

Natural Sisal Fibre Reinforced Concrete with Experimental Studies

V. Karunya Latha¹, B. Beeraiah²

¹M.Tech scholar, Department of Civil Engineering, Velaga Nageswara Rao College of engineering, Ponnur, Andhra Pradesh (India)

²Asst Professor, Department of Civil Engineering, Velaga Nageswara Rao College of engineering, Ponnur, Andhra Pradesh (India)

ABSTRACT: Concrete is strong in compression and weak in tension. So we will provide the reinforcement to the concrete. Majorly steel is used as the reinforcement. Many of the researches are in progress to find a substitute to this material. Many investigations proposed artificial fibres. In this project we would like to take the naturally available fibre named sisal fibre is taken as a substitute material to the reinforcement and studied the propertie.The results show that the composites reinforced with sisal fibres are reliable materials to be used in practice for the production of structural elements to be used in rural and civil construction. This material could be a substitute to the steel reinforcement which production is a serious hazard to human and animal health and is prohibited in industrialized countries. The production of sisal fibres as compared with synthetic fibres or even with mineral asbestos fibres needs much less energy in addition to the ecological, social and economical benefits.

Keywords: sisal fibre, asbestos fibres, compression & tensile strength.

1. Introduction

Natural fibres are prospective reinforcing materials and their use until now has been more traditional than technical. They have long served many useful purposes but the application of materials technology for the utilization of natural fibres as the reinforcement in concrete has only taken place in comparatively recent years. The distinctive properties of natural fibre reinforced concretes are improved tensile and bending strength, greater ductility, and greater resistance to cracking and hence improved impact strength and toughness. Besides its ability to sustain loads, natural fibre reinforced concrete is also required to be durable. Durability relates to its resistance to deterioration resulting from external causes as well as internal causes.

1.2 Generally the fibers are classified in to two types

They are artificial fibers and natural fibers. In the artificial fibers steel, asbestos, glass, carbon, synthetics etc are used and in the natural fibers horse hair, sisal, coir, bamboo, jute, aware, elephant grass, coconut fibers etc are used and in this human hair was used as a fiber. Human hair is natural fiber and it is strong intension.

Fiber reinforced concrete has so far been successfully used in slabs on grade, architectural panels, precast products, offshore structures, structures in seismic regions, thin and thick repairs, crash barriers, footOings, hydraulic structures and many other applications. Fiber Reinforced Concrete (FRC) is gaining attention as an effective way to improve the performance of concrete. Fibers are currently being specified in tunneling, bridge decks, pavements, loading docks, thin unbounded overlays, concrete pads, and concretes slabs. These applications of fiber reinforced concrete are becoming increasingly popular and are exhibiting excellent performance. 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 this study presents understanding strength of



Fig 1 Sisal Fibre extraction

fibres reinforced concrete. Mechanical properties and durability of fiber reinforced concrete.

1.3 Scope

Concrete is strong in compression and weak in tension. To increase the tensile strength of concrete we are adding sisal fibre. Also it resists the plastic shrinkage cracks. This sisal fibre is a natural product that is available in the fields and if this could replace the reinforcement in the concrete it would be a gigantic change in the construction industry.

1.4 Objective

The main objective is to study the effect on utilization of sisal fibre in the concrete as the reinforcement and in this investigation the fibre is mixed in different proportions by cutting it into small pieces of size 3 to 5 cm.

To study the mechanical and transport properties of concrete

1. Compressive test on concrete cubes (150 × 150 × 150 mm)
2. Split tensile strength on cylinders (Ø 100 mm & 200 mm long)
3. Evaporation test on cubes (150 × 150 × 150 mm)
4. Water absorption test on cubes (150 × 150 × 150 mm)
5. Moisture migration test on cubes (150 × 150 × 150 mm)

2. Literature Review

M. A. Aziz, P. Paramasivam and S. L. Lee 1984: Natural fibres are prospective reinforcing materials and their use until now has been more traditional than technical. They have long served many useful purposes but the application of materials technology for the utilization of natural fibres as the reinforcement in concrete has only taken place in comparatively in recent years. The distinctive properties of natural fibre reinforced concretes are improved tensile and bending strength, greater ductility and greater resistance to cracking and hence improved impact strength and toughness. Besides its ability to sustain loads, natural fibre reinforced concrete is also required to be durable. Durability

relates to its resistance to deterioration resulting from external causes as well as internal causes.

Mechanical characterization and impact behaviour of concrete reinforced with natural fibres were studied by S.K. Al-Oraimi and A. C. Seibi (1995). Here an experimental study was conducted using glass and palm tree fibres on high strength concrete. Mechanical strength properties such as compressive, split tensile, flexural strengths and post cracking toughness were studied. It was concluded that natural fibres are comparable with glass fibres. A finite element analysis was also done using ANSYS software. Both analytical and experimental results were compared an acceptable.

