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Combined Effect of Glass Powder & Sisal Fiber on Strength of Concrete

Angela C. Joy [1], Beyoola Wilson [2], Krishnapriya K [3], Mohammed Azhar [4], Fathima Nashmiya [5]

[1, 2] *Assistant Professor, Department of Civil Engineering, IES College of Engineering, Kerala, India*

[3 ,4 ,5] *Student, Department of Civil Engineering, IES College of Engineering, Kerala, India*

Email_id: angelacjoy@gmail.com, beyoolawilson@gmail.com, kskrishnapriya123@gmail.com neshmiyaa@gmail.com, azharazhar7306@gmail.com

Abstract

The incorporation of sisal fiber and glass powder into concrete has been investigated to evaluate their combined effect on the mechanical properties and overall strength of concrete. Sisal fibers, known for their high tensile strength and natural availability, provide reinforcement to the concrete matrix, enhancing its ductility and toughness. Glass powder, on the other hand, is a waste byproduct of glass production, and its use in concrete not only promotes sustainability but also contributes to improved compressive strength due to its pozzolanic properties. This study explores the synergistic effects of combining both materials in varying proportions and examines how the inclusion of sisal fiber and glass powder influences concrete's compressive, tensile, and flexural strength. Results indicate that the optimal combination of sisal fiber and glass powder leads to a significant improvement in the mechanical performance of concrete, as it combines the benefits of increased strength, durability, and sustainability. The findings of this research support the potential of using these materials as an effective means to enhance the performance of concrete in construction applications, while also addressing environmental concerns by utilizing industrial waste products.

Keywords: Soil Piping, Modified Polysaccharides, Versicular Arbuscular Mycorrhizae

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1. Introduction

The construction industry is continually seeking innovative and sustainable solutions to enhance the performance and longevity of concrete structures. Among the promising materials, glass powder and sisal fiber have gained significant attention. Glass powder, a by-product of recycled glass, has demonstrated the ability to improve the compressive strength and durability of concrete. It not only strengthens the material but also helps address waste management challenges by repurposing glass waste. Meanwhile, sisal fiber, which is derived from the agave plant, contributes to the tensile strength and toughness of concrete, improving its resistance to cracking and deformation under stress.

When combined, these two materials are expected to produce a synergistic effect, enhancing the overall mechanical properties of concrete. Glass powder improves compressive strength, while sisal fiber boosts tensile strength, making the material more durable and resistant to damage over time. This study aims to explore the full potential of these sustainable materials in concrete, ultimately contributing to the development of eco-friendlier construction practices. By incorporating this 1 material, the construction industry can reduce its environmental footprint while improving the per

formance of concrete structures, leading to a more sustainable and durable future for the industry.

2. Objectives of the Study

- Investigate the individual and combined effects of glass powder and sisal fiber on the compressive strength of concrete.
- To evaluate the tensile strength of concrete with varying proportions of glass powder and sisal fiber.
- To determine the optimal proportion of glass powder and sisal fiber for achieving the best strength and durability properties of concrete.
- To compare the performance of concrete with glass powder and sisal fibre with that conventional.

2.1. Scope of the Study

This study investigates the combined effect of sisal fibre and glass powder on the strength of concrete. The objective is to explore how these materials can enhance the mechanical properties, including compressive, flexural, and tensile strength, as well as durability. Sisal fibre, a natural reinforcement, and glass powder, a waste product from the glass industry, will be incorporated into concrete mixes in varying proportions. The research will compare the performance of concrete with these additives to control samples, assessing their synergistic effects on strength and durability. The study aims to identify the optimal mix ratio for maximum strength enhancement, contributing to more sustainable concrete solutions

- Sustainable Materials: Using sisal fibre and glass powder as eco-friendly concrete additives.
- Strength Improvement: Enhancing compressive, flexural, and tensile strength.
- Durability: Assessing the impact on concrete's resistance to environmental factors.

3. Materials and Methods

3.1 Materials Used

The various materials used in the experimental program are described below.

Cement

A substance with cohesive and adhesive properties, such as cement, can bond mineral fragments into compact wholes that are solid in the presence of water.

Figure 1: Cement

Water

The water used is potable, colorless and odorless, having a pH of 7 and contains no impurities that may alter the chemical reaction of the cement and aggregates.

Aggregates

When making mortar or concrete, aggregates are bridging materials like cement, lime, or mud that are mixed with hard, inert filler materials. Aggregates make up between 70 and 75 per cent of the volume of a mass of concrete.

