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Partial Replacement of Concrete with Sisal Fibre

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Abstract - Concrete is a mix of cement, water, fine and coarse aggregate that may be poured and hardens to become a sturdy building material. The globe over, concrete is a crucial construction material that is used extensively. Tension is weak in concrete. Different types of fibers are added to concrete in varying quantities to increase its tensile strength. Concrete that self-compacts can spread and flow into the form without the use of mechanical vibration. It may be utilized in situations where compacting freshly laid concrete would be laborious, such as underwater concreting, pile foundations, and walls with crowded reinforcing. The primary goal of this project is to use natural fiber to improve the performance of self-compacting concrete (sisal fiber). In order to halt the cracks, the aforementioned fibers are used; fibers might continue to hold the matrix together even after a crack is developing. The machine-decortication technique produces the fibers. This study examines the qualities of freshly-poured and hardened concrete with reinforced sisal fiber SCC at various fiber adding rate. In order to improve the mechanical properties of concrete it will be replaced by sisal fiber as 0.5% ,1% and 1.5% by volume for M-45 design mix. The concrete specimens will be tested for compressive strength at 7 ,14 and 28 days respectively and Split tensile Strength at 7 and 28 days and Compressive Strength test at 28 days also the results obtained will be compared with those of traditional concrete.

Key Words: Sisal fiber, concrete, compressive test, aggregate, flexural test.

1. INTRODUCTION

In recent years, cementitious composite materials reinforced with natural fibers have emerged as appealing low-cost and environmentally friendly alternatives to the widely used synthetic fibers in civil engineering. These fibers are readily available, cost-effective, and produce fewer hazardous fumes during production. Use of supplemental cementitious materials, such as fly ash and metakaolin, as partial fillers is an alternative to increase their durability alternatives to cement. Additionally, the utilization of these materials decreases cement use, which has the effect of the synthesis of carbon dioxide and its atmospheric release. One of the most popular natural fibers in the world, sisal fiber plays a significant role in the creation of textile fibers. The use of sisal fibers as reinforcement for cementitious matrices has thus been the subject of several, significant investigations. Two factors affect how well fiber-reinforced cementitious composites withstand time-dependent impacts. The first relates to the material's strength and durability in maintaining its qualities over time under various exposures and settings, while the second speaks to the material's ability to withstand deformations over time. The sisal fibers durability is tied to it as already demonstrated in earlier works, deterioration occurs in a matrix environment with a high concentration of calcium hydroxide Sisal is a natural fiber, however with time, the fiber matrix interface can become damaged from the impacts of fiber swelling and shrinkage. The deterioration of lignin and hemicellulose as well as calcium hydroxide precipitation's mineralization can be linked to the degrading mechanisms in natural fibers.

1.1 Experimental program

Materials and processing

Sisal Fiber

The Brazilian city of Valente in the state of Bahia provided the sisal fibers utilized in this piece. Decortication, a method, was used to separate these fibers from the Agave sisalana plant's leaves. To enhance the performance of the created composites, the fibers underwent a process to eliminate impurities before usage. The fibers were delivered in bundles with a length of around 100 cm. During this procedure, the fibers are submerged in water that has been heated to about 70 C with a 5 C temperature difference for about an hour, and they are then dried at room temperature for 48 hours. Following that, the threads are brushed to separate them into individual filaments.

The structure of the sisal fiber is hierarchical and intricate. Numerous elongated individual fibers, also known as fiber-cells, make up each fiber. In the microscale, each fiber-cell is made up of four main components: the primary wall, secondary wall, tertiary wall, and lumen. Each of these components is composed of cellulose, lignin, pectin, and hemicellulose at the nanoscale. Since the primary components (cellulose, hemicellulose, pectin, and lignin) are important for the composite binding behavior, fiber toughness and strength, the composition of the fibers may have an effect on their mechanical qualities. In addition to the chemical makeup, shape also affects the characteristics of fibers. For instance, the lumen can be round, polygonal, or elliptical, and together with the pores, they form the fibers' porous structure. Its ability to absorb moisture increases with porosity, which can raise the possibility of it degrading. Additionally, the weathering circumstances to which the fibers may be subject causes ongoing changes in the volume of the fiber's cell walls. This can cause the matrix and cellulosic fiber to degrade. Sisal fibers have a high elastic modulus of up to 27.9 G Pa and a mechanical strength ranging from 280 MPa to 750 MPa. Long sisal fibers were arranged in a direction alone and used as reinforcement. They were constructed into layers of 6.5 g after being cut into 250 mm and 500 mm lengths. A cross section of a sisal fiber is shown in a scanning electron micrograph. The fiber structure's porous and cellular characteristics can be seen.

