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Study on the Strength of Sisal Fiber Reinforced Concrete

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ABSTRACT: Sisal Fiber is one of the agricultural by-products from sisal fiber industry. If it is not treated properly, it may become solid waste in landfills. However, sisal fiber is high in tension and low in density, hence many researches were conducted by scientists and engineers regarding the application of this fiber on the concrete structure material. Natural fiber is 100% bio-degradable and recyclable, thereby eliminating pollution biodiversity and conservation of natural resources and thus environmentally friendly.

Various percentages of sisal fiber were used to conduct a study on the strength of concrete. The length of the fiber used were 5cm for each percentage of fiber. The percentages of fiber was 0%, 0.5%, 1% , 1.5% and 2% by the weight of cement. A total of 30 cubes specimen (100mm*100mm*100mm), 30 cylinder specimen (100mm*300mm) and 10 beam specimen(100mm*100mm*500mm) were prepared for standard testing. These include compression, split tensile and flexural test were conducted at concrete age of 3, 7 and 28 days. The test result showed till 1% the compression strength will increase as it reaches its certain limit that is after 1% the compression strength of the concrete gets reduced. This can yield increase in strength development compared to the normal specimen. This has indicated a good sign for further investigation of other engineering properties to produce a more effective engineering material using sisal fiber.

KEYWORDS: Fiber reinforced concrete, Compression strength test, Split tensile test, Flexural strength test.

I. INTRODUCTION

Concrete is a versatile material which has the possibility of moulding into geometric shapes which can be manufactured easily. Utilizing the resilient nature of this material, expeditious progress has been made in the field of construction in the recent years. When the matrix of the concrete is modified like lowering water content, use of super-plasticizers, use of natural and synthetic fibers, optimization of grain size distribution has emanated striking improvements in its many properties such as strength, ductility, compactness and durability. The main aim of using fibers as reinforcement in concrete is that they are capable of enhancing the mechanical properties such as fracture toughness, impact, tension, fatigue, thermal shock, spalling and much more.

Many experimental investigations have been carried out in the recent years on the mechanical, physical and durable properties of concrete reinforced with various natural fibers. Fibers are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion and shatter resistance in concrete. If the modulus of elasticity of the fiber is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increase in the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix.

SISAL FIBER REINFORCED CONCRETE

Sisal fibre reinforced concrete is the concrete with randomly distributed fibers. The failure strength and modulus of elasticity depends on the amount of cellulose and the orientation of the micro-fibers. The study is done to

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enhance the properties of concrete using sisal fiber by replacing cement with respective percentage of fiber and finding the strength variation on concrete.

PROPERTIES OF SISAL FIBER

- Sisal fiber is exceptionally durable with a low maintenance with minimal wear and tear.
- It is recyclable.
- Sisal fibers are antistatic, does not attract or trap dust particles and does not absorb moisture or water easily.
- It exhibits good sound and impact absorbing properties.
- Its leaves can be treated with natural borax for fire resistance properties.
- The fine texture takes dyes easily and offers the largest range of dyed colours of all natural fibers.

II. MATERIALS AND METHODOLOGY

A. MATERIAL USED

Cement(53grade OPC), M-sand, Coarse aggregate, Potable water, sisal fiber, sulphonated naphthalene formaldehyde.

Cement

A cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel together.

Fine Aggregate

The aggregates passing through I.S. sieve 4.75 mm sizes is termed as fine aggregate. The sum of percentage of all types of deleterious materials in fine aggregate should not exceed 5%. Natural sand or crushed stone dust is the fine aggregate mainly used in concrete mix. M-sand is used as fine aggregates.

Coarse Aggregate

Coarse aggregate, or simply aggregate, is a broad category of coarse to medium grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geo synthetic aggregates. Aggregates are the most mined materials in the world.

Water

The water is more and easily available material for forming the concrete. The very small amount of water is utilized for cement hydration process and remaining water is behaves like a grease material between the aggregates and it makes the concrete workable. The used material must be free from external agents.

