# EXPERIMENTAL STUDY ON THE STRENGTH PROPERTIES OF FIBER REINFORCED CONCRETE USING SISAL FIBER AND POLYPROPYLENE FIBER

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***Abstract :*** Concrete is strong in compression and weak in tension. So when we 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 fibers. In this project we would like to take the naturally available fiber named sisal fiber is taken as a substitute material to the reinforcement and study the properties. The results show that the composites reinforced with sisal fibers 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 fibers as compared with synthetic fibers or even with mineral asbestos fibers needs much less energy in addition to the ecological, social and economical benefits. Then the sisal fibered concrete is compared with the mechanical properties of the polypropylene fiber and shown the comparison between the both fibred concrete. In this investigation the fiber is added to the concrete to study the properties of the fiber reinforced concrete, the addition is about 0, 0.5, 1, 1.5, 2 percentages by weight of concrete for the relative mixes using sisal fiber. A special mix is done using 0.5% for the polypropylene fiber. This work continues with the testing of concrete specimens in addition with sisal fiber and polypropylene fiber, the mechanical and transport properties of concrete were tested i,e compressive test, split tensile strength, evaporation test, water absorption test, water absorption test.

## 1. Introduction

Natural fibers are Ability reinforcing materials and their use till now has been extra traditional than technical. They have long served numerous useful purposes however the application of materials generation for the usage of natural fibers as the reinforcement in concrete has handiest taken region in comparatively latest years.The extraordinary residences of natural fiber strengthened concretes are improved tensile and bending energy, more ductility, and more resistance to cracking and as a result stepped forward impact energy and durability. Besides its ability to maintain masses, herbal fiber reinforced concrete is likewise required to be long lasting. Durability pertains to its resistance to deterioration because of outside reasons in addition to inner causes. Earlier, mechanical characterization and impact behaviour of concrete reinforced with natural fibers were studied. Here an experimental study was done using sisal fiber On this investigation the mechanical electricity homes which includes compressive, cut up tensile and some of the shipping houses like evaporation, absorption and moisture migration are studied. The natural fiber is added in the different percentages and the optimum is found out and then usage of the polypropylene is taken by 0.5% of the weight and that is taken as the optimum percentage and compared with the natural fiber. Sisal fiber is one of the most widely used natural fibers and is very easily cultivated. It has quick renewal times and grows wild in the hedges of fields and railway tracks. Nearly 4.Five million tons of sisal fiber is produced every year at some point of the sector. Tanzania and Brazil are the two main producing countries. Sisal fiber is a hard fiber 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 extensively grown in tropical international locations of Africa, the West Indies and the Far East. Sisal fibers are extracted from the leaves. A sisal plant produces about 200±25 leaves and each leaf contains a 1000±1200 Fiber package deal which consists of 4% fiber, 0.75% cuticle, 8% dry rely and 87.25% water. So normally a leaf weighing about 600 g will yield about 3% by means of weight of fiber with every leaf containing approximately 1000 fibers. Concrete is by nature a Brittle material that performs well in compression, but is extensively much less powerful when in anxiety. Reinforcement is used to take in those tensile forces in order that the cracking which is inevitable in all high-electricity concretes does not weaken the structure. For a few years, metal inside the shape of bars or mesh (also called "re-bar") has been used as reinforcement for concrete that are designed to experience the tensile loading. Latest trends in concrete technology now include reinforcement inside the shape of fibers, appreciably polymeric fibers, as well as steel or glass fibers 1-5. Fiber-reinforcementIs predominantly used for crack manage and not structural strengthening. Although the idea of reinforcing brittle substances with fibers is quite vintage, the current interest in reinforcing cement-based substances with randomly distributed fibers is pretty vintage; the current interest in reinforcing cement based totally materials with randomly allotted fibers is based on research starting in the 1960's. Since then, there have been substantial research and development activities throughout the world. It has been hooked up that the addition of randomly allotted polypropylene fibers to brittle cement based substances can boom their fracture sturdiness, ductility and effect resistance.Since Fibers can be premixed in a conventional manner, the idea of polypropylene fiber concrete has introduced an additional size to concrete production.