G.Ramakrishna and T. Sundararajan (2002). Flow value, cohesion and angle of internal friction were determined for three different mix ratios and four different aspect ratios and fibre contents. Based on the rheological properties of fresh mortar, it was recommended to use shorter fibres with low fibre- content for achieving workability and higher fibre content for better cohesiveness in wet state.

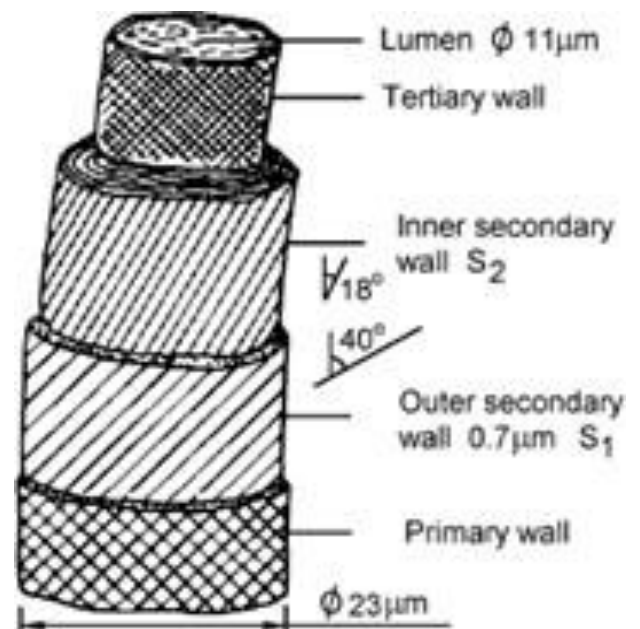


Fig 2. Schematic sketch of a sisal fibre

3. MATERIALS AND PROPERTIES

Cement: OPC 53 grade cement from a single batch will be used throughout the course of the project work. The properties of cement used are shown in table below.

Table 1: Physical properties of Cement

S.no	Particulars	Results
1	Specific gravity	3.05
2	Initial setting time	170 min
3	Final setting time	230 min
4	Consistency	25%
5	Fineness	298 m ² /kg
6	Compressive Strength of cement @ 3, 7, 28 days	35, 46, 58 N/mm ²

Fine aggregate: Fine aggregate used in the experiments was locally available river sand conforming to IS 383- 1970(6). The physical properties of the fine aggregates were tested in accordance with IS 2386(10).

Table 2: Properties of fine aggregates

S. no	Particulars	Results
1	Type	River sand
2	Specific Gravity	2.4
3	Water absorption	1%
4	Fineness modulus	3.40
5	Grading	Zone-III
6	Density	1.57

Coarse Aggregate: The coarse aggregate used in this study was crushed granite of maximum size 20 mm obtained from the local crushing plant. The physical properties of the coarse aggregate were tested in accordance with IS 2386(10).

Table 3: Properties of coarse aggregates

S. no	Particulars	Results
1	Type	Crushed stone
2	Specific Gravity	2.6
3	Water absorption	0.8%
4	Fineness modulus	7.98
5	Size	20 mm (max)
6	Density	1.48

Sisal Fibre: Sisal fibre (Agave sisalena) is an agave that yields a stiff fibre traditionally used in making twine rope and also dartboards. The term may refer either to the plant or the fibre, depending on context. It is sometimes incorrectly referred to as sisal fibre hemp because hemp was for centuries a major source for fibre, so other fibres were sometimes named after it.

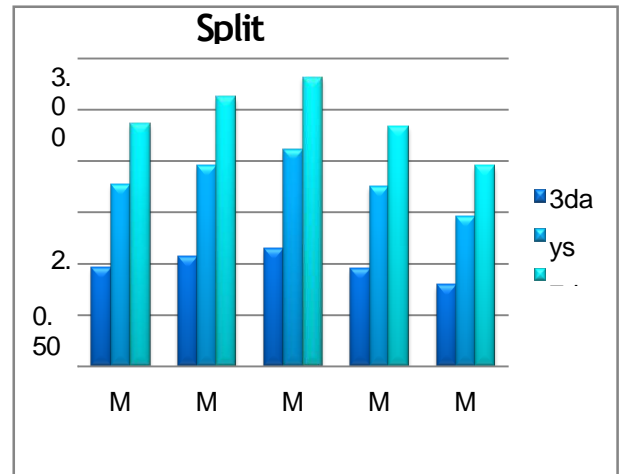
The Sisal fibre plants consist of a rosette of sword-shaped leaves about 1.5 to 2 meters tall. Young leaves may have a few minute teeth along their margins, but lose them as they mature. The sisal fibre plant has a 7–10 year life-span and typically produces 200–250 commercially usable leaves. Each leaf contains an average of around 1000 fibres. The fibres account for only about 4% of the plant by weight. Sisal fibre is considered a plant of the tropics and subtropics, since production benefits from temperatures above 25 degrees Celsius and sunshine.