Sisal Fiber

Sisal fiber is a sort of agave. Naturally the plant is known as agave sisilana. Filaments are gained from the leaves of the plant. The use of sisal, a natural fiber with enhanced mechanical performance, as reinforcement in a cement based matrix.

Sulphonated Naphthalene Formaldehyde

Sulphonated Naphthalene Formaldehyde is produced in liquid and powder form. It improves concrete mix by dispersing cement particles and thus, improving their workability and compressive flexural strength. Used as a super plasticizer 1.5% by the weight of cement.

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B. LABORATORY TESTS

Cement

SL NO	CHARACTERISTICS	RESULTS	SPECIFICATIONS
1	Specific gravity	3.14	IS:2720[part 3]
2	Standard consistency	26%	IS:4031[26-33%]
3	Fineness	2%	Not more than 10%
4	Initial setting time	39min	IS:4031[>30min]

Table 1 :Laboratory tests on cement

Fine Aggregate

SL NO	PROPERTIES	TEST RESULT
1	Specific gravity	2.46
2	Optimum moisture content	6%
3	Fineness modulus	2.91
4	Bulk density	1750 kg/m ³
5	Grading zone	ZONE II

Table 2 :Laboratory tests on fine aggregate

Coarse Aggregate

SL NO	PROPERTIES	TEST RESULT
1	Specific gravity	2.64
2	Fineness modulus	5.56
3	Bulk density	1630kg/m ³
4	Crushing value	20.06%
5	Impact value	16.01%
6	Water absorption	0.6%

Table 3 :Laboratory tests on coarse aggregate

C. MIX PROPORTION

The mix was designed as per IS 10262 to have a characteristics compression strength of 35N/mm² based on the mix design the cement content was identified as 341Kg/m³. The water cement ration is taken as 0.45, Superplasticiser was used in this study. The details of mixed proportion and quantity of material were given in table.

SL.NO	CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER	SUPER PLACISIECER
1.	1	1.94	3.56	0.45	0.015

Table 4 :Mix proportion

D. SLUMP TEST

The workability of fresh composite property which includes the diverse requirements stability, mobility, compactibility, placeability&finishability. There are different methods of measuring the workability.

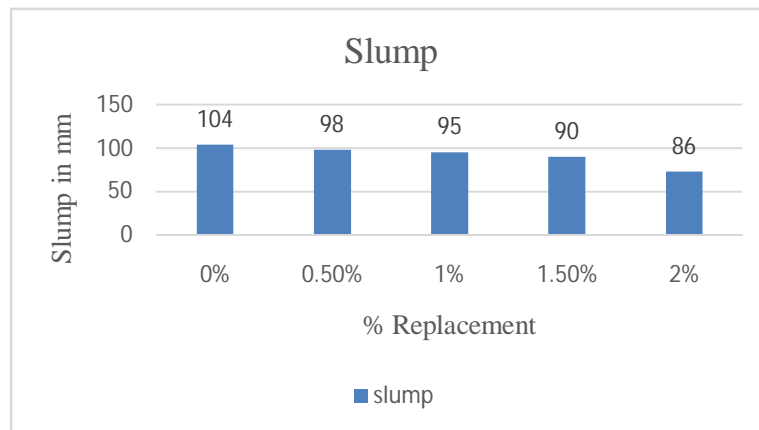
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Unsupported fresh concrete flows to the sides & a sinking in a height takes place. This vertical settlement is known as slump. In this fresh concrete is filled into mould of specified shape & dimensions & the settlement is measured when supporting mould is removed. Slump increases as water content is increased.



Graph 1 :Showing slump values

Observation from the above table and graph:

- From the above graph and table, for 0% or conventional concrete the slump value is more.
- The slump value goes on decrease, by the addition of sisal fiber.

