Sisel Fiber Reinforced Concrete

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***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 properties. 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.

I. INTRODUCTION

1.1 General

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.

Earlier, mechanical characterization and impact behaviour of concrete reinforced with natural fibres were studied. Here an experimental study was done using sisal fibre in this investigation the mechanical strength properties such as compressive, split tensile and some of the transport properties like evaporation, absorption and moisture migration are studied.

1.2 Sisal Fibre

Sisal fibre is one of the most widely used natural fibres and is very easily cultivated. It has short renewal times and grows wild in the hedges of fields and railway tracks. Nearly 4.5 million tons of sisal fibre is produced every year throughout the world. Tanzania and Brazil are the two main producing countries. Sisal fibre is a hard fibre extracted from the leaves of the sisal plant (Agave sisalana). Though native to tropical and sub-tropical North and South America, sisal plant is now widely grown in tropical countries of Africa, the West Indies and the Far East. Sisal fibres are extracted from the leaves. A sisal plant produces about 200±250 leaves and each leaf contains 1000±1200 fibre bundles which are composed of 4% fibre, 0.75% cuticle, 8%dry matter and 87.25% water. So normally a leaf weighing about 600 g will yield about 3% by weight of fibre with each leaf containing about 1000 fibres.

Key Words: Concrete, Sisel Fibre, strength, Durability

1.3Scope

Concrete is strong in compression and week in tension. To increase the tensile strength of the 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 for

- Compressive test on concrete cubes (150 × 150 × 150 mm)
- Split tensile strength on cylinders (Ø 100 mm & 200 mm long)
- Evaporation test on cubes (150 × 150 × 150 mm)
- Water absorption test on cubes (150 × 150 × 150 mm)
- Moisture migration test on cubes (150 × 150 × 150 mm)

II. LITERATURE REVIEW

2.1 Reviews on Natural Fibres

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.

S.K. Al-Oraimi and A.C.Seibi (1995)

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 and acceptable.

G.Ramakrishna and T.Sundararajan (2002).

Rheological properties of coir fibre reinforced cement mortar were carried out by 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.G.Ramakrishna, T.Sundararajan and Usha Nandhini (2002) compared the theoretical and experimental investigations on the compressive strength and elastic modulus of coir and sisal fibre reinforced concretes for various volume fractions. It was observed that both the experimental and analytical values of elastic modulus had shown 15% discrepancy, which can be regarded as comparatively small.

III. MATERIALS AND PROPERETIES

3.1 Cement

Ordinary Portland Cement of 53 Grade of brand name dalmia cements, available in the local market was used for the investigation.

3.2 Aggregate

The basic objective in proportioning any concrete is to incorporate the maximum amount of aggregate and minimum amount of water into the mix, and thereby reducing the cementitious material quantity, and to reduce the consequent volume change of the concrete.

3.2.1 Coarse aggregate

Selection of the maximum size of aggregate mainly depends on the project application, workability, segregation, strength and availability. In this research aggregates that are available in the crusher nearby was used. The maximum size of aggregate was varying between 26 -12.5 mm.

3.2.2 Fine aggregate

River sand locally available in the market was used in the investigation. The aggregate was tested for its physical requirements such as gradation, fineness modulus, specific gravity and bulk density in accordance with IS: 2386-1963.The sand was surface dried before use. The amount of fine aggregate usage is very important in concrete. This will help in filling the voids present between coarse aggregate and they mix with cementaneous materials and form a paste to coat aggregate particles and that affect the compactability of the mix. The aggregates used in this research are without impurities like clay, shell and organic matters. It is passing through 4.75mm sieve.