## II LITERATURE SURVEY

M.A.Aziz, P.Paramasivam and S.L.Lee 1984

Natural fibers are potential 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 fibers as the reinforcement in concrete has only taken place in comparatively in recent years. The distinctive properties of natural fiber 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 fiber 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 fibers were studied by S.K. Al-Oraimi and A.C.Seibi (1995). Here an experimental study was conducted using glass and palm tree fibers 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 fibers are comparable with glass fibers. 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).

Romildo D. Toledo Filho et.al (2005)

Robert S.P. Coutts (2005) made some experiments on free, restrained and drying shrinkage of cement mortar composites reinforced with vegetable fibers. The free and restrained shrinkage were studied by subjecting the specimens to wind speed of 0.4-0.5 m/s at 40o C temperature for up to 280min. drying shrinkage tests were carried out at room temperature with about 41% relative humidity for 320 days. It was concluded that free plastic shrinkage is significantly reduced by the inclusion of 0.2% volume fraction of 25mm short sisal fibers in cement mortar. Also it was stated that the presence of sisal and coconut fibers promotes an effective self-healing of plastic cracking after 40 days at 100% RH. The drying shrinkage was increased by up to 27% when up to 3% of sisal and coconut fibers were present in that stud. The capability to absorb energy, called toughness is important in actual service conditions. For that an experimental investigation was carried out by Ramakrishna.G and Sundararajan (2005) on impact strength of a few natural fiber reinforced cement mortar slabs. Four types of natural fibers such as coir, sisal, jute and hibiscus cannebinus with four different fiber contents such as 0.5%, 1.0%, 1.5% and 2.0% by weight of cement were used. The tests were carried using repeated projectile test apparatus and the performance of specimens was ascertained based on the parameters namely impact resistance, residual impact ratio, crack resistance ratio and the condition of fiber at ultimate. From this elaborative test results, it was concluded that coir fibers absorb more energy ie., 253.5 J at 2% fiber content and fiber length of 40 mm. Coir fiber reinforced slab specimens exhibit fiber pull out failure, whereas all other types of fiber reinforced specimens exhibit fiber fracture at ultimate failure.
Some studies have been also conducted by Ramakrishna.G and Sundararajan (2005) on the durability of natural fibers and the effect of corroded fibers on the strength of mortar. Coir fibers were found to retain higher percentages of their initial strength than all other fibers after the specified exposure in the various mediums.

Mechanical properties of natural fibers A.Kriker et.al (2005)

Mechanical properties of date palm fibers and concrete reinforced with date palm fibers were tested and reported by A.Kriker et.al (2005) in two different climates. In addition to the above properties, continuity index, microstructure and toughness were also studied. The volume fraction and length of fibers chosen were 2-3% and 15-60mm respectively. It was concluded that male date palm fiber got more tensile strength. Also it was stated that observing micro-structure of the fiber-matrix interface cured in hot-dry and water environments. Based on the results and observations of that work, it was suggested that future research should be developed on the treatment of Male date palm surface fiber concretes to improve their mechanical properties using local industrial wastes, especially hot-dry climate. Microstructure and mechanical properties of waste fiber-cement composites were studied by H. Savastano Jr, P.G.Warden and R.S.P.Coutts (2005). Both secondary and back-scattered electron imaging and energy dispersive X-ray spectrography were used for compositational analysis. It was concluded that sisal waste fibers presented satisfactory bonding in matrices. BSE images and EDS analyses confirmed the fiber-matrix transition zone can be improved by using production process based on vaccum dewatering and pressure.

K.Murali Mohan Rao and K.Mohana Rao (2005)

K.Murali Mohan Rao and K.Mohana Rao (2005) introduced and studied the extraction and tensile properties of new natural fibers used as fillers in a concrete matrix enabling production of economical and light weight composites for load carrying structures. The cross sectional shape, the density and tensile properties of these fibers along with established natural fibers like sisal, banana, coconut and palm were determined experimentally under similar conditions and compared. The density of newly introduced fibers such as vakka, date and bamboo were less than the existing fibers.

## III. PROPERTIES OF MATERIALS

Cement is the binding material which is the most constituent material that is used in the preparation of the concrete. Ordinary Portland Cement of 53 Grade of brand name dalmia cements, available in the local market was used for the investigation. Care has been taken to see that the procurement was made from single batching in air tight containers to prevent it from being effected by atmospheric conditions. The cement that procured was tested for physical requirements in accordance with the Indian Specification IS: 12269-1989 and for chemical requirement in accordance Indian Specification IS: 4031-1988.

