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STRENGTHENING ON KEVLAR FIBER CONCRETE WITH ROBOSANDANDTAMARIND KERNEL SHELL POWDER

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ABSTRACT

Concrete is the most widely used construction material, and its modification with sustainable and advanced materials is an area of current research. In this study, natural fine aggregate is partially replaced with Robo sand to improve workability and strength. Tamarind kernel powder is incorporated as a partial replacement of cement to explore its potential as a supplementary cementitious material. Kevlar fibers are added to concrete as reinforcement to enhance crack resistance, ductility, and toughness. Standard cubes and cylinders are prepared with these materials and cured under controlled conditions. Compressive strength tests are carried out at 7 and 28 days to evaluate load-bearing capacity. Split tensile strength tests are also conducted at the same ages to study resistance to tensile stresses. The results are compared with conventional concrete to determine improvements in mechanical properties. The study highlights the synergistic effect of Robo sand, tamarind kernel powder, and Kevlar fibers in concrete performance. Overall, the experimental work demonstrates a sustainable and high-strength concrete mix with improved durability characteristics.

***KEYWORDS*:Robos and, Tamarind kernel powder,Kevlar fiber,High strength,Compressive strength and Split tensile strength**

1. INTRODUCTION

Concrete is the most widely used construction material in the world because of its strength, durability, and versatility. It is a composite material made from cement, fine aggregate, coarse aggregate, and water. When mixed, cement reacts with water in a process called hydration, which binds the aggregates together. Concrete can be molded into any shape before setting, making it suitable for a wide range of structures. Its main advantages are high compressive strength, long service life, and resistance to weathering. However, conventional concrete production consumes large amounts of cement and natural resources. This leads to environmental issues such as CO_2 emissions and depletion of aggregates. To overcome these challenges, researchers are exploring sustainable materials to improve concrete's performance and eco-friendliness.

Robo sand, also known as manufactured sand (M-sand), is a fine aggregate obtained by crushing hard stones into sand-sized particles. It is increasingly used in concrete production as a sustainable alternative to natural river sand, which is becoming limited due to excessive mining and environmental concerns. The angular shape and uniform grading of Robo sand provide better particle interlocking, leading to improved strength and durability of concrete. Its consistent quality ensures good workability and reduces voids in the mix. By partially replacing natural sand with Robo sand, concrete not only achieves comparable or higher compressive and tensile strength but also contributes to environmental protection by minimizing riverbed degradation. Thus, Robo sand serves as a cost-effective and eco-friendly substitute for fine aggregate in modern construction practices.

Tamarind kernel powder (TKP) is a natural biopolymer obtained from the seeds of the tamarind fruit. It can be used as a partial replacement or additive in cement to improve workability and mechanical properties of concrete. TKP has the potential to enhance strength development, reduce cracks, and improve durability when used in small proportions. Being a natural and renewable material, it offers an eco-friendly alternative to chemical admixtures. Its incorporation in concrete promotes sustainable construction practices while maintaining structural performance.

Kevlar fibers are high-strength synthetic fibers used as reinforcement in concrete to enhance its mechanical properties. They help control cracking by bridging microcracks and increasing ductility and toughness. The addition of Kevlar fibers improves impact resistance, tensile strength, and durability of concrete structures. These fibers are lightweight, chemically stable, and provide long-term performance benefits. Incorporating Kevlar fibers in concrete promotes safer, more resilient, and high-performance construction.

2. OBJECTIVES

1. **To evaluate the effect of Robo sand** as a partial replacement of fine aggregate on the compressive and split tensile strength of concrete.
2. **To study the influence of Tamarind Kernel Powder (TKP)**as a partial addition to cement on the strength, durability, and crack resistance of concrete.
3. **To investigate the impact of Kevlar fibers** as an additive in concrete for enhancing ductility, toughness, and overall structural performance.

3. MATERIALS

1. Cement:-Cement is a fine binding material used in construction that sets and hardens when mixed with water.It acts as a binder to hold aggregates together in concrete or mortar.The most common type is Ordinary Portland Cement (OPC).

2. Fine Aggregate:-Fine aggregate consists of small particles of sand or crushed stone that pass through a 4.75 mm sieve.It fills the voids between coarse aggregates and improves the concrete's strength and workability.

3. Coarse Aggregate:-Coarse aggregate refers to larger particles of gravel, crushed stone, or other materials retained on a 4.75 mm sieve.They provide bulk, strength, and stability to concrete.

4.Water:- Water is an essential ingredient in concrete that reacts chemically with cement during hydration.It provides workability for mixing, placing, and compaction of concrete.Only clean, potable water free from salts, oils, and impurities is suitable for durable concrete.

5. RoboSand:-RoboSand is a manufactured sand produced by crushing stones, usually granite, to obtain sand-like particles.It is an eco-friendly alternative to natural river sand.It improves strength and reduces voids in concrete and mortar.

6. Tamarind Kernel Shell Powder (TKSP):-TKSP is a byproduct obtained from the outer shells of tamarind seeds after processing.It can be ground into fine powder and used as a supplementary material in cement or concrete.It enhances binding properties and contributes to eco-friendly construction.

