



HIGH PERFORMANCE CONCRETE USING NATURAL ADDITIVES – BANANA FIBERS AND NEEM EXTRACT

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Abstract: When banana fibers and neem extract were used together, the concrete showed improvements in both strength and durability, along with a low eco impacts. This shows that these natural additives can serve as a good alternative to synthetic admixtures. The study also ensures the use of turning agro and herbal waste into construction materials, which not only improves performance but also supports ecofriendly. These reports give a foundation for further calculations into eco concrete and its real time applications in civil engineering. In this experiment, banana fibers are added in three different levels (0.45%, 0.75%, and 1.25% by weight of cement) to see how they react into tensile strength and crack control. Neem extract is added at 0.7% to serve as a natural agent that can stop microbial growth and improve the concrete's durability. The plasticizer at 1.15% is also added to make the mix workable. Concrete cubes are casted, cured, and tested at different levels to observe their strength improvement. The starting results showed that the banana fibers lower the cracks and slightly increased the tensile strength. In other side Neem extract improved the bonding of the mix and results to better durability with time limit. When both banana fibers and neem extract used together, the concrete showed improved strength and durability and also being ecofriendly. This turns those daily natural materials can be used in construction not relaying on chemicals. More detailed studies can be taken up in the future to check how these materials perform under different conditions and large-scale applications.

Index Terms: High Performance Concrete, Banana Fibres, Neem Extract, Natural Admixtures, Sustainable Construction, Mechanical Properties, Compressive Strength, Eco-friendly Materials

1. INTRODUCTION

Concrete is mostly used construction material due to its different advantage of properties and ability. Traditional concrete produces significant uses to environmental affects like high carbon dioxide release and more amount consumption of natural resources [1]. In certain years researchers interested on producing High Performance Concrete (HPC), which provides good mechanical and durability properties in respective to conventional concrete [2]. The use of natural fibers and neem extracts as additional materials in HPC has reached good attention because of their eco-friendly property and ability to improve performance. Banana fibers, taken from agro waste, are lighter in weight, biodegradable, and gives high tensile strength. Adding these into concrete is reported to reduce small cracking and improves tensile resistance [3]. In the same way neem extract, collected from the neem tree (*Azadirachta Indica*), contains natural antibacterial and chemical sources that leads to improved durability and resistance to microbial attacks in concrete [4]. The mixing of such natural additives not only strengthens concrete but also promotes sustainability in the construction practices. In this study, an attempt has been made to develop High Performance Concrete by partially replacing chemical admixtures with natural additives. Banana fibers are used in different levels (0.45%, 0.75%, and 1.25% by weight of cement) but neem extract is added at 0.7% [5]. A plasticizer level of 1.15% is maintained for workability [6].

1.1 Natural Additives in Concrete

Before deciding the experimental program, the literature was reviewed to understand the concepts, abilities of natural fibers and neem extracts in improving the performance of concrete. Previous studies established those natural fibers improve tensile and flexural strength, but herbal extracts can induce antibacterial and durability benefits [7]. Based on this property, the project work focuses on combining these two natural additives in an experimental way.

1.2 Research Significance and Scope

The use of natural additives in concrete gives a dual advantage of improving mechanical properties and also promoting environmental sustainability. Banana fibers, sourced from agro waste not only improve tensile strength also promotes crack resistance and as a reduction factor in depending on synthetic fibers, which are non-biodegradable and costly [8]. On the other hand, Neem extract, acts as a natural durability by providing antimicrobial properties and improving bonding in the cement mix [9]. This study provides the combined utilization of banana fibers and neem extract in High Performance Concrete. By differentiating the percentage of banana fibers 0.45%, 0.75%, 1.25% in weight of cement and providing neem extract at 0.7%, the experiment shows the result on the compressive strength and durability of concrete cubes. A plasticizer dosage of 1.15% is also used to ensure good workability without reducing strength [8]. This experimental research addresses key issues in sustainable construction by incorporating the ease of replacing partial chemical admixtures with natural, ecofriendly materials. The result of this study for future research in optimizing natural additive combinations for high-strength and durable concrete.