**Fig.3.1.Cement**

## IV. EXPERIMENTAL INVESTIGATION

In this chapter it is detailed about the tests conducted on the concrete. Mainly they explain the basic strength properties and the transportation properties. The tests conducted in our investigation are:

1. Strength Properties
Compressive Strength Test
Split Tensile Strength Test
2. Transportation Properties
Evaporation test.
Absorption test.
Moisture migration test.

ompressive Strength Test

Compression test is done confirming to IS: 516-1953. All the concrete specimens that are tested in a 2000KN capacity Compressive-testing machine. Concrete cubes of size 150mm x 150mm x150mm and cylinders of size 100mm dia & 200mm height were tested for crushing strength, crushing strength of concrete was determined by applying load at the rate of 1400 N/cm2/min till the specimens fail. The maximum load applied to the specimens was recorded and divided the failure load with cross-sectional area of the specimens for compressive strength has been calculated.
Compressive Strength of concrete=Load/Area
Compressive strength test was conducted on cubes of 150mmX150mmX150mm cubes for the various mixes M1, M2, M3 M4 M5 and M6 of concrete. The details about the loading and strength of the specimens are given in the table 4.1 and 4.2.

Fig 4.1. Cube Specimen

Fig.4.2.Casted concrete fiber cube

Figure 4.3.Compression Test

## V.RESULTS AND DISCUSSION

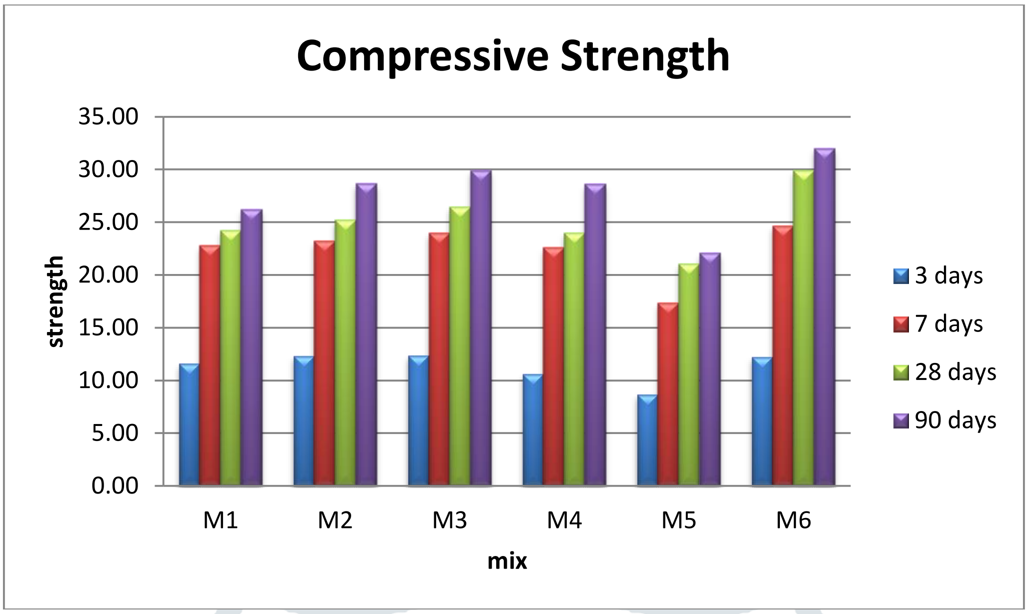
### Compressive Strength

The Overall variations in the compression strength of the different mixes of the fiber is shown below in the table 5.1

| Compressive strength N/mm2 | | | | |
|---|---|---|---|---|
| Mix | 3days | 7 days | 28 days | 90 days |
| M1 | 11.57 | 22.81 | 24.22 | 26.22 |
| M2 | 12.31 | 23.19 | 25.19 | 28.66 |
| M3 | 12.34 | 24.00 | 26.44 | 29.92 |
| M4 | 10.61 | 22.59 | 24.00 | 28.59 |
| M5 | 8.67 | 17.33 | 21.04 | 22.07 |
| M6 | 12.23 | 24.66 | 29.92 | 32 |

Table 5.1 Compressive Strength of different mixes

Graph 5.1 plot the overall variations in the compression strength of the different mixes of the fiber is shown below




