FLEXURAL STRENGTH OF SELF COMPACTIMNG CONCRETE WITH SILICA FUME AND POLYPROPYLENE FIBRES WITH AND WITHOUT REINFORCEMENT

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ABSTRACT

Self Compacting Concrete (SCC) is high performance concrete which compacts on its own weight without any vibration. The normal concrete is weak in initial shrinkage where as introduction of Fibres to concrete decreases its initial shrinkage and also imparts strength to concrete later on stage. In this project a study has been done on the effect of Polypropylene Fibres on both the fresh and hardened properties of SCC like compressive and flexural strength. The SCC is made with 20% replacement of cement with silica fume and varying percentage Polypropylene fibres from 0% to 0.2% i.e., 0%, 0.05%, 0.1%, 0.15%, 0.2% to the total volume of concrete along with addition of super plasticizer 0.6% to the volume of cement content for M30 and M35 mix designations. The main focus of this study will be on investigating maximum percentage of replacement Polypropylene Fibres that can be made added to total volume of concrete to attain maximum value of both compressive and flexural strength and to study the flexural behaviour of beams with and without reinforcement.

Keywords - SCC, Polypropylene Fibres, Silica Fume, Superplasticizer, Flexural Strength

I. INTRODUCTION

Self compacting concrete is special type of concrete which compacts on its own without any vibration and without losing its homogeneity. Concrete is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally, the member breaks. The formation of cracks in the early stage concrete is due to the drying shrinkage, these are a basically micro crack which increases in size and magnitude as the time elapses. To avoid these problems tensile reinforcement is provided to increase the strength of concrete. However cracks in reinforced concrete members extend freely until encountering are bar. Thus there arises need for multi directional closely spaced reinforcement which is practically impossible. Fiber reinforcement concrete gives solution for this problem. These fibres are uniformly distributed and randomly arranged which will arrest the formation of cracks thereby increasing flexural strength of concrete. Mounir M. Kamal et al.., [1] developed SCC with steel and polypropylene fibres and effect of these with compressive and flexural strength the results showed that: the optimum dosage of steel and polypropylene

fiber was 0.75% and 1.0% of the cement content, respectively. Saeed Ahmed et al..,[2] developed concrete with addition of various proportions of polypropylene fiber results showed there is notable increase in flexural, tensile, and shear strength was found.

Self-compacting mixes are designed to have fresh properties that have a higher degree of workability than convectional concrete. Workability is a way of describing the performance of concrete in the plastic state and for SCC, workability is often characterized by the following properties:

- Filling ability: ability to fill formwork under its own weight.
- Passing ability: ability to overcome obstacles like reinforcement.
- Stability: homogeneous composition of concrete during and after placing concrete.

II. MATERIAL PROPERTIES

The materials used in the manufacture of fiber reinforced concrete are Cement, Fine aggregate, Coarse aggregate, Silica fume, Polypropylene fibres and Superplasticizer.

***Cement*:** ordinary Portland cement of 53 grade cement is used confirming to various specifications as per IS: 12269-1987. Results showed that specific gravity 3.12 and Normal consistency 31%.

Fine aggregate: River sand confirming to IS: 2386-1975 is used. Results showed that the specific gravity 2.68, Fineness modulus 2.72, and a bulk density of 1715 Kg/m^3 which is confirms to Zone II

Coarse aggregate: Crushed coarse aggregate of 20mm down size is used which is confirming to IS: 2386-1975.Results showed that the specific gravity 2.72, Fineness modulus 5.4 and a bulk density of 1545 Kg/m^3.

Silica fume: Obtained from Nuchem India pvt Ltd., having specific gravity of 2.17.

Polypropylene fibres*:* Recon 3s Polypropylene fibres obtained from Ms. Reliance Industries Ltd. which confirms to ASTMC 1116 type 3. The fibres are triangular cross section of cut length 12mm having effective diameter 25-40 microns and specific gravity in ranges of 0.90-0.91.

Superplasticizer: A new generation Conplast SP 430 is used as a Superplasticizer having relative density 1.08± 0.001at 25^{0}C, and pH>6, which also ensures the rheoplastic properties of concrete in excess of 45 minutes at 25^{0}C.

Steel: Fe500 HYSD steel bars are used of main bars of dia 8mm and tie bars of 6mm are used.

Water: Potable water is used.