E. Compression Test

Concrete cubes of 150mm*150mm*150mm size are casted to check the compressive strength. Specimens are subjected to ambient curing for 7, 14 and 28 days. Specimens are tested as per IS(part 5).The point at which specimen fails is considered as maximum load (N),and cross section of specimen is known. Thus compression strength is calculated by the formula,

$$\text{Compression strength or stress} = [\text{Load/Area}] \text{ N/mm}^2$$

III.COMPRESSION STRENGTH TEST RESULTS:

Compressive strength in N/mm ²	Age(days)		
	3	7	28
0%	18.23	30.27	43.54
0.5%	21.30	34.21	45.43
1%	22.65	35.35	46.88
1.5%	21.77	34.40	46.00
2%	21.12	33.79	44.89

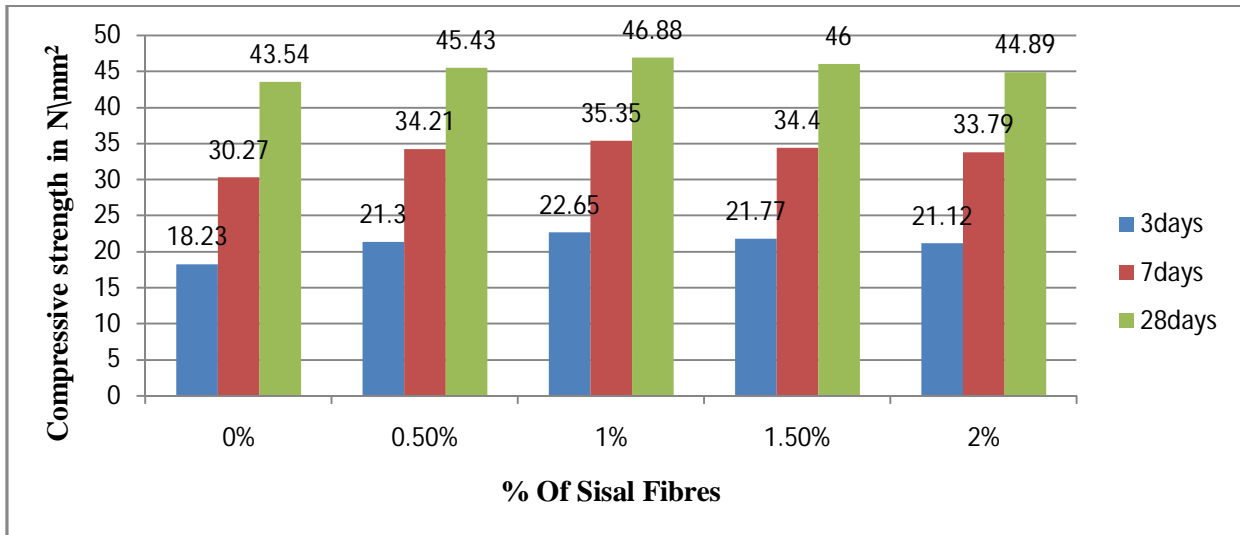
Table 5: Compression Test Results

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Graph 2: Comparison of Compressive Strength

F. Split Tensile Test

For these test cylinders of 150mm diameter (D) and 300mm height (H) are casted. These specimens are placed horizontally between the plates of compression testing machine and maximum load(P) at which specimen fails is noted and tensile strength is calculated using formula,

$$\text{Split tensile test} = 2 \times P / [\pi D L]$$

SPLIT TENSILE TEST RESULTS

Tensile strength in N/mm ²	Ages(days)		
	3	7	28
0%	1.27	2.47	3.11
0.5%	1.76	2.75	3.81
1%	2.19	3.04	4.24
1.5%	2.40	3.46	4.59
2%	2.68	3.74	4.88

