STRENGTH AND ANALYSIS OF SISAL FIBRE IN CONCRETE

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Abstract — This thesis focus on — "STRENGTH AND ANALYSIS OF SISAL FIBRE", works were carried out on experimental investigation of Sisal fibre concrete. Properties of concrete were checked by testing cubes and cylinders. The examples were thrown utilizing M25 Grade concrete with locally accessible materials. The object of the current work is to consider the the effect of different proportions of sisal fibres in the concrete and find out optimum percentage of fibres with maximum strength criteria. The cubes and cylinders were cast to test the compression strength and split tensile strength. The concrete specimens with various extents (0.5%, 1%, and 1.5%) of sisal strands were used. In view of the Literature study, it was discovered that the sisal fiber concrete have preferred durability and effect qualities over the concrete. It was likewise discovered that the addition of sisal fiber in Concrete changes the method of failure from brittle mode of failure to ductile mode of failure when subjected to compression, bending and impact. Due to its high tensile property it improves rigidity of concrete when blended in ideal fiber proportion and has demonstrated satisfactory upgrade in flexural behavior such as Load-deflection, Moment-curvature and crack pattern.The experimental results of sisal fibre concrete is compared with basalt fibre concrete results.

Key words **- Sisal fibre concrete (SFC), Compressive strength, Flexural strength, Split tensile strength, Sisal fibres, M-sand**

1. INTRODUCTION

Development is a significant part of advancement plan of creating nations including India. To satisfy the enormous need for infrastructure development, maintenance and life enhancement of structures are very important. Concrete is the most broadly utilized man-made development material. Plain concrete has an exceptionally low rigidity, constrained malleability and little resistance against cracking. Conventional concrete doesn't meet numerous useful prerequisites, for example, impermeability, protection from frost sufficiently. The nearness of smaller cracks at the mortar–total interface is liable for the innate weakness of plain concrete. On account of the poor tensile strength, crack proliferates with the utilization of load prompting brittle fracture of concrete. Micro cracks are formed in concrete during solidifying stage. Catastrophic events like quakes, typhoons, tidal wave, and so forth crush the tall structures, spans, grand structures, world miracles, and so forth. One such advancement has been two stage composite materials for example fiber strengthened cement, in which cement based matrix, is reinforced with fibre.

II. OBJECTIVE OF THE STUDY

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 the mix.

3. To determine the strength of cubes and cylinders at 7 and 28 days and comparing with conventional concrete.

4. To determine the percentage variation in strength in cubes and cylinders at 7days and 28 days.

5. Comparison of mechanical properties results of sisal fibre concrete with respect to Basalt fibre concrete.

III. SISAL FIBRE

Fig:1 Sisal Fibre

Sisal fiber is one of the most broadly utilized normal fibre and is effortlessly developed .Sisal is a hard fiber extricated from the leaves of the sisal plant (Agave sisalana). Sisal is completely biodegradable and exceptionally sustainable asset of vitality. The material is picked to improve the different quality properties of the structure to get supportability and better quality structure. There are three kinds of strands in sisal, curve filaments, directing filaments and basic filaments. Out of which basic strands are for the most part embraced in light of its strength as they don't part during extraction process. Out of which auxiliary strands are for the most part received due to durability as they don't split during extraction process. They are very well safe against heat. In creating nations, sisal filaments are utilized as support in houses. Sisal fiber of breadth 0.6mm and length 4.5cm is used in this experiment.

Chemical Composition of sisal fibre

- Cellulose - 65%
- Hemi cellulose - 12%
- Lignin - 9.9%

Properties of sisal fibre:

- Sisal fiber is exceptionally durable with a low maintenance with minimal wear and tear.
- It is recyclable.
- Sisal fibers are Anti static, does not attract or trap dust particles and do not absorb moisture or water easily.
- It exhibits a good sound and impact absorbing properties.
- It is available as plaid, herringbone and twill.

Applications of Sisal fibre:

- It is also used as cement reinforcement.
- In developing countries, sisal fibres are used as reinforcement in houses.
- Sisal is also used in housing schemes. Sisal house is panelised system for building emergency shelters.
- Sisal-based bricks, roofing tiles, insulation material and fibreboard.

