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Combined Effect of Banana Fibre and Nano Silica on the Strength Properties of Concrete

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***Abstract:** This study investigates the combined effect of nano silica and banana fibres on mechanical properties of concrete of grade M-25. Nano silica has been used as a partial replacement of cement by weight. Nano silica has been kept constant at 3% as maximum strength was achieved at this percentage according to past studies. Banana fibre has been added by weight of cement in proportions of 0.5%, 1%, 2%, 3%, 4% and 5%. Length of banana fibres kept at 40mm. Compressive strength was determined by using different combinations of nano silica and banana fibre. Nano concrete provides good strength as compared to conventional concrete. The addition of banana fibres in nano concrete improved the strength properties of nano concrete as well as improvement in crack resistance of concrete. On the other hand, the addition of banana fibres resulted in reduction workability as well as permeability of concrete.*

***Keywords:** Nano silica, banana fibre, compressive strength, workability, cement, concrete.*

I. INTRODUCTION

Concrete is the most widely used material in the construction industry because of its high load bearing capacity. It is an artificial composite material, comprising of cementitious material (typically Portland cement), filler material aggregate (typically a rocky material, loose stones, and sand) and water. Now-a-days many types of concrete are available, determined by the type and formulations of binders and the other types of materials used to suit the application of the engineered material. In the recent years, researchers have targeted on the use of different materials like fly ash, nano silica, micro silica, steel fibres, banana fibres etc.

A lot of researchers have found a remarkable result in enhancing the strength and other properties of conventional concrete by using nano silica and banana fibre. Nano-silica or silicon dioxide (SiO2) has an amazing cementitious property which can be used to partially replace cement. The addition of nano silica in a required amount within a concrete mixture modifies the material properties and performance by reducing the void space between the cement and aggregate in the cured concrete. This improves the strength, durability, shrinkage and bonding to steel reinforcing bars. In most studies, it was found that nano silica gives highest strength on partially replacing cement by 3% nano silica content. Banana fibres are eco-friendly and have valuable qualities like low density, light weight, low cost, excellent strength properties, fire and water resistance. This type of waste has a higher likelihood of finding use in various construction and building material applications. Adding banana fibres in concrete also resulted in increase in strength, prevents shrinkage cracks, reduces permeability and lessens water bleeding. In this investigation, cement is partially replaced by nano silica and different combinations of banana fibre and nano silica are used together in concrete by varying banana fibre content and keeping nano silica constant at 3%.

II. OBJECTIVES

1) To determine the compressive strength of nano concrete by using banana fibre (Musa acuminate) in different proportions.
2) The comparison is made between conventional concrete and the concrete using nano silica and banana fibre in different percentages.
3) To determine the optimum content of banana fibre.

III. EXPERIMENTAL DETAILS

A. *Materials*

- Ordinary Portland cement of 53 grade
- Coarse aggregate
- Fine aggregate
- Nano silica
- Banana fiber
- Water

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1) *Cement:* For making of M-25 concrete, OPC 53 grade (Emami double bull cement) was used having specific gravity of 3.14.
2) *Coarse Aggregate:* Machine crushed stone angular in shape was used as coarse aggregate. Two fractions of coarse aggregates were used, of size 20mm and 12.5mm in proportions of 60% and 40% respectively. Specific gravity of aggregates is 2.94 and water absorption is 0.8%.
3) *Fine Aggregate:* Locally available Narmada river sand is used for experiment passing through 4.75mm sieve having specific gravity of 2.67 and water absorption of 1.8%.
4) *Nano Silica:* Nano silica, also called quartz dust or silica dust is one of the most widely used nano materials to improve the mechanical properties of concrete. It comes in white powdered form and the size is below 100nm. It is known to increase the strength and durability of concrete as well as workability. It can significantly improve the carbonation resistance, chloride resistance, and sulphate resistance of concrete.



Fig. 3.1 Nano silica

5) *Banana Fibre:* Banana fibres are widely available as agricultural waste and are eco-friendly. Its chemical composition has cellulose, hemicelluloses and lignin content. It is highly strong and lightweight fibre which has smaller elongation. Banana fibre offers the resistance to suddenly applied loads, limits the shrinkage and cracks, increases the compressive and flexural strength, decreases the permeability and hence ultimately decreases the bleeding of water as its water absorption capacity is good. Length of fibres used is 40mm.



