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EXPERIMENTAL INVESTIGATION ON THE PROPRETIES OF SISAL FIBRE 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 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.*

Key Words: Sisal fibre natural fibre, concrete testing.

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.
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.

1.1 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 is 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.

2. LITERATURE SURVEY

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. Botanical components, 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-mortar composites of improved 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.

3.0 MATERIALS AND PROPERTIES

The following materials are considered for the current work

Fig -1:Cement

Fig -2:Fine Aggregate

Fig.3 Sisal Fibre

Fig. 4 Coarse Aggregate

3.1 Mix Proportioning

There are various methods of mix proportioning. Mix proportioning was based on the water cement ratio (water/cement) and the density of the concrete is 2400 kg/m^3. Quantity of water is taken according to slump of concrete 0.5 for economical purpose. The quantity of cement i.e; 350 kg/m^3 is used. Therefore quantity of water should be 175kg/m^3. For fine and coarse aggregate absorption of water in additional 1 % and 0.8% of water was used. The quantity of aggregates is taken based on the aggregate grading curve is selected. The quantity of fine aggregates used is 646kg/m^3, coarse aggregates is 1229kg/m^3, the quantity of 20mm and 12mm are 502kg/m^3 and 727kg/m^3.

For the investigation purpose the fibre is added to the concrete to study the properties of the fibre reinforced concrete, the addition is about 0, 0.5, 1, 1.5, 2 percentages by weight of concrete for the relative mixes M1,M2, M3,M4 and M5 respectively.

Table -1: Mix Proportions

Mix	Cement	C.A 12mm	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

3.2 Specimen Details

The specimens like cubes, cylinders and beams that are used to conduct the strength tests are taken according *to IS 10086-1982*.

Compression strength = cube moulds of 150mm X 150mm X 150mm are used.

Split tensile strength = cylindrical moulds of 100dia @ 200mm height are used.

The following tests conducted in our investigation:

1. Compressive Strength Test
2. Split Tensile Strength Test

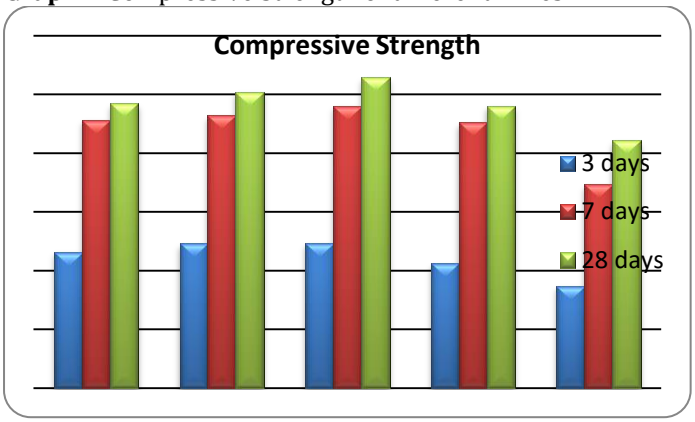
4.0 RESULTS AND DISCUSSIONS

4.1 Compressive Strength

Table 2 Compressive Strength of different mixes

Compressive strength N/mm²			
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 1 Compressive Strength of different mixes



Compression test is most commonly conducted test as it is the most desirable characteristic property of the concrete that is to be achieved. In this investigation totally 45 cube moulds of size 150 × 150 × 150 were tested for knowing compressive strength of different mixes at 3 days , 7days, and 28 days.

Comparison between the strengths of different mix proportions:

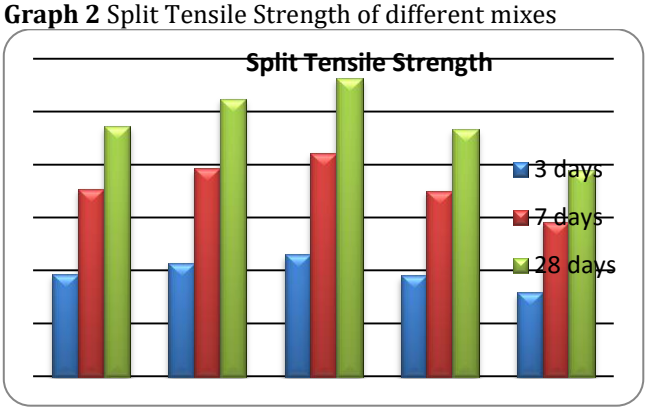
- The compressive strength has been increasing till the mix percentage is up to 1% and then the strength started decreasing.
- At 0% of fibre the strengths were 11.57 and 12.23Mpa when it was 1% then it increased to 12.34 at 1.5%.
- The strength has been reduced when 1.5% fibre is added. This has been 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 22.81 Mpa to 24 Mpa.
- In this investigation it shows that the strength parameters of the 28 days had been finally made small variations in the mix proportions 0% and 1.5%.
- The results at 28 days for have been increased in the mix ratio up to 1.5% and then it has been decreased.
- As the 28 days strength should achieve 20Mpa and in the results we can observe that the strength of the entire mix ratios when fibre is added whether it has been achieved the strength of the M20 grade mix.

4.2 Split Tensile Strength

Table 2 Split Tensile Strength for different mixes

Split Tensile Strength N/mm²			
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

Graph 2 Split Tensile Strength of different mixes



Direct measuring of the tensile strength of concrete is difficult. Neither specimen nor testing apparatus have been designed which can assure uniform distribution of pull is applied to the concrete. Many tests are made by finding out the flexural strength by making the beam moulds. In the present case the tensile strength is found by and indirect method that is Cylinder Split Tension Test.

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.
Comparison between the strengths of different mix proportions:

- As we know that concrete is strong in compression and weak in tension.
- Generally it is noted that Tensile strength must achieve 10% of compressive strength, as all the results have achieved the result.
- 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 up to the fibre was 1.0% and then it start decreasing.
- This affect made in the concrete may be due to the agglomeration of the fibre content.
- In this investigation it shows that the strength parameters 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.
- As there are many fibres present in the present world we made a research on the natural fibre.
- We can make use of the fibres to increase the tensile property of the concrete and it can also serve as the substitute material for the steel provided in the reinforced cement concrete.

5.CONCLUSION

The material tests, strength test such as compression and split tensile tests are 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.
- 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, but decreases permeability.

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