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Experimental Study on Flexural Behaviour of Self Compacting Steel Fibre Concrete

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ABSTRACT

Conventional concrete tends to present a problem with regard to adequate compaction in thin sections or areas of congested reinforcement, which leads to a large volume of entrapped air voids and compromises the strength and durability of the concrete. Self-Compacting Concrete (SCC) can minimize this problem since it is designed to compact under its own mass. It is found that steel fibers have superior resistance to cracking and crack propagation which leads to increased extensibility and tensile strength.
In this study 12 cubes and 12 beams for ordinary and self-compacting concrete will be casted and their compressive strength and flexural strength results will be analyzed for 28days and compared with ordinary and self-compacting concrete.

Experimental results indicate that there is an increase in the compressive strength and flexural strength of self-compacting concrete with steel fiber when compared with ordinary concrete with steel fiber.

1. INTRODUCTION

Fibre composites possess increased extensibility and tensile strength, both at first crack and at ultimate, particular under flexural loading and the fibers are able to hold the matrix together even after extensive cracking.
T. Suresh Babu, M.V. Seshagiri Raob and D. Rama Seshu (2008) have suggested that incorporation of glass fibre by 0.03% has increased the strengths at 28 days by 2.0 to 5.5 % in compression, 3.0 to 7.0 % in tension, and 11.0 to 20.0 % in flexure. Energy absorption capacity of SCC has increased to an extent of 30% due to the addition of glass fibre.
Hemant B. Dhonde,.I., Thomas T.C. Hsu and John Vogel (2007) have confirmed the effectiveness of steel fibers in enhancing the tensile strength, flexural strength, and ductility of the concrete in their research on SCFRC mixes.

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2. TEST DATA FOR MATERIALS

Cement used	OPC - 53 grade
Specific gravity of cement	3.15
Specific gravity of coarse aggregate	2.73
Specific gravity of fine aggregate	2.63
Water absorption of coarse aggregate	0.32%
Water absorption of fine aggregate	0.50%
Sieve analysis:	
Coarse aggregate	Nominal size of 10 mm
Fine aggregate	Grade III zone

Table-1 Mix Proportion for M30 as per IS: 10262 – 1982

Water	Cement	Fine Aggregate	Coarse Aggregate
214.24	563.79	553.68	999.87
0.38	1	0.98	1.81

Table-2 Mix Proportions for ordinary-compacting concrete

Material	Unit	OCC+0%	OCC+0.5%	OCC+1%	OCC+1.5%
Water	Lit/m^3	214	214	214	214
Cement	Kg/m^3	564	564	564	564
F. Agg	Kg/m^3	554	554	554	554
C. Agg	Kg/m^3	1000	1000	1000	1000
Steel fibre		0% of cement	0.5% of cement	1% of cement	1.5% of cement

Mix proportion for self-compacting concrete as per EFNARC Specification (European Federation for Specialist Construction Chemicals and Concrete system)

Mix design for Self Compacting concrete is based on trial and error method, since there is no standard mix design for SCC using super plasticizer - Sika ViscoCrete-R550 (I) - 1% of cement.

Table-3 Mix Proportions for self-compacting concrete

Material	Unit	SCC+0%	SCC+0.5%	SCC+1%	SCC+1.5%
Water	Lit/m^3	214	214	214	214
Cement	Kg/m^3	339	339	339	339
F. Agg	Kg/m^3	554	554	554	554
C. Agg	Kg/m^3	1000	1000	1000	1000
Steel fibre	------	0% of cement	0.5% of cement	1% of cement	1.5% of cement
Super plasticiser	-------	1% of cement	1% of cement	1% of cement	1% of cement

Table-4 Specimen details:

% of fibre	Cube (150x150x150mm)	Beam (100x150x1500mm)
Ordinary Cement Concrete (0 %)	3	3
OCC + 0.5% of steel fibre	3	3
OCC + 1% of steel fibre	3	3
OCC + 1.5% of steel fibre	3	3
Self Compacting Concrete (0%)	3	3
SCC + 0.5% of steel fibre	3	3
SCC + 1% of steel fibre	3	3
SCC + 1.5% of steel fibre	3	3