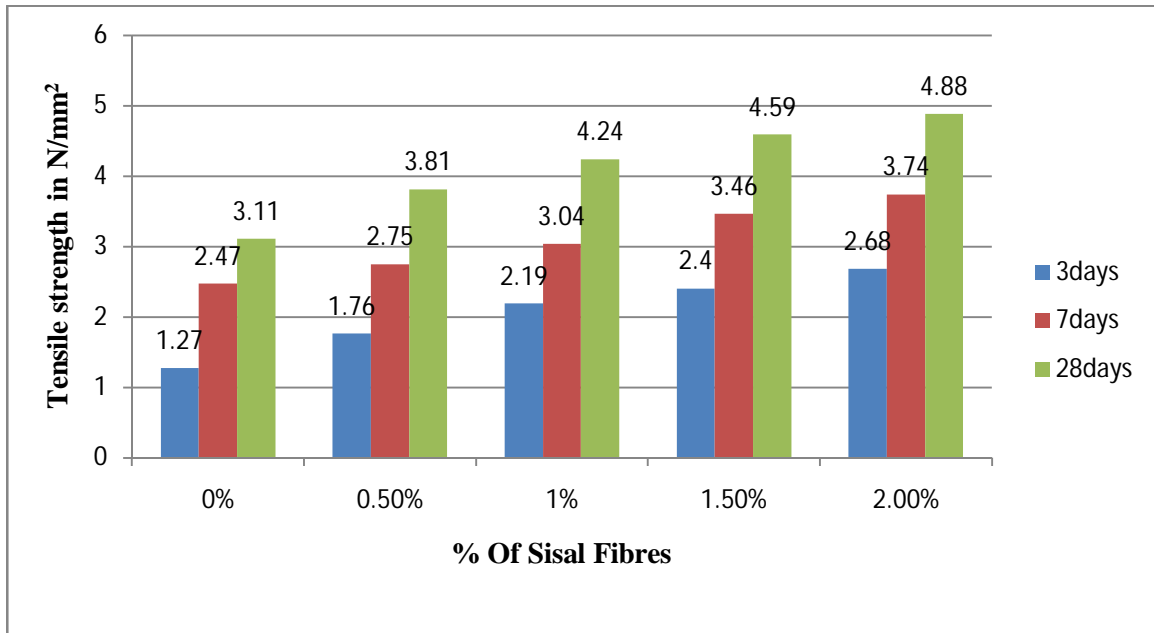
Table 6: Split Tensile Test Results

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Graph 3: Comparison of Tensile Strength

G. Flexural Strength Test

Flexural strength is one of the measures of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. For this test beam of 700mm length (L), 150mm breadth (B) and 150mm height (H) are casted. The flexural strength is calculated using the formula,

$$\text{Flexural strength test} = \frac{P L}{bd^2}$$

FLEXURAL STRENGTH TEST RESULTS

Flexural strength in N/mm ²	Agess(days)
	28
0%	4
0.5%	5.75
1%	6.87
1.5%	7.12
2%	7.5

