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EXPERIMENTAL INVESTIGATION ON THE MECHANICAL PROPERTIES OF CONCRETE MIXED WITH BANANA STEM FIBER AS WELL AS HYBRID STEEL FIBER

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ABSTRACT
Fibers have been used to reinforce concrete over the last few decades because fiber has the significant influence on concrete static and dynamic properties. There are several fiber reinforcement methods for improving the performance of concrete, which lacks in load carrying stability and soundness. Use of banana stem fiber and steel fiber will have greater improvement in the properties of concrete. So the comparison of banana stem fiber and steel fiber reinforced concrete (SFRC) was the basic concern of this study and also how these fibers influence concrete properties by inclusion of banana stem fibers and steel fibers in percentage 0.5 to 2.5. For this purpose cubes, cylinder and flexural beams were cast and carried out the test under the different testing machine for compressive, tensile, flexural, impact, and bond strength. The result obtained from the experiments had been analyzed and compared with the conventional concrete (CC).
Keywords: Banana stem fiber, steel fiber,reinforcement, impact strength, renewable resource

INTRODUCTION

At present concrete is one of the broadly used materials in the field of construction industry. The reason for this because of its availability can be manufactured in any desired shape, low maintenance, affordability, and also it has better compressive strength. As we know concrete is stronger in compressive strength in comparison to the tensile strength. So this may create some cracks in concrete while carrying the load. Due to this many studies have been done to utilize fiber as reinforcement materials in concrete by altering the mix proportion and the inclusion of foreign materials will help the concrete to gain specific strength and soundness. In which, fiber reinforcement is considered as promising and superior to any other constituents in modifying basic properties of concrete due to its availability and low consumption of energy. Fiber reinforced concrete can settle the constraints of the normal concrete e.g. lack of tensile strength, less toughness, less post cracking capacity. The foremost role of fiber in concrete is to bridge the crack, reduce shrinkage cracking. So the fiber reinforcement will help to create a concrete, which has superior characteristics and properties to that of normal concrete. So the application of fiber reinforced concrete is getting higher in various fields.

EXPERIMENTAL

Material used

Cement (53opc), river sand, coarse aggregate, banana stem fibers and steel fibers. The fine and coarse aggregate materials used in this project are locally available.

Cement

Ordinary Portland cement of 53 grades was the major constituents of all the trail mixes (with or without fibers). This grade cement bought from the store.

Sand

The sand used in concrete is conforming to zone III of IS: 383:1997. Then the sand was sieved through 4.75mm. The specific gravity of sand was 2.63.

Coarse Aggregate

The coarse aggregate was used 20 mm. Crushed granite gravel obtained from the local market was used as coarse aggregate. The specific gravity of coarse aggregate was 2.74.

Banana Stem Fiber

Banana stem fiber of diameter 1mm and length of 40mm was used. The aspectratio of banana stem Fiber was 40. The specific gravity of banana stem fiber was 1.35.

Steel Fiber

The fiber is used as hooked end steel fibers. Steel fibers used are of aspect ratio 50 with diameter 1 mm and length 50 mm. The specific gravity of steel fiber was 7.85.

RESULTS AND DISCUSSION

Concrete mix of 1:1:2 was used with 0.45 water-cement ratio. For each mix, the test specimen was prepared for testing at 3, 7 and 28 days. These experiments were conducted using a differentamount of fibers.

Compressive Strength Test

The size of the cube specimen was 150mmx150mmx150 mm. The test specimens were placed in the CTM and the load applied was truly axial.

Table-1: Compressive strength of CC, Banana stem fiber concrete and SRFC

Compressive strength (N/mm^2)				
Type of Mix	Fiber (%)	3^{rd} day	7^{th} day	28^{th} day
Normal Concrete	0	13.25	19.78	29.91
Concrete with inclusion of Banana stem fiber	0.5	14.83	22.51	31.63
	1	15.91	26.75	35.55
	1.5	14.56	21.63	29.45
	2	13.10	19.39	22.76
	2.5	11.63	15.81	18.91
Concrete withinclusion of Steel fiber	0.5	18.71	23.63	32.37
	1	24.11	34.54	38.73
	1.5	17.01	28.31	35.33
	2	16.31	21.80	28.72
	2.5	16.0	20.3	25.16

