Partial Replacement of Fine Aggregates By Sisal Fiber– A Review

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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 as a substitute material to the reinforcement and study 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. Nearly 4.5 million tons of sisal fibre is produced every year throughout the world. A sisal plant produces about 200±250 leaves and each leaf contains 1000±1200 fibre bundles which is composed of 4% fibre, 0.75% cuticle, 8% dry matter and 87.25% water.*

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.

By utilizing the natural products and wastes is very much helpful to the environmental protection. Sisal fibre (SF) is the natural fibre extracted from the tree leaves (Agave sisalana tree), it is possible to use directly to concrete or in a chopped form. To emphasis durability and corrosion resistance of sisal fibre reinforced concrete (SFRC) the thermal treatment and Na_2CO_3 surface layer treatmentis good practicable way on SF.

II. OBJECTIVES AND SCOPE

This study is conducted to accomplish some predefined objectives. These objectives are:

1. To study the mechanical properties such as compressive strength and split tensile strength of conventional concrete and fibre reinforced concrete by introducing 05%,1%and 1.5% sisal fibre.
2. To determine effect of different proportion of Sisal fibre in themix.
3. To determine the strength of cubes and cylinders at 7 and 28 days and comparing with conventionalconcrete.
4. To determine the percentage variation in strength in cubes and cylinders at 7days and 28 days.

III. SISAL FIBER

Sisal fiber is one of the most widely used natural fiber and is very easily cultivated.It is obtain from sisal plant. The plant known formally as agave sisilana. The Sisal plant is one of the types of perennial shrub which grows in the tropical and subtropical regions of the world. It is one of the most extensively cultivated hard fibres in the world. It grows in very hardy type soils where normal plants may not be grown. Though, the ideal condition in which the plant may be cultivated are in the areas where average temperature is between 20 to 28°C and the average annual rainfall is between 600 to 1500 mm. The main advantage of this plant is that, it can be grown where prolong droughts and high temperature are the problems where other plants cannot be grown.Sisal fibre made from the process of Decortication ,leaves are crushed and beaten by a rotating wheel set with blunt knives,so that only fibres remain. The other parts of the leaf are washed away by water.Decorticated fibres are washed before drying the sun or by hot air.

Properties of Sisal fiber

Properties	Values Observed
Tensile strength (Mpa)	385-728
Elongation of break (%)	2.75
Diameter (mm)	0.8-1.2

IV. LITERATURE REVIEW

M.A.Aziz et al stated that 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 concrete 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. (Here an experimental study was conducted using glass and palm tree fibres on high strength concrete. It was concluded that natural fibres are comparable with glass fibres. Both analytical and experimental results were compared and acceptable. G.Ramakrishna, T.Sundararajan and Usha Nandhini 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.

Sisalfibre reinforced cement composites were studied by K.Bilba, M.A.Arsene and A.Ouensanga Various fibre-cement composites were prepared and influence various parameters on the setting of the composite materials were studied. Botanicalcomponents, thermal and chemical treatment of Sisal fibres were also studied. The natural fibre composites may undergo a reduction in strength and toughness as a result of weakening of fibres by the combination of alkali attack and mineralisation through the migration of hydrogen products to lumens and spaces. Romildo D. Toledo Filho, Khosrow Ghavami, George L. England and Karen Scrivener (2003) reported their study on development of vegetable fibre-mortarcomposites ofimproved durability. Robert S.P. Coutts) and V.Agopyan reviewed critically about the Australian research in to natural fibre cement composites. It was mentioned that over the last three decades considerable research has been committed to find an alternative fibre to replace asbestos and glass fibres. Robert S.P. Coutts made some experiments on free, restrained and drying shrinkage of cement mortar composites reinforced with vegetable fibres. It was concluded that free plastic shrinkage is significantly reduced by the inclusion of 0.2% volume fraction of 25mm short sisal fibres in cement mortar. Also it was stated that the presence of sisal and coconut fibres promotes an effective self-healing of plastic

Mechanical properties of date palm fibres and concrete reinforced with date palm fibres were tested and reported by A.Kriker et.al in two different climates. In addition to the above properties, continuity index, microstructure and toughness were also studied. The volume fraction and length of fibres chosen were 2-3% and 15-60 mm respectively. Microstructure and mechanical properties of waste fibre-cement composites were studied by H. Savastano Jr, P.G.Warden and R.S.P.Coutts. Both secondary and back-scattered electron imaging and energy dispersive X-ray spectrography were used for compositational analysis.