Figure 2: Aggregates

Sisal fiber

Scientifically named as Agave sisalana, sisal is a leaf fibre that is derived from the leaves of this plant. One kind of perennial shrub found worldwide in tropical and subtropical areas is the sisal plant. It is among the hard fibres that are farmed the most globally. It thrives in extremely tough soils that may not support the growth of typical plants.

Figure 3: Sisal Fiber

Glass powder

A finely ground powder made from recycled glass, has emerged as a versatile and sustainable material in various industries. With its unique combination of physical and chemical properties, glass powder has been increasingly used as a supplementary cementitious material (SCM) in concrete production.

Figure 4: Glass Powder

3.2 Experimental Setup

- Quantity of cement, fine aggregate, coarse aggregate and water were measured and taken according to calculated mix design for M20.
- Initially, 8 cubes of dimension 150 x 150x 150 mm were casted and cured with just sisal fiber replacement as 0%, 0.5%,1%&1.5% for strength of 7 ,14 & 28 days.
- Compressive strength test was conducted and results were compared and found compressive strength to be maximum when sisal fiber replacement was 1% but lesser than strength of standard concrete.
- Then, as 1% fiber constant, 8 more cubes of same dimensions with varying glass powder percentage as 5%, 10% &15% were casted and cured for 7 ,14 & 28 days. compressive strength test was conducted again and results were compared.
- Then for flexural test, 10-cylinder specimens were prepared with same 1% fiber content and varying glass powder content as 0%, 5%, 10%, 15% & 20%.
- The cylinder specimens were casted and cured for 7 ,14 & 28 days.
- Tensile strength test was conducted, and results were compared with that of standard concrete.

4. Results and Discussion

Cubes & cylinders were cured for 7 ,14 & 28 days and compression & Tensile test were conducted respectively. The test result is plotted on graph for better presentation.

4.1 Compressive Strength

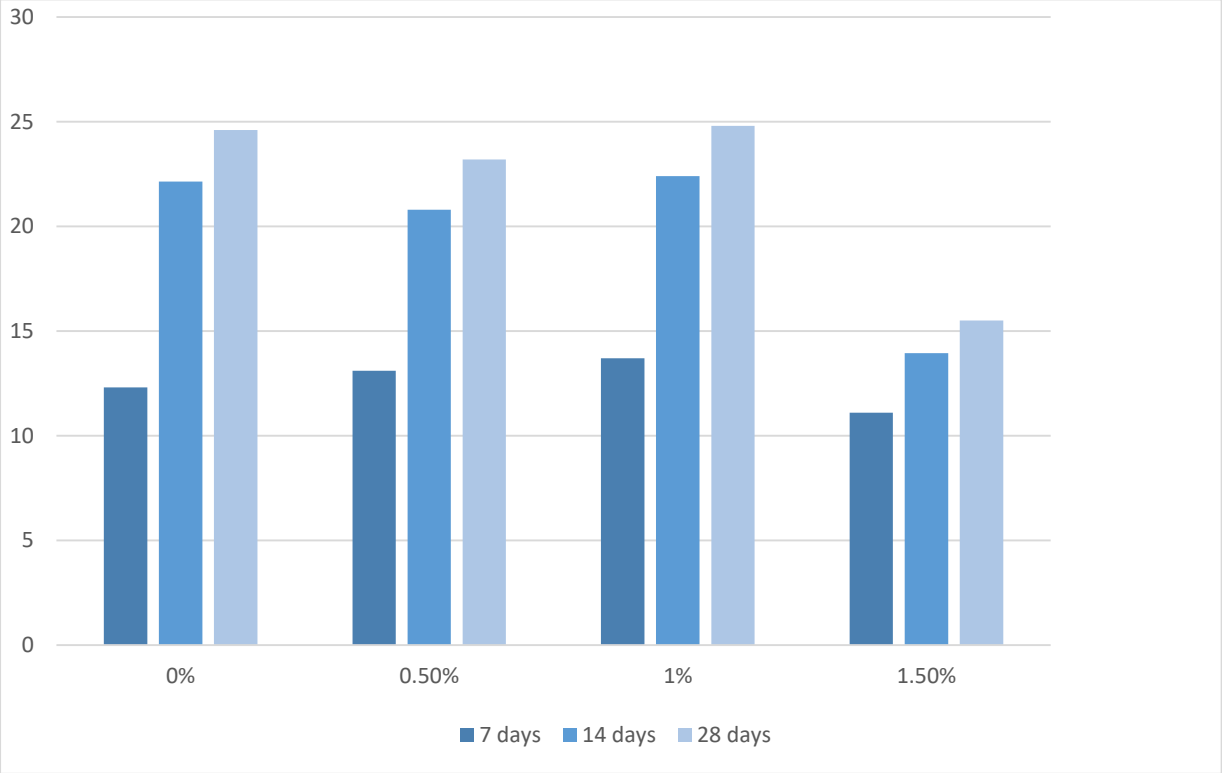
Compressive strength test was conducted on cube specimens. Cubes were tested at 7 ,14 & 28 days of curing. The

