Sisal Fiber Reinforced Concrete

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***Abstract*— Fiber reinforced concrete is one among the important field of research gaining due importance. Tensile properties of concrete are improved using fibers without compromising on compressive strength. In this investigation an effort was made to study the effect of natural sisal fiber in concrete by replacing cement partially. Here the sisal fiber is chemically treated for use in concrete. The mechanical properties such as compressive strength, split tensile strength and flexural strength of fiber reinforced concrete, with 0.5%,1%,1.5% of fiber replacing cement by volume fraction with the aspect ratio of the sisal fiber as 1:20 is compared with conventional M25 concrete. Compressive strength at 28 days increased by 13.8%, 21%, 16.3% for the 0.5%,1% and 1.5% fiber replacements respectively compared to conventional concrete. The increase in split tensile strength at 28 days is 24%, 56%, 80% and the initial cracking load in flexure is increased by 12.5%, 27.5% and 20% for 0.5%,1% and 1.5% fiber replacements compared to conventional M25 concrete.**

***Key Words*— Sisal Fiber, Concrete, Compressive Strength, Split Tensile Strength, Flexural Strength**

I. INTRODUCTION

Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. The character of fiber reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities. In plain concrete and similar brittle materials, structural cracks develop even before loading, particularly due to drying shrinkage or other causes of volume change. When loaded, the micro cracks propagate and open up, additional cracks form in places of minor defects the structural cracks precede slowly or by tiny jumps because they are retard by various obstacles, changes direction by passing the more resistant grains in the matrix. The development of such micro cracks is the main cause of the inelastic deformation in the concrete. This type of concrete is known as fiber reinforced concrete. Sisal Fiber reinforced concrete can be defined as composite material consisting of mixtures of cement mortar or concrete, uniformly dispersed treated fibers. It also been used for improving the durability of composites.

II. LITERATURE REVIEW

The mechanical properties such as compressive strength and modulus of rupture of M40 grade concrete by varying the dosage of fiber content from 0.1%, 0.2%, 0.3%, 0.4%, and 0.5%, by volume of cement with length of 35mm sisal fibre. The optimum dosage of fibre is found to be 0.3% up to which the compressive strength increased. (Athiappan. K, Vijaychandrakanth. S 2014). The number of natural fibers such as jute, sisal, coir etc are being considered as suitable candidates for fibre reinforcement materials in composites following chemical modification. The advantages of natural fibres is their continuous supply, easy and safe handling and biodegradable nature. (L. Nagarajan, S. Pavithra 2016). The investigation on cement in concrete is replaced accordingly with the percentage of 10 %, 20% and 30% by weight of slag and 1% of sisal fiber is added by weight of cement. Concrete cubes are tested at the age of 7, 14, and 28 days of curing. The strength performance of slag blended fiber reinforced concrete is compared with the performance of conventional concrete. (P. Sathish, V. Murugesh 2016). The investigation on Quarry dust and sisal fiber to be used in concrete the density was comparatively low when compared with conventional concrete. Use of quarry dust at 20% constantly as replacement of fine aggregate and to use addition of sisal fiber in the range of 0.25%, 0.50% and 0.75% for the total volume of concrete. (P. Sasikumar, J. Thivya,2017).

III. MATERIALS AND METHODS

OPC 53 grade confirming to IS 12269-1987 is used for this experiment. River sand satisfying IS 383-1970 is used. Angular aggregate of 20mm nominal size is been used as per IS 383-1970 provision. The properties of this aggregates have been tested and listed. Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. It is a stiff fiber traditionally used in making twine, rope and also as the fiber core of the steel wire cables of elevators. It is obtained from sisal plant. The plant, known formally as Agave sisalana. The length of the fiber is fixed at 20 mm. The sisal fiber is treated with 5% solution of NaOH (0.1 concentration) for 20 minutes and dried. Later washed with 1% acetic acid to remove any excess NaOH. Sisal fiber is dried at room temperature and then used in concrete.

The properties of sisal fiber as given by the supplier is presented in Table 1. As it is a natural fiber the diameter varies slightly. River sand as fine aggregates under Zone II category is used. Coarse aggregate with 20 mm as nominal size conforming to IS 383-1975 is used. Portable water with pH value of 7.0 $\pm$ 1 and confirming to the requirement of IS 456-2000 was used for preparing and curing the concrete. The water cement ratio used is 0.43 for conventional concrete. Conplast WL is used as super

plasticizer. 36 cubes of side 150 mm and 36 cylinders of 150 mm ×300 mm was cast and tested for compressive strength and split tensile strength respectively at 7 days ,14 days and 28 days.