K.Murali Mohan Rao and K.Mohana Rao introduced and studied the extraction and tensile properties of new natural fibres used as fillers in a concrete matrix enabling production of economical and light weight composites for load carrying structures.

V. METHODOLOGY

- A concrete mix was designed to achieve the grade of M25 (by taking 1:1:2 as nominal mix) as required by IS 456 – 2000. The investigation was done by taking 0%, 0.5%,1 %, 1.5%,2%, and 2.5% (by the weight of concrete) sisal fiber in the concrete mix. And sisal fiber were obtained from market. Minimum of three test specimen were taken for each analysis. The following tests were conducted on the respective specimens
- Splitting Tensile Strength on cylinder
- Flexural Strength on beam
- Compressive Strength on cube

VI. MIX PROPOTION

The mixture proportioning was done according to the Indian Standard Recommendation method IS 10262-2009. The ordinary Portland cement (opc) of Grade 53 is used. Cement, fine aggregate, coarse aggregate & sisal fibre were properly mixed together in accordance with IS codein the ratio 1:1.93:1.67 by weight before waterwas added and was properly mixed together to achieve homogenous material. Water absorption capacity and moisture content were taken into consideration and appropriately subtracted from the water/cement ratio used for mixing. Sisal fibres with different percentages 0.5%,1.0%,1.5% are being replaced for the total volume fine aggregates. Cubes & cylinders were used for casting; The propotion for that we got are as follows;

Cement=438 kg/m^3
Water=197liters
Coarse Aggregates=1108kg
Fine aggregates=708kg
so, the mix propotion is **1:2.14:3.77**

VII. STRENGTH PROPERTIES

The program was conducted for understanding the effectiveness of adding sisal fibres in concrete, the testing was carried out on 12 concrete cubes (150mm x 150mm x 150mm) for compressive strength, 12 concrete cylinders (150mm x 300mm) for Elasticity modulus. CastingwasmadeinM 25 Gradeandthe specimens were made to cure for 28 days in potablewater.

Table2: Details of specimens

Specimens	Cubes	Cylinders
Conventional concrete	3	3
Concrete with sisal fibre at 0.50%	3	3
Concrete with sisal fibre at 1.0%	3	3
Concrete with sisal fibre at 1.5%	3	3

a. COMPRESSIVE STRENGTH OF CONCRETE CUBE(150*150*150 mm)

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 No.3 Compression test

Percentage of sisal fibre replaced	7 days N/mm2	14 days N/mm2	28 days N/mm2
0%	17	24	27.5
0.5%	19.5	26.4	31.1
1.0%	21.6	28.3	33.3
1.5%	20.8	27.2	32

b. SPLIT TENSILE STRENGTH OF CONCRETE CYLINDER (150*300mm)

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 No. 4 Split tensile Test

Percentage of sisal fibre replaced	7 days N/mm2	14 days N/mm2	28 days N/mm2
0%	1.7	2	2.5
0.5%	2.2	2.6	3.1
1.0%	2.8	3.2	3.9
1.5%	3.5	3.8	4.5

c. FLEXURAL STRENGTH OFCONCRETE

The experimental program contained 12 beams. All the beams were utilized to study theeffect 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

Table No. 5 Flexural test

Sl. No	Parameter	Conventional concrete	0.5% sisal fibre	1.0% sisal fibre	1.5% sisal fibre
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

VIII. CONCLUSION

From this experimental investigation, the following conclusion were arrived. Using the natural sisal fiberincrease 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

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