results of compressive strength test conducted on various specimens are discussed in this section with graphs.

4.1.1 Sisal Fibre Replacement

Replacement % of SF	7 Days [N/mm^2]	14 Days [N/mm^2]	28 Days [N/mm^2]
0%	12.3	22.14	24.6
0.5%	13.1	20.8	23.2
1%	13.7	22.4	24.8
1.5%	11.1	13.95	15.5

Table 1: Compressive Test Result with Various Fibre Replacement %

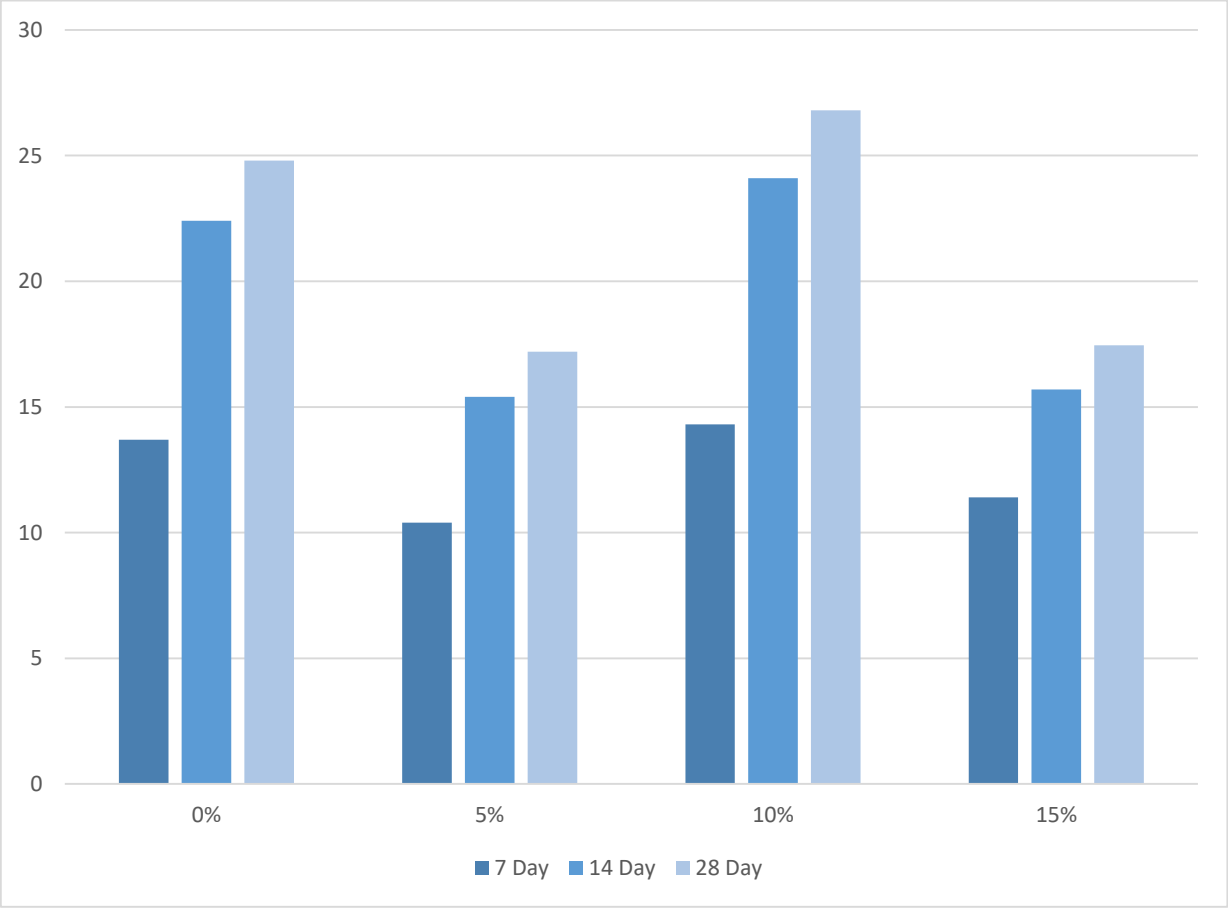


Graph 1**:** Compressive Strength of Concrete cubes at Various Sisal Fibre Content.