Total no beams - 24
Total no cubes - 24

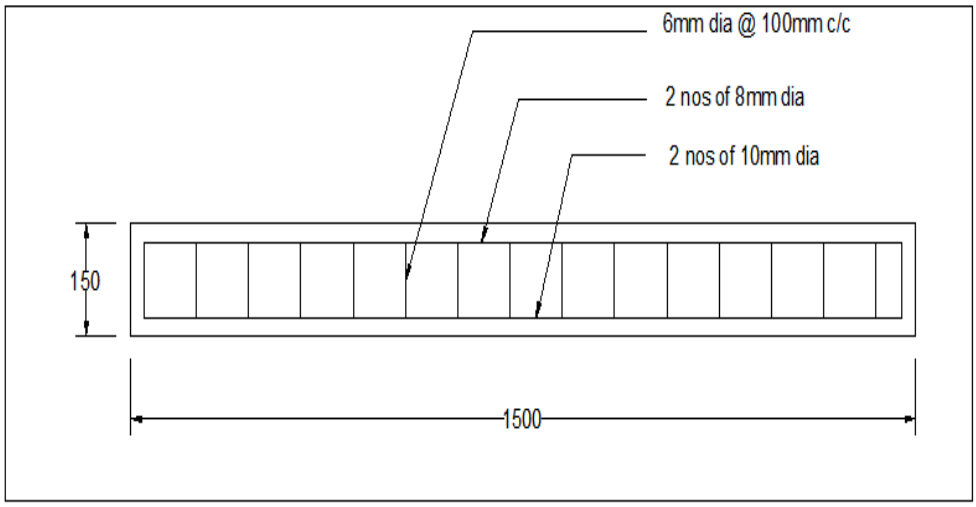

Fig. 1 Reinforcement details

Fig. 2 beams and cubes

Fig. 3 Compression strength test setup

Fig. 4 Flexural strength test setup

3. RESULT:

Table-5 (28 days compressive strength):

% of Steel Fibre	28 days compressive strength (N/mm^2)	
	OCC	SCC
0	39.77	42.81
0.5	41.83	47.34
1	43.85	54.85
1.5	44.31	66.90

Table-6 Flexural strength test results for OCC:

Sample	Initial Crack Load(KN)	Ultimate Load(KN)	Flexural Strength (N/mm^2)
OCC (M30)			
Sample 1	17.77	37.4	19.95
Sample 2	15.55	36.3	19.36
Sample 3	14.83	35.84	19.11
OCC+ 0.5% F			
Sample 1	20.00	39.6	21.12
Sample 2	20.55	38.5	20.53
Sample 3	18.56	40.7	21.71
OCC+ 1% F			
Sample 1	21.67	40.7	21.71
Sample 2	24.44	39.6	21.12
Sample 3	22.78	42.84	22.85
OCC+ 1.5% F			
Sample 1	30.55	49.5	26.4
Sample 2	29.44	51.7	27.57
Sample 3	28.46	47.32	25.24

Table-7 Flexural strength test results for SCC:

Sample	Initial Crack Load(KN)	Ultimate Load(KN)	Flexural Strength (N/mm^2)
SCC			
Sample 1	20.55	41.25	22.00
Sample 2	19.33	40.70	21.71
Sample 3	18.66	42.53	22.68
SCC+ 0.5% F			
Sample 1	24.32	44.00	23.47
Sample 2	22.78	43.45	23.17
Sample 3	25.55	42.88	22.87
SCC+ 1% F			
Sample 1	23.33	46.20	24.64
Sample 2	21.67	45.65	24.35
Sample 3	26.11	47.32	25.24
SCC+ 1.5% F			
Sample 1	26.66	50.60	27.00
Sample 2	27.74.	51.70	27.57
Sample 3	26.86	52.78	28.15