Table 1 Physical Properties of Sisal Fiber

Tensile Strength (Mpa)	385 to 728
Elongation of Break (%)	2.75
Diameter (mm)	0.8 to 1.2mm
Density (g/cm^3)	1.58
Young's Modulus (Gpa)	9—22
Moisture %	6.55

Reinforcement Details

Flexural strength of sisal fiber reinforced concrete is tested using RC beam of size 130 mm×200 mm with the reinforcement shown in Fig.1. 12 beams were cast and tested at 28 days for flexural strength in two-point loading. Loading frame of 50 T capacity is used with 25 T load cell. Dial gauges of Baker make with Dial gauges of Baker make with least count of 0.01mm and maximum of 25mm was used to measure deflection at the center.

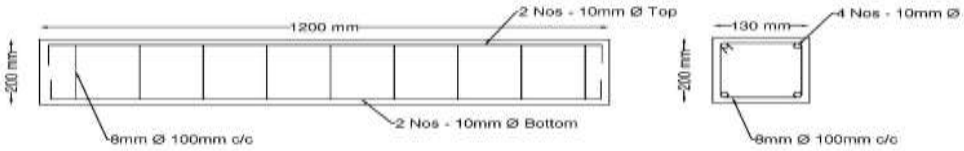

Figure 1 Reinforcement Details

Casting and Curing of Specimens

Based upon the design mix the required ingredients are taken. The concrete was mixed manually, then the fresh concrete is filled in moulds. The tamping rod is used for compacting the fresh concrete in moulds. The specimens casted are demouled after 24 hours, and then specimens were cured in water till the day of testing.

Figure 2 Cube Specimens

IV. RESULTS AND DISCUSSIONS

Slump value

The slump value of conventional concrete is higher than the sisal fiber replaced concrete. The slump value decreased with increase in percentage of sisal fiber.

Table 2 Slump Values

Addition of fiber %	**Value**
0%	60 mm
0.5%	45 mm
1%	42 mm
1.5%	35 mm

Compressive strength

The most common of all tests on hardened concrete is to find the compressive strength of concrete. Testing on concrete is done as per IS 516-1959.Three specimens each of all the four mixes shall be made for testing at 7, 14 and 28 days.

Table 3 Average Compressive Strength

Percentage of sisal fiber replaced	Compressive strength 28 days (N/mm^2)		
	7 days	14 days	28 days
0%	17	24	27.5
0.5%	19.5	26.4	31.1
1%	21.6	28.3	33.3
1.5%	20.8	27.2	32

Split tensile strength

In this investigation the test is carried out on cylinder by splitting along its middle plane parallel to edges by applying the compressive load to opposite edges. Three specimens shall be made for testing at 7, 14 and 28 days respectively.

Table 4 Average Split Tensile Strength

Percentage of sisal fiber replaced	Split tensile strength (N/mm^2)		
	7 days	14 days	28 days
0%	1.7	2	2.5
0.5%	2.2	2.6	3.1
1%	2.8	3.2	3.9
1.5%	3.5	3.8	4.5

Flexural Strength

The experimental program contained 12 beams. All the beams were utilized to study the effect of flexural strengthening. RCC beams were casted with 0.5%,1%,1.5% of and conventional concrete are tested. M25 grade concrete RCC Beam maximum ultimate load is found on 1% sisal fiber replaced RCC Beam the value is115 kN.