4.1.2 Compressive Test Result with Fibre and Glass powder

Strength %	7 Day	14 Day	28 Day
0%	13.7	22.4	24.8
5%	10.4	15.4	17.2
10%	14.3	24.1	26.8
15%	11.4	15.7	17.45

Table 2: Compressive test result with fiber and glass powder

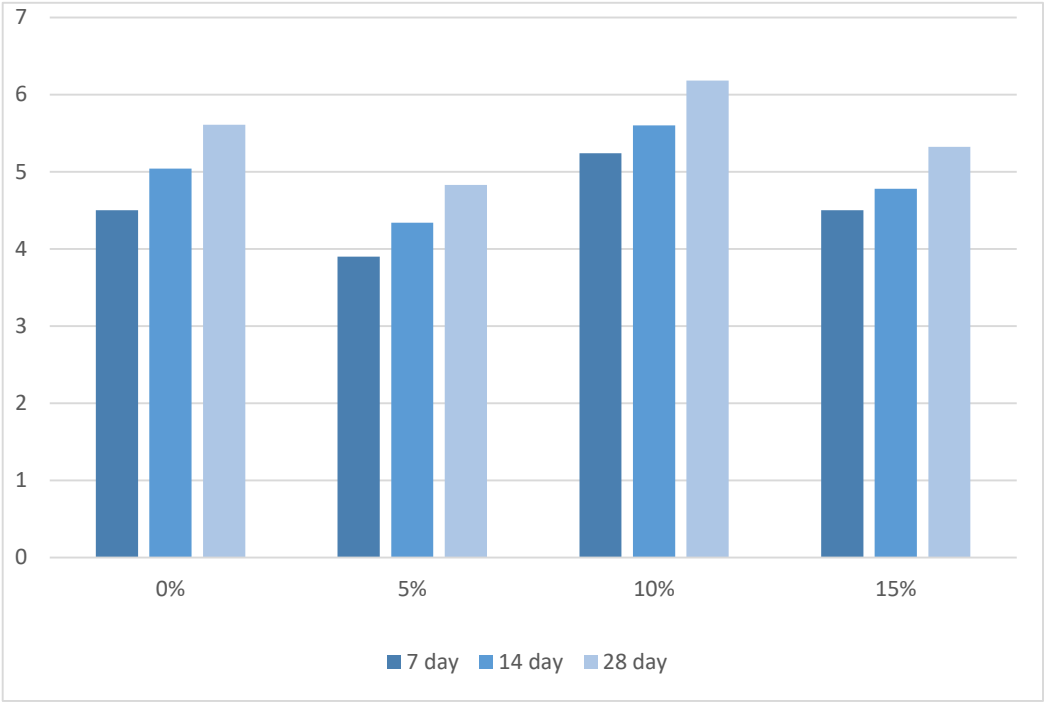


Graph 2: Compressive test result with fiber and glass powder

4.1.3 Tensile Strength

Strength %	7 Day	14 Day	28 Day
0%	4.5	5.04	5.61
5%	3.9	4.34	4.83
10%	5.24	5.6	6.18
15%	4.4	4.78	5.32

Table 3:Tensile strength test result with sisal fiber and glass powder



Graph 3:Tensile strength test result with sisal fiber and glass powder

5. Conclusion

From the results of tests conducted on various specimens, the following conclusion can be noted:

- The Normal Concrete of Compressive Strength results for 28day is 24.6N/mm2.The Normal Concrete of tensile Strength is 5.6.
- compressive test result of maximum percentage is 1 %and its result is 24.8 in 28 day.
- Using 1%Sisal fiber and 10 % glass powder the Compressive Strength results for 28 day is 26.8.
- Using 1% Sisal fiber and 10% glass powder the tensile strength result for 28 day is 6.18.
- The optimum value of sisal fiber is 1 % and glass powder is 10%. Then we can use these sustainable materials in concrete.

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