Fig 3. Raw Sisal Fibre

Table 4: Physical Properties of Sisal Fibre

S. no	Particulars	Results
1	Diameter	0.2mm
2	Elongation	4.3%
3	Water absorption	3%
4	Cellulose	70%
5	Tensile Strength	300 Mpa
6	Density	1.450gm/cm ³



Graph 1. Shows the split tensile strength of concrete

4. EXPERIMENTAL INVESTIGATION

4.1 SPLIT TENSILE STRENGTH

Split Tensile test is conducted on the cylinders of the sizes in ratio 1:2 to the diameter and length of the specimen. In this investigation totally 45 cylindrical moulds of size 100mm*200 mm were tested for knowing Split tensile strength of different mixes at 3 days , 7days, and 28 days.

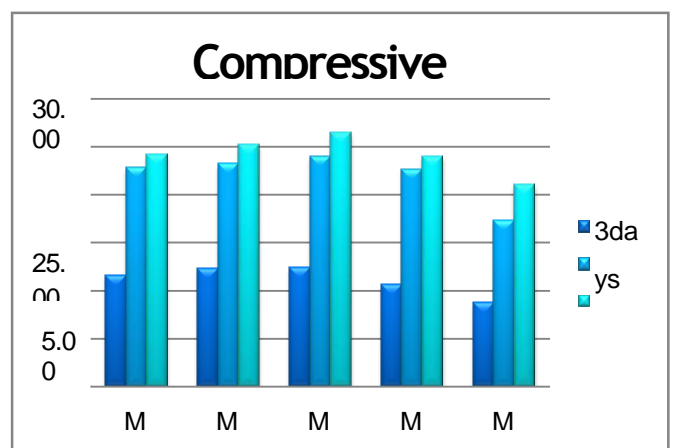
Table 5 Split Tensile Strength for different mixes

Split Tensile Strength N/mm ²			
Mix	3 days	7 days	28 days
M1	0.96	1.77	2.36
M2	1.07	1.96	2.62
M3	1.15	2.11	2.81
M4	0.95	1.75	2.33
M5	0.79	1.46	1.95

4.2 COMPRESSIVE STRENGTH

Table 6 Compressive Strength of different mixes

Compressive strength N/mm ²			
Mix	3days	7 days	28 days
M1	11.57	22.81	24.22
M2	12.31	23.19	25.19
M3	12.34	24.00	26.44
M4	10.61	22.59	24.00
M5	8.67	17.33	21.04



Graph 2. Shows the Compressive strength of concrete

4.3 EVAPORATION TEST

Evaporation is the basic property to know about the transport property of the concrete and that may affect the concrete if the concrete is having the large amounts of the water evaporation as the durability of the concrete may be affected.

Table 7 Evaporation percentage in different mixes

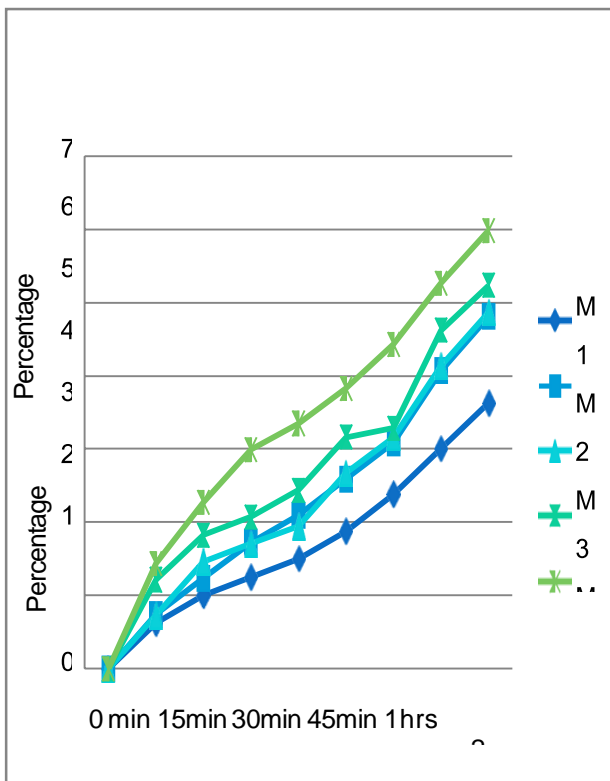
Evaporation in %									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	0	0.259	0.389	0.519	0.519	0.649	0.908	1.427	1.946
M2	0	0.265	0.529	0.795	1.06	1.325	1.589	1.987	2.384
M3	0	0.412	0.96	1.235	1.646	1.783	1.92	2.195	2.606
M4	0	0.549	1.098	1.374	1.923	2.473	2.747	3.434	3.846
M5	0	0.543	1.222	1.495	1.766	2.446	2.853	3.804	4.484