Graph 5.1 Compressive Strength of different mixes

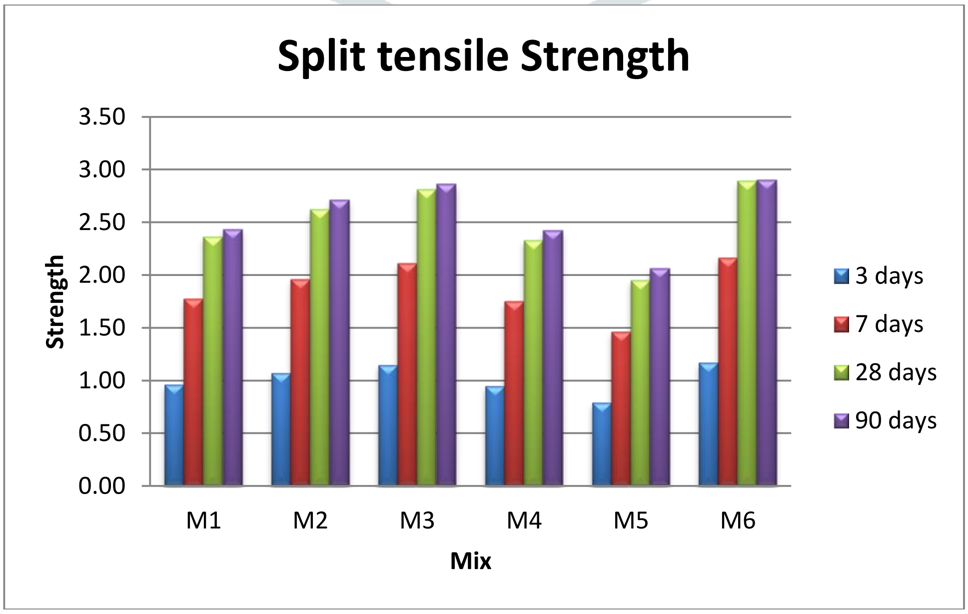
5.1.2 Split Tensile Strength

The Overall variations in the split tensile strength of the different mixes of the fiberis shown below in the table 5.2

| Split Tensile Strength N/mm2 | | | | |
|---|---|---|---|---|
| Mix | 3 days | 7 days | 28 days | 90 days |
| M1 | 0.96 | 1.77 | 2.36 | 2.43 |
| M2 | 1.07 | 1.96 | 2.62 | 2.71 |
| M3 | 1.15 | 2.11 | 2.81 | 2.86 |
| M4 | 0.95 | 1.75 | 2.33 | 2.42 |
| M5 | 0.79 | 1.46 | 1.95 | 2.06 |
| M6 | 1.17 | 2.16 | 2.89 | 2.9 |

Table 5.2 Split Tensile Strength for different mixes

Graph 5.2 plot the overall variations in the split tensile strength of the different mixes of the fiber is shown below




Graph 5.2 Split Tensile Strength of different mixes

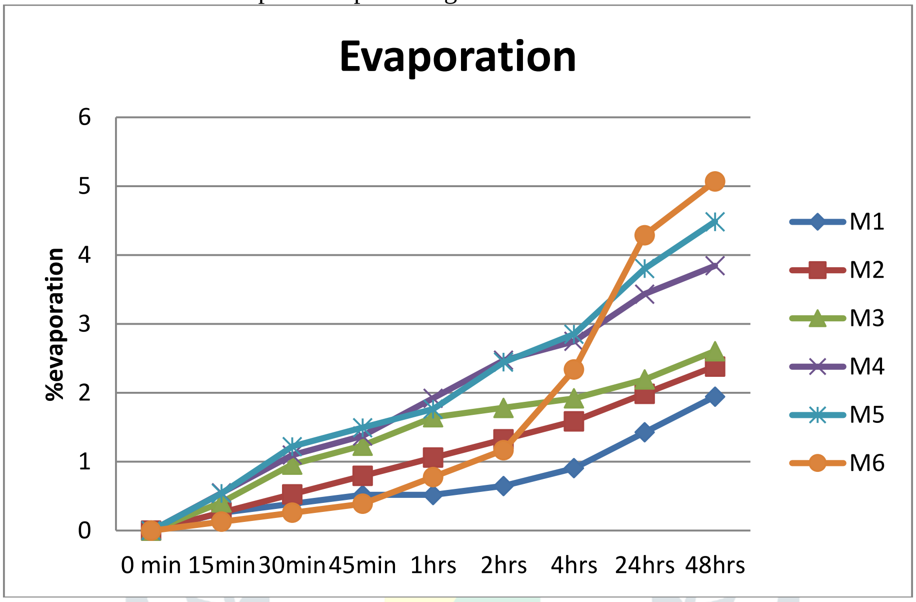
### 5.1.3 Evaporation Test

The overall variations in the Evaporation Percentages of the different mixes of the fiber is shown below in the table 5.3

| 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 |
| M6 | 0 | 0.13 | 0.26 | 0.39 | 0.78 | 1.17 | 2.34 | 4.29 | 5.07 |

