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Experimental Studies on 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 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 tube 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 economic benefits.

Keywords: Sisal Fibre Reinforced Concrete, Synthetic Fibres, Tension, Ecological, Social, Economic Benefits.

I. 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 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 3.5 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. Shown in figure 1.1

1.3 Scope

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

- 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. METHODS AND MATERIAL

2.1 Cement

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 thus procured was tested for physical requirements in accordance with IS: 12269-1989 and for chemical requirement in accordance IS: 4031-1988. Cement is the most important material in the concrete and it act as the binding material. Its physical and chemical properties shown in table 2.1 & 2.2.

2.2 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.

2.2.1 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. Shown in figure 2.4.Its properties shown in table 2.3

2.2.2 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 compact ability 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. Shown in figure 2.2.Its properties shown in table 2.4

2.3 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. Shown in figure 2.3.Its properties shown in table 25.

2.4 Fibre Extraction

Fibre is extracted by a process known as Decortications, where leaves are crushed and beaten by a rotating wheel set with blunt knives, so that only fibres remain. In India, where production is typically on large estates, the leaves are transported to a central decortications plant, where water is used to wash away the waste parts of the leaf. The fibre is then dried, brushed and baled for export. Superior quality sisal fibre is found in East Africa. Proper drying is important as fibre quality depends largely on moisture content. Artificial drying has been found to result in generally better grades of fibre than sun drying.

2.5 Water

Water acts lubricant for the fine and coarse aggregate and acts chemical with cement to form the binding paste for the aggregate water is used for curing the concrete after it has cast into the forms.

Water used for both mixing and curing should be free from contaminants. Portable water is generally considered satisfactory for mixing and curing of concrete. If water contains any sugar or an excess of acid, alkali it should not be used. Ordinary tap water used in the preparation of concrete.

2.6 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 2307kg/m^3. Quantity of water is taken according to slump of concrete 0.5 for economical purpose. The quantity of cement i.e. 372 kg/m^3 used. Therefore quantity of water should be 186 kg/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 632kg/m^3, coarse aggregates is 1117 kg/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 M_1, M2, M3,M4 and M5respectively.Shown in table 3.8.

2.7 Specimen Details

The specimens like cubes, cylinders and beams that are used to conduct the strength tests are taken according *to IS10086-1982*.

Compression strength = cube moulds of 150mmX150mmX150mm are used.
Split tensile strength = cylindrical moulds of 100dia@200mm height are used.

2.8 Casting of Specimens

After completion of the workability tests, the concrete has been placed in the standard metallic moulds in three layers and has been compacted each time by tamping rod. Before placing the concrete inside faces of the mould are coated with the machine oil for easy removal afterwards. The concrete in the moulds has been finished smoothly. The casted specimens are shown in Figure 2.5.

2.9 Curing Procedure

After casting the cubes and cylinders the specimens the moulds are kept in air curing for one day and the specimen are removed from the moulds after 24 hours of casting of concrete specimens. Markings have been done to identify the different percentages of fibred specimens. Then specimens were kept for normal water curing until testing age.

3.1 Compressive 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/cm^2/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, M3M4 and M5 of concrete. The details about the loading and strength of the specimens are given in the table 3.1 and 3.2. Shown in figure 3.1

3.2 Split Tensile Strength Test

The cylinders were subjected to split tensile tension by replacing them horizontally on the ailoure in the 2000KN CTM. The load is applied uniformly at a constant rate until failure by splitting along the vertical diameter takes place load at which the specimens failed is recorded and the splitting tensile stress is obtained using the formula based on *IS: 5816-1970.*

$$F_t = 2P/\pi DL$$

Where P = Compressive load on the cylinder
L = Length of the cylinder D = Diameter of the cylinder
Split tensile strength has done for the mixes M1, M2, M3, M4 and M5 of concrete for 1 day, 7 days and 28 days. The test has conducted on the cylinder of 100mmX200mm. The details about the loading and strength of the specimens are given in the table 3.3 and 3.4. Shown in figure 3.2.

3.3 Evaporation test

Evaporation test has done on the cubes of 150mmx150mmx150mm for the mixes of recycled fine aggregate concrete. It has done after curing of 28 days. After curing of 28 days cube specimens were allowed to normal temperature to normal dry, after normal drying cube specimens were kept in oven at the temperature of 95^{0}C cube specimens were taken from the oven at ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours, 72hours. The values of weight changes and percentages of evaporation at the ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours, and 72hours are given below in Table 3.5 and Table 3.6.Shown in figure 3.5.

