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A Review Study on Sisal Fiber Reinforced Concrete

Praveen Kumar [a], Kamlesh Kumar Choudhary [b]

[a] *M,Tech Student, Saraswati Institute Of Engineering And Technology Jabalpur*
[b] *HOD Civil engineering Department, Saraswati Institute Of Engineering And Technology Jabalpur*

A B S T R A C T

Due to their adaptability as cladding panels, ridged equipment, and water containers that are available in a vast array of agriculture and building applications, sisal fiber cement is extensively used in construction projects. The toughness, tensile strength, and bend characteristics of the resultant composite are increased by including sisal fibers into the cement matrix. The sisal fibers have recently been used in concrete as reinforcement. These cementitious composites are currently thought to be among the best structural machinery available in terms of industrial technology. As a result, numerous articles are included in the survey to analyse the effectiveness of sisal fibers. Additionally, the papers chosen for assessment are examined based on the sisal and concrete ingredients used in the architectural masterpiece. Additionally, an illustration of sisal fiber with a different composition than concrete is included. The contributions to the adopted papers' tensile and compression strengths, as well as their compositional percentages, are analysed. Additionally, a thorough analysis of the evolutions of the adopted articles and their numerous applications is done.

Keywords: Sisal Fiber, Concrete, Compressive Strength, Split Tensile Strength, Flexural Strength

1. Introduction

The need for construction services is rising as the world's population rises. Concrete is the greatest and most widely used building material because of its exceptional inherent properties, which include strong compressive capacity, excellent durability, fire resistance, and low penetrability. In addition to these benefits, there are certain drawbacks, such as reduced tensile strength, brittleness, poor fracture resistance, and decreased impact resistance. The creation of techniques to improve the properties of concrete was required due to these problems. Some of these defects, such low tensile strength, can be somewhat remedied by using conventional steel reinforcement bars and, to a lesser extent, by adding the proper quantity of certain fibers to concrete.

Since ancient times, several parts of the world have been using fibers in construction materials. The motivation for this effort was to enhance the tensile strain of the material's "perceived" delicate properties. In the 20th century, this technique was employed to produce fiber-reinforced concrete, which has grown in popularity and use in the building industry due to its improved strength and stiffness. When utilised as secondary reinforcement in concrete, natural fibers are a better choice for the environment than synthetic fibers. Small, discrete reinforcement materials known as fibers come in a variety of shapes and sizes and are made from a number of materials, both natural and manufactured. One natural fiber that has consistently demonstrated promise is sisal; it has a number of positive qualities, including sustainability, excellent tensile strength, and low price.

Natural fibers are now among the most widely used options for concrete reinforcement in terms of sustainability and biodegradability due to their non-toxicity and environmental friendliness, attributes that are particularly favourable for the manufacturing of natural fibers. Instead, they assist in lowering CO2 emissions into the atmosphere. Bio composites are becoming more well-known as desirable materials in a variety of industries, including biomedicine, building, architecture, and the automobile industry. Natural fibers can be found all over the world, are more rigid than synthetic fibers, cost less, and are recyclable. The shells of ripe coconuts are harvested to make coir, a common natural fiber used to make hard, strong objects. Due to their many advantages, such as their widespread availability, biodegradability, light weight, low cost, and ease of manufacture, natural fiber-based biocomposites have essentially supplanted synthetic polymers for a variety of purposes. Researchers have proposed a variety of natural fiber concretes for use in a range of technical applications. Numerous countries around the world, particularly in tropical and subtropical regions, grow coconuts, and they play a significant role in economic growth. A recent study found that coir fibers from about 50 billion coconuts are harvested worldwide. Due to its accessibility, affordability, environmental benefits, and mechanical similarities to hemp, banana, and jute, sisal is becoming more and more popular among natural fibers like kenaf, jute, oil palm, cotton, flax, and hemp. Sisal Fibers (SSF)

Sisal is easily cultivable in a short period of time. The plant naturally grows along railway tracks and field hedges. A research found that SSF is extracted globally at a rate of about 4.5 million tonnes annually. It is manufactured from the leaves of the Agave sisalana plant, which is now cultivated in tropical Asian, African, and Caribbean nations. Each of a sisal plant's 200–250 leaves might have at least 1000–1200 fiber bundles. In India it is produced in various states like Tamil Nadu , Kolkata etc. A sisal plant has a total composition of 87.25% water, 4% fiber, 0.75% cuticle, and 8% dry matter. SSF is often eliminated by retting, scraping, and mechanical methods like decorticators.

To slow down the cement's hydration process and lengthen setting times, sisal fibers may be used. Due to its inherent advantages over synthetic fiber composites, such as cost and environmental friendliness, natural fiber composites are becoming more and more popular. The primary strength metrics of fiber-containing concretes significantly improved as compared to fiber-free concretes.

Fig. 1 – Sisal plant and fiber

2. Literature Review

Jawad Ahmad 1,ORCID,Ali Majdi 2ORCID,Ahmed Farouk Deifalla 3,ORCID,Nabil Ben Kahla 4 and Mohammed A. (2022)

An overview of recent developments in SSF and composites is provided in this article. Examinations have been done on the characteristics of SSF, the contact between SSF and the matrix, and SSF-reinforced characteristics such freshness, mechanical strength, and durability. The findings reveal that SSF decreased its flowability while increasing strength and durability. The review makes recommendations for additional research.