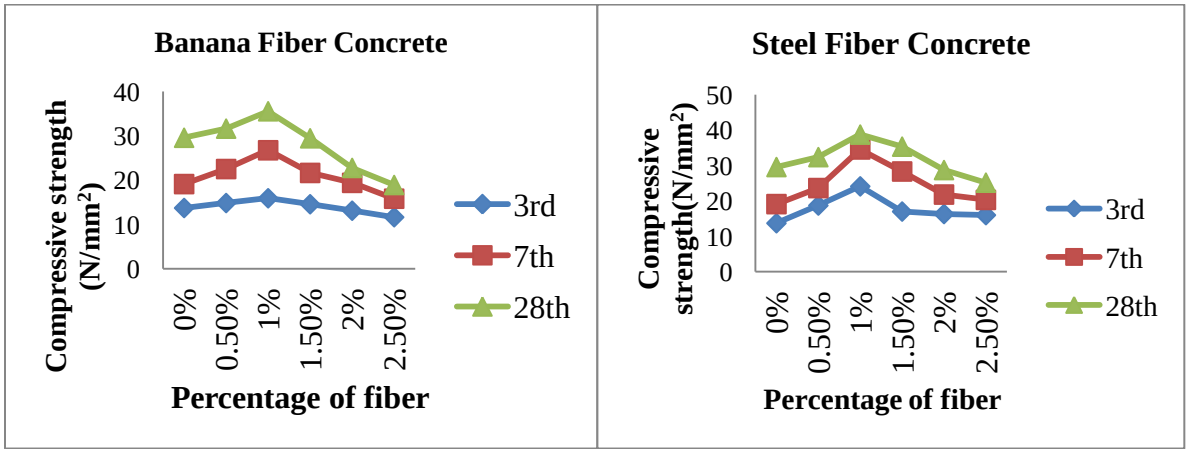

Fig.-1: Line diagram for compressive strength of banana stem fiber and SFRC

Split Tensile StrengthTest

For each mix, a cylinder with 300mm height and 150mm diameter was prepared for testing at 3, 7 and 28 days. The ultimate load has been recorded and determines the split tensile strength of concrete.

Table -2: the Split tensile strength of CC, Banana stem fiber concrete andSRFC

Split tensile strength (N/mm^2)				
Type of Mix	Fiber (%)	3^{rd} day	7^{th} day	28^{th} day
Normal Concrete	0	1.10	1.83	3.01
Concrete with inclusion of Banana stem fiber	0.5	1.40	2.81	3.01
	1	1.46	2.95	3.96
	1.5	1.32	2.65	3.72
	2	1.18	2.32	3.60
	2.5	1.16	2.16	3.43
Concrete with inclusion of Steel fiber	0.5	1.52	2.84	3.83
	1	1.68	2.97	3.98
	1.5	1.43	2.69	3.69
	2	1.38	2.36	3.68
	2.5	1.25	2.24	3.54

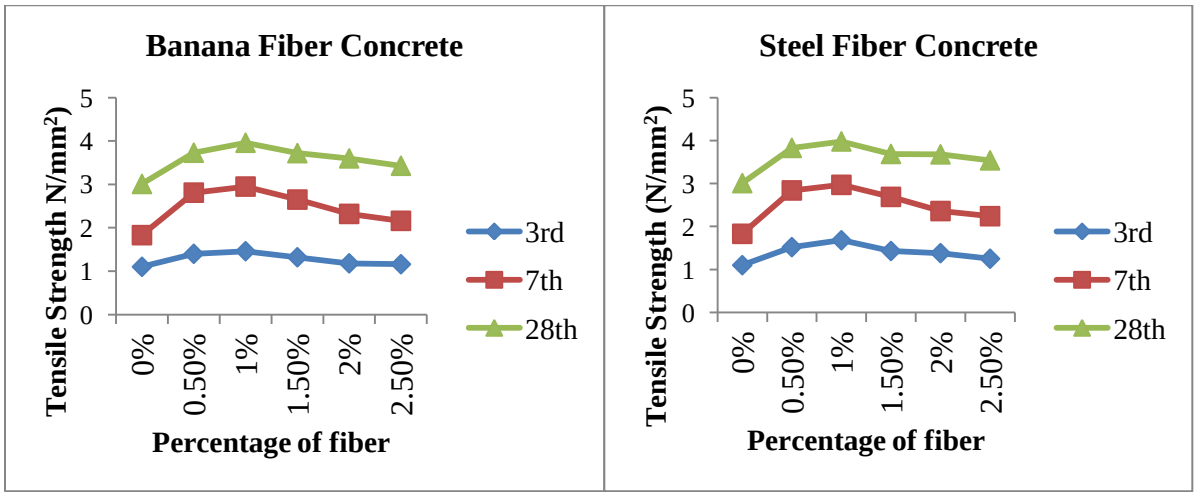

Fig.-2: Line diagram for the split tensile strength of banana stem fiber and SFRC concrete.