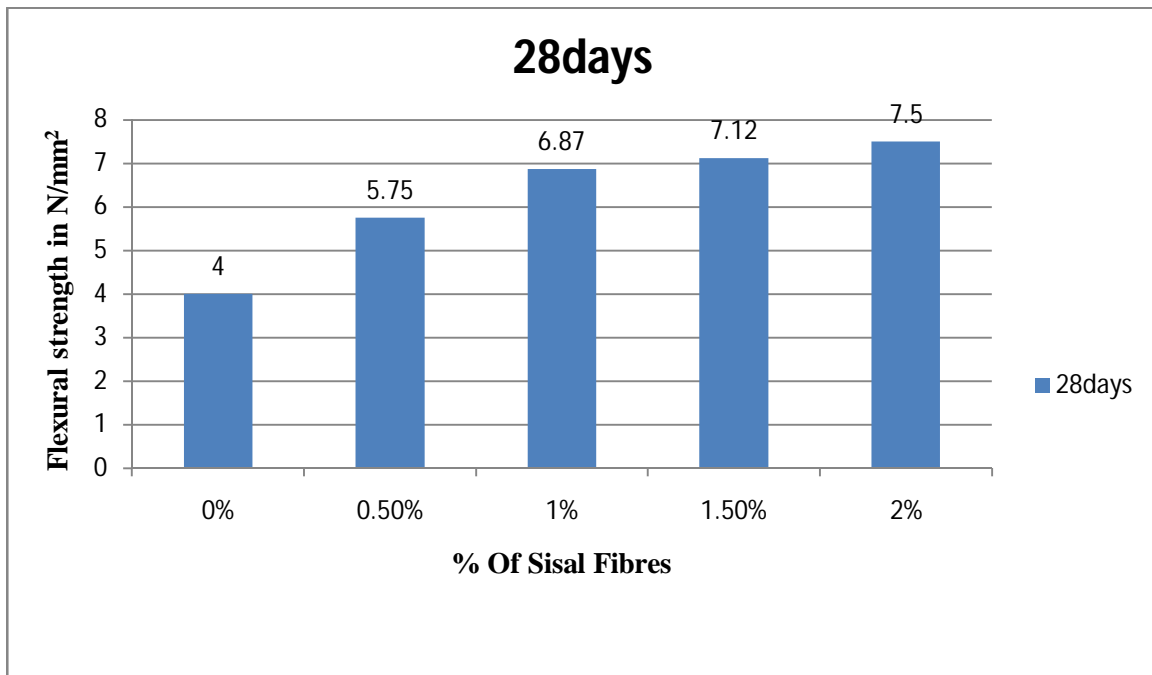
Table 7: Flexural Test Results

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Graph 4: Comparison of Flexural Strength of 28Days

IV. CONCLUSION

The following broad conclusion can be drawn from the experimental study on development strength of concrete using sisal fiber.

- Sisal fiber can act as reinforcement because as it has high tensile strength compared to other natural fiber, the fiber is strong due to the properties of lignin in it which act as lignified cellulose fibers which retains its strength when its goes to hydration process compared to other natural fibers.
- Maximum compressive strength is achieved at 1% then after it decreases.
- We can replace sisal fiber up to 1% only to the concrete, incase if we increase the amount of fiber beyond that it leads to failure.

REFERENCES

- [1] Ammar Abid, Kenneth B. Franzén, "Design of Fibre Reinforced Concrete Beams and Slabs," M.S Thesis, Dept Civil Eng., Chalmers Univ., Göteborg, Sweden, 2011.
- [2] Patrick Oguguo Nwankwo, Emmanuel Achuen, "Compressive Behaviour of Sisal Fibre Reinforced Ternary Concrete at Elevated Temperatures," IJOART, Vol. 3 no.8, pp. 123-131, 2014.
- [3] Romildo Dias Tolêdo Filho, Kuruvilla Joseph, Khosrow Ghavami, George Leslie England, "The Use of Sisal Fibre as Reinforcement in Cement Based Composites," Revista Brasileira de Engenharia Agrícola e Ambiental, vol. 3, no.2, pp. 245-256, 1999.
- [4] G. H. D. Tonoli, H. Savastano Jr, S. F. Santos, C. M. R. Dias, V. M. John, F. A. R. Lahr, "Hybrid Reinforcement of Sisal and Polypropylene Fibers in Cement Based Composites," Journal of Materials in Civil Engineering, ASCE, vol. 23, no.2, pp. 177-187, 2011.
- [5] Jitendra D. Dalvi, Uttam B. Kalwane, Pallavi Pasnur, "Effect of Fibre Length and Percentage of Sisal on Strength of Concrete," Multidisciplinary Journal of Research in Engineering and Technology, vol. 3, no.1, pp. 923-932, 2016.
- [6] Md. Naimathullah Tameen Mohd, Younus Mohiuddin, M. A. Haleem, "Experimental Investigation of Agave Fiber on the Properties of Concrete," Journal of Advances in Science and Technology, vol. 11, no. 22, 2016.