Table 5.3 Evaporation percentage in different mixes

Graph 5.3 plot the overall variations in the evaporation percentages of the different mixes of the fiber is shown below




Graph 5.3 Evaporation percentages in different mixes

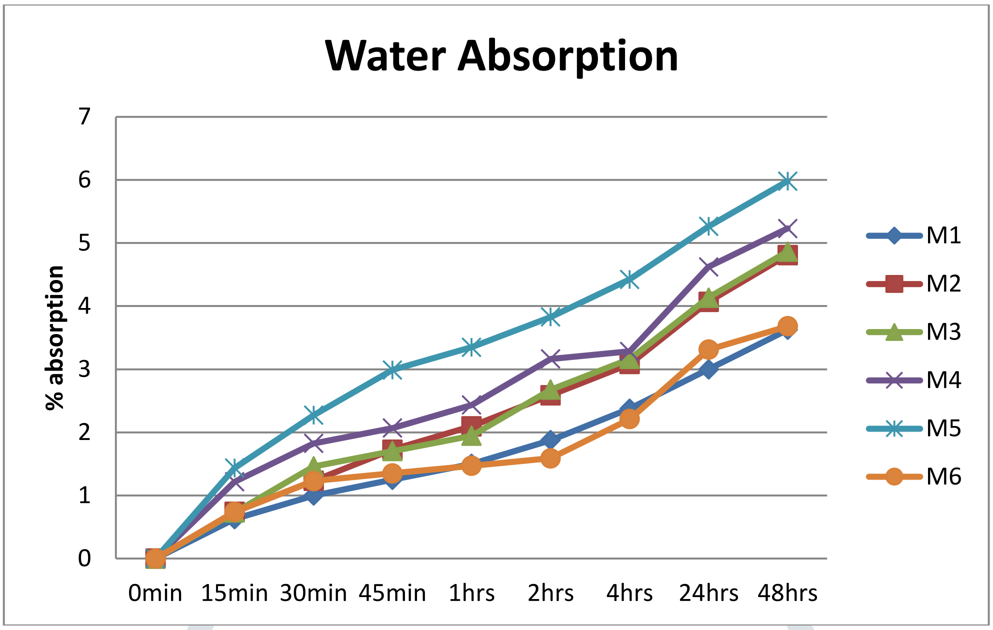
5.1.4 Water Absorption Test

The Overall variations in the Water Absorption percentages of the different mixes of the fiber is shown below in the table 5.4

Table 5.4 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 |
| M6 | 0 | 0.74 | 1.23 | 1.35 | 1.47 | 1.59 | 2.21 | 3.31 | 3.68 |

Graph 5.4 plot the overall variations in the Water Absorption percentages of the different mixes of the fiber is shown below




Graph 5.4 Water Absorption percentages in different mixes

## V. CONCLUSION

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 fiber is added with different percentages The following conclusions are drawn from the investigation One day strength results are not to be estimate for the fiber content as the increase in the fiber percentage the setting time of the concrete is delayed. Freshly prepared Sisal fiber contain some gelatinous chemical reagents which may affect the chemical properties of cement in concrete When the percentage of Sisal fiber is increased by more than 1% reduction in mechanical properties is observed. Reduction in strength is due the increase in the fiber percentage and that may leads to porous structure by the agglomeration of the fiber by more volume. Increase in strength up to 1% and this is noted as the optimum percentage use of the sisal fiber. The addition of the fiber 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 fiber. When it is compared with the artificial fiber also it has shown the similar values for the strength test. Due to the gelatinous material present in the fiber reaction is taking place at the curing stage and that should be controlled by adding some oxidants. Varying in length of the fiber also may vary in the strength so we can make investigation using different lengths also.

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