE

Crushed granite aggregate with specific gravity of 2.64 and passing through 20mm sieve and retained on 10mm is used for casting all specimens.

Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite.

3.2.4 CHEMICAL ADMIXTURE

A vertical slump of 120mm was aimed and it was achieved by adding commercially available super-plasticizer (Melamine Sulfonate) of 0.2% weight of cement to the normal mix.

3.2.5 SPECIMEN

Concrete Cubes having a cross-section of 150x150x150mm and 150mm diameter & 300mm height of Cylinders were used.

3.3 MATERIAL PROPERTIES

TABLE 3.1 MATERIAL PROPERTIES

S.NO	MATERIAL PROPERTIES	OBTAINED VALUE
1.	Fineness modulus of cement	3.8
2.	Fineness modulus of fine aggregate	2.8
3.	Specific gravity of cement	3.15
4.	Specific gravity of fine aggregate	2.6
5.	Specific gravity of coarse aggregate	2.64
6.	Bulk density of coarse aggregate	1641.19 kg/m^3
7.	Bulk density of fine aggregate	1559.68 kg/m^3

3.4 MIX DESIGN

- Using EFNARC method of mix design, the concrete mix was designed for M30.
- The mix proportion is 1:1.74:1.69 with a water cement ratio is 0.42.
- A slump flow of 500mm was aimed and it was achieved by adding super plasticizers of 1% weight of the cement to the normal mix. For M30 grade of concrete.
- The specimens were casted for 150mmx150mmx150mm cube, and 150mm dia & 300mm height cylinder.
- The cubes and cylinders were placed in water for curing about 28 days. The cubes were tested in CTM.

IV. EXPERIMENTAL PROCEDURE

4.1 WORKABILITY PROPERTIES OF CONCRETE

The discussion of the test on fresh concrete as well as hardened concrete are based on the tests such as workability and mechanical properties, which were performed by using copper slag replaced with sand in concrete as well as normal mix concrete.

4.1.1 SLUMP FLOW TEST

It is the most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without booking, but may give some indication of resistance to segregation.

4.1.2 V-FUNNEL TEST

This is a widely used test, suitable for laboratory and perhaps Filling site use. It asses filling and passing ability of SCC, and serious lack of stability can be detected visually.

4.1.3 L-BOX TEST

This is a widely used test, suitable for laboratory and perhaps Filling site use. It asses filling and passing ability of SCC, and serious lack of stability can be detected visually.

TABLE 4.1 SCC TEST RESULTS

S.No	SCC test method	Observed value for 1% dosage of super plasticizer					
		Nominal concrete	Aramid fiber %				
			0.05	0.10	0.15	0.20	0.25
1.	Slum flow test	670mm in 3.3s	650 mm in 3s	630 mm in 4s	610 mm in 3.5s	605 mm in 3s	603 mm in 3.2s
2.	L-Box test	0.93	0.9	0.8	0.85	0.86	0.87
3.	V-Funnel test	9s	8s	10s	9s	10s	11s

V. EXPERIMENTAL PROGRAMME

5.1 DESCRIPTION OF SPECIMEN

This experimental program includes six specimens. Control concrete specimen was named as C and concrete specimens with various proportions of waste plastic were named as Sp1, Sp2, Sp3, Sp4 and Sp5. Table 5.1 shows various percentage of waste paper sludge ash replace the cement in concrete.

5.2 CASTING AND TESTING

- Using IS method of mix design, the concrete mix was designed for M30.
- The mix proportion is 1:1.76:1.70with water cement ratio as 0.42.
- A vertical slump of 120 mm was aimed and it was achieved by adding super plasticizer of 0.5% weight of cement to the normal mix. For M30 grade of concrete.
- The specimens were casted for 150mm x 150mm x 150mm cube, and 150mm diameter with 300mm height cylinder.

TABLE 5.1 EXPERIMENTAL PROGRAMME

S.NO	Identification of Specimen	% of Fiber added	No. of cubes and cylinder	
			7th day	28th day
1.	Control	0	3	3
2.	SP 1	0.05	3	3
3.	SP 2	0.10	3	3
4.	SP 3	0.15	3	3
5.	SP 4	0.20	3	3
6.	SP 5	0.25	3	3

