Strength Studies on Pine Apple Fibre Concrete With Nano Silica

Chandra Mouli K, Pannirselvam N, Vijaya Kumar D, Anitha V, M.Chaitanya Nava Kumar

Abstract*: This study investigates the combined effect of deploying Nano-Silica (NS) and Pine apple fibres (PF) on mechanical properties of hardened concrete. NS has been used as the partial replacement of cement by 0, 1, 2, 3, 4, 5 and 6% by weight, and Pine apple fibres are used as volume substitution by 0, 1, 2, 3, 4, 5 and 6%. In our present investigation, Pine apple fibres having 40mm length were used. Compressive strength and pulse velocity test values are determined by using various combinations of NS and PF. Nano-Silica, because of its small particle size, can modify the properties by altering the micro-structure of the concrete. A notable improvement is being noticed in the strength properties of concrete when NS is used by virtue of its high pozzolanic activity confirming the evolution of higher amount of C–S–H gel in the existence of nano-particles. The addition of NS to the concrete will improve the properties strength as well as durability to a great extent. On the other hand, the addition of pine apple fibres to the concrete results in the reduction of permeability and the improvement in the crack resistance eventually.

Index Terms*: Compressive strength, Crack resistance, Durability, Nano-Silica, Pineapple fibre.

I. INTRODUCTION

Construction technology has advanced through several investigations and experiments to enhance the durability and strength of concrete. The material, which contains a fibrous structure and length, is thousands of times larger than FIBRE. Man was innovative all the time. Man has produced many plants of natural fibres when talking about textile fibres. Pina, a textile fiber obtained from pineapple leaves, is one of these inventions. Fibres used in concrete are mainly categorized into natural and artificial fibres. The sources of natural fibres are vegetables, animal and mineral sources. The artificial fibres are produced from synthetic materials, steel and natural polymers. Fibres exist in various forms such as Cocosnucifera (coconut) fibre, Musa acuminate (banana) fibre, steel fibre, AR glass fibre, natural fibre, jute fibre, pine apple fibres, synthetic fibre, etc. Pineapple fibre offers the resistance to suddenly applied loads, limits the shrinkage crackings, decreases the permeability and hence ultimately decreases the bleeding of water.

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Chandra Mouli K, Professor & HOD, Department of Civil Engineering, NRI Institute of Technology, Visadala(V), Medikonduru(M), Guntur, Andhra Pradesh, India

Pannirselvam N, Associate Professor, Department of Civil Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai, Tamilnadu, India.

Vijaya Kumar D, Principal & Professor, Department of Civil Engineering, Kodada Institute of Technology and Science for Women, Kodada, Andhra Pradesh, India.

Anitha V, Asst. Professor, Department of Civil Engineering, NRI Institute of Technology, Visadala (V), Medikonduru(M), Guntur, Andhra Pradesh, India.

M.Chaitanya Nava Kumar, Asst. Professor, Department of Civil Engineering, NRI Institute of Technology, Visadala (V), Medikonduru(M), Guntur, Andhra Pradesh, India.

A lot of researchers have shown a remarkable interest in determining the behavior of concrete using Nano-Silica(NS) and its effect on the strength properties. Nano - silica fibres have an amazing feature of acting as a cementiouspozzolonic additive and, on the other hand, can also improve the concrete porous structure. Nano-silica can play a vital role in densifying the micro-structure of the cement paste. In this particular investigation, the strength properties of concrete are investigated and determined experimentally by deploying various combinations of nano-silica and pine apple fibres in concrete to attain the concrete with high characteristics compared with conventional concrete.

II. OBJECTIVES OF THE EXPERIMENTAL INVESTIGATION

1. To evaluate the compressive strength of the Nano-Silica concrete by using pine apple fibre in different proportions at different ages.
2. The comparison is made between pine apple fibre reinforced Nano-silica concrete and normal concrete with different percentages at different ages.
3. To evaluate the optimum percentage of pine apple fibres.

III. EXPERIMENTAL DETAILS

The materials used in this investigation have been presented below, such as

- Ordinary Portland cement of 53 Grade.
- Fine aggregate
- Coarse aggregate
- Nano-Silica particles
- Pine apple fibres
- Water

1. Cement: The physical properties of 53 Grade Ordinary Portland cement tested in the laboratory in Table 1.

Table 1 Physical properties of cement

S.No.	Properties	Values
1	Normal consistency	31%
2	Initial setting time	120 min
3	Final setting time	300 min
4	Fineness test	7 %
5	Specific gravity	3.15
6	Fineness modulus	2.5

2. Fine Aggregate: The nearby available river sand is used for the experimental investigation. The physical properties are presented in Table 2.

Table 2 Physical Properties of fine aggregate

S.no.	Properties	value
1	Specific gravity	2.60
2	Water absorption	1.65%
3	Fineness modulus	2.5

3. Coarse Aggregate: The tested physical properties of the coarse aggregates are tabulated in Table 3.

Table 3.Physical properties of coarse aggregate

S.No.	Properties	Value
1	Specific gravity	2.70
2	Water absorption	1.40%
3	Bulk density	1490m^3

4. Nano-Silica Particles: Nano Technology for concrete includes the use of nanomaterials such as nano - silica, nano fibres, etc. The addition of nano materials allows the production of concrete composites with superior properties. The addition of NS in concrete and mortar leads to more efficient cement hydration. This also helps to reduce the requirement for cement. NS improves the microstructure and reduces the concrete water permeability. Concretes with strengths up to 100 MPa can be produced with high workability, anti - bleeding properties and a short de - molding time. Nano - silica can be used as an eco - concrete mixture additive. A reaction between cement and water produces calcium silicate hydrate, which gives concrete strength and other concrete mechanical properties, as well as certain by - products, including calcium hydroxide.

