International Journal of Scientific Research & Engineering Trends
Volume 4, Issue 3, May-June-2018, ISSN (Online): 2395-566X

Experimental Investigation on Behaviour of Natural Fibre Concrete (Sisal Fibre)

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Abstract **– Fibre reinforced concrete contains discontinuous discrete fibers along with cement, water, fine, coarse aggregate. Sisal fibre is generally used as the natural discrete fibres. It is extracted from the leaves of sisal plant. The concrete with sisal fibres are called as Sisal Fibre Reinforced Concrete (SFRC). The sisal fibre reinforced concrete can enhance many of the engineering properties of the basic materials, such as fracture toughness, flexural strength and resistance to fatigue, impact, thermal shock and spalling. In this project work, the general properties of the composites are described in relation to fibre content, length, strength and stiffness. The mix is designed for M30 grade concrete with w/c ratio of 0.52 .The mix ratio 1:1.92:3.24 is arrived as per IS code.10262:2009. The sisal fibre of 50mm length and 4 to12 µm. Diameter is used. The specimens are prepared by adding fibre content of 0.5%, 0.75%, 1.0%, 1.25%, 1.5% and 2% volume of concrete. Further specimens are to be cast for 2.5 % Volume of concrete. A total of 15 cubes, 15 cylinders, 15 prisms are cast for SFRC in addition to 3 cube, 3 cylinder and 3 prism specimens for conventional concrete. The Hardened concrete properties of cast specimens after 7 days of curing is tested and the results are compared with conventional concrete. The strength properties of SFRC is found to increase with increase in fibre content upto 1.5%. The results are yet to be found for fibre percentage above 1.5% whose casting is under progress. After that Optimum percentage of sisal fibre content will be founds.**

Keywords **– 3 cylinder and 3 prism, Sisal fibre natural fibre, concrete testing.**

I.INTRODUCTION

Cement is a very commonly used construction material. It is byproducts which can be mixed with desired quantity of fine aggregate, coarse aggregate and water to make a hardened product called concrete. An enormous amount of concrete is used for various construction projects. The compressive strength of concrete is more comparatively higher than that of its tensile strength. Cement based materials have low tensile strength and easily cause brittle failure. Because of the load and environment changes, micro cracks appeared in cement products. Therefore, it is the main reason for cement aging and destruction.

In order to improve the mechanical properties of concrete, it is good to mix cement with fibres which have good tensile strength. Fibers of various shapes and sizes produced from steel, plastic, glass, and natural materials are being used. However, for most structural and non structural purposes, steel fibre is the most commonly used of all the fibres. While Vegetable fibres have features such as high slenderness ratio, high specific strength and surface area, and is light weighted. types of natural fibres such as Coir, Sisal, Jute, Elephant Grass, Bamboo and Hibiscus cannabin's are used for making concrete. It can also be easily acquired. Trillion tons of vegetable fibres are produced in the world. Hence it is a very green and cheap fibre reinforced material. In ancient period, Egyptians used straw to reinforce mud bricks. In beginning of 19th century asbestos fibre was used to reinforce clay posts.

From 1960 onwards fibres were used in making Fibre Reinforced Composite materials. From 1990, its applications were found in various fields of micromechanics, hybrid systems, wood based fibre systems manufacturing techniques. It also used as secondary reinforcement, and used in high strength concrete. It provides solution for ductility issues, shrinkage crack control.

In 20th century, it found various Structural applications like Fibre Reinforced Concrete. Fibre Reinforced Concrete (FRC) is defined as a composite material made with Portland cement, aggregate, and incorporating discrete discontinuous fibres. Fibre reinforced concrete is a concrete mix that contains short discrete fibres that are uniformly distributed and randomly oriented in them. As a result of these different formulations, four categories of fibre reinforcing have been created. These include steel fibres, glass fibres, synthetic fibres and natural fibres.

Within these different fibers' the character of Fibre Reinforced Concrete changes with varying concrete fibre materials, geometries, distribution, orientation and densities. The amount of fibers' added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibers') termed Volume Fraction and the Aspect ratio of the Fibers.

Aspect ratio (l/d) is the ratio of the Fibre length to its diameter .Fibers with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. However, fibers' which are too long tend to "ball" in the mix and create workability problems.