3.3 Sisal Fibre

Sisal fibre (*Agave sisal fibreana*) 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 plant's origin is uncertain; while traditionally it was deemed to be a native of Yucatan; there are no records of botanical collections from there. Gentry hypothesized a Chiapas origin, on the strength of traditional local usage. In the 19th century, sisal fibre cultivation spread to Florida, the Caribbean islands and Brazil, as well as to countries in Africa, notably Tanzania and Kenya, and Asia. The first commercial plantings in Brazil were made in the late 1930s and the first sisal fibre exports from there were made in 1948. It was not until the 1960s that Brazilian production accelerated and the first of many spinning mills was established. Today Brazil is the major world producer of sisal fibre. There are both positive and negative environmental impacts from sisal fibre growing. Traditionally used for rope and twine, sisal fibre has many uses, including paper, cloth, wall coverings and carpets and here for get good values of flexural strength for

concrete.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.

Table.1: 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

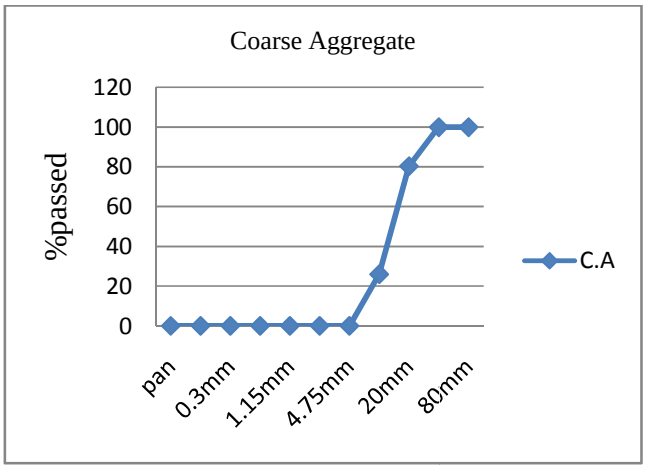

Fig. 1: Sieve Analysis for Coarse Aggregate

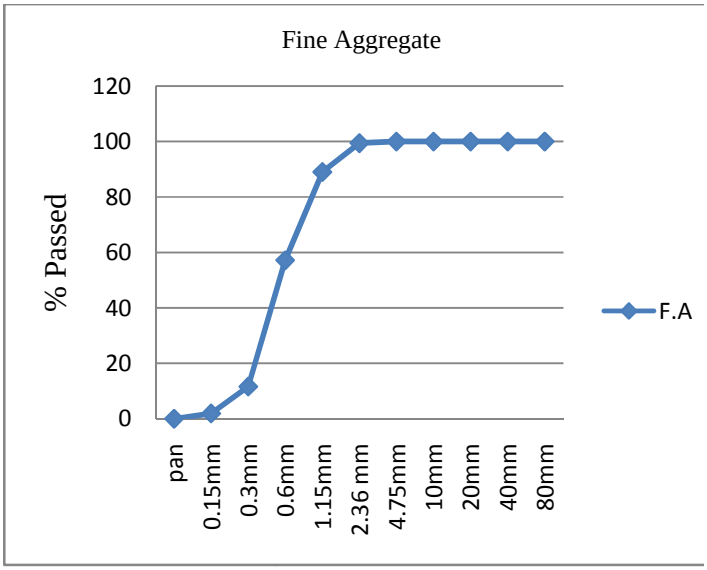

Fig. 2: Sieve Analysis for Fine Aggregate

Table.2: Mix Proportions

Mix	Cement	C.A 12 mm	C.A 20mm	Fine Aggregate	Sisal Fibre	W/C
M1	350	727	502	646	0	0.547
M2	350	727	502	646	1.75	0.547
M3	350	727	502	646	3.50	0.547
M4	350	727	502	646	5.25	0.547
M5	350	727	502	646	7.00	0.547