Flexural Strength Test

For this test, the beam size of 100mmx100mmx500mm was used for testing at 3, 7 and 28 days. During this test, maximum applied load was recorded to calculate the flexural strength.

Table-3: Flexural strength of CC, Banana stem fiber concrete and SRFC

Flexural strength (N/mm^2)				
Type of Mix	Fiber (%)	3^{rd} day	7^{th} day	28^{th} day
Normal Concrete	0	2.1	3.1	5
Concrete with inclusion of Banana stem fiber	0.5	2.2	3.19	6.1
	1	2.8	3.93	6.8
	1.5	2.5	3.74	6.4
	2	2.4	3.38	6.3

	2.5	2.2	3.20	6.1
Concrete with inclusion of Steel fiber	0.5	2.7	4	7.3
	1	2.9	4.4	7.5
	1.5	2.83	4.3	7
	2	2.76	4.2	6.6
	2.5	2.73	4.2	6.3

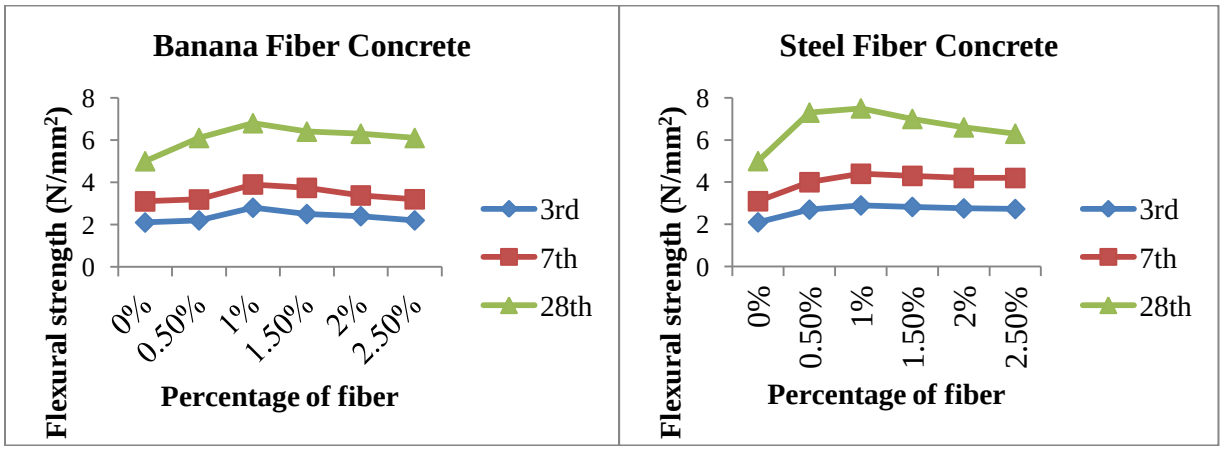

Fig.-3: Line diagram for flexural strength of banana stem fiber and SFRC concrete

Impact Strength Test

For this test,a disc with 63.5 mm thick and 152.4 mm in diameter was used.This test was performed in accordance with the guidelines of ACI committee 544 specifications.

Table-4: Impact strength ofCC, Banana stem fiber concrete and SRFC

Impact Strength							
Type of Mix	Fiber (%)	3rd day (No. of blows)		7th day (No. of blows)		28th day (No. of blows)	
		Initial Crack	Final Crack	Initial Crack	Final Crack	Initial Crack	Final Crack
Normal Concrete	0	12	15	18	21	23	26
Concrete with inclusion of Banana stem fiber	0.5	65	69	73	79	91	95
	1	69	71	83	80	110	115
	1.5	73	77	86	89	121	127
	2	78	81	89	93	123	128
	2.5	82	84	90	95	124	130
Concrete with inclusion of Steel fiber	0.5	71	76	80	84	115	118
	1	75	79	96	101	146	153
	1.5	81	85	103	110	155	160
	2	83	89	108	113	158	162
	2.5	83	90	111	117	161	165

Bond Strength Test

This investigation involved pullout test on both plain and deformed steel bars and comparison of bond strength with conventional concrete, banana stem fiber concrete, and steel fiber concrete. For bond strength test, specimens of size 200mm height and 100mm diameter were used and specimens were incorporated with both deformed bars (RTS) and plain bars (MS) of 8, 10, 12 and 16mm (Table-5).