Fibre Reinforced Concrete composites contains a less percentage of fibres which are generally arranged in planar or random orientation. Unidirectional fibres uniformly distributed throughout the volume are the most in uniaxial tension. While flexural strength may depend on the uni-directional alignment of the fibres dispersed for away from the neutral plane. A proper shape and higher aspect ratio are also needed to develop an adequate bond between concrete and fibre, so that the fracture of the fibres may be fully utilized.

II. MANUFACTURING OF SISAL FIBRE

Sisal fibre is extracted from the leaves of sisal plant. The fibres are extracted through hand extraction machine composed of either serrated or non serrated knives. The peel is clamped between the wood plank and knife and hand-pulled through, removing the resinous material. The extracted fibres are sun-dried which whitens the fibre once dried the fibres are ready for knotting.

A bunch of fibres are mounted or clamped on a stick to facilitate segregation. Each Fibre is separated according to Fibre sizes and grouped accordingly. To knot the Fibre, each Fibre is separated and knotted to the end of another Fibre manually. The separation a knotting is repeated until bunches of unknotted Fibres are finished to form a long continuous strand. This sisal Fibre can be used for making variety of products.

Fig.1 sisal Fibre can be used for making variety of products

1.SISAL FIBER

The length of the original fiber is between 0.5 to 1 m. In the experiments, fibers were cut into 20mm length. The diameter of the fiber is 0.15 - 0.2 mm. The following table 3.7 and table 3.8 shows the physical and chemical properties of Sisal fiber got from the manufacturer.

Table 1.Physical properties of sisal fibre

S.no	Properties	Values
1.	Length	50mm
2.	Diameter	0.15 - 0.2 mm
3.	Aspect ratio	250mm
4.	Specific gravity	1370kg/m^3
5.	Tensile strength	347-378Mpa
6.	Modulus of elasticity	15Gpa
7.	Bulk density	1158kg/m^2
8.	Water absorption	110%

III. EXPERIMENTAL INVESTIGATION

In this experimental work, the various mix proportion arrived. At first, mix design is arrived from the IS10262-09

3.1. Materials

Throughout the experimental work ordinary Portland cements 53grade confirming to IS12269was used. The chemical and physical properties of cement are tabulated in Table 2.

Table 2. Chemical composition of sisal fiber

S.no	Chemical compounds	% of compounds
1.	Cellulose	54-66%
2.	Hemicelluloses	12–17%
3.	Lignin	7–14%
4.	Pectin	1%
5.	Ashes	1–7%

Table 3. Physical properties of cement

S.no	Properties	Test results	Standard value
1.	Specific gravity	3.15	3.15
2.	Standard consistency	28%	26-33%
3.	Initial setting time	45 min	>30
4.	Final setting time	512 min	<600min

Table4. Test on fine aggregate

S.no	Properties	Value	Standard value
1.	Specific gravity	2.52	2.50min
2.	Fineness modulus	3.786	Medium sand
3.	Bulk density	1650 Kg /m^3	>1920
4.	Water absorption	1.20%	>3.50

Table5. Test on coarse aggregate

S.no	Properties	Values	Standard value
1.	Specific gravity	2.74	2.5-5.0
2.	Fineness modulus	3.752	2-4
3.	Bulk density	1507.5kg/m^3	1520-1680kg/m^3
4.	Water absorption	0.80%	0-2.0%

Table 6. Slump test values.

S.no	% of fiber	slump value (mm)	degree workability of
1.	0	82	Medium
2.	0.5	74	
3.	0.75	67	
4.	1.00	55	
5.	1.25	51	Low
6.	1.50	46	
7.	2.00	39	

Table 7.Compressive strength of the cubical specimens

S.no	adding fiber% of content	compressive strength (7days) KN/m^2	compressive strength (14days) KN/m^2	compressive strength (28days) KN/m^2
1.	0	15.58	18.13	22.00
2.	0.5	16.11	18.72	22.15
3.	0.75	16.36	19.10	22.63
4.	1.0	16.81	19.12	23.10
5.	1.25	17.45	19.35	23.34
6.	1.5	17.98	20.12	23.82
7.	2.0	16.58	19.10	21.56