Biju C. Thomas a, Y. Stalin Jose b (2022)

Natural fiber is given more attention in this study since it is more readily available. The SISAL Fiber [SF], a substitute material in mount, is the name of the fiber used for reinforcing. The fibers' chemistry, physics, and structural characteristics are carefully examined. Analysis of the SF revealed that the sisal fiber reinforced composite has strong structural roots in both urban and rural construction. Steel materials are toxic to both humans and animals, thus this can be used as an alternative. The manufacturing of SF is contrasted with that of artificial fibers and mineral asbestos. This sisal fiber is regarded as one that has both social and economic advantages and is cost-effective to produce.

Biju Thomas, Y. Stalin Jose (2022)

Several papers are included in the survey that is being given to analyse the functionality of sisal fibers. Additionally, the papers chosen for assessment are examined based on the sisal and concrete ingredients used in the architectural masterpiece. Additionally, an illustration of sisal fiber with a different composition than concrete is included. The contributions to the adopted papers' tensile and compression strengths, as well as their compositional percentages, are analysed. Additionally, a thorough analysis of the evolutions of the adopted articles and their numerous applications is done.

Mr. Mithun K1 ,R.M. Mahalinge Gowda. 2 , H.S Suresh Chandra3 (2019)

. This project involved a study of the effects of treating sisal fibers with Na2CO3 for five days on the strength metrics of standard concrete. Utilising IS10262-2009, 0.5%, 1%, 1.5%, and 2% for M30 grade concrete design. Concrete cubes and cylinders are put to the test 7, 14, and 28 days after they've finished curing. From the experimental studies, it has been found that 1% of Na2CO3-treated sisal fiber for M30 grade is the ideal percentage.

M.P Iniya[1] and K Nirmalkumar[2] (2020)

The use of sisal, a natural fiber with improved mechanical strength, as reinforcement in a cement-supported matrix. The amount of sisal fiber used in concrete ranged from 0.1% to 2%, and the fibers' lengths in concrete with aspect ratio were 50mm to 60mm. Tensile strength is increased, thaw resistance is frozen, impact resistance is increased, and concrete brittleness is decreased by the addition of short fibers. As the replacement moment in the reinforcing of structural steel is decreased, fiber generally does not increase the concrete's strength. This paper also discusses environmental concerns, fiber content limitations, and FRC, a recent development in civil engineering technology. The compressive strength test, flexural strength test, tensile strength test, and other tests are also discussed in this review study.

1Venkateshwaran.S, 2 Kalaiyarrasi. A. R. R (2018)

This study attempted to examine the impact of natural sisal fiber on concrete by partially substituting cement. For usage in concrete, sisal fiber is chemically processed in this instance. Compressive strength, split tensile strength, and other mechanical characteristics, Flexural strength of fiber reinforced concrete, with 0.5%, 1%, and 1.5% of fiber replacing cement by volume fraction, is contrasted with normal M25 concrete, with sisal fiber having an aspect ratio of 1:20. In comparison to normal concrete, the fiber substitutions of 0.5%, 1%, and 1.5% increased the compressive strength at 28 days by 13.8%, 21%, and 16.3%, respectively. The first cracking load in flexure is raised by 12.5%, 27.5%, and 20% for 0.5%, 1%, while the rise in split tensile strength at 28 days is 24%, 56%, and 80%.

3. Materials and Methods

Cement-

Cement is a binder substance that can bind other materials together. Physical properties of Ordinary Portland cement are as follows: -

Properties	**Values**
Specific Gravity	3.12
Normal Consistency	29%
Initial Setting time	65min
Final Setting time	275 min
Fineness	330 kg/m2
Soundness	2.5mm
Bulk Density	830-1650 kg/m3

Table 1 properties of OPC

Fine Aggregate (Sand)

Sand is a granular substance that occurs in nature and is made up of tiny material particles. The fine material was retained mostly on sieve #200 (75 m), which was used after it passed through sieve #4 (4.75 mm). The sand has a fineness modulus of 2.6, a bulk density of 1647 kg/m3, and a specific gravity of 2.67.

Coarse Aggregate (Gravel)

One of the key elements of concrete composite materials is coarse aggregate. The largest coarse aggregate utilised was 12.5 mm. The gravel has a fineness modulus of 6.2, a specific gravity of 2.74, and a bulk density of 1600 kg/m3.

Sisal Fibers

Sisal fiber is made from the leaves of the plant. The fiber is usually obtained by machine decortication in which the leaf is crushed between rollers. The resulting pulp is scraped from the fiber, and the fiber is washed and then dried by mechanical or natural means. The lustrous fiber strands, usually creamy white, average 100 to 125 cm (40 to 50 inches) in length and are fairly coarse and inflexible. Sisal fiber is especially valued for cordage use because of its strength, durability, ability to stretch, affinity for certain dyestuffs, and resistance to deterioration in salt water.

Water

For the mixing and curing processes, pure water is required. Applying the used water should follow the mix proportion design.

4. Conclusion

This review article provides a database for selecting SSF in the building and construction industries. The key conclusions from the most recent study on reinforced concrete based on SSF are listed below:

- Depending on the maturity of the plants, SSF has different physical properties.
- Due to the increased surface area of SSF, which required more water, flowability reduced when SSF was added.
- Similar to other types of fiber, the inclusion of SSF boosted the strength qualities of concrete up to a point. Additionally, it was shown that SSF's compressive capacity is not much higher than its flexural or tensile capacity.
- With the addition of SSF, water absorption rose but density decreased.

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