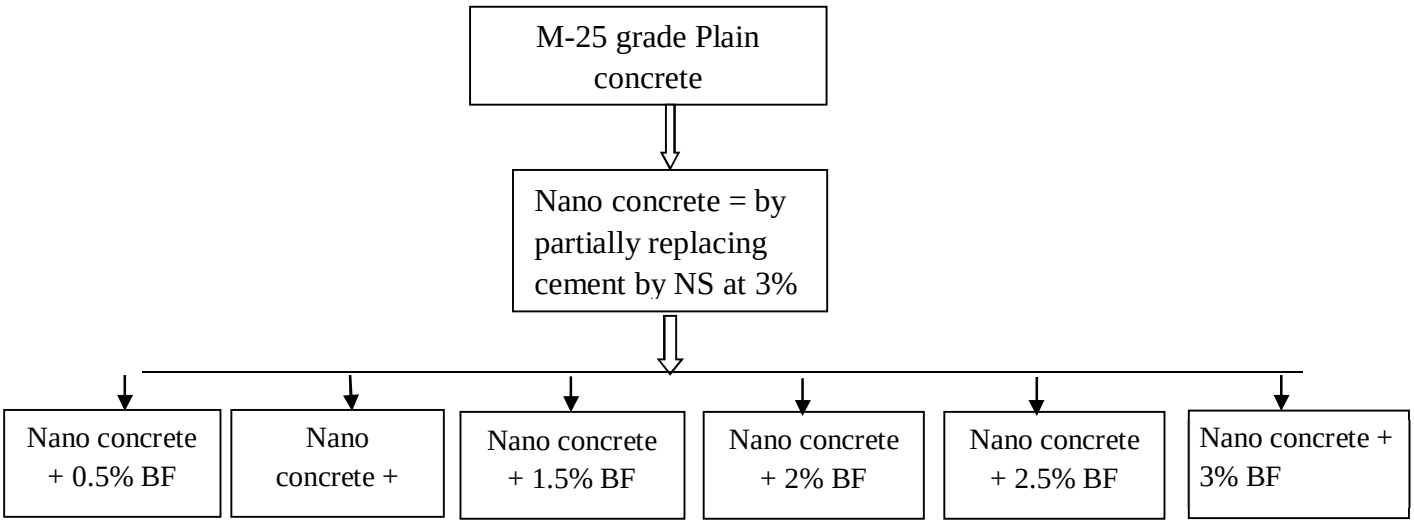
Fig. 3.2 Banana fiber

6) *Water:* Portable water from the laboratory was used for mixing and curing of concrete.

B. Methodology

1) *Test Specimen Preparation:* All the materials were tested in the laboratory as per the guidelines. Mix design of M-25 concrete was done conforming to IS- 10262: 2019.Target strength was 31.6 KN/mm2. Variations were done in the standard mix according to the percentage replacement of cement by nano silica at 3% and addition of banana fibre in variations of 0.5%, 1%, 2%, 3%, 4% and 5% by weight of cement. Water cement ratio used was 0.5. Mix design ratio of materials used was 1: 1.89: 3.41 for cement, fine aggregates and coarse aggregates respectively. Cube moulds of size 150mm*150mm*150mm were used. Cube specimens were casted for compressive strength test and cured for 28 days. Testing was done using UTM machine after 28 days of curing.

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IV. RESULTS

A. Compressive Strength Test

Cube samples were tested in the UTM machine after 28 days of curing.

Sample No.	Nano silica %	Banana fiber %	Average compressive strength at 28 days (N/mm2)
Conventional concrete	0%	0%	31.8
Nano concrete	3%	0%	40.3
Sample 1	3%	0.5%	44.6
Sample 2	3%	1%	48.1
Sample 3	3%	1.5%	41.2
Sample 4	3%	2%	36.7
Sample 5	3%	2.5%	30.33
Sample 6	3%	3%	25.5

V. CONCLUSION

1) Workability was improved by using nano silica but decreases on adding banana fibre.