IV. MIX PROPORTION

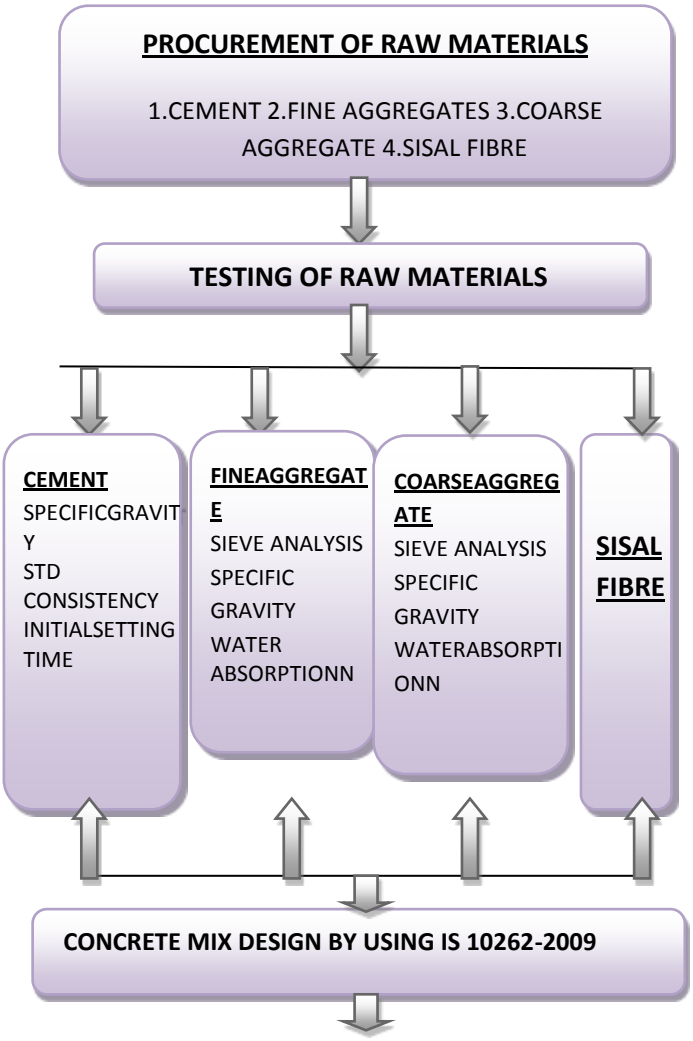
The mixture proportioning was done according to the Indian Standard Recommendation method IS 10262-2009. The ordinary Portland cement (opc) of Grade 53 is used. Cement, fine aggregate, coarse aggregate & sisal fibre were properly mixed together in accordance with IS code in the ratio 1:1.93:1.67 by weight before water was 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. Basalt fibres with different percentages 0.5%,1.0%,1.5% are being replaced for the total volume of concrete. Cubes & cylinders were used for casting; compaction of concrete in

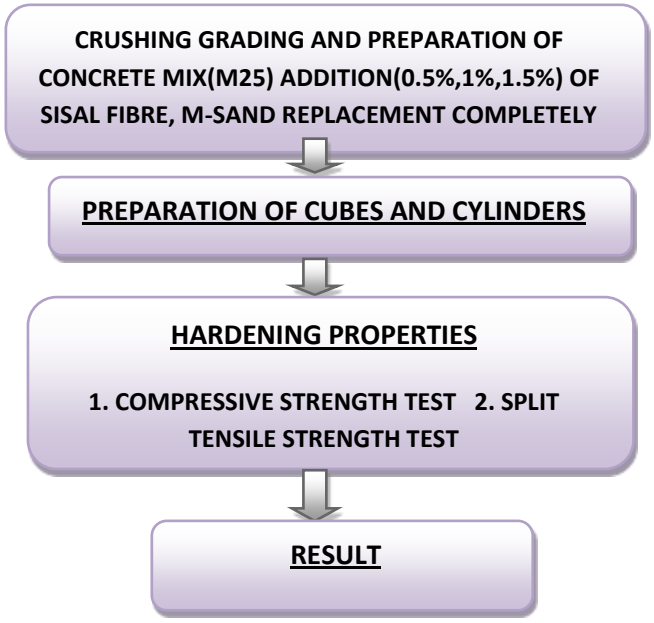
three layers with 25 strokes of 16mm rod was carried out for each layer. The concrete was left in the mould and allowed to set for 24 hours before the moulds were de-moulded and then they were placed in the curing tank until the day of testing (7&28 days). The mix proportion obtained is as shown below.

