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STRENGTH STUDIES ONBANANA FIBER CONCRETE WITH SILICAFUME ANDZEOLITE POWDER

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ABSTRACT

This study investigates how adding zeolite powder, silica fume, and banana fiber to concrete mixtures can work in concert.Banana fiber was used as an extra reinforcement, and different weight percentages of zeolite powder and silica fume were used to partially replace cement.The goal of the study was to determine how these additional cementitious ingredients and natural fibers affected the concrete's mechanical qualities.Compressive strength and split tensile strength were evaluated in order to determine the performance improvement.Through pozzolanic processes, silica fume was added to the concrete in an effort to increase its density and strength.Zeolite powder was also used because of its potential to improve durability and lessen the environmental effect of producing concrete. Banana fiber was also added in an effort to increase the concrete's durability and crack-resistant qualities.The experimental findings shed light on the ideal ratios of these components to produce concrete composites with increased strength and sustainability.This study advances the creation of more environmentally friendly building materials with enhanced structural qualities.Compressive and split tensile strengths should be tested after 28, 56, and 90 days.

KEYWORDS: Banana Fibre,Silicafume, Zeolite powder, Environmental impact, Compressive strength, Split tensile strength

1. INTRODUCTION

Concrete is one of the most widely used building materials in the modern world for a variety of reasons, despite its varied applications.Its strength, affordability, longevity, and adaptability are what make it so appealing.As a result, concrete is regarded as a simple, reliable, and secure building material.In addition to infrastructure like highways and bridges, it is used in a wide range of construction projects, such as multistory office buildings and residential complexes.Concrete is required when constructing load-bearing components such as slabs, beams, and columns.Its primary ingredients are cement, water, aggregates (such sand and gravel), and sometimes admixtures or additives to enhance performance.

Zeolite powder, an aluminosilicate substance that can be generated synthetically or organically, is becoming more and more valued as an additive for concrete mixtures. Its high silica content and porous structure provide a number of possible advantages. Zeolite can function as a pozzolanic substance when added to concrete, interacting with calcium hydroxide to create more cementitious compounds that increase the material's strength and durability over time.

A highly reactive pozzolanic substance, silica fume is a byproduct of the manufacturing of silicon and ferrosilicon alloys and can be used as a partial substitute for cement.Its high silica content and incredibly tiny particle size greatly improve the qualities of concrete.Additional calcium silicate hydrate (C-S-H) gel is created when silica fume is added to cementitious mixes and reacts with the calcium hydroxide created during cement hydration.The concrete gains strength, decreased permeability, and increased durability as a result of this secondary reaction, which also creates a denser microstructure.By using an industrial waste product, silica fume can also be used to partially replace cement, which has positive environmental effects.To maximize its effectiveness and produce the required concrete properties, dose and mixing techniques must be carefully considered.

Banana fiber, a natural and sustainable resource derived from the pseudo-stem of the banana plant, is gaining attention as a potential reinforcement in concrete. These lignocellulosic fibers offer an environmentally friendly alternative to synthetic options. Incorporating banana fiber into concrete mixes aims to improve tensile strength and control cracking. The fibers act as micro-reinforcement, bridging cracks and enhancing the material's ductility. While challenges related to durability and moisture absorption exist, pretreatments can improve fiber-matrix bonding. Research explores optimal fiber content by weight to balance strength enhancement with workability.

A natural and sustainable resource, banana fiber is extracted from the pseudo-stem of the banana plant and is becoming more and more popular as a possible reinforcement for concrete.An eco-friendly substitute for synthetic fibers is provided by these lignocellulosic fibers.The purpose of adding banana fiber to concrete mixtures is to increase tensile strength and reduce cracking.The fibers improve the ductility of the material by bridging cracks and serving as micro-reinforcement.Pretreatments can enhance fiber-matrix bonding, despite issues with durability and moisture absorption.The ideal fiber content by weight is being investigated in research to strike a balance between workability and strength development.