4. EXPERIMENTAL RESULTS

4.1 Compressive strength:-In this test, standard concrete cubes of 150 mm × 150 mm × 150 mm are cast and cured. After 7 or 28 days of curing, the cubes are tested in a compression testing machine, where load is applied gradually until failure. The maximum load at failure is then used to determine the compressive strength.

Table 1: Compressive strength results of concrete Robo sand as partial replacement of fine aggregate.

Sl.no	% of Robosand	Compressive Strength Results, N/mm^2	
		7 days	**28 days**
1	0%	22.28	32.57
2	25%	24.21	35.13
3	50%	26.33	37.54
4	75%	24.89	35.62

Table 2: Compressive strength results of concrete addition of tamarind kernel shell powder in cement.

Sl.no	% of Tamarind Kernel Powder	Compressive Strength Results, N/mm^2	
		7 days	**28 days**
1	0%	22.28	32.57
2	0.25%	25.84	37.45
3	0.5%	30.32	42.89
4	0.75%	25.35	36.33

Table 3: Compressive strength results of concrete by addition of Kevlar fiber .

Sl.no	% of Kevlar fibers	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	22.28	32.57
2	0.5%	26.27	37.86
3	1%	28.85	40.99
4	1.5%	27.13	38.82

Table 4: Compressive strength results of Combined replacement of 50% of RS+0.5% of TKP+1% of KF in concrete.

Sl.no	50% of RS+0.5% of TKP+1% of KF	Compressive Strength Results, N/mm^2	
		7 days	28 days
1	0%	22.28	32.57
2	50% RS+0.5%TKP+1% KF	34.64	49.85

4.2 Split tensile strength :-The split tensile strength test is an indirect method used to determine the tensile resistance of concrete, as it is naturally weak in direct tension. In this test, a cylindrical specimen is placed horizontally, and a compressive load is applied along its diameter. This loading generates tensile stresses within the cylinder, leading to its splitting along the loaded diameter. The test is typically conducted after 7 and 28 days of curing to assess the cracking behavior and the development of tensile strength in concrete.

Table 5: Split tensile strength results of concrete Robos and as partial replacement of fine aggregate.

Sl.no	% of Robosand	Split tensileStrength Results, N/mm^2	
		7 days	28 days
1	0%	2.24	3.28
2	25%	2.41	3.47
3	50%	2.58	3.75
4	75%	2.46	3.53

Table 6: Split tensile strength results of concrete addition of tamarind kernel shell powder in cement.

Sl.no	% of Tamarind Kernel Powder	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	2.24	3.28
2	0.25%	2.56	3.71
3	0.5%	3.07	4.33
4	0.75%	2.48	3.59

Table 7: Split tensile strength results of concrete by addition of Kevlar fiber .

Sl.no	% of Kevlar fibers	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	2.24	3.28
2	0.5%	2.52	3.73
3	1%	2.97	4.22
4	1.5%	2.63	3.84

Table 8: Split tensile strength results of Combined replacement of 50% of RS+0.5% of TKP+1% of KF in concrete.

Sl.no	50% of RS+0.5% of TKP+1% of KF	Split tensile Strength Results, N/mm^2	
		7 days	28 days
1	0%	2.24	3.28
2	50% RS+0.5%TKP+1% KF	3.57	5.01

5. CONCLUSION

1. The normal concrete without any replacement achieved a compressive strength of **22.28 N/mm^2 at 7 days**and**32.57 N/mm^2 at 28 days.**
2. The use of **robosand as a partial replacement of fineaggregate** showed the optimum strength at **50% replacement**, reaches 26.33**N/mm^2 at 7 days**and **37.54 N/mm^2 at 28 days.**
3. The addition of **tamarind kernel shell powder** showed maximum improvement at0.5% addition achieving 30.32**N/mm^2 at 7 days** and **42.89 N/mm^2 at 28 days**.
4. The addition of **Kevlar fibers** showed maximum improvement at **1% addition**, achieving 28.85 **N/mm^2 at 7 days** and**40.99 N/mm^2 at 28 days.**
5. The **combined replacement of** 50% RS+0.5%TKP+1% KFgave the highest strength, reaching 34.64**N/mm^2 at 7 days**and 49.85 **N/mm^2 at 28 days**, which is significantly higher than normal concrete.

6. The normal concrete without any replacement achieved a split tensile strength of 2.24**N/mm² at 7 days**and**3.28 N/mm² at 28 days.**
7. The use of **robosand as a partial replacement of fineaggregate** showed the optimum strength at **50% replacement**, reaches 2.58**N/mm² at 7 days**and **3.75 N/mm² at 28 days.**
8. The addition of **tamarind kernel shell powder** showed maximum improvement at 0.5% addition achieving 3.07**N/mm² at 7 days** and 4.33 **N/mm² at 28 days**.
9. The addition of **Kevlar fibers** showed maximum improvement at **1% addition**, achieving 2.97**N/mm² at 7 days** and**4.22 N/mm² at 28 days.**
10. The **combined replacement of** 50% RS+0.5%TKP+1% KFgave the highest strength, reaching 3.57 **N/mm² at 7 days**and 5.01 **N/mm² at 28 days**, which is significantly higher than normal concrete.

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