IV. RESULTS AND DISCUSSIONS

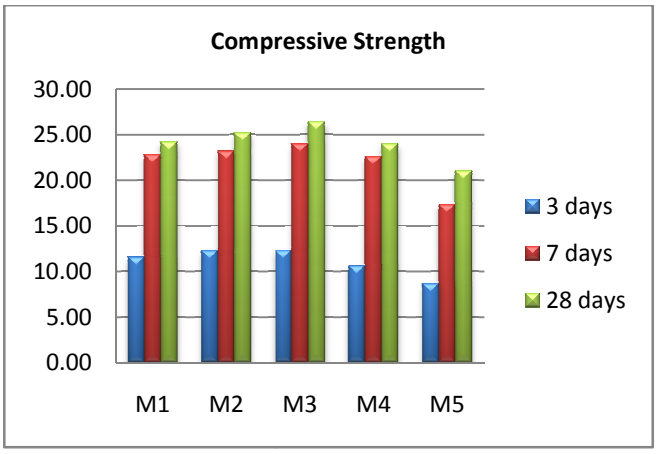

Fig. 3: Compressive Strength of different mixes

- At 0% of fibre the strengths were 11.57 and 12.23Mpa when it was 1% then it increased to 12.34 at 1.5%.

- The strength has been reduced when 1.5% fibre is added. This has been repeated in all the periods of testing.
- As the strength parameters in the 7 days test had been increasing till the fibre was 1.5% and then the strength reduced when fibre is added by 1.5% and 2%.
- The results at 7 days for 0% and 1.5% have increased the strength from 22.81mpa to 24 mpa.
- As it is mentioned as fibre can be used in concrete in the partial replacement to the reinforcement to some extent as it does not affect the strength property

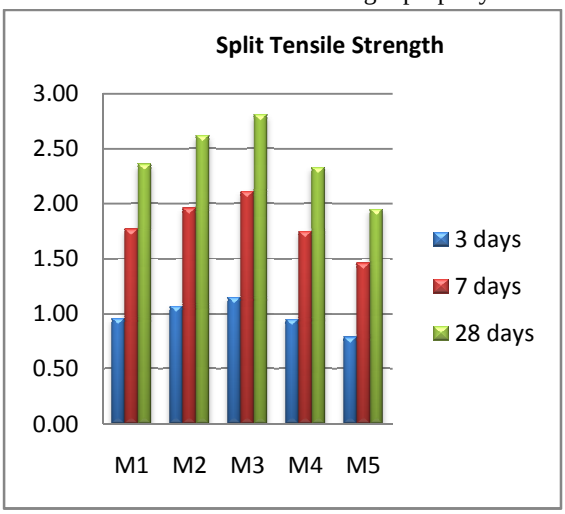

Fig. 4: Split Tensile Strength of different mixes

- At 0% of fibre mix the strength is 0.96 when it was 0.5% then it increased to 1.07.
- As the strength parameters in the 7 days test had been increased in the mix upto the fibre was 1.0% and then it start decreasing.
- This affect made n the concrete may be due to the agglamiration of the fibre content.
- In this investigation it shows that the strength pararmeters of the concrete can be increased by adding the fibre content to the concrete.
- In all the periods and when the fibre is added to the concrete the split tensile strength has been increased.

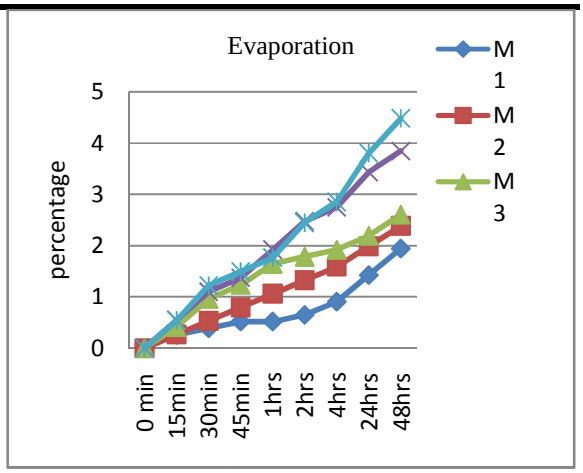

Fig. 5: Evaporation percentages in different mixes

- We can observe that in the early stages of the cube placed in the oven the evaporation is more from the specimens.
- Such that in the observations from the graph we can make a statement that the evaporation is increased by increasing the percentages of fibre.
- As the fibre is a natural dried weed material it will be having some percentage of water absorption.
- We can check the results absorbed from the 48 hrs test that has been conducted for the different types of the mixes of fibre.
- It has been noted as1.94, 2.38, 2.60, 3.84 and 4.48 for the fibre percentages of 0, 0.5 1, 1.5 and 2 respectively.
- We can observe the percentage evaporation is increased with the increase in the fibre percentage.