2. OBJECTIVES

1. Natural and sustainable banana fiber. By partially substituting zeolite powder for cement and using its pozzolanic reactivity to produce a denser microstructure, concrete's overall durability can be increased and its resistance to weathering and chemical assault strengthened.

2. By adding banana fiber, which serves as micro-reinforcement inside the matrix and creates more robust structural parts, concrete's mechanical qualities, such as its tensile strength and toughness, can be improved.

3. To improve particle packing and reduce shrinkage and cracking in concrete structures by partially substituting copper slag for fine aggregate.This could lower the mix's water requirement and increase the structure's long-term stability.

3. MATERIALS

3.1 Cement: Cement is a finely ground binding material used mostly in mortar and concrete building. It solidifies when mixed with water, binding aggregates like sand and gravel to form strong, durable structures. For structures and infrastructure to be strong and stable, cement—which is composed of limestone, clay, and other minerals is essential.

3.2 Fineaggregate: Fine aggregate, which is typically crushed stone or sand, is a building material composed of small particles that pass through a 4.75 mm sieve. By filling up the gaps between coarse particles in mortar and concrete, it increases workability and strength. Fine aggregate is necessary to create a thick, smooth mixture in construction projects.

3.3 Coarse aggregate: Coarse aggregate, a building element, is made up of larger particles that range in size from 4.75 mm to 50 mm and are typically crushed stone or gravel. It provides the concrete mix with bulk, strength, and durability and creates its framework. Coarse aggregate increases the overall stability and load-bearing capacity of structures.

3.4 Water: Water is an essential building component for a number of construction processes, such as mixing cement, making mortar, and curing.The quality of the water used directly affects the strength and durability of cement concrete and mortar, which in turn affects the overall performance of the project.

3.5Silica fume: The ultrafine powder known as silica fume, or microsilica, is gathered as a byproduct of the electric arc furnaces used to produce silicon and ferrosilicon alloys.It is mostly composed of very tiny particles called amorphous silicon dioxide (SiO_2), which are usually 100 times finer than cement particles.It is a very reactive pozzolanic material because of its large surface area and silica concentration.Silica fume and calcium hydroxide combine to create calcium silicate hydrate (C-S-H) gel, which is an extra cementitious ingredient that strengthens concrete.As a result, concrete has increased durability, strength, and decreased permeability.

3.6 Zeolite Powder: Natural or artificial zeolites, which are microporous aluminosilicate minerals distinguished by their distinct crystalline structure and large surface area, can be ground into a fine powder.Ions, water, and other molecules can be exchanged or trapped by the networked channels and voids in this structure.Because of its pozzolanic qualities, zeolite powder is used as an additional cementitious ingredient in construction, especially in concrete.It increases the strength and durability of concrete by reacting with calcium hydroxide to create more cementitious compounds.Because of its tiny particle size, the concrete matrix becomes denser, which lowers permeability.

3.8Banana Fiber: After the fruit is harvested, the pseudo-stem of the banana plant yields the natural lignocellulosic fiber known as banana fiber.These fibers are an eco-friendly resource because they are lightweight, biodegradable, and quite robust.Banana fibers are being investigated as a reinforcing material in construction, namely in concrete, to increase tensile strength and decrease cracking.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength

The minimum compressive strength of a cubes is represented as the cube of compressive strength (15 cm x 15 cm x 15 cm). The concrete specimens are typically evaluated between the ages of seven and twenty-eight days. The cubes are usually assessed after 28, 56 and 90 days.

Table 1: Compressive strength results of concrete with Silicafume used as a partial replacement for cement.

Sl.no	% of Silica Fume	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.48	35.07	37.69
2	4%	34.62	37.38	40.15
3	8%	37.79	40.82	43.96
4	12%	36.03	38.91	41.79

Table 2: Compressive strength results of concrete with Zeolite powder used as a partial replacement for cement.

Sl.no	% of Zeolite Powder	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.48	35.07	37.69
2	5%	35.82	38.68	41.54
3	10%	38.01	41.05	44.21
4	15%	40.93	44.36	47.45
5	20%	39.69	42.86	46.02

Table 3: Compressive strength results of banana fiber concrete.