3.4 Water Absorption test

Water Absorption test has done on the cubes of 150mmx150mmx150mm for the mixes of concreteM1, M2, M3 M4 and M5. It has done after 72 hours evaporation cube specimen. After 72hours evaporation cube specimens were allowed to normal temperature, cube specimens were kept in curing tank and the weight of the specimen are taken at the ages of 15mins ,30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours, 72hours and percentage absorption is calculated. The values of weight changes and percentages of absorption at the ages of 15mins, 30mins, 1 hour, 2hours, 3hours, 4hours, 24hours, 48hours and 72hours are given in Table 4.7 and Table 4.8.Shown in figure 3.4.

3.5 Moisture migration test

Moisture migration test has done on the cubes of 150mmx150mmx150mm for the mixes of concreteM1, M2, M3 M4 and M5. It has done after 72 hours evaporation, cube specimens were allowed dry to normal temperature. Cube specimens were kept on the layer of water for the absorption of moisture, cube specimens were taken from the moisture migration test at the ages of 15mins, 30mins, 1hour, 2hours, 3hours, 4hours, 24hours, 48hours and 72hours. The values of moisture migration in mm are noted and the percentages of moisture migration at the ages of 15mins, 30mins, 1 hour, 2hours, 3hours, 4hours, 24hours, 48hours and 72hours are calculated. The values are given below in Table 3.9, Table 2.10 and Table 2.11.Shown in figure 2.3.

Figures and Tables

Figure 1.1 Sisal Fibres

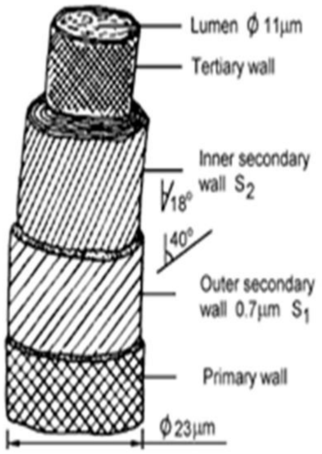


Figure 2.1 Schematic sketch of a sisal fibre

Figure 3.1 Cement

Figure 3.2 Fine Aggregate

Figure 3.3 Sisal Fibre

Figure 3.4 Coarse Aggregate

Figure 3.5 Cube Moulds

Figure 3.6 Specimen

Figure 3.7 Curing

Figure 3.1 Compreesion Test

Figure 3.2 Split Tensile Test

Figure 3.3 Moisture Migration Test

Figure 3.4 Absorption Test

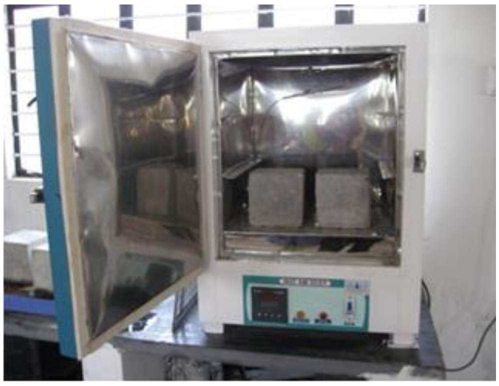


Figure 3.5 Evaporation Test

III. RESULTS AND DISCUSSION

5.1 Compressive Strength

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 mx percentage is upto 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 22.81mpa 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 upto 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.
- We can observe that the strength in the concrete has been increased by the addition of the fibre.
- 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. Compressive strength load details shown in table 4.1.Compressive strength details shown in table 4.2.

5.2 Split Tensile Strength

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 agglamiration 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 naterial for the steel provided in the reinforced cement concrete. Split tensile strength load details &strength details shown in figure 4.3 &4.4

5.3 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.

Discussion between the evaporation occurred between the mix proportions of the slag.

- The results that show in the table are made for all the mix proportions to make the variation that evaporation may vary by adding fibre to concrete.
- 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.
- So we can state that fibre has the property of the absorption
- That absorption of the water by the fibre should be calculated and the amount of the water percentage that is required should be added to it. Shown in table 4.5& 4.6

5.4 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 for this test is 150mm*150mm*150mm of size.