4.4 WATER ABSORPTION TEST

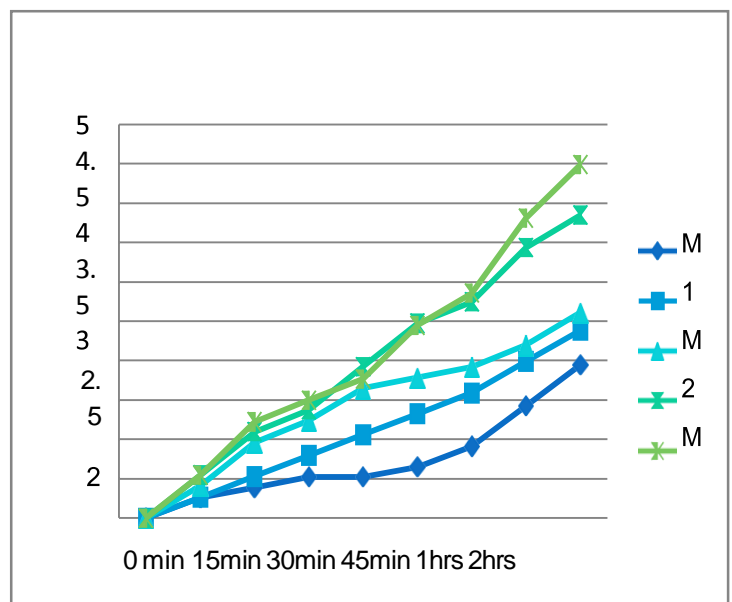
Water Absorption Test is conducted to find out the transport property of the concrete and this is not tested on the shorter periods of time from the casting. In this investigation we had observed the absorption property of the specimens after the cubes are cured for the period of 28 days after they have casted. The cube used Water Absorption Test is conducted to find out the transport property of the concrete and this is not tested on the shorter periods of time from the casting. In this for this test is 150mm*150mm*150mm of size.

Table 8 Water Absorption percentage in different mixes

Water Absorption in %									
MIX	0 min	15min	30min	45min	1hrs	2hrs	4hrs	24hrs	48hrs
M1	0	0.625	1	1.25	1.5	1.875	2.375	3	3.625
M2	0	0.74	1.233	1.726	2.096	2.589	3.082	4.069	4.808
M3	0	0.73	1.459	1.703	1.946	2.676	3.163	4.136	4.866
M4	0	1.217	1.824	2.068	2.433	3.163	3.284	4.622	5.231
M5	0	1.435	2.272	2.99	3.349	3.827	4.425	5.263	5.98



Graph 3. Water evaporation percentages in different mix.



Graph 4 Water Absorption percentages in different mix.

Conclusions

All the material tests, strength test such as compression, split tensile and the transport properties like evaporation, water absorption and moisture migration had been carried out in the laboratory and as per code provision only. Results of experiments on different properties of different mixes in which fibre is added with different percentages

The following conclusions are drawn from the investigation

- One day strength results are not to be estimate for the fibre content as the increase in the fibre percentage the setting time of the concrete is delayed.
- Freshly prepared Sisal fibre contain some gelatinous chemical reagents which may affect the chemical properties of cement in concrete
- When the percentage of fibre is increased by more than 1% reduction in mechanical properties is observed.
- Reduction in strength is due the increase in the fibre percentage and that may leads to porous structure by the agglomeration.
- Increase in strength up to 1% is due to utilization of water present in fibre for chemical reaction at time of curing and less concentration of fibre created density compacted medium in cement concrete
- The addition of the fibre in small amounts will increase the tensile strength.
- Addition of fibers not only increases tensile strength but also increases bond strength, decreases permeability.
- Toughness of concrete also increases by the addition of the fibre.

References

- M. A. Aziz, P.Paramasivam and S. L. Lee 1984- Natural fibers are prospective reinforcing materials and their use
- S.K. Al-Oraimi and A.C.Seibi (1995)-Mechanical characterization and impact behavior of concrete reinforced with natural fibers'
- G.Ramakrishna and T.Sundararajan (2002)-Rheological properties of coir fibre reinforced cement mortar
- K. Bilba, M. A. Arsene and A.Ouensanga (2003) - Sisal fibre reinforced cement composites
- Text book on properties of concrete by Neville
- Text book on concrete technology by M.S Shetty
- Text book on concrete technology by Ghambhir.
- IS: 383-1970 "Specification For Coarse And Fine Aggregates From Natural Sources For Concrete"