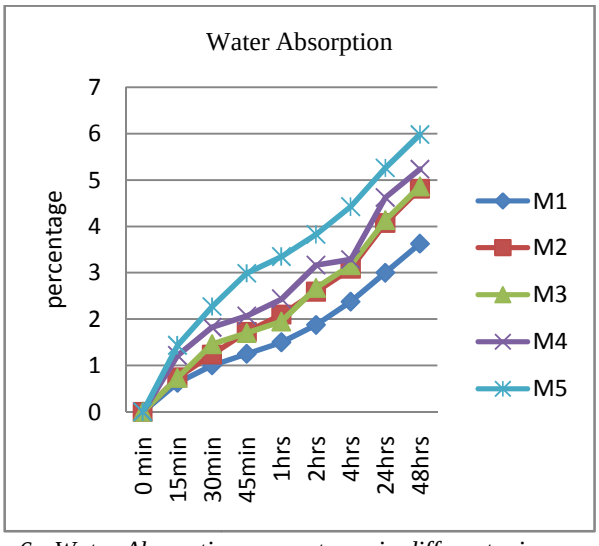

Fig. 6: Water Absorption percentages in different mixes

- The first 1 hour we can notice that large amounts of water absorptiontaken place.
- In the normal mix the absorption for first hour is 1.5% and after 48 hours it is 3.625%
- As it takes the 50% absorption occurred in the first 1 hour and later it takes very slowly.
- In case of curing of concrete and at mixing also water absorption takes place in the large amounts as the cement is a heat evolving material.

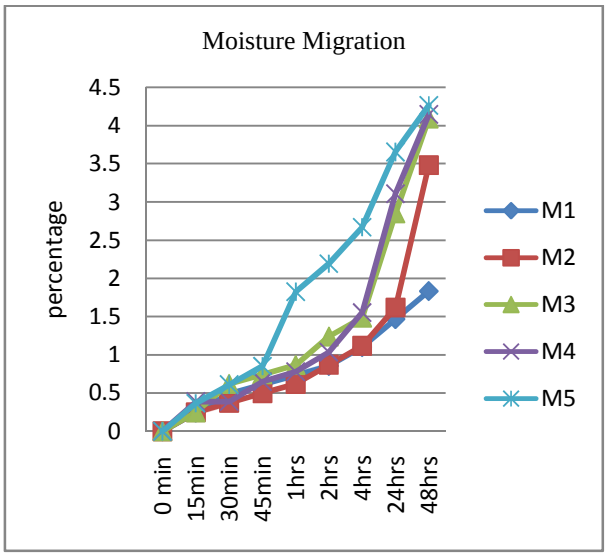

Fig. 7: Moisture Migration percentages in different mixes

- As the fibre has the absorption property the migration has been steadily increased in the mix as the fibre increases.
- We can observe that by having noticed values in the 48 hrs test for the different percentages of fibre such as 0, 0.5, 1, 1.5 and 2 are 1.83, 3.48, 4.09, 4.14 and 4.26.
- In the above values we can make a note that 0% is having 1.83% migration where as 0.5% fibre added is increased to 3.48% of migration.

V. CONCLUSION

- 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 densely compacted medium in cement concrete
- The addition of the fibre in small amounts will increase the tensile strength.
- Addition of fibres not only increases tensile strength but also increases bond strength, decreases permeability.
- Toughness of concrete also increases by the addition of the fibre.

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