Table1: Mix proportion

Concrete Type	Notation Used	Ratio	W/C
Conventional concrete	C1	1:1.93:1.67	0.477
0.5%SF+M-sand	C2	1:2.39:2.08	0.55
1.0%SF+M-sand	C3	1:2.39:2.08	0.55
1.5%SF+M-sand	C4	1:2.39:2.08	0.55

V. METHODOLOGY





VI. PROPERTIES OF USED MATERIALS

- Sisal fibre of breadth 0.6 and length4.5 cm.
- Cement: Ordinary Portland cement of 53 grade having specific gravity of 3.14
- Fine aggregate: M sand conforming to IS-383, Zone-II having specific gravity 2.67
- Coarse aggregate: Crushed granite angular aggregate of size 20mm confirming to IS-383 having specific gravity 2.63.
- Water: Ordinary potable water conforming to IS 456.

VI. STRENGTH PROPERTIES

GENERAL

The programwas 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. Casting was made in M_{25}Grade and thespecimens were made to cure for 28 days in potable water.

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

VII. COMPRESSION STRENGTH TEST

The Compressive strength is the capacity of a material or structure to withstand compressive load without failure. It can be measured by plotting applied force against deformation noted from the universal testing machine. A few materials break at their compressive quality cutoff, others disfigure irreversibly, so a given measure of distortion might be considered as the cutoff for compressive burden. Compressive quality is the key an incentive for plan of solid structures.

Fig 2 Compressive strength test set up

Compressive strength of the concrete is gotten by testing cubes of size 150mmx150mmx150mm at 7 and 28th day. The cubes intended for M25 grade were thrown and relieved for 28 days. Following 28 days of nonstop restoring the examples were taken out and they were presented to climate for barely any hours. Surface water and coarseness will be cleared off and any anticipating blades are evacuated. On account of 3D squares, the example is set in the machine in such a way, that the heap is applied to inverse sides of the shapes. The pivot of the example is deliberately lined up with the focal point of push of the roundly situated plate. No bundling is utilized between the essences of the test example; The mobile segment is pivoted is turned tenderly by hand with the goal that uniform seating might be acquired. The heap is applied without stun and expanded ceaselessly until the opposition of the example to the expanding load separates and no more prominent burden can be continued. The compressive test on solidified control and Sisal concrete were performed on a 2000kN limit pressure driven testing machine in understanding to the pertinent Indian models. A run of the mill arrangement is appeared in fig 2. Three concrete cubes were tried for each compressive quality test.

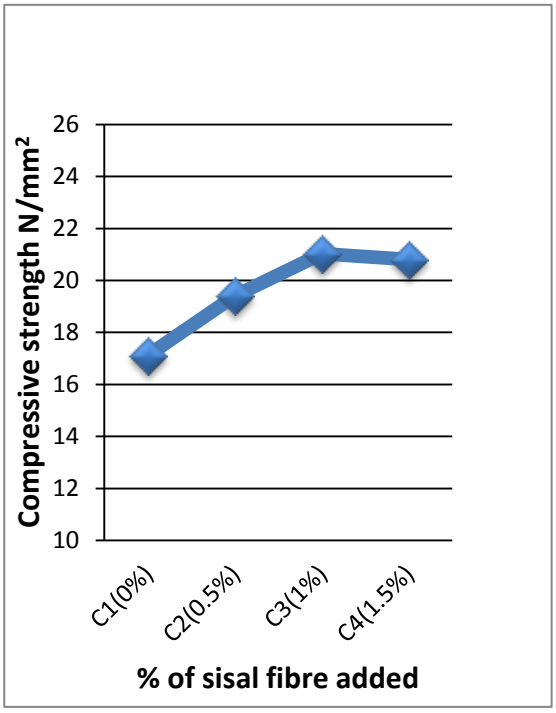
$$\text{Compressive strength} = \frac{\text{Ultimate load}}{\text{Area of specimen}}$$