Sl.no	% of Banana Fiber	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.48	35.07	37.69
2	0.5%	32.98	35.61	38.25
3	1%	33.71	36.38	39.12
4	1.5%	34.42	37.18	39.96
5	2%	35.12	37.93	40.74
6	2.5%	34.43	37.19	39.91

Table4: Ccombined Compressive strength of Banana fiber concrete with Silica fume and Zeolite powder.

Sl.no	Combined Replacement(s)	Compressive Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	32.48	35.07	37.69
2	15% of ZP+8% SF+2%BF	44.91	48.52	52.03

4.2 Split tensile strength

Split tensile strength is a measure of a material's ability to resist tension, determined by applying a load along a horizontal cylindrical specimen until failure occurs. This test is crucial for evaluating the tensile properties of concrete, as it simulates the tensile stresses that occur in structural elements. High split tensile strength indicates better durability and resistance to cracking in concrete structures for 28, 56 and 90 days.

Table 5: Split tensile strength results of concrete with Silicafume used as a partial replacement for cement.

Sl.no	% of Silica Fume	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.21	3.45	3.72
2	4%	3.46	3.87	4.09
3	8%	3.81	4.12	4.46
4	12%	3.59	3.89	4.33

Table 6: Split tensile strength results of concrete with Zeolite powder used as a partial replacement for cement.

Sl.no	% of Zeolite Powder	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.21	3.45	3.72
2	5%	3.54	3.82	4.14
3	10%	3.79	4.08	4.37
4	15%	4.17	4.51	4.83
5	20%	3.94	4.26	4.68

Table 7: Split tensile strength results of banana fiber concrete.

Sl.no	% of Banana Fiber	Split tensileStrength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.21	3.45	3.72
2	0.5%	3.26	3.52	3.89
3	1%	3.34	3.68	4.01
4	1.5%	3.42	3.74	4.23
5	2%	3.58	3.86	4.38
6	2.5%	3.43	3.59	4.15

Table 8: Ccombined Split tensile strength of Banana fiber concrete with Silica fume and Zeolite powder.

Sl.no	Combined Replacement(s)	Split tensile Strength Results, N/mm^2		
		28 days	56 days	90 days
1	0%	3.21	3.45	3.72
2	15% of ZP+8% SF+2%BF	4.54	4.92	5.26

5. CONCLUSION

1. The normal concrete compressive strength result for 28, 56 and 90 days is given as 32.48, 35.07 and 37.69 N/mm^2 .
2. At optimum of 15% zeolite powder as partial replacement with cement compressive strength test result for 28, 56 and 90 days is 40.93, 44.36 and 47.45N/mm^2 .
3. At optimum of 8% silica fume as partial replacement with cement compressive strength test result for 28, 56 and 90 days is 37.79, 40.82 and 43.96 N/mm^2 .
4. At optimum of 2% banana fiber is addition to concrete compressive strength test result for 28, 56 and 90 days is35.12, 37.93 and 40.74N/mm^2 .
5. The normal concrete split tensile strength test result values for 28, 56 and 90 days isgiven as 3.21, 3.45 and 3.72N/mm^2 .

6. At optimum of 15% zeolite powder as partial replacement with cement split tensile strength test result for 28, 56 and 90 days is 4.17, 4.51 and 4.83N/mm^2 .
7. At optimum of 8% silica fume as partial replacement with cement split tensile strength testresult for 28, 56 and 90 days is 3.81, 4.12 and 4.46N/mm^2 .
8. At optimum of 2% banana fiber is addition to concrete split tensile strength test result for 28, 56 and 90 days is 3.58, 3.86 and 4.38N/mm^2 .
9. By Combined Replacement of 15% of ZP+8% SF+2%BF the compressive strength test result for 28, 56 and 90 days is 44.91, 48.52 and 52.03N/mm^2 .
10. By Combined Replacement of 15% of ZP+8% SF+2%BF the Split tensile strength test result for 28, 56 and 90 days is 4.54, 4.92 and 5.26 N/mm^2 .

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