VI. RESULT AND DISCUSSION

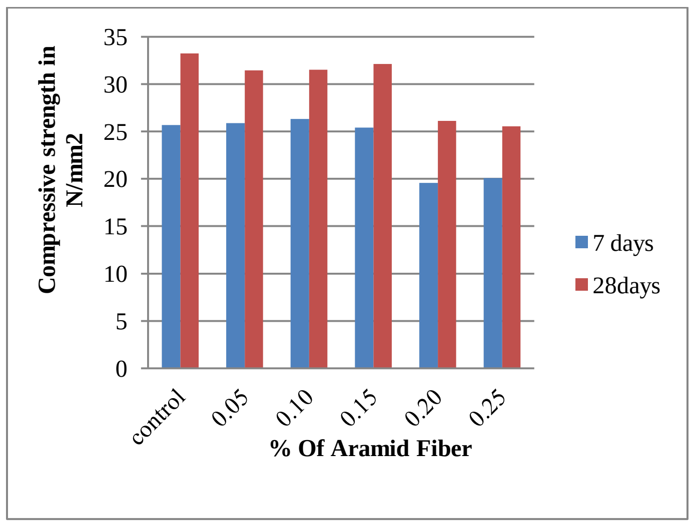
6.1 COMPRESSIVE STRENGTH TEST

Compression test on concrete cubes has been carried out confirming to IS 516-1999. All the concrete cube specimens were tested in a 2000KN capacity compression testing machine. The crushing strength of concrete cube is determined by applying compressive load at the rate 140 kgf/cm^2/min or 140 KN/min till the specimen fail. After 28 days of curing, the cubes were then allowed to become dry for few hours before testing. Cubes were tested on 7th and 28th days. Plane surfaces of the specimen were between plates of compression testing machine and subjected to compression loading. Three cubes are tested for each specimen and average values are taken. The compressive strength of the concrete cubes on 7th and 28th days are given in Table 6.1.

Compressive strength of cube = Load / Area

TABLE 6.1 COMPRESSION STRENGTH TEST

S.NO	Identification of Specimen	% of Fiber added	No. of cubes and cylinder	
			7th day	28th day
1.	Control	0	25.67	33.23
2.	SP 1	0.05	25.89	31.43
3.	SP 2	0.10	25.32	31.42
4.	SP 3	0.15	25.41	30.11
5.	SP 4	0.20	19.57	24.13
6.	SP 5	0.25	18.07	22.55



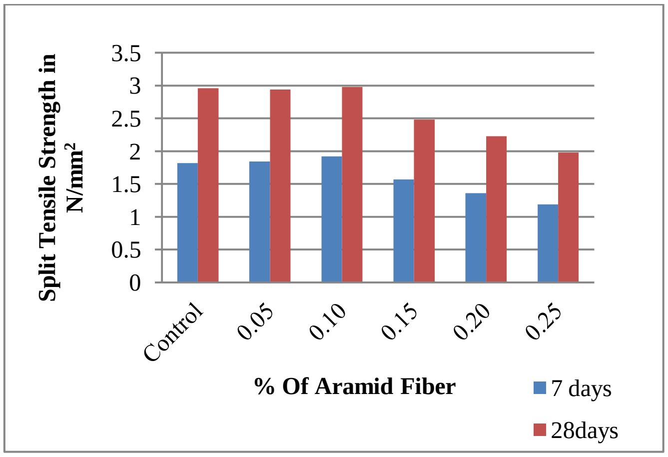
6.2 TENSILE STRENGTH TEST

Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

The split tensile strength of Cylinder $T_{sp} = \frac{2p}{\pi DL}$

TABLE 6.2 SPLIT TENSILE STRENGTH TEST

S.NO	Identification of Specimen	% of Fiber added	No. of cubes and cylinder	
			7th day	28th day
1.	Control	0	1.82	2.96
2.	SP 1	0.05	1.84	2.94
3.	SP 2	0.10	1.57	2.48
4.	SP 3	0.15	1.92	2.38
5.	SP 4	0.20	1.36	1.98
6.	SP 5	0.25	1.19	1.48



VII. CONCLUSION

The following conclusion have been made from the above experimental study

- From the test results of self compacting concrete, it has been found that the all the mixes achieved the designed characteristic strength of M30 grade.
- It is observed that the compressive strength, Split tensile strength are on higher side for 0.15 % fibers
- It is observed that compressive strength increases upto 0.15% and it will decreases above 0.15% with addition of aramid fiber.
- It is observed that split tensile strength increases upto 0.15% and it will decreases above 0.15% with addition of aramid fiber.

REFERENCES

1. Shahul Hameed, M., Saraswathy, V. and Sekar,A.S.S., **"Rapidchloride permeability test on self-compacting high performance green concrete",** e- journal of Non-Destructive Testing (eJNDT), ISSN. No.1435-4934, Vol.15, No.1, 2010.
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