5. Pine Apple Fibre: Pina is a fibre made from pineapple plant leaves and is widely used in the Philippines. A textile fabric is sometimes combined with silk or polyester. The name of Pina comes from the Spanish word pina, meaning literally Pineapple. Pina fabric is only a few weavers looming by hand, it is very precious and scarce, which also makes it expensive. Since pina is a leaf, the leaf must first be cut out of the plant. The fibre is then removed or divided from the leaf. Most fibres of the leaf are long and stiff. Each pina fibre strand is hand scraped and knotted one by one to form a continuous hand - woven filament. Pina is intensive, as every step is mostly done by hand.

a. Properties of Pina Fibre

Pine Apple Leaf Fibre (PALF) Pineapple leaf fibre is multi-cellular with an average ultimate cell length of 5 mm. The fibre is lignocelluloses in nature and its physical and chemical properties are furnished in Table 4 and 5.

Table 4 Physical properties of Pina fibre

S.No.	Parameter	Value
1	Length (mm)	3-9
2	Breadth (10-3 mm)	4-8
3	L/B ratio	450
4	Gravimetric Fineness (tex)	1.54
5	Tenacity (gm/tex)	50
6	Extension at break (%)	2-6
7	Flexural rigidity (dyne cm^2)	3.8
8	Density (Gm/cc)	1.48
	Moisture Regain at 65%	

Table 5 Chemical properties of Pina fibre

Holocellulose	87.56%
Alpha-cellulose	78.11%
Hemicellulose	9.45%
Lignin	4.78%

Chemical constituents Various pineapple fibre constituents viz. α- cellulose, pentosans, lignin, fat and wax, ashcontent, nitrogenous matter, pectin ,degree of polymerization and crystallinity of α-cellulose determined with standard methods.

b. Advantages of Pina Fibre

The fabric has a silk - like natural gloss and is better in quality. This gloss protects the fibres and therefore no treatment with toxic chemicals is required for pina. Washing and care is easy; no dry cleaning is required. Pina cloth is wear-resistant It is an ideal eco-textile for clothing Pina fibre Long, fine, lustrous.

6. Water: To mix the concrete and also to heal the specimens, potable water from the laboratory was used.

IV. HARDENED CONCRETE

a. Compressive Strength: The compressive strength of Nano-Silica concrete in association with pine apple fibres has shown increment. The results that are obtained for the compressive strength at 28days are as shown in Table 6.

***b. Pulse Velocity Test*:** The results that are obtained for the Pulse Velocity test at 28 days are as shown in Table 6.

Table 6 Results of compressive strength and pulse velocity test values of Nano-Silica concrete reinforced with Pine apple fibre

S.No	Combined % of NS & PF	Compressive Strength (N/mm^2)		Pulse Velocity (m/s)
		7 days	28 days	28 days
1	0+0	29.37	40.80	4415
2	1+1	33.67	47.77	4500
3	2+2	37.67	54.39	4545
4	3+3	41.78	60.61	4592
5	4+4	40.66	56.86	4573
6	5+5	37.71	53.07	4531
7	6+6	36.67	50.83	4515

V. CONCLUSION

Results have been analyzed taking into consideration the strength characteristics of Nano-Silica concrete reinforced with the pine apple fibre of M30 grade.

1. The experimental tests showed that the strength of concrete improved by adding pine apple fibres to the nanosilica concrete.
2. The addition of pine apple fibres considerably increased the strength characteristics of Nano-silica concrete, mainly compressive and tensile strength.
3. The cracking resistance of the concrete has also improved to a greater extent.
4. When compared to normal concrete, the compressive strength of pine apple fibre reinforced Nano-silica concrete of M30 grade has improved.
5. The compressive strength of concrete has increased gradually up to 3+3% addition of NS+PF and has shown gradual decrement in the compressive strength beyond that percentage.
6. The maximum increment of compressive strength i.e.at 3+3% is 42.25% for 7 days and 48.55% for 28 days.
7. The value of pulse velocity test showed the maximum increment of 4592m/s at 3+3% addition of NS+PF fibres.

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AUTHORS PROFILE

Dr.N.Pannirselvam Ph.D from Structural Engineering and life time member in ISTE, ISE, ICI, ISRD and IAENG. Presented 16 in National and 6 in International Conferences. Published 45 papers in peer reviewed International Journals. Reviewer in 9 Journals and editorial board member in 12 Journals. Delivered six Guest Lecturers in Earthquake Resistant Design of Structures. Received Rajiv Gandhi Gold Award for outstanding achievements.

Dr. K.Chandramouli Ph.D from JNTUH and life time member in ISTE. Presented 2 in National and in International Conferences. Published 80 papers in peer reviewed International Journals.

Dr. D. Vijaya Kumar, PhD. Presented 4 in National and 4 in International Conferences. Published 18 papers in peer reviewed International Journals.

Ms. Anitha V, Published 15 papers in peer reviewed International Journals.

Mr. M.Chaitanya Nava Kumar M.Tech in Structural Engineering. Published 04 papers in peer reviewed International Journals.