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# Experimental Investigation on Pine Apple Leaf Fiber Concrete with Silica Fume

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**ABSTRACT:** This study investigates the mechanical properties of concrete with pineleaf fiber addition and the replacement of silica fume with cement. Pineleaf fibers, sourced from renewable pine forests, are explored as a sustainable alternative to traditional concrete reinforcement materials. Additionally, the substitution of silica fume with cement aims to improve the environmental of concrete production. Various concrete mixtures were prepared with different proportions silica fume blends with cement- 5%,7.5% and 12.5%. 0.3% of Pineleaf fibers were added to concrete. Mechanical tests, including compressive strength and Split tensile strength assessments, were conducted to evaluate the performance of the modified concrete. The results indicate that the inclusion of pineleaf fibers enhances the tensile strength and crack resistance of concrete. To asses strength at 7 and 28 days.

**KEY WORDS:** Pine leaf fibers, Silica Fume, Sustainable, Compressive Strength and Split Tensile Strength.

## I. INTRODUCTION

Concrete, being the most widely used construction material globally, has seen continuous innovation to meet the demands of sustainable development. Traditional concrete production relies heavily on non-renewable resources, such as aggregates and cement, leading to environmental concerns due to high energy consumption and carbon emissions. In this context, the exploration of alternative materials and additives to improve the performance and sustainability of concrete has gained significant attention from researchers and practitioners.

One such promising avenue is the incorporation of natural fibers into concrete mixtures. Natural fibers offer several advantages, including their renewable nature, low cost, and ability to enhance the mechanical properties of concrete. Pineapple leaf fibers (PALF) are among the natural fibers that have garnered interest due to their abundance as agricultural waste and their potential to reinforce concrete effectively.

In addition to natural fiber reinforcement, the use of supplementary cementitious materials (SCMs) has been widely studied to enhance the performance of concrete. Silica fume (SF), a byproduct of silicon and ferrosilicon alloy production, is a commonly used SCM known for its pozzolanic properties. By incorporating silica fume into concrete mixtures, improvements in strength, durability, and resistance to chemical attack can be achieved. Moreover, the utilization of silica fume contributes to the reduction of greenhouse gas emissions associated with cement production, thus promoting sustainability in the construction industry.

## II. OBJECTIVE

1. Evaluate the impact of replacing a portion of cement with silica fume on the performance of pineapple leaf fiber concrete, focusing on improvements in strength, durability, and sustainability.

## III. MATERIALS

**3.1 Cement:** The most common type of cement used in construction globally is regular Portland cement, which is a necessary component of plaster, concrete, mortar, and most nonspecialty grouts. Cement is the main ingredient used in the production of concrete. Concrete's characteristics will be significantly affected by changes in cement content. The cement used in this project is regular Portland cement, grade 53, in compliance with IS 12269-2013.



**3.2 Fine Aggregate:** The most important ingredient in concrete that is created with crushed stone or natural sand is fine aggregate. The density and caliber of the fine aggregate have a significant impact on the properties of the cured concrete.

**3.3 Coarse Aggregate:** The greatest and minimum sizes of the coarse material that was employed were 20 and 12.5 mm, respectively. Locally, it was easily accessible. The aggregates were cleaned to get rid of dirt and dust, and then they were dried until just the surface was damp. It was discovered that the aggregates complied with IS: 383-1970.

**3.4 Silica Fume:** Silica fume, also known as microsilica, is a byproduct of producing silicon metal or ferrosilicon alloys. It consists of very fine particles, mostly amorphous silica, that are created during the process of reducing high-purity quartz with coal in an electric arc furnace. Silica fume is typically collected from the furnace exhaust gases. It is extremely fine, with most particles being less than 1 micron in diameter.

**3.5 Pine Apple Leaf Fiber :** Material science and bio composites have greatly benefited from pineapple leaf fiber composite. PALF has shown to be an effective replacement for artificial filaments because of its reasonable and endless character. To generate the fibers, the outermost layer of the leaves is separated from the leaf fibers and dried.

**3.6 Water:** Water is one of the most important building elements. It is required for many different operations, such as curing work, mixing cement concrete, and creating mortar. The quality of the water used in the construction project has a direct impact on the strength of the motor and cement concrete.

#### IV. EXPERIMENTAL INVESTIGATIONS

**4.1 Compressive Strength Results:** To determine the material's compressive strength, concrete specimens are cast and cured under carefully monitored circumstances according to standard procedures. These specimens are typically put through a series of increasingly stronger compressive forces until they fail in a compression testing machine. The greatest compressive load that a specimen can support is divided by its cross-sectional area to determine the concrete's compressive strength, which is commonly expressed in megapascals (MPa) or N/mm<sup>2</sup>.

**Table 1: Compressive Strength of Pine Apple Leaf fiber Concrete With 0.3% Constant Percent and Varying Percentage of Silica Fume as Partial Replacement of Cement.**

S.No	0.3% of PALF+ % of Silica Fume	Compressive Strength results, (N/mm <sup>2</sup> )	
		7 days	28 days
1	0%	26.38	39.08
2	0.3%+5%	32.96	48.34
3	0.3%+7.5%	36.11	51.67
4	0.3%+12.5%	32.63	47.72

**4.2 Split Tensile Strength Test:** To assess the split tensile strength of concrete, a device with two compressive platens and a cylindrical specimen placed horizontally between them is used. Diametric compression causes the specimen to split repeatedly along its length. Tensile stress that develops perpendicular to the applied force is known as split tensile stress.

**Table 2: Split tensile Strength of Pine Apple Leaf fiber Concrete With 0.3% Constant Percent and Varying Percentage of Silica Fume as Partial Replacement of Cement.**

S.No	0.3% of PALF+ % of Silica Fume	Split tensile Strength results, (N/mm <sup>2</sup> )	
		7 days	28 days
1	0%	2.56	3.81
2	0.3%+5%	3.27	4.74
3	0.3%+7.5%	3.55	5.12
4	0.3%+12.5%	3.24	4.67

## V. CONCLUSIONS

1. The compressive strength results for 7 and 28 days of normal concrete are 26.38 and 39.08 N/mm<sup>2</sup>.
2. The split tensile strength results for 7 and 28 days of normal concrete are 2.56 and 3.81 N/mm<sup>2</sup>.
3. 0.3% of Pine apple leaf fiber in concrete and at 7.5% of silica fume the compressive strength results is optimum for 7 and 28 days is 36.11 and 51.67 N/mm<sup>2</sup>.
4. 0.3% of Pine apple leaf fiber in concrete and at 7.5% of silica fume the split tensile strength results is optimum for 7 and 28 days is 3.55 and 5.12 N/mm<sup>2</sup>.

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