This test is conducted to find the property of water absorption in concrete may be affected by the materials that we have used in the concrete. As the fiber is the natural material and that will be changing the property according to the climatic conditions and move over it has the property of water absorption. We have made an test to check whether the property of the concrete is affected by adding fibre to the concrete.

Discussion between the water absorption occurred between the mix proportions of the slag:

- The results that show in the table are made for all the mix proportions to make the variation that absorption may vary by adding fibre.
- We can observe that in the early stages of the cube placed in the water tub the absorption is more from the specimens because they are oven dried before they are put for the absorption test.
- So in the first 1 hour we can notice that large amounts of water absorption taken 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.
- As the fibre is having the absorption property the water is added in excess to the concrete.
- So we can state that fibre do not affect the concrete property. Shown in table 4.7 &4.8

5.5 Moisture Migration Test

Moisture migration is made in accordance with the water absorption in the absorption test the specimen is immersed totally into the water where in this the bottom surface is touched to the water and then water is made to migrate to the top direction of the surfaces.

When the materials are closely packed and have the property of absorption the moisture migration will be occurred more. In some of the researches that are made the materials that are added as replacement of the ingredients or additional strength inducing elements will make more variations in the transport properties.

Discussion between the moisture migrations occurred between the mix proportions of the slag:

- The graph represent the different variations occurred in the different mix proportions.
- 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.
- So it will not cause any harm to the durability conditions of the concrete if the fibre is soaked in water and the addition of the water percentage is given to it by knowing the percentage absorption. Shown in table 4.9,4.10 and 4.11

Table 2.1: 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

Table 2.2: Chemical Properties of Cement

S.no	Particulars	Test results	Specification as per IS:12269:1987
1	LSF(Lime Saturation factor)	0.89	0.8-1.02
2	Alumina Modulus	0.83	Min 0.66
3	Insoluble residue (%)	1.48	Max 3.0
4	Magnesia (%)	1.46	Max 6.0
5	Sulphuric Anhydride (%)	2.06	Max 3.0
6	Loss on Ignition (%)	1.58	Max 4.0
7	Chloride Content (%)	0.009	Max 0.1

Table 2.3: 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

Table 2.4: 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

Table 2.5: 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

Table 2.6 : Sieve analysis of coarse aggregates
Weight of sample taken = 5000 gm

S.no	I.S.Sieve designation	Weight of sample retained	Cumulative weight retained	Cumulative %age retained	%age passed.
1	80mm	0	0	0	100
2	40mm	0	0	0	100
3	20mm	980	980	19.6	80.4
4	10mm	2972	3952	79.04	25.96
5	4.75mm	1048	5000	100	0
6	2.36mm	-	-	100	0
7	1.18mm	-	-	100	0
8	0.6mm	-	-	100	0
9	0.3mm	-	-	100	0
10	0.15mm	-	-	100	0
11	pan	-	-	100	0
Total			798.6		

Fineness modulus = Sum of cumulative percentage retained on standard sieves /100

= 798.6/100

The fineness modulus of coarse mixture is 7.98

Table 2.7: Sieve analysis of fine aggregates Weight of sample taken = 500 gm

S.no	I.S.Sieve designation	Weight of sample retained	Cumulative weight retained	Cumulative %age retained	%age passed.
1	80mm	0	0	0	100
2	40mm	0	0	0	100
3	20mm	0	0	0	100
4	10mm	0	0	0	100
5	4.75mm	0	0	0	100
6	2.36mm	2.8	2.8	0.56	99.44
7	1.18mm	52.15	54.95	10.99	89.01
8	0.6mm	159.1	214.05	42.81	57.19
9	0.3mm	227.95	442	88.4	11.6
10	0.15mm	48.5	490.5	98.1	1.9
11	pan	9.5	500	100	0
Total			340.86		

Fineness modulus = Sum of cumulative weight retained on standard sieves /100

= 340.86/100

The fineness modulus of fine mixture is 3.40

Table 2.8 : Mix Proportions

Mix	Cement	Coarse Aggregate	Fine Aggregate	Sisal Fibre	W/C
M1	372	1117	632	0	0.42
M2	372	1117	632	1.75	0.42
M3	372	1117	632	3.50	0.42
M4	372	1117	632	5.25	0.42
M5	372	1117	632	7.00	0.42