1.2 Cement, Water, Aggregate

Concrete is prepared by mixing various materials like cement, Water, aggregates etc. which are economically available. IS 8112 is used for the work. The fine aggregate used in this investigation was clean river sand, whose maximum size is 4.75 mm, conforming to grading zone II. Machine crushed granite stone is used as coarse aggregate. Two size of coarse is used; one 10 mm passing through 4.75 mm retained and other 20 mm passing through 10mm retained. As per IS: 2486 – 1964 recommendations the following properties of coarse aggregates were determined.

2. Methodology

Cementations composites satisfy various civil engineering requirements such as high durability or impact load resistance. To study the behavior of reinforced concrete with different volume ratios, nearly 36 specimens were cast and tested for compressive test,24 specimens were cast and tested for tensile strength test and 12 specimens were cast and tested for Flexural test.

2.1Test

2.1.1Tests on Cement

In Cement, the tests conducted were:

1. Fineness test by sieve analysis

2. Standard consistency test using Vicat apparatus

3. Initial and final setting time by using Vicat apparatus

2.1.2Tests on Fine Aggregate

1.Specific gravity

2.Sieve Analysis

2.1.3TEST ON FINAL PRODUCT:

Testing of specimen

1) Casting detail of specimen

2) Compression test for sisal fiber mix concrete

3)Split Tensile Test for sisal fiber mix concrete

4)Three Point Load Test for sisal fiber mix concrete

2.2Compressive Strength Test

For compression test, Total 36 cube specimens of size 150 x 150 x 150 mm were cast for M45 grade of concrete. The moulds were filled with different proportions of cement, glass powder. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 7,14,28 days. After 7,14,28 days of curing, these cubes were tested on compression testing machine as per I.S. 516-1959. The failure load was noted. The cubes were tested and their average value is reported. The formula used for compressive strength calculation:

Compressive strength (MPa) = Failure load / cross sectional area

Tensile Strength Test

For Tensile Strength test, Total 24-cylinder specimens of size 300 mm x 150 mm were cast for M45 grade of concrete. The moulds were filled with different proportions of cement, glass powder. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 7 and28 days. After 7 and28 days of curing, these cubes were tested on compression testing machine as per I.S. 5816-1999. The failure load was noted. The cubes were tested and their average value is reported. The formula used for tensile strength calculation:

$$f_{ct} = \frac{2P}{\pi\, ld}$$

Where,

P=maximum load in Newtons applied to the noted before testing.

I = length of the specimen (in mm), and d = cross sectional dimension of the specimen

Flexural Test

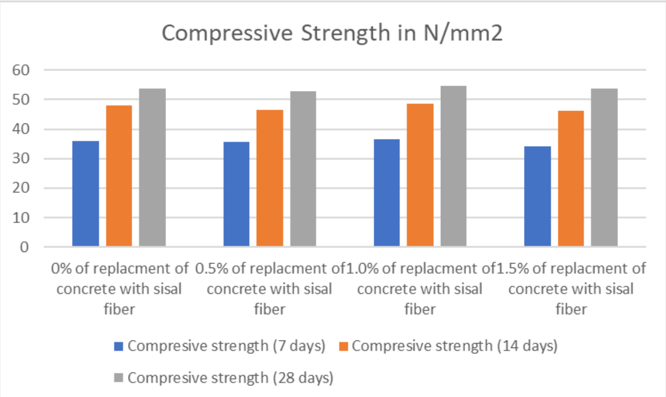
For Flexural test, Total 12 beam specimens of size 750 x 150 x 150 mm were cast for M45 grade of concrete. The moulds were filled with different proportions of cement, glass powder. Vibration was given to the moulds using table vibrator. The top surface of the specimen was leveled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 28 days. After 28 days of curing, these cubes were tested on three point load testing machine as per I.S. 516-1959. The failure load was noted. The beam were tested and their average value is reported.