Table: 1. Mix Proportions for M30 Grade Concrete

Mix designation	Cement Kg	Micro silica (20%replacement) Kg	Fine aggregate Kg	Coarse aggregate Kg	Water Litres	Polypropylene % to total volume
$M30_1$	370.35	92.58	928.213	759.45	208.32	0.00%
$M30_2$	370.35	92.58	928.213	759.45	208.32	0.05%
$M30_3$	370.35	92.58	928.213	759.45	208.32	0.10%
$M30_4$	370.35	92.58	928.213	759.45	208.32	0.15%
$M30_5$	370.35	92.58	928.213	759.45	208.32	0.20%

Table: 2. Mix Proportions for M35 Grade Concrete

Mix designation	Cement Kg	Micro silica (20%replacement) Kg	Fine aggregate Kg	Coarse aggregate Kg	Water Litres	Polypropylene % to total volume
$M35_1$	416.64	104.16	900.588	736.846	208.32	0.00%
$M35_2$	416.64	104.16	900.588	736.846	208.32	0.05%
$M35_3$	416.64	104.16	900.588	736.846	208.32	0.10%
$M35_4$	416.64	104.16	900.588	736.846	208.32	0.15%

$M35_5$	416.64	104.16	900.588	736.846	208.32	0.20%

III. EXPERIMENTAL RESULTS

3.1 Fresh state properties

Table: 3. Workability test Results

Sl. No	Mixture No	W/C Ratio	Slump (mm)	T 50_{Cm} Slump Flow (sec)	V-Funnel (sec)	L- Box {h2/h1)	U-Box (h2-h1)	J-Ring (mm)
1	$M30_1$	0.45	712	3	8	0.85	16	11
2	$M30_2$	0.45	695	3	8	0.89	17	10
3	$M30_3$	0.45	670	4	9	0.9	20	8
4	$M30_4$	0.45	665	4	10	0.92	24	8
5	$M30_5$	0.45	652	5	10	0.96	29	9
6	$M35_1$	0.40	710	3	8	0.8	15	12
7	$M35_2$	0.40	687	3	8	0.86	18	13
8	$M35_3$	0.40	665	4	9	0.89	22	8
9	$M35_4$	0.40	660	5	9	0.9	24	9
10	$M35_5$	0.40	648	5	10	0.95	28	10

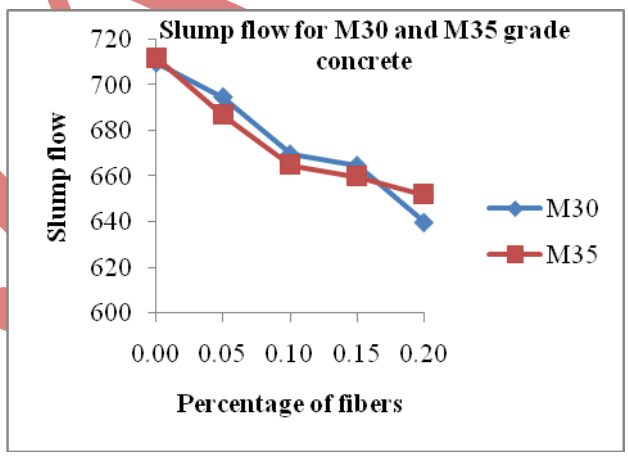

Fig: 1. Slump flow for M30 and M35 Grade Concrete

3.2 Specimen Details

The specimens casted are

- Cubes of 150mm×150mm×150mm size

- Beams of 150mm×150mm×700mm size The moulds were first cleaned and greased properly, and then moulds were filled with concrete without any tamping since it is self compacting concrete. All the specimens kept for curing for required period of time. Potable water is used for curing.

3.3 Hardened state properties

In this study hardened state properties considered are Compressive strength of cubes for 7 and 28 days, and Flexural strength for beams with and without reinforcement for 28 days.

Fig: 2. Compressive strength test

Fig: 3. Flexural Strength test

3.4 Test results

The compressive strength of cubes and flexural strength of beams with and without reinforcement are tabulated below.