Table 3.1: Compressive strength load details

Compressive Load details of specimen of various mixes in KN							
Mix	cubes	3days		7days		28days	
		Load	Avg	Load	Avg	load	avg
M1	1	260	260.33	500	513.33	525	545
	2	255		515		565	
	3	266		525		545	
M2	1	287	277	510	521.67	600	566.67
	2	272		520		600	
	3	272		535		500	
M3	1	267	277.67	550	540	610	595
	2	264		545		625	
	3	302		525		550	
M4	1	267	238.67	500	508.33	525	540
	2	199		515		550	
	3	250		510		545	
M5	1	200	195	400	390	495	473.33
	2	170		340		450	
	3	215		430		475	

Table 3.2: Compressive strength details

Compressive Strength Details of specimens in KN/mm^2							
Mix	cubes	3days		7days		28days	
		Load	Avg	Load	Avg	load	avg
M1	1	11.56	11.57	22.22	22.81	23.33	24.22
	2	11.33		22.89		25.11	
	3	11.82		23.33		24.22	
M2	1	12.76	12.31	22.67	23.19	26.67	25.19
	2	12.09		23.11		26.67	
	3	12.09		23.78		22.22	
M3	1	11.87	12.34	24.44	24.00	27.11	26.44
	2	11.73		24.22		27.78	
	3	13.42		23.33		24.44	
M4	1	11.87	10.61	22.22	22.59	23.33	24.00
	2	8.84		22.89		24.44	
	3	11.11		22.67		24.22	
M5	1	8.89	8.67	17.78	17.33	22.00	21.04
	2	7.56		15.11		20.00	
	3	9.56		19.11		21.11	

Table 3.3 : Split Tensile Load details

Split Tensile Load details of specimen of various mixes in KN							
Mix	cubes	3days		7days		28days	
		Load	Avg	Load	Avg	load	avg
M1	1	29	30.29	54	55.67	72	74.22
	2	31		57		76	
	3	30		56		75	
M2	1	34	33.56	63	61.67	83	82.22
	2	30		55		73	
	3	37		68		90	
M3	1	35	36.01	65	66.17	87	88.22
	2	37		68		90	
	3	36		66		88	
M4	1	31	29.93	58	55.00	77	73.33
	2	30		55		73	
	3	29		53		70	
M5	1	26	24.94	48	45.83	63	61.11
	2	24		45		60	
	3	24		45		60	

Table 3.4 : Split Tensile Strength details

Split Tensile Strength Details of Specimens in KN/mm^2							
Mix	cubes	3days		7days		28days	
		Load	Avg	Load	Avg	load	avg
M1	1	0.94	0.96	1.72	1.77	2.29	2.36
	2	0.99		1.81		2.42	
	3	0.97		1.78		2.38	
M2	1	1.08	1.07	1.99	1.96	2.65	2.62
	2	0.95		1.75		2.33	
	3	1.17		2.15		2.86	
M3	1	1.13	1.15	2.07	2.11	2.76	2.81
	2	1.17		2.15		2.86	
	3	1.14		2.10		2.80	
M4	1	1.00	0.95	1.83	1.75	2.44	2.33
	2	0.95		1.75		2.33	
	3	0.91		1.67		2.23	
M5	1	0.82	0.79	1.51	1.46	2.02	1.95
	2	0.78		1.43		1.91	
	3	0.78		1.43		1.91	

Table 3.5: Evaporation percentage in different mixes

Evaporation in %									
MIX	0min	15 min	30 min	45min	1hr	2hrs	4hrs	24hr	48hr
M1	0	0.25	0.38	0.50	0.50	0.63	0.89	1.39	1.90
M2	0	0.25	0.51	0.77	1.03	1.29	1.55	1.94	2.32
M3	0	0.40	0.93	1.20	1.60	1.73	1.87	2.13	2.60
M4	0	0.50	1.05	1.32	1.85	2.38	2.64	3.30	3.70
M5	0	0.52	1.17	1.43	1.69	2.34	2.73	3.64	4.29