2) Compressive strength of concrete was maximum at 1% banana fibre content and after that it gradually decreases on increasing banana fibre content.

3) Compressive strength increased by 51.25% as compared to conventional concrete and by 19.35% as compared to nano concrete.

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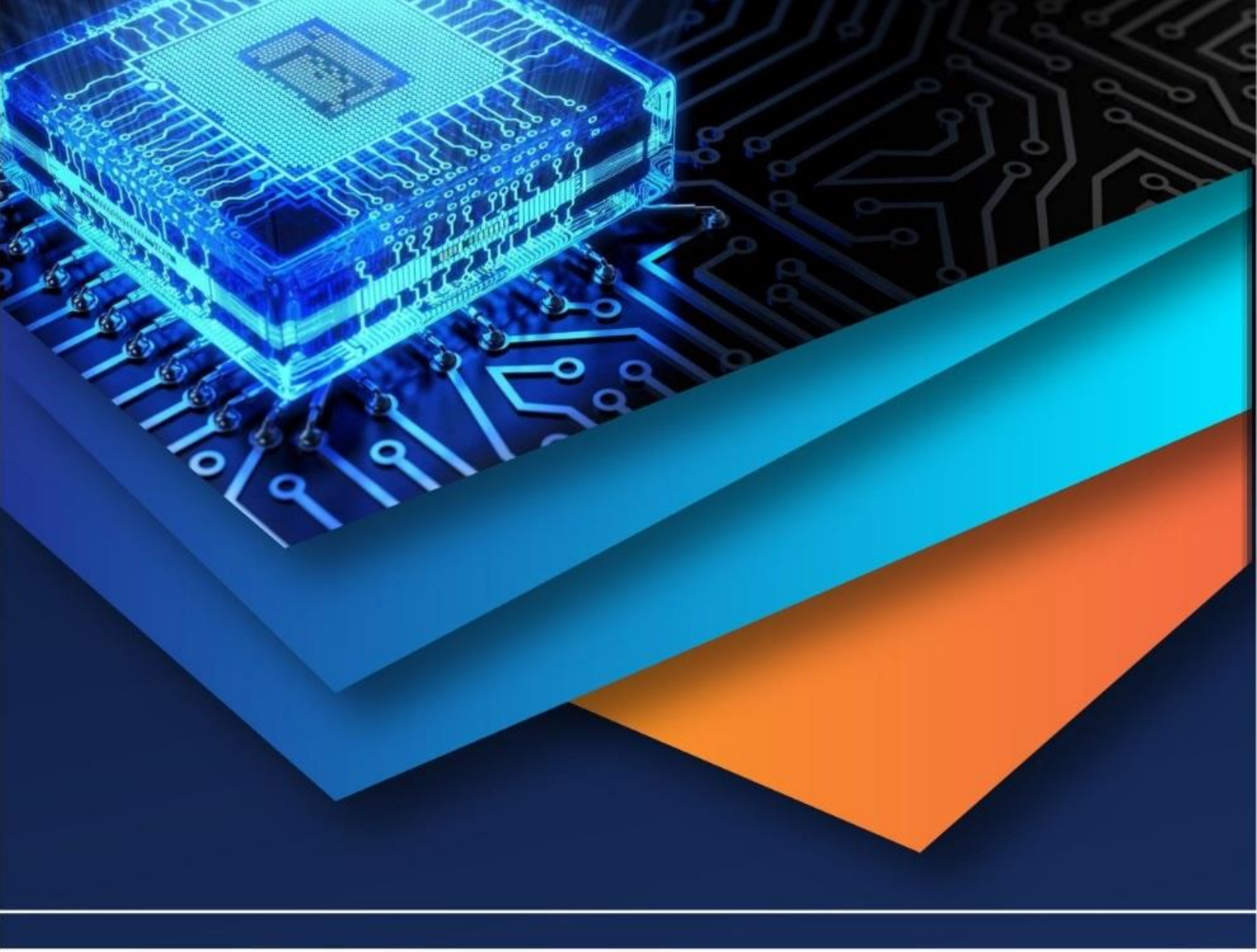
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