Table2: Compressive strength result

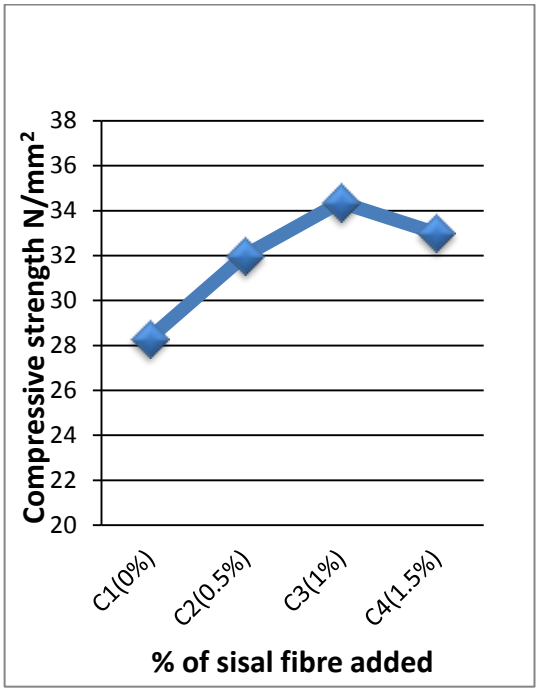
Sl. No	Type of specimen	Ultimate load in KN	Average Load in KN	Compressive strength at 7 days
1	Conventional C1	335	385	17.11
		430		
		390		
2	0.5%SF+M-Sand C2	395	437.66	19.40
		425		
		490		
3	1.0% SF+M-Sand C3	495	473	21.03
		420		
		505		
4	1.5%SF+M-Sand C4	460	469.33	20.81
		440		
		505		

Sl. No	Type of specimen	Ultimate load in KN	Average Load in KN	Compressive strength at 28 days
1	Conventional C1	598	637.66	28.3
		705		
		610		
2	0.5%SF+M-Sand C2	735	720	32
		650		
		775		
3	1.0% SF+M-Sand C3	815	773.3	34.37
		775		
		730		
4	1.5%SF+M-Sand C4	790	742.66	33
		722		
		716		

GRAPH SHOWING COMPRESSIVE STRENTH OF CUBES FOR VARIOUS PERCENTAGE OF SISAL FIBRE @ 7 & 28 DAYS



Graph 1: Compressive strength value @ 7 day



Graph 2: Compressive strength value @ 28 day

Percentage increase or decrease of strength w.r.t Conventional Concrete and Admixture Concrete is given below:

Table:**3** Percentage increase or decrease of strength in Cubes @ 7days

Concrete Type	Strength N/mm²	%Increase/Decrease w.r.t C1 (%)
Conventional concrete	17.11	--
0.5%SF+M-sand	19.4	13.38 increase
1.0%SF+M-sand	21.03	22.91 increase
1.5%SF+M-sand	20.81	21.62 increase

Table:4 Percentage increase or decrease of strength in cubes @28 days

Concrete Type	Strength N/mm²	%Increase/ Decrease w.r.t C1 (%)
Conventional concrete	28.3	---
0.5%SF+M-sand	32	13.07 increase
1.0%SF+M-sand	34.37	21.44 increase
1.5%SF+M-sand	33	16.6 increase

Fig.3 Split Tensile Test Setup

Table5: Split tensile test of concrete cylinder @ 7 days

Sl. No	Type of specimen	Ultimate load in KN	Average Load in KN	Split Tensile strength N/mm² at 7 days
1	Conventional C1	175	198	1.7
		190		
		160		
2	0.5%SF+M-Sand C2	285	245	2.2
		220		
		257		
3	1.0% SF+M-Sand C3	321	333	2.8
		342		
		335		
4	1.5%SF+M-Sand C4	406	388	3.5
		382		
		376		