Graph 3.1: Sieve Analysis for Coarse Aggregate

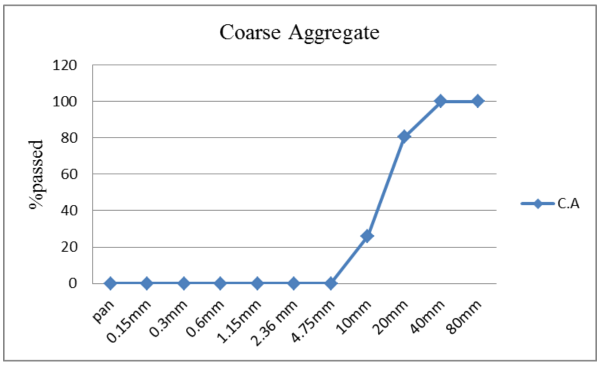


Table 3.6 : Water Absorption percentage in different mixes

Water Absorption in %									
MIX	0 min	15 min	30 min	45 min	1hr	2hrs	4hrs	24hrs	48hrs
M1	0	0.64	1.03	1.29	1.55	1.94	2.46	3.11	3.76
M2	0	0.77	1.29	1.81	2.20	2.72	3.23	4.27	5.05
M3	0	0.76	1.53	1.79	2.04	2.81	3.32	4.34	5.11
M4	0	1.28	1.92	2.18	2.56	3.33	3.46	4.87	5.51
M5	0	1.52	2.41	3.18	3.56	4.07	4.70	5.57	6.36

Table 3.7: Moisture Migration percentage in different mixes

Moisture Migration in %									
MIX	0 min	15 min	30 min	45 min	1hr	2hrs	4hrs	24hrs	48hrs
M1	0	0.24	0.49	0.62	0.74	0.87	1.12	1.49	1.86
M2	0	0.25	0.38	0.51	0.64	0.90	1.15	1.67	3.60
M3	0	0.25	0.64	0.77	0.90	1.29	1.55	2.97	4.26
M4	0	0.40	0.40	0.67	0.81	1.80	1.62	3.24	4.32
M5	0	0.38	0.63	0.89	1.90	2.29	2.79	3.81	4.45

Graph 3.2: Sieve Analysis for Fine Aggregate

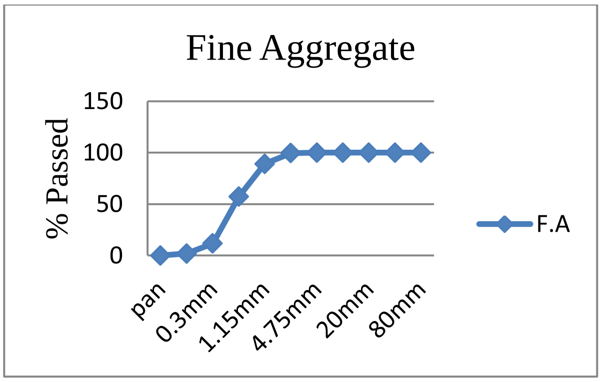


Table 3.8 Compressive Strength of different mixes

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 4.1 Compressive Strength of different mixes

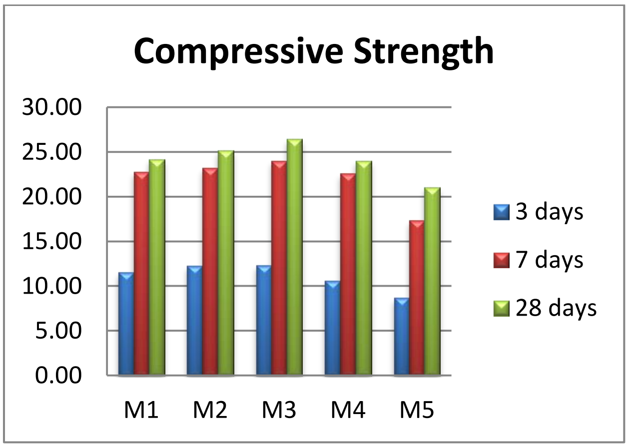
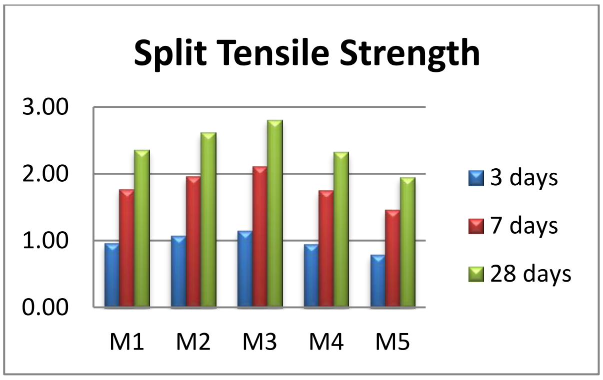


