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FIBER-REINFORCED CONCRETE USING SYNTHETIC FIBERS

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Abstract - *Fiber Reinforced Concrete (FRC) is a cutting-edge composite material that improves the mechanical qualities and durability of concrete by incorporating discrete fibers into the matrix. By addressing typical problems including shrinkage, tensile weakness, and cracking, this novel method greatly enhances the performance of traditional concrete. A variety of materials, including steel, glass, polypropylene, and natural fibers, may be used to create fibers, and each one offers special advantages to the concrete.*

Fiber-reinforced concrete (FRC) has gained significant attention in modern construction due to its enhanced mechanical properties and durability. This study explores the use of polyester fibres as a reinforcement material in M25 grade concrete to assess their impact on the performance of concrete under various loading conditions. Polyester fibres, known for their lightweight, cost-effectiveness, and high tensile strength, were incorporated into the concrete mix in varying proportions by weight of cement.

The primary objective was to evaluate the compressive strength, flexural strength, and durability of the concrete. Experimental investigations revealed that the inclusion of polyester fibers improved crack resistance, tensile strength, and toughness, with optimal performance observed at specific fiber content. The research highlights the potential of polyester fibers in reducing micro-cracking and improving post-crack behavior, making it a viable alternative for applications requiring enhanced ductility and durability.

This study emphasizes the role of polyester fibers in achieving sustainable and efficient concrete solutions, contributing to the advancement of construction materials in infrastructure development. Further research is recommended to analyze long-term durability and cost implications in real-world applications.

Key Words*: *Machine Learning (ML), Mobile Ad-Hoc Networks (MANETs), Intrusion Detection Systems (IDS), Malicious Attacks, Routing Security

1. INTRODUCTION

In recent years, the demand for durable, sustainable, and high-performance construction materials has led to increased innovation in concrete technology. One area of focus has been on fiber-reinforced concrete (FRC), which incorporates various fibers to enhance the material's strength, flexibility, and durability. FRC is widely recognized for its applications in structural components that require superior resistance to cracking, impact, and fatigue. Polyester fibers, known for their cost-effectiveness and favorable mechanical properties, represent a promising reinforcement material, especially in the context of environmental and economic considerations. This research aims to explore the potential of polyester fibers in enhancing the mechanical properties and sustainability of concrete mixes, paving the way for more resilient infrastructure..

2. Background of the Work

Concrete is one of the most widely used construction materials globally, yet its inherent brittleness and susceptibility to cracking have driven the development of innovative reinforcing solutions. Fiber-reinforced concrete (FRC) stands out in this regard, offering significant improvements in durability, tensile strength, and crack resistance. However, unlike traditional steel reinforcements, the use of synthetic fibers such as polyester has been gaining traction due to their advantageous properties and cost-effectiveness. Polyester fibers are known for their high tensile strength, resistance to alkalis, and ability to disperse microcracks, thereby enhancing the resilience of concrete and extending its lifespan. With a growing emphasis on sustainable and resilient construction materials, polyester fiber-reinforced concrete (PFRC) presents a promising alternative that addresses both performance and durability demands in infrastructure development and genetics. Algorithms have become an important choice for researchers in finding effective and optimized solutions to MANET security. Therefore, in this

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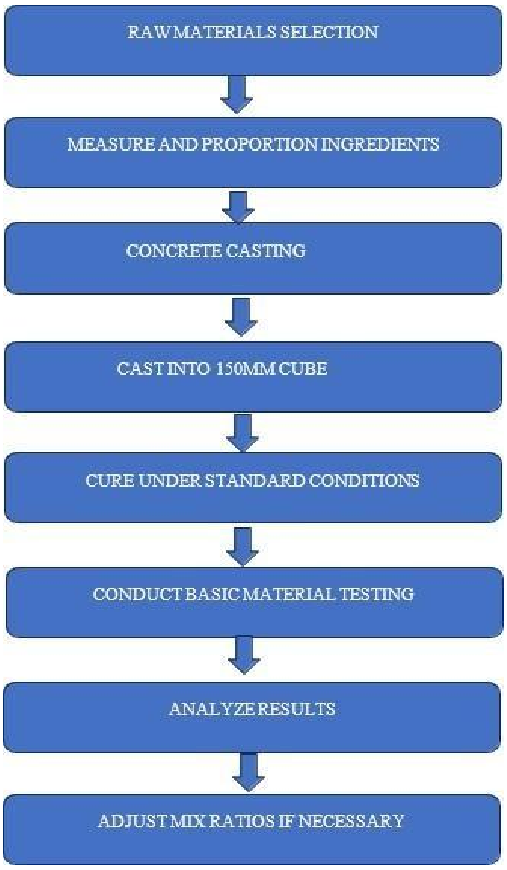
3. RAW MATERIALS SELECTION BASED ON:

Choose Ordinary Portland Cement (OPC) or other types based on strength and durability requirements, with the grade selected (e.g., 43 or 53 grade) to match the desired concrete strength.