3 Results and Discussion

3.1 Compression Test:

Table -1: Compressive Strength

S.No.	% Of replacement of concrete with sisal fiber	Compressive strength (7 days) In N/mm2	Compressive strength (14 days) in N/mm2	Compressive strength (28 days) in N/mm2
1	0%	35.83	48.12	53.83
2	0.5%	35.73	46.54	52.8
3	1.0%	36.43	48.53	54.64
4	1.5%	34.12	46.26	53.6

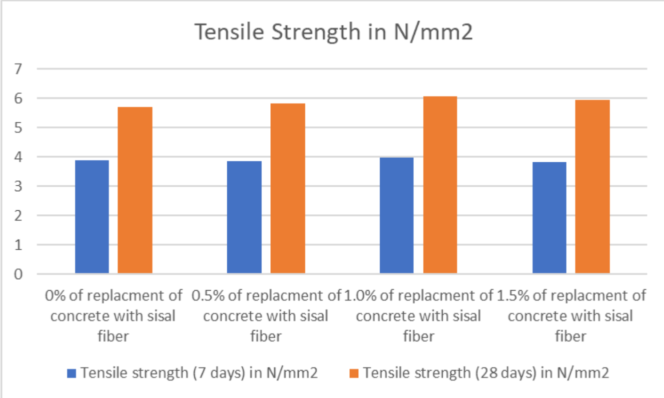


Graph - 1: Compressive Strength

3.2 Split Tensile test:

Table -2: Tensile Strength

S.No.	% Of replacement of concrete with sisal fiber	Tensile strength (7 days) In N/mm2	Tensile strength (28 days) in N/mm2
1	0%	3.89	5.7
2	0.5%	3.87	5.82
3	1.0%	3.97	6.07
4	1.5%	3.83	5.94

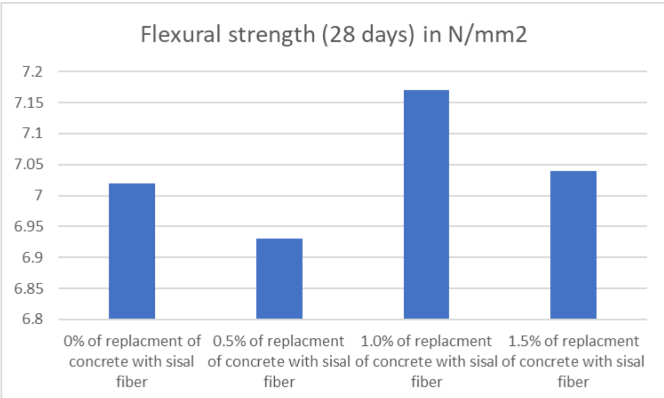


Graph -2: Tensile Strength

3.3 Flexural Test:

Table -3: Flexural Strength

S.No.	% of replacement of concrete with sisal fiber	Flexural strength (28 days) In N/mm2
1	0%	7.02
2	0.5%	6.93
3	1.0%	7.17
4	1.5%	7.04



Graph -3: Flexural Strength

4. CONCLUSIONS:

This investigation intent to evaluate the effective utilization of glass powder on concrete. A concrete grade M45 was designed as per IS 10262:2000 for this concrete mix. The water cement ratio 0.33 was adopted. The main aim of this investigation to find the improvement in compressive strength, tensile strength and flexural strength of a given mix by replacement of concrete with sisal fiber by volume at proportion 0%,0.5%,1.0% and 1.5%.

In this research we had found that

I. For M45 grade of concrete using replacement of concrete with sisal fibre by volume at proportion 0%,0.5%,1.0% and 1.5%. It was found that the compressive strength of concrete for 7,14 and 28 days were increased at concrete with sisal fibre by volume at proportion 1% about 1.50% as compared with conventional concrete at 28 days.

II. Tensile strength concrete of M45 grade of concrete using replacement of concrete with sisal fibre by volume at proportion 0%,0.5%,1.0% and 1.5% for 7 days and 28 days. It was found that the tensile strength of concrete for 7 and 28 days were increased at concrete with sisal fibre by volume at proportion 0.5%,1.0% and 1.50% about 2.06%,6.35% and 4.12% as compared with conventional concrete at 28 days.

III. Flexural strength of M45 grade of concrete using replacement of concrete with sisal fibre by volume at proportion 0%,0.5%,1.0% and 1.5%. It was found that the flexural strength of concrete for 28 days were increased at 1.0% and 1.5% replacement of concrete with sisal fibre by volume about 2.13% and 0.28% as compared with conventional concrete at 28 days.

From the above results discussion it is concluded that replacement of concrete with sisal fibre by volume at proportion 1.0% gives better result of compressive, tensile as well as flexural strength as compared to the conventional concrete.

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