2. Abbreviation and Definitions

Abbreviations used in this project are defined the HPC refers to High Performance Concrete, OPC refers to Ordinary Portland, Cement, and CTM refers to Compression Testing Machine. This topic provides a planned methodology that provides proper execution and ensures that the combined effect of natural

3. Literature Review

The use of natural additives in concrete has been a topic of interest for researchers aiming to improve performance while maintaining sustainability several studies have reported that plant-based fibers such as banana fibers and neem extract coir can enhance the tensile strength and crack resistance if concrete. Banana fibers in particular are lightweight biodegradable and possess high tensile properties which contribute to improved ductility and reduces shrinkage in Cementous mixes. Previous experimental investigations have shown that banana fibers reinforced concrete exhibits higher toughness and better energy absorption compared to conventional mixes.[9]Similarly, the inclusion of herbal extracts like neem has been recognized for its durability benefits Neem extract contains bio active compounds that possess antimicrobial and antifungal properties, which can reduce the risk of microbial induced concrete deterioration research has demonstrated that the addition of neem solutions improves long term durability by reducing permeability and enhancing resistance against harmful chemical attacks. When combined natural fibers and herbal extracts provide a balanced improvement in both mechanical and durability aspects of concrete. these findings highlight the ecofriendly additives not only reduce the reliance on synthetic admixtures not only reduces the reliance on synthetic admixtures but also promote sustainable construction practices. This study builds upon such research by exploring the cooperatives effect of banana fibers and neem extract in high performance concrete [10].

4. OBJECTIVES AND METHODOLOGY

4.1 Objectives

The primary objective of this project is to find the effect of ecofriendly materials like banana fibers and neem extract and their properties in the inclusion of High-Performance Concrete (HPC) [11].

- To find the compressive strength of Concrete with 3 different percentage levels of banana fibers (0.45%, 0.75%, and 1.25%).
- To assess the durability growth provided by neem extract at 0.7%
- To Optimize the mixture of banana fibers and neem extract for sustainable and eco-friendly concrete application
- To promote a practical reference for using natural additives in concrete while maintaining good workability.

4.2 Materials Used

High Performance Concrete (HPC) was mixed using Ordinary Portland Cement (OPC 53 grade), fine aggregate sand, and

coarse aggregate of 20mm sizes. Banana fibers are mixed in three proportions, and neem extract was added as a natural durability compound. Super plasticizer of 1.15% is mixed to maintain the workability in the cubes [12]. All materials are used correctly, and primary tests on cement, sand, and aggregate was conducted to ensure proper results. The mix design involves of using cement, sand, water is used in the quantity as follows, Fine aggregates combining sand and cement 33.6kg, coarse aggregate 34kg and natural additives Banana Fire as 57g,96g and 160g for different level of mixes. The mix design ratio which we decided to perform for this project HPC is 1:1.65:3.2 to obtain the desired results [21].



“Fig:1”



“Fig:2”

4.3 Methodology

The methodology follows:

- Mix preparation: Mixing of cement, sand, coarse aggregate, and banana fibers, and by addition of water, neem extract, and Super plasticizer [13].
- Casting of Cube: The mixed concrete was poured into 150 mm × 150 mm × 150 mm cube molds, compacted, and finished properly and left for curing.
- Curing: Cubes are cured under water for 7, 14, and 28 days.
- Testing: Compressive strength tests were conducted using a Compression Testing Machine (CTM), and results were recorded for each curing period
- Analysis: Average compressive strength values for three cubes per was calculated, and comparison are made to determine the optimal combination of natural additives.

This methodology ensures productivity in using eco materials and accurate resulting of material performance, and proper

assessment of the combined effect of banana fibers and neem extract on HPC.

