A Comparitive Study of Fibres in Concrete

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***Abstract* - This paper deals with experimental investigation for M-20 grade concrete to study the possibility of reusing the locally available waste fibrous materials (steel, coir and sugarcane bagasse fibre) as concrete composites to determining the compressive and tensile strength of concrete .The fibres with volume fractions 0.5%, 1.0%, 1.5% and aspect ratios 80, 106.2, 35.3 . The results data obtained has been analyzed and compared with a control specimen (0% fiber).From these results, it is concluded that the addition of fibres reduces the workability of fresh concrete but marginal improvements found in the compressive and tensile strength of concrete.**

***Keywords:* Waste fibrous materials, Compressive strength, Split tensile strength**

I.INTRODUCTION

Concrete is one of the most versatile building materials. The advantages of using concrete include high compressive strength, good fire resistance, high water resistance, low maintenance, and long service life. The disadvantages of using concrete include poor tensile strength, low strain of fracture and formwork requirement. The major disadvantage is that concrete develops micro cracks during curing. Hence fibres are added to concrete to overcome these disadvantages. Concrete containing a hydraulic cement, water, fine and coarse aggregate, and discontinuous discrete fibers is called fiber-reinforced concrete (FRC). Unreinforced concrete has a low tensile strength and a low strain capacity at fracture. These shortcomings are traditionally overcome by adding reinforcing bars or prestressing steel. Reinforcing steel is continuous and is specifically located in the structure to optimize performance. Fibers are discontinuous and are generally distributed randomly throughout the concrete matrix. Fibers are being used in structural applications with conventional reinforcement. Because of the flexibility in methods of fabrication, fiber reinforced concrete can be an economic and useful construction material.

In India a great amount of Municipal Solid wastes and Agricultural wastes is produced every day. Reuse of such waste materials in concrete construction is happening now days. But they are in the form of Aggregates, Cement (for example fly ash, brick wastes, Crushers powder etc.) Similarly only small quantity of work is concentrated on Composites, particularly on natural waste materials. In many smaller towns and villages in the south regions of India, materials such as Rice Husk, Coir, Nylon Fibre and Sugarcane stems result in the form of fibres and granular materials as waste. Such materials were chosen and properly treated and shaped in the form of fibres or granules to increase the concrete strength . There are numerous fibre types available for commercial and experimental use. The basic fiber categories are:

- Steel Fibers reinforced concrete- SFRC
- Glass Fibers reinforced concrete - GFRC
- Synthetic Fibers reinforced concrete - SNFRC
- Natural Fibers reinforced concrete - NFRC

Here in this paper we planned to investigate the SFRC and NFRC such as coir fibre and sugarcane bagasse fibre. Fibers help to improve the compressive strength, tensile strength, flexural strength, post peak ductility performance, pre-crack tensile strength, fatigue strength, impact strength and eliminate temperature and shrinkage cracks. Essentially, fibers act as crack arrester restricting the development of cracks and thus transforming an inherently brittle matrix, i.e. cement concrete with its low tensile and impact resistances, into a strong composite with superior crack resistance, improved ductility and distinctive post-cracking behavior prior to failure.

Hence this study explores the feasibility of fibres; aim is to do parametric study on compressive strength, tensile strength with M20 grade of concrete, aspect ratio and percentage of various fibres .

II . MATERIAL USED

In this experimental study, Cement, sand, coarse aggregate, water and steel fibers were used.

Cement: Ordinary Portland cement of 43 grade was used in this experimentation conforming to I.S-8112- 1989.

Fine Aggregate: Natural river sand was used as fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part- I).

Coarse Aggregate: Crushed granite stones obtained from local quarries were used as coarse aggregate. The maximum size of coarse aggregate used was 20 mm. The properties of coarse aggregate were determined by conducting tests as per IS: 2386 (Part – III).

Water: Potable water was used for the experimentation.

Types of fibre : steel(undulated) ,coir, sugarcane bagasse.

Table 1 : Typical properties of fibre

Properties of fibre	Fibre type		
	steel	Coir	Sugarcane baggase
Diameter (mm)	0.35	0.5	2.20
Aspect ratio	93.2	106.2	35.3
Specific gravity	6.46	0.93	0.69
Water absorption	35.23	220	298.7

Concrete for M20 grade were prepared as per I.S.10262:2009 with w/c 0.5.Mix proportion for M20 grade concrete for tested material as follows:

Table 2: concrete mix proportions

Materials	Quantity (kg/m^3)
Cement	370
Fine aggregate	663
Coarse aggregate	1209.85
Water	185

Table 3: slump value with different fibres

Mix	Slump value			
	Volume fractions			
	0%	0.5%	1%	1.5%
Steel fibre	85	79	70	62
Coir fibre	85	71	56	45
Sugarcanebaggase	85	68	51	36