Analysing Fiber-Reinforced Concrete (FRC) Using Polyester Fiber:

- compressive Strength Test: Use a compression testing machine to determine the compressive strength of the concrete specimens (cubes/cylinders) after curing.
- Tensile Strength Test: Conduct a splitting tensile strength test on cylindrical specimens to evaluate the tensile strength of the fiber-reinforced concrete.
- Flexural Strength Test: Perform a three-point bending test on beam specimens using a flexural testing machine to measure the flexural strength of the concrete.
- Water Absorption Test: Assess the porosity and water absorption characteristics of the concrete samples to evaluate durability.
- Durability Testing: Conduct tests such as rapid chloride permeability or freeze-thaw cycles to assess the durability of the fiber-reinforced concrete under various environmental conditions.
- Microstructural Analysis: Use scanning electron microscopy (SEM) to investigate the fiber distribution, bonding, and overall microstructure of the fiber-reinforced concrete matrix.
- Workability Test: Perform the slump test to evaluate the workability of the fresh concrete mix before casting

1. Cement Tests:

• Fineness:

Specific Surface Area: Greater than 300 m^2/kg (Blaine's Air Permeability Test) Retained on 45 µm sieve: Not more than 10%.

• Consistency:

Standard Consistency: 25% to 30% (dependent on the type of cement)

• Setting Time:

Initial Setting Time: Minimum 30 minutes

Final Setting Time: Maximum 600 minutes

Specific gravity of M sand:

Calculate the Specific Gravity

Calculate the weight of the M sand:

Weight of M sand = W2−W1

Calculate the weight of the water displaced (which is equal to the weight of water):

Weigh of water = $W4-W1$

Calculate the specific gravity using the formula:

Specific Gravity = Weight of M sand/Weight of water

Calculation:

Assuming the following weights were recorded:

W1 (Weight of empty cylinder) = 0.50 g

W2 (Weight of cylinder with M sand) = 1.50 g

W3 (Weight of cylinder with M sand submerged in water) = 1.80 g

3.2 Pycnometer Test for Steel Slag:

W1 = 0.532g (Weight of the empty container)

W2 = 1.222g (Weight of the container with steel slag)

W3 = 2.056g (Weight of the container with steel slag and water)

W4 = 1.453g (Weight of the container with water)

Steps to Calculate Bulk Density and Specific Gravity

1.Calculate the weight of the steel slag:

$W\text{slag} = W2 - W1$

3.3 PROCEDURE FOR CYLINDER CASTING FOR M40 GRADE FRC WITH POLYESTER FIBER (Cylinder Diameter 15 cm, Height 30 cm)

I. Volume of Cylinder:
Volume of Cylinder=$\pi \times d2/4*$ h=3.1×530=3.14×2254×=5306.25 cm3=0.00531 m3
Volume of Cylinder=π× 4d 2×h=3.14× 415 2×30=5306.25cm 3=0.00531m 3

II. Mix Proportions for Casting:
Cement:
35
=2.518×0.531=0.1662 kg=166.2 gm=
82.51×0.531=0.1662kg=166.2gm

Coarse Aggregate:
=2.8×0.531=1.4868 kg=1486.8 gm

Water (Water-Cement Ratio = 0.40):
=0.4×166.2=66.48ml=0.4×166.2=66.48ml
feeding simulated data into a recurrent neural network (RNN).

4 PROCEDURE FOR CUBE CURING:

Curing concrete cubes is an essential process in determining the compressive strength of concrete.
Here's a general procedure for curing concrete cubes.
Curing Compound Application:
After casting and finishing, cover the moulds with a plastic sheet to prevent moisture loss.
Curing Duration:
Cure the concrete cubes for a specified duration as per relevant standards or
project requirements (commonly 7 to 28 days).
Transportation and Testing:
Transport the cured cubes to the testing laboratory in a manner that ensures they remain undamaged.Perform compressive strength testing on the cubes using a suitable testing machine according to the relevant standards

4.2. Adaptive Routing Using Reinforcement Learning

Q-learning algorithm: Nodes use Q-learning to dynamically adjust their routing decisions based on feedback from the network. The Q-value is updated based on the current network state (e.g. congestion, battery levels) and security state (e.g. attack detected).
State and action space: The state space represents the state of the network, and the action space consists of possible routing decisions.
Reward function: The reward function is designed to maximize secure and efficient routing, penalizing routing on compromised nodes or attacked paths.

5. SIMULATIONS AND RESLUTS

We use simulation tools like NS-3 to assess the suggested protocol's performance. Fifty mobile nodes with different network topologies and speeds make up the simulation environment.

5.1. Evaluation Metrics

The performance of the proposed protocol is evaluated based on:

Detection Rate: The proportion of attacks that were successfully identified.

False Positive Rate: The percentage of benign behavior that is mistakenly categorized as malevolent.

Packet Delivery Ratio (PDR): The proportion of successfully delivered data packets.

End-to-End Delay: The duration of a packet's journey from its origin to its final destination

Energy Consumption: The amount of energy used by nodes while the network is operating.

5.2. Results

According to the simulation results, the machine learningbased protocol performs noticeably better than conventional security measures. While the reinforcement learning-based routing offers more secure and effective routes, the anomaly detection system achieves a high detection rate with a low false positive rate.

6. CONCLUSION

Using machine learning techniques, this paper suggests a novel smart security protocol for MANETs with an emphasis on adaptive routing and anomaly detection. According to the results of our simulation, the suggested protocol efficiently reduces common security risks while maintaining optimal network performance. Future research will concentrate on enhancing the protocol's scalability even more and incorporating more machine learning models for allencompassing threat mitigation.

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