Table 8.Results of tensile test for cylindrical specimen

S.no	adding fiber% of content	Tensile strength (7days) kN/m^2	Tensile strength (28days) kN/m^2
1.	0	1.62	2.31
2.	0.50	1.78	2.75
3.	0.75	1.81	2.82
4.	1.00	1.87	3.10
5.	1.25	1.93	3.23
6.	1.50	1.99	3.88
7.	2.00	1.90	3.21

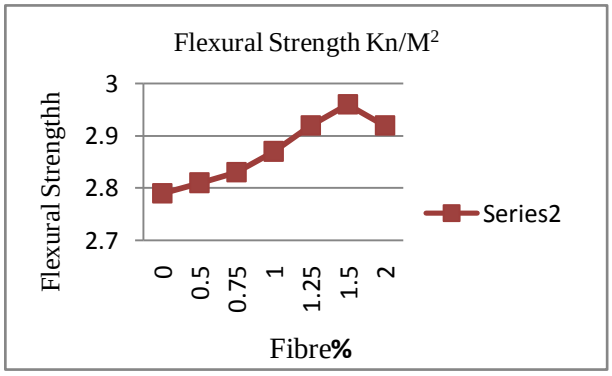

Fig.2. Comparison of compressive strength.

Table 9. Results of tensile test for cylindrical specimen.

S.no.	adding fiber % of content	flexural strength (7days) KN/m2	flexural strength (28days) KN/m2	strength increased in %
1.	0	2.79	3.2	0
2.	0.50	2.81	4.2	0.70
3.	0.75	2.83	4.55	1.43
4.	1.00	2.87	4.65	2.86
5.	1.25	2.92	4.76	4.65
6.	1.50	2.96	4.92	6.09
7.	2.00	2.92	4.12	4.66

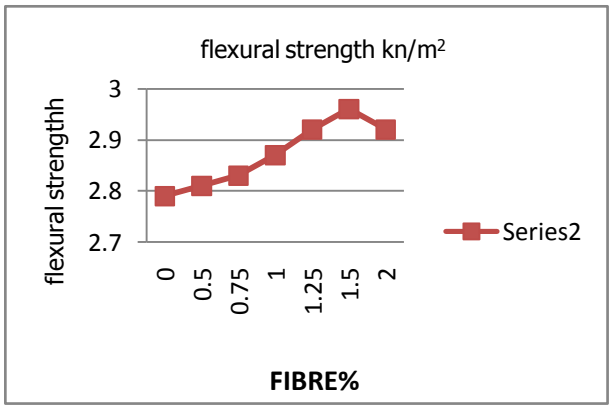

Fig .3 Comparison of flexural strength

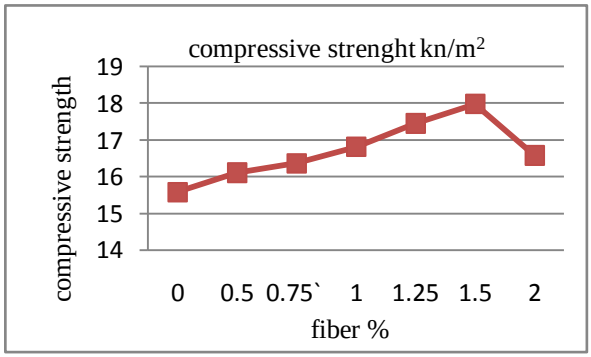

Fig.4. Comparison of tensile strength

IV.CONCLUSION

In this paper, Sisal Fibre is chosen for making Fibre Reinforced Concrete. Fibres are added in percentage by weight of cement viz., 0.5%,0.75 ,1.0%,1.25%,1.5%,&2.0,.%.When the compressive strength of SFRC with 1.5% of sisal fiber is compared to the conventional concrete on 7 days, SFRC's compressive strength will increase by 15.4%.So that the SFRC with 1.5% of Fibre by weight of cement shows better compressive strength characteristics. When compared to the Tensile strength of the concrete with 0 % of fibre, the concrete with 1.5 % of Fibre increases by 22.83 %. From this, it is evident that the concrete with 1.5 % sisal Fibre by weight of cement shows better tensile strength characteristics.And also SFRC with 1.5% of sisal fiber increase the flexural strength by 6.1%, when compare to the conventional concrete. From review above results, the optimum fiber content is obtained by studying the all the properties by varying amount of fiber content for 7 days. In this percentage mechanical strength of concrete is considerably increased.

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