Table: 4. Compressive Strength of M30 and M35 grade concrete

% of Fibres	Compressive strength N/mm2			
	M30 Grade		M35 Grade	
	7 days	28 days	7 days	28 days
0%	22.09	31.10	25.58	36.77
0.05%	23.25	32.12	26.74	38.22
0.10%	26.16	34.15	29.21	40.26
0.15%	24.56	30.96	27.03	36.48
0.20%	23.69	30.08	24.56	34.59

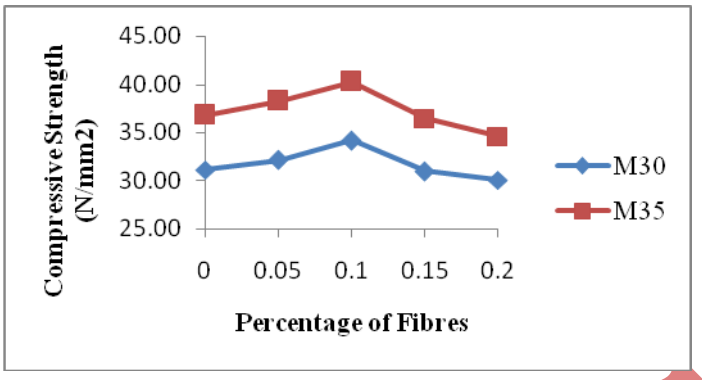

Fig: 4. Compressive strength 7days

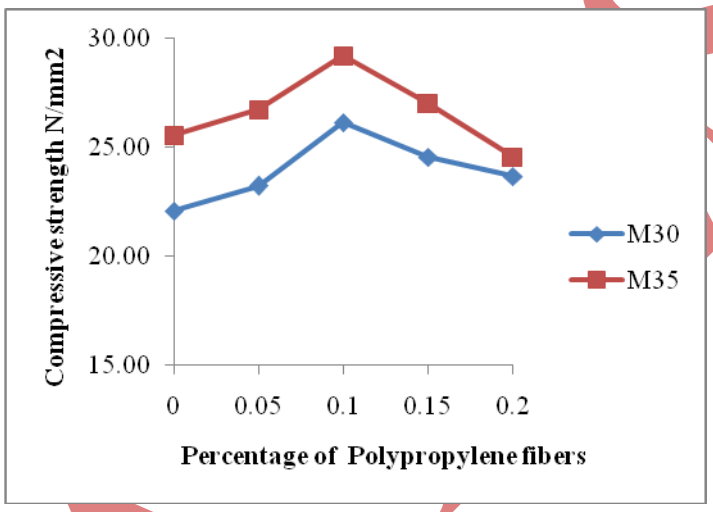

Fig: 5. Compressive strength 28days

Table: 5. Flexural Strength of Concrete with and without Reinforcement

% of Fibres	Flexural strength N/mm2			
	M30 Grade	M35 Grade	M30 Grade	M35 Grade
0%	4.46	4.65	12.98	14.89
0.05%	4.65	4.94	13.34	14.93
0.10%	5.41	5.66	15.66	16.59
0.15%	4.29	4.44	13.53	15.20
0.20%	3.91	4.29	12.65	13.19