VIII. SPLIT TENSILE OF CONCRETE

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

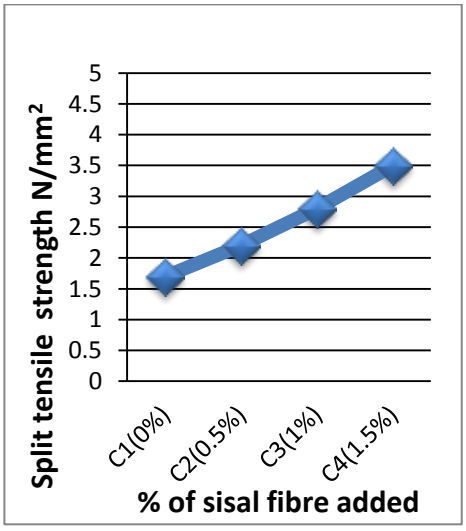
FORMULA:

Split tensile Strength = 2P/(3.142*D*L)s

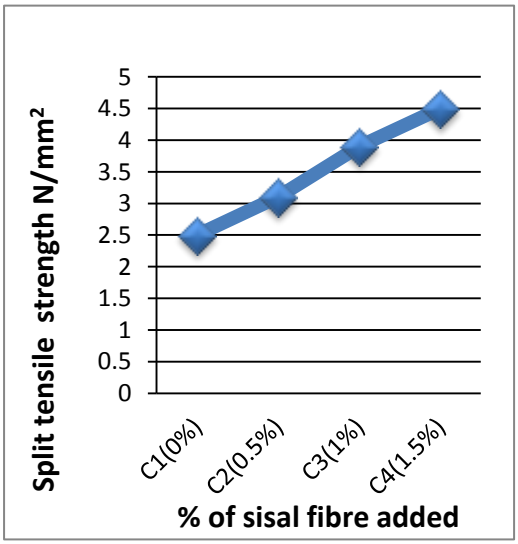
Table6: Split tensile test of concrete cylinder @ 28 days

Sl. No	Type of specimen	Ultimate load in KN	Average Load in KN	Split Tensile strength N/mm² at 28 days
1	Conventional C1	236	258	2.5
		276		
		262		
2	0.5%SF+M-Sand C2	286	289	3.1
		311		
		272		
3	1.0% SF+M-Sand C3	382	367	3.9
		298		
		422		
4	1.5%SF+M-Sand C4	428	417	4.5
		462		
		361		

GRAPH SHOWING SPLIT TENSILESTRENGTH OF CYLINDERS FOR VARIOUS PERCENTAGE OF SISAL FIBRE @ 7 & 28 DAYS



Graph.3 Split Tensile Strength @ 7 days



Graph.4: Split Tensile strength @ 28 days

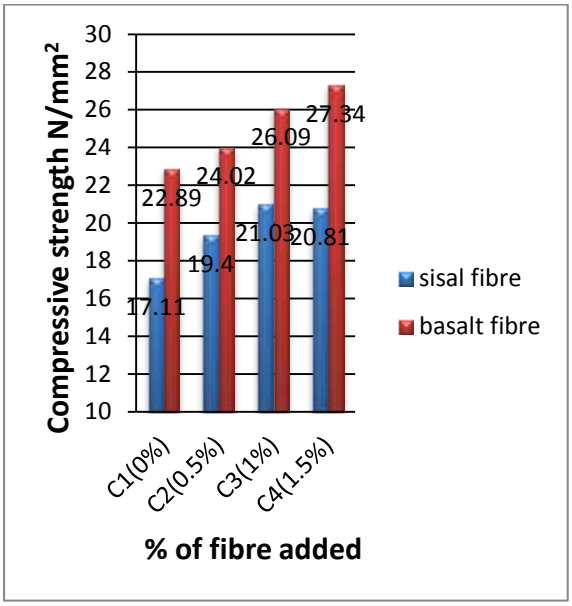
Percentage increase or decrease of strength w.r.t Conventional Concrete and Admixture Concrete is given below:

Table7: Percentage increase or decrease of strength in Cylinder @ 7days

Concrete Type	Strength N/mm²	%Increase/Decrease w.r.t C1 (%)
Conventional concrete	1.7	---
0.5%SF+M-sand	2.2	29.4 increase
1.0%SF+M-sand	2.8	64.7 increase
1.5%SF+M-sand	3.5	105.8 increase

