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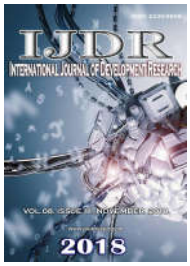

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

EXPERIMENTAL INVESTIGATION OF NANO SILICA CONCRETE IN ASSOCIATION WITH BANANA FIBRE REINFORCEMENT

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ABSTRACT

This study investigates the combined effect of deploying Nano-Silica (NS) and banana fibers (BF) on mechanical properties of hardened concrete. NS has been used as the partial replacement of cement by 0, 2, 2.5, 3, 3.5, 4 and 4.5% by weight, and BF has used as volume substitution by 1, 2, 3, 4, 5 and 6%. In our present investigation, banana fibres having 40mm length were used. Compressive strength and split tensile strengthare determinedby using various combinations of NS and BF. 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 usedby 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 banana fibres to the concrete results in the reduction of permeability and the improvement in the crack resistance eventually.

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INTRODUCTION

Construction technology has advanced through several investigations and experiments to enhance the durability and strength of concrete. 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, synthetic fibre, etc. Banana 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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A lot of researchers have shown a remarkable interest in determining the behavior of concrete using Nano-Silicaand its effect on the strength properties. NS fibres do have an amazing characteristic of acting as a cementitious Pozzolonic additive and on the other hand, it can also enhance the pore structure of concrete. NS 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 NS and BF in concrete to attain the concrete with high characteristics compared with conventional concrete.

Objectives of the Experimental Investigation

The main objective of this project is to determine experimental investigation on behavior of Nano-Silica concrete in association with Banana fiber reinforcement.

1. To evaluate the compressive strength, split tensile strength of the Nano-Silica concrete by using Musa acuminate (banana) fibre in different proportions at different ages.
2. The comparison is made between Banana Fibre reinforced Nano-Silica concrete and normal concrete with different percentages at different ages.
3. To evaluate the optimum percentage of Musa acuminate (banana) fibres.

Experimental Details

In the present investigation, the materials used were presented below such as

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

Cement: Locally available 53 Grade Ordinary Portland cement is used for the experimental work. The physical properties of 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

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

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	1490 kg/m^3

Nano-Silica particles: Nano technology applied to concrete includes the use of nanomaterial like Nano-Silica, Nano fibres etc. By adding the Nano materials, concrete composites with superior properties can be produced. Addition of NS in concretes and mortars results in more efficient hydration of cement. Due to the pozzolanic activity, additional calcium silicate hydrates are formed to generate more strength and to reduce free calcium hydroxide. This also helps in reducing the cement requirement. NS improves the microstructure and reduces the water permeability of concrete thus making it more durable. Concretes with strengths as high as 100 MPa with high workability, anti-bleeding properties and short de-moulding time can be produced. NS can be used as an additive to eco concrete mixtures. A reaction between the cement and water yields calcium silicate hydrate, which gives concrete strength and other mechanical properties of concrete as well as some by-products including calcium hydroxide.

Banana Fibre: Banana Fibre is a very good replacement for synthetic fibre. The banana used for this work is collected from the local village, Cherukupalli. The fibres are made into uniform length of 40mm by using cutting machine. Salient physical and mechanical properties of banana were determined in their natural form. The physical properties of BF tested in the laboratory in Table 4.

Table 4. Physical Properties of Banana Fibre

S.No.	Properties	Value
1	Density	1350 kg/m^3
2	Moisture content	11 %
3	Tensile strength	56 MPa
4	Elongation at Break	2.60%
5	Young's modulus	3.5 MPa
6	Fineness	17.15

Fig.1. Banana fibres

Water: Potable water from the laboratory was used for mixing the concrete and also for curing the specimens.

Tests on Hardened Concrete

Compressive strength: The compressive strength of Nano-Silica concrete in association with banana fibers has shown increment. The results that are obtained for the compressive strength at 7 and 28days are shown in Table 5.

Table 5. Results of compressive strength test of Nano-Silica concrete reinforced with banana fibre

S.No	Combined % of NS & BF	Compressive Strength (N/mm^2) 7 days	28 days
1	0+0	29.37	40.80
2	1+2	31.57	44.79
3	2+2.5	35.61	51.41
4	3+3	39.73	57.63
5	4+3.5	38.54	53.89
6	5+4	35.60	50.09
7	6+4.5	34.52	47.85

Split Tensile Strength

The addition of Banana Fibres to the Nano-Silica concrete increases the split tensile strength appropriately. The results that are obtained for the split tensile strength at 7 and 28 days are presented in Table 6.

Table 6. Results of split tensile strength test of Nano Silica concrete reinforced with banana fibre

S.No	Combined % of NS & BF	Split Tensile Strength(N/mm^2) 7 days	28 days
1	0+0	2.89	4.02
2	1+2	3.23	4.46
3	2+2.5	3.54	5.26
4	3+3	3.67	5.75
5	4+3.5	3.64	5.69
6	5+4	3.47	4.94
7	6+4.5	3.21	4.61

Conclusion

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

1. The experimental tests revealed that the strength properties of concrete improved with the addition of banana fibres to the Nano-Silicaconcrete.
2. The addition of Banana Fibres considerably increased the strength characteristics of Nano-Silica concrete, mainly compressive strength 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 Banana 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+BS 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 35.2% for 7 days and 41.25% for 28 days.
7. The split tensile strength of concrete has increased gradually up to 3+3% addition of NS+BS fibre and has shown gradual decrement beyond that percentage.
8. The maximum increment of split tensile strength i.e.at 3+3% is 26.9% for 7 days and 43.03% for 28 days.

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