5. MATERIALS AND METHODS

High Performance Concrete (HPC) is prepared using Ordinary Portland Cement River sand as fine aggregate, and 20 mm coarse aggregate. Banana fibers are added in three different percentages of (0.45%, 0.75%, and 1.25% to test their reaction on tensile and compressive strength. Neem extract (0.7% by weight of cement) is used to improve durability and in turn it also provides natural antimicrobial properties. A plasticizer of 1.15% was used to maintain workability of the concrete mix [14].



“Fig: 3”



“Fig: 4”

6. Mixing and Cube Casting

All materials are measured correctly and mixed in a dry state before adding water and. The proportions used in the mix for one cube were as follows, Cement 1.14kg, Sand 1.71kg, CA 3.42kg, Water ratio 0.43. Neem Extract 7.98ml as 0.7%, Banana Fiber 5.13g, 8.55g, 13.11g for three different percentages (0.45%,0.75%,1.15%). Then the mixed concrete is poured into 150x150x150mm cube molds for compressive strength testing. The cubes were left to curing under normal water for 7, 14, and 28 days [15]. Compression Testing Machine (CTM) is used to test the cubes and the results are analyzed. The experiment ensured consistency under different mix percentages which provides comparison of the effects [16].



“Fig:5”

7. Testing and Result Analysis

The compressive strength of the High-Performance Concrete (HPC) cubes is tested using a Compression Testing Machine (CTM) with correct procedure Cubes of 150 mm × 150 mm × 150 mm were tested at curing period of 7, 14, and 28 days [17]. The cubes are taken off from water curing, by using CTM machine the load was applied centrally until failed [18].

The initial results indicate that the addition of banana fiber reduces micro-cracking, and also improves compressive strength. Among the three percentages tested (0.45%, 0.75%, and 1.25%), the 0.75% fiber mix resulted good performance with a compressive strength of 20.5Mpa, balancing strength and workability [19]. The usage of neem extract (0.7%) showcased durability growth, providing improved bonding in the cement mix and enhancing antimicrobial properties [20].



“Fig:6”

8. DICSUSSION

The results of this experimental study clearly demonstrate that the incorporation of banana fibers and neem extract has a significant influence on the mechanical behavior and durability of high-performance concrete. The different trial mixes, 0.7 neem extract and 0.75% banana fibers gained the optimum performance in compressive strength and also in workability. This indicates that moderate's proportions of fibers are effective in bringing micro cracks and improving tensile resistance while neem extracts contribute to long term durability by reducing permeability and microbial activity. It was also observed that when the dosage of banana fibers was increased to 1.15% the workability of the mix reduced due to fiber balling and poor dispersion which negatively affected the strength gain. On the next view, lower fiber content such as 0.45 enhances the flexibility but did not provide the level of crack resistance as the like the optimum mix. The inter usage effect of combining herbal extract with natural fibers shows that a sustainable approach as it reduces the usage on synthetic admixtures while proving similar performance improvements in these

natural fibers and materials. The findings show that with earlier research reported in the literature, thereby validating the potential of natural additives in developing durable ecofriendly and cost-effective construction materials.

9. FUTURE SCOPE

- Long-term durability tests like chloride penetration, acid resistance and sulphate cause test can be carried to confirm field working performance
- Microstructural analysis using SEM and XRD can provide better understanding of bonding between fibers, neem extract, and cement matrix.
- The experiment study can focus to other structural elements like beams, slabs, and paver blocks.
- Cost-benefit analysis and findings can be tried to compare natural additives with traditional chemical admixtures.
- Large-scale field trials can be conducted to produce the practical application of this eco-friendly high performance concrete mix.

10. CONCLUSION

This experimental study on High Performance Concrete using Natural Additives like Banana fibers and neem extract shows that natural additives can improve the durability and mechanical properties of concrete. Neem extract produces long-term durability and establish antimicrobial benefits, same time banana fibers improve structural performance of concrete, control small cracks and improves tensile strength. The concrete cubes were uniformly compacted and had good flowability and the addition of 1.15% Super plasticizer was Advantage. The cooperative effect of combining banana fibers with neem extract was resulted good for the practical application in the field of Civil Engineering.

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