Table8: Percentage increase or decrease of strength in Cylinder @ 28days

Concrete Type	Strength N/mm²	%Increase/Decrease w.r.t C1 (%)
Conventional concrete	2.5	--
0.5%SF+M-sand	3.1	24 Increase
1.0%SF+M-sand	3.9	56 increase
1.5%SF+M-sand	4.5	80 increase

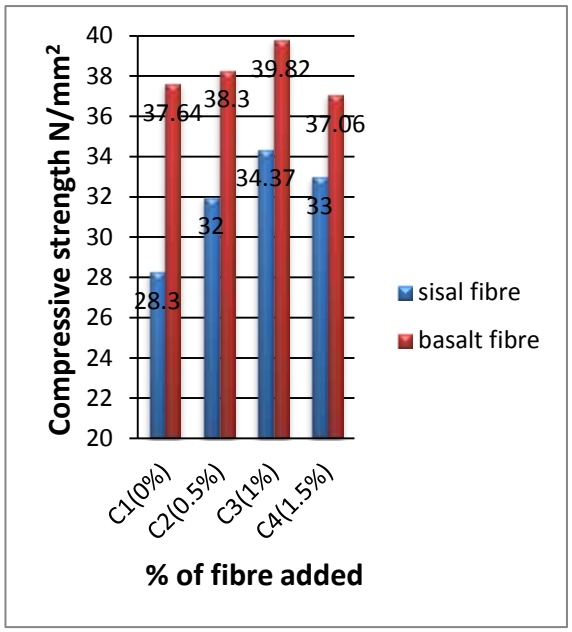


Graph: 5 Comparison between compressive strength of sisal fibre &basalt fibre concrete @ 7 Days

COMPARISION BETWEEN SISALFIBRE REINFORECED CONCRETE AND BASALT FIBRE REINFORECED CONCRETE

Table 9. Comparison b/w sisal and basalt fibre concrete

Type of Fibre used	Percentage (%) of fibre added	Compressive Strength in N/mm²	
		7 days	28 days
Sisal	0	17.11	28.3
	0.5	19.4	32
	1	21.03	34.37
	1.5	20.81	33
Basalt	0	22.89	37.64
	0.5	24.02	38.3
	1	26.09	39.82
	1.5	27.34	37.06



Graph: 6 Comparison between compressive strength of sisal fibre &basalt fibre concrete @ 28 Days

IX. CONCLUSION

1].Compressive strength of addition 0.5% of Sisal fibre + M- sand concrete (C2) increases when compared with the conventional concrete (C1) by 13.38% at 7 days & 13.07% at 28 days respectively. (From table 3 & table 4)

2].When compared to Compressive strength of C1, addition 1.0% of Sisal fibre + M- sand concrete (C3) increases by 22.91% and 21.44% at 7 days and 28 days respectively. (From table 3 & table 4)

3].When compared to Compressive strength of C1, addition 1.5% of Sisal fibre + M- sand concrete (C4) increases by 21.62% at 7 days and increases by 16.60% at 28 days respectively. (From table 3 & table 4)

4.]Split tensile strength of addition 0.5% of Sisal fibre + M- sand concrete (C2) increases when compared with the conventional concrete (C1) by 29.41% at 7 days & 24% at 28 days respectively. (From table 7 & table 8)

5].When compared to split tensile strength of C1, addition 1.0% of Sisal fibre + M- sand concrete (C3) increases by 64.7% at 7 days and 56% at 28 days respectively. (From table 7 & table 8)

6.] When compared to split tensile strength of C1, addition 1.5% of Sisal fibre + M- sand concrete (C4) increases by 105.8% at 7 days and 80% 28 days respectively. (From table 7 & table 8)

6].The study has been concluded that the compressive strength and split tensile strength results shows that the strength of 0.5% sisal fibre reinforced concrete has increased gradually with respect to conventional concrete.

7] Hence it is recommended that sisal fibre reinforced concrete gives better result compared to conventional concrete.

8].Based on the above mentioned tests it is concluded that Sisal fibers of great interest for the building industry. The benefit of using fiber is that it is non-corrosive. The strength is very good. The heat resistance power is very good which is extremely important for every building.

9].The compressive strength and Split tensile strength of Sisal fibre concrete is lesser than Basalt Fibre concrete and it shows that Basalt fibre is much better than sisal fibre.

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