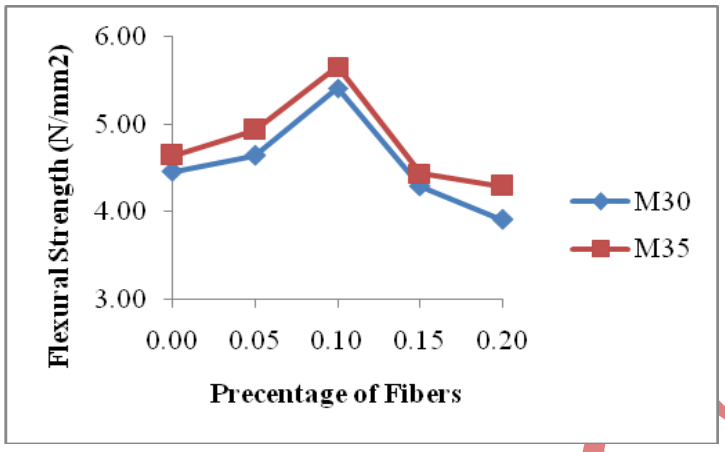

Fig: 6. Flexural strength of concrete without Reinforcement

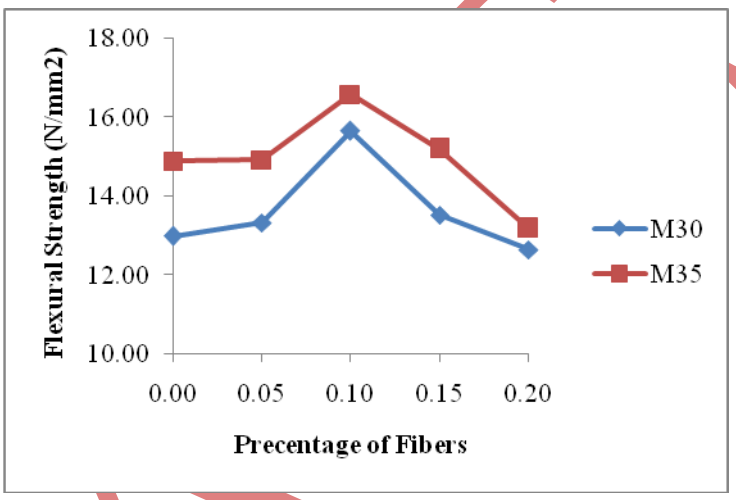

Fig: 7. Flexural strength of concrete with Reinforcement

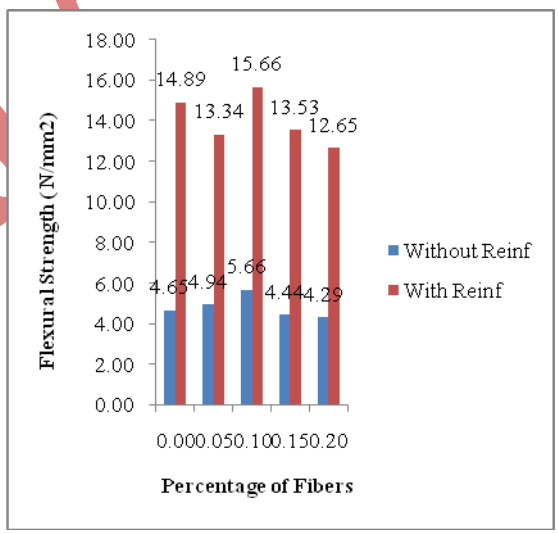

Fig: 8. Flexural strength of M30 grade concrete

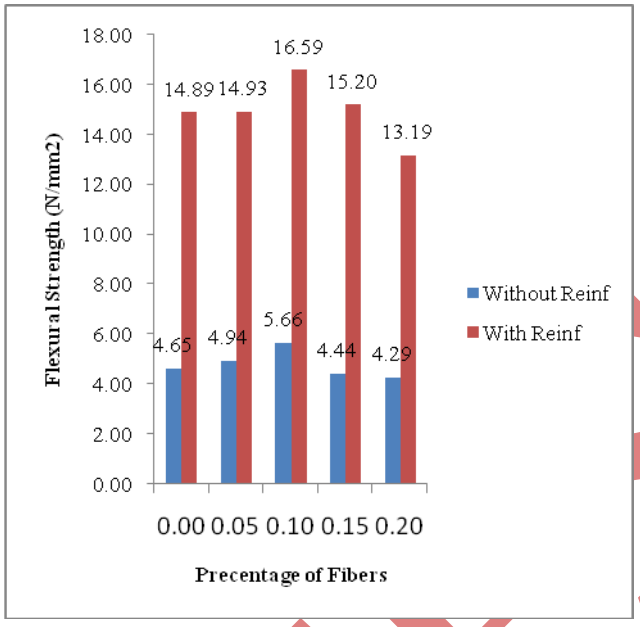

Fig: 9. Flexural strength of M35 grade concrete

Fig: 10. Failure of beam without Reinforcement

Fig: 11. Failure of beam with Reinforcement

IV. CONCLUSIONS

After studying the results following conclusions are made:

- In the fresh state of concrete as the percentage of fibres increases slump flow value decreases.
- In the hardened state of concrete there is no considerable increase in compressive strength of concrete, but there is a noticeable increase flexural strength of concrete by the addition of Polypropylene fibres.
- In the hardened state of concrete there is an overall increase in strength of concrete both in compressive and flexural strength for the 0.1% addition Polypropylene fibres.

Percentage of increase in strength of SCC

***Compressive strength*:**

- ***7 days***: Increase in compressive strength by 18.42% and 14.19% for M30 and M35 grade respectively.
- ***28 days***: Increase in compressive strength by 9.8% and 9.49% for M30 and M35 grade respectively.

***Flexural strength*:**

- ***Without Reinforcement*:** Increase in flexural strength by 21.30% and 22.72% for M30 and M35 grade respectively.
- ***With Reinforcement*:** Increase in flexural strength by 20.64% and 11.41% for M30 and M35 grade respectively.

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