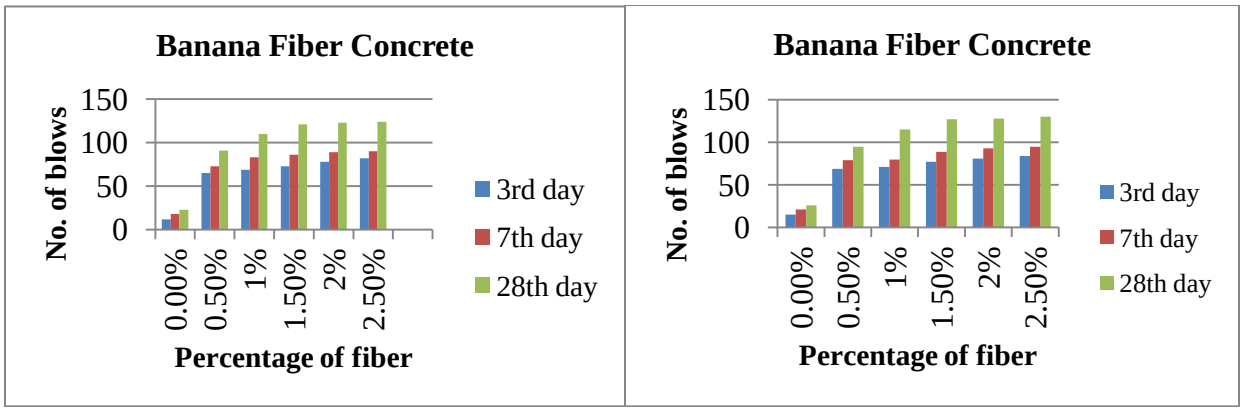

Fig.-4: Comparison of the initial& final crack of banana stems fiber concrete

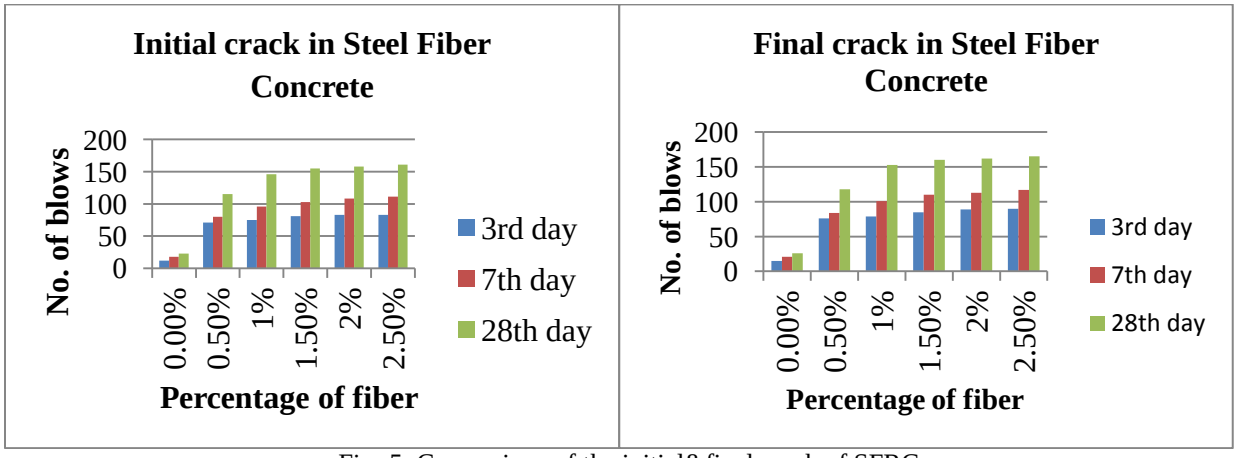

Fig.-5: Comparison of the initial&final crack of SFRC

Table-5: Bond strength of Conventional Concrete with RTS bars and MS bars

Diameter of RTS bars (mm)	Conventional concrete (CC)						Diameter of MS bars (mm)	Conventional concrete (CC)					
	Bond strength(N/mm^2)			Slip (mm)				Bond strength(N/mm^2)			Slip (mm)		
	3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day		3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day
8	3.86	6.5	10.6	12	8.2	4	8	2.75	5.61	9.03	6.14	4.34	2.10
10	3.02	5.31	8.28	10.4	7.2	3.8	10	2.66	4.39	7.68	4.45	3.73	1.72
12	2.41	4.06	6.47	8.76	5	1.7	12	2.01	2.29	5.62	3.84	3.44	1.48
16	1.67	2.63	5.01	6.26	4.7	3.4	16	1.37	2.16	4.06	3.7	3.19	1.18