Figure 3 Flexure Test on Loading Frame

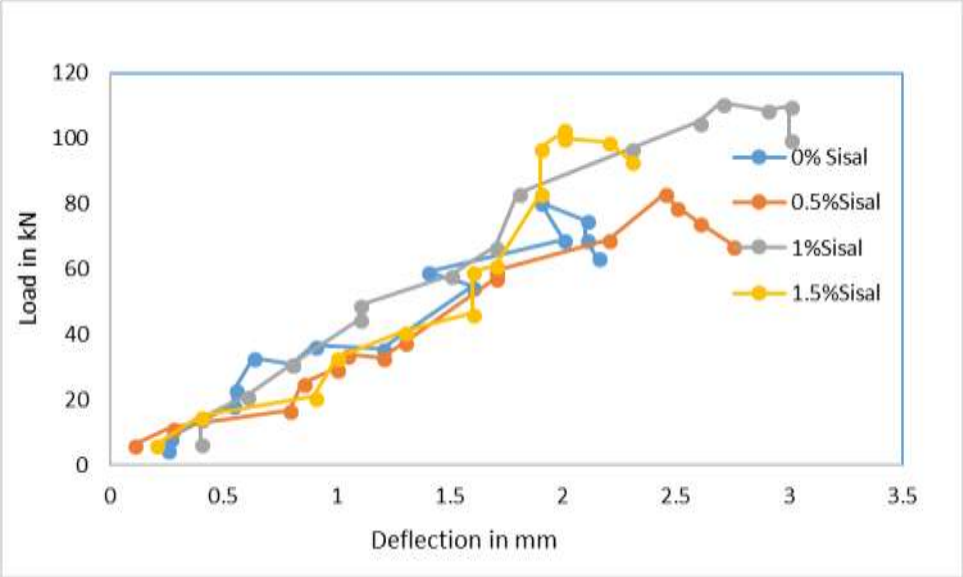

Figure 4 Load deflection Curve in Flexure

Table 5 Flexural Strength

S.No	Parameter	Conventional Concrete	0.5% Sisal Fiber concrete	1% Sisal Fiber concrete	1.5% Sisal Fiber concrete
1	Initial crack load (kN)	40	45	51	48
2	Ultimate load (kN)	79	93	115	103
3	Ultimate deflection (Mid Span) mm	2.2	2.75	2.9	2.3

V. CONCLUSION

From this experimental investigation, the following conclusion were arrived. Using the natural sisal fiber increase the strength of concrete. The optimum percentage of sisal fiber for maximum strength was 1% for compressive strength and 1.5% for split tensile strength. Workability decreases with increase in percentage of sisal fiber replaced with 0.5%, 1%, 1.5 % of volume of cement. The flexural strength of the sisal fiber replaced beam the strength attained is higher than normal strength concrete. The initial crack load value is increased it indicates strength of concrete is improved than conventional concrete. The maximum ultimate flexure strength of beam was attained at 1% replacement of sisal fiber concrete.

REFERENCES

[1] Abhishek Sharma, Tara Sen, Joyanta Pal "Flexural characteristics of RC beams retrofitted using FRP and cement matrix composite", ISOR Journal of Mechanical and Civil Engineering (ISOR-JMCE), 2016, e- ISSN: 2278 -1684, p-ISSN 2320-344X

[2] Anand Daftardar, Jigisha Vashi, Shirish Vichare, "Deflection in RCC beam covered with sisal cordage", advance in engineering and scientific research ,2016 2(1).1-7

[3] Arslan Qayyum Khan, Qudeer Hussain, Winyu Rattanapitikon and Amorn Pimanmas. "Flexural strengthening of RC beams with sisal fiber composites and sisal fiber rods", Research gate,2016, ISSN 1662-9752 Volume 860, p144-147.

[4] Athiappan. K, Vijaychandrakanth. S, "Experimental study on flexural behaviour of sisal fiber in reinforced concrete beams", International Journal of Research in Engineering & Technology, 2014, volume 3, issue 5, ISSN 2278-0181.

[5] Nagarajan.L, S.Pavithra, "Use of natural fibers for structural engineering", International Journal of science and Research , 2016,volume 5,issue 7, ISSN 2319-7064.

[6] Preetam Prem Raj.D, "Shear and Flexural strengthening in RC beams using FRP", International Journal of Science, Technology & Management 2015, volume 4, issue 5, ISSN 2394-1537.

[7] Raghu Yadav Golla, Ranganath T V L,"Strength of sisal fiber concrete with fine construction waste aggregate", International Journal of Research in Engineering & Technology , 2015, volume 4,special issue 02,p-ISSN 2321-7308.

[8] Saurabh Sood, Dr. Hemant Sood, "Comparative study of sisal fiber and glass fiber reinforced concrete", International Journal for Research in Applied Science & Engineering Technology, 2017, volume 5, issue VIII.

[9] Sabarish K.V, "Strength and durability evaluation of sisal fiber reinforced concrete", International Journal for Research of Civil Engineering & Technology, 2017 volume 8, issue 9, pp 741-748 p-ISSN 0976-6316

[10] Sathish.P, V.Murugesh, "Experimental study on Sisal fiber reinforced concrete with partial replacement of cement by ground granulated blast furnace slag", International Journal of science and Research , 2016,volume 5,issue 6, ISSN 2319-7064.

[11] Sabarinathan.S, "A study on mechanical properties of sisal fiber reinforced concrete", SSRG International Journal of Civil Engineering , 2017, special issue.

[12] Sasikumar.P, J.Thivya, "An investigation of sisal fiber concrete using quarry dust", International Journal of Innovative Research in Science Engineering & Technology , 2017,volume 6,issue 4.

[13] Tara sen & jagannatha reddy "Strengthening of RC beams in flexure using natural jute fiber textile reinforced composite system and its comparative study with CFRP and GFRP strengthening systems", International Journal of Sustainable Built Environment, 2013, 2, 41-55.