4. ANALYSIS:

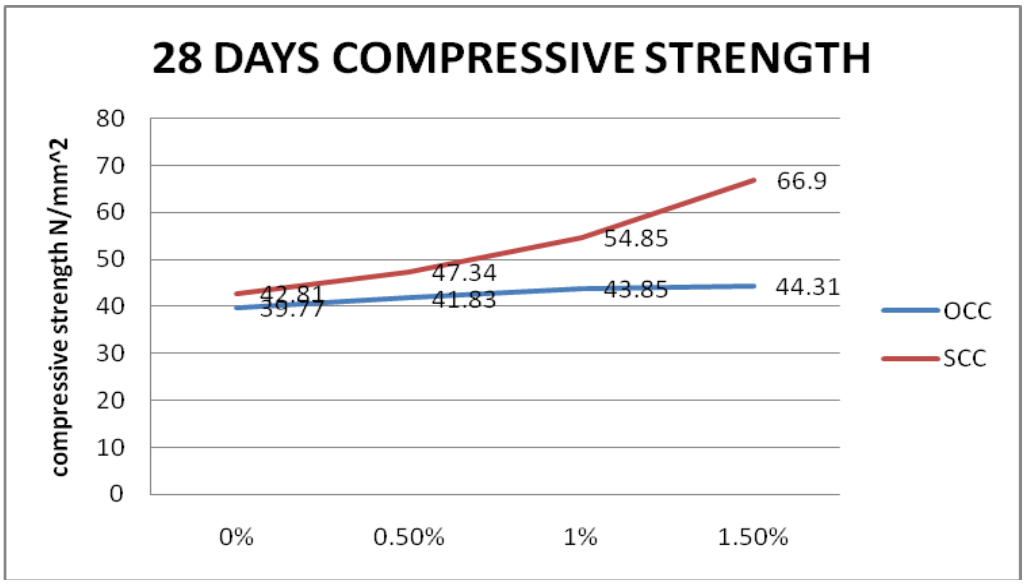

Fig. 5 (28 days compressive strength)

From the compressive strength test results it is observed that:

The compressive strength of self compacting concrete with steel fibre is higher than the ordinary concrete with steel fibre. Compressive strength increases with increase of % of steel fibre. Compressive strength of SCC with 1.5% of steel fibre is 66.90N/mm^2 which is about 51% more than M30 grade concrete with 1.5% of steel fibre. Compressive strength of M30 grade concrete with 1.5% of steel fibre is 44.31N/mm^2 which is about 11% more than M30 grade concrete without steel fibre. Compressive strength of SCC with 1.5% of steel fibre is 66.90N/mm^2 which is about 56% more than SCC without steel fibre.

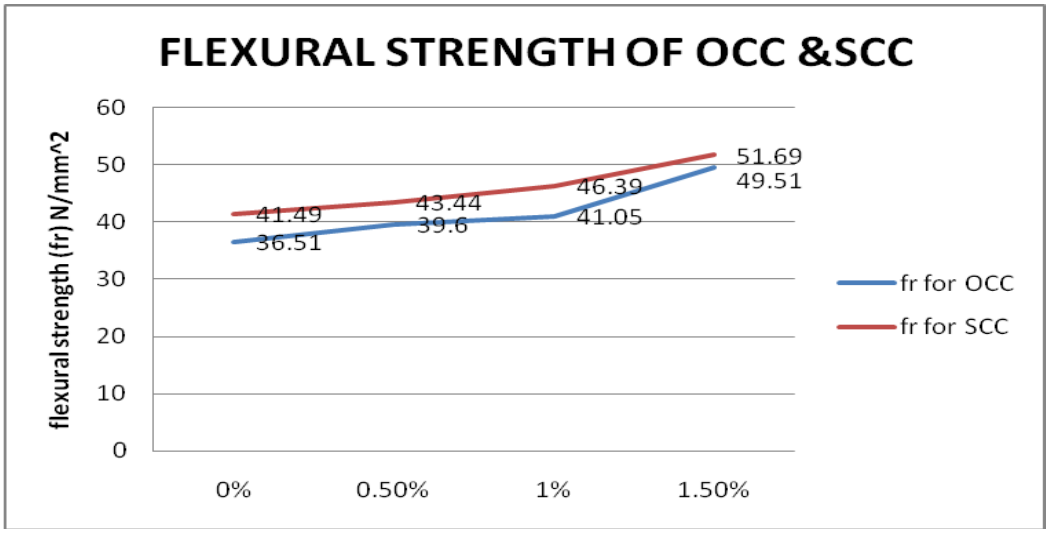

Fig. 6 (Flexural strength of OCC & SCC)

From the flexural strength test results it is observed that:

The flexural strength of self compacting concrete with steel fibre is higher than the ordinary concrete with steel fibre. Flexural strength increases with increase of % of steel fibre. Flexural strength of SCC with 1.5% of steel fibre is 27.57N/mm^2 which is 25% more than SCC without of steel fibre. Flexural strength of SCC with 1.5% of steel fibre is 26.40N/mm^2 which is 36% more than OCC without of steel fibre. Flexural strength of SCC with 1.5% of steel fibre is 27.57 N/mm^{2}which is 4.43% more than OCC with 1.5% of steel fibre.

5. CONCLUSION

The result from this study indicates that there is an increase in the compressive strength and flexural strength of self-compacting concrete with steel fibre when compared with ordinary concrete with steel fibre.

At 1% of steel fibre in % of increase flexural strength was larger than other % of steel fibre in SCC. Deflection of SCC with steel fibre was lesser than deflection of OCC with steel fibre. Curvature decrease with % of steel fibre increase. At 1% of steel fibre in SCC and OCC, flexural Rigidity was more than other percentage of steel. Young's modulus increases with increase % of steel fibre.

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