Table-6: Bond strength of RTS bars with 1% of Banana Stem Fiber and SFC

The diameter of RTS bars (mm)	Banana stem fiber concrete (BFC- 1%)						Steel fiber concrete (SFC- 1%)					
	Bond strength (N/mm^2)			Slip (mm)			Bond strength (N/mm^2)			Slip (mm)		
	3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day
8	3.7	6.37	9.79	11.8	8.7	5.21	4.33	6.80	11.8	12	8.7	4.7
10	2.85	5.18	7.29	9.86	7.56	4.82	3.43	5.61	9.08	10.4	8	4.4
12	2.29	4.03	5.78	8.6	6.6	3.2	2.54	4.89	7.3	8.85	6.4	2.5
16	1.58	2.58	4.03	6.5	5	4.1	1.86	2.73	5.56	6.29	5.1	3.8

Table-7: Bond test result of MS bars with 1% of Banana Stem Fiber and SFC

The diameter of MS bars (mm)	Banana stem fiber concrete (BFC- 1%)						Steel fiber concrete (SFC- 1%)					
	Bond strength(N/mm^2)			Slip (mm)			Bond strength(N/mm^2)			Slip (mm)		
	3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day	3^{rd} day	7^{th} day	28^{th} day
8	3.06	6.01	10.08	6.14	4.1	2.56	2.91	5.28	7.38	5.82	3.82	2.81
10	2.84	4.48	8.59	4.49	3.4	2.18	2.65	4.27	6.37	4.29	3.13	2.13
12	2.29	2.69	6.39	3.86	3.42	1.97	1.88	2.19	4.81	3.57	2.69	1.68
16	1.68	2.38	4.73	3.78	3.19	1.68	1.42	2.01	3.49	3.18	2.47	1.32

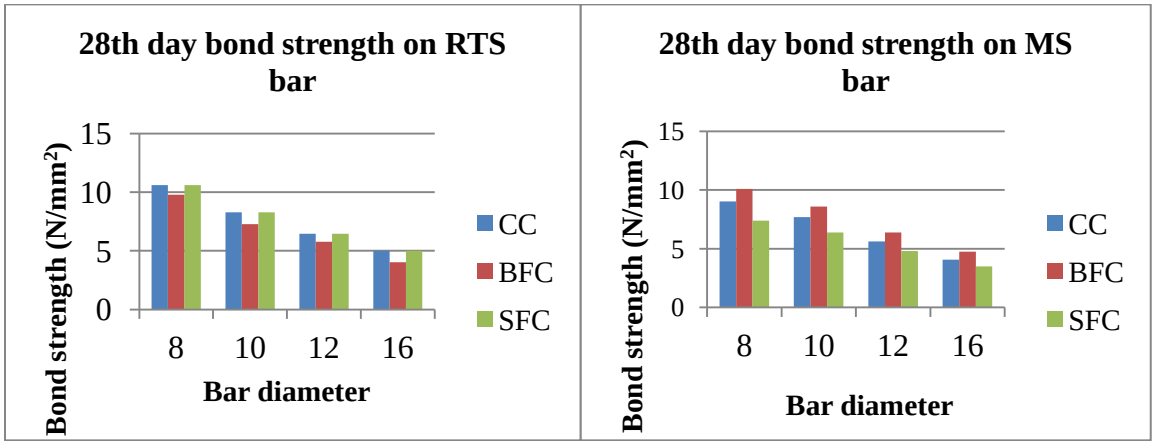

Fig.-6: Comparison of bond strength of RTS& MS bars with CC and fiber concrete at 28^{th} day

CONCLUSION

- From the test result it can be seen that, with the presence of both banana stem and steel fiber in concrete, the compressive, tensile and flexural strength found to be optimum at 1 % volume fraction of fiber.
- It was observed that steel fiber reinforced concrete is having better compressive, tensile, flexural, and impact strength as compared to banana stem fiber.
- It can be seen that beyond 1% volume fraction of fiber content in concrete there is a gradual decrease in compressive, tensile and flexural strength.
- The impact strength of both type concrete observed to be increased as the percentage of banana stem fibers and steel fibers are increased and also steel reinforced fiber concrete having more impact strength than banana stem fiber concrete.
- It was observed that inclusion of steel fiber in concrete changes the brittle form of concrete to ductile and improved impact resistance.
- Fibered concrete specimens with deformed bars as well as plain bars are comparable with conventional concrete. Conventional concrete with steel fiber having more bond strength compared to banana stem fiber concrete.
- It was observed that both normal and steel reinforced concrete with deformed bars showing improved bond strength at the age of 28 days.
- .Based on this result, we can conclude thatthe addition of both banana stem fiber and steel fiber emphasizes the basic physical properties of concrete. But steel fibers are superior as compared to banana stem fiber.

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