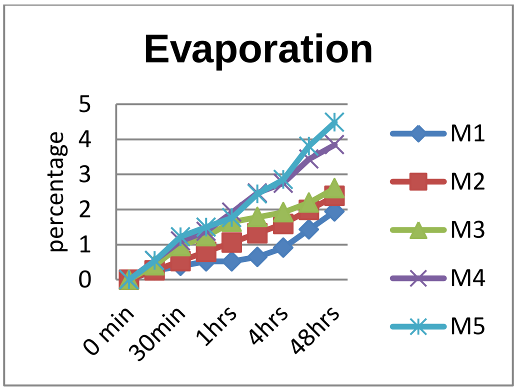
Table 3.9 Split Tensile Strength for different mixes

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

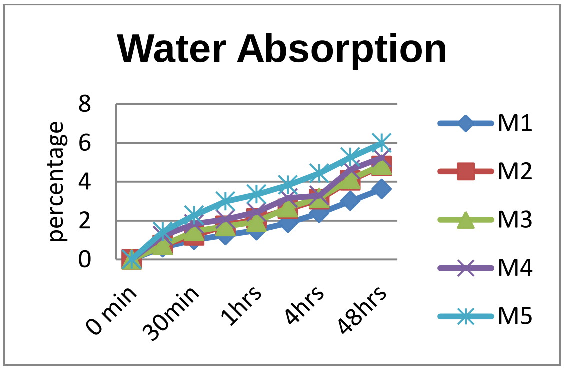
Graph 4.2 Split Tensile Strength of different mixes



Graph 4.3 : Evaporation percentage in different mixes



Graph 4.4 Water Absorption percentages in different mixes



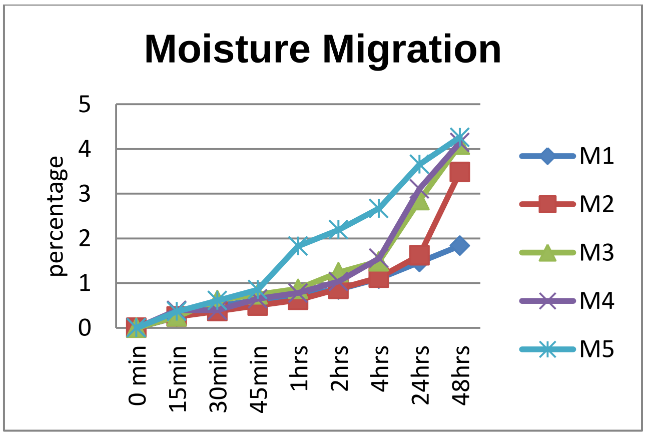
Water Absorption Test is conducted to find out the transport property of the concrete and this is not tested on the shorter periods of time from the casting. In this investigation we had observed the absorption property of the specimens after the cubes are cured for the period of 28 days after they have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

This test is conducted to find the property of water absorption in concrete may be affected by the materials that we have used in the concrete. As the fiber is the natural material and that will be changing the property according to the climatic conditions and move over it has the property of water absorption. We have made an test to check whether the property of the concrete is affected by adding fibre to the concrete.

Discussion between the water absorption occurred between the mix proportions of the slag:

- The results that show in the table are made for all the mix proportions to make the variation that absorption may vary by adding fibre.
- We can observe that in the early stages of the cube placed in the water tub the absorption is more from the specimens because they are oven dried before they are put for the absorption test.
- So in the first 1 hour we can notice that large amounts of water absorption taken 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.
- As the fibre is having the absorption property the water is added in excess to the concrete.
- So we can state that fibre do not affect the concrete property.

Graph 4.6 Moisture Migration percentages in different mixes



IV. 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 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 agglomerations.
- 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 fibers not only increases tensile strength but also increases bond strength, decreases permeability.
- Toughness of concrete also increases by the addition of the fibre

V. REFERENCES

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