III. EXPERIMENTAL METHODOLOGY

a) Compressive Strength Test:

For compressive strength test, both cube specimens of dimensions 150 x 150 x 150 mm were cast for M20 grade of concrete. The moulds were filled with 0%, 0.5%,1%,1.5% fibers. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were de -moulded and were transferred to curing tank where in they were allowed to cure for 7 days and 28 days. After 7 and 28 days curing, these cubes and cylinders were tested on digital compression testing machine as per I.S. 516-1959. The failure load was noted. In each category, three cubes and three cylinders were tested and their average value is reported. The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

b) Tensile strength test:

For tensile strength test, cylinder specimens of dimension 100 mm diameter and 200 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 7 and 28 days. These specimens were tested under compression testing machine. In each category, three cylinders were tested and their average value is reported.

Tensile strength was calculated as follows as split tensile strength:

Tensile strength (MPa) = 2P / π DL,

Where, P = failure load, D = diameter of cylinder

IV. EXPERIMENTAL RESULTS

1) Compressive Strength Test:

A) Using cube Specimen:

The compressive strength test is consider the most suitable method of evaluating the behaviour of steel fiber reinforced concrete for underground construction at an early age, because in many cases such as in tunnels, steel fiber reinforced concrete is mainly subjected to compression .

Results of Compressive strength for M-20 grade of concrete on cube specimen with 0% , 0.5%, 1%,and 1.5% are shown in table and graph below:

Table4: Results of Compressive strength using cubes specimen

Compressive strength test in N/mm^2					
Type of Fibre	Duration	Volume fraction			
		0%	0.5%	1%	1.5%
Steel	7 days	15.47	16.58	17.80	18.94
	28 days	21.34	23.06	24.81	26.27
Coir	7 days	15.47	16.23	17.52	18.70
	28 days	21.34	22.63	24.46	26.07
Sugarcane baggasse	7days	15.47	16.02	17.28	18.42
	28 days	21.34	22.26	23.99	25.76

figure 1: compressive strength for different fibres using cube for 7 days

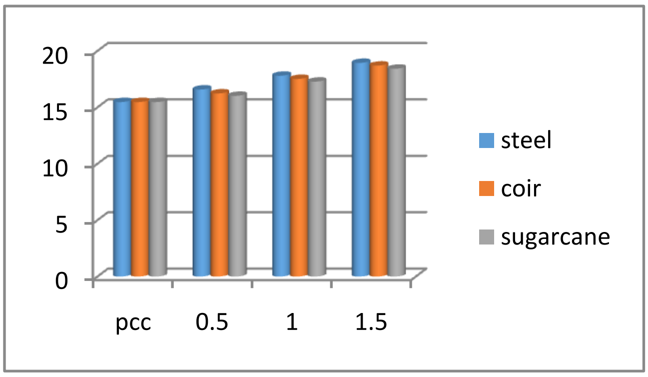
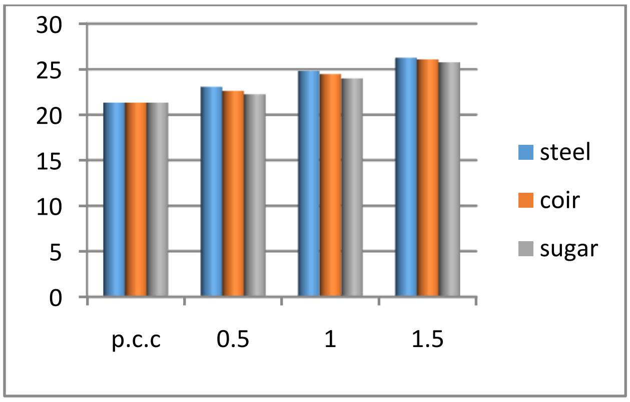


figure 2: compressive strength for different fibres using cube for 28 days



b) Tensile strength test:

Results of split tensile strength for M-20 grade of concrete with 0.5%,1.0%,1.5% steel fibers for aspect ratio 80,106.2 and 35.3 are shown in table and Figure below:

Table 5: Results of split tensile strength using cylinder.

Split tensile strength test in N/mm^2					
Type of Fibre	Duration	Volume fraction			
		0%	0.5%	1%	1.5%
Steel	7 days	2.97	3.43	3.96	4.57
	28 days	4.28	5.28	5.93	6.73
coir	7 days	2.97	3.33	3.73	4.15
	28 days	4.28	5.03	5.82	6.52
Sugarcane baggasse	7days	2.97	3.24	3.49	3.95
	28 days	4.28	4.92	5.43	6.05

figure 3: tensile strength for different fibres using cylinder for 7days

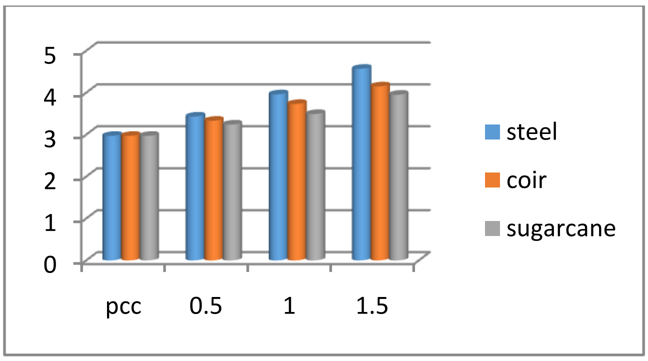


figure 4: tensile strength for different fibres using cylinder for 28 days

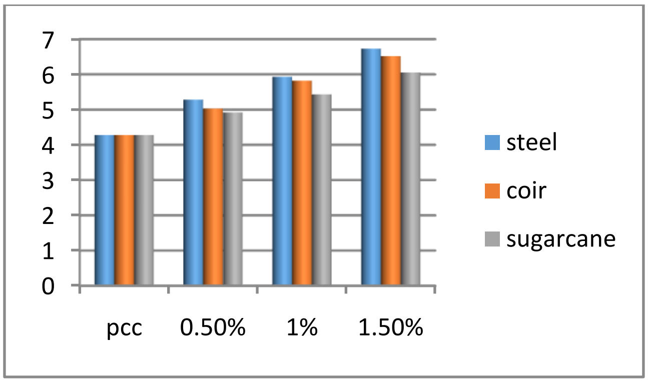


Table 5: comparative test results on 28 days

Fibre types	Volume fraction in %	Compressive strength in N/mm^2	% -↑ in strength	Split tensile strength in N/mm^2	%-↑ stre-ngth
p.c.c	0	21.34	-	4.28	-
Steel fibre	0.5	23.06	08.1	5.28	23.4
	1.0	24.81	16.3	5.93	38.6
	1.5	26.7	23.1	6.73	57.2
Coir fibre	0.5	22.63	06.0	5.03	17.5
	1.0	24.46	14.6	5.82	35.9
	1.5	26.07	22.2	6.52	52.3
Sugar -cane bagas -se	0.5	22.26	04.3	4.92	14.9
	1.0	23.99	12.4	5.43	26.9
	1.5	25.76	20.7	6.05	41.4

Where,

↑-% increase in strength

The comparative test results of two different fibres reinforced concrete such as SFRC and NFRC of coir and sugarcane bagasse fibres as shown Table-7 .This indicates that when steel fibres are added 0.5%, 1.0% & 1.5% in volume of concrete, it increases the compressive strength and the split tensile strength of concrete compared to the conventional concrete. Similarly when coir fibre of the same volume fractions as above is added to the volume of concrete it also increase its compressive and split tensile strength but low when compared to the steel fibre .When sugarcane bagasse fibre in the same volume fraction of the above is added in the volume of concrete there is tremendous decrease in its strength when compared to other two fibres.

VI .CONCLUSION

The following conclusions could be drawn from the present Investigation:

1. The use of fibres in concrete, its ability to increase the compressive and tensile strength of the concrete for M20 grade of concrete from three different fibers at same volume fractions.
2. Use of fiber reduces the space between the cracks.
3. The addition of fibres in concrete reduces the workability.
4. The water absorption quality of natural fibres causes reduction in strength of concrete.
5. When coir fibre are added in concrete the small and larger voids or pores where visible with defined boundaries. This indicates that the air entrained is more and thereby reduction in its strength when compared to steel fibre.
6. When sugarcane bagasse is added in concrete the innumerous pore can be seen on its surface and the finish was irregular. This indicates improper bonding of concrete and thereby reduction in its strength is compared to other concrete.
7. when sugarcane is added to the concrete it absorb more water and there was a change in colour of the concrete as the sugarcane is an pozzolanic material and reduction in its strength of the concrete due to air entrained.
8. Adding the fibres in concrete with some volume fractions of 0.5%,1.0% and 1.5% increases the strength of concrete especially by increasing the split tensile strength than compressive tensile strength.
9. It is observed that, the split tensile strength of fiber reinforced concrete is depends on length of fiber, the split tensile strength increases with length of fiber used.
10. Finally, there is the marginal improvements found in the compressive strength of concrete increases which ranges from 8% to 21% and the split tensile strength of concrete increases which ranges from 23% to